Erlang Solutions Ltd

An Introduction to Erlang

From behind the trenches…

GOTO Copenhagen
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So Here I Am….

Erlang

The Computer Science Lab

Erlang

Telecom Applications: Issues

Complex

No down time

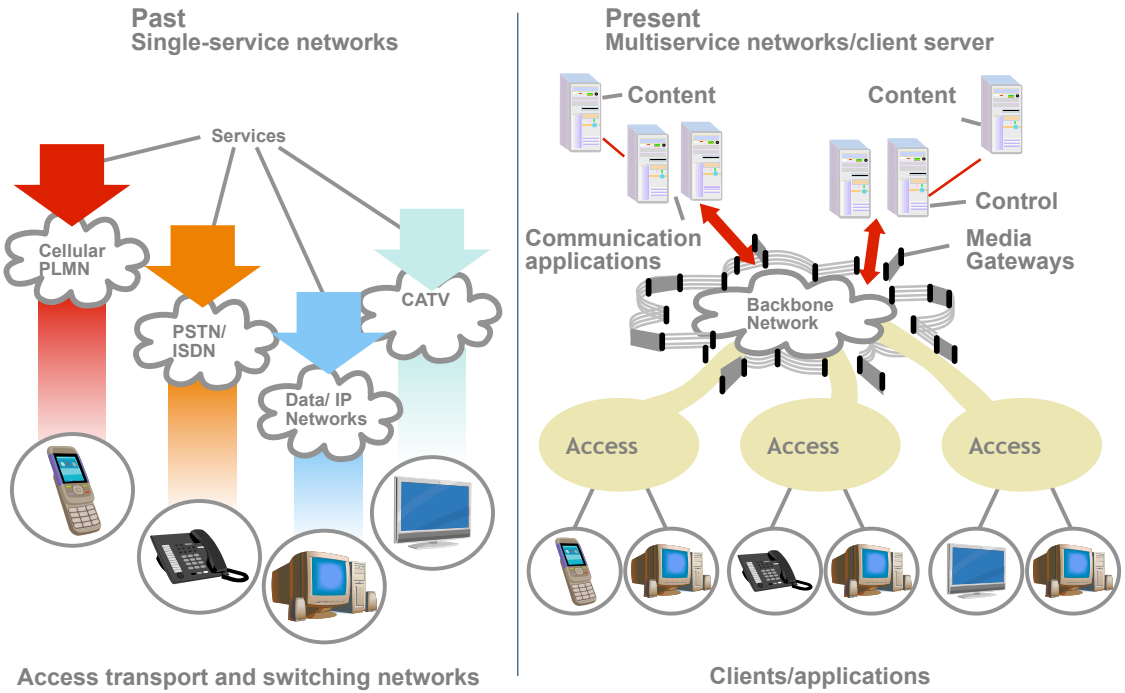
Scalable

Maintainable

Distributed

vs

Time to Market



Erlang

The Ancestors

Languages like SmallTalk, Ada, Modula or Chill

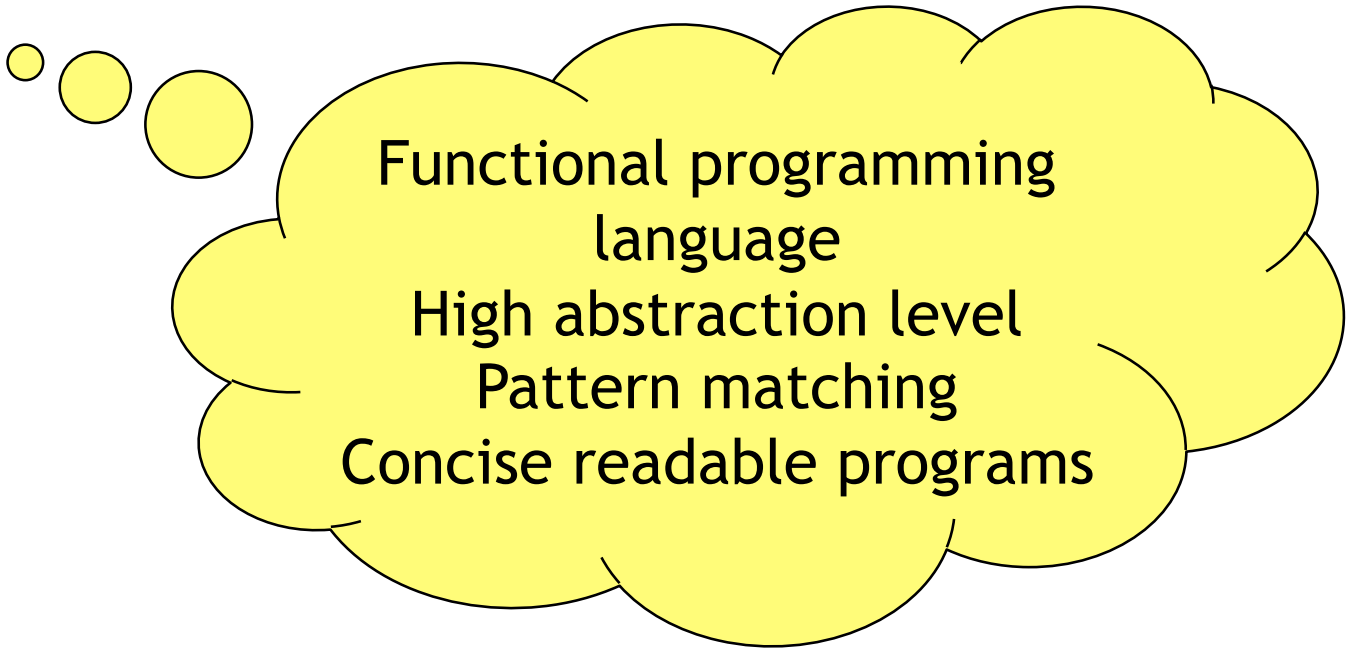
Functional languages like ML or Miranda

Logical languages like Prolog

Erlang

Erlang Highlights

- Declarative
- Concurrent
- Robust
- Distributed
- Hot code loading
- Multicore Support
- OTP



Erlang

Erlang Highlights: Factorial

Factorial using Recursion

Definition

$$n! = \begin{cases} 1 & n = 0 \\ n*(n-1)! & n \geq 1 \end{cases}$$

```
Eshell V5.0.1  (abort with ^G)
1> c(ex1).
{ok,ex1}
2> ex1:factorial(6).
720
```

Implementation

```
-module(ex1).
-export([factorial/1]).

factorial(0) ->
   1;
factorial(N) when N >= 1 ->
   N * factorial(N-1).
```


Erlang

