Module 03:
”Signaling with Events and Handles”

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Agenda

- **Signaling with Events**
- Using Wait Handles

AutoResetEvent

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AutoResetEvent

- Derives from the general **`EventWaitHandle`**
  - Is automatically reset when first thread passes **`WaitOne()`**

```
void Update()
{
    _event.Set();   // Signals event
    ...;
}
```

```
void Compute()
{
    _event.WaitOne(); // <-- Waits for event to be signalled
                      // <-- Automatically resets event
    ...
}
```

- **`WaitOne()`** has overloads providing timeouts

- Can be both local and cross-process (*)!

ManualResetEvent

ManualResetEvent

- Derives from the general **`EventWaitHandle`**
  - Needs to be manually reset by invoking **`Reset()`**

```
void Update()
{
    _event.Set();   // Signals event
    ...;
    _event.Reset(); // <-- Note: Necessary to reset manually
```

```
void Compute()
{
    _event.WaitOne(); // <-- Waits for event to be signalled
    ...
}
```

- **`WaitOne()`** has overloads providing timeouts
- Can be both local and cross-process (*)!

ManualResetEventSlim

- Introduced in .NET 4.0
- Optimized, local-only version of **`ManualResetEvent`**
  - About 10-50 times more performant!

- Does not derive from **`EventWaitHandle`**, but exposes a **`WaitHandle`** property

- `WaitHandle` has `WaitOne()`
  - `EventWaitHandle` has `Set() + Reset()`
    - `AutoResetEvent`
    - `ManualResetEvent`

CountdownEvent

CountdownEvent

- Counts down from specific count (e.g. 5) by **`Signal()`**
  - `Wait()` blocks until count reaches 0

```
void Update()
{
    _event.Wait();  // Wait for 5 x Signal()
    ...;
    _event.Reset(); // <-- Resets counter to 5
}
```

```
void Compute()
{
    _event.Signal(); // <-- Decrements counter by 1
    ...
}
```

- **`Wait()`** has overloads providing timeouts and cancellation

- Fully managed (not an **`EventWaitHandle`**, but exposes **`WaitHandle`**)
- Can only be local (*)

Agenda

- Signaling with Events
- **Using Wait Handles**

WaitHandle

- Why is **`WaitHandle`** or not so important? ☺

- `WaitHandle` has `WaitOne()`
  - `EventWaitHandle` has `Set() + Reset()`
    - `AutoResetEvent`
    - `ManualResetEvent`
  - `Mutex`
  - `Semaphore`

- Everything is **`WaitHandle`** or exposes **`WaitHandle`**
- Can be treated uniformly in certain scenarios

Advanced Synchronization

- `WaitHandle.`
  - `WaitAny()`
  - `WaitAll()`
  - `SignalAndWait()` ~ `Set() + WaitOne()`
- Can implement many advanced scenarios such as
  - Thread Rendezvous
  - Compound waiting
  - …

Barriers

- `Barrier`
  - Introduced in .NET 4.0 as an atomic Thread Execution Barrier
  - Signals 1 and waits for the total count to be signaled
  - Atomically resets count when 0 is reached and unblocks
  - `Barrier` ~ "AutoCountdownEvent"

```
Barrier _barrier = new Barrier(4, barrier =>
    WriteLine($"{barrier.ParticipantCount}-thread rendezvous")
);
```

```
void Compute()
{
    ...
    _barrier.SignalAndWait();
    Console.WriteLine(result);
}
```

Summary

- Signaling with Events
- Using Wait Handles

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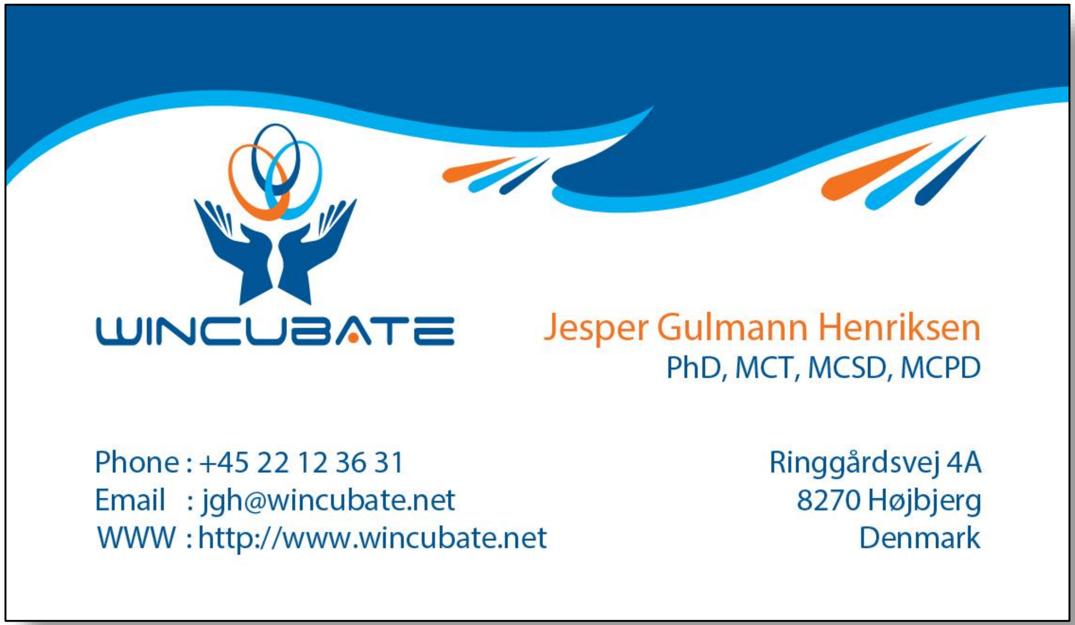

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