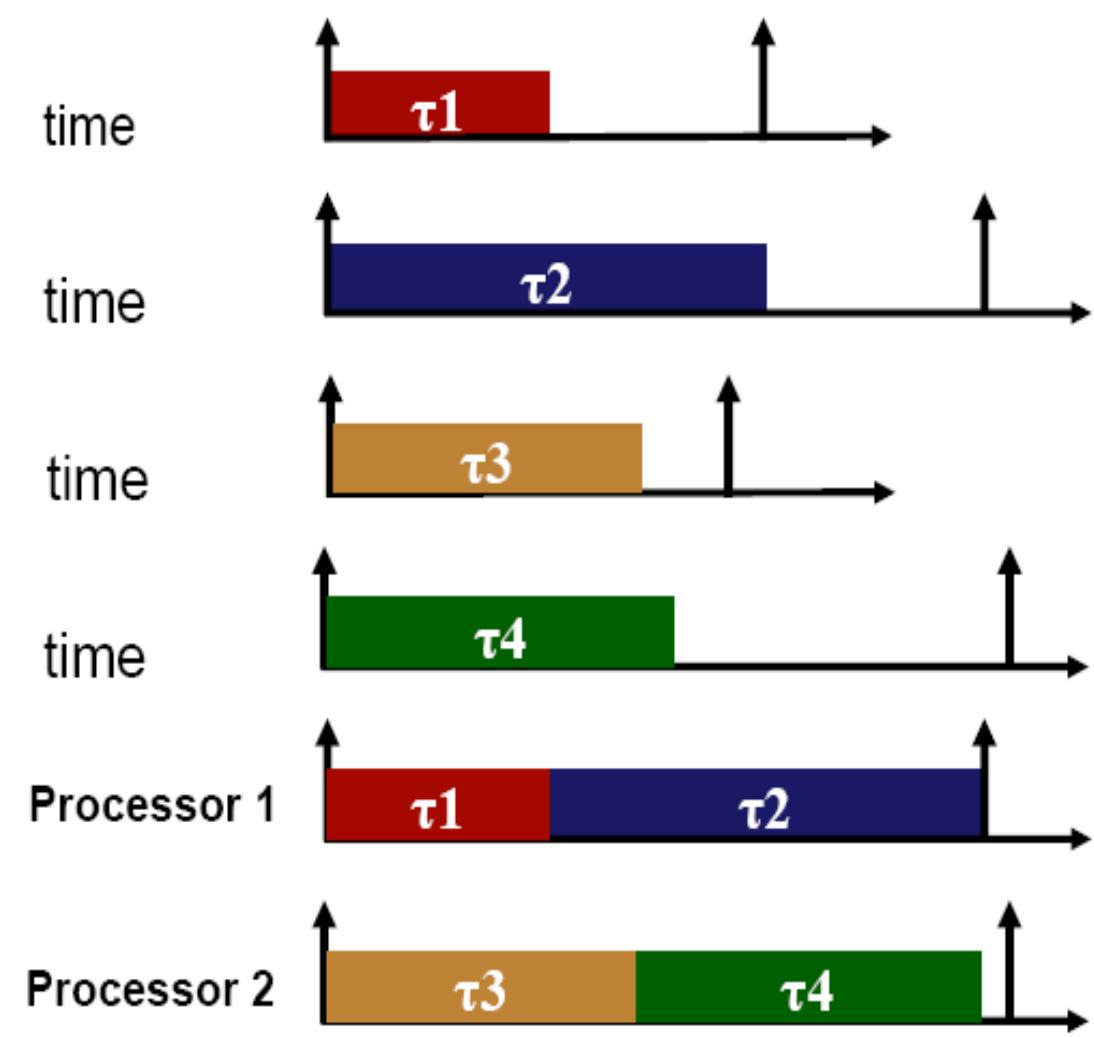


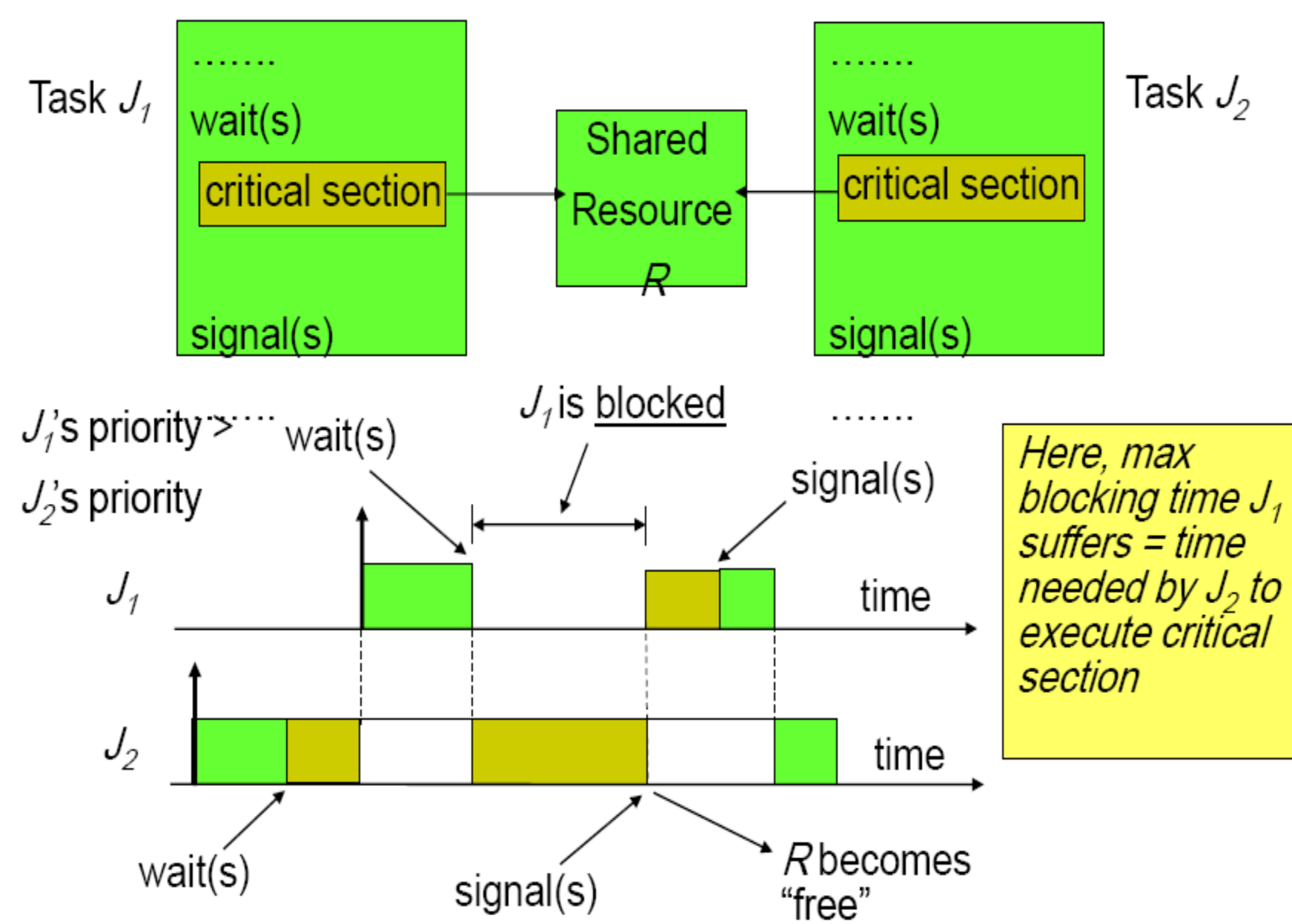
STM Concurrency Control for Embedded Real-Time Software with Tighter Time Bounds

Real-Time Scheduling on Multicores



- G-EDF: Global Earliest Deadline First
- G-RMA: Global Rate Monotonic Algorithm

