PART 1

THE TRANSPUTER FAMILY

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Transputer Family Strategy

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Transputer 5 Point Strategy

1. Low Cost - T400 and plastic packaging
2. Next Generations - Hxx and Exx
3. Enhance / Customize - ASIC Macrocells
4. Target Growth Markets - S/W and H/W
5. iq systems for prototyping and OEM

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INMOS Product Family

SRAMs
Broad range of fast static RAMs. 4K to 256K, x1 to x8, 15 to 70ns. 1 & 4M planned.

Transputer
Family of 16 and 32 bit microprocessors for fast, powerful multi processing

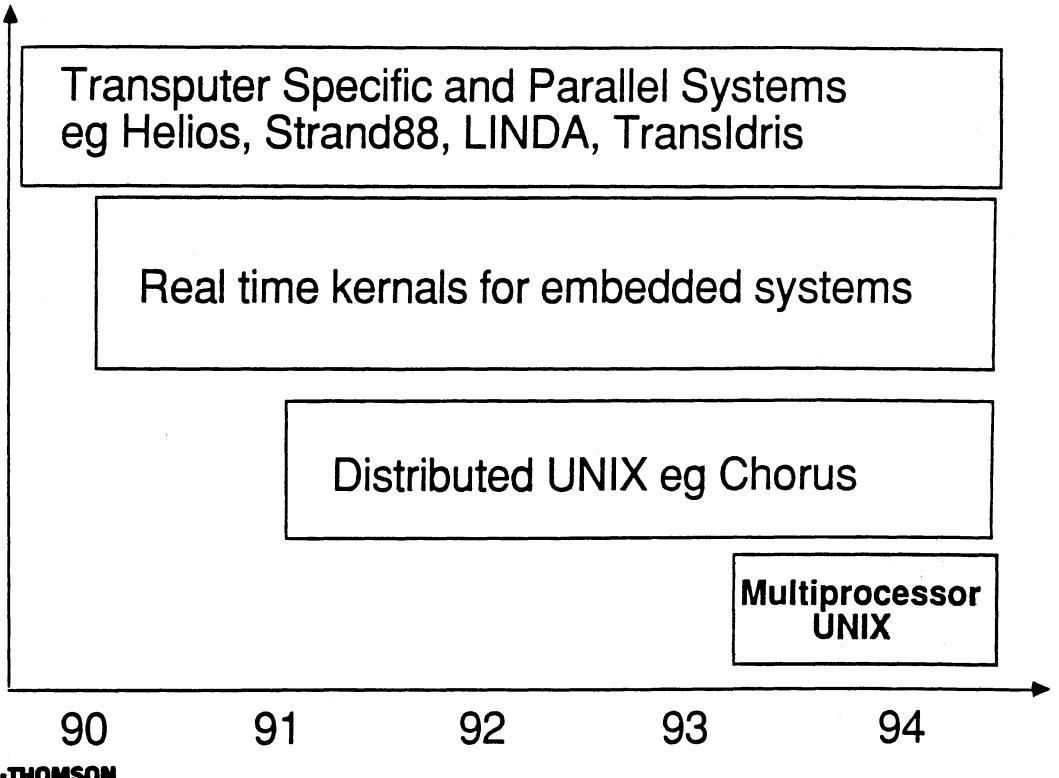
iq systems
A family of modular board level products and application software.

Graphics
Colour Look Up Tables - PC standard. High performance Colour Video Controllers

Low Cost Transputers

- T400 - Introduced at *2$ per MIPS* Sept 89.
- T400 makes 32 bit processors and multiprocessing cost effective for volume production.
- Low cost surface mount packaging.
  PQFP for Japan and PLCC options.
- T400 designed to be the first ASIC core

Operating Systems



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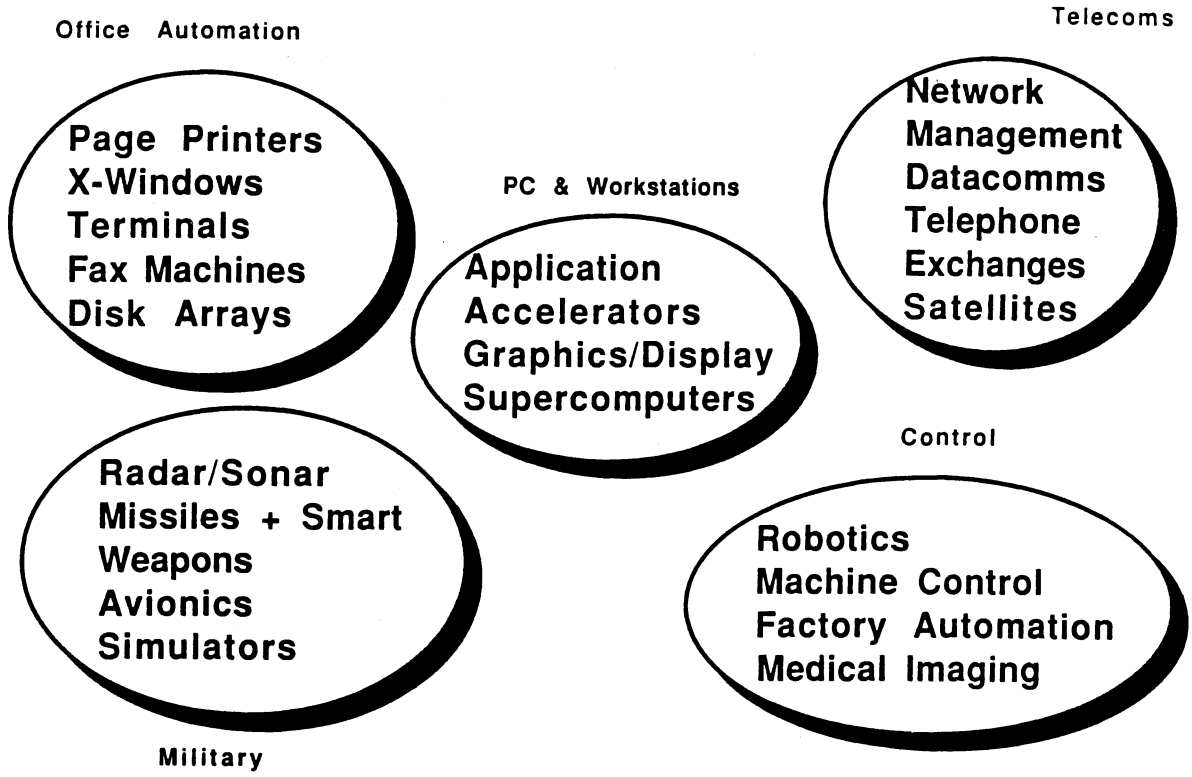
Transputer Target Applications



GPS (Global Positioning by Satellite)

Emerging Market.

Worldwide TAM growing to 500ku by 1995

Could be 1.5Mu if adopted in cars.

Satellites available and costs decreasing.

Transputer solution eliminates need for dedicated DSP hardware. Minimizes time to market

INMOS have complete system solution with h/w and licensable s/w.

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X- Terminals

Market projected to grow from 200ku to 1Mu in 1993

Application requires high performance for Networks, X-Protocol, and graphics

Primary target is upgrade of VT100.

Transputers meet X-Terminal model of communicating sequential processes.

Transputers offer scaleable performance for range of low to high end terminals.

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Disk Arrays

Problems with single drives :
- Transfer speed, Capacity, Access time, Fault tolerance

Applications in servers, networks and fault tolerant systems

Transputers have high comms b/width with low overheads

Transputers can offer intelligence for backups, and file searches

SCSI software and hardware solution available today.

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Office Automation - Page Printers

- Fastest growth application for for 32 bit uP's.
  32 bit TAM = 140Ku 1988 ⟶ 4.8Mu in 1993. (x30)
- Transition from 300 DPI mono to 600 DPI full colour.
  Full colour requires large memory capacity.
  over 80% of system cost.
- Transputers offer scalable performance. Software available to support transputer.
- Communications and multiprocessing support banded postscript architecture for future development.

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Transputer

Customer Support

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TRANSPUTER CUSTOMER SUPPORT

- RTC's - 50 PEOPLE

- 49 W/W SGS-THOMSON SALES OFFICES
- OVER 50 DISTRIBUTORS
- 13 CENTRES

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Software - Support Network

1 Inmos Business Centres

Field Application Engineers (FAEs).
Day to day enquiries.

2 Regional Transputer Centres

Regional Transputer Engineers.
Customer related projects, benchmarks etc.

3 Software Support

Central Technology Group.
Guaranteed turnarounds.
New releases, bug fixes.
Direct line to software developers.
Electronic mail support.

