

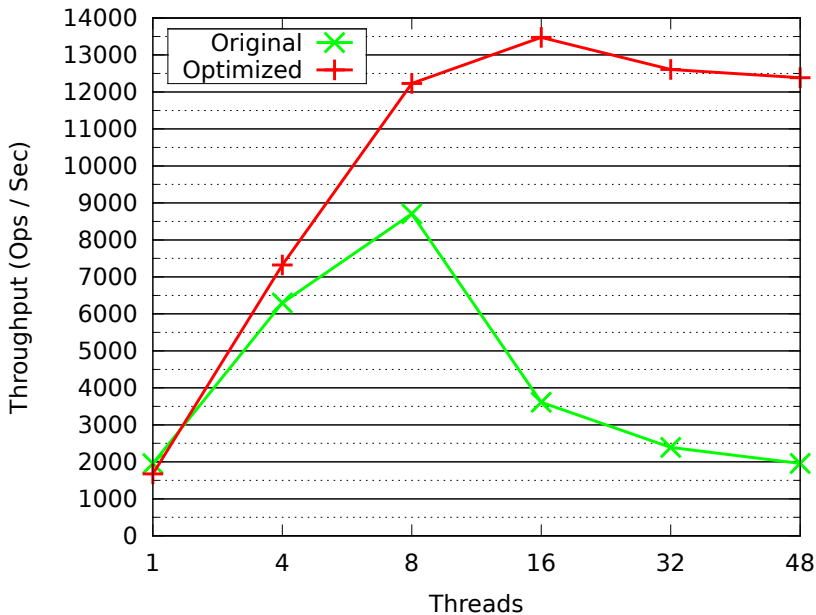
# Profiling and tuning the performance of an STM-based concurrent program

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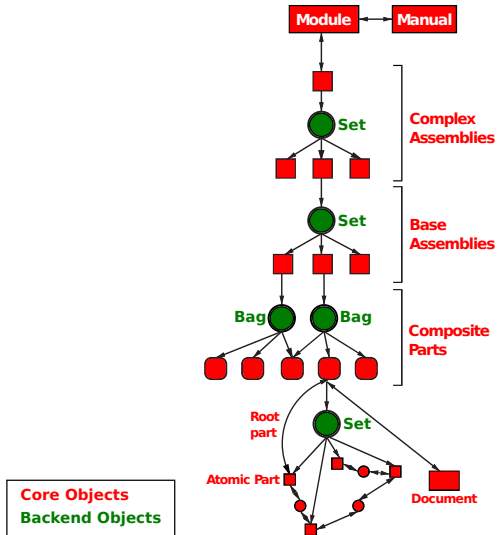
INESC-ID/Technical University of Lisbon

October 23, 2011

Workshop on Transitioning to MultiCore  
(TMC'11)



# STMBench7



# JVSTM

## Java Versioned Software Transactional Memory

```
01 class Counter {  
02     int c = 0;  
03  
04     void inc() { c = c + 1; }  
05     void reset() { c = 0; }  
06     int get() { return c; }  
07 }
```

# JVSTM

## Java Versioned Software Transactional Memory

```
01 class Counter {  
02     int c = 0;  
03  
04     @Atomic void inc() { c = c + 1; }  
05     @Atomic void reset() { c = 0; }  
06     @Atomic int get() { return c; }  
07 }
```

# JVSTM

## Java Versioned Software Transactional Memory

```
01 class Counter {  
02     final VBox<Integer> c = new VBox<Integer>(0);  
03  
04     @Atomic void inc() { c = c + 1; }  
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07 }
```

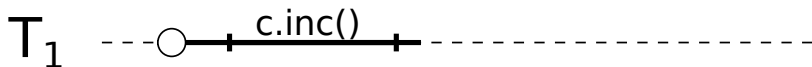
# JVSTM

## Java Versioned Software Transactional Memory

```
01 class Counter {  
02     final VBox<Integer> c = new VBox<Integer>(0);  
03  
04     @Atomic void inc() { c.put(c.get()+1); }  
05     @Atomic void reset() { c.put(0); }  
06     @Atomic int get() { return c.get(); }  
07 }
```

# JVSTM

## Transactions



| VBox | (Most Recent) Value | (Most Recent) Version |
|------|---------------------|-----------------------|
| c    | 0                   | 0                     |

