An Enhanced Crossbar Router Chip for a Shared MemoryMultiprocessor

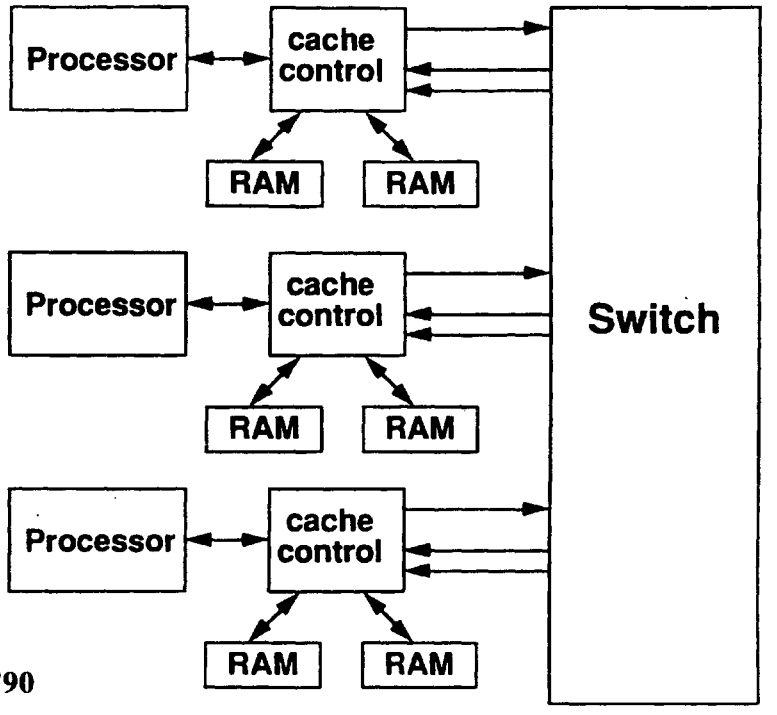
- A "RISC" approach to router chip architecture and design
- High performance system engineering
- How simple can we make it?

MIT TRANSIT

Transit Target Specifications

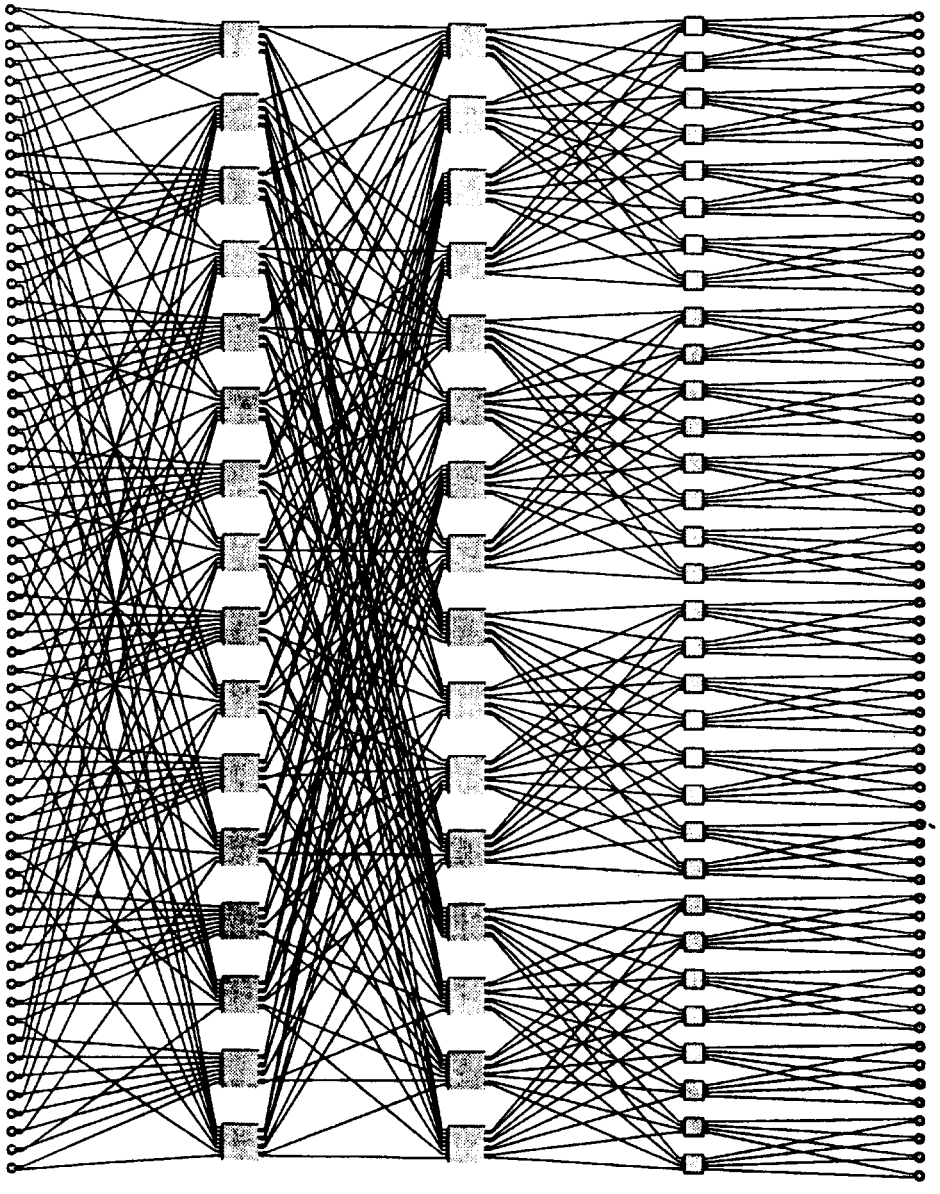
- 256 Processor / Memory clusters
  - expandable with fat tree techniques
- 8 bit parallel transfers
  - one additional control line per port
- 100 Megabytes/sec/port
- 220 ns. remote memory reference
- Robust against single point failures
- Compact - 50 x 50 x 5 cm

