



# Good News from Some JTime Predictability Tests

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# RTSJ History (Review)

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- Started in 1998
- 1998 Embedded Systems Conference (23 orgs)
- Java Community Process 1999
- JSR-01 Approved Feb. 1999
- RTSJ 0.9 Release June 2000
- JCP Approved Final, RTSJ 1.0, Release Nov. 2001
- Reference Implementation Jan. 2002
- TimeSys RTSJ Product, JTime, Released March 2003

# RTSJ Guiding Principles (Review)

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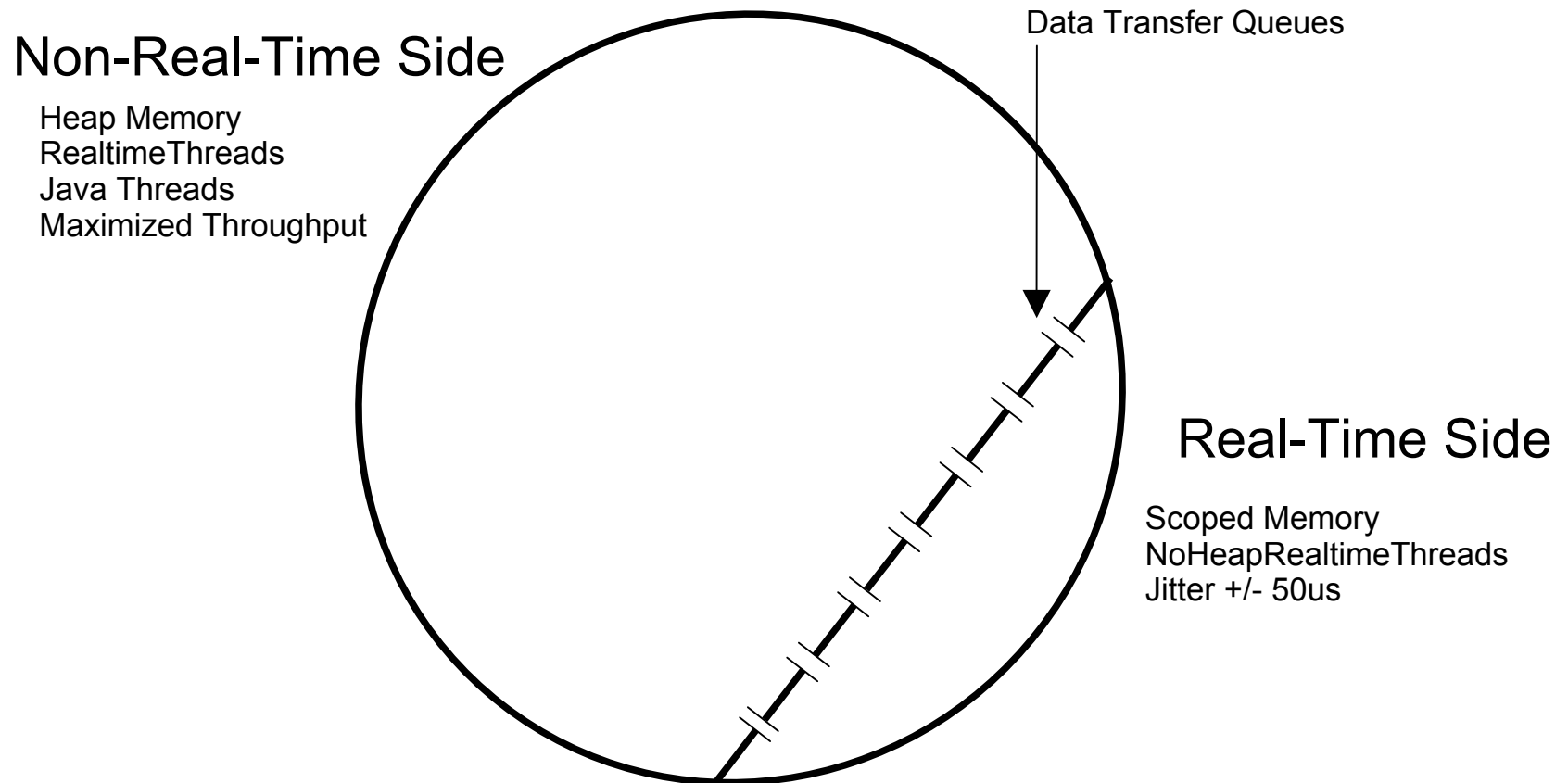
- Predictable Execution
- Support Current Practice
- Backward Compatibility
- Any Java Edition
- Support Leading Edge Scheduling
- WOCRAC
- Allow for Implementation Trade-offs