Erlang Highlights: High-level Constructs

QuickSort using List Comprehensions

```
-module(ex2).
-export([qsort/1]).

qsort([Head|Tail]) ->
   First = qsort([X || X <- Tail, X =< Head]),
   Last  = qsort([Y || Y <- Tail, Y > Head]),
   First ++ [Head] ++ Last;
qsort([]) ->
   [].
```

```
Eshell V5.0.1  (abort with ^G)
1> c(ex2).
{ok,ex2}
2> ex2:qsort([7,5,3,8,1]).
[1,3,5,7,8]
```

"all objects Y taken from the list Tail, where Y > Head"

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Erlang Highlights: High-level Constructs

Parsing a TCP packet using the Bit Syntax

```
<< SourcePort:16, DestinationPort:16, SequenceNumber:32,
   AckNumber:32, DataOffset:4, _Reserved:4, Flags:8,
   WindowSize:16, Checksum:16, UrgentPointer:16,
   Payload/binary>> = Segment,

OptSize = (DataOffset - 5)*32,
<< Options:OptSize, Message/binary >> = Payload,
<< CWR:1, ECE:1, URG:1, ACK:1, PSH:1,
   RST:1, SYN:1, FIN:1>> = <<Flags:8>>,

%% Can now process the Message according to the
%% Options (if any) and the flags CWR, ..., FIN
```