Processor Organization

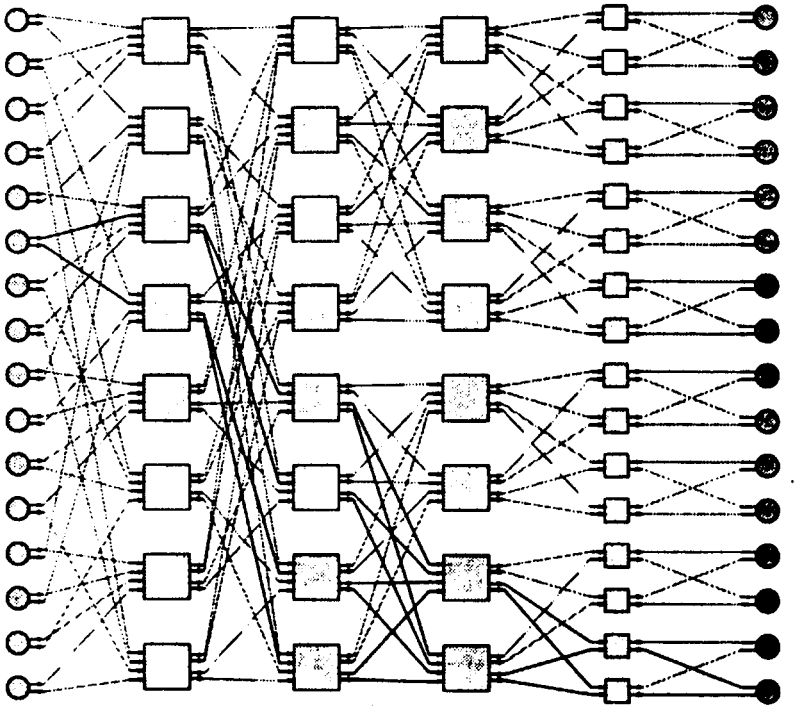


The "RISC" Approach To Routing

- Amazingly simple network protocol gives flexiblity to system designers
- Logic is simplified, speeded up
- Wiring topology of network combined with router dilation gives good collision statistics
- No external components needed to cascade chips in network