Read-Set

| Tx    | VBox | Version |
|-------|------|---------|
| $T_1$ | c    | 0       |

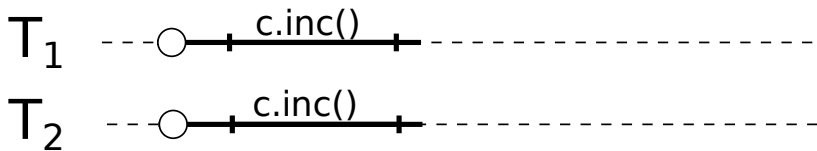
Write-Map

| Tx    | VBox | New Value |
|-------|------|-----------|
| $T_1$ | c    | 1         |



# JVSTM

## Transactions



| VBox | (Most Recent) Value | (Most Recent) Version |
|------|---------------------|-----------------------|
| c    | 0                   | 0                     |

Read-Set

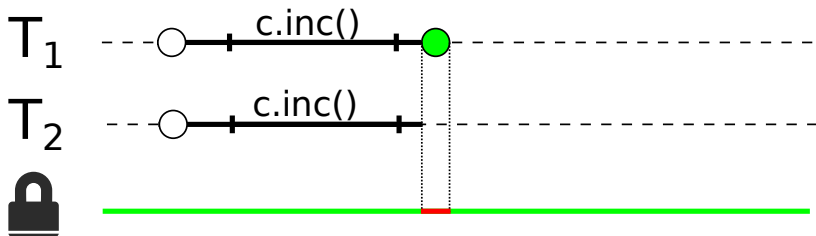
| Tx    | VBox | Version |
|-------|------|---------|
| $T_1$ | c    | 0       |
| $T_2$ | c    | 0       |

Write-Map

| Tx    | VBox | New Value |
|-------|------|-----------|
| $T_1$ | c    | 1         |
| $T_2$ | c    | 1         |

# JVSTM

## Transactions



| VBox | (Most Recent) Value | (Most Recent) Version |
|------|---------------------|-----------------------|
| c    | 0                   | 0                     |

Read-Set

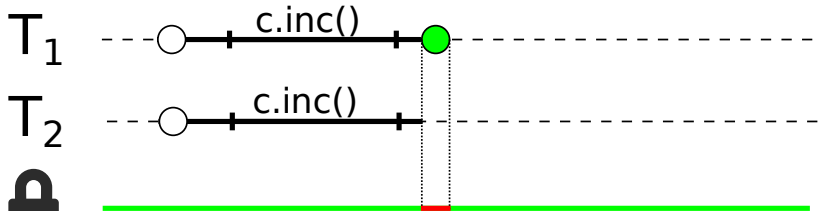
| Tx    | VBox | Version |
|-------|------|---------|
| $T_1$ | c    | 0       |
| $T_2$ | c    | 0       |

Write-Map

| Tx    | VBox | New Value |
|-------|------|-----------|
| $T_1$ | c    | 1         |
| $T_2$ | c    | 1         |

# JVSTM

## Transactions



| VBox | (Most Recent) Value | (Most Recent) Version |
|------|---------------------|-----------------------|
| c    | 1                   | 1                     |

Read-Set

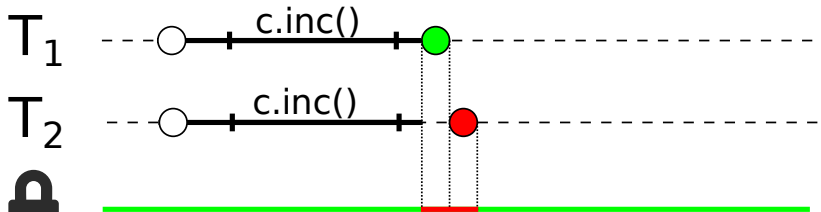
| Tx    | VBox | Version |
|-------|------|---------|
| $T_2$ | c    | 0       |

Write-Map

| Tx    | VBox | New Value |
|-------|------|-----------|
| $T_2$ | c    | 1         |

# JVSTM

## Transactions



| VBox | (Most Recent) Value | (Most Recent) Version |
|------|---------------------|-----------------------|
| c    | 1                   | 1                     |