etc…

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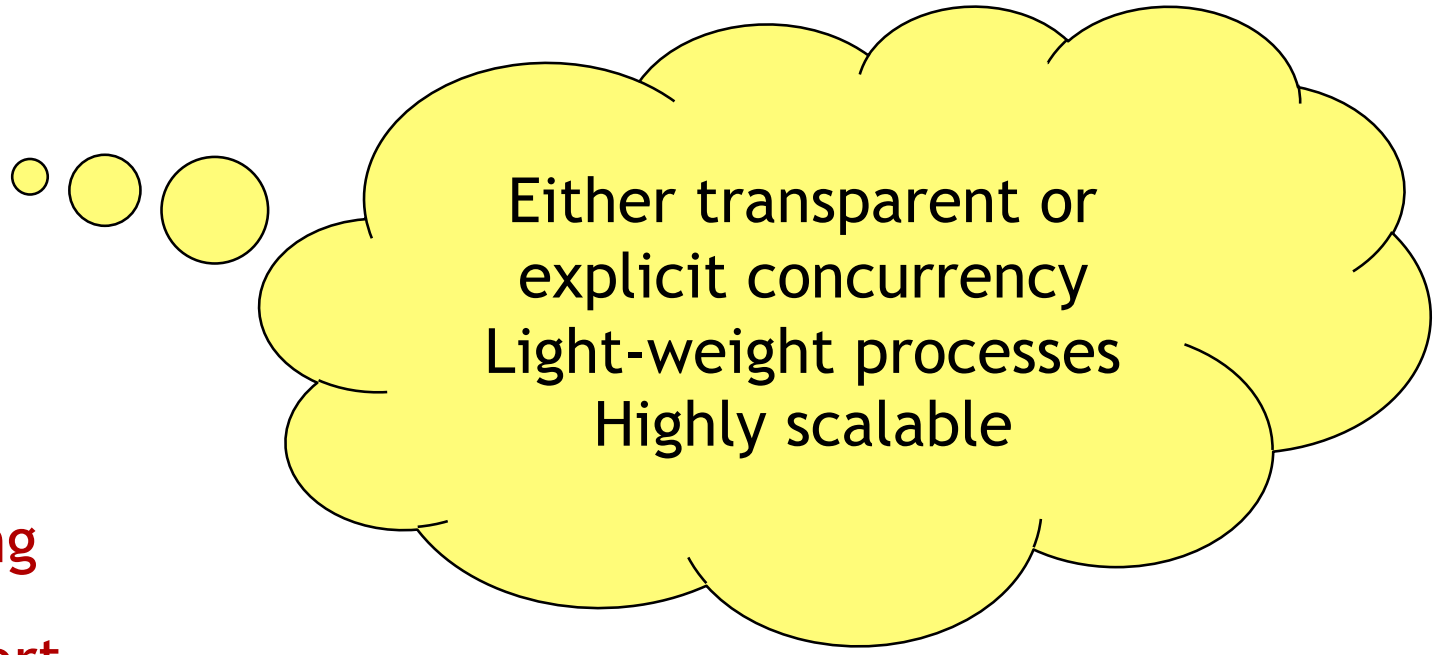

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Erlang Highlights: Concurrency

Creating a new process using spawn

```
-module(ex3).
-export([activity/3]).

activity(Name,Pos,Size) ->
    ..........
```


```
Pid = spawn(ex3,activity,[Joe,75,1024])
```


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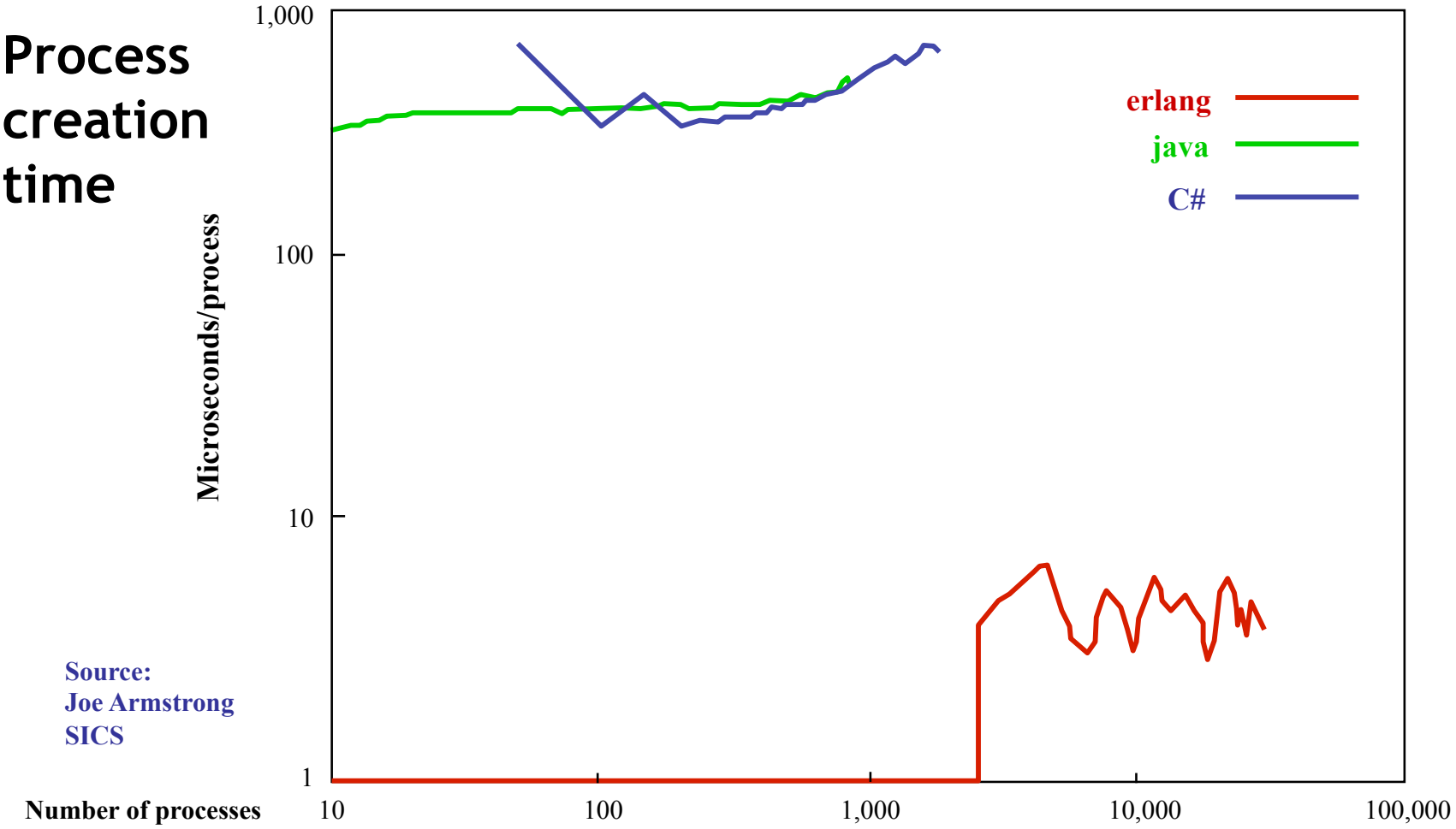
Erlang Highlights: Concurrency

