MF#K - Introduction to F#

meeting @ GroupM 2015-07-08

Mødegruppe for Funktionelle Københavnere
(MF#K)

Overview

- About me
- Matching of expectations
- Agenda
  - 15:30 |> Short introduction to F# (sales pitch)
  - 15:50 |> Demo: Producer/Consumers/Reducer with F# Agents
  - 16:30 |> Summary: U want more?

About me (very shortly)

- Ramón Soto Mathiesen
- MSc. Computer Science from DIKU (Minors in Mathematics)
- Managing Specialist |> CTO of CRM Department @ Delegate A/S
  - ER-modeling, WSDL, OData (REST API)
- F# / C# / JavaScript / C++: Delegate A/S @ GitHub
- Blog: http://blog.stermon.com/

Matching of expectations

- What are you expectations for this introduction to F#?

Matching of expectations

- Functional Copenhageners Meetup Group will try to get more and more software projects to be based on functional programming languages. We mainly focus on F# and Haskell, but other functional programming languages like Scala, Lisp, Erlang, Clojure, OCaml, etc. are more than welcome.
- We expect that attendees to this introduction to F#, will get inspired to use the language in the future ☺
- In order to get you hooked, we always try to inspire you with some code you can relate to and that's why ask in advance for some task or paradigm you might find interesting.

Short introduction to F# (sales pitch) - Buzzwords

- *less code, error-free projects, only one code base, big data, parallelism, concurrency, asynchronous processes*

Short introduction to F# (sales pitch) - F# - What is it?

- Is an ***open-source***, ***strongly typed***, ***multi-paradigm*** programming language encompassing ***functional***, ***imperative*** and ***object-oriented*** designed by Don Syme (MS Research Cambridge UK) and maintained by Microsoft, F# Software Foundation and open contributors
- It's a mature language that is part of Visual Studio and the .NET Framework
- Loved by the ***very talented*** who contribute to it for free with sometimes very usable projects:
  - Special mention to (among others):
    - Tomas Petricek (TomASP.NET)
    - Scott Wlaschin (F# for fun and profit)

Short introduction to F# (sales pitch) - F# - Why use it?

- Conciseness
- Convenience
- Correctness
- Concurrency
- Completeness

Short introduction to F# (sales pitch) - F# - Why use it?

```
let swap (x,y) = y,x
let foo = swap(42,0)
let bar = swap("42","0")
```

```
> val swap : x:'a * y:'b -> 'b * 'a
> val foo : int * int = (0, 42)
> val bar : string * string = ("0", "42")
```

- Conciseness:
  - F# is not cluttered up with coding noise such as curly brackets, semicolons and so on
  - You almost never have to specify the type of an object, thanks to a powerful ***type inference system***.
  - And, compared with C#, it generally takes ***fewer lines of code*** to solve the same problem

Short introduction to F# (sales pitch) - F# - Why use it?

```
let f g x = g x
f (fun x -> x * x) 42
```

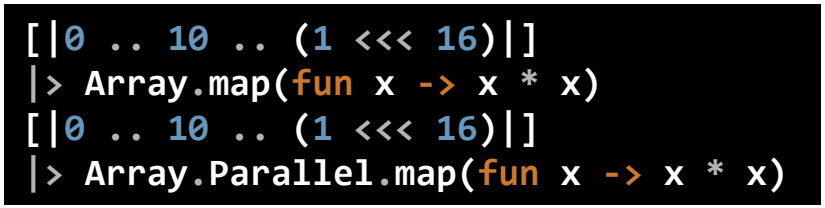
```
> val f : g:('a -> 'b) -> x:'a -> 'b
> val it : int= 1764
```

- Convenience:
  - Many common programming tasks are much simpler in F#. This includes things like creating and using ***complex type definitions***, doing ***list processing***, ***comparison and equality***, ***state machines***, and much more
  - And because functions are first class objects, it is very easy to create powerful and reusable code by creating functions that have ***other functions as parameters***, or that ***combine existing functions*** to create new functionality