Read-Set

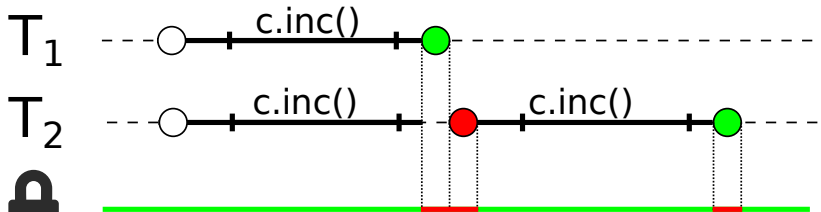
| Tx    | VBox | Version |
|-------|------|---------|
| $T_2$ | c    | 0       |

Write-Map

| Tx    | VBox | New Value |
|-------|------|-----------|
| $T_2$ | c    | 1         |

# JVSTM

## Transactions



| VBox | (Most Recent) Value | (Most Recent) Version |
|------|---------------------|-----------------------|
| c    | 1                   | 1                     |

Read-Set

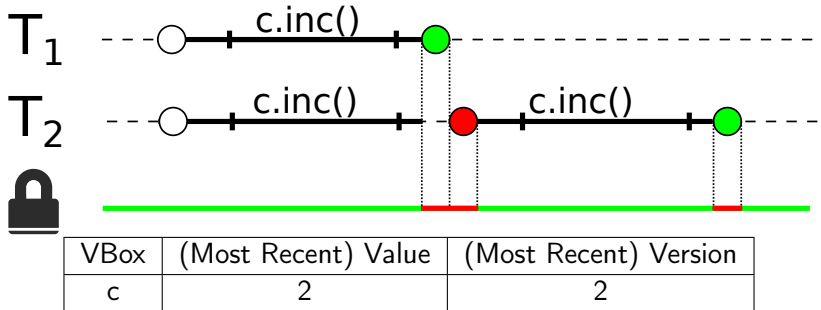
| Tx    | VBox | Version |
|-------|------|---------|
| $T_2$ | c    | 1       |

Write-Map

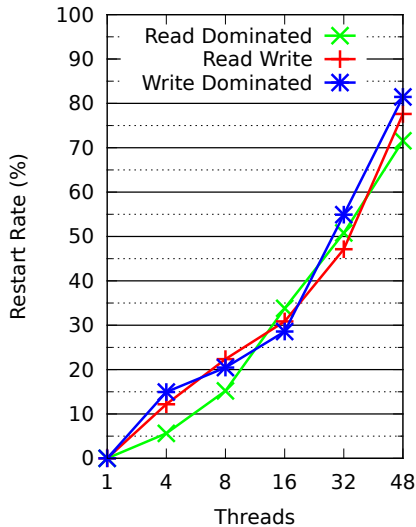
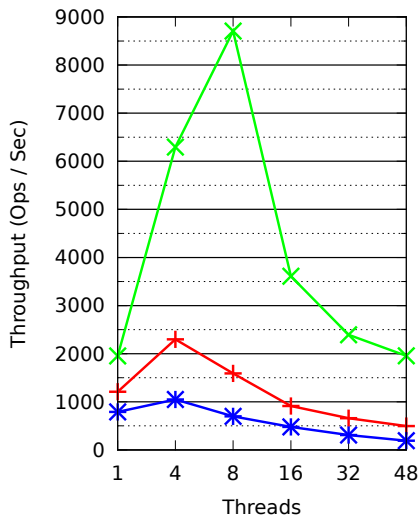
| Tx    | VBox | New Value |
|-------|------|-----------|
| $T_2$ | c    | 2         |

# JVSTM

## Transactions



## Conflicts and Performance



# Detecting Conflicts

Number of Conflicts

|                        | 8       | 16        | 32         | 48         |
|------------------------|---------|-----------|------------|------------|
| AtomicPartImpl::y      | 521.417 | 1.457.949 | 18.477.298 | 64.052.709 |
| AtomicPartImpl::x      | 521.417 | 1.457.949 | 18.477.298 | 64.052.709 |
| LargeSetImpl::elements | 706.930 | 961.391   | 882.978    | 93.991     |
| LargeSetImpl::count    | 706.587 | 960.635   | 870.216    | 47.154     |
| ManualImpl::text       | 15.765  | 12.144    | 13.838     | 16.850     |
| VQueue::front          | 30.254  | 39.296    | 42.617     | 18.245     |
| VIndex::index          | 46.363  | 56.586    | 50.038     | 15.210     |
| BuildDate::buildDate   | 80      | 861       | 4.025      | 5.491      |
| VQueue::rear           | 2.455   | 5.377     | 3.491      | 879        |
| AtomicPartImpl::to     | 0       | 200       | 200        | 300        |



