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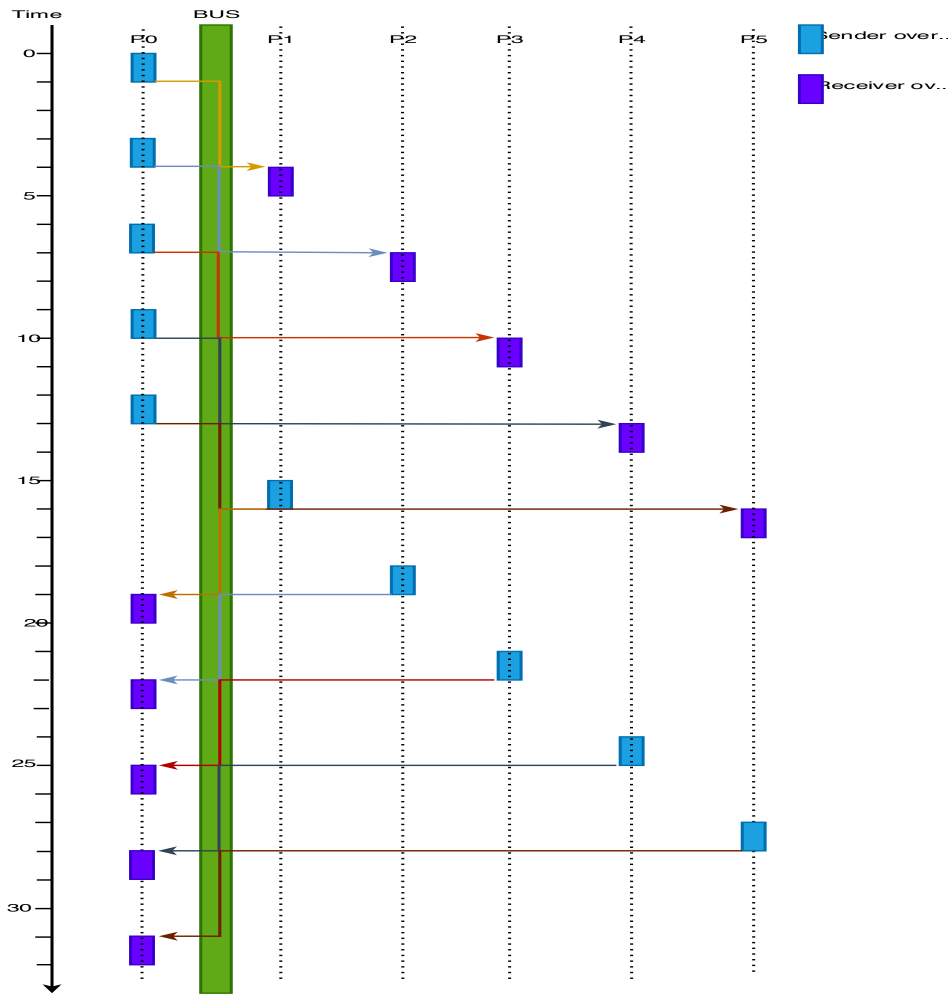
Exercise Sheet 2

LogP Model – bus topology

a. Unique messages to all processors



The first message flow illustrates the case where the P1 sends distinct messages to each of the units. The messages enter the bus after the sender overhead and travels in the bus for 3 clock cycles before being delivered to the first processor (P1). While the message is in the bus, no other message can be sent or received by P1 because only one message can occupy the bus at the same time. But during this time, P1 is already preparing to send the next message and as soon as the bus is free (message delivered), the next message

