The Pervasiveness & Complexity of Java Synchronizers



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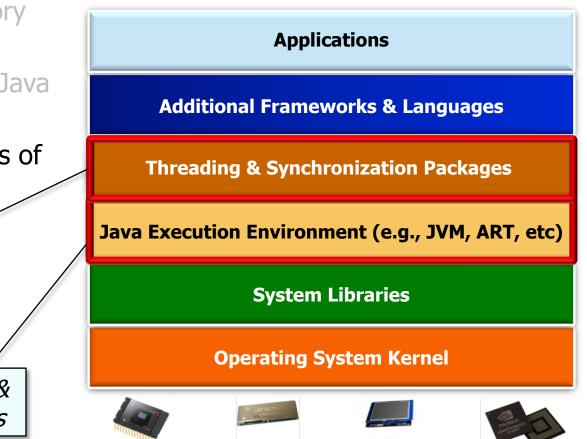


Learning Objectives in this Part of the Lesson

- Be aware of the Java memory model
- Understand the purpose of Java synchronizers
- Recognize the pervasiveness of Java synchronizers

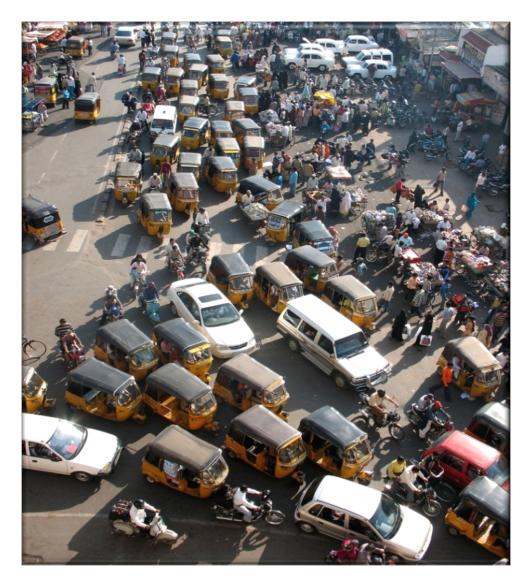
e.g., Java atomics, locks, & other synchronizers

e.g., volatile variables & built-in monitor objects



Learning Objectives in this Part of the Lesson

- Be aware of the Java memory model
- Understand the purpose of Java synchronizers
- Recognize the pervasiveness of Java synchronizers
 - As well as their complexities



The Pervasiveness of Synchronizers in Java

The Pervasiveness of Java Synchronizer Classes

 Multiple layers of synchronizers are provided on the Java platform



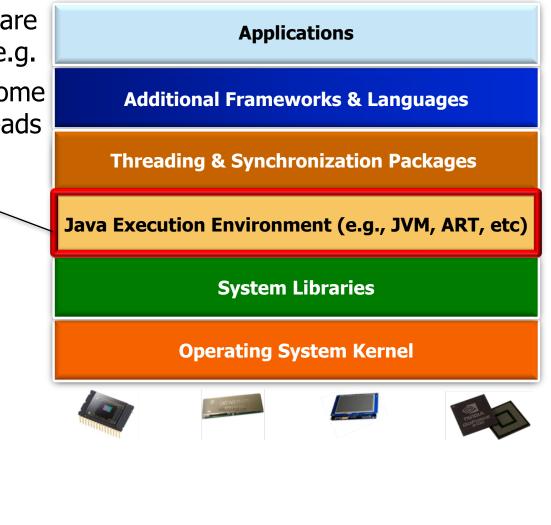
See en.wikipedia.org/wiki/Java_(software_platform)

The Pervasiveness of Java Synchronizer Classes

- Multiple layers of synchronizers are provided on the Java platform, e.g.
 - The Java language contains some features that synchronize threads

e.g., volatile variables & built-in monitor objects





See en.wikipedia.org/wiki/Java_(programming_language)

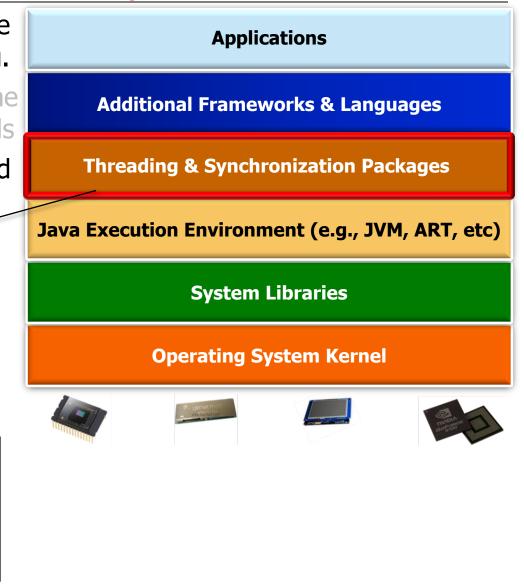
The Pervasiveness of Java Synchronizer Classes