# RTSJ Enhanced Areas (Review)

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- Scheduling
- Memory Management
- Synchronization
- Asynchronous Events
- Asynchronous Transfer of Control
- Physical Memory Access

# RTSJ System Model (Review)



# JTime Test System

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- TimeSys JTime x86 1.0
- TimeSys LinuxNet x86
- Generic PC H/W platform
  - Pentium 4, 1.1 GHz clock frequency
- Measurements taken with Pentium time stamp counter (RTSC)
- Conversion from cycle count to time uses measured frequency average
- Conversion to time only after all measurements and computations

# JTime Temporal Predictability



		Java Thread†	RealtimeThread‡	NoHeapRealtimeThread‡
Without GC	Jitter°/Std. Dev.	7.5 ms/0.9µs	0.04 ms /1.0µs	0.03 ms /0.9µs
With GC	Jitter°/Std. Dev.	<b>1895 ms/NA</b>	1905 ms/NA	<b>0.131 ms</b> /13.0µs

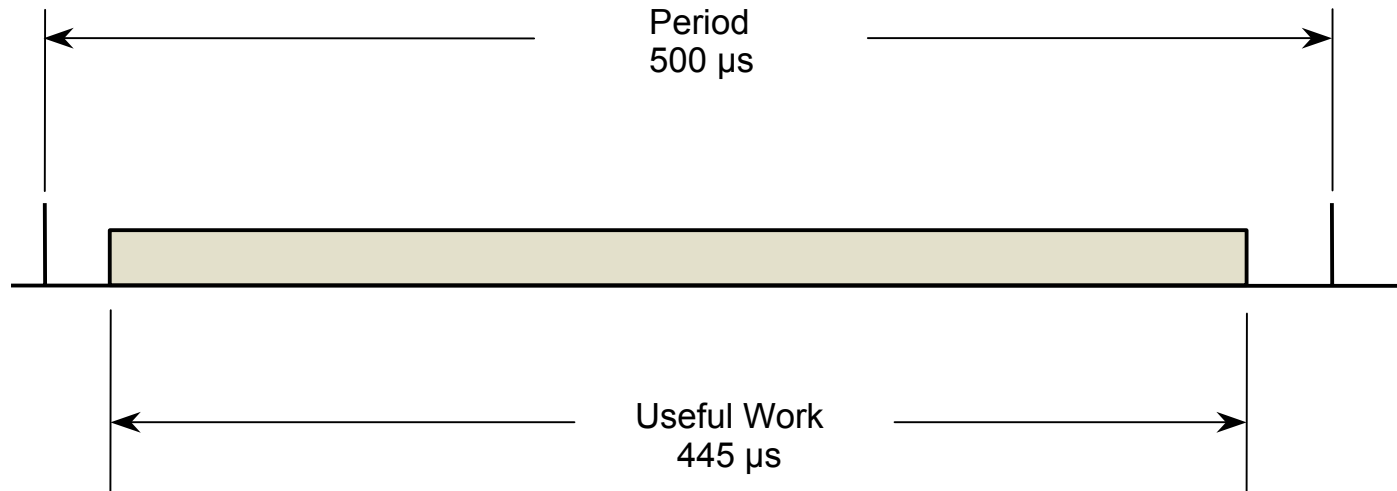
° Maximum Interval – Minimum Interval

† sleep()

‡ waitForNextPeriod()

# JTime Utilization

Utilization = 89% at 500  $\mu$ s period (2000Hz)



In a separate test for minimum period we found (62 $\mu$ s, 17 kHz)

# Scoped Memory Enter Overhead

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```
while (true) {  
    end = end_time();  
    memArea.enter(...  
        // multiple object creation  
        start = start_time();  
    );  
}
```

- Average 39 $\mu$ s
- Independent of number of objects
- Independent of memArea size

# AsyncEventHandler Latency

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- Various tests, heap, noheap, boundAEH, with and without GC
- Latency varies from  $60\mu\text{s}$  to  $90\mu\text{s}$



Questions?

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