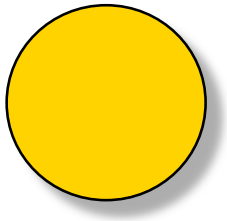
Process creation time

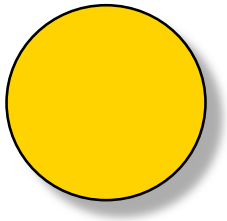


Source:
Joe Armstrong
SICS

Erlang Highlights: Concurrency

Processes communicate by asynchronous message passing





```
Pid ! {data,12,13}
```

```
receive
     {start} -> ……
     {stop} -> ……
     {data,X,Y} -> ……
end
```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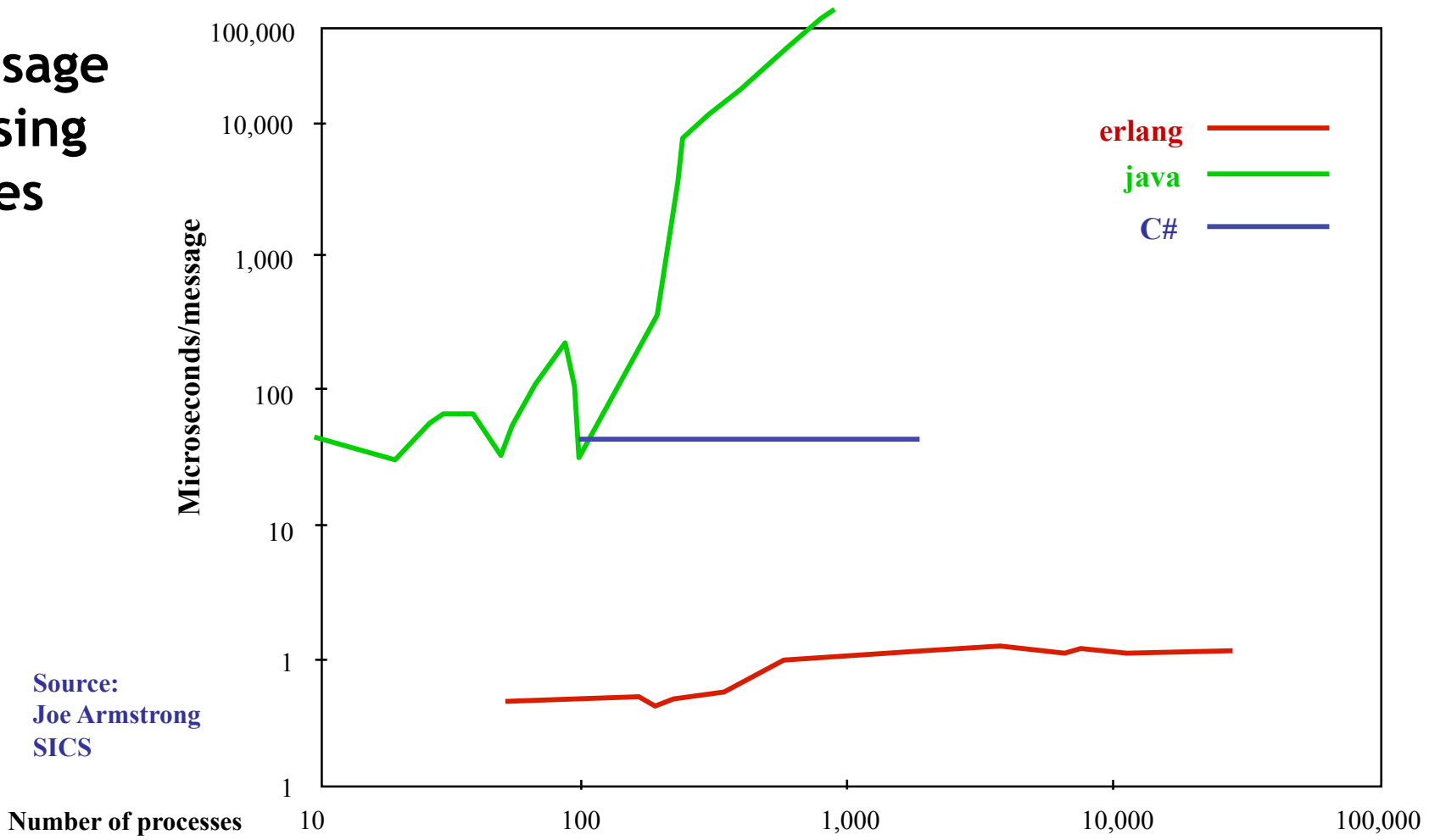
Erlang Highlights: Concurrency

