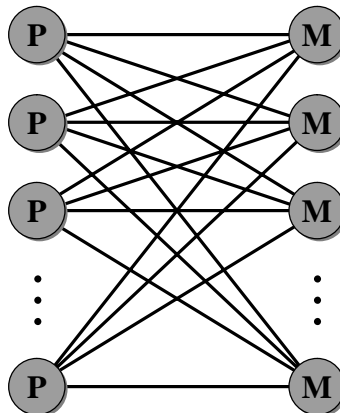


# Hypercubic Networks

Charles E. Leiserson  
*6.895 Theory of Parallel Systems*  
November 2, 2003

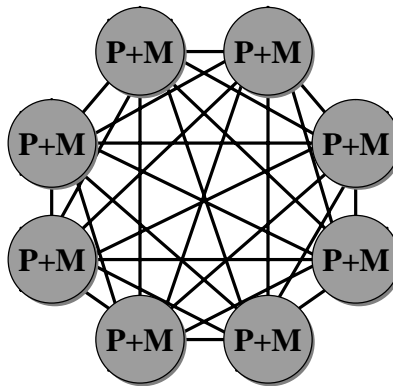
1

## “Ideal” Parallel Computer



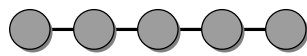
2

# “Ideal” Distributed-Memory Parallel Computer

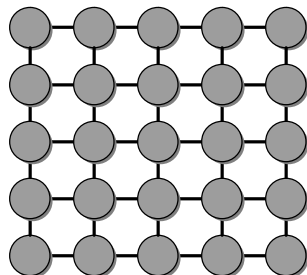