Short introduction to F# (sales pitch) - F# - Why use it?

```fsharp
[<Measure>] type DKK
[<Measure>] type USD
let rate : float<USD/DKK> = 0.2<USD/DKK>
let usd2dkk (amount: float<USD>) = amount / rate
type OpportunityDK = { Customer : string; Amount : float<DKK> }
type OpportunityUS = { Customer : string; Amount : float<USD> }
type Opportunities = | DK of OpportunityDK | US of OpportunityUS
let odk0 = { OpportunityDK.Customer = "Skillshouse A/S"; Amount = 42.<DKK> }
let odk1 = { OpportunityDK.Customer = "Microsoft Danmark ApS"; Amount = 42.<DKK> }
let ous2 = { OpportunityUS.Customer = "Microsoft Redmond HQ"; Amount = 42.<USD> }
[ DK(odk0); DK(odk1); US(ous2); ]
|> List.map(fun x -> match x with | DK y -> y.Amount | US y -> usd2dkk y.Amount)
|> List.reduce(+)
```

- Correctness:
  - F# has a ***powerful type system*** which prevents many common errors such as ***null reference exceptions***.
  - Values are ***immutable by default***, which prevents a large class of errors
  - In addition, you can often encode ***business logic*** using the ***type system*** itself in such a way that it is actually ***impossible to write incorrect code*** or mix up ***units of measure***, greatly ***reducing the need for unit tests***



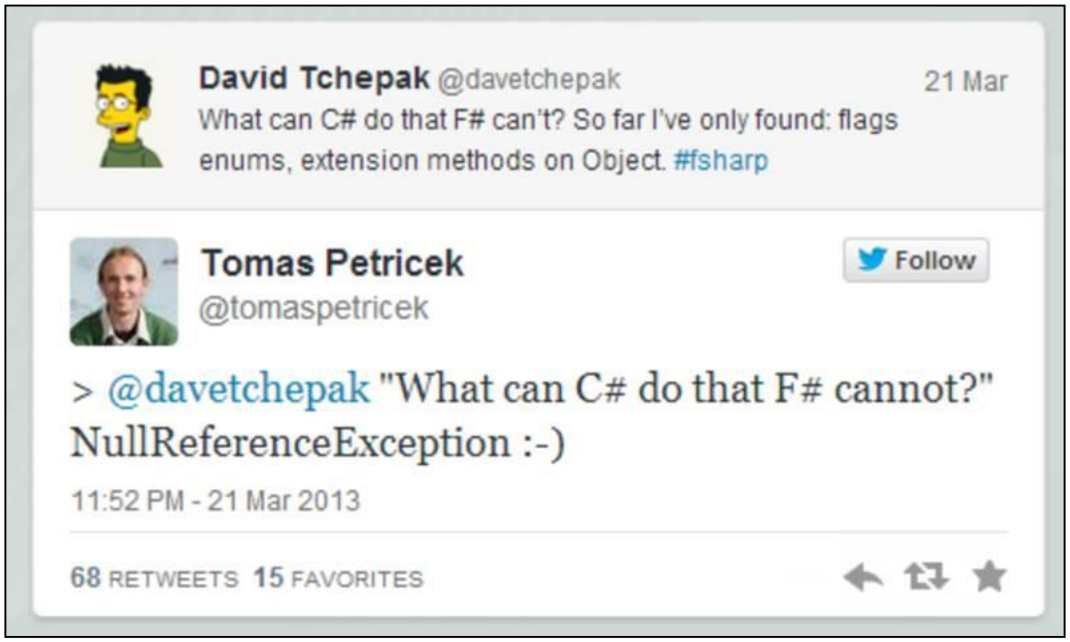
```
[|0 .. 10 .. (1 <<< 16)|]
|> Array.map(fun x -> x * x)
[|0 .. 10 .. (1 <<< 16)|]
|> Array.Parallel.map(fun x -> x * x)
```