Message passing times



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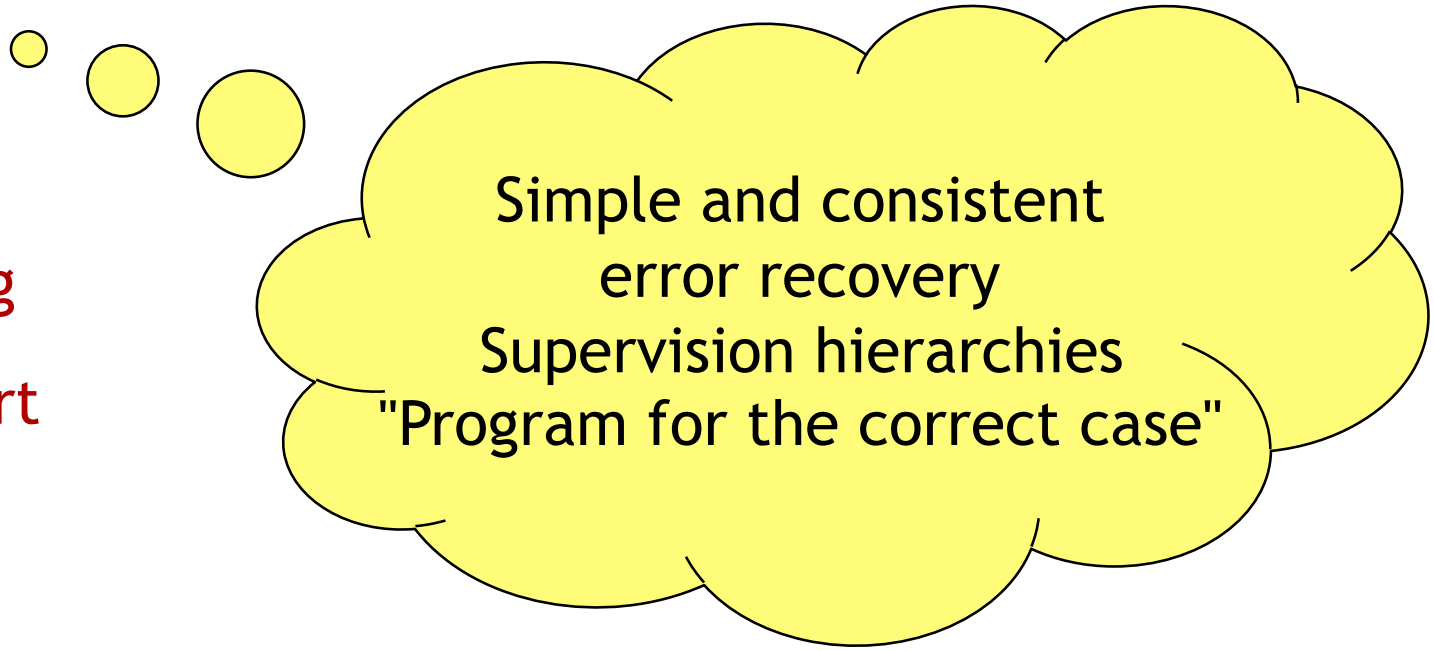