3

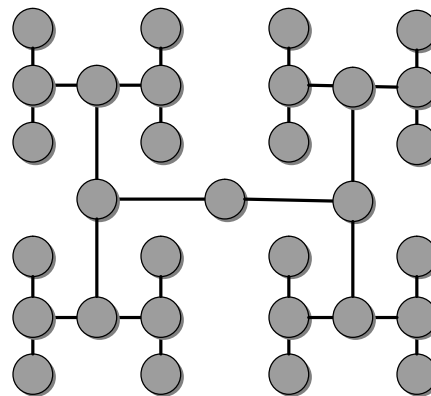
## Interconnection Networks



linear array



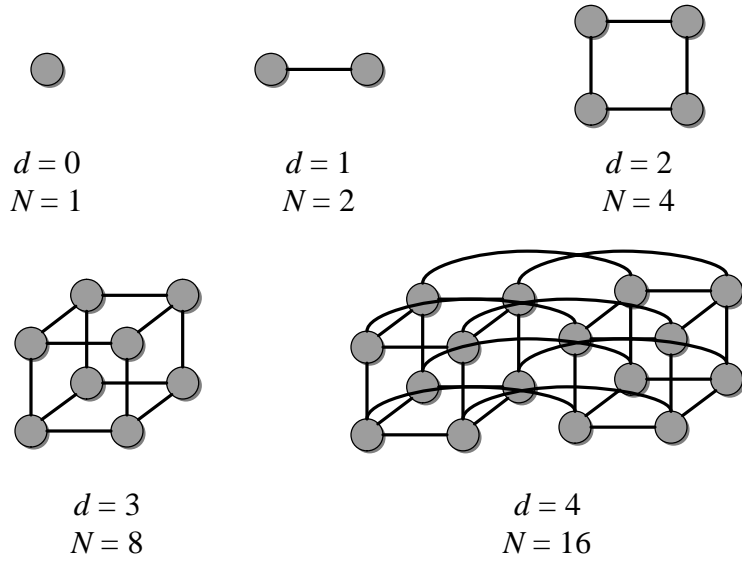
2D mesh



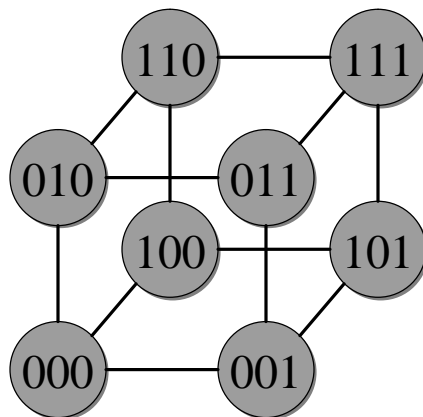
binary tree

4

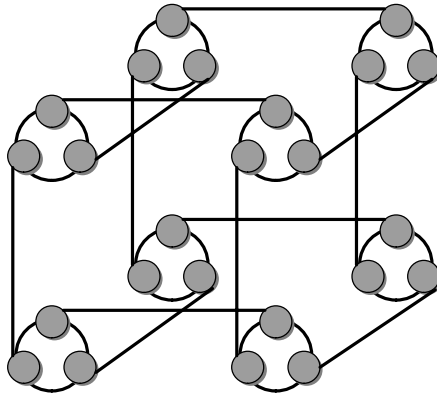
# Hypercube



# Hypercube

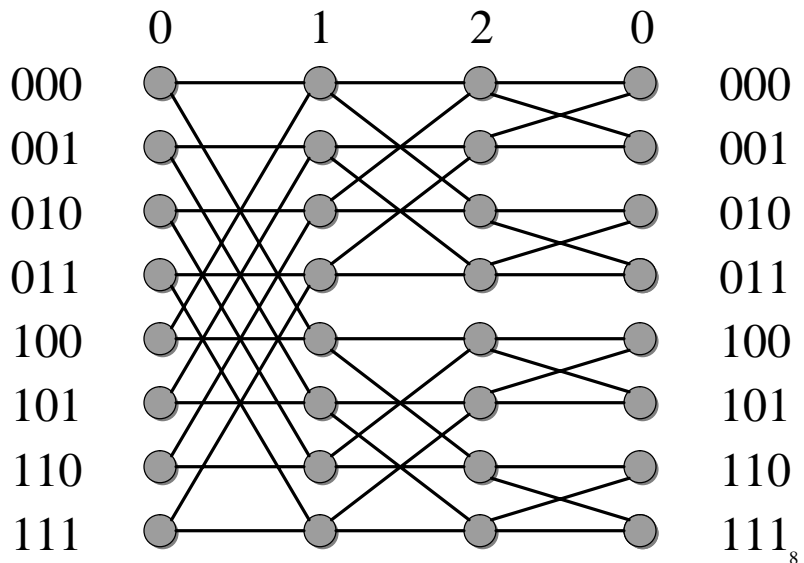


## Cube-Connected Cycles

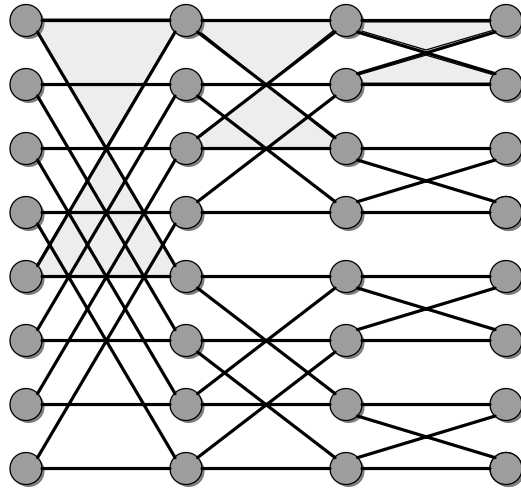


