

## EECS 570 Program Assignment 2

### Hsiang-Yang Fan

#### Description of MSI protocol

The baseline mechanism in my MSI 3-hop protocol has three virtual channels VC0, VC1, and VC2. The lowest priority in my virtual channel is VC0, it sends the initial request (ex. GetM or GetS) from the processor to the HomeNode. The highest priority is VC2, the reply to the initial messages will be sent through VC2.

The messages that I add are the acknowledged count for the sharers, there may have circumstances that have multiple sharers or only one sharer, if acknowledged count equals to 1 and IsSharer function is correct. There is only one sharer in the sharer list. However, if acknowledged counts larger than 1 and IsSharer function is incorrect. There are multiple sharers in the sharer list. For example, when the directory is in the shared state and receives a GetM request from one of the processors, the requesting processor is expected to receive two acknowledged invalid counts from multiple sharers. The directory will send the Data message, which included the data value and acknowledged count of 2 to the processor who is requesting it through the highest priority VC2. When the count eventually returns to 0, it means that the processor has received all the acknowledged invalid from sharers. The FinishInvReqToSharers procedure will then send the Inv messages to all sharers in order to make the directory into Modify state.

#### Verification approach

I have created several invariants and rules for checking the correctness of my MSI protocol. Eventually, I have the state of no error, the state space explored 21451 states and 75664 rules have been simulated, as well. Therefore, the results match my expectations.

```
Status:
    No error found.

State Space Explored:
    21451 states, 75664 rules fired in 2.05s.

Analysis of State Space:
    There are rules that are never fired.
    If you are running with symmetry, this may be why. Otherwise,
    please run this program with "-pr" for the rules information.
    The maximum size for the multiset "HomeNode.sharers" is: 3.
    The maximum size for the multiset "Net[HomeType]" is: 4.
    The maximum size for the multiset "Net[Proc_1]" is: 4.
    The maximum size for the multiset "Net[Proc_2]" is: 4.
    The maximum size for the multiset "Net[Proc_3]" is: 4.
```

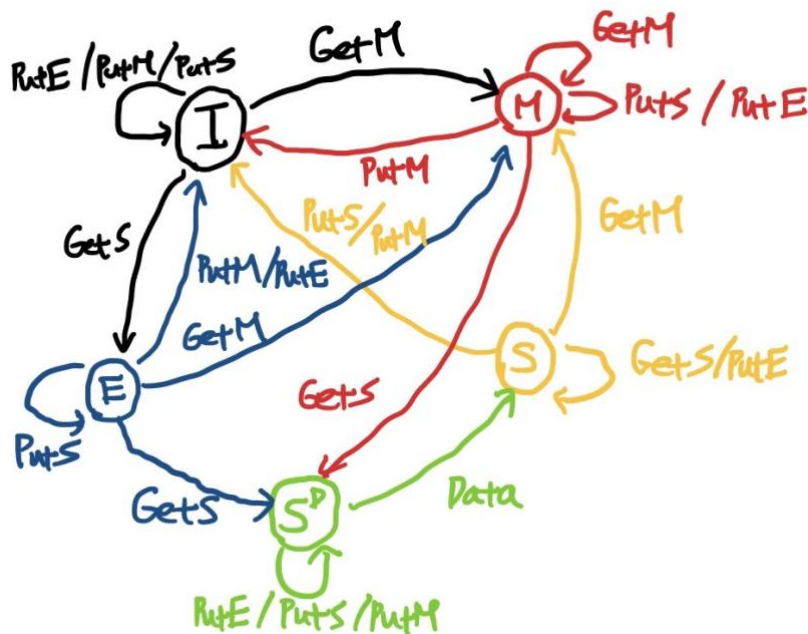
## Description of MESI protocol

In my MESI protocol, I add the Exclusive state. Hence, the added directory node is called H\_E. The virtual channel of MESI is same as MSI protocol to prevent deadlock. The rule that evicted in the Exclusive state is added in the rule section, it will send the PutE request to directory. After receiving the message, The processor state will then transfer to transient state EI\_A.

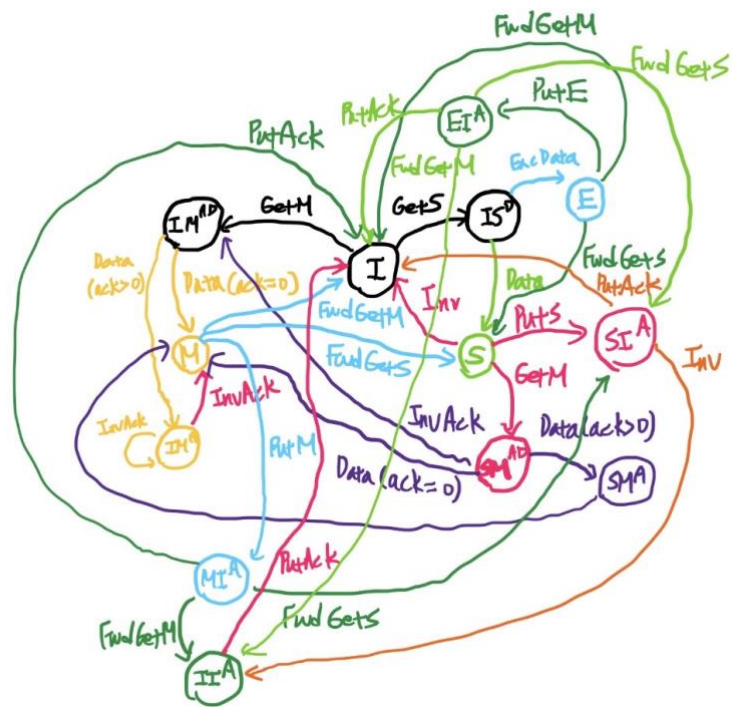
## Verification approach

After compiling and simulating the MESI protocol. There is no error found and the results have been simulating with 24998 states and 116326 rules through Murphi.

```
Status:
    No error found.
State Space Explored:
    24998 states, 116326 rules fired in 2.93s.
Analysis of State Space:
    There are rules that are never fired.
    If you are running with symmetry, this may be why. Otherwise,
    please run this program with "-pr" for the rules information.
    The maximum size for the multiset "HomeNode.sharers" is: 3.
    The maximum size for the multiset "Net[HomeType]" is: 4.
    The maximum size for the multiset "Net[Proc_1]" is: 4.
    The maximum size for the multiset "Net[Proc_2]" is: 4.
    The maximum size for the multiset "Net[Proc_3]" is: 4.
```



Directory of MESI



Cache Controller of MESI