

SURNAME \_\_\_\_\_

FIRST NAME

1a) [Points 8/30] Draw the diagram of the MOESI protocol according to the above description.



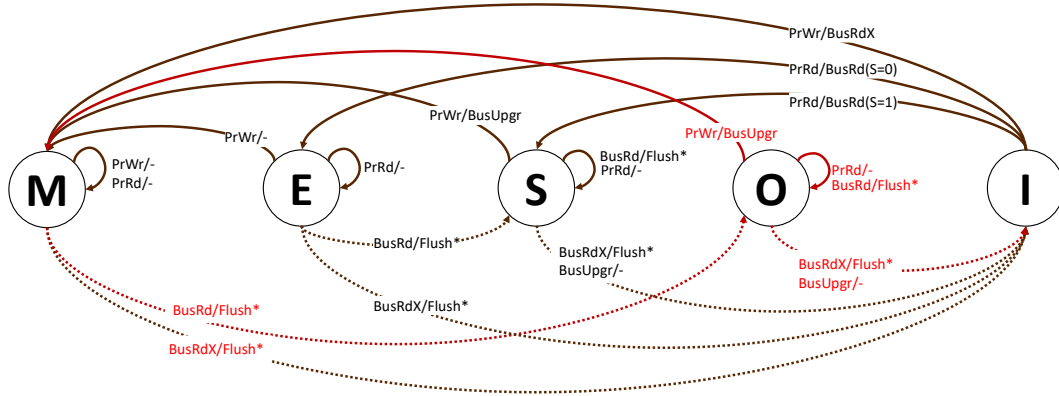
stream-1 MOESI	Core Operation	C1	C2	C3	Bus Transaction	Data from	Cycles
	PrRd1						
	PrWr1						
	PrRd1						
	PrWr1						
	PrRd2						
	PrWr2						
	PrRd2						
	PrWr2						
	PrRd3						
	PrWr3						
	PrRd3						
PrWr3							
TOTAL							
stream-2 MOESI	Core Operation	C1	C2	C3	Bus Transaction	Data from	Cycles
	PrRd1						
	PrRd2						
	PrRd3						
	PrWr1						
	PrWr2						
	PrWr3						
	PrRd1						
	PrRd2						
	PrRd3						
	PrWr3						
	PrWr1						
TOTAL							
stream-3 MOESI	Core Operation	C1	C2	C3	Bus Transaction	Data from	Cycles
	PrRd1						
	PrRd2						
	PrRd3						
	PrRd3						
	PrWr1						
	PrWr1						
	PrWr1						
	PrWr1						
	PrWr2						
PrWr3							
TOTAL							

**EXERCIZE 1a)**

First, we start drawing the states of the MESI protocol, and then let's focus on the M-state and O-state.

**M-state:** PrRd and PrWr are exactly as in MESI; however, when there is a BusRd, the copy enters into O-state while providing the copy to the requesting cache (via a Flush\* transactions) without the need of updating the memory; since it is now the cache with the copy in O-state that has the responsibility to provide a shared-modified copy, the memory is updated on replacement (i.e., for cache conflicts) of M copies or O copies. If a BusRdX transaction is observed in M-state, that cache provides the copy (via a Flush\* transaction ) to the requesting cache and change its state from M to I.

**O-state:** since it is now this state that has the responsibility to update memory on replacement or to provide the copy to other caches, the local read or write behave like in the S-state; similar for BusRd, BusRdX or BusUpgr the O-state will have the same behavior for operations and transactions happening in the S-state.

**EXERCIZE 1b)**

stream-1 MOESI	Core Operation	C1	C2	C3	Bus Transaction	Data from	Cycles
	PrRd1	E	I	I	BusRd (S=0)	Mem	90
	PrWr1	M			-	-	1
	PrRd1	M			-	-	1
	PrWr1	M			-	-	1
	PrRd2	O	S		BusRd (S=1) , Flush*	C1	90+20
	PrWr2	I	M		BusUpgr	-	60
	PrRd2		M		-	-	1
	PrWr2		M		-	-	1
	PrRd3		O	S	BusRd (S=1) , Flush*	C2	90+20
	PrWr3		I	M	BusUpgr	-	60
	PrRd3			M	-	-	1
	PrWr3			M	-	-	1
	TOTAL						437
stream-2 MOESI	Core Operation	C1	C2	C3	Bus Transaction	Data from	Cycles
	PrRd1	E	I	I	BusRd (S=0)	Mem	90
	PrRd2	S	S		BusRd (S=1) , Flush*	C1	90+20
	PrRd3	S	S	S	BusRd (S=1) , Flush*	C1/C2	90+20
	PrWr1	M	I	I	BusUpgr	-	60
	PrWr2	I	M		BusRdX, Flush*	C1	90+20
	PrWr3		I	M	BusRdX, Flush*	C2	90+20
	PrRd1	S		O	BusRd (S=1) , Flush*	C3	90+20
	PrRd2	S	S	O	BusRd (S=1) , Flush*	C3	90+20
	PrRd3	S	S	O	-	-	1
	PrWr3	I	I	M	BusUpgr	-	60
	PrWr1	M		I	BusRdX, Flush*	C3	90+20
	TOTAL						981
stream-3 MOESI	Core Operation	C1	C2	C3	Bus Transaction	Data from	Cycles
	PrRd1	E	I	I	BusRd (S=0)	Mem	90
	PrRd2	S	S		BusRd (S=1) , Flush*	C1	90+20
	PrRd3	S	S	S	BusRd (S=1) , Flush*	C1/C2	90+20
	PrRd3	S	S	S	-	-	1
	PrWr1	M	I	I	BusUpgr	-	60
	PrWr1	M			-	-	1
	PrWr1	M			-	-	1
	PrWr1	M			-	-	1
	PrWr2	I	M		BusRdX, Flush*	C1	90+20
	PrWr3		I	M	BusRdX, Flush*	C2	90+20
	TOTAL						594