4 Distributor Support

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User's Groups

- Over 5000 members worldwide
- Includes both academic and industrial subscribers
- Forum for the interchange of information among existing and prospective users of INMOS products
- Groups established in Europe, North America, Australasia and Japan
- Newsletter and Technical papers published
- Conferences held twice yearly
- First Worldwide Meeting - California, April 1991

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Literature Available

- Glossy Brochures
- Product Flyers
- Transputer Databooks
- Transputer Applications Notes

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Transputer

The Concept

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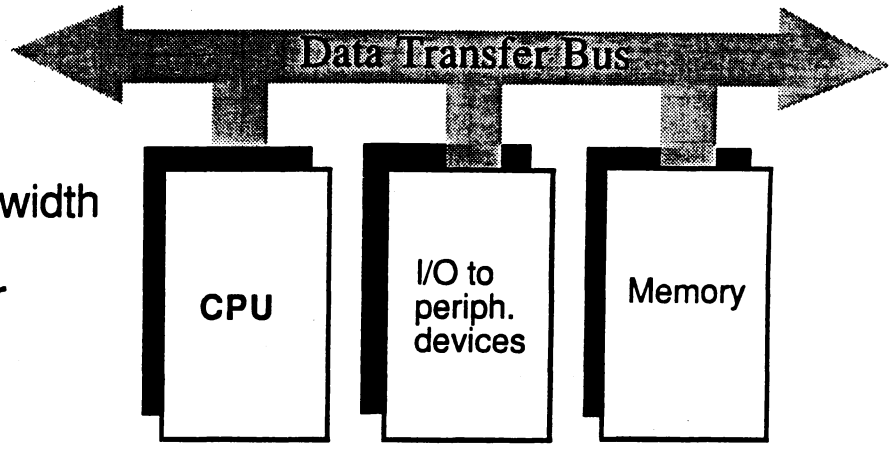
Traditional MICROPROCESSOR Architecture



Fixed Bus Bandwidth

Fixed Processor Bandwidth

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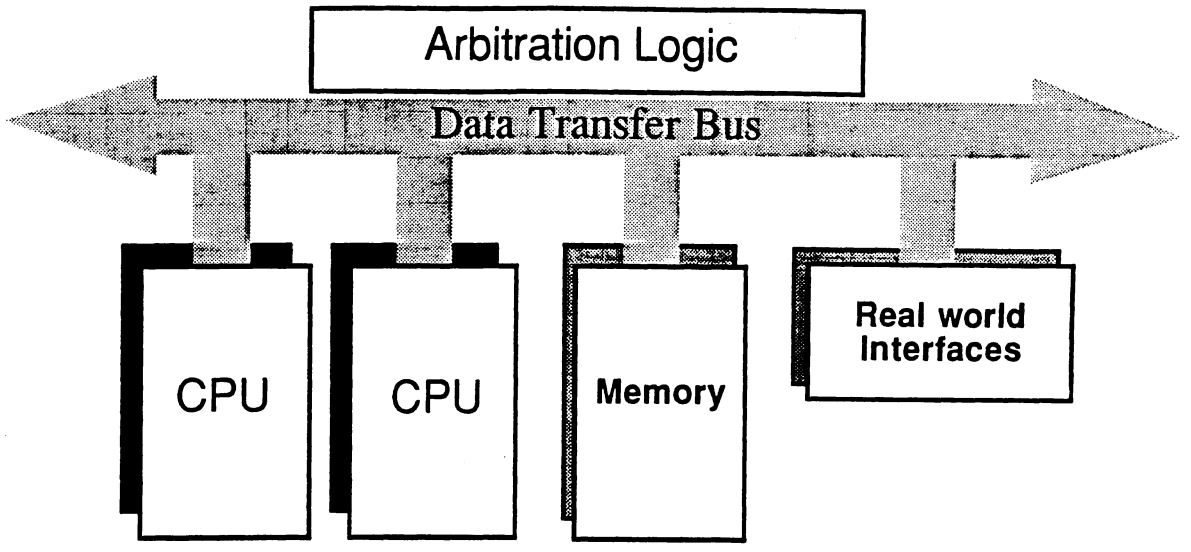
Traditional Multiprocessor Architecture - 1



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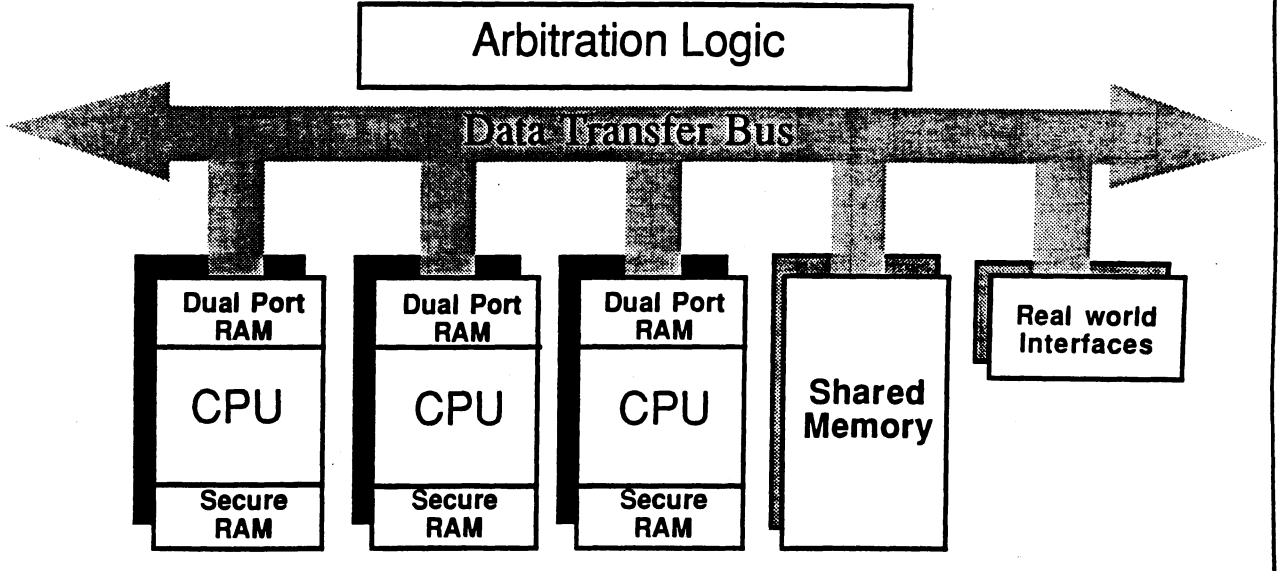
Traditional Multiprocessor Architecture - 2



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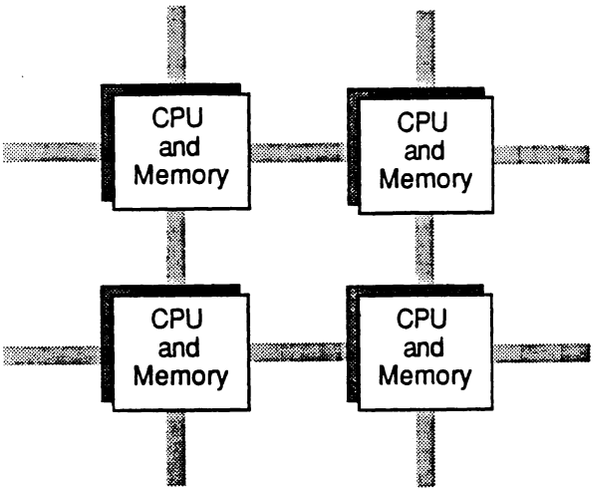
The Transputer



More Processor Bandwidth

More Comms Bandwidth

No arbitration Software

No arbitration Hardware

Transfer supported by CPU

Multiprocessing Made Simple !

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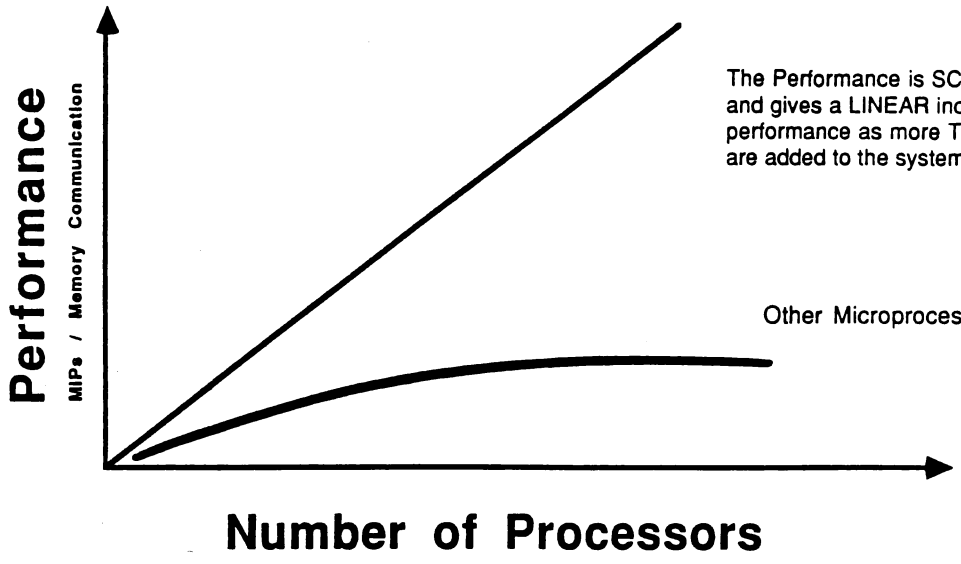
Scalable Performance

10 transputers - 10 X Performance !



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Generic Transputer

Fast CPU - best of RISC and CISC !

Fast On-Board Memory

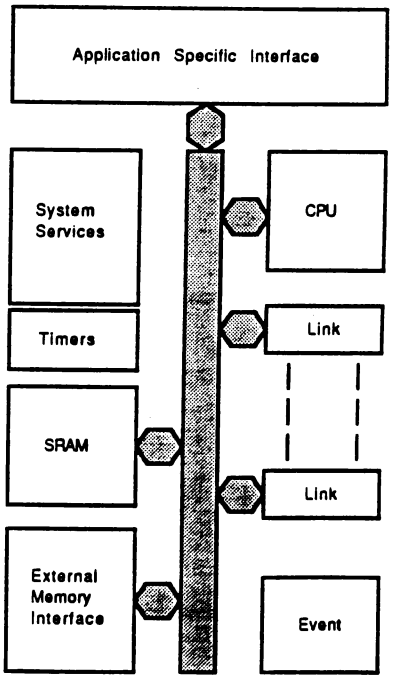
Hardware Support for concurrency

High speed Serial Links support multiprocessor operation

Virtual Timers

Minimum External Support circuitry

Simple System Engineering



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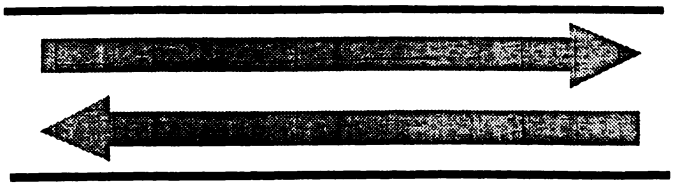
Serial Link



- Means of Interconnection between transputers.
- Bidirectional.
- Point-to-point.
- Speed Options : 5, 10, 20 Mbits/s.
- Can function independantly of CPU.

