



C# PROGRAMMING 2007

Multithreading

Thomas J. Fuchs

BackgroundWorker

BackgroundWorker is a helper class in the **System.ComponentModel** namespace for managing a worker thread.

- A "**cancel**" flag for signaling a worker to end without using Abort
- A standard protocol for **reporting** progress, completion and cancellation
- An implementation of **IComponent** allowing it be sited in the Visual Studio Designer
- **Exception handling** on the worker thread
- The ability to **update Windows Forms** controls in response to worker progress or completion.

Control.Invoke

- In a multi-threaded Windows Forms application, it's illegal to call a method or property on a control from any thread other than the one that created it.
- All cross-thread calls must be explicitly marshalled to the thread that created the control (usually the main thread), using the `Control.Invoke` or `Control.BeginInvoke` method.
- The `BackgroundWorker` class wraps worker threads that need to report progress and completion, and automatically calls `Control.Invoke` as required.

Thread Pool

- The BackgroundWorker class uses the **thread-pool**, which recycles threads to avoid recreating them for each new task.
- This means one should never call **Abort** on a BackgroundWorker thread.



Using the BackgroundWorker

- Instantiate BackgroundWorker, and handle the **DoWork** event.
- Call **RunWorkerAsync**, optionally with an object argument.
- Handle the **reporting events** for progress, completion and cancellation

|| e.Argument

- Any argument passed to RunWorkerAsync will be forwarded to DoWork's event handler, via the event argument's **Argument property**.
- `private void bw1_DoWork(object sender, DoWorkEventArgs e)`
- `e.Argument` is of type System Object.
- Therefore one can pass any number of arguments packed in a class, structure or array.

RunWorkerCompleted

- The **RunWorkerCompleted** event fires after the DoWork event handler has done its job.
- Handling RunWorkerCompleted is not mandatory, but one usually does so in order to query any **exception** that was thrown in DoWork.
- Code within a RunWorkerCompleted event handler is able to **update Windows Forms controls** without explicit marshalling; code within the DoWork event handler cannot.

Progress Reporting

1. Set the WorkerReportsProgress **property** to true.
2. Periodically call **ReportProgress** from within the DoWork event handler with a "**percentage complete**" value, and optionally, a user-state object.
3. Handle the **ProgressChanged event**, quering its event argument's ProgressPercentage property.

Code in the ProgressChanged event handler is free to **interact with UI** controls just as with RunWorkerCompleted. This is typically where you will update a progress bar.

|| Cancellation Support

- Set the **WorkerSupportsCancellation property** to true.
- Periodically check the **CancellationPending** property from within the DoWork event handler – if true, set the event argument's **Cancel property** true, and return.
(The worker can set Cancel true and exit without prompting via CancellationPending – if it decides the job's too difficult and it can't go on).
- Check **e.Cancelled** in the RunWorkerCompleted event handler.
- Call **CancelAsync** to request cancellation.

Subclassing BackgroundWorker

- BackgroundWorker is not sealed!
- It provides a virtual OnDoWork method.
- When writing a potentially long-running method, one can write a version returning a subclassed BackgroundWorker.
- Pre-configured to perform the job asynchronously.
- The consumer then only needs to handle the RunWorkerCompleted and ProgressChanged events.



PRACTICAL EXAMPLES ...




QUESTIONS ?

Resources


- Course Homepage:
▪ se.inf.ethz.ch/teaching/ss2007/251-0290-00


- Exercise Material:
▪ www.inf.ethz.ch/personal/thomas.fuchs



```
public class Client {
    Dictionary <string,int> GetFinancialTotals (int
foo, int bar) { ... }
    ...
}
```

```
public class Client {
    public FinancialWorker GetFinancialTotalsBackground
(int foo, int bar) {
        return new FinancialWorker (foo, bar);
    }
}
```






```
public class FinancialWorker : BackgroundWorker {
    public Dictionary <string,int> Result;    // We can add
typed fields.
    public volatile int Foo, Bar;           // We could even
expose them

                                           // via
```

properties with locks!

```
    public FinancialWorker() {
        WorkerReportsProgress = true;
        WorkerSupportsCancellation = true;
    }
```



```
    public FinancialWorker (int foo, int bar) : this() {
        this.Foo = foo; this.Bar = bar;
    }
```

```
protected override void OnDoWork (DoWorkEventArgs e) {
    ReportProgress (0, "Working hard on this report...");
    Initialize financial report data

    while (!finished report ) {
        if (CancellationPending) {
            e.Cancel = true;
            return;
        }
        Perform another calculation step
        ReportProgress (percentCompleteCalc, "Getting
there...");
    }
    ReportProgress (100, "Done!");
    e.Result = Result = completed report data;
}
}
```


|| GetFinancialTotalsBackground

- Whoever calls GetFinancialTotalsBackground then gets a FinancialWorker – a wrapper to manage the background operation with real-world usability. It can report progress, be cancelled, and is compatible with Windows Forms without Control.Invoke. It's also exception-handled, and uses a standard protocol (in common with that of anyone else using BackgroundWorker!)