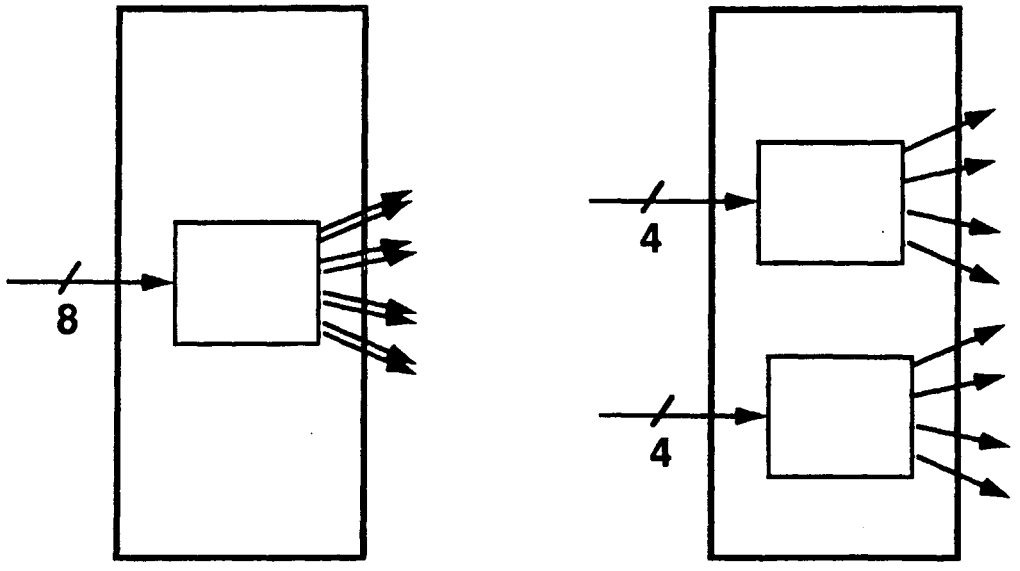


Multipath Bidelta Network



16 x 16 Bidelta Network Constructed from 4 x 2 Crossbars with a Dialation of 2

RN1 Crossbar Chip



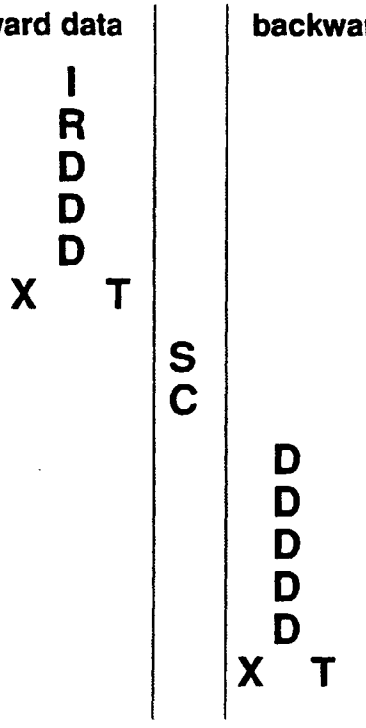
8x8 mode

4x4 (x2) mode

Transit Routing Protocol

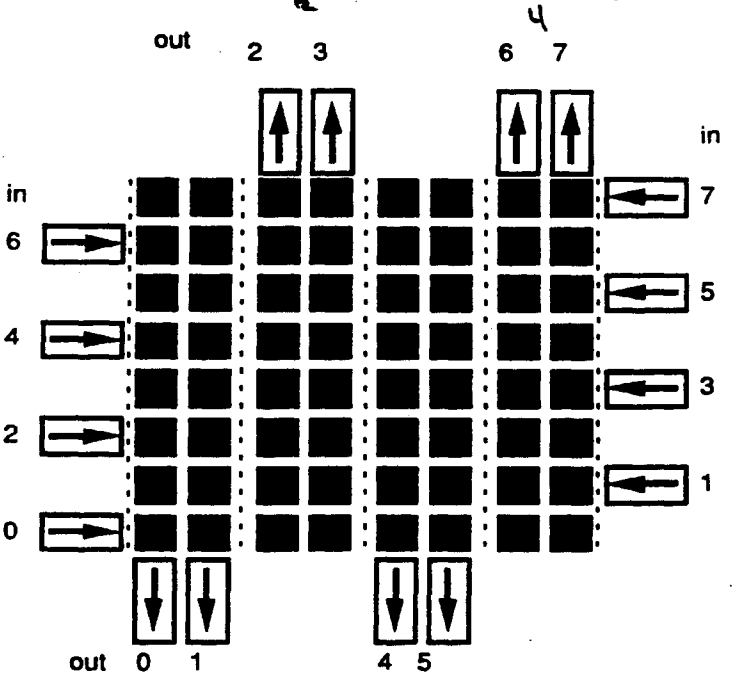
- Circuit Switched
- Source Responsible Routing
- Explicit Acknowledgement
- Simple
  - No buffering
  - No queuing
  - No flow control
- Non-Deterministic Paths
- Fault Tolerant
- Fault Localization

