T9000

Processor Pipeline		
Workspace Cache	Address Generator 1	FPU
	Address Generator 2	ALU

32

System Services

Timers

16k bytes Instruction and Data Cache

Programmable Memory Interface

Cross Bar

32

32

32

32

32

32

32

Virtual Channel Processor

Link 0

Link 1

Link 2

Link 3

Event 0-3

CLink 0

CLink 1

292

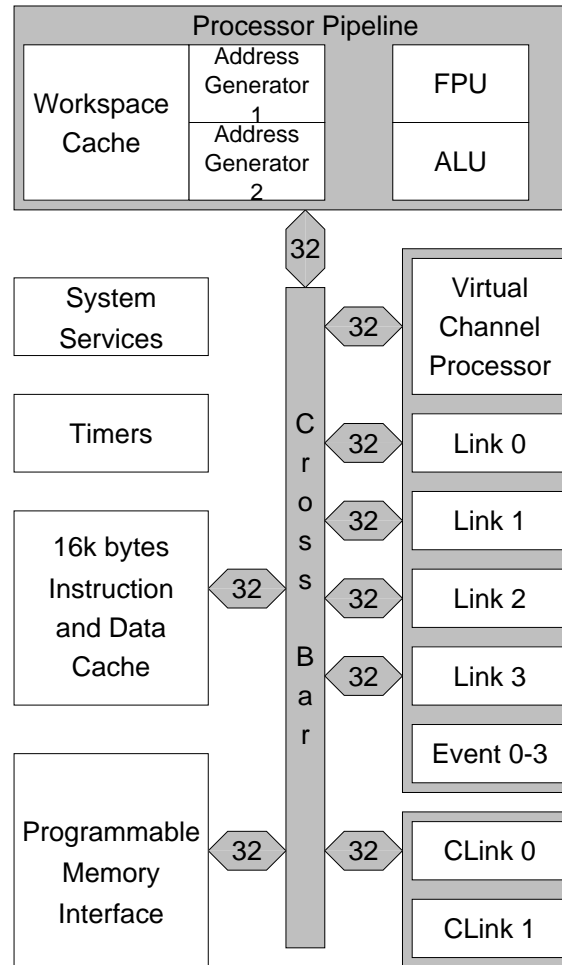# ? The Transputer

H1 / T9000 - The Next Generation
Source : T9000 Data Book 1991!

- Cache Memory

  - 16 kbytes
  - Selectable as On-chip RAM or Cache
  - 4 banks of 4 kbytes each

- Crossbar Switch and Arbitrator

  - Replaces internal bus
  - Allows concurrent access to different memory banks.

- Programmable Memory Interface

  - 64 bit memory interface.
  - Direct support for DRAM
  - Simultaneous support for DRAM SRAM ROM and something else.
  - Memory management in protected mode.

H1 / T9000 - continued

- Pipelined Processor

  - 5 stage pipeline

  - Automatic instruction grouping

  - Can issue multiple instructions per cycle

  - Three port Workspace Cache & Instruction Buffer

    - - Allows pipeline to do 4 data reads and one instruction read in one cycle.
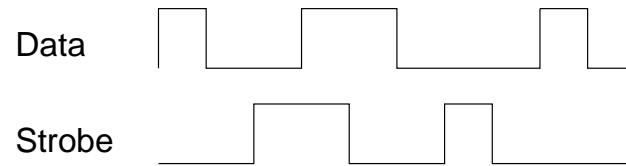
- Faster Links

  - 100 MBaud per link.

  - 4 wire bi-directional links, 2 Data/Strobe pairs.

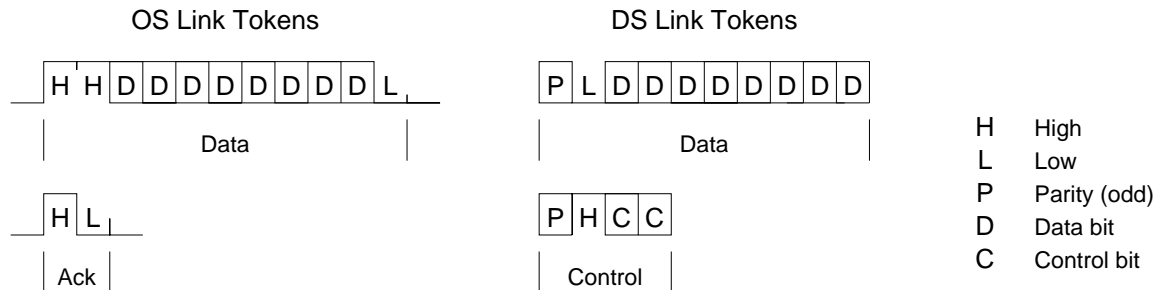 - 2 Extra Control Links for daisy chained control.

Data Strobe (DS) Links

Strobe line

Data

Strobe

- Strobe changes every time data doesn't.

  – Easier clock recovery.

