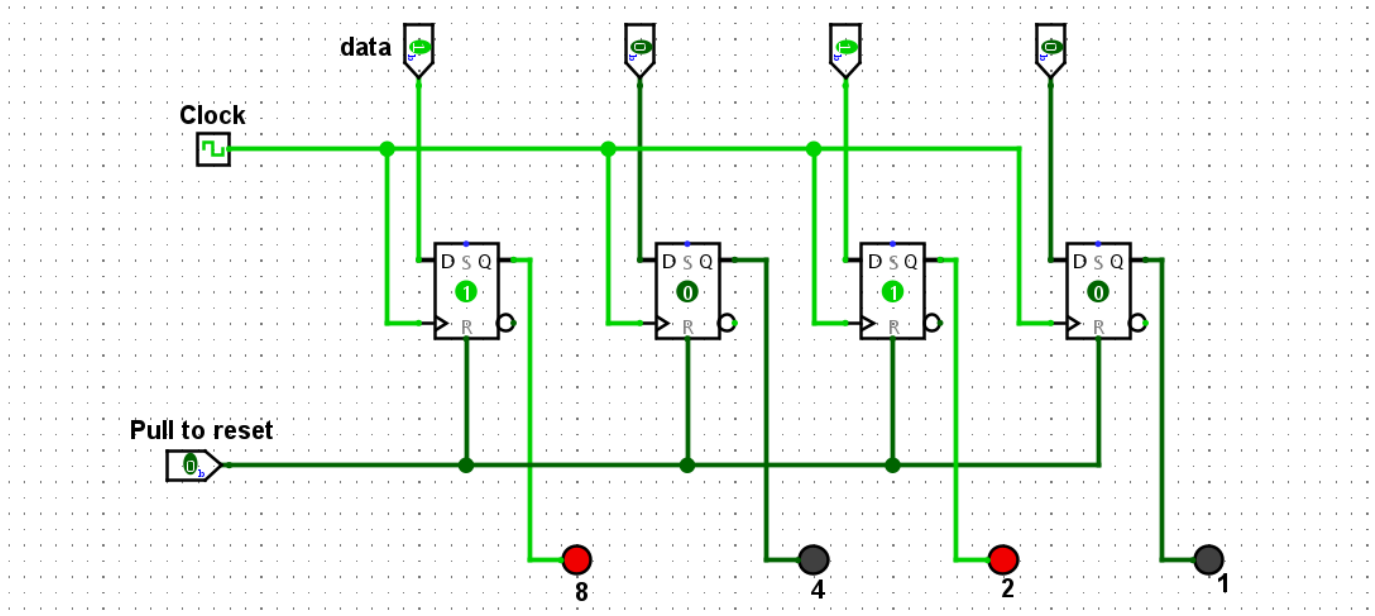
4-Bit Big-endian Register with D Flip Flops



Ox	*Input Binary*	*Output Binary*
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
A	1010	1010
B	1011	1011
C	1100	1100
D	1101	1101
E	1110	1110
F	1111	1111

Counters are fundamental to modern computing architectures. Review the lecture slides on counters and answer the following questions:

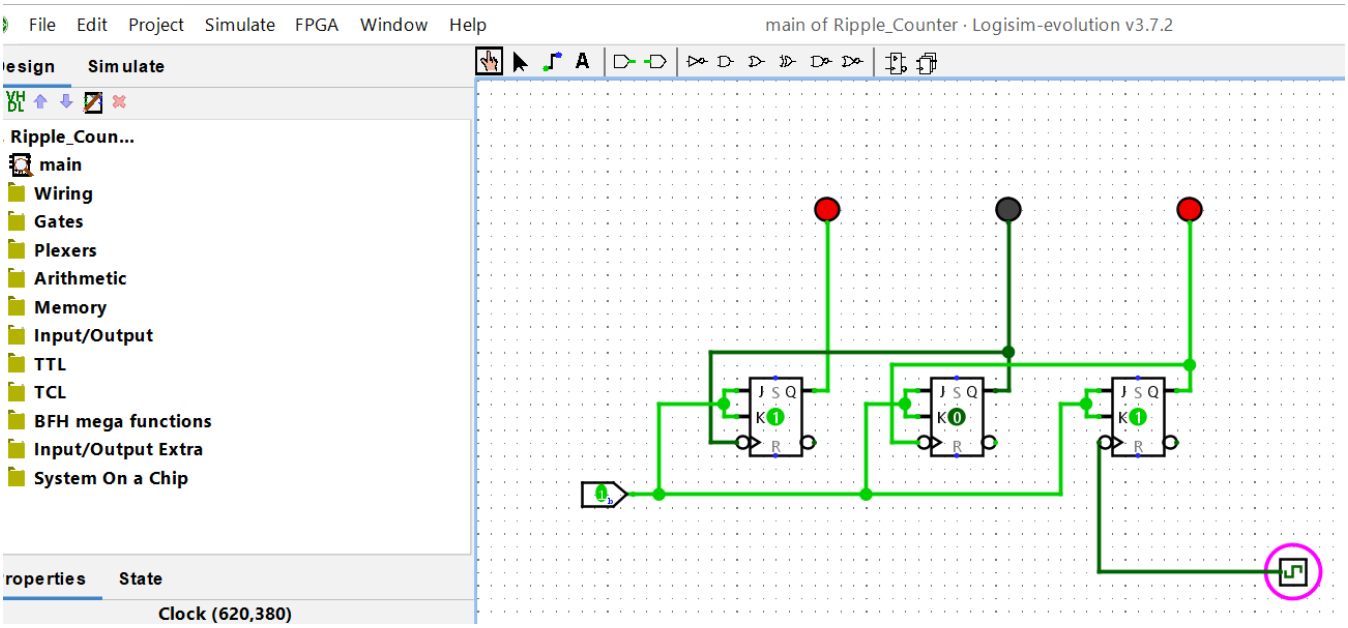
a) Name one crucial role (hardware) counters play in modern computing architectures?