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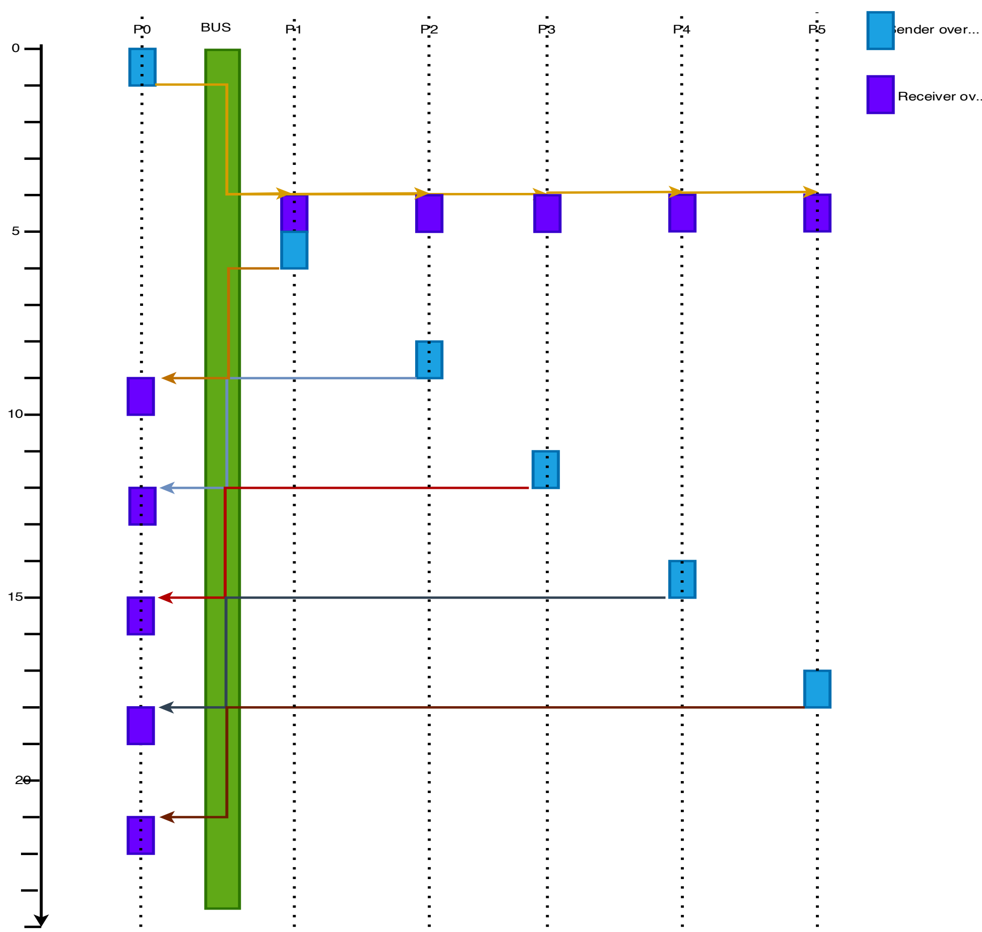
enters the bus. The sender overhead of the sender is spent while the message is in the bus, so that the processor can send another message immediately the bus is free. This continues until all processors have received their messages. As soon as the processors receive their messages, they start preparing to send the reply. However, they cannot send yet until the bus is free. Once the bus is free, the first processor send the response to P0. Messages are serially sent both ways (not at the same time). Therefore, the overall runtime for this setup is the sum of the latencies of all the messages plus the sender overhead for the first message sent by P0 and the sender overhead of the last message sent to P0.