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The Channel Concept

A Channel is :

Point to point	Communication is from one process to another
One Way	Use two channels for bi-directional transfer
Unbuffered	Data is copied direct from one process to another
Synchronised	Data is copied when both sender and receiver are ready

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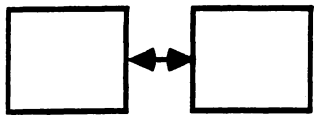
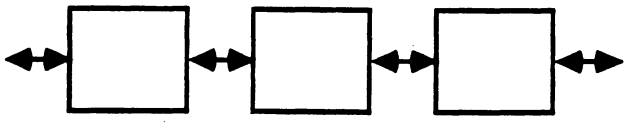
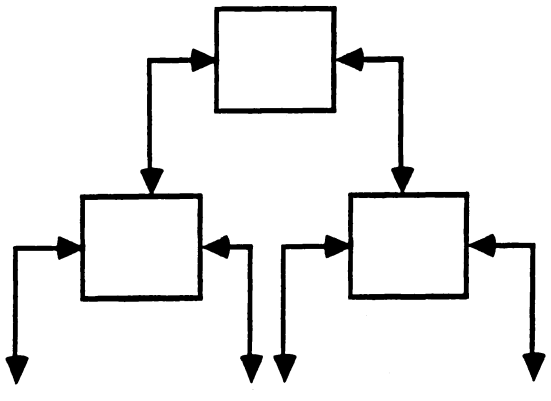
Connectivity



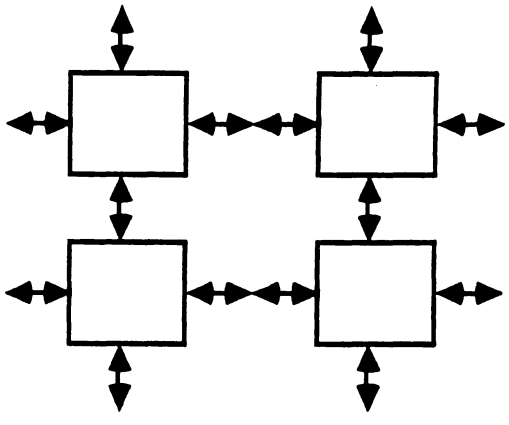
One link connects two transputers



Two links allow pipelines



Three links for tree structures



Four links for square arrays

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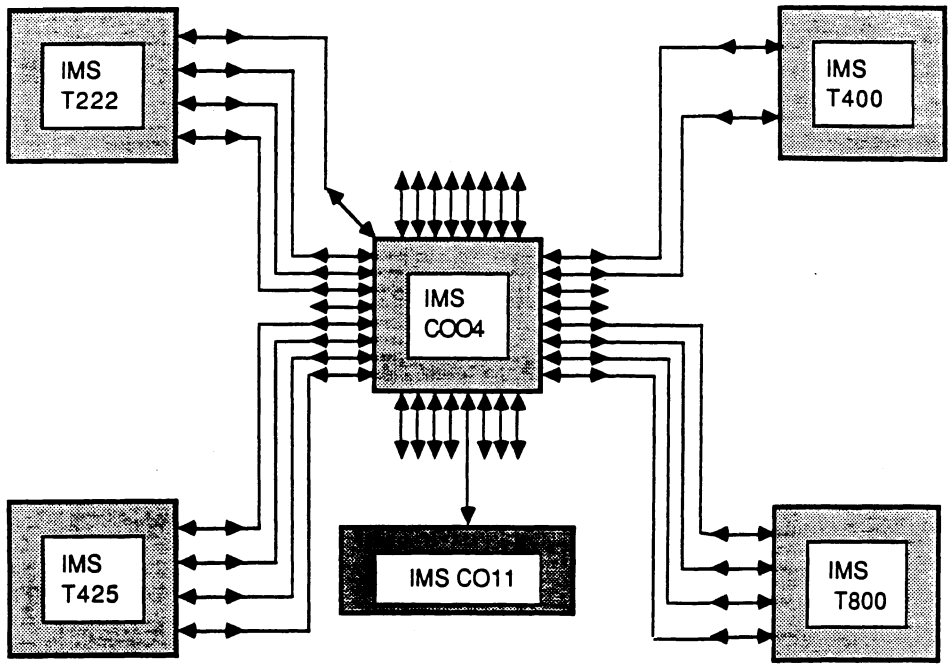
IMS COO4 Link Switch



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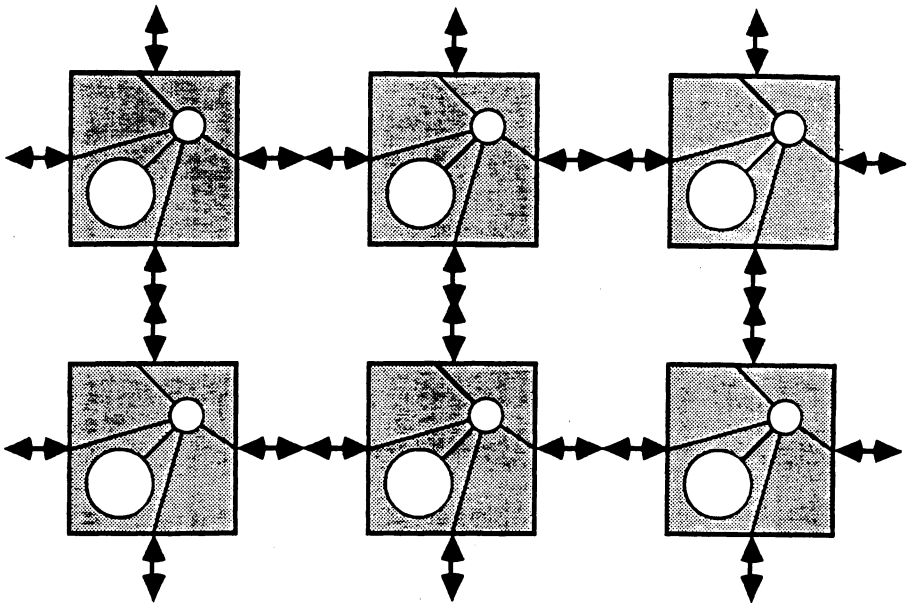
Multi-transputer Communication



Computation and Communication run in parallel

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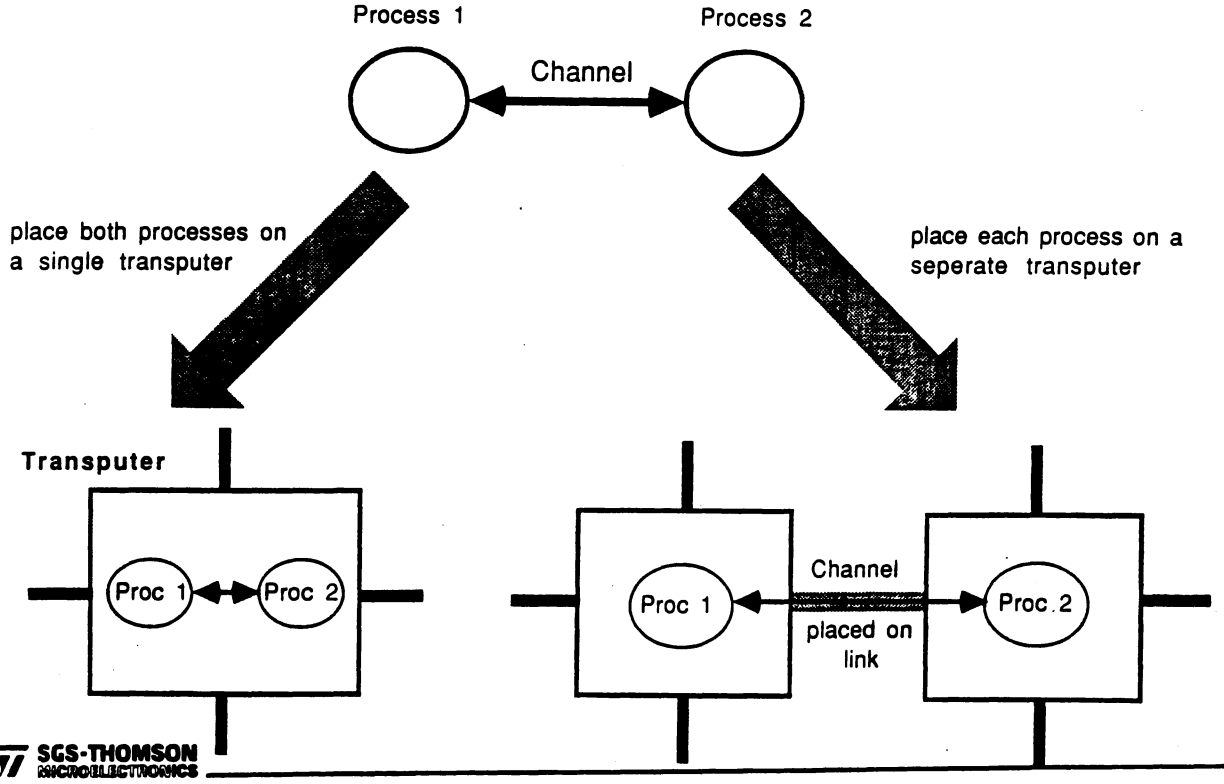
Multiprocessing



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Concurrent Processes

- Run simultaneously
- Asynchronous
- Completely Independant
- Local Data Storage
- No shared variables
- Data Communicated via channels

