

Note: empty entries in the table indicate state+event pairs that will not happen and do not need to be supported by the cache controller

Note: the term "state" means the cache controller should transition to the state provided by the coherence message; the cache controller can assume the state provided is the correct next state

Note: For the cache controller, implementing a protocol is simply implementing the subset of rows from MOESIF that are required, M and I are required at a minimum, F and O require S to be present

#### MOESIF - Cache Controller / LCE

	Core Action		CCE Action								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Shared (S)</b>	hit	Write Req	InvAck / I		store / state (M)	-- / state					
<b>Exclusive (E)</b>	hit	hit / M					Null WB / state	Null WB / E		Set Tag + Data / state	Set Tag + Data, Null WB / state
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state
<b>Owned (O)</b>	hit	Write Req			store / state (M)		WB / state	WB / O	Set Tag + Data / O	Set Tag + Data / state	
<b>Forward (F)</b>	hit	Write Req			store / state (M)	-- / state			Set Tag + Data / F	Set Tag + Data / state	
			Invalidate sharer on Write Req	Data from Dir Data from Owner	Upgrade	Downgrade Replacement Inv	Downgrade Replacement Inv	Update Mem	Data from Owner on Read Req	Data from Owner on Write Req	Data from Owner on Read Req

**MI - Cache Controller / LCE**

	Core Action		Coherence Message								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state

**MSI - Cache Controller / LCE**

	Core Action		Coherence Message								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Shared (S)</b>	hit	Write Req	InvAck / I		store / state (M)	-- / state					
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state

**MESI - Cache Controller / LCE**

	Core Action		Coherence Message								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		Do load or store/ State							
<b>Shared (S)</b>	Hit	Write Req	InvAck / I		Do store / M	-- / State					
<b>Exclusive (E)</b>	Hit	Hit / M					Null WB / State	Null WB / E		Set Tag + Data / State	Set Tag + Data, Null WB / State
<b>Modified (M)</b>	Hit	Hit					WB / State	WB / M		Set Tag + Data / State	Set Tag + Data, WB / State
			Invalidate	Data from Directory or Owner	Upgrade	Downgrade	Replacement / Eviction	Writeback	Unused in MESI	Transfer dirty block to new writer	Transfer block to new reader, downgrade to S

**MESIF - Cache Controller / LCE**

	Core Action		CCE Action								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Shared (S)</b>	hit	Write Req	InvAck / I		store / state (M)	-- / state					
<b>Exclusive (E)</b>	hit	hit / M					Null WB / state	Null WB / E		Set Tag + Data / state	Set Tag + Data, Null WB / state
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state
<b>Forward (F)</b>	hit	Write Req			store / state (M)	-- / state			Set Tag + Data / F	Set Tag + Data / state	

**MOSI - Cache Controller / LCE**

	Core Action		CCE Action								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Shared (S)</b>	hit	Write Req	InvAck / I		store / state (M)	-- / state					
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state
<b>Owned (O)</b>	hit	Write Req			store / state (M)		WB / state	WB / O	Set Tag + Data / O	Set Tag + Data / state	

**MOSIF - Cache Controller / LCE**

	Core Action		CCE Action								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Shared (S)</b>	hit	Write Req	InvAck / I		store / state (M)	-- / state					
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state
<b>Owned (O)</b>	hit	Write Req			store / state (M)		WB / state	WB / O	Set Tag + Data / O	Set Tag + Data / state	
<b>Forward (F)</b>	hit	Write Req			store / state (M)	-- / state			Set Tag + Data / F	Set Tag + Data / state	

**MOESI - Cache Controller / LCE**

	Core Action		CCE Action								
State	Load	Store	Invalidate	Set Tag + Data	Set State + Wakeup	Set State	Set State + Writeback	Writeback	Transfer	Set State + Transfer	Set State + Transfer + Writeback
<b>Invalid (I)</b>	Read Req	Write Req		do load or store / state							
<b>Shared (S)</b>	hit	Write Req	InvAck / I		store / state (M)	-- / state					
<b>Exclusive (E)</b>	hit	hit / M					Null WB / state	Null WB / E		Set Tag + Data / state	Set Tag + Data, Null WB / state
<b>Modified (M)</b>	hit	hit					WB / state	WB / M		Set Tag + Data / state	Set Tag + Data, WB / state
<b>Owned (O)</b>	hit	Write Req			store / state (M)		WB / state	WB / O	Set Tag + Data / O	Set Tag + Data / state	