Lecture 30: November 2, 2020
Computer Architecture and Organization-II
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Parallel Computers -IV

0.6.2 Delta network

An $a^n \times b^n$ multistage switching network is called the delta network.

Its switching components are the $a \times b$ elementary switches.

It is a^n-input b^n-output n-stage network; all input output terminals are connected.

There exists a unique path from any source to any destination.

An example $2^3 \times 2^3$ delta network is shown in Figure 42.

It is a 3-stage network where the numbers of inputs and outputs are 8.

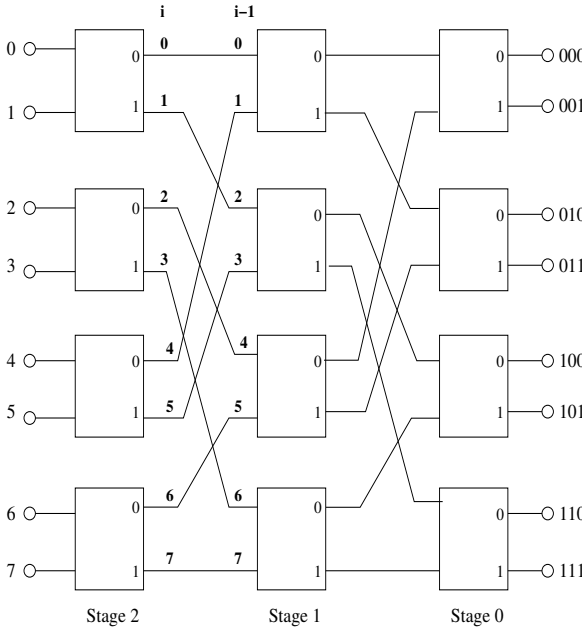

Figure 42: The $2^3 \times 2^3$ delta network

The $a^n \times b^n$ delta network is an a-shuffle network.

It defines link between output of a switch at i^{th} stage and input to $(i-1)^{th}$ stage.

Example, in following figure, outputs 0-7 (boldface) of Stage 2 (i) form a=2 columns

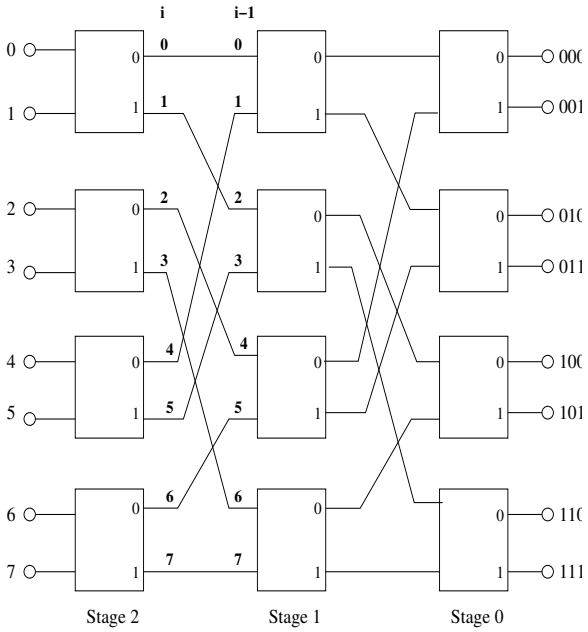

Figure 43: The $2^3 \times 2^3$ delta network

0 4
1 5
2 6
3 7.

To connect the outputs of Stage 2 (i) to 0-7 inputs of Stage 1 ($i-1$) choose output from the first column and then connect it to the first available input of Stage 1.

Then for next input of Stage 1, choose next available output of column 2 and so on.

In other words, k^{th} output of i^{th} stage is to be connected to the j^{th} input of $(i-1)^{th}$ stage where j can be get from the circular left shift of k (k is represented in n-bit).

Destination address D = $d_{n-1}d_{n-2}\cdots d_1d_0$, where d_i is a digit of base b (b: number of outputs of a switch), is supplied at the input of a switch. It sets CONT bit of the switch at $(n-i)^{th}$ stage of the network.

Example: to connect 110 destination of Figure 42 from an input (say, 2), the destination address to be supplied is 110. It sets the CONT at Stage 2, Stage 1, and Stage 0 as 1, 1, and 0 respectively (Path 1 of Figure 44).

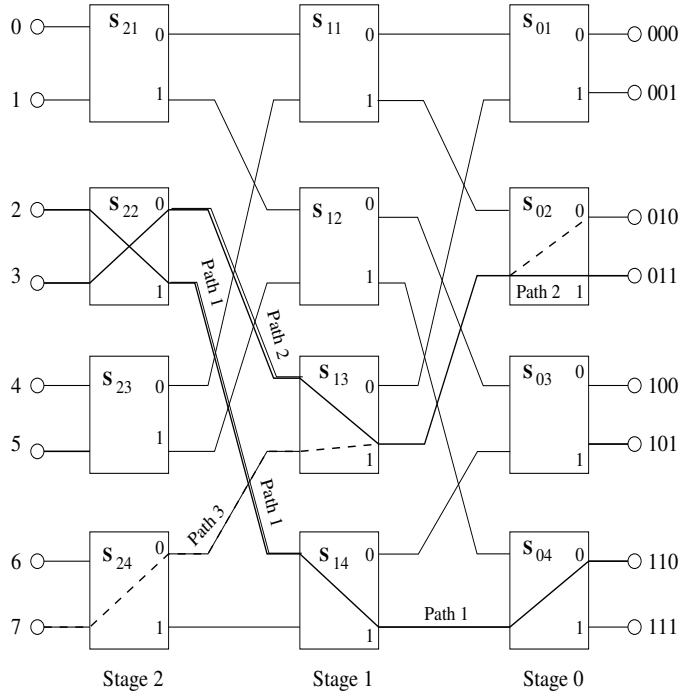

Figure 44: The conflict in delta network

In delta network, simultaneous access to different resource modules is possible.

Simultaneous access from source (input) 2 to destination 110 and from source 3 to destination 011 (Path 1 and Path 2 of Figure 44) can be allowed.

But Path 3 (source 7 to module 010) results in conflict at switch S_{13} with Path 2 -that is, simultaneous access from 7 to module 010 and from 3 to 011 is not permitted.

Realization of a switch must be capable of resolving such conflict (at switch S_{13}).

0.6.4 Cost of delta network

Cost means cost of a switch and number switches required for delta network.

A) Number of switches in an n-stage $a^n \times b^n$ delta network is

a^{n-1} switches in Stage (n-1) + $a^{n-2} \times b$ switches for Stage (n-2) + ... + $a^{n-i} \times b^{i-1}$ switches for Stage (n-i) + ... + b^{n-1} switches for Stage 0.

That is, a^{n-1}+$a^{n-2} \times b$+ ..... +$a^{n-i} \times b^{i-1}$+ b^{n-1}

That is, $\frac{a^n - b^n}{a-b}$ when $a \neq b$. For a=b, it is $n \times a^{n-1}$.