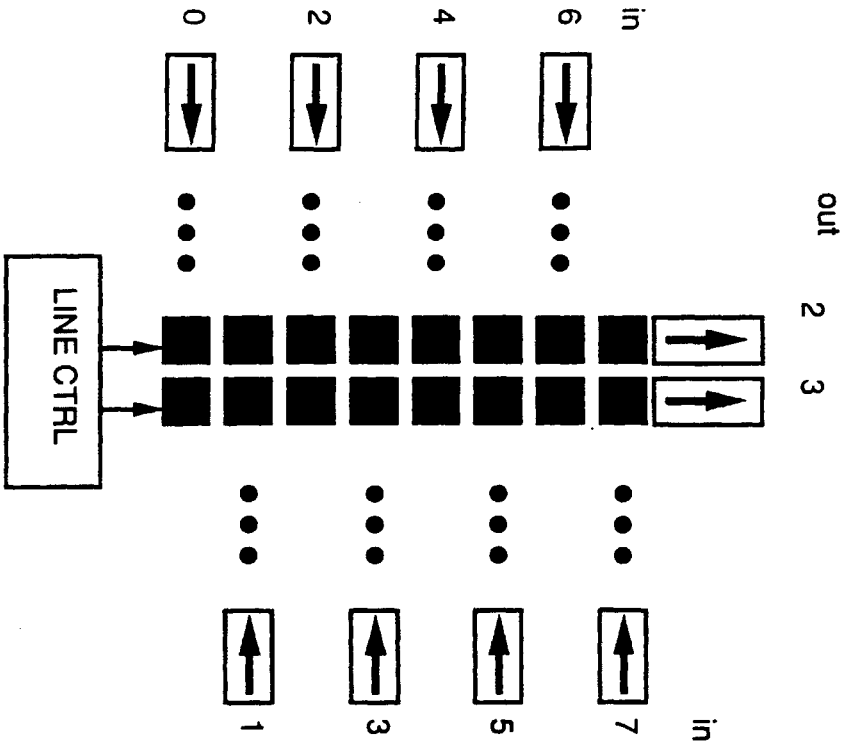
Transit Routing Protocol



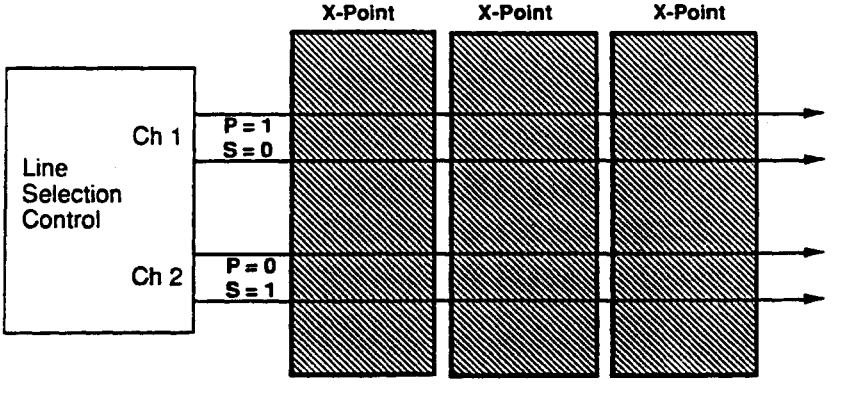
I = idle byte
R = routing byte
D = data byte
T = turn
X = drop
S = status
C = checksum