- Concurrency:
  - F# has a number of built-in libraries to help when more than one thing at a time is happening. Asynchronous programming is ***very easy***, as is parallelism. F# also has a built-in ***actor model***, and excellent support for event handling and ***functional reactive programming***
  - And of course, because ***data structures are immutable by default***, ***sharing state*** and ***avoiding locks*** is much easier

```
open System
let ts () = DateTime.Now.ToString("o")           // ISO-8601
let ts' () = (ts ()).Replace(":", String.Empty) // Filename safe
let cw (s:string) = Console.WriteLine(s)
let cew (s:string) = Console.Error.WriteLine(s)
```

- Completeness:
  - Of course, ***F# is part of the .NET ecosystem***, which ***gives you*** seamless ***access to all the third party .NET libraries and tools***.
  - Finally, ***it is well integrated with Visual Studio***, which means you get a great IDE with ***IntelliSense support***, ***a debugger***, and many plug-ins for unit tests, source control, and other development tasks
  - Although it is a functional language at heart, F# does support other styles which are not 100% pure, which makes it much easier to interact with the non-pure world of web sites, databases, other applications, and so on. In particular, F# is designed as a hybrid functional/OO language, ***so it can do virtually everything that C# can do except …***

Short introduction to F# (sales pitch) - F# - Why use it? (*f*unny)



Remark: **string** in F# can be ***null*** as well (primitive .NET types)

Short introduction to F# (sales pitch) - F# - Why use it? (Business)

- Time to Market:
  - Easy prototyping (REPL: Read-Evaluate-Print-Loop)
  - Run as .NET code
- Efficiency:
  - JIT compilation (as C#)
  - Easy to implement parallelism
- Complexity:
  - Flexible language
  - Type inference
- Correctness:
  - Advanced types
  - Close to math

Demo: Producer/Consumers/Reducer with F# Agents

- Dzumali Salmani and Lars Nymand were interested in hearing about how F# handles “assembly line” code:

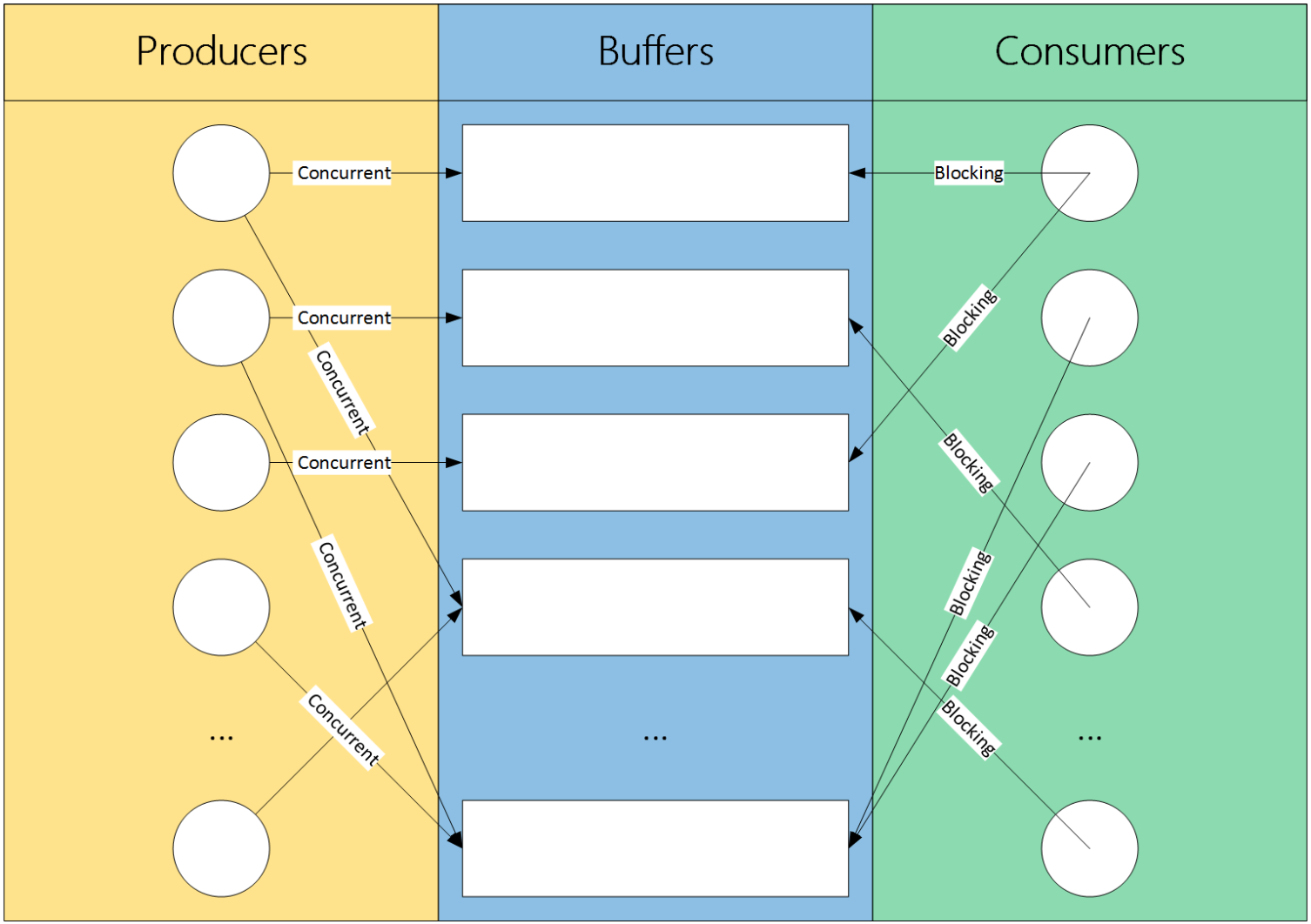
  Producers (push) → Buffer ← Consumers (pull)