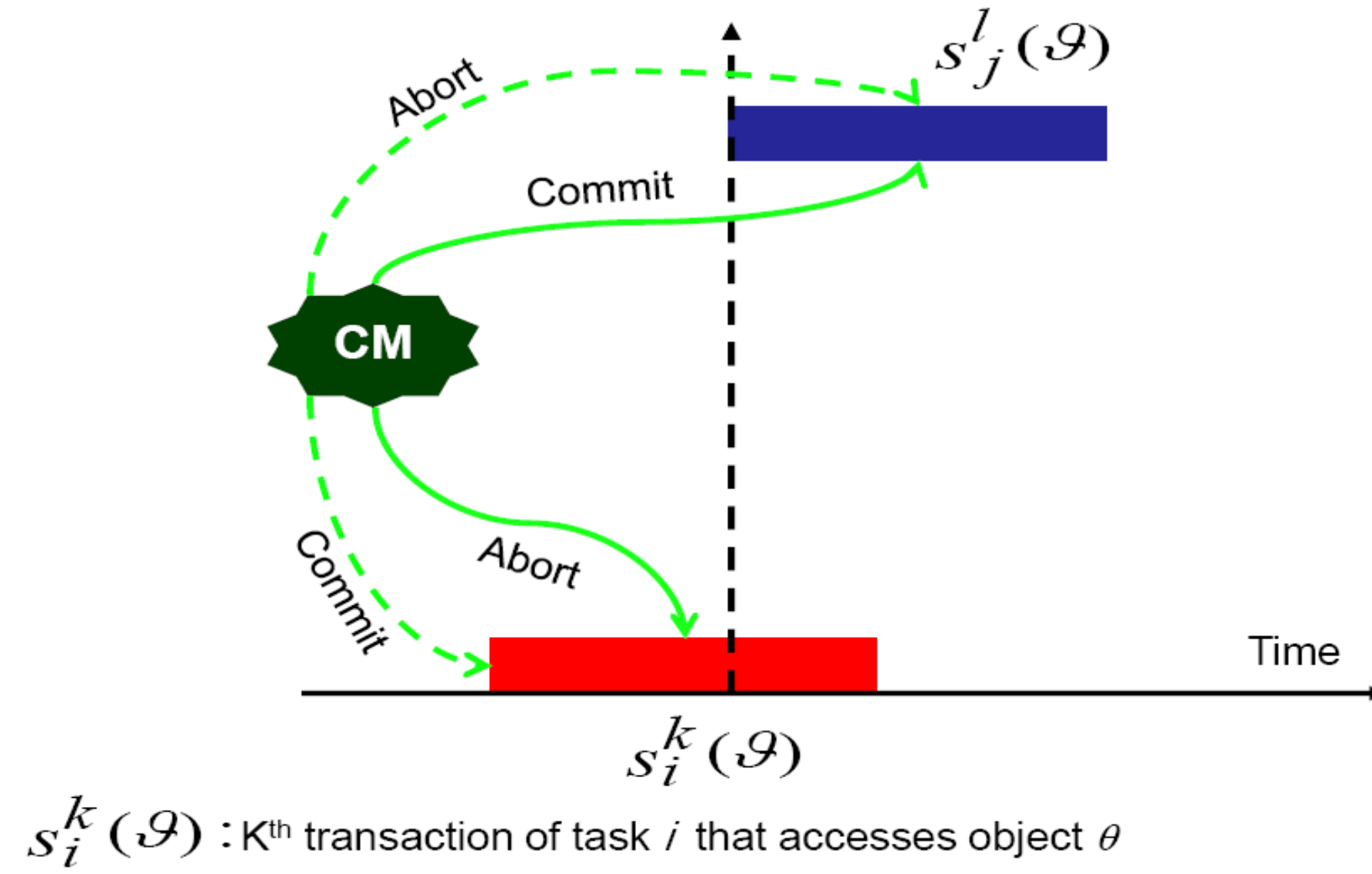
Real-Time Concurrency Control



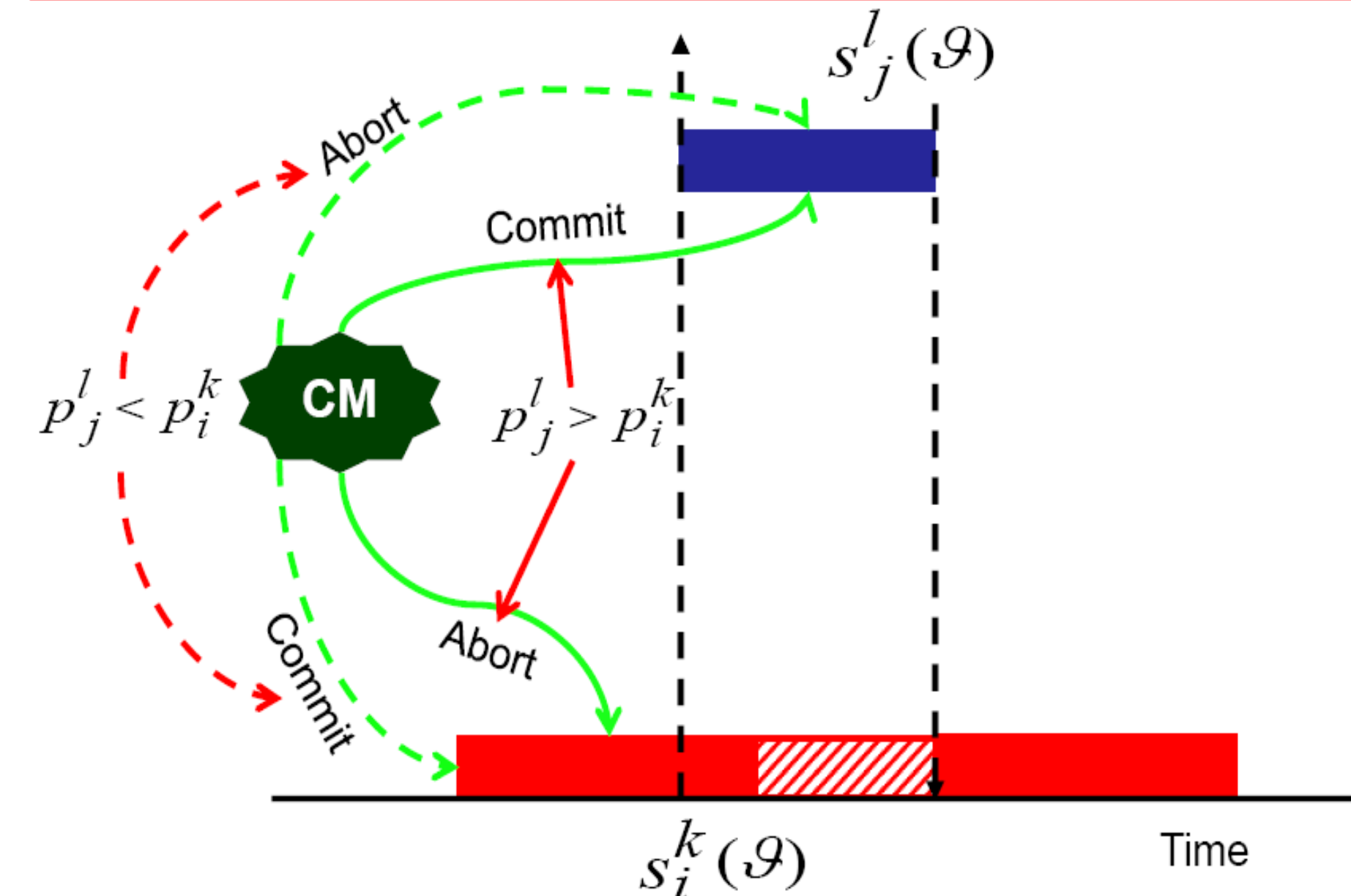
- Real-time locking protocols
 - ❖ PIP, PCP, SRP
- Lock-free and wait-free
- (Software) Transactional Memory (S)TM
 - ❖ Like database transactions