RN1 Crossbar Chip



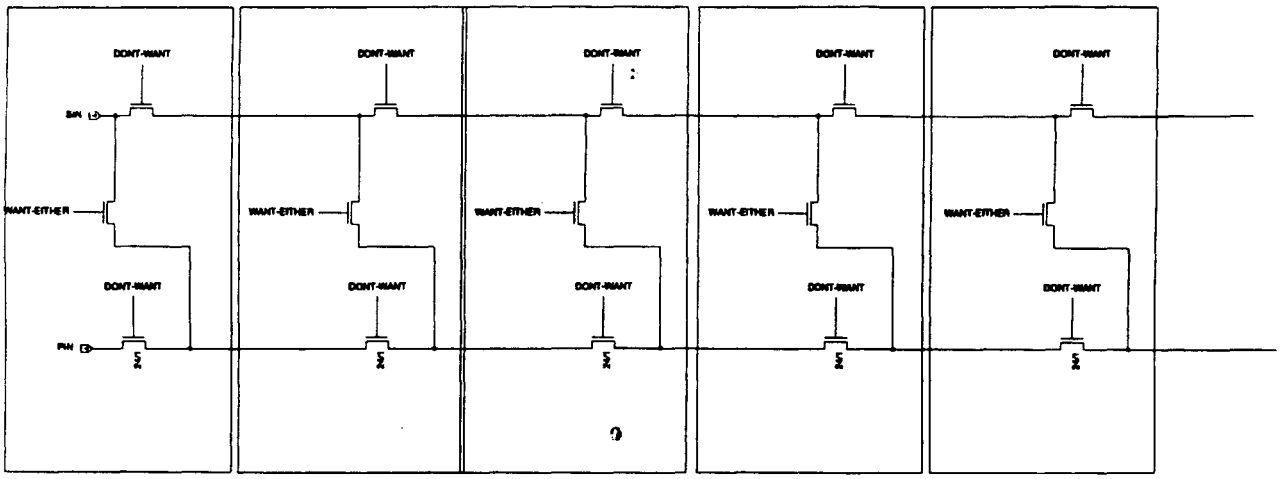


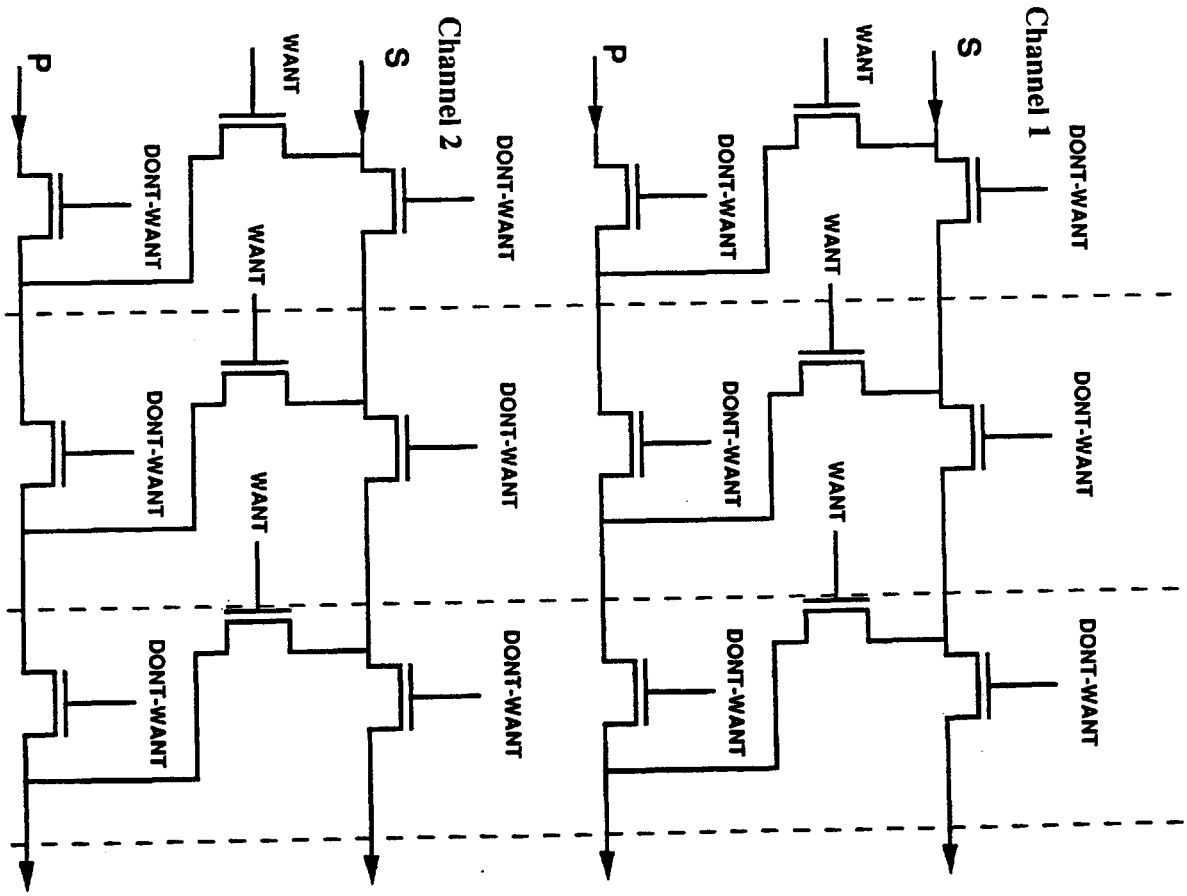
Allocate Grant Chain

