## Hoare's Monitor Model

An object-based synchronization mechanism.



## Condition Synchronization

Mutual exclusion is insufficient to guarantee that operations only happen when the system is in a proper "state" for the operation to be done without loss of safety

A condition on the state of the system must be associated with the operation in such a way that the operation is only attempted when the condition is true



## Condition Synchronization

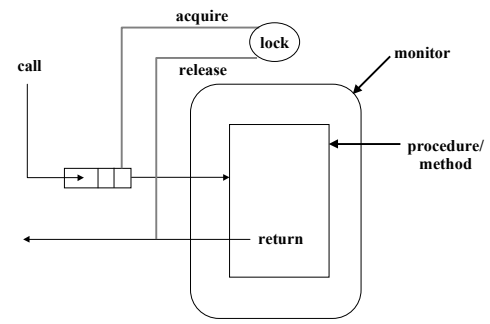
**Examples**:

- Producer-Consumer problem
  - produce only when buffer is not full
  - consume only when buffer is not empty
- Readers-Writer problem
  - readers may read if the only other operation in progress is another read operation
  - writers may write if there is no other operation in progress of either kind

Evaluating the condition requires that the state of the system not change during the condition's evaluation ==> mutual exclusion during the evaluation

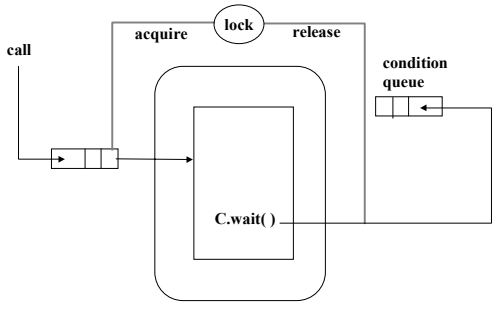


## Hoare's Monitor Model






## Hoare's Monitor Model



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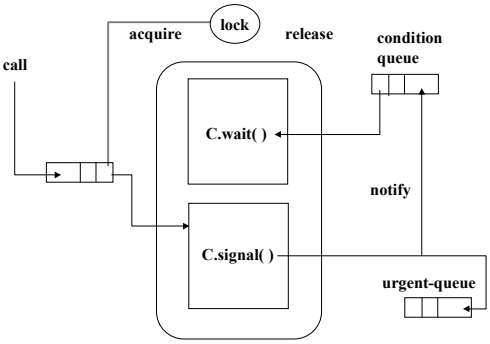

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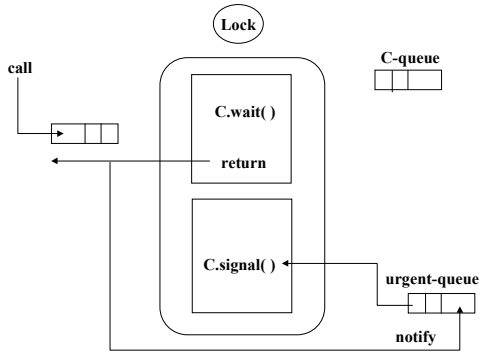




## Hoare's Monitor Model

```
monitor BoundedCounter
begin
   condition belowMax, aboveMin;
   integer value;
   constant MAX=100, MIN=0;
   void value() begin return value; end
   void inc()
      begin
         if (value == MAX) belowMax.wait();
         value = value + 1;
         if (value == MIN+1) aboveMin.signal();
         return;
      end
   void dec()
      begin
         if(value == MIN) aboveMin.wait();
         value = value - 1;
         if(value == MAX-1) belowMax.signal();
         return;
      end
   begin
      value = MIN;
   end
end
```