# Reducing Conflicts

- Per Transaction Boxes
- Transactional Futures
- Restartable Transactions

# Reducing Conflicts

Per Transaction Boxes

|                        | 8       | 16        | 32         | 48         |
|------------------------|---------|-----------|------------|------------|
| AtomicPartImpl::y      | 521.417 | 1.457.949 | 18.477.298 | 64.052.709 |
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| BuildDate::buildDate   | 80      | 861       | 4.025      | 5.491      |
| VQueue::rear           | 2.455   | 5.377     | 3.491      | 879        |
| AtomicPartImpl::to     | 0       | 200       | 200        | 300        |

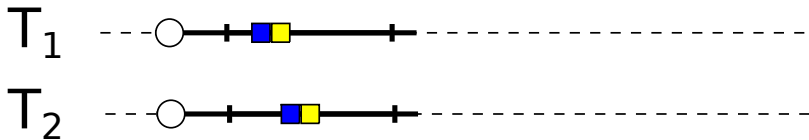
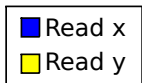
# Reducing Conflicts

## Per Transaction Boxes

```
01 class AtomicPartImpl {  
02     final VBox<Integer> x, y;  
03  
04     void swap() {  
05         int tmp = x.get();  
06         x.put(y.get());  
07         y.put(tmp);  
08     }  
09  
10     int getX() { return x.get(); }  
11     int getY() { return y.get(); }  
12 }
```

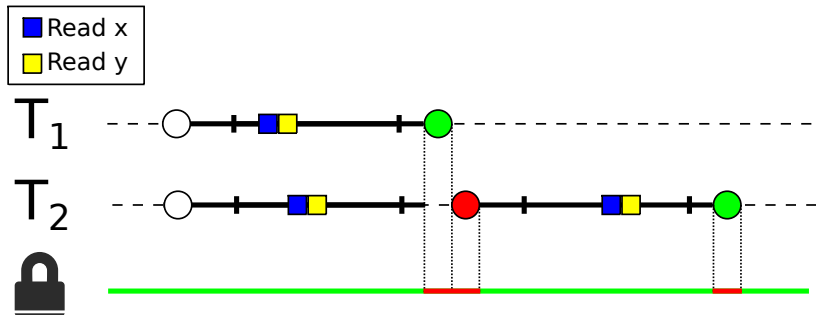
# Reducing Conflicts

Per Transaction Boxes



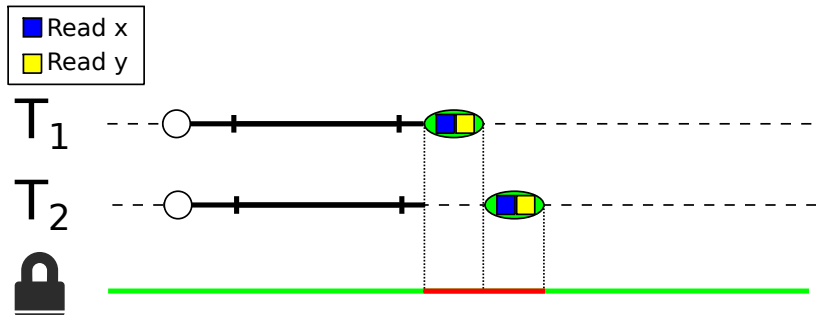
# Reducing Conflicts

## Per Transaction Boxes



# Reducing Conflicts

Per Transaction Boxes



## Reducing Conflicts

Per Transaction Boxes

|                        | 8       | 16        | 32         | 48         |
|------------------------|---------|-----------|------------|------------|
| AtomicPartImpl::y      | 521.417 | 1.457.949 | 18.477.298 | 64.052.709 |
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| BuildDate::buildDate   | 80      | 861       | 4.025      | 5.491      |
| VQueue::rear           | 2.455   | 5.377     | 3.491      | 879        |
| AtomicPartImpl::to     | 0       | 200       | 200        | 300        |