- Multiple layers of synchronizers are provided on the Java platform, e.g.
 - The Java language contains some features that synchronize threads
 - Other synchronizers are provided by the Java Class Library

e.g., Java atomics, various locks, conditions, semaphores, & barriers

Description of Java Conceptual Diagram

		Java Language	Java Language										
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	Tools & Tool APIs		JConsole	Console Java Visua		IVM Java DB		Security	Int'i				
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		User Interface Toolkits	Swi	ing		Java 2D	AWT			Accessibility		ility	
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			Beans	Int'l Support		t	Input/Output			JMX			
		Other Base Libraries	JNI		Math		Networking			Override Mechanism			
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	ī	ava Virtual Machine	Java HotSpot Client and Server VM										



See <u>en.wikipedia.org/wiki/Java_Class_Library</u>

The Complexities of Synchronizers in Java

• Synchronization complexity arises from coordinating the interactions of entities that run concurrently



• There are two general type of synchronization complexities



See <u>en.wikipedia.org/wiki/No_Silver_Bullet</u>

- There are two general type of synchronization complexities
 - Inherent complexities

These fundamental challenges constitute the "rocket science" of the synchronization domain



See www.informit.com/articles/article.aspx?p=726130&seqNum=2

- There are two general type of synchronization complexities
 - Inherent complexities
 - Mutual Exclusion
 - Ensure concurrent threads don't simultaneously run in a program's critical sections



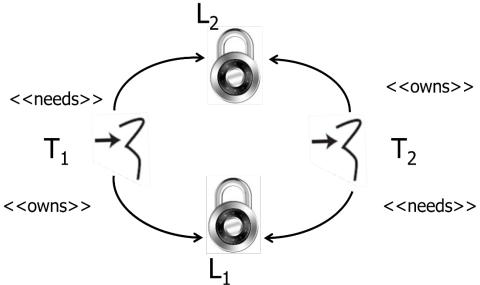
Race conditions arise when an application depends on the sequence or timing of threads for it to operate properly

See en.wikipedia.org/wiki/Race_condition

- There are two general type of synchronization complexities
 - Inherent complexities
 - Mutual Exclusion
 - Coordination
 - Manage the order or time in which operations are performed to ensure threads access system resources correctly & efficiently



- There are two general type of synchronization complexities
 - Inherent complexities
 - Mutual Exclusion
 - Coordination
 - Deadlock
 - Occurs when 2+ competing actions each wait for the other <<owr to finish, & thus none ever do





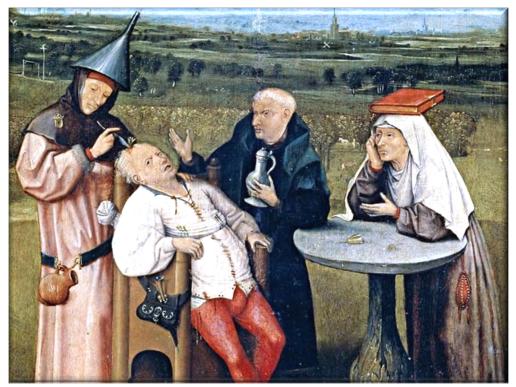
- There are two general type of synchronization complexities
 - Inherent complexities
 - Accidental complexities



These complexities arise from common limitations with techniques, tools, & methods used to synchronize programs

See wiki.c2.com/?AccidentalComplexity

- There are two general type of synchronization complexities
 - Inherent complexities
 - Accidental complexities
 - Tool limitations make it hard to debug concurrent programs

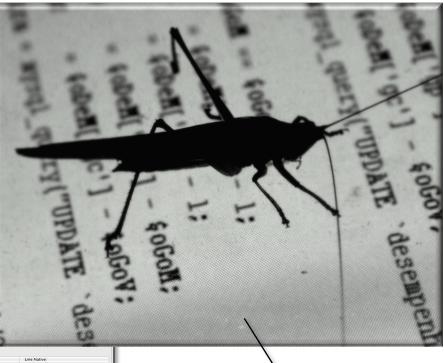




See <u>en.wikipedia.org/wiki/Trepanning</u> for more on traditional "debugging" techniques!