Counters, being a circuit, store and increment the count of hardware-related occurrences of an event.

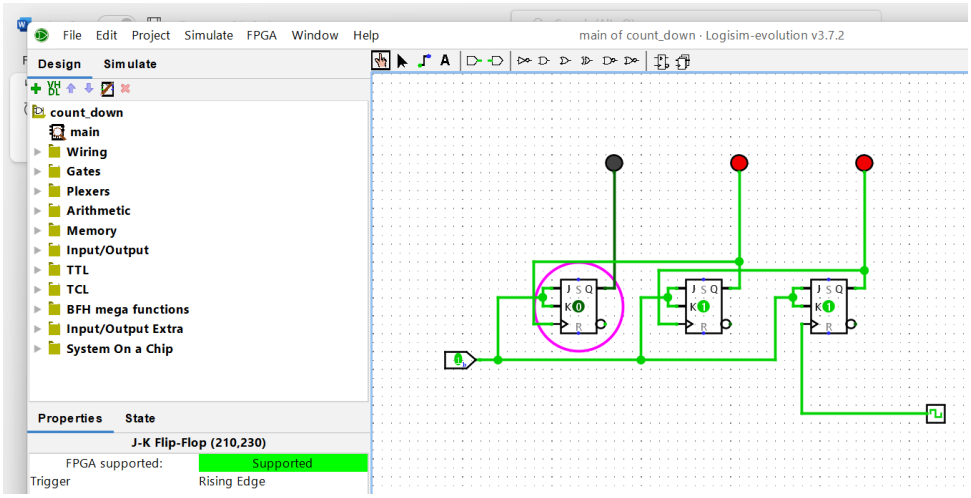
b) Describe in a few sentences how a ripple counter works. How does the "ripple" occur?

Ripple counter, being an asynchronous counter, uses the toggle setting of a J-K Flip-Flop to trigger the on/off from LEDs and this effect leads to ripple effect, also caused by clock pulse rippling through the circuit. This matches exactly binary counts.

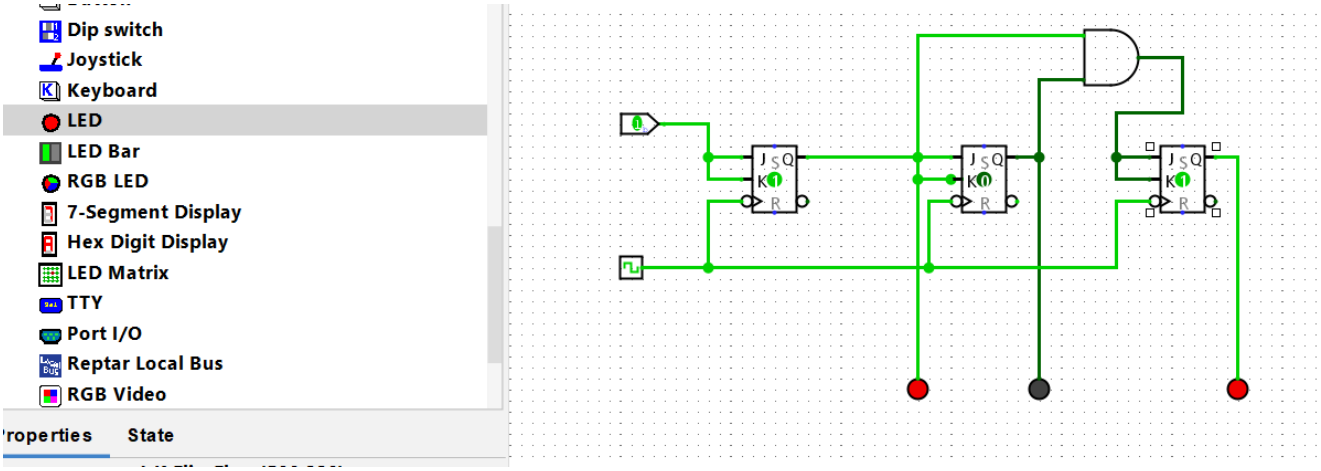
3-Bit Ripple Counter with J-K Flip Flops (from 000 to 111)