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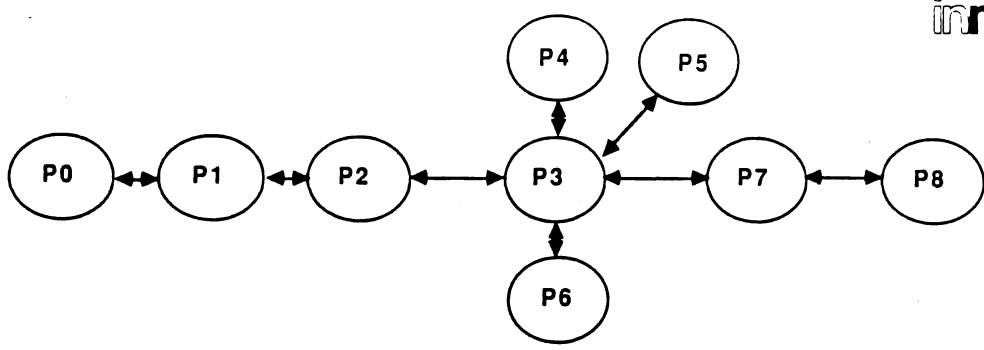
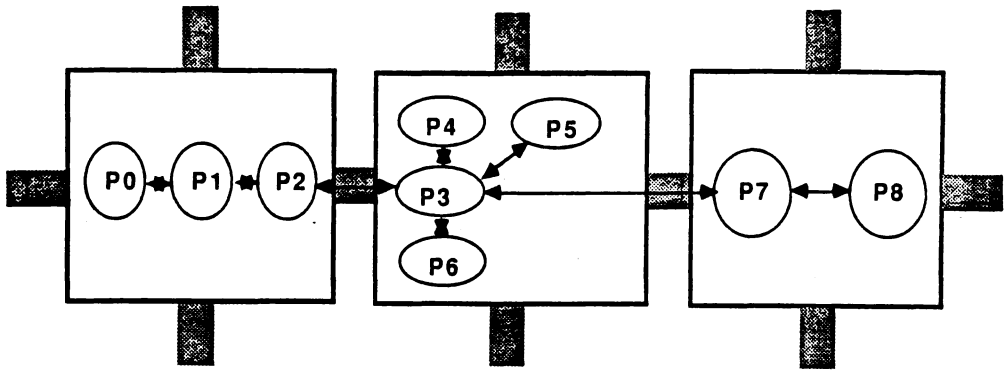


Could be Mapped as :



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The Transputer

Unique Architecture

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Generic Transputer

Fast CPU - best of RISC and CISC !

Fast On-Board Memory

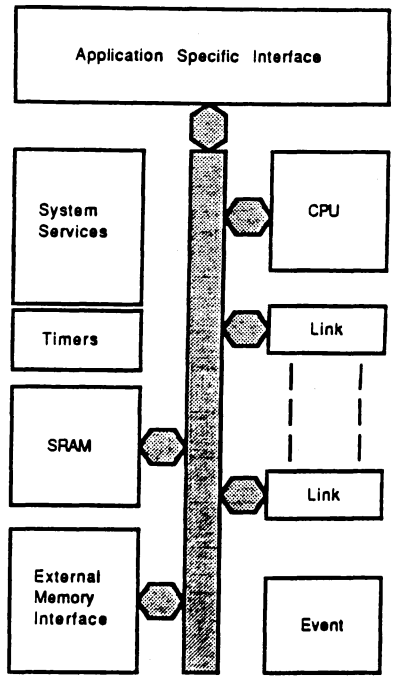
Hardware Support for concurrency

High speed Serial Links support multiprocessor operation

Virtual Timers

Minimum External Support circuitry

Simple System Engineering



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Fast CPU

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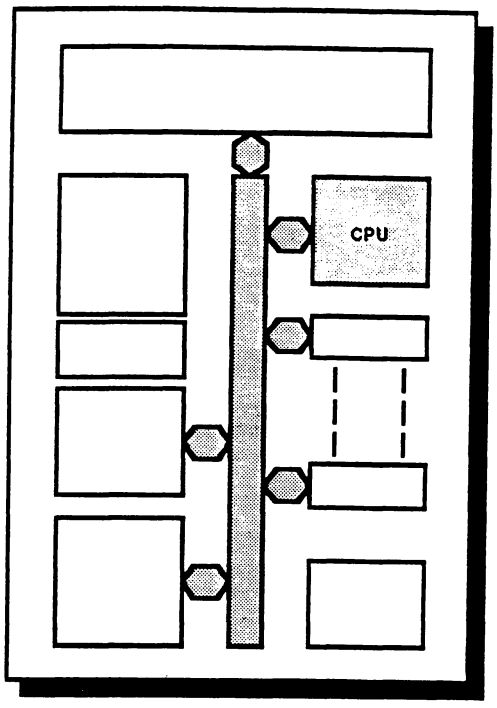

32 bit processor.
30 MIPs peak performance.

16 byte sized direct functions.
145 microcoded instructions.

Processor initiates link transfers and FPU operations.

Sub microsecond process switch.
Instruction prefetch.

The best of RISC and CISC architectures !

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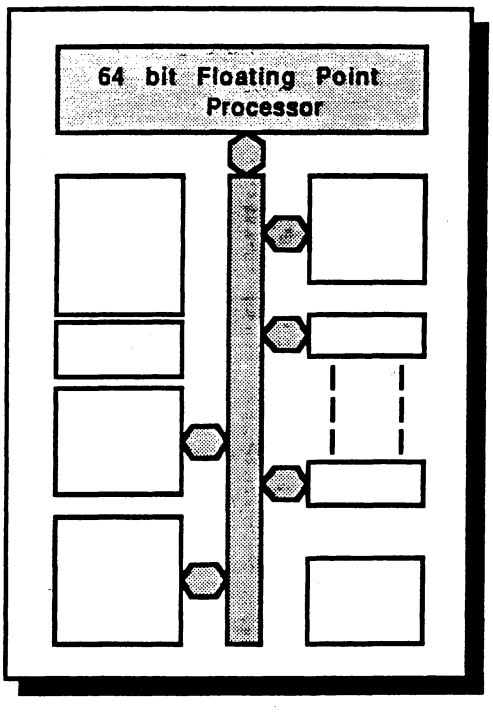
Floating Point Unit



64 bit on-chip FPU

ANSI-IEEE 754-1985 representation.

Sustained 2.25 MFLOPS (30 MHz).

Overlaps with integer operations.

6.9M Whetstones/s
(single length @ 30 MHz)

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On-Chip RAM

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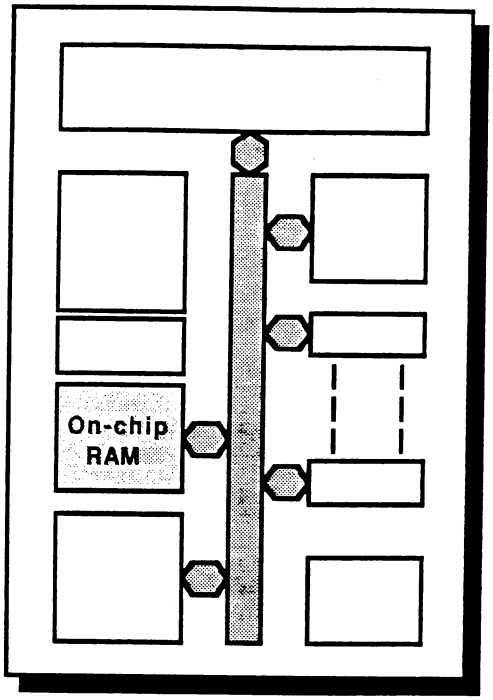

2 or 4 Kbytes of on-chip RAM.

Single-cycle word access.

120 MBytes/sec bandwidth (30MHz).

Forms base of linear address space.

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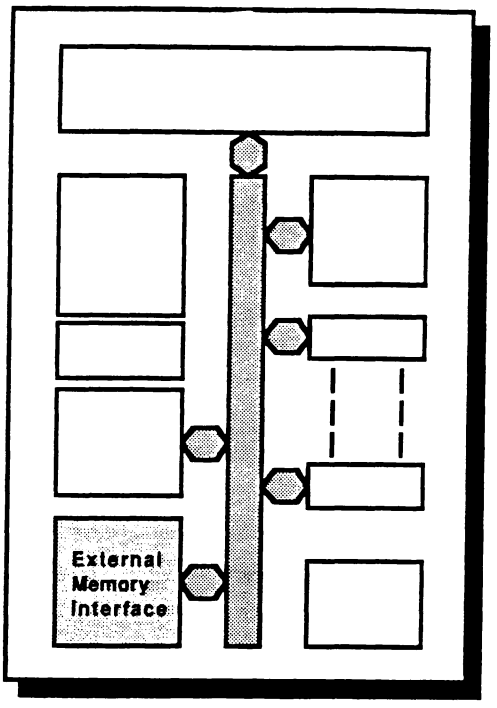
External Memory Interface



Programmable Memory Controller.

32-bit multiplexed address/data bus or

32-bit non multiplexed address and data buses.

Programmable timing and strobes.

Configurable refresh.

Support for mixed memory systems.

Support for external DRAM

4 Gbyte address space - 32 bit parts

64 Kbyte address space - 16 bit parts

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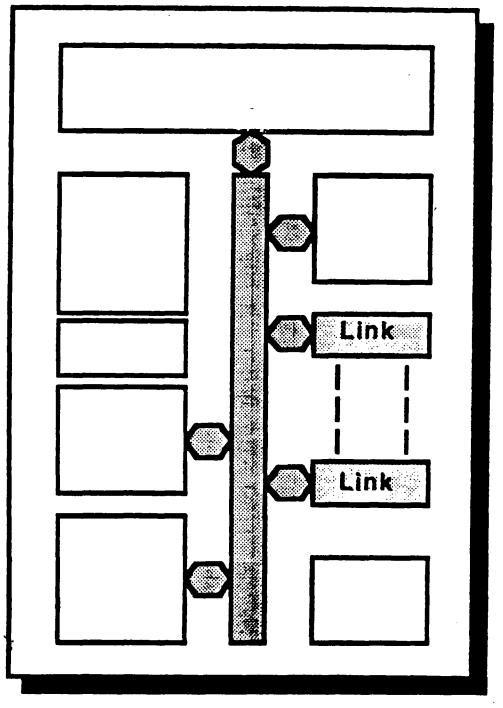
Serial Links



Bi-directional asynchronous communications.

Automatic acknowledgements per byte.

1.7 Mbytes/s uni-directional data transfer,

2.3 Mbytes/s bi-directional data transfer.
(For 1 link @ 20 Mbits)

All link transfers and computation can overlap.

Processor can bootstrap from any link.