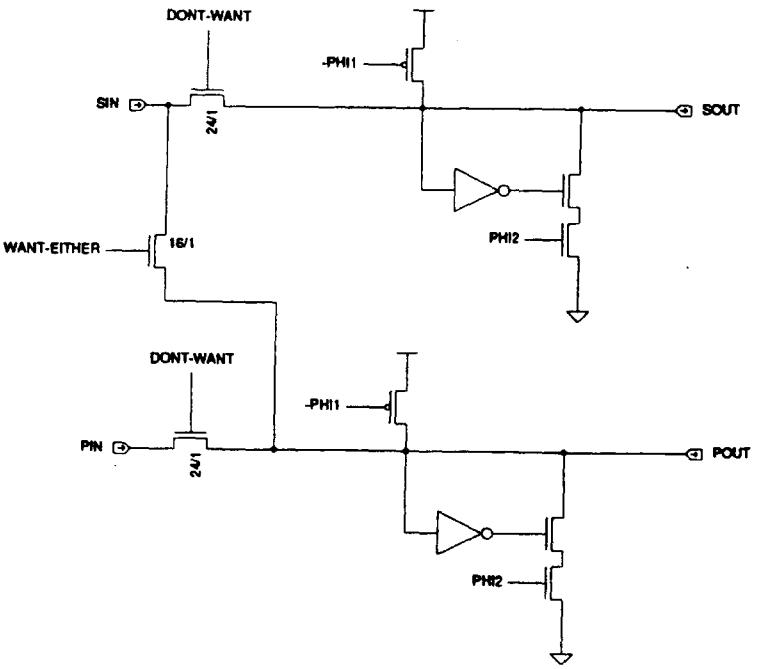


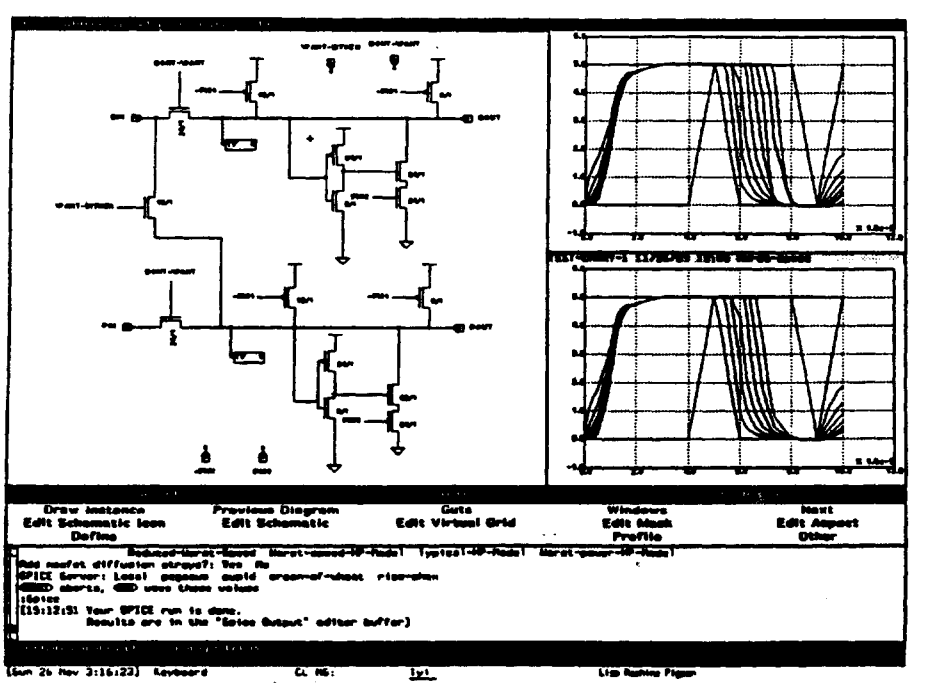
A Dilated output column.

Channel 1 is the Primary, Channel 2 is the secondary.