7

## Butterfly (FFT) Network

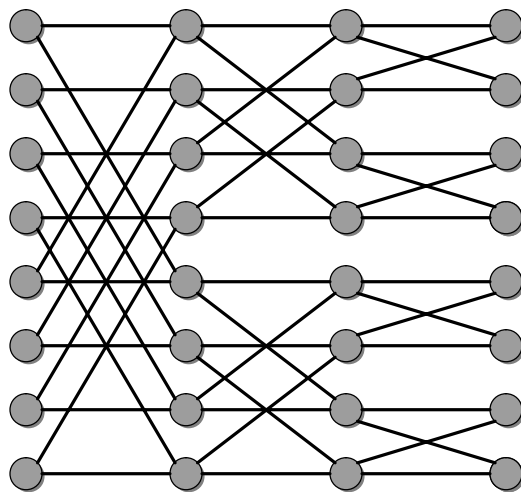


## Butterflies



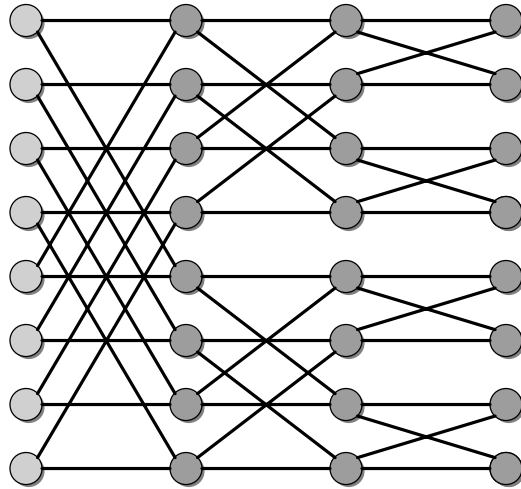
9

## Decomposing a Butterfly



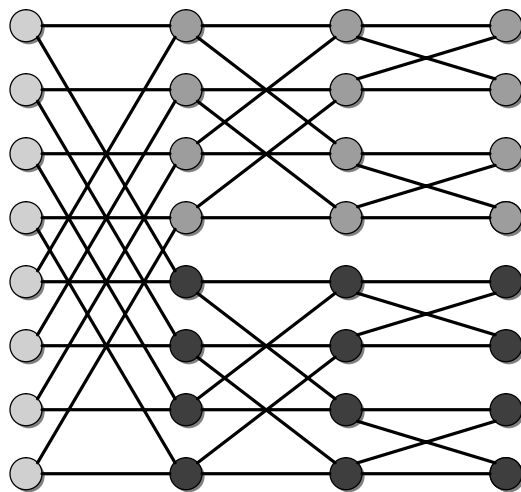
10

## Decomposing a Butterfly



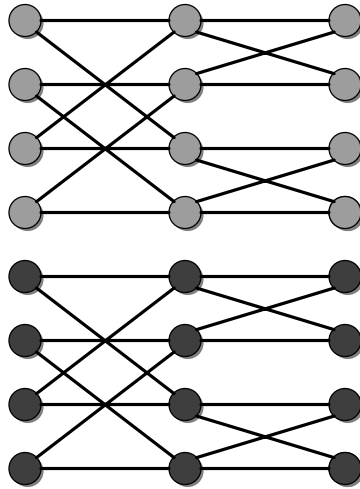
11

## Decomposing a Butterfly



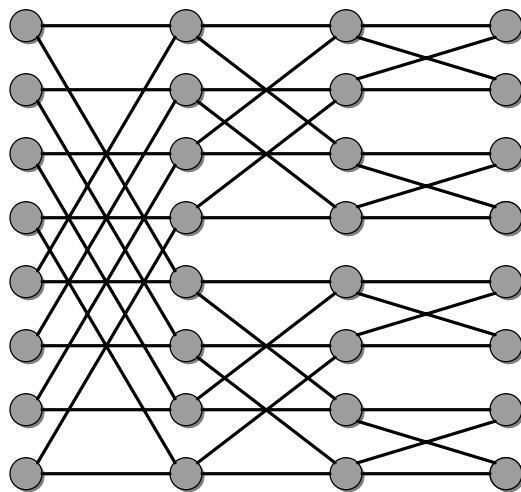