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Interrupts / Events

- Unique architecture simplifies Interrupt handling
- Simple 2 levels of priority (high and low)
- Very fast Interrupt response time - sub microsecond
- Incoming Interrupt is assigned to a process queue

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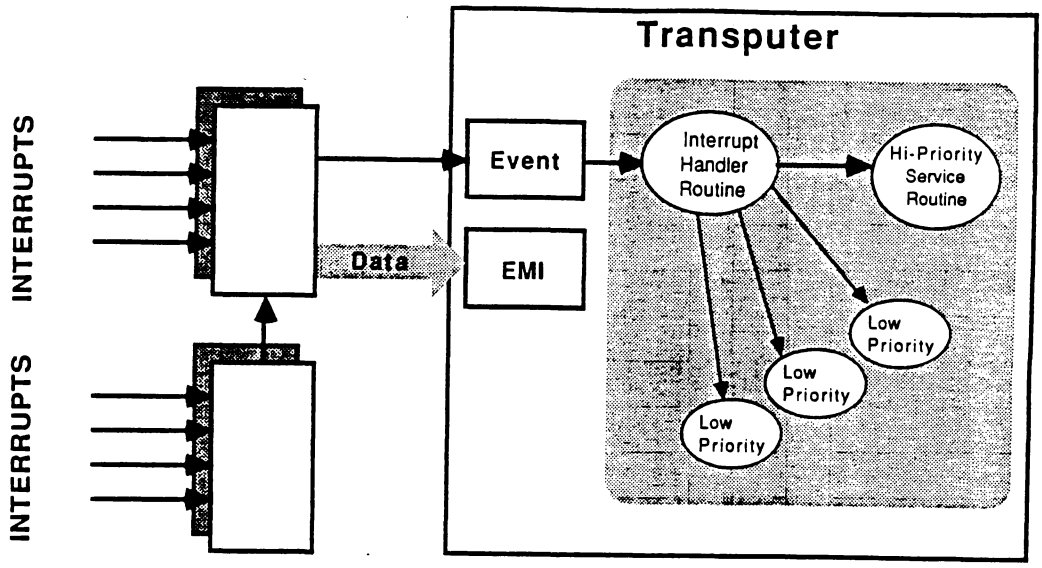
Interrupt Handling



Interrupt Handler
eg. Intel 8259A

Interrupt Handler Routine assigns priority to incoming interrupts

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Low System Cost

- Low Pin Count 84/100 pin
- Single 5 MHz Clock input.
- Low Power Consumption - under 1 Watt
- On chip EMI - minimises external glue logic
- Two timers
- Interrupt Pin

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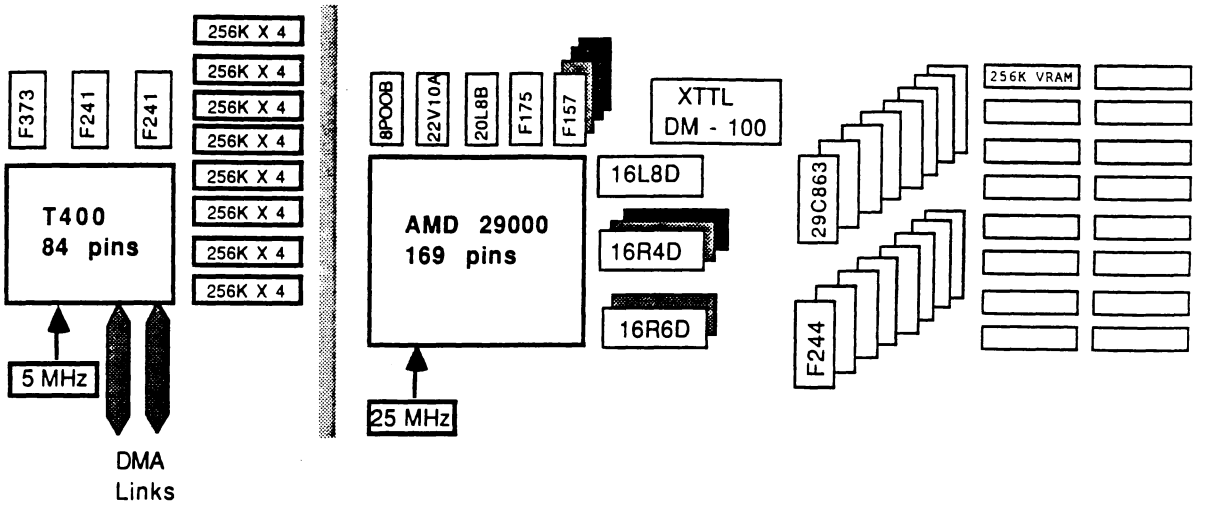
T400 System Cost Comparison



10 MIPS, 1 Mbyte, 4.7 Mbyte/sec I/O	11.5 MIPS, 512KByte VRAM, NO I/O
12 Components	48 Components
Power < 5 Watts	Power > 25 Watts
System Cost ratio - 1	System Cost Ratio - 5

Source: AMD - AMD 29000 Memory Design H/book

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Transputer

Development Made Simple

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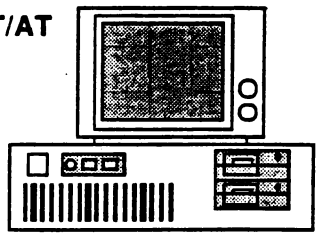
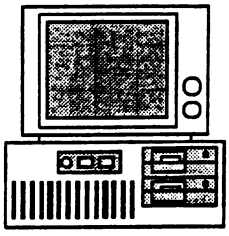
INMOS Development Hosts

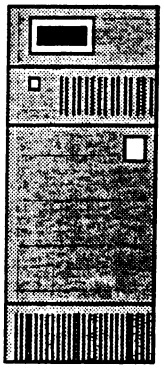
IBM XT/AT
PS2



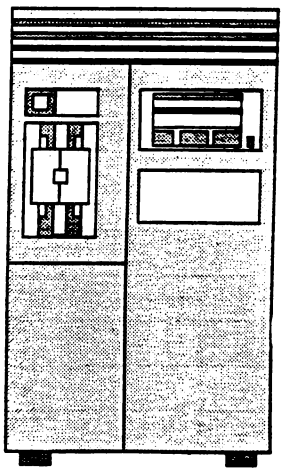
NEC
PC



Sun 3
Sun 4
Sun 386i



MicroVAX



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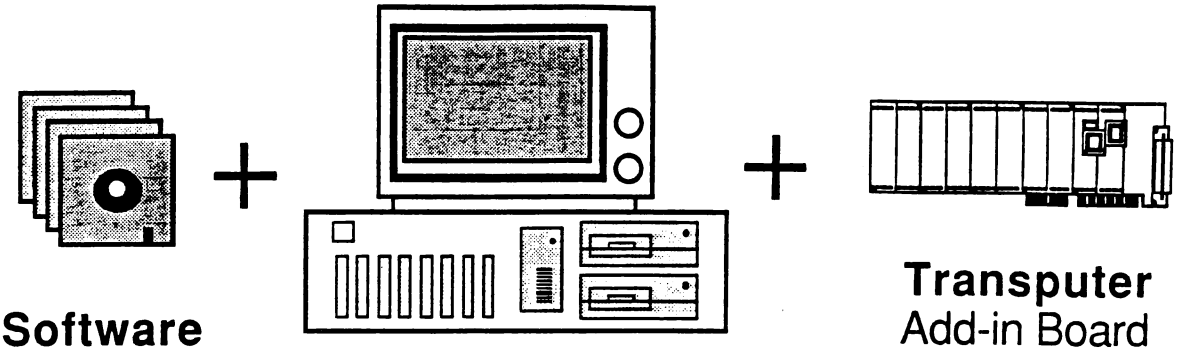
PC Development Made Simple



Software

C, Fortran
Pascal Ada
and occam

Host System
eg IBM PC, NEC PC,

Transputer
Add-in Board

* INMOS supports all common languages + Parallel Processing
  - Customer can use existing software

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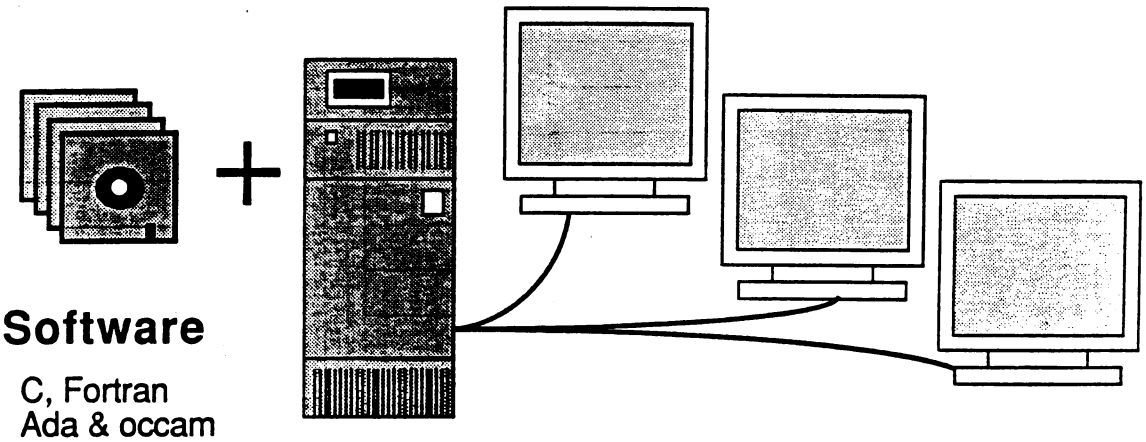
SUN Development Made Simple



Software

C, Fortran
Ada & occam

Sun 3 workstation
VME motherboard
IMS BO14/BO16

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Software Product Range

	SUN 3	SUN 4	VAX	IBM PS2/PC XT 386 i	NEC
occam Toolset	D505	D405	D605	D705	D705
C Compiler	D511		D611	D711	D711
C Toolset	D5214	D4214	D6214	D7214	D7214
Fortran	D513	D413	D613	D713	D713
Pascal				D712	D712

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Transputer Toolsets

- Tools invoked from O/S command line (PC, SUN, VAX)
- Supports multi-user / multi-language development
- Interactive symbolic debugging (with Breakpoints)
- Post Mortem symbolic debugging
- Simulator
- Support for assembly language inserts
- Support for EPROM programming

INMOS Parallel Compilers

Compilers for occam, C and FORTRAN.

