"It's a nice result, but think of yourself as an observer who happened to stumble upon it".

— Nick McKeown, Lessons in Humility[†]

G

Centralized Parallel Packet Switch Algorithm

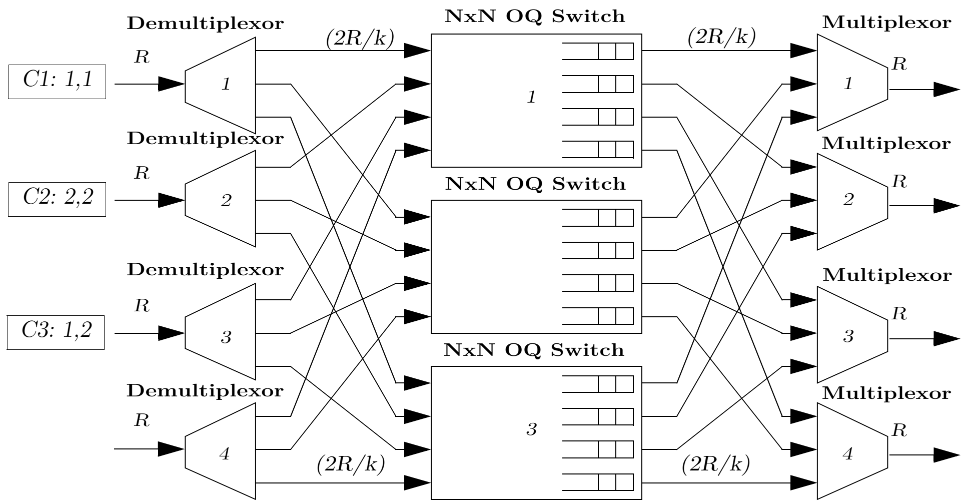
In this appendix, we present an example of the CPA algorithm that was described in Chapter 6. The example in Figure G.1 and Figure G.2 shows a 4×4 PPS, with $k = 3$ center stage OQ switches.

The CPA algorithm functions like an insert and dispatch scheme, where arriving cells are "inserted" into the correct center stage OQ switches, so that they can be dispatched to the multiplexor at their correct departure time. Our example is for FCFS-OQ emulation, and so the PPS operates with speedup $S = 2$, in accordance with Theorem 6.2.

Our example shows the following sequence of steps, as cells arrive in two consecutive external time slots.

1. **Time Slot 1:** In external time slot 1, cells $C1$, $C2$, and $C3$ arrive to inputs 1, 2, and 3 respectively. They are destined to outputs 1, 2, and 1 respectively. Note that the notation $Ci : (j, k)$, refers to a cell numbered i, destined to output j, which is sent to center stage OQ switch k. Cell $C1$ is sent to center stage OQ switch 1, and cells $C2$ and $C3$ are both sent to center stage OQ switch 2 as shown in Figure G.1. The manipulations done on the $AIL(.)$ and $AOL(.)$

[†]Nick McKeown, Stanford University, California, Dec 1998.