The total runtime is 1 + 10 messages * 3 + 1 = **32 clock cycles**

b. A single message broadcasted to all processors



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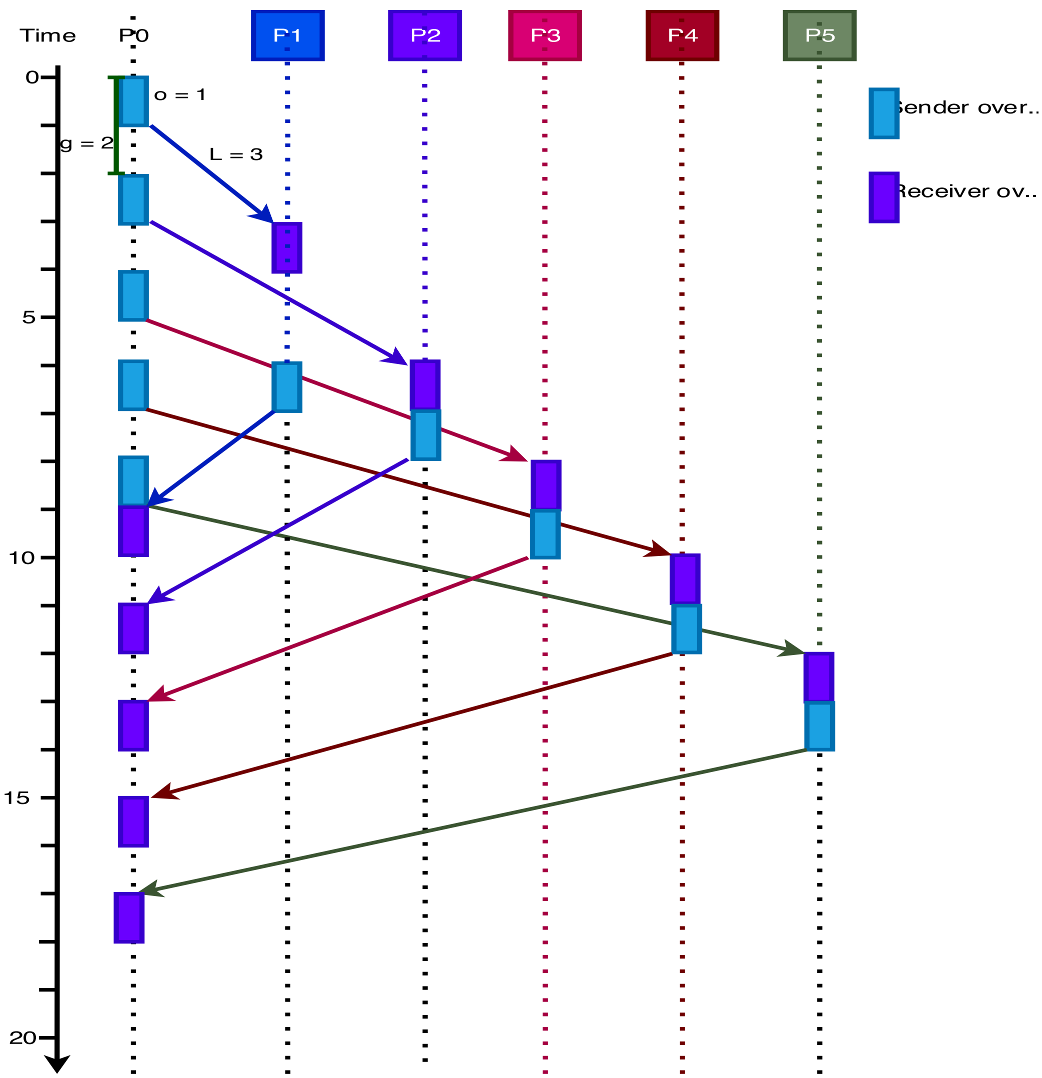
In an alternative scenario, P_0 only sends one message and is broadcasted to all processors. Again, they prepare to send the message as soon as possible. The total runtime for this scenario is the total time for P_0 to send 1 message plus the messages it received. That is $O_s + L + O_r + 5L + O_s + O_r = 1 + 3 + 1 + 5 * 3 + 1 + 1 =$ **22 clock cycles**

$T_{\underline{run}}$ = 22 clock cycles

LogP Model - Star Topology



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P0 sends messages serially to each processor at intervals g = 2. The messages take time L = 3 to reach each processor. Once processor P1 receives the messages it processes it with time o_r = 1 cycle and prepares with time os = 1 cycle to send the response to P0. However, since the messages will arrive at t=8, P0 cannot receive it because it in the sender overhead preparing to send the message to P5. Therefore, P1's message must be postponed. The other processors immediately start the sender overhead after the receiver overhead since the messages will arrive P0 when it is not currently receiving or sending any messages.