 - ❖ Atomicity, Consistency, Isolation and Durability properties
 - ❖ Easier to program
 - ❖ Fine-grained performance
 - ❖ Composable
- STM uses Contention Manager (CM) to resolve conflicts

```
public boolean add(int item) {
    Node pred, curr;
    atomic {
        pred = head;
        curr = pred.next;
        while (curr.val < item) {
            pred = curr;
            curr = curr.next;
        }
        if (item == curr.val) {
            return false;
        } else {
            Node node = new Node(item);
            node.next = curr;
            pred.next = node;
            return true;
        }
    }
}
```

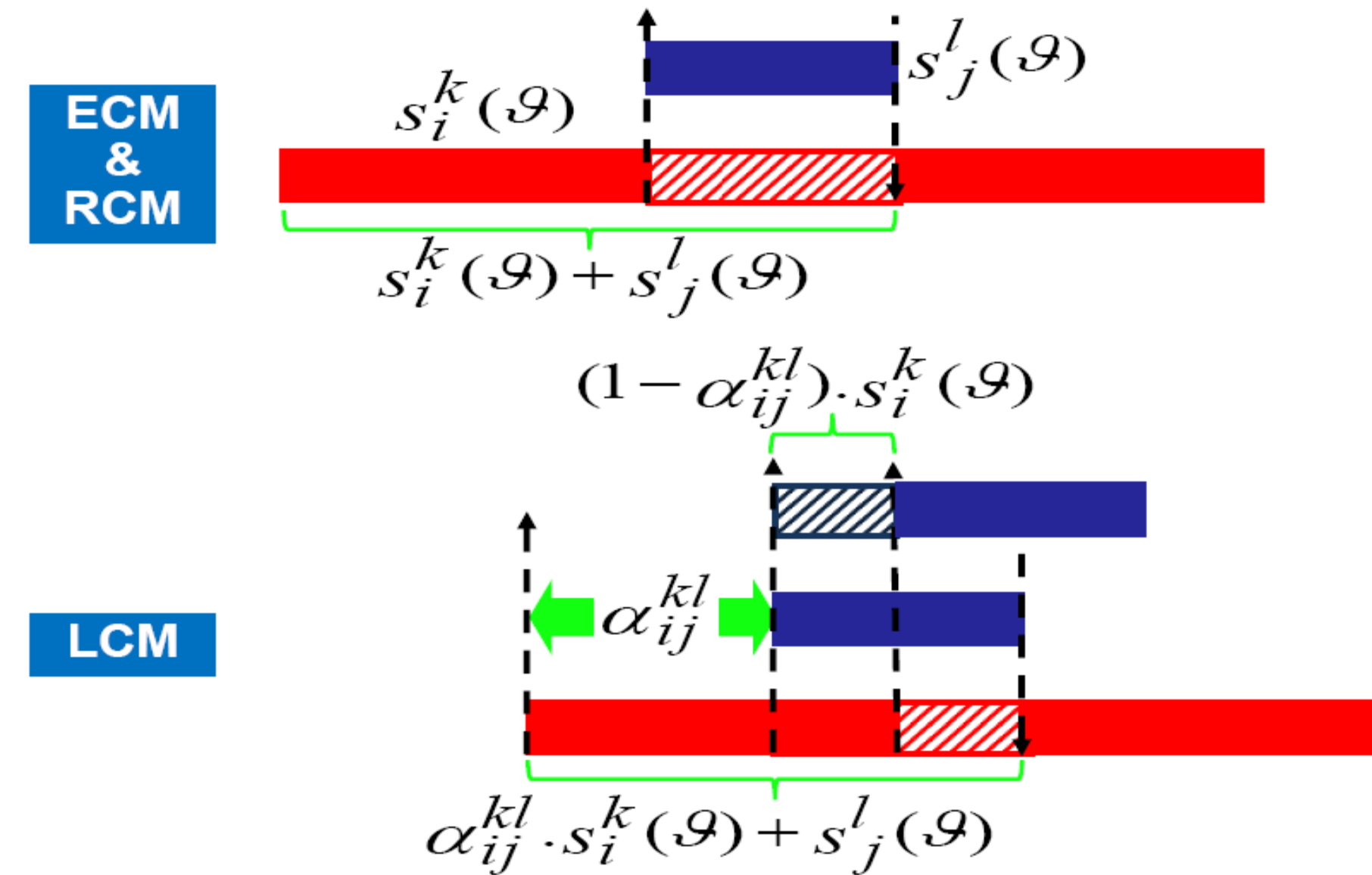
Real-Time STM Concurrency Control



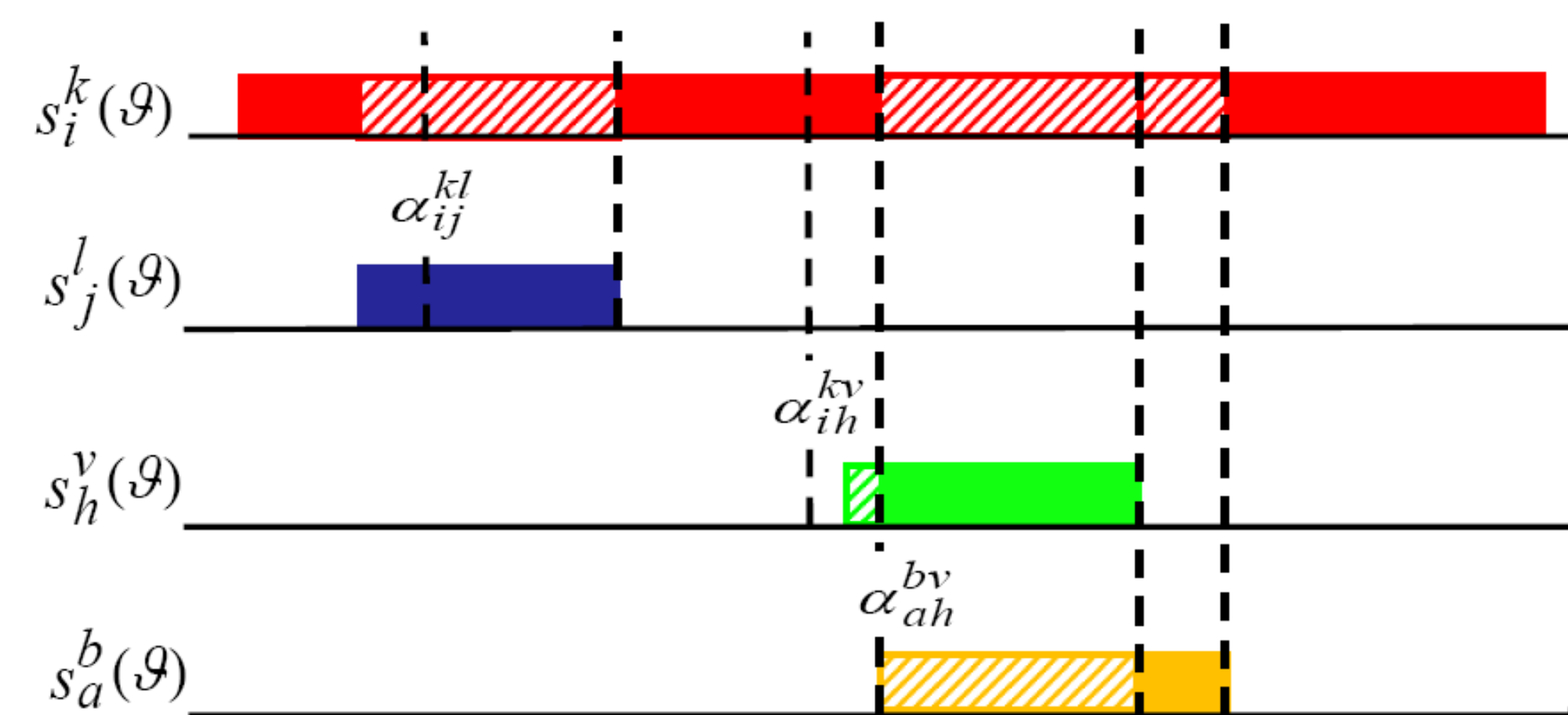
Earliest Deadline (ECM) and Rate Monotonic (RCM)



Length-based CM (LCM)