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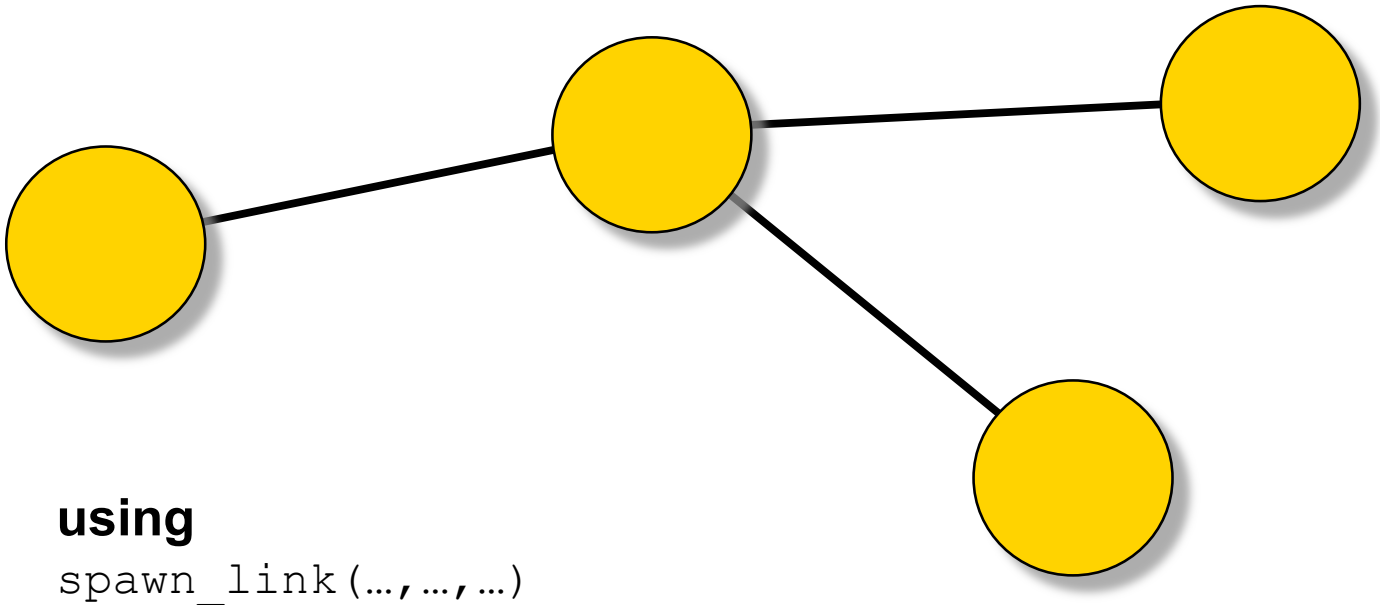
Erlang Highlights: Robustness