Therefore T_{run} = time for P0 to send messages to all 5 processors ((n-1) * g) + Time for the last message to arrive P5 + Time for P0 to receive the last message (from p5)

$T_{run}=(n-1) * g+2 * (o_s + L + o_r)$

$T_{run} = (5 * 2) + 2 * (1 + 3 + 1) =$ **18 cycles.**

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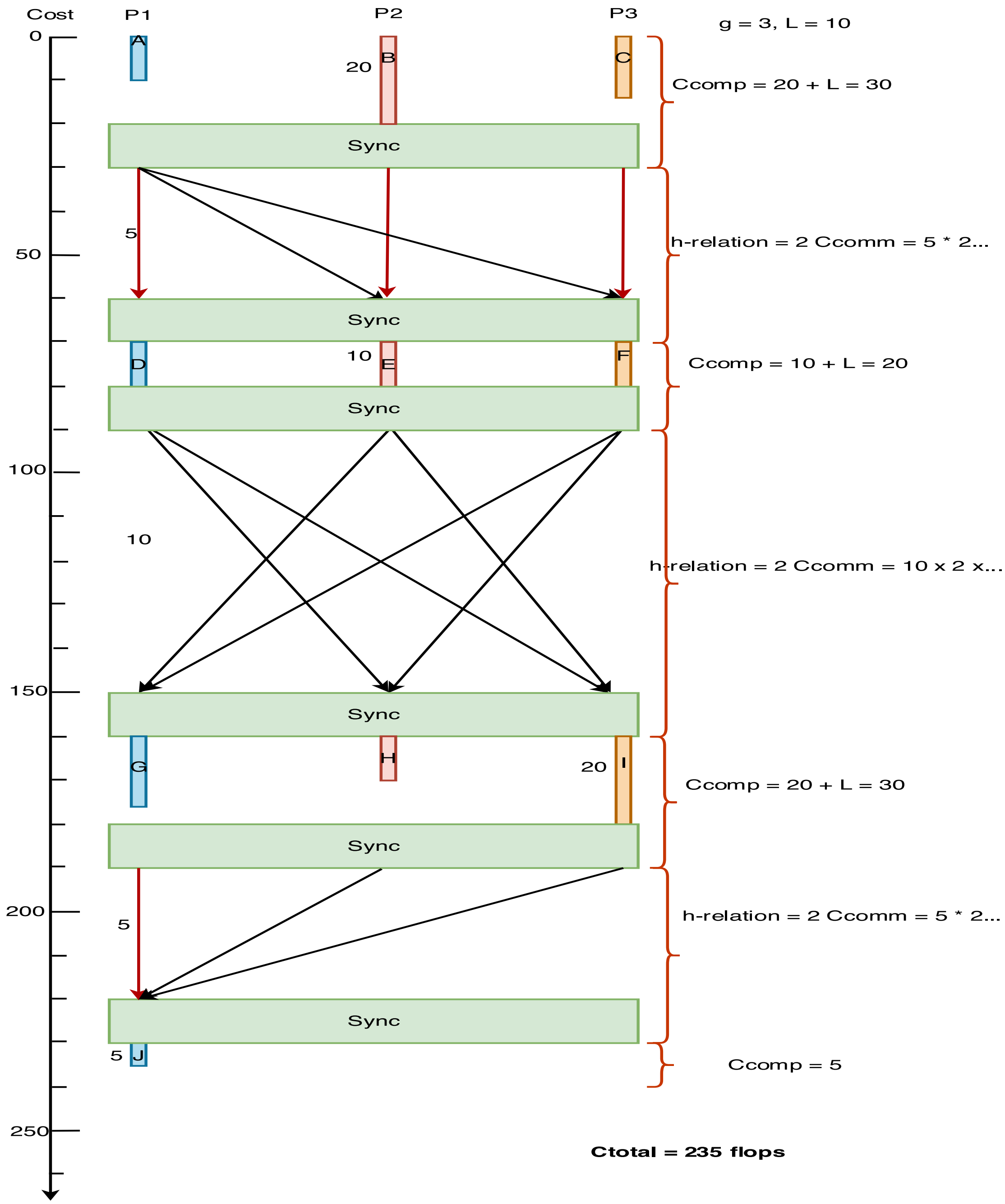
BSP

The figure shows the sequence graph for BSP. The lines marked in red are local data transfer within a processor which do not contribute to the communication cost of that processor.