  They mention that currently they are using a MS .NET BlockingCollection as the buffer, which supports concurrent producers and consumers.

  The main process would be that there arrive many log files which are sent to different buffers depending on the tasks to be performed. On each of the consumers of the buffers, there is used MS .NET Parallel.ForEach in order to parallelize the process

Remark: The source collection is partitioned and the work is scheduled on multiple **threads** based on the **system environment**. The **more processors** on the system, the **faster the parallel method runs**. ***For some source collections, a sequential loop may be faster, depending on the size of the source***, and the kind of work being performed (source: MSDN - dd460720). In other words, Parallel.ForEach = Blocking Fork/Join with System Threads ☺

Demo: Producer/Consumers/Reducer with F# Agents (Blocking)



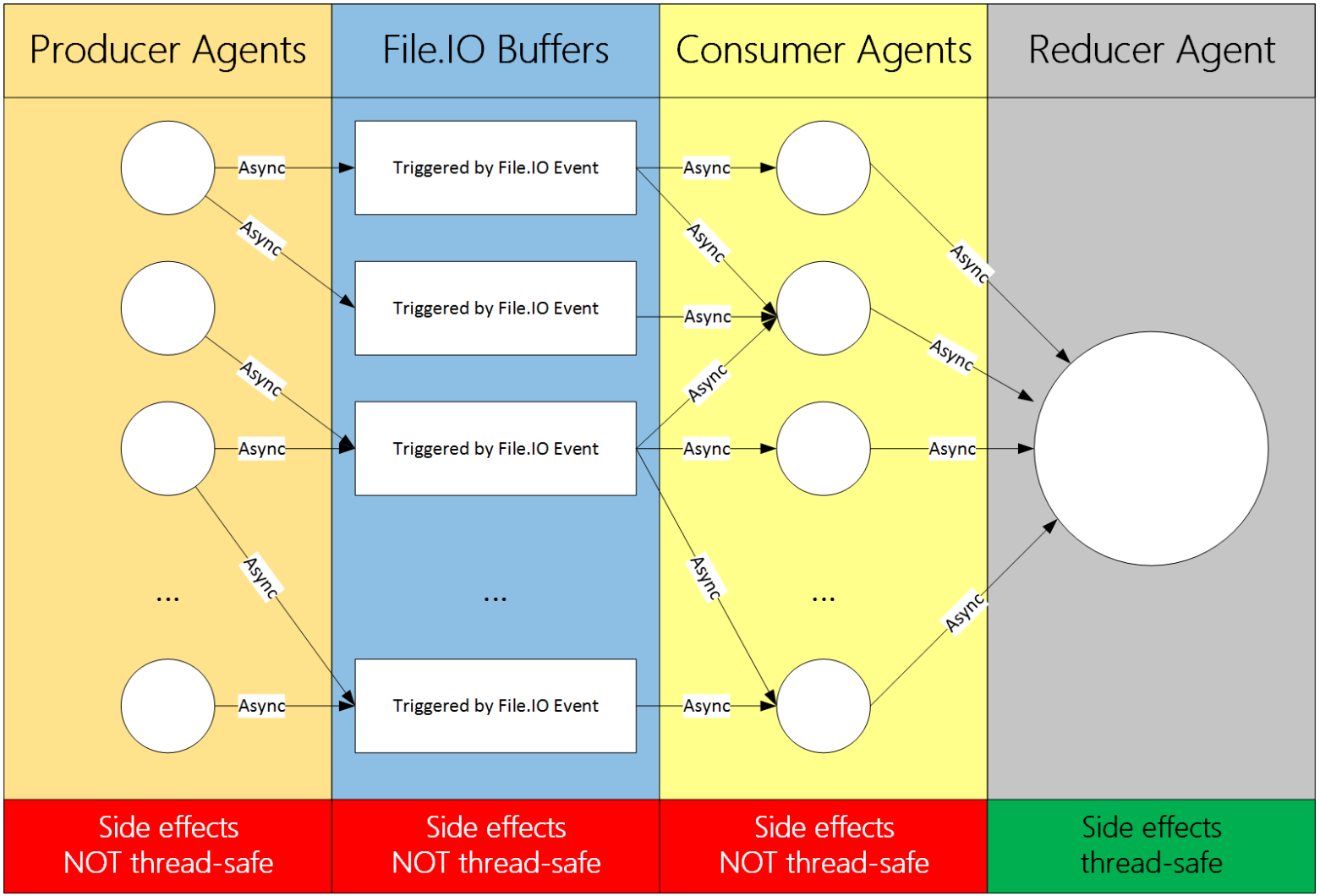
Demo: Producer/Consumers/Reducer with F# Agents

- We have chosen to solve the problem with F# Agents:
  - Alias type: type Agent<'a> = MailboxProcessor<'a> (Erlang style)