Cooperating processes may be linked together



using

```
spawn_link(…,…,…)
```

or

```
link(Pid)
```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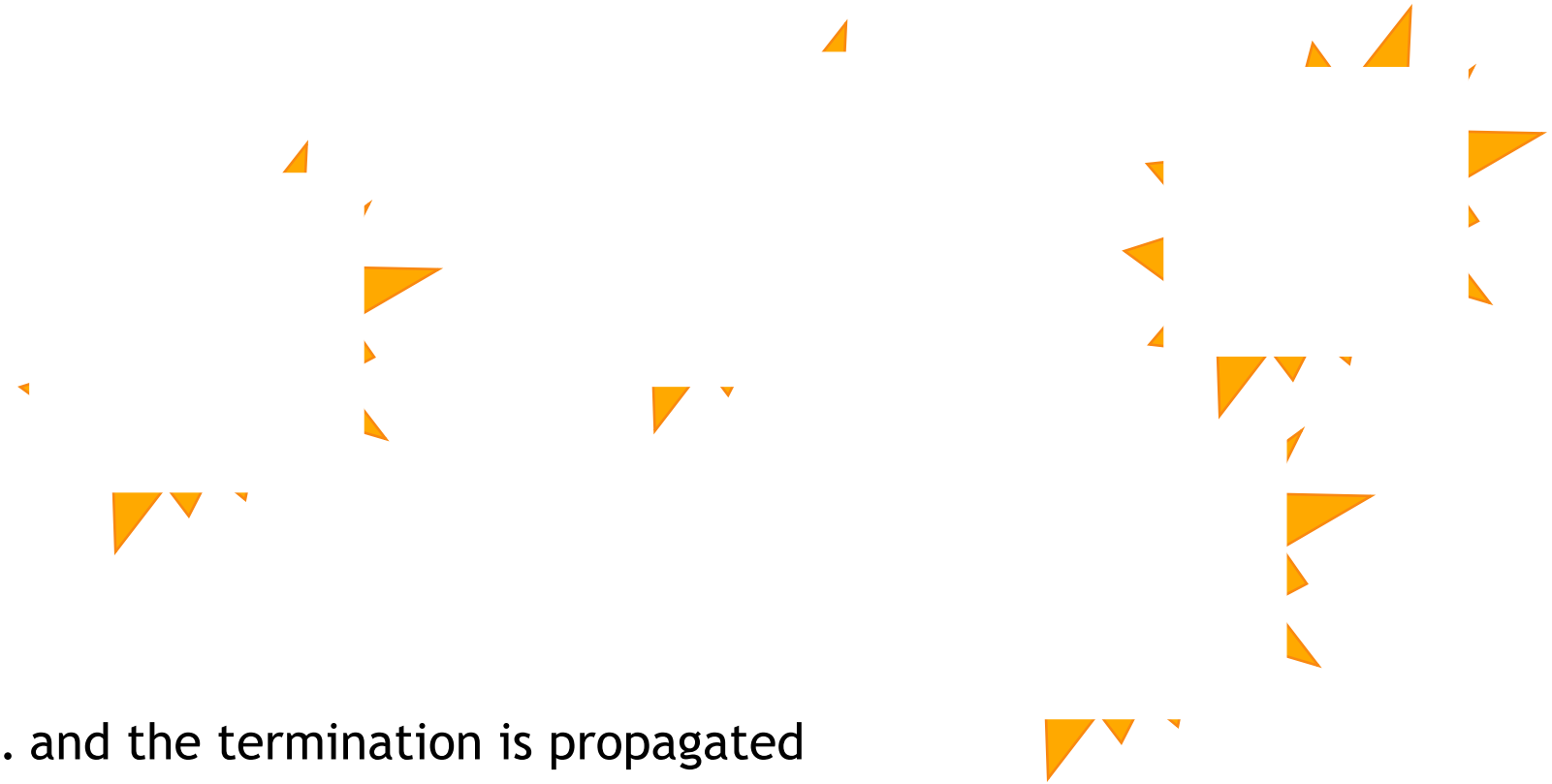
Erlang Highlights: Robustness

When a process terminates, an exit signal is sent to all linked processes



… and the termination is propagated

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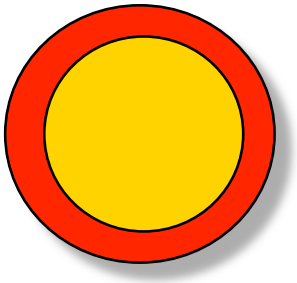
Erlang Highlights: Robustness