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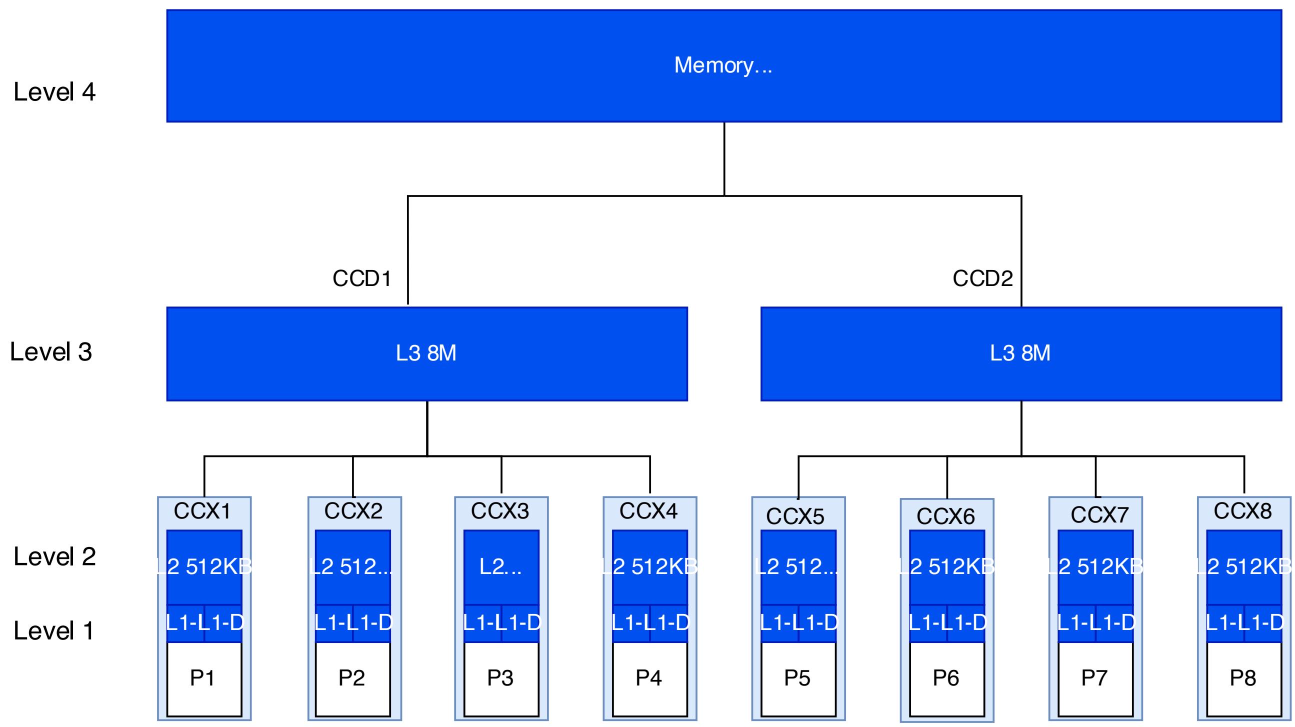
Multi-BSP