12

## Decomposing a Butterfly



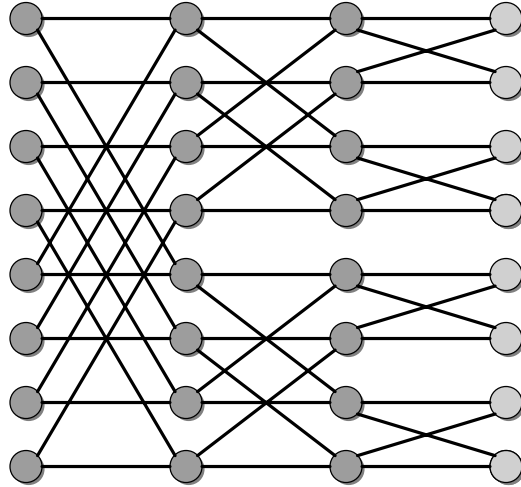
13

## Decomposing a Butterfly II



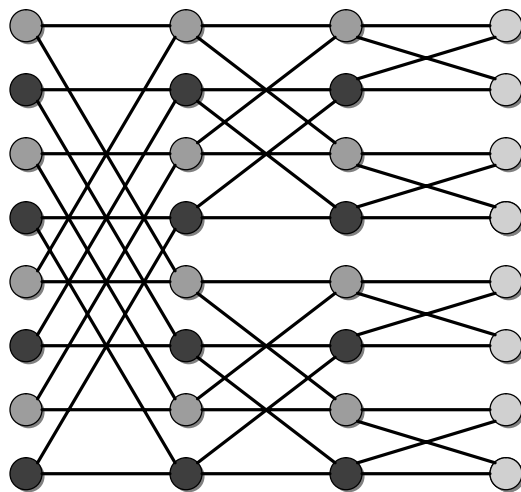
14

## Decomposing a Butterfly II



15

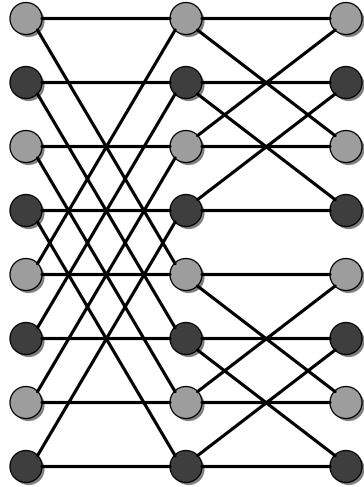
## Decomposing a Butterfly II



16

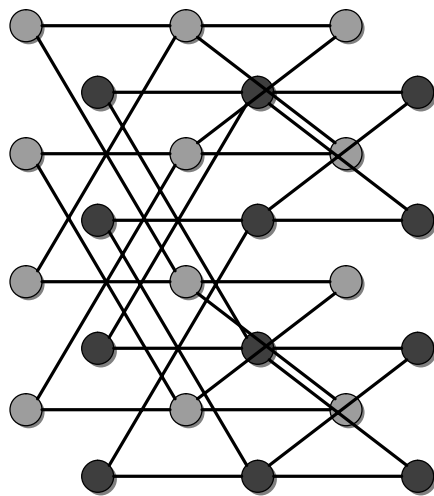