Exit signals can be trapped and received as messages



```
receive
   {‘EXIT’,Pid,...} -> ...
end
```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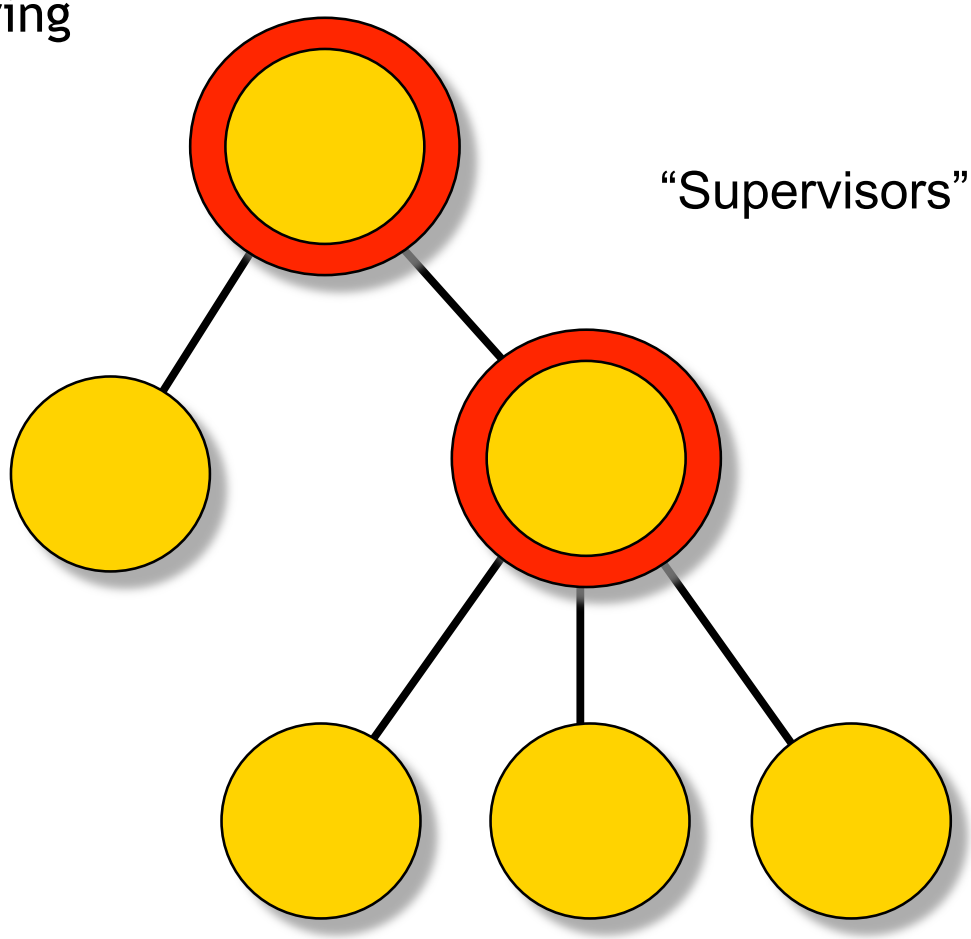
Erlang Highlights: Robustness

Robust systems can be built by layering



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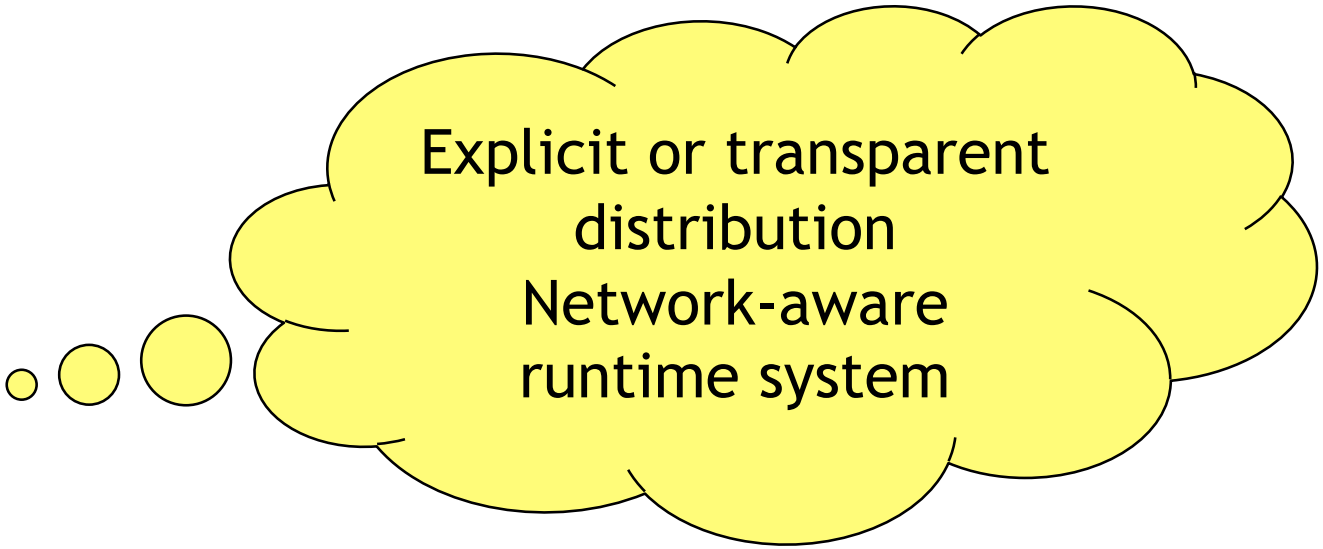

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