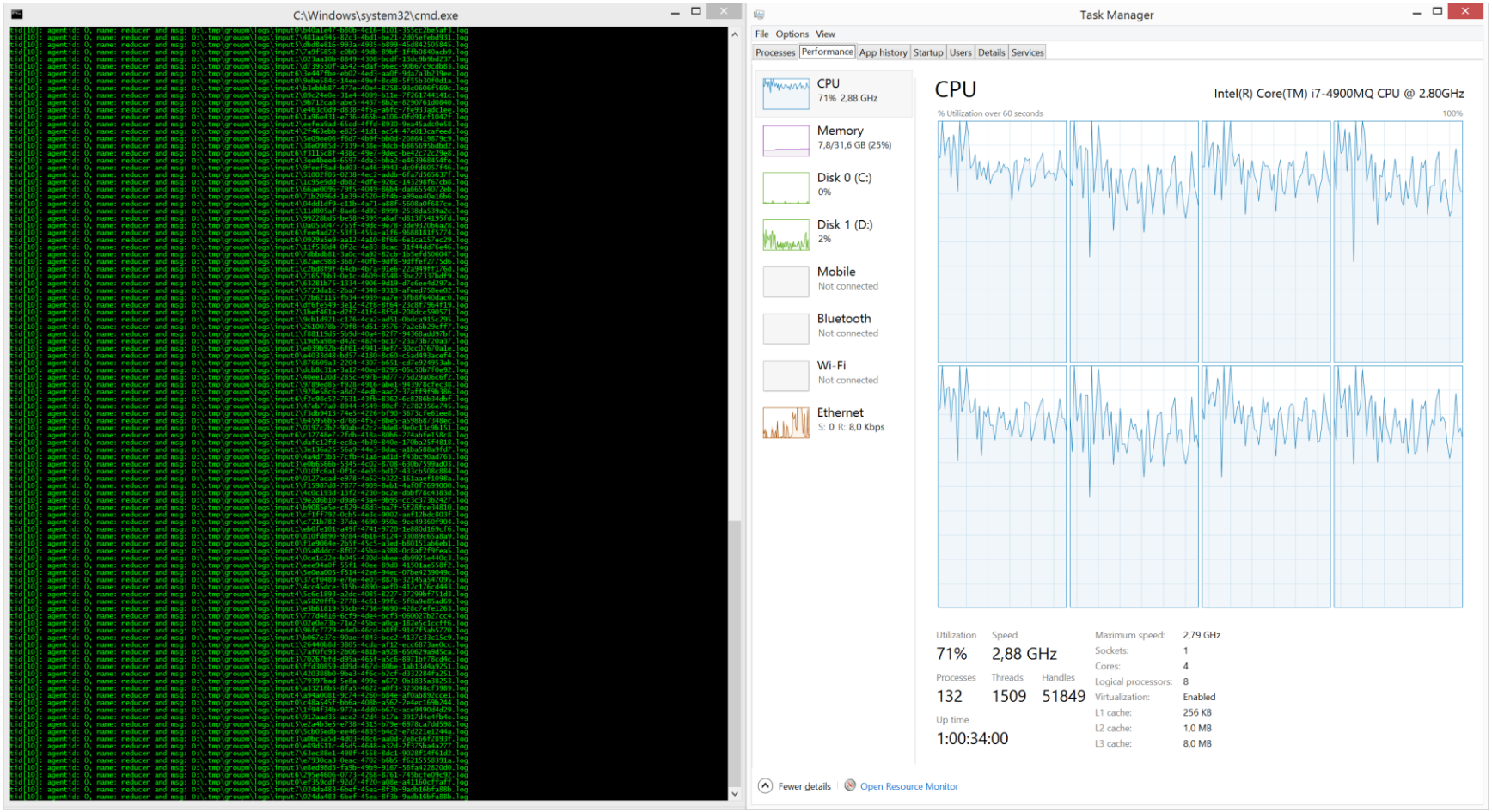
    Remark: MS .NET MailboxProcessors are NOT Erlang Agents
  - Agents → Async → Non-blocking fibers (lightweight threads)
  - Task to be shown:
    1. Utility functions
    2. Domain functions (just a simple Agent implementation)
    3. Reducer function and agent (thread-safe side effects)
    4. Consumer function and agents (show unsafe side effects)
    5. Buffer based on File.IO
    6. Producer function and agents (show unsafe side effects)
    7. Recursive main method that calls producer agents
       (imagine they are produced by people accessing your systems)

  Remark: All the above in about 75 lines of well-written code ☺

Demo: Producer/Consumers/Reducer with F# Agents (Async)



Demo: Producer/Consumers/Reducer with F# Agents (Performance)



U want more?

- Code will be available @ dzumali.salmani@groupm.com
- Slides will be available @ dzumali.salmani@groupm.com
- Sign up @ MF#K for:
  - More ***fun***
  - Hands-on:
    - Claes Worm on OCaml (2015-07-08)
  - Talks:
    - In the pipeline talks about: ***Erlang***, ***Haskell***, ***Rust***, ...
      - Up next: Elixir / Erlang (September month)
- MF#K would like to thank our sponsor(s):