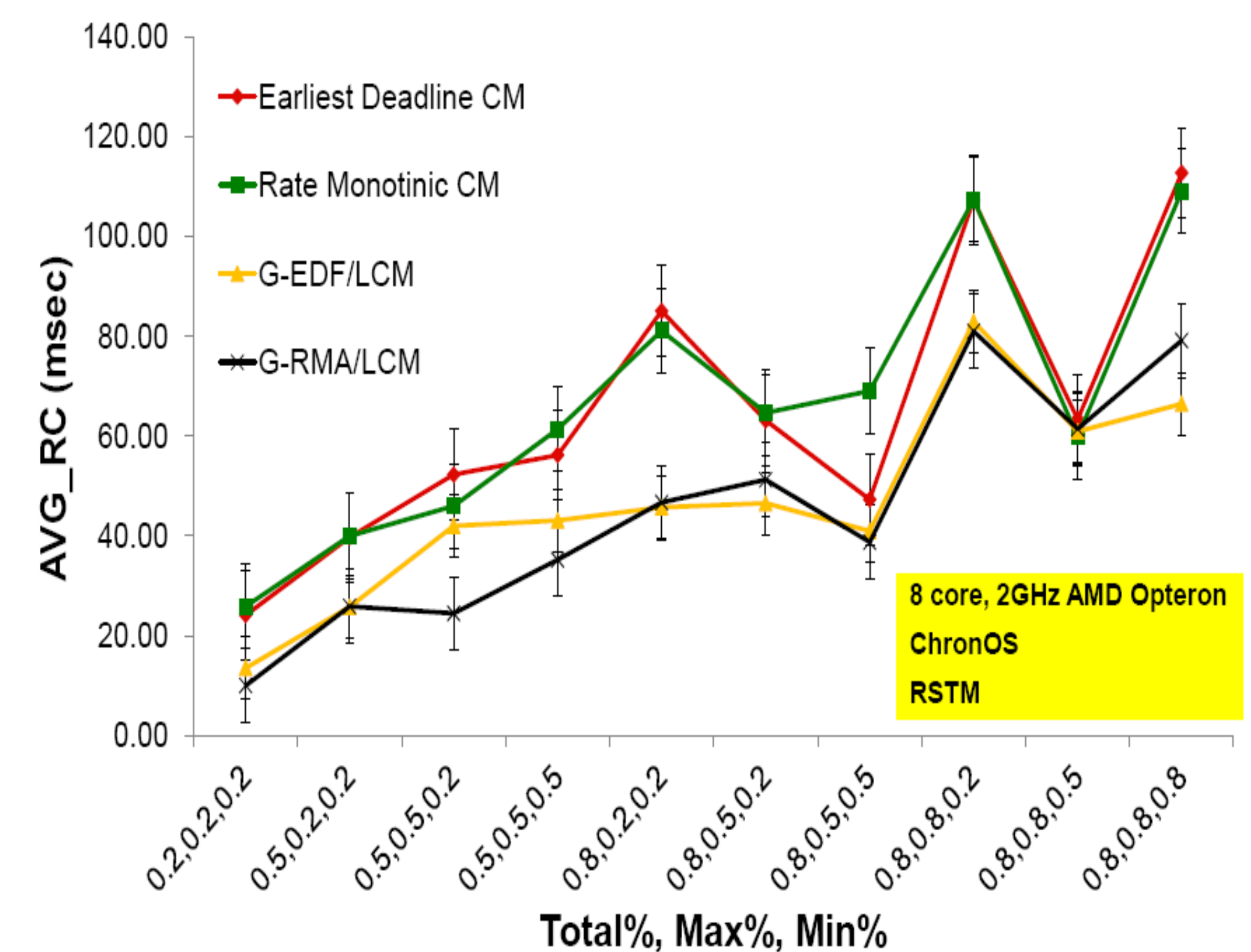
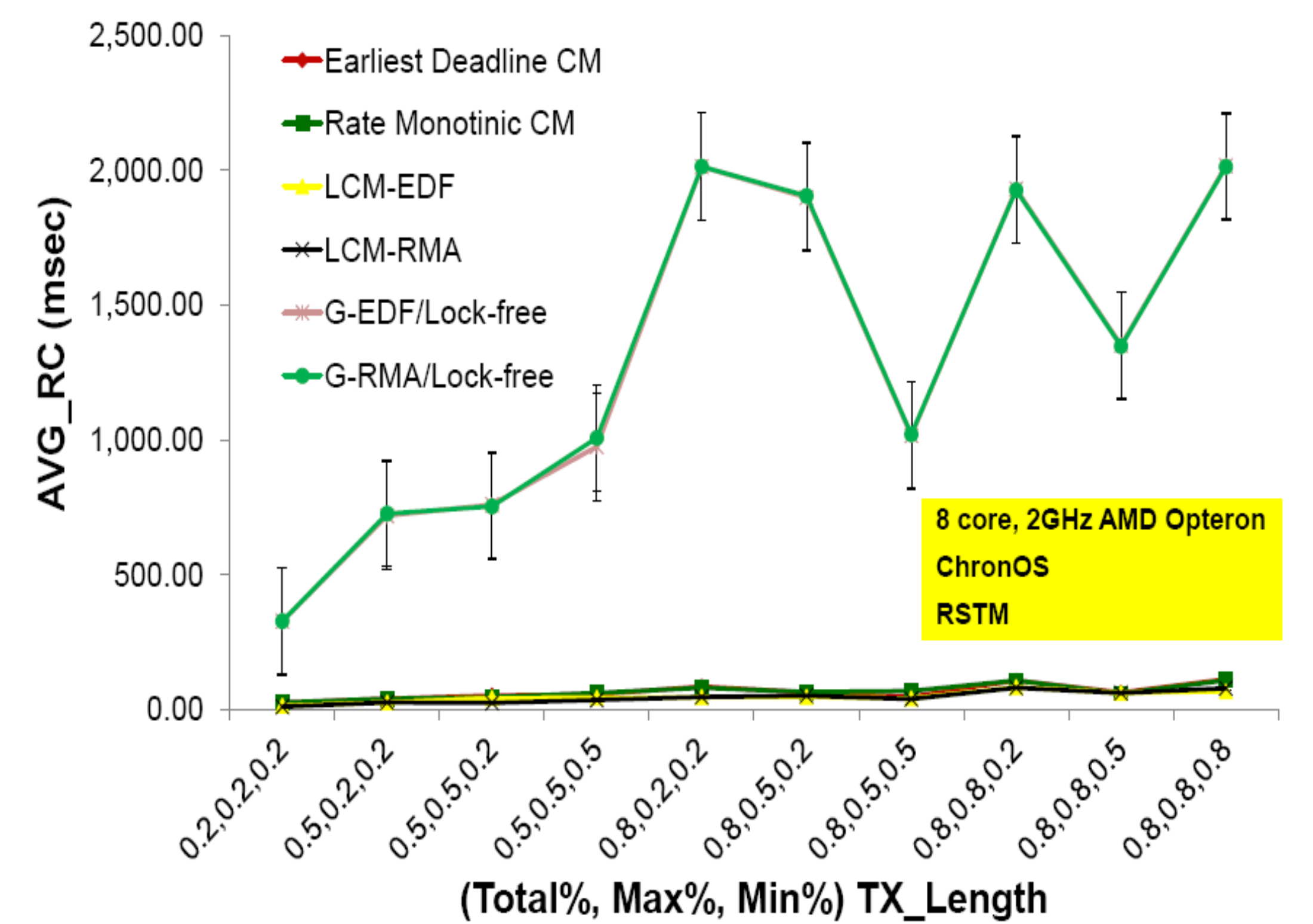


LCM Example



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<http://www.real-time.ece.vt.edu>

Implementation Results (8 Tasks - 8 Cores)



Conclusions

- LCM considers priority, as well as remaining execution length of interfered transaction
- ECM & RCM → Retry cost of $2 \times \text{smax}$
- LCM → Retry cost of $(1 + \alpha_{\text{max}}) \times \text{smax}$
- Higher priority task can be delayed by lower priority task
- By proper choice of α_{max} and α_{min} , schedulability of G-EDF/LCM (G-RMA/LCM) is equal or better than ECM (RCM)
- $\text{smax}/\text{rmax} \Rightarrow 0.5$ to 2 for better schedulability of G-EDF/LCM than lock-free
- $\text{smax}/\text{rmax} \Rightarrow 0.5$ Large-values for better schedulability of G-RMA/LCM than lock-free