1. Hierarchy tree of Processor



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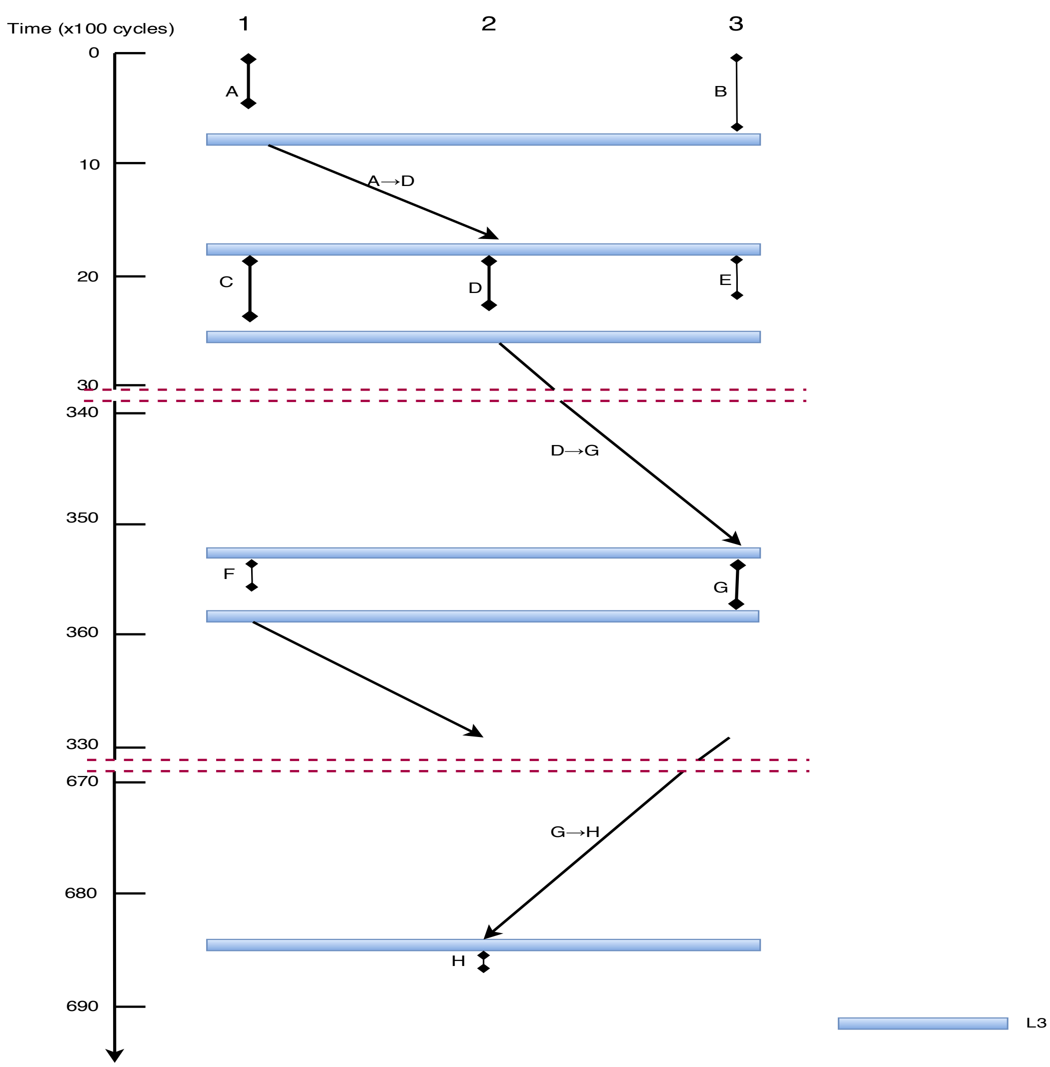
2. Processing Flow when All tasks are executed on 1 CCD

Task	Time	Start	Type	End
A5, B7	500, 700.0	0.0	Computation	700.0
Sync	40.0	700.0	Sync L3	740.0
A→D	1024.0	740.0	Transfer L3	1764.0
C7, D5, E3	700.0, 500, 300	1764.0	Computation	2464.0
Sync	40.0	2464.0	Sync L3	2504.0
D→G	32768.0	2504.0	Transfer L3	35272.0
F3, G5	300, 500.0	35272.0	Computation	35772.0
Sync	40.0	35772.0	Sync L3	35812.0
F→H	1024	35812.0	Transfer L3	36836.0
G→H	32768.0	36836.0	Transfer L3	68580.0
H2	200.0	68580.0	Computation	68780.0

The large range for the time forces the time axis to be broken for better visualization



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3. When tasks are executed on both CCDs

Task	Time	Start	Type	Level	End
A5, B7	500.0, 700.0	0.0	Computation	N/A	700.0
E3	300.0,	700			1000
Sync	40.0	500.0	Sync	L3	540.0
A→C(L3), A→D(L3), B→E(L3)	1024.0	740.0	Transfer	L3	1564.0
C7, D5	700.0, 500	1564.0	Computation	N/A	2264.0
Sync	300.0	2264.0	Sync	L4	2564.0
D→G(L4)	65536.0	2564.0	Transfer	L4+L3	68100.0
F3, G5	500.0	68100.0	Computation	N/A	68800.0
Sync	300.0	68600.0	Sync	L4	68900.0
F→H(L3), G→H(L4)	65536.0	68900.0	Transfer	L4+L3	134436.0
H2	200.0	134436.0	Computation	N/A	134636.0