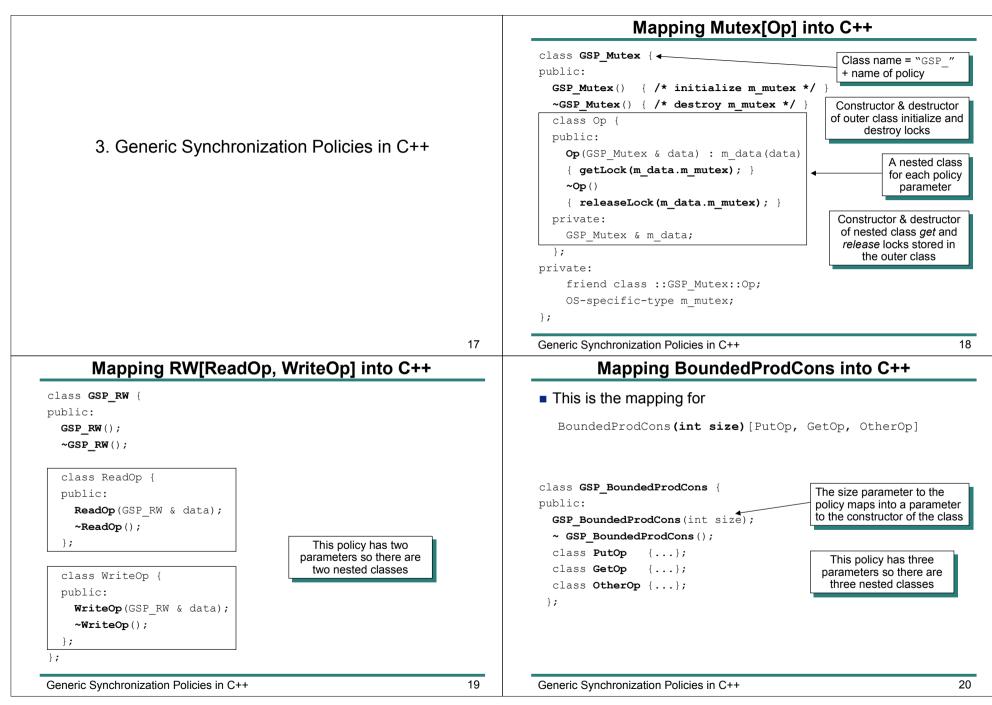
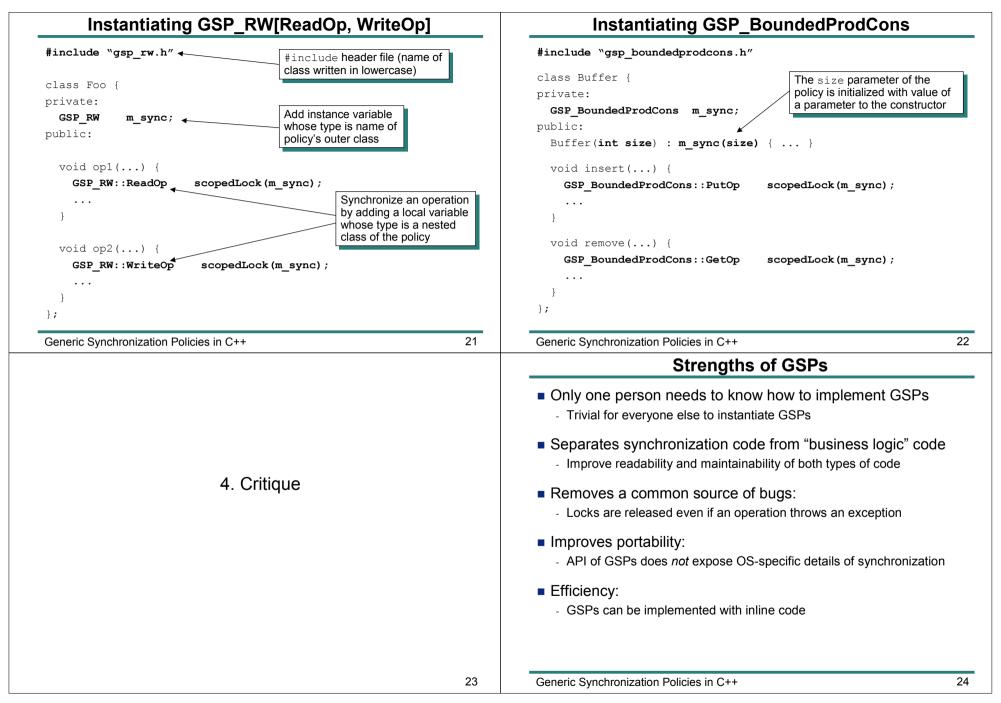
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Generic Synchronization Policies in C++ Ciaran McHale	Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:
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CiaranMcHale.com Complexity explained simply 1	Generic Synchronization Policies in C++ 2
Introduction	
 Most people know that writing synchronization code is: Difficult: APIs are low-level Non-portable: many threading APIs: POSIX, Windows, Solaris, DCE, 	
 In practice, most synchronization code implement a small number of high-level "usage patterns": Let's call these <i>generic synchronization policies</i> (GSPs) The most common GSPs can be implemented as a C++ library 	1. Scoped Locks
 Using GSPs in applications: Is much easier than using low-level APIs Encapsulates the underlying threading package → provides portability 	
Generic Synchronization Policies in C++ 3	4