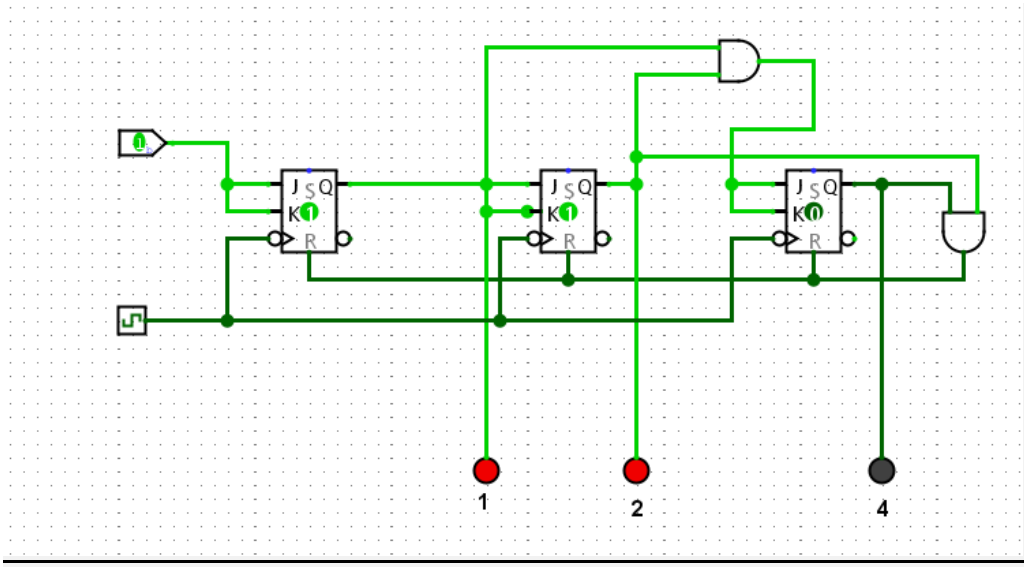
3-Bit Ripple 'count-down' Counter (from 111 to 000)



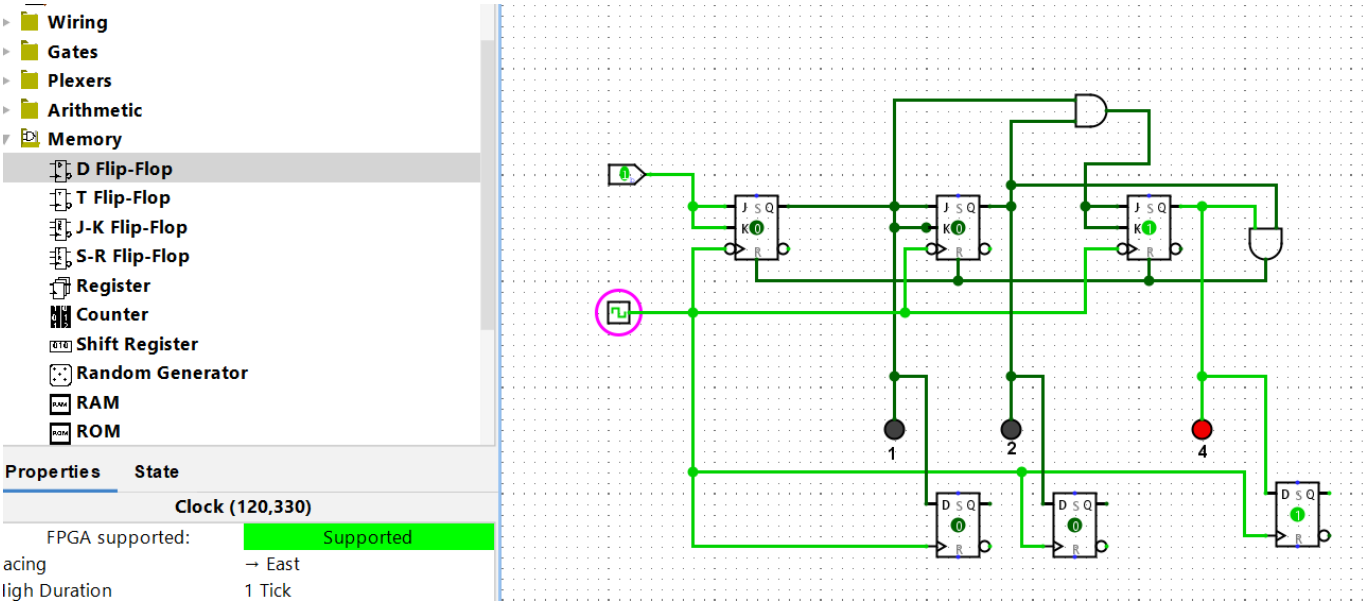
Common Clock



Common Clock counting from 0 to 5



Common Clock counting from 0 to 5 with D Flip-Flop acting as Buffer to eliminate Illegal State



Common Clock counting from 0 to 5 with D Flip-Flop acting as Buffer to eliminate Illegal State connected to a Hexadecimal Display