- There are two general type of synchronization complexities
 - Inherent complexities
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 - Tool limitations make it hard to debug concurrent programs
 - The behavior in the debugger doesn't reflect actual behavior

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The very act of observing a program can alter its state

See en.wikipedia.org/wiki/Heisenbug

- There are two general type of synchronization complexities
 - Inherent complexities
 - Accidental complexities
 - Tool limitations make it hard to debug concurrent programs
 - The behavior in the debugger doesn't reflect actual behavior
 - Lack of tool support to identify & rectify race conditions

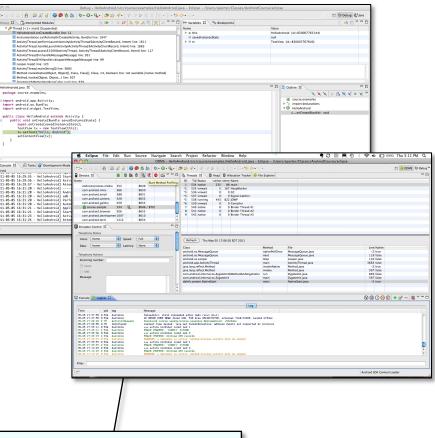


Occur when multiple threads "crash" into unprotected data structures & corrupt them

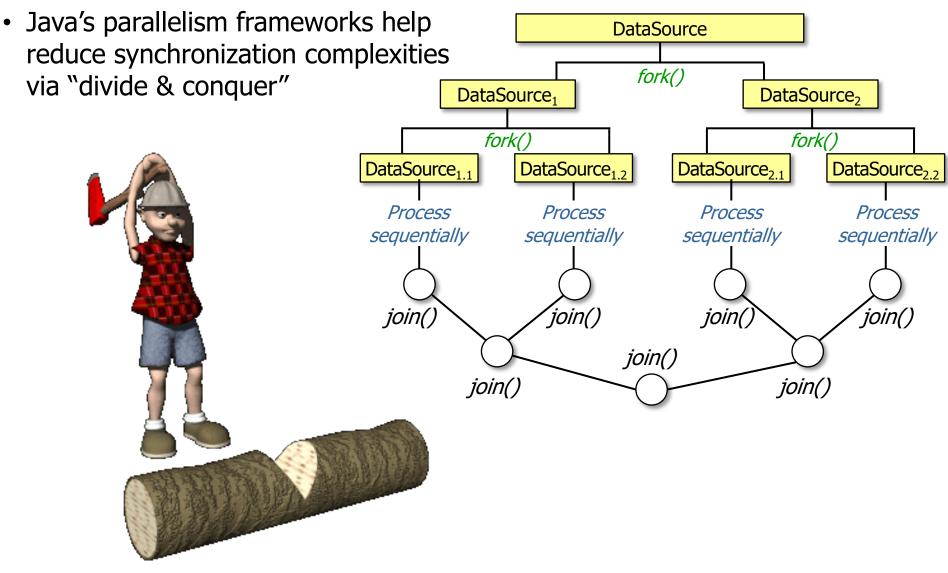
See en.wikipedia.org/wiki/Race_condition

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 - Inherent complexities
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 - Tool limitations make it hard to debug concurrent programs
 - The behavior in the debugger doesn't reflect actual behavior
 - Lack of tool support to identify & rectify *race conditions*
 - Conventional Java debuggers don't detect race conditions

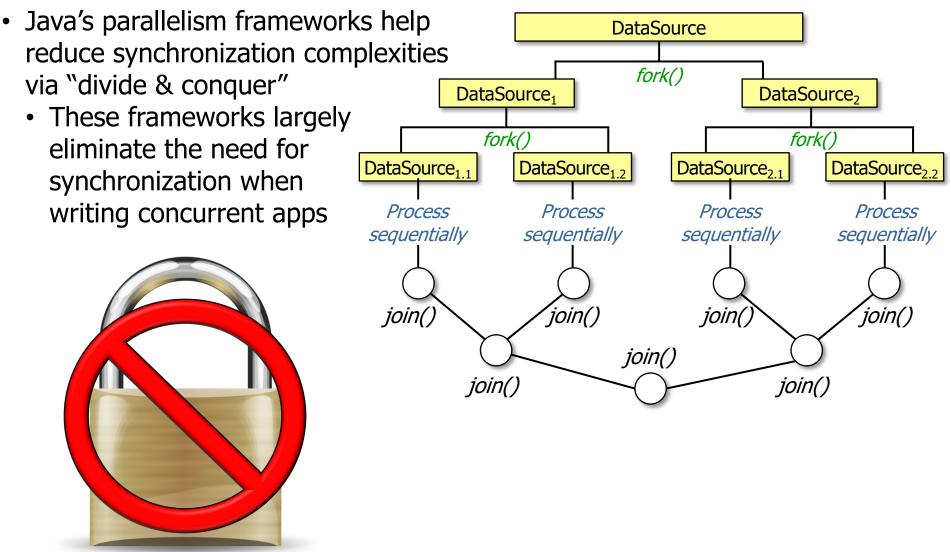




Problems often don't surface until runtime



See <u>en.wikipedia.org/wiki/Divide-and-conquer_algorithm</u>



End of the Pervasiveness & Complexity of Java Synchronizers