Validated - eg C Plum Hall suites.

Library support for parallelism

Optimizations - eg workspace allocation, dead code, instruction scheduling, constant folding.

Full ANSI C

Faster compilation and execution

inmos

occam

- Designed to reflect transputer architecture.
- occam model consists of parallel processes communicating through channels.
- Channels allow data transfer between processes.
- Each process can be comprised of a set of processes.
- Other languages can be integrated by simply making them appear to be occam processes

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INMOS Parallel Fortran

- Implements Fortran77, ANSI Std X3.9-1978 .
- Supports concurrent tasks.
- Ability to allocate stack in on-chip RAM.
- Available for SUN, VAX and PC.
- Configurers provided for multi-transputer development.
- Can be used standalone or with Toolset for mixed language support.

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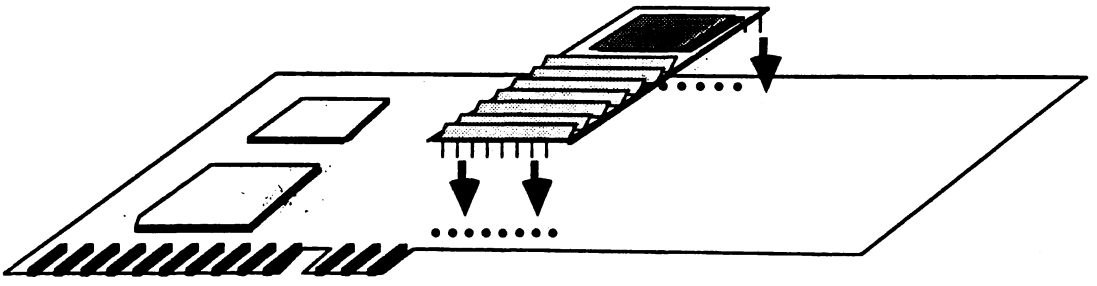
Mothercards



- **IBM PC XT/AT**
- **VME**
- **PS2**
- **Double Eurocard**
- **NEC PC**
- **Third Party Products support other Hosts**

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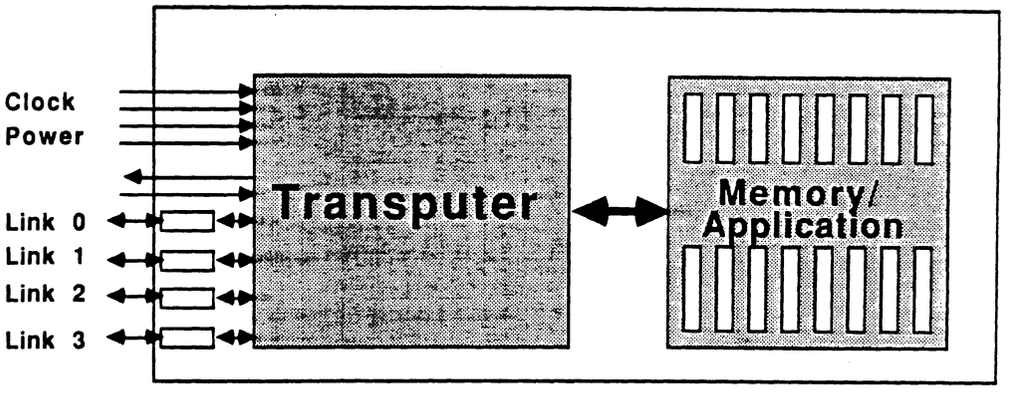
Unique Modular Hardware



A Transputer Module (TRAM)

* TRAMs can be used to build prototype systems

* INMOS/Third Party - Wide range of products

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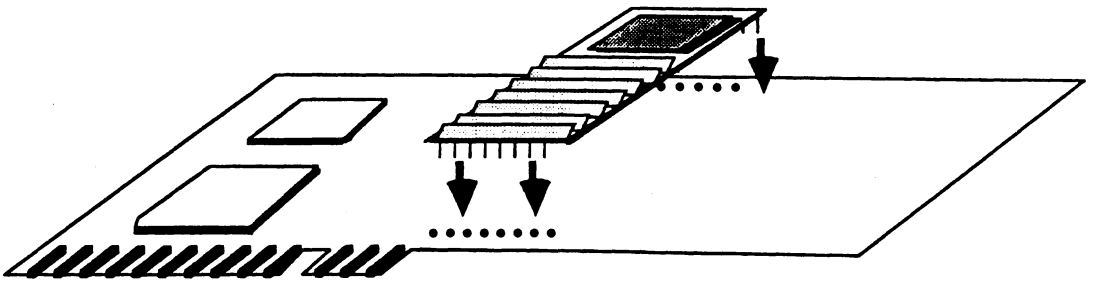
Transputer Introduction Kits



Includes :

IMS B008 IBM Motherboard
IMS B404 T800 TRAM with 2 Mbytes DRAM
Choice of Development Software

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The Transputer
Products

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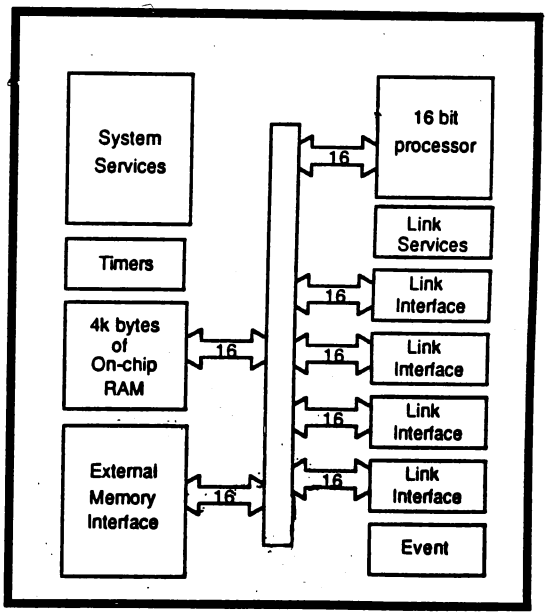
IMST225 transputer

- 16 bit architecture
- 30 MIPS (peak)
- 630 ns interrupt response
- 4 Kbytes on-chip SRAM
- 4 high speed serial links (5/10/20 Mbits/sec)
- 20, 25 and 30 MHz
- 68 pin PLCC, PGA and 100 PQFP packages



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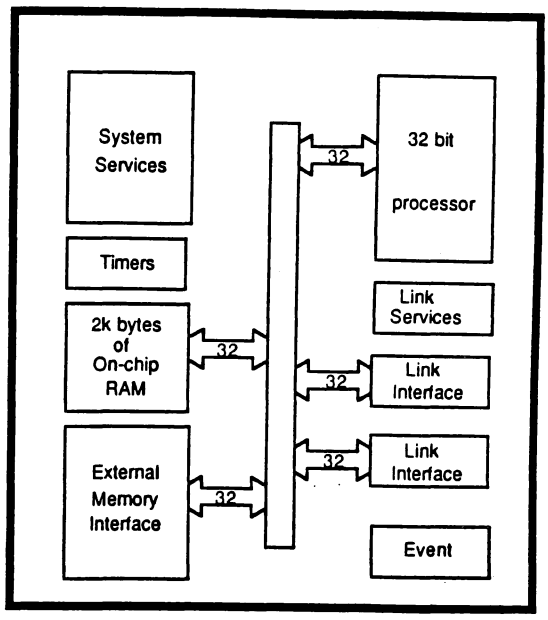
IMST400 - Low cost transputer - $2/MIPS

- 32 bit architecture
- 20 MIPS (peak) 10 MIPS (sustained)
- 950 ns interrupt response
- 2 Kbytes on-chip SRAM
- 2 high speed serial links (5/10/20 Mbits/sec)
- 20 MHz single speed option
- 84 pin PGA, PLCC and 100 pin QFP



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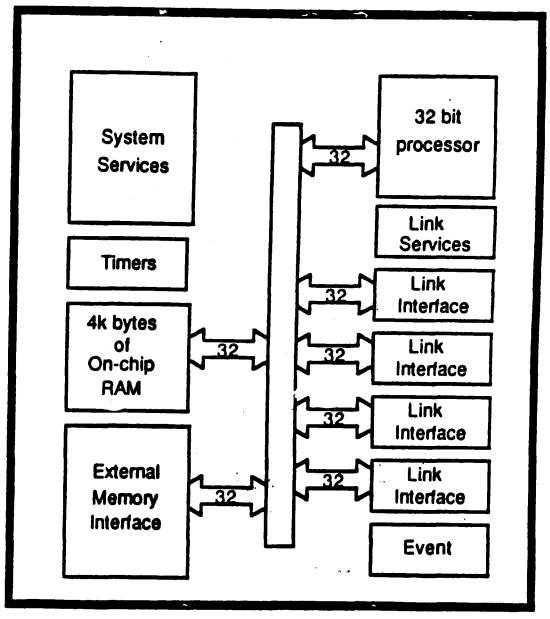
IMST425 transputer

- 32 bit architecture
- 30 MIPS (peak)
- 630 ns interrupt response
- 4 Kbytes on-chip SRAM
- 4 high speed serial links (5/10/20 Mbits/sec)
- 20 , 25 and 30 MHz
- 84 pin PLCC , PGA and 100 PQFP packages



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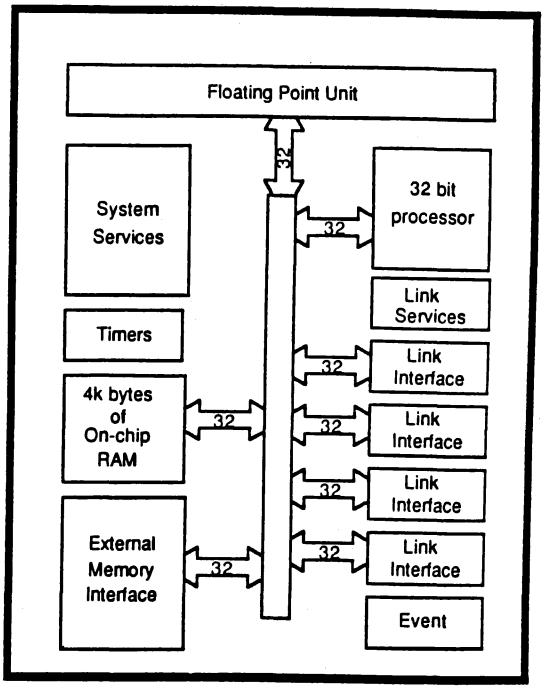
IMST805 transputer