Tokens

OS Link Tokens

| H | H | D | D | D | D | D | D | D | D | L |

Data

| H | L |

Ack

DS Link Tokens

| P | L | D | D | D | D | D | D | D | D |

Data

| P | H | C | C |

Control

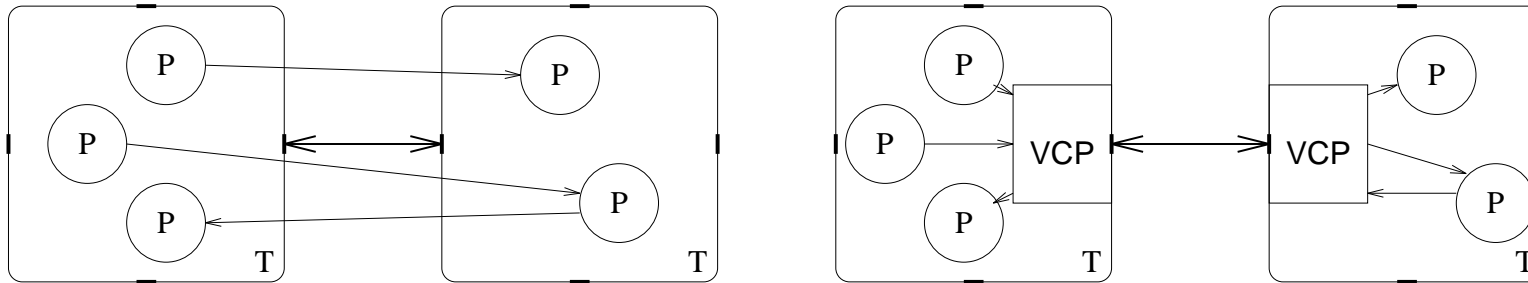| H | High |
L	Low
P	Parity (odd)
D	Data bit
C	Control bit

- Old oversampled (OS) links support Data tokens and Ack tokens.

- DS links support Data tokens and 4 different Control tokens.

295

T9000 - Virtual Channel Processor

- Support for *Virtual Channels*:

    - Divide messages into 32 byte packets.

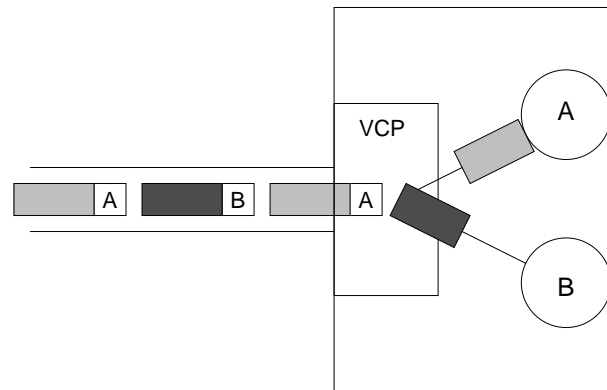   - - Packets are given a header to indicate the *virtual channel*.
        - - Packets are terminated with either an *end of packet* or an *end of message* control token.

296

- Interleave packets from different *virtual channels* down a single physical link.

- Each data packet is acknowledged by a zero length packet carrying the same header.[1]

---

[1]

This packet acknowledge is quite separate from the data token acknowledge. Every data token is acknowledged by a flow control token.
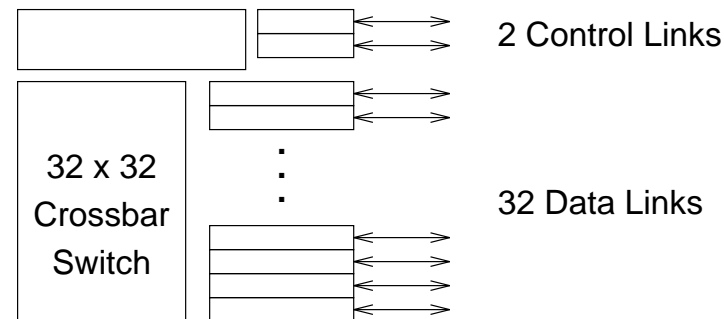
C104 - Packet Routing Switch

The T9000's Virtual Channel Processor does not perform message forwarding, for this INMOS have provided the C104 packet routing switch.


- 32 DS data links to 32x32 Crossbar switch.

- Wormhole Packet Routing is used based on the packet address header.

- Where the required output link is busy the communication is blocked until the link is free.

- C104 is configured via the Control Link daisy chain - Routing strategy is programmable.

298

? **The Transputer**

T9000/C104 Networks

- Up to 5 T9000s can be used in a fully connected network - using Control Links for booting.
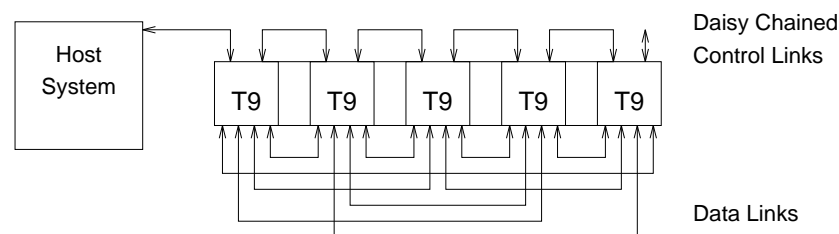
- For larger networks, links can be connected via one or a number of C104s to provide an arbitrary (cycle free) network.