# Reducing Conflicts

Per Transaction Boxes

|                        | 8       | 16      | 32      | 48      |
|------------------------|---------|---------|---------|---------|
| ManualImpl::text       | 183.317 | 230.422 | 186.706 | 345.556 |
| VIndex::index          | 11.021  | 11.604  | 34.967  | 20.342  |
| VQueue::front          | 18.019  | 14.612  | 31.713  | 21.623  |
| BuildDate::buildDate   | 517     | 1.332   | 4.806   | 9.744   |
| VQueue::rear           | 1.050   | 1.265   | 3.338   | 1.513   |
| VLinkedSet::entries    | 894     | 711     | 796     | 1.659   |
| AtomicPartImpl::to     | 0       | 200     | 200     | 280     |
| AtomicPartImpl::y      | 31      | 104     | 236     | 322     |
| AtomicPartImpl::x      | 31      | 104     | 236     | 322     |
| DocumentImpl::text     | 16      | 11      | 40      | 161     |
| LargeSetImpl::elements | 0       | 0       | 0       | 0       |
| LargeSetImpl::count    | 0       | 0       | 0       | 0       |



# Reducing Conflicts

## Transactional Futures

```
01 class ManualImpl {
02     VBox<String> string;
03
04     @Atomic
05     int capitalize() {
06
07
08         int ret = string.get().countChar('a');
09         string.put(string.get().replace('a', 'A'));
10         return ret;
11
12
13     }
14 }
```

# Reducing Conflicts

## Transactional Futures

```
01 class ManualImpl {
02     VBox<String> string;
03
04     @Atomic
05     TransFuture<Integer> capitalize() {
06         return new TransFuture<Integer>(){
07             Integer execute() {
08                 int ret = string.get().countChar('a');
09                 string.put(string.get().replace('a', 'A'));
10                 return ret;
11             }
12         };
13     }
14 }
```

# Reducing Conflicts

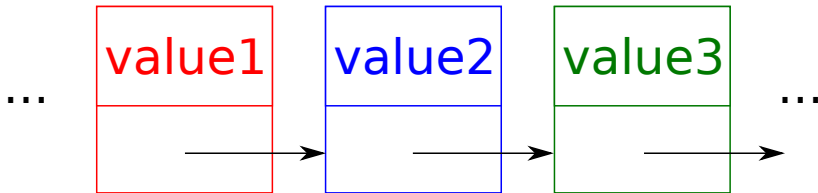
## Transactional Futures

|                              | 8      | 16     | 32     | 48     |
|------------------------------|--------|--------|--------|--------|
| VIndex::index                | 90.485 | 73.293 | 72.378 | 75.668 |
| VQueue::front                | 86.066 | 55.763 | 56.539 | 57.300 |
| BuildDate::buildDate         | 2.044  | 5.605  | 11.280 | 16.307 |
| VQueue::rear                 | 6.365  | 6.696  | 6.595  | 6.620  |
| VLinkSet::entries            | 6.686  | 1.513  | 760    | 935    |
| BagImpl::elements            | 48     | 70     | 116    | 186    |
| AtomicPartImpl::y            | 100    | 113    | 262    | 309    |
| AtomicPartImpl::x            | 100    | 113    | 262    | 309    |
| BaseAssemblyImpl::components | 24     | 25     | 44     | 89     |
| AssemblyImpl::superAssembly  | 24     | 42     | 85     | 140    |
| ManualImpl::text             | 0      | 0      | 0      | 0      |

# Reducing Conflicts

## Restartable Transactions

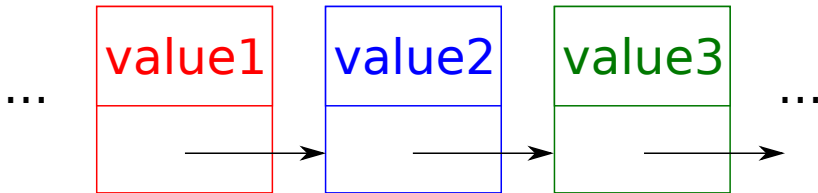
```
01  
02 //Tx1:  
03 if (set.contains(value3))  
04   doStuff();  
05  
06 //Tx2:  
07 set.remove(value2);
```