- 32 bit architecture
- 30 MIPS (peak)
- On-chip IEEE 754 FPU
- 4.3 Mflops (peak)
- 630 ns interrupt response
- 4 Kbytes on-chip SRAM
- 4 high speed serial links (5/10/20 Mbits/sec)
- 20 , 25 and 30 MHz
- 84 pin PGA,PLCC and 100 PQFP packages



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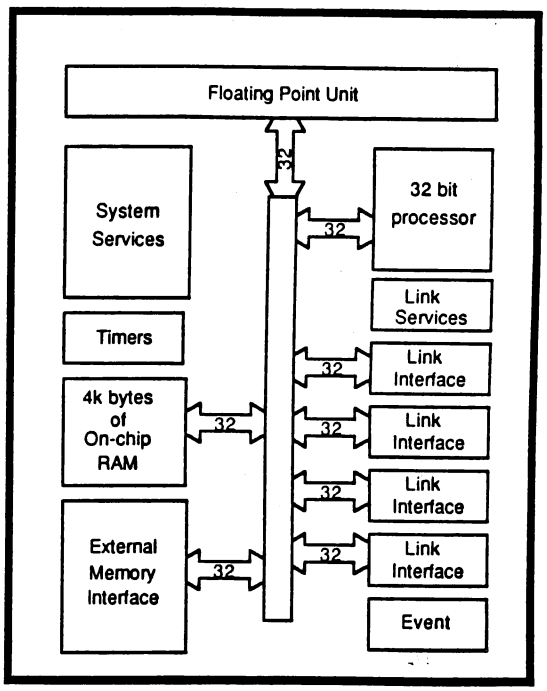
IMST801 transputer

- 32 bit architecture
- 30 MIPS (peak)
- On-chip IEEE 754 FPU
- 4.3 Mflops (peak)
- 630 ns interrupt response
- De-mulitplexed address and data bus
- 60 Mbytes/sec data rate to external memory
- 4 Kbytes on-chip SRAM
- 4 high speed serial links (5/10/20 Mbits/sec)
- 20 , 25 and 30 MHz
- 100 pin PGA package.



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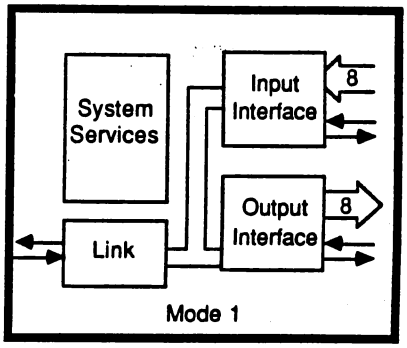
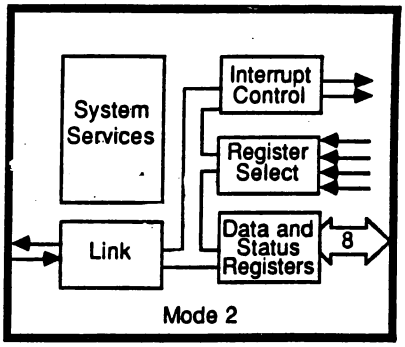
IMS C011 link adaptor

- Standard INMOS link protocol
- 5,10 or 20 Mbits/sec operating speed
- Communicates with INMOS transputers
- Converts between serial link and parallel bus.
- Mode 1: 8-bit peripheral interface.
- Mode 2: 8-bit bus interface.





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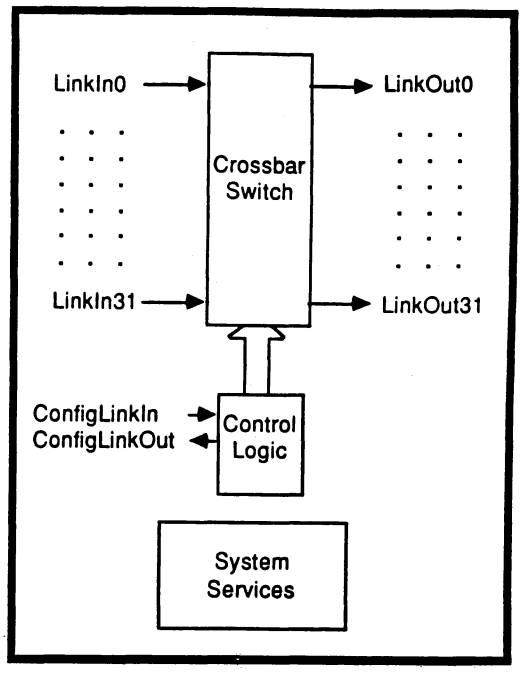
IMS C004 programmable link switch

- Standard INMOS serial links
- 32 way crossbar switch
- Cascadable
- 10 or 20 Mbits/sec
- 84 pin PGA package



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16 Bit Transputer Family

Family	Part No.	Serial Links	Speed (MHz)	On Chip SRAM	Package
T2 16 Bit CPU	T222-17S	4	17.5	4k	68 PGA/PLCC
	T222-20S	4	20.0	4k	68 PGA/PLCC
	T225-17S	4	17.5	4k	68 PGA/PLCC
	T225-20S	4	20.0	4k	& 100 PQFP
	T225-25S	4	25.0	4k	68 PGA
	T225-30S	4	30.0	4k	68 PGA
All parts have 64k byte Non -Multiplexed 2 Cycle External Memory Interface and 2 on-chip timers.					

Use T225 for new designs

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32 Bit Transputer Family

Family	Part No.	Serial Links	Speed (MHz)	On Chip SRAM	Package
T4 32 Bit CPU	T400-20S	2	20.0	2k	84 PGA/PLCC & 100 PQFP
	T425-17S	4	17.5	4k	84 PGA/PLCC
	T425-20S	4	20.0	4k	& 100 PQFP
	T425-25S	4	25.0	4k	
	T425-30S	4	30.0	4k	84 PGA
All parts have 4G byte Multiplexed External Memory Interface and 2 on-chip timers.					

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32 Bit Transputer Family with Floating Point Unit

Family	Part No.	Serial Links	Speed (MHz)	On Chip SRAM	Package
T8 32 Bit CPU + on chip FPU	T801-20S	4	20.0	4k	100 PGA
	T801-25S	4	25.0	4k	
	T801-30S	4	30.0	4k	
	T805-17S	4	17.5	4k	84 PGA/PLCC & 100 PQFP
	T805-20S	4	20.0	4k	
	T805-25S	4	25.0	4k	
	T805-30S	4	30.0	4k	84 PGA
T805 has 4G byte Multiplexed External Memory Bus and T801 has 4G Non-Multiplexed Bus. All parts have 2 on-chip timers.					

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Transputer Family

Communications Peripherals

Part Number	Speed Mbits/sec	Package	Comments
IMS C004	5/10/20	84 PGA/QFP	32 way crossbar switch
IMS C011-20S	5/10/20	28 DIP 28 SOJ	Link to parallel interface. Mode1: 8 bit parallel interface. Mode2: bidirectional 8 bit bus.
IMSC012-20S	5/10/20	24 DIP	C011 mode2 only

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Transputer Family

Military Qualified MIL STD 883C

Family	Part Number	Speed (MHz)	SRAM	Package
T2 16 Bit CPU	T222-17M	17	4k	68 PGA
T4 32 Bit CPU	T425-17M	17	4k	84 PGA
T8 32 Bit CPU+FPU	T800-17M	17	4k	84 PGA/QCP
Periphirals	C011-20M	10/20		28 Cer. DIP
	C004-20M	10/20		84 PGA/QCP

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Transputer Family
Military Qualified MIL STD 883C

Family	Part Number	Speed (MHz)	SRAM	Package
T2 16 Bit CPU	T225-20M	20	4k	68 PGA / 100 CQFP
T4 32 Bit CPU	T425-20M	20	4k	84 PGA / 100 CQFP
T8 32 Bit CPU+FPU	T805-20M	20	4k	84 PGA / 100 CQFP
	T801-20M	20	4k	100 PGA
Periphirals	C011-20M	10/20		28 DIP / LCCC
	C004-20M	10/20		84 PGA / 100 PQFP

Planned Products

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Transputer

Who's Using it ?

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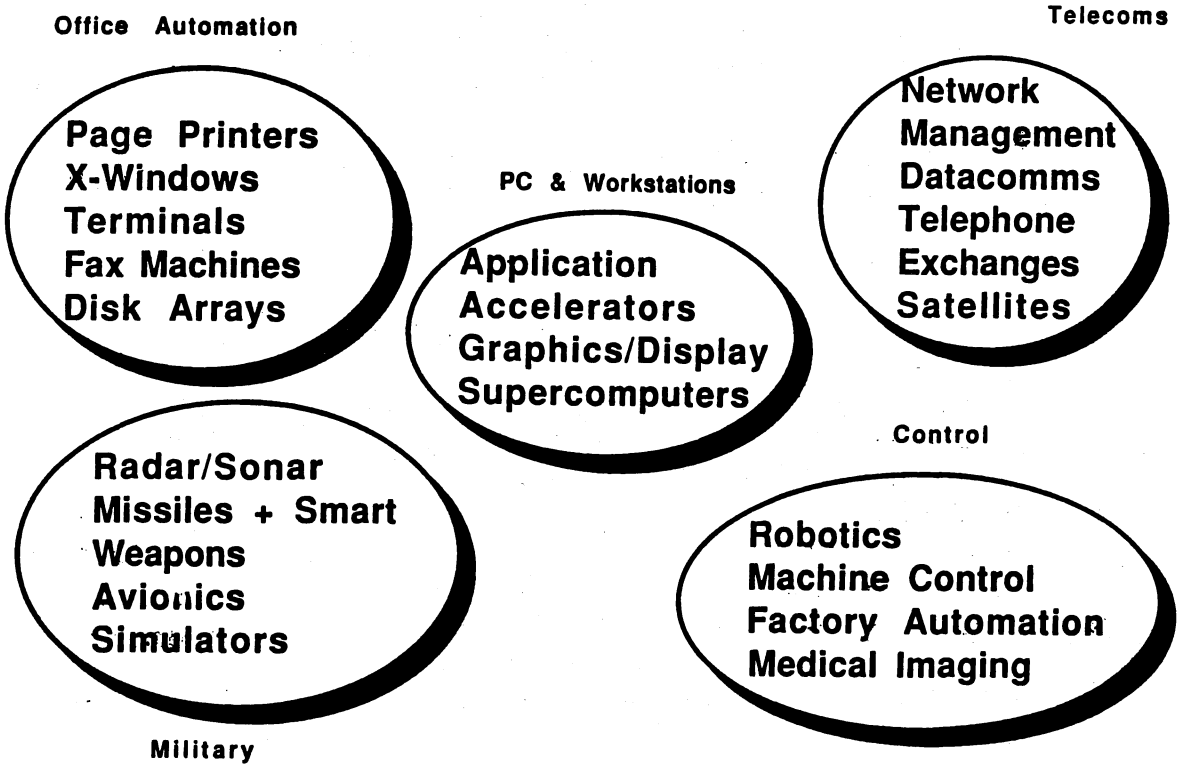
Transputer Target Applications