DONT-WANT
WANT-EITHER
DONT-WANT

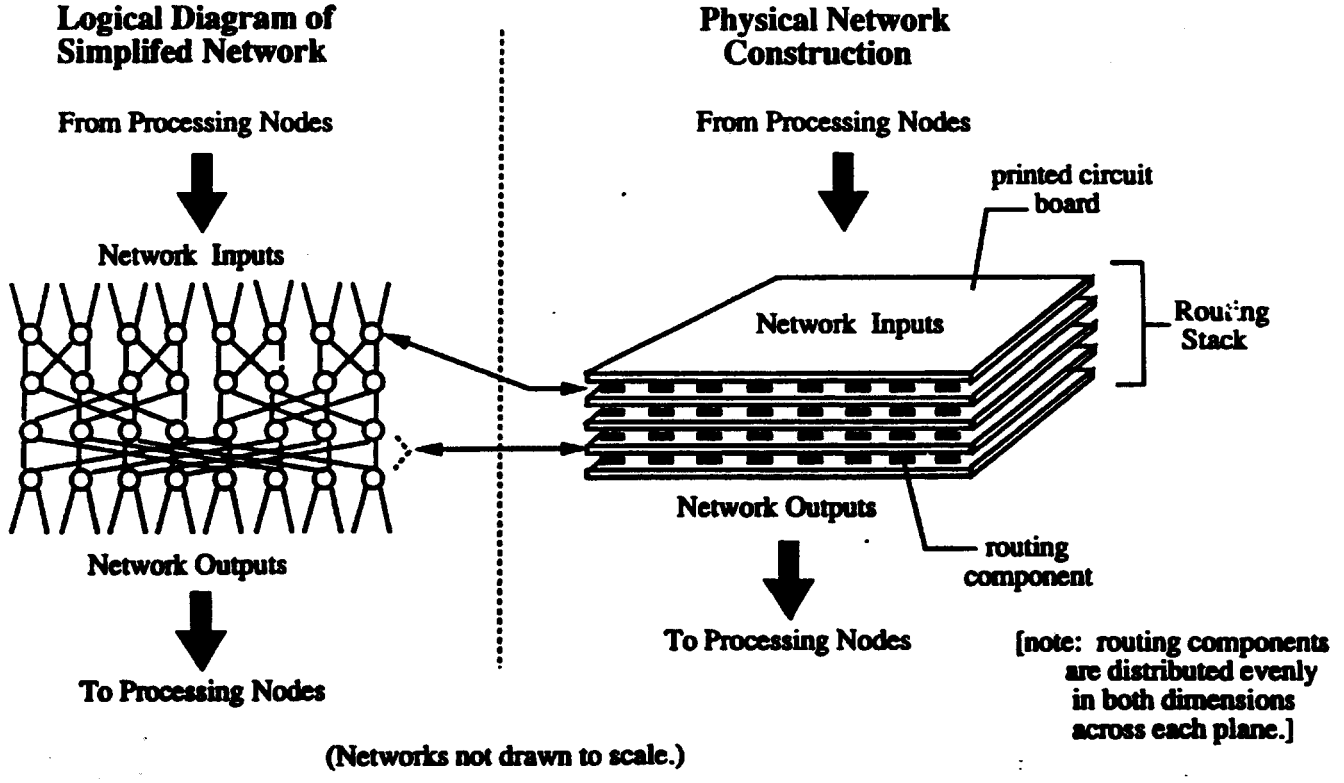

Channel 1
Channel 2
S
P
WANT
DONT-WANT


DONT-WANT
-PHI1
SIN
24/1
SOUT
PHI2
WANT-EITHER
16/1
DONT-WANT
-PHI1
PIN
24/1
POUT
PHI2

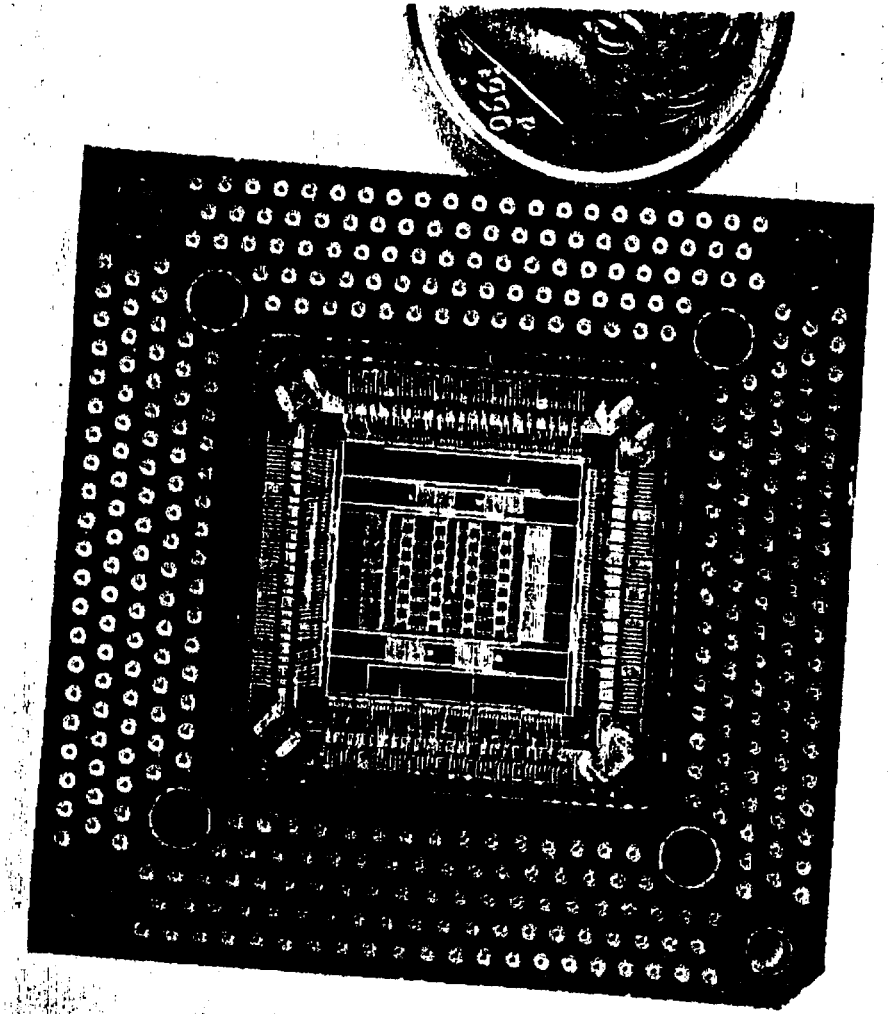


Packaging of Transit

- True Three Dimensional wiring
  - Roughly constant wiring density in all three axes (within factors of 5)
- Laminated stack of alternating layers of components and horizontal wiring
- Dense Connectors made from Fuzz Buttons
- Controlled Impedance 50 Ohm stripline wiring
- Fluid cooling - Fluorinert
- Domiant Signal Flow is Vertical
- Each wiring / component layer is identical



POLAROID
H004 7976 C



POLAROID
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