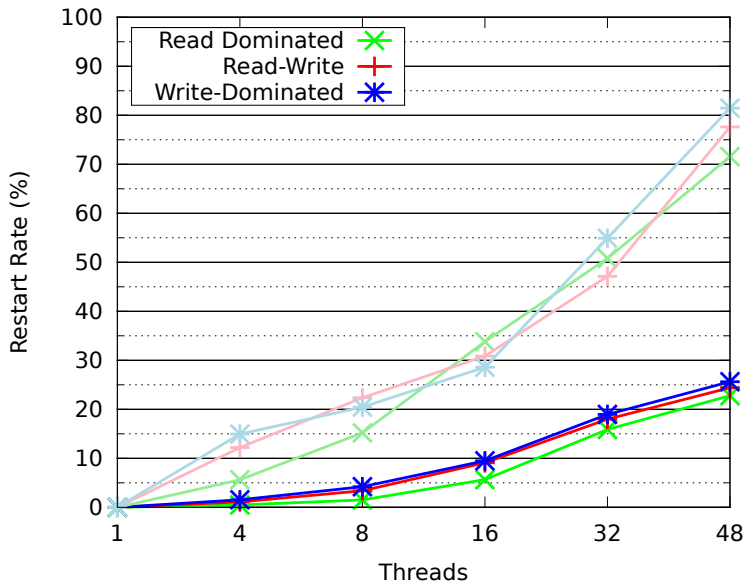
# Reducing Conflicts

## Restartable Transactions

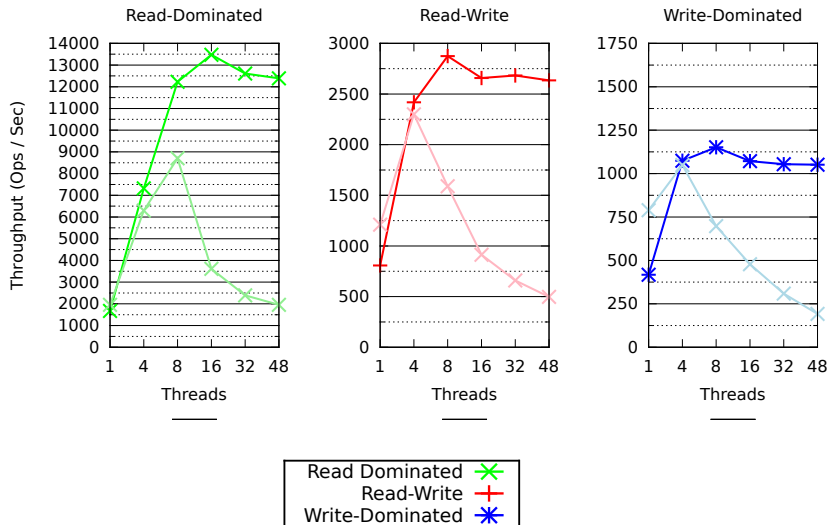
```
01 class LinkedListSet<E> {  
02   ...  
03   @Restartable  
04   boolean contains(E e) {  
05     ...  
06   }  
07 }
```



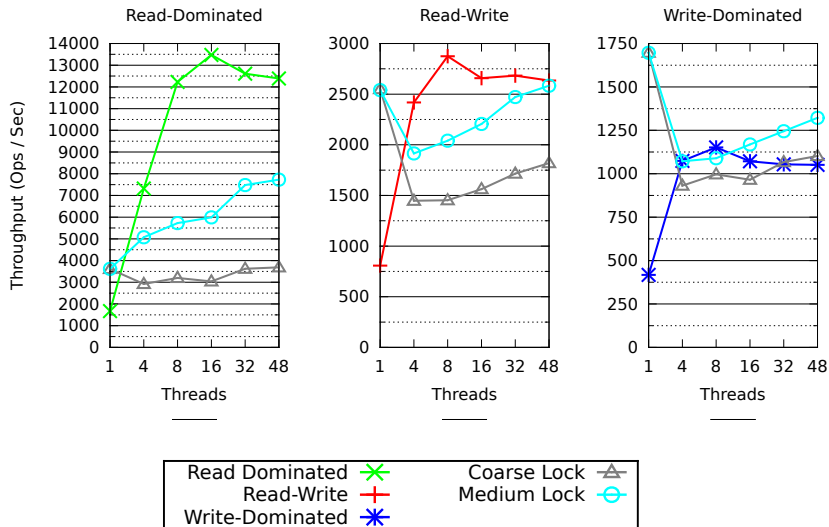
## Results



# Results



# Results





# Conclusion

- Conflict detection technique
- Conflict reduction
  - PerTxBoxes
  - Transactional Futures
  - Restartable Transactions

# Thank you!

Q&A