## Decomposing a Butterfly II



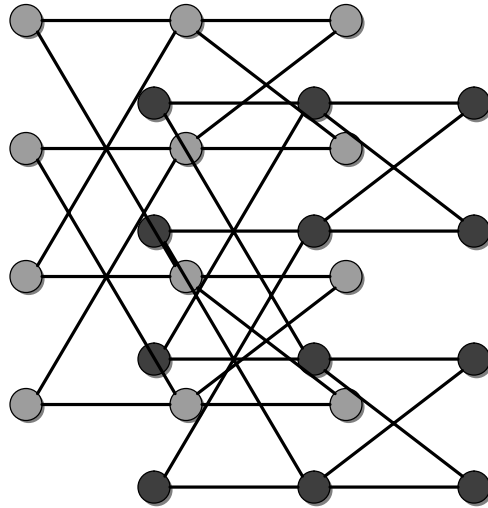
17

## Decomposing a Butterfly II



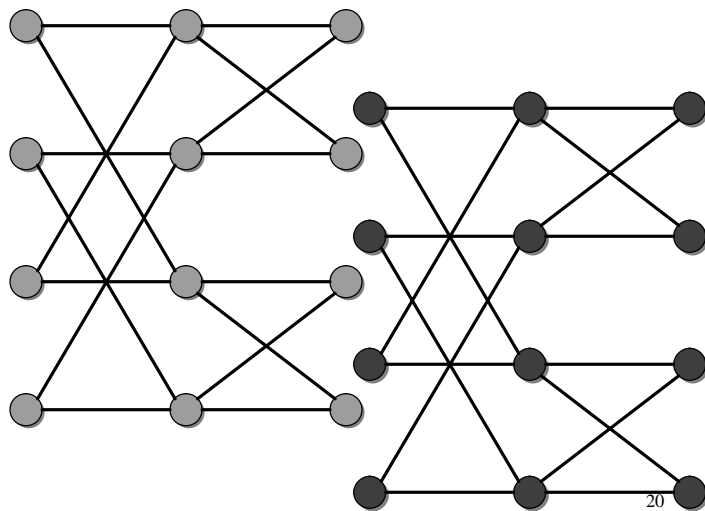
18

## Decomposing a Butterfly II



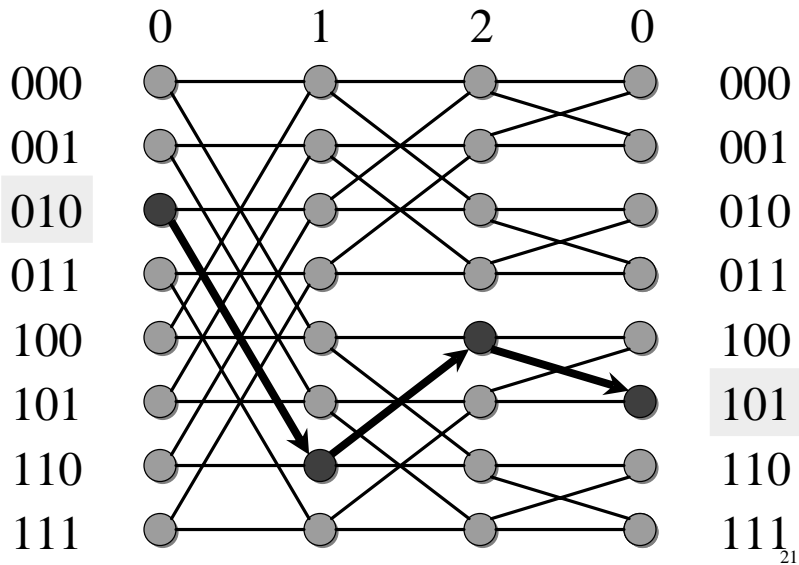
19

## Decomposing a Butterfly II

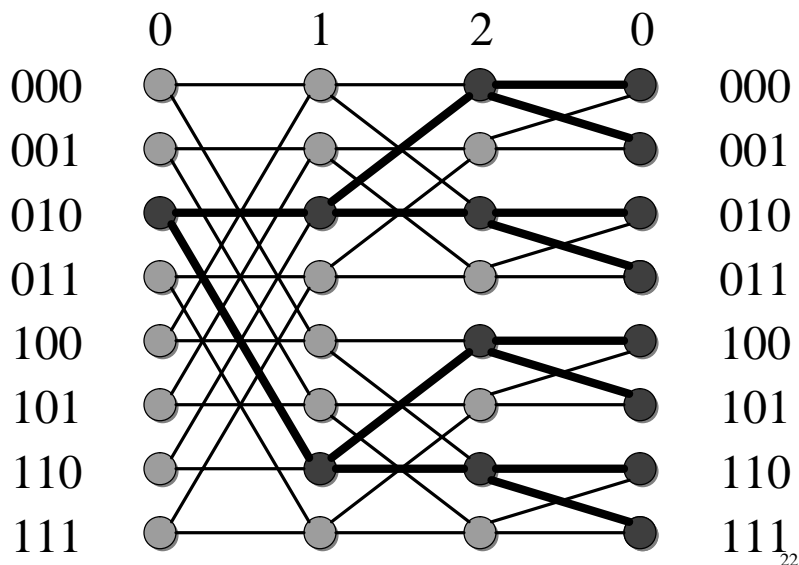


20

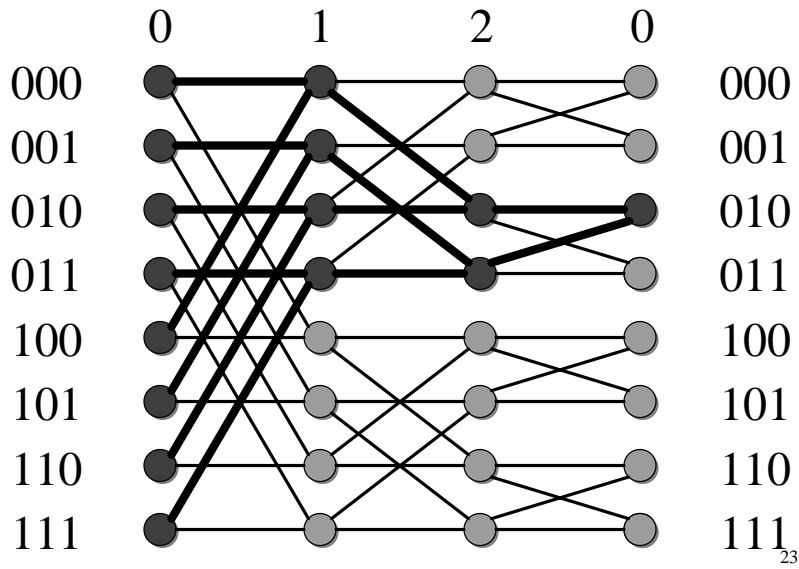
## Routing on a Butterfly



## Tree in Butterfly

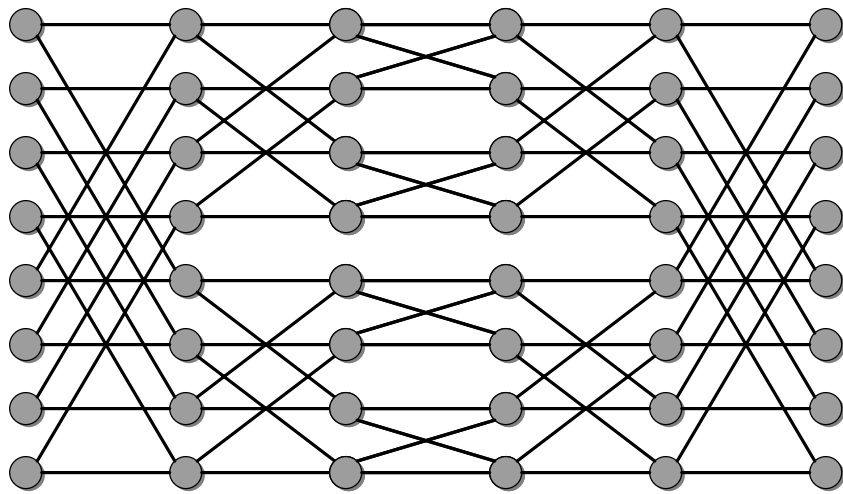


## Tree in Butterfly



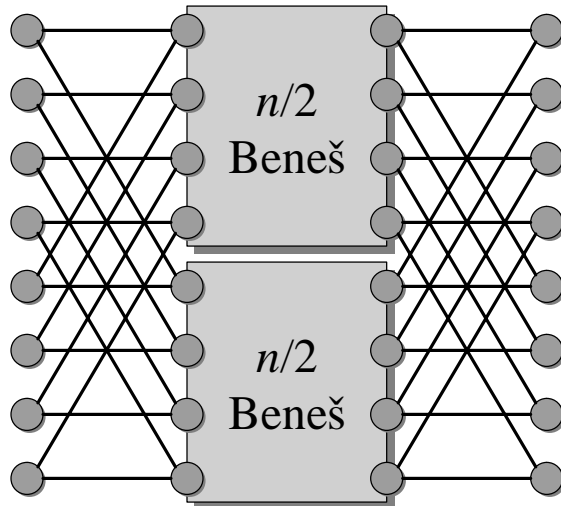
23

## Beneš Network



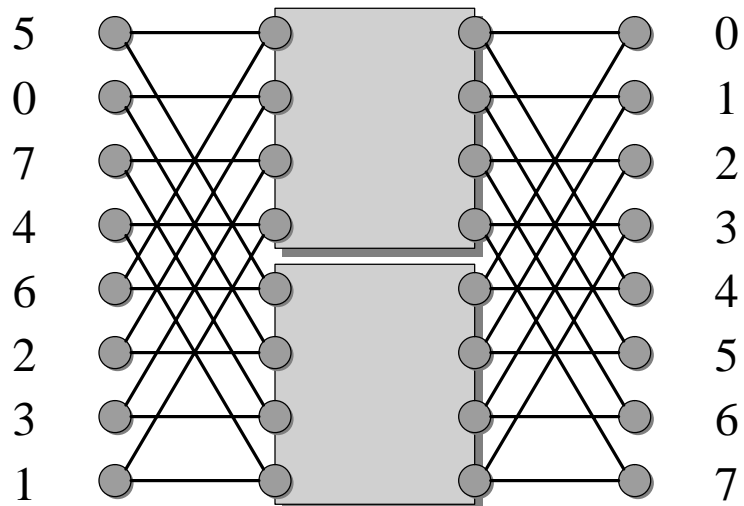
24

## Decomposing a Beneš Network



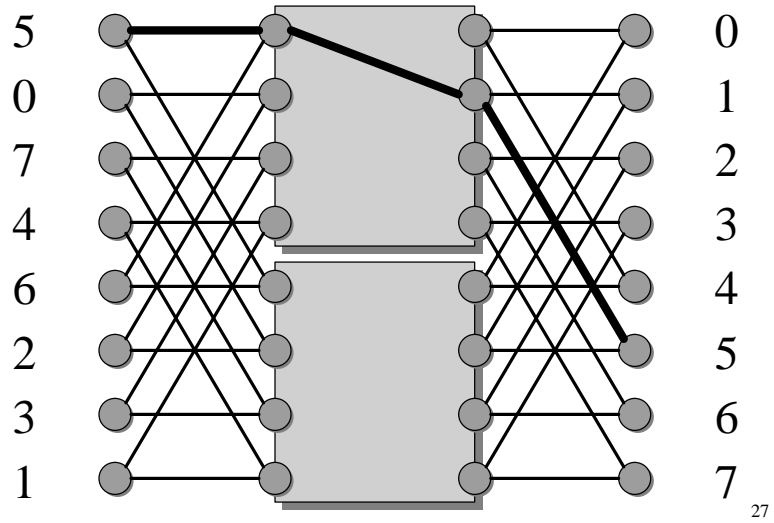
25

## Routing on a Beneš Network

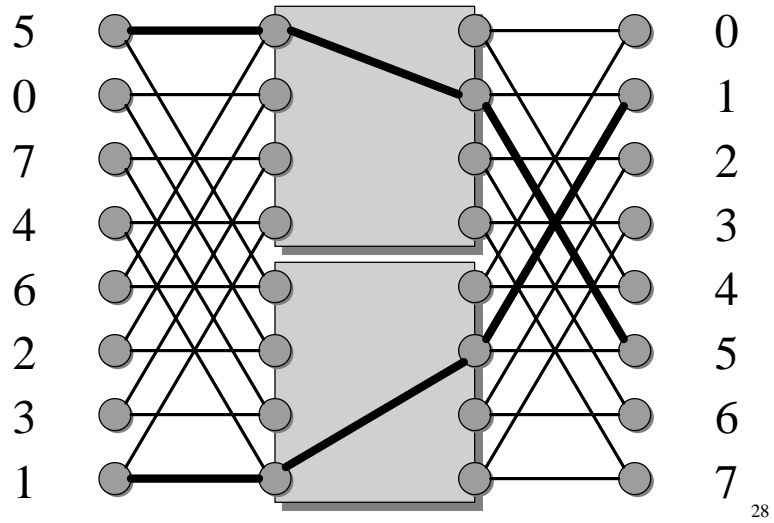