Critical section	Critical section with multiple exit points
The following (pseudocode) function uses a critical section:	void foo()
•	{
void foo()	getLock(mutex);
getLock(mutex);	if () {
··· releaseLock(mutex);	releaseLock(mutex);
leiedsellock (mater) ,	return;
]	} Have to call releaseLock() at
The above code is very simple. However	if () { every exit point from the function
	releaseLock (mutex) ;
Complexity increases if the function has several exit points:	throw anException;
- Because releaseLock() must be called at each exit point	
- Examples of extra exit points:	
- Conditional return statements	releaseLock(mutex);
 Conditionally throwing an exception 	
Generic Synchronization Policies in C++ 5	Generic Synchronization Policies in C++
Critique	Solution: ScopedMutex class
Needing to call releaseLock() at every exit point:	Define a class called, say, ScopedMutex:
- Clutters up the "business logic" code with synchronization code	 This class has no operations! Just a constructor and destructor
- This clutter makes code harder to read and maintain	- Constructor calls getLock ()
	- Destructor calls releaseLock()
Forgetting to call releaseLock() at an exit point is a	
common source of bugs	Declare a ScopedMutex variable local to a function
	- At entry to function → constructor is called → calls getLock()
	- At exit from function → destructor is called → calls releaseLock()
	The following two slides show:
	 Pseudocode implementation of ScopedMutex class
	- Use of ScopedMutex in a function
There is a better way	

The ScopedMutex class	Use of ScopedMutex
class ScopedMutex {	void foo()
public:	{
ScopedMutex (Mutex & mutex)	ScopedMutex scopedLock (mutex) ;
: m_mutex(mutex)	
{ getLock(m_mutex); }	<pre>if () { return; } if () { throw anException; }</pre>
~ScopedMutex()	
<pre>{ releaseLock(m_mutex); }</pre>	}
private:	
Mutex & m_mutex;	No need to call releaseLock() at every exit point from the function!
Seneric Synchronization Policies in C++	9 Generic Synchronization Policies in C++
Comments on ScopedMutex	
 This technique is <i>partially</i> well known in the C++ community: 50% of developers the author worked with already knew this technique They considered it to be a "basic" C++ coding idiom Other 50% of developers had not seen the technique before 	
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Genericity for types	Genericity for synchronization policies
 C++ provides template types Example of a template type definition: template<t> class List { };</t> Examples of template type instantiation: List<int> myIntList; List<double> myDoubleList; List<widget> myWidgetList;</widget></double></int> Some other languages provide a similar capability, often with different terminology and syntax Perhaps called generic types instead of template types Perhaps surround type parameters with [] instead of <> 	 Using a pseudocode notation, here are declarations of mutual exclusion and readers-writer policies Mutex[Op] RW[ReadOp, WriteOp] In above examples, each parameter is a set of operations Example instantiations on operations Op1, Op2 and Op3 Mutex[{Op1, Op2, Op3}] RW[{Op1, Op2}, {Op3}]
Generic Synchronization Policies in C++ 13 Producer-consumer policy	Generic Synchronization Policies in C++ 14 Bounded producer-consumer policy
 Useful when: A buffer is used to transfer data between threads A producer thread <i>puts</i> items into the buffer A consumer thread <i>gets</i> items from the buffer If the buffer is empty when the consumer tries to get an item then the consumer thread blocks The buffer might have <i>other</i> operations that examine the state of the buffer In pseudocode notation, the policy declaration is: ProdCons [PutOp, GetOp, OtherOp] Example instantiations: 	 Variation of the producer-consumer policy: Buffer has a fixed size If the buffer is full when the producer tries to put in an item then the producer thread blocks In pseudocode notation, policy is: BoundedProdCons (int size) [PutOp, GetOp, OtherOp] Typically, the size parameter is instantiated on a parameter to the constructor of the buffer class An example instantiation will be shown later
<pre>■ Example instantiations: ProdCons[{insert}, {remove}, {count}] ProdCons[{insert}, {remove}, {}] Generic Synchronization Policies in C++ 15</pre>	Generic Synchronization Policies in C++ 16





Potential criticisms fo GSPs	Issues not addressed
 "Can they handle all my synchronization needs?" 80/20 principle: most synchronization needs can be handled by just a small library of GSPs You are not restricted to a library of pre-written GSPs. Instead You can write new GSPs if the need arises "GSPs are just a ScopedMutex with a new name" The "just" part is inaccurate GSPs generalize the ScopedMutex concept so it can be used for a much wider set of synchronization policies 	 GSPs do not address: POSIX thread cancellation Timeouts Lock hierarchies In the author's work, these issues arise infrequently so he did not bother to support them GSPs could probably be extended to support the above issues
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	Generic Synchronization Policies in C++ 2 Ready-to-run GSPs
5. Ready-to-run GSPs	

Using GSP classes	Summary
 Define one of the following preprocessor symbols before you #include a GSP header file P_USE_POSIX_THREADS P_USE_SOLARIS_THREADS P_USE_WIN32_THREADS P_USE_DCE_THREADS P_USE_NO_THREADS Typically done with -D<symbol> command-line option to compiler</symbol> 	 GSPs are a generalization of the ScopedMutex class: Out-of-the-box support for mutual-exclusion, readers-writer and (bounded) producer-consumer policies You can write new GSPs if the need arises Benefits: Makes it trivial to add synchronization to a C++ class Makes code easier to read and maintain Portability across multiple thread packages Minimal performance overhead due to inline implementation All software and documentation is available: MIT-style license (open-source, non-viral) Download from www.CiaranMcHale.com/download
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