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Transputer Applications

Kobe Steel

- Location: Japan
- Application: Graphics add-in card for NEC PC.
- Description: T800 based graphics card for the NEC PC using "hoops" software. Performance of the system can be increased by adding additional cards.
- The transputer was chosen as the processor because of the need for scalable performance.

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Transputer Applications

Toyo Communications

- Location: Japan
- Application: Artificial Intelligence Workstation
- Description: System is a standalone workstation running under a version of Unix. Minimum configuration uses 4 IMST414 with the option to upgrade with more transputers for improved performance.
- Toyo Comm has published several papers in Japan on their work in Artificial Intelligence using transputers.

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Transputer Applications
Pixar

- Location: California, US

- Application: Transputer accelerator for SUN's, PC's and SGI workstations for generation of high quality images using the "Renderman" scene description interface.

- Description:

  1- VME Raster Imaging Processor using 16 T800's per card.
  2- PC Raster Imaging Processor using 2 T800's per card.

- Development Environment: SUN workstations and C compiler.

- " The tranpsuter was used for its ease of design and cost/performance"

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Transputer Applications
Parsytec

- Location: Aachen, Germany
- Application: Modular cluster-oriented computer system.
- Description: Each module comprises 64 x IMST800, 6 x IMST425 and 6 x IMST222. Each system can be expanded by adding additional modules. Offers Helios operating system and Megatool (a port of the TDS).
- Development Environment: MEGATOOL
- Product Name: Supercluster
- "Transputer and occam offer the only meaningful solution for parallel processing." (Dr. Peise, Parsytec)

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Transputer Applications
Yasakawa Electric Mfg

- Location: Japan
- Application: Expert System
- Description: A high performance real-time system to be applied to to diagnostic/control of PLC's, robots and numerical controllers. Uses 17 IMST800 running an OPS5 structured language.
- Product Name: RTPS (Real Time Production System)

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Transputer Applications
CSS

- Location: California, US
- Application: Laser Printer Controller
- Description: A single T414 can do emulation of existing printer cntl codes and print at about 55 pages per minute. By adding extra transputers the board will easily handle next generation colour laser printers
- Development Environment: TDS
- "Occam is a fast and efficient language allowing me to do all that low level control quite easily. My biggest surprise is that when I translate C code into occam that it is now smaller and faster."

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Transputer Applications Columbus Positioning Ltd.

- Location : UK
- Application : Global Positioning By Satellite (GPS)
- Description : A portable hand held unit capable of giving a position fix within 10 seconds to an accuracy of 10 m.The unit uses a single T800 transputer.
- Product Name : Gypsy

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Transputer Applications General Dynamics

- Location: California, US
- Application: Image enhancement and recognition.
- Description: System includes 5 IMST800's and 4 IMSA100's for a target recognition and battle management system. Scalable performance improvement is important for future enhancements.
- Development Environment: TDS
- "Occam is such an elegant way of doing this. With a 2-5us message overhead, why should I use an Operating Sytem with its excess luggage giving us 150us overhead per message."

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Transputer Applications
Cogent Research

- Location: Oregon, US
- Application: Modular desk-top parallel-processing supercomputer.
- Description: Basic system has 2 T800's. Can add up to 334 T800's. Uses Linda, a parallel processing software environment.
- Product Name: XTM
- "Compute power previously found only in vector processors is now available in a general purpose computer, where it can be harnessed for simulation, modelling, graphics and inferencing, as well as scientific computation." (Affordable Supercomputing through Parallel Processing, 1988).

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Transputer Applications

KDD

- Location: Japan
- Application: Video Telephone
- Description: Uses up to 20 IMST425's for transmission of still pictures on telephone lines.
- Required the performance of parallel processing

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Transputer Applications

Merino Wool Harvesting

- Location: Adelaide, Australia
- Application: Portable robotic sheep shearer
- Description: Uses multiple T800's to get the performance needed where system cost and size were important. Could not get the same scalable performance from traditional microprocessors.
- Using occam to port the application to multiple T800's

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Transputer Applications

NASA

- Location: Johnson Space Center, US
- Application: Robotics
- Description: The "EVA-Retriever" is a self-propelled vehicle for us with the Space Station and Space Shuttle for retrieval of objects in space. T800's are used as the main central processors with T2's used as intelligent peripheral controllers. The design required the processing power and scalability of the transputer to handle the various tasks needed (i.e. pattern recognition, reasoning, perception, world modelling etc.) where space and power were limited.
- Product Name: EVA-Retriever

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Transputer Applications

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Marconi Defence Systems

- Location: Bracknell, UK
- Application: Radar Defence System
- Description : Scalable radar system comprised of multiple Transputer nodes each using 50 T222's for data processing. Range of system sizes up to large 5,000 transputer system.
- " The transputer - the most cost effective array technology."

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iq systems

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iq Systems Charter

To provide an extensive range of innovative modular hardware and software products to meet the high quality standards and service requirements of the OEM and system developer.

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IQS A 002

iq systems
Innovation and Quality

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Innovation

Flexible Modular Architecture for multiprocessor systems.

Quality

Mature range of industry standard software tools.

Rigorous design, production and QA standards.

Technical Support Worldwide

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IQS A 003

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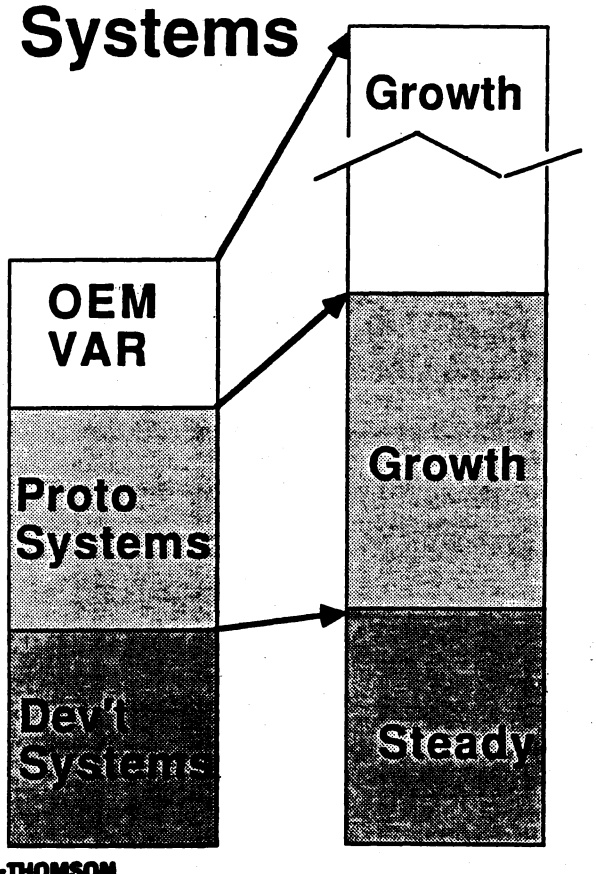
iq Systems



OEM and system integrator business. Adds value with s/w and system solutions.

Prototyping business for board manufacturers. Unique concept. Expanding quickly.

Core business to support silicon design-ins.

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IQS A 004

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iq Systems

Benefits for 3 Market Segments

1. Transputer Application Development
To support board level designers build transputer based systems.

2. Transputer System Prototyping
To allow board level designers to build proof of concept and pre-production systems.

3. End System Integration
To offer a range of board level products to system integrators and Value Added Resellers.

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1 Transputer Application Development

Comprehensive range of mature tools for single and multiprocessor projects

Available for PC, PS2, SUN and VAX hosts

Common tools for both 16 and 32-bit processors

Industry standard languages C, Fortran, Pascal and occam

Extensive range of 3rd Party Development tools

Backed up by a worldwide network of technical support centres

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IQS A 006

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2 Transputer System Prototyping

iq Systems minimises development costs and accelerates projects to market by :

- Using common H/W for design and prototyping

- Providing an extensive range of complimentary products for a variety of applications

- Supercomponent concept fully supported with software provides plug in and run capability

Early prototyping means early system software development giving faster time to market !

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IQS A 007

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3. End System Integration

- Most efficient modular processing architecture for flexible end systems
- Fully compatible with industry standard buses eg. VME, MCA etc
- Increased return on investment through extended S/W life cycles
- One system design will meet variety of end product performance and configurations
- Common TRAM components across variety of systems performances and hosts, reducing inventory holding

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iq Systems - Existing Customer Examples

Henson

Application
- Dental CAD System
- Supplied direct to Dentists

Company Profile
- 35 people (20 Engineers)
- System Integrator
- Buy 'off the shelf' Hardware
- S/W Experience in the End application

Why ?
- Interface to Standard Bus available
- Multi-processor Power (3 Transputers Used)

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