26

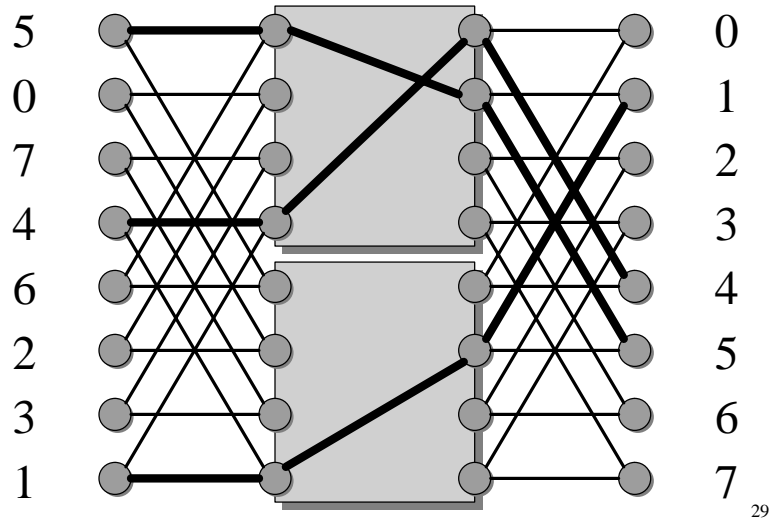
## Routing on a Beneš Network



## Routing on a Beneš Network

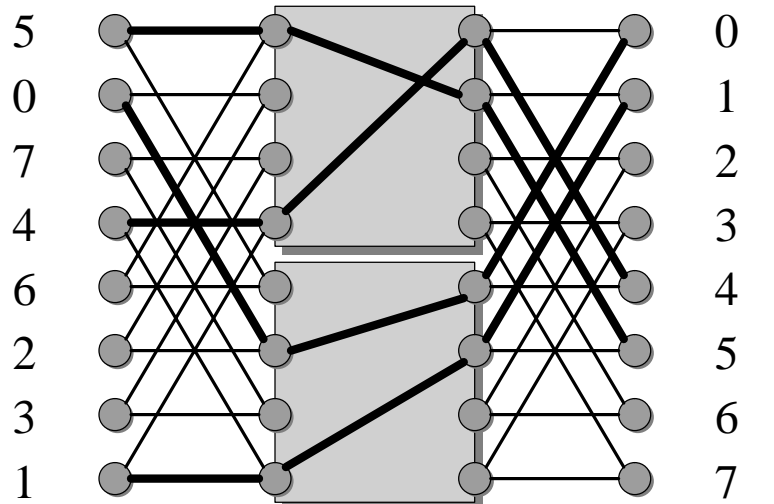


## Routing on a Beneš Network



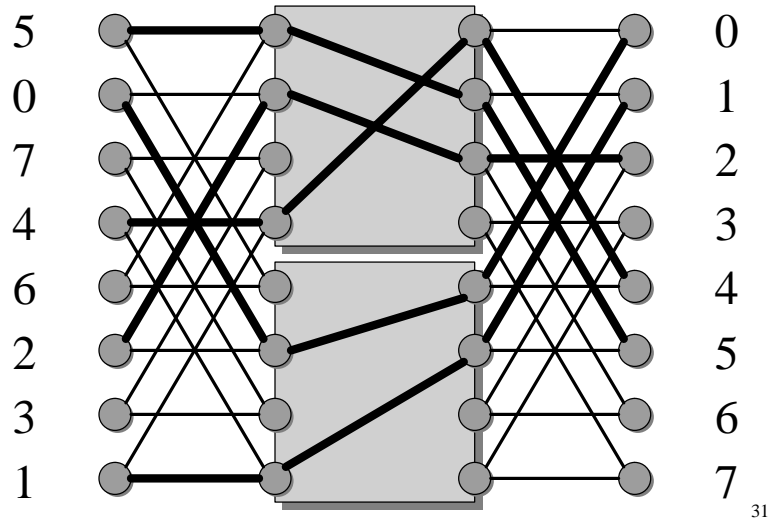
29

## Routing on a Beneš Network



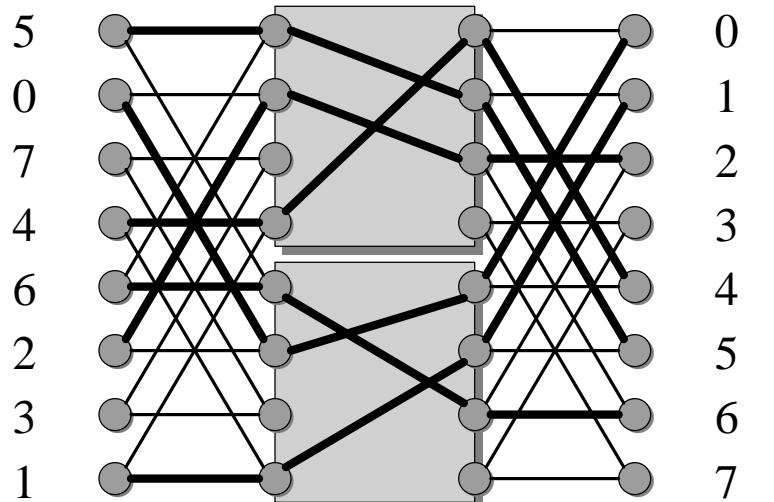
30

## Routing on a Beneš Network



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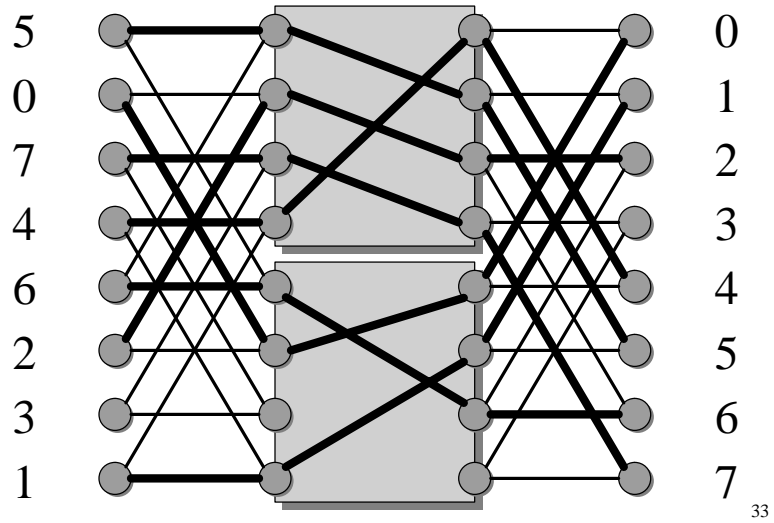
## Routing on a Beneš Network



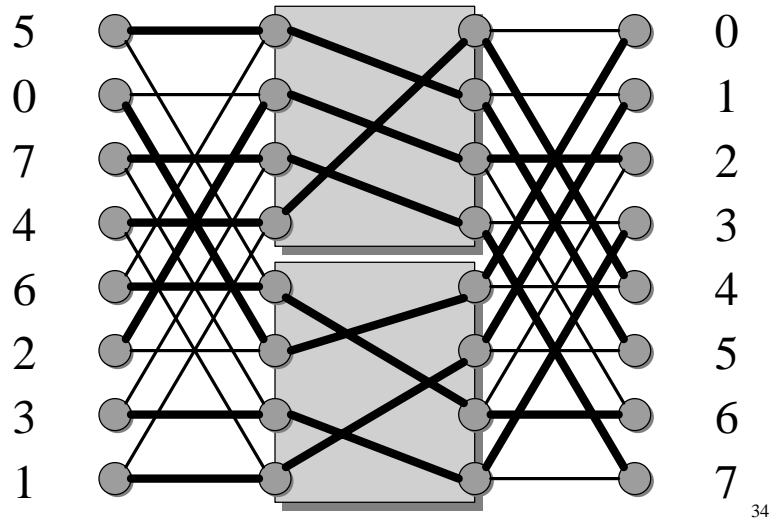
32



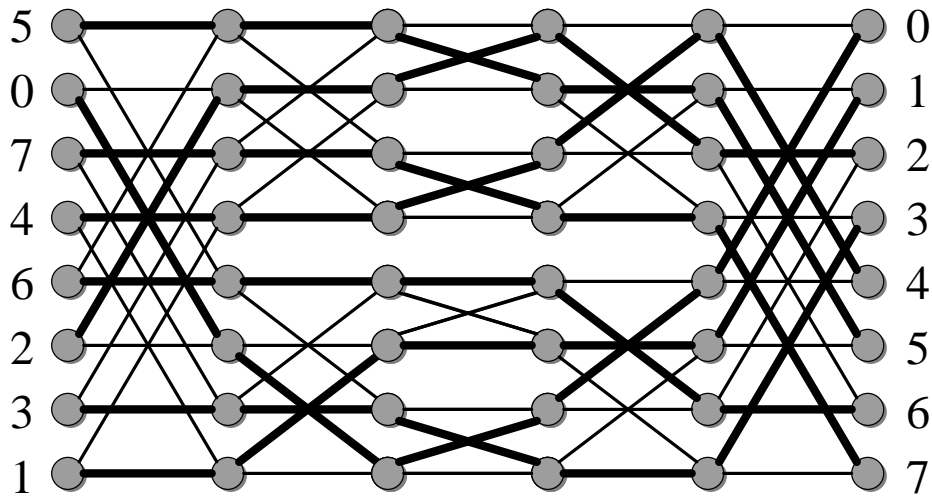
## Routing on a Beneš Network



## Routing on a Beneš Network



## Routing on a Beneš Network



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