Tutorial 7 - SS2021
Communication Systems and Protocols

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Task 1: Networks

Task 1.1: General Questions

A) Name three basic building blocks in a Network-on-Chip and explain their function. 2

Network Interface: Mediating between Computing Unit and Network
Routing Unit: Embedded intelligence that decides on the direction of the data
Link : Physical communication channel between neighboring nodes.

B) Which type of switching is preferable in a NoC where the computing units mainly communicate by streaming data, thus in need of high and guaranteed throughput. Justify your decision. 1

Circuit Switching, easier to guarantee throughput

C) What is the edge connectivity and diameter of a 4x4 Torus ? 2

4,4

Task 1.2: Routing

Figure 1.1 shows a 4x4 Mesh network with packet-switching communication.

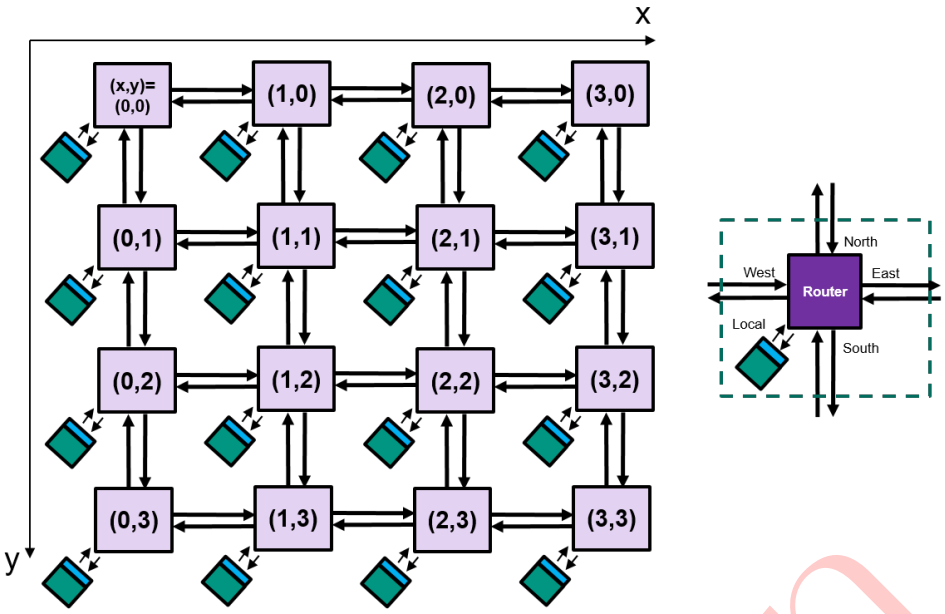

Figure 1.1: 4x4 Mesh network

A) Name all the traversed routers when a packet is sent from $(x, y) = (1, 0)$ to $(3, 3)$ using common XY-Routing. Please provide the coordinates of the traversed router. **1**

$(1,0)$, $(2,0)$, $(3,0)$, $(3,1)$, $(3,2)$, $(3,3)$

B) The routers at address $(1, 0)$ and $(2, 1)$ are experiencing heavy traffic at their east port, such that packets have to wait before being forwarded. To handle such cases a custom routing algorithm called as the "XY-YX" was designed. The "XY-YX" algorithm is described as follows: When a packet arrives, an output port is chosen using the XY routing. If the output port is not busy, the packet is forwarded. If the output port chosen is busy, YX routing is applied to the packet and a new output port is computed. Name all traversed nodes when a packet travels from $(x, y) = (1, 0)$ to $(3, 3)$? **2**

$(1,0)$, $(1,1)$, $(2,1)$, $(2,2)$, $(3,2)$, $(3,3)$

C) Which categories of routing algorithms is the "XY-YX" routing described above associated with? Explain your answer. **2**

Adaptive Routing: Since Ports are used depending on Traffic in Routers
Distributed Routing : Routing computations is done in the nodes Minimal Routing: Packets travel using minimum number of hops

D) Now only the east port of router at (1,1) is busy in the network. Using the same "XY-YX" routing described before, name all traversed routers when the source is (0,1) and destination is (3,1). What do you notice ? **1**

Packet gets stuck at (1,1).
The Packet can get discarded because the algorithm does not store the packet.

E) An additional feature was added to the "XY-YX" algorithm. If the chosen output port is busy even after the YX algorithm was used by the router, then another output port is chosen among the remaining ports according to the priority : North > East > South > West. Now name all traversed routers when the source is (0,1) and destination is (3,1). Again only the east port of router at (1,1) is busy in the network. Is the new routing algorithm minimal ? **2**

$(0,1)$, $(1,1)$, $(1,0)$, $(2,0)$, $(3,0)$, $(3,1)$
No. The packets travel away from the destination. They choose non-minimal path as seen in this case.

F) Now the busy ports are at the south and east of router at (1,1). There is another busy port at south of router (2,0). Use the "XY-YX" routing algorithm with the additional feature mentioned in the above task. Now name all traversed routers when the source is (0,1) and destination is (2,2). What do you notice ? **2**

(0,1) -> (1,1) -> (1,0) -> (2,0) -> (3,0) -> (2,0)
We see a livelock

G) Describe two scenarios: one in which XY Routing is preferable and one in which the "XY-YX" routing is preferable. **1**

Balanced network traffic XY Routing will find the shortest Path
If heavy traffic is present at certain ports, "XY-YX" routing can reduce the latency

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Task 2: Dijkstra

In Figure 2.1 you can see a network of six nodes (A..F). The nodes each have a different number of ports, numbered from #1 to #4. Each connection between the tiles is annotated with the communication cost. Your task is to generate the routing tables for the individual nodes.

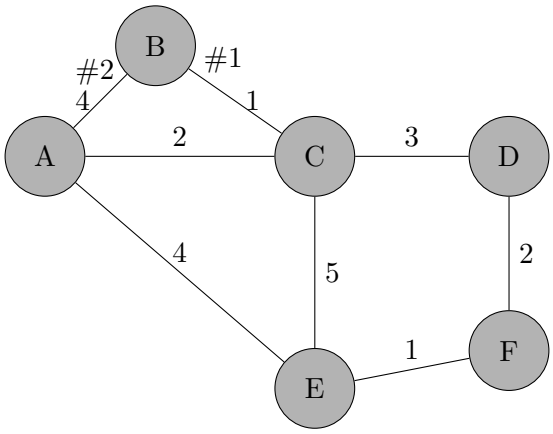

Figure 2.1: Given network topology

A) Determine the shortest path from node B to all other nodes using the Dijkstra-Algorithm. Make use of the tables 2.2 and 2.3. 5

B) Use the results from the previous task to generate the routing table of node B. 5

Destination	Port #
A	#1
B	-
C	#1
D	#1
E	#1
F	#1

Table 2.1: routing table of node B

node	step 1 **B**		step 2		step 3		step 4		step 5	
vertex	dist.	pred.	dist.	pred.	dist.	pred.	dist.	pred.	dist.	pred.
A	∞	-	4	B	3	C	3	C	3	C
B	∞	B	0	B	0	B	0	B	0	B
C	∞	-	1	B	1	B	1	B	1	B
D	∞	-	∞	-	4	C	4	C	4	C
E	∞	-	∞	-	6	C	6	C	6	C
F	∞	-	∞	-	∞	-	∞	-	6	D

Table 2.2: Dijkstra algorithm

node	step 6		step 7	
vertex	dist.	pred.	dist.	pred.
A	3	C	3	C
B	0	B	0	B
C	1	B	1	B
D	4	C	4	C
E	6	C	6	C
F	6	D	6	D

Table 2.3: Dijkstra algorithm