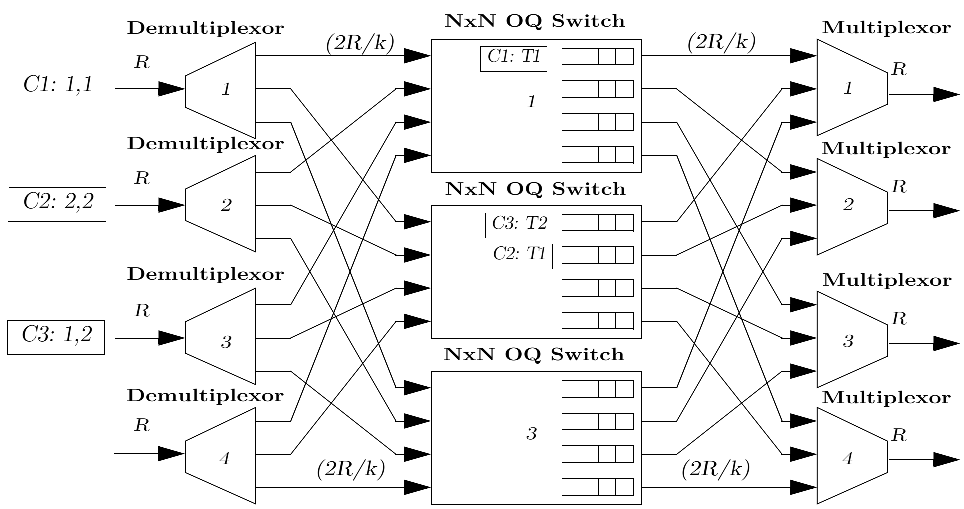


(a1) Cell C1 chooses layer 1 arbitrarily from {1,2,3} ^ {1,2,3}

(a2) AOL(1,1) is updated to {1,2,3} - {1} = {2,3}

(a3) AIL(1,1) is updated to {1,2,3} - {1} = {2,3}

(a4) Cell C2 chooses layer 2 arbitrarily from {1,2,3} ^ {1,2,3}



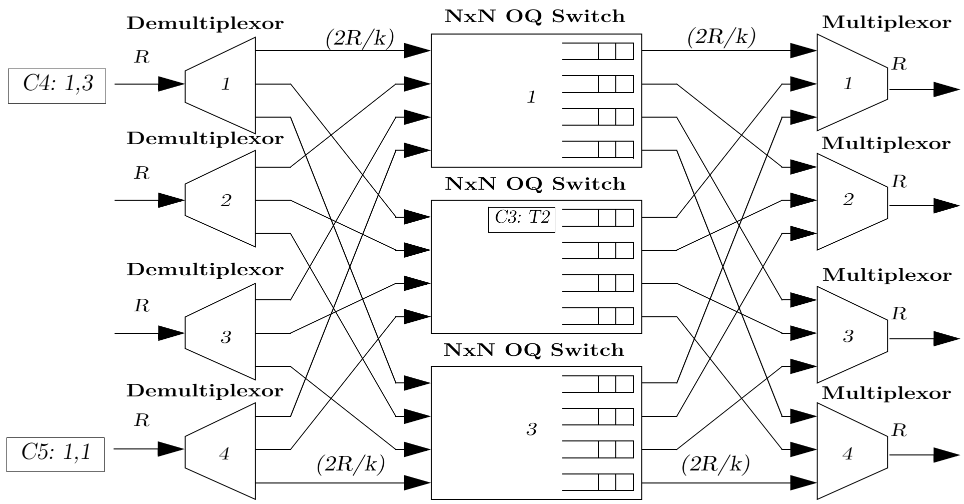
(b1) Cell C3 has a departure time DT(0,3,1)=1

(b2) Cell C3 has to choose from AIL(3,0) ^ AOL(1,1)

(b3) Cell C3 chooses layer 2 from {1,2,3} ^ {2,3}

(b4) AOL(1,2) is updated to {2,3} - {2} + {1} = {1,3}

Figure G.1: *An example of the CPA algorithm.*

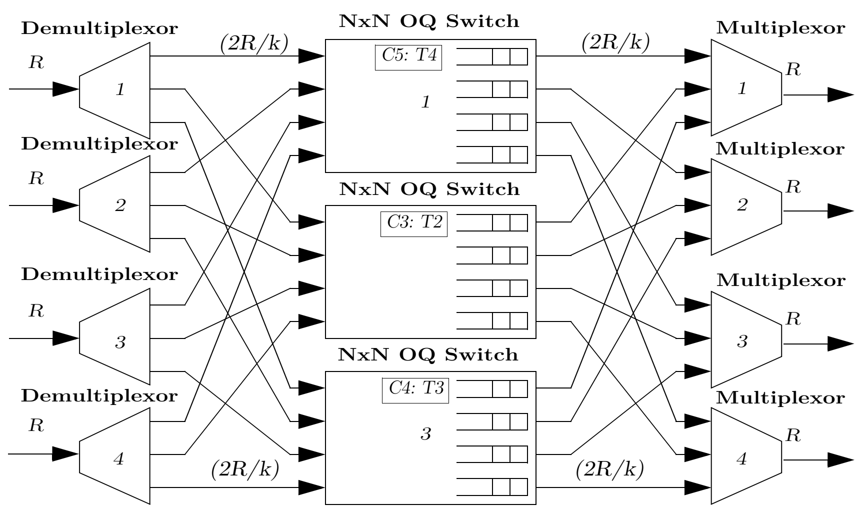


(c1) Cell C4 has an expected departure time DT(1,1,1) = 2

(c2) Cell C4 has to choose from AIL(1,1) ^ AOL(1,2)

(c3) Cell C4 chooses layer 3 from {2,3} ^ {1,3}

(c4) AOL(1,3) is updated to{1,3} - {3} + {2} = {1,2}



(d1) Cell C5 has an expected departure time DT(4,1,1) = 3

(d2) Cell C5 has to choose from AIL(4,1) ^ AOL(1,3)

(d3) Cell C5 chooses layer 1 from {1,2,3} ^ {1,2}

(d4) AOL(1,4) is updated to {1,2} - {1} + {3} = {2,3}

Figure G.2: *An example of the CPA algorithm (continued).*

sets for these cells are also shown in Figure G.1. Note that in the bottom of the figure, the cells are shown to be conceptually "buffered in the center stage switches". Of course, depending on the internal delays, this event may not have occurred.

2. **Time Slot 2:** In external time slot 2, cells $C4$ and $C5$ arrive to inputs 1 and 3 respectively. They are both destined to output 1. Note that cells $C1$ and $C2$ are shown as conceptually "already having left" the center stage switches. However, depending on the internal delays on the links, this event may not have occurred. Cell $C4$ is sent to center stage OQ switch 3, and cell $C5$ is sent to center stage OQ switch 1 as shown in Figure G.2. Again, the manipulations done on the $AIL(.)$ and $AOL(.)$ sets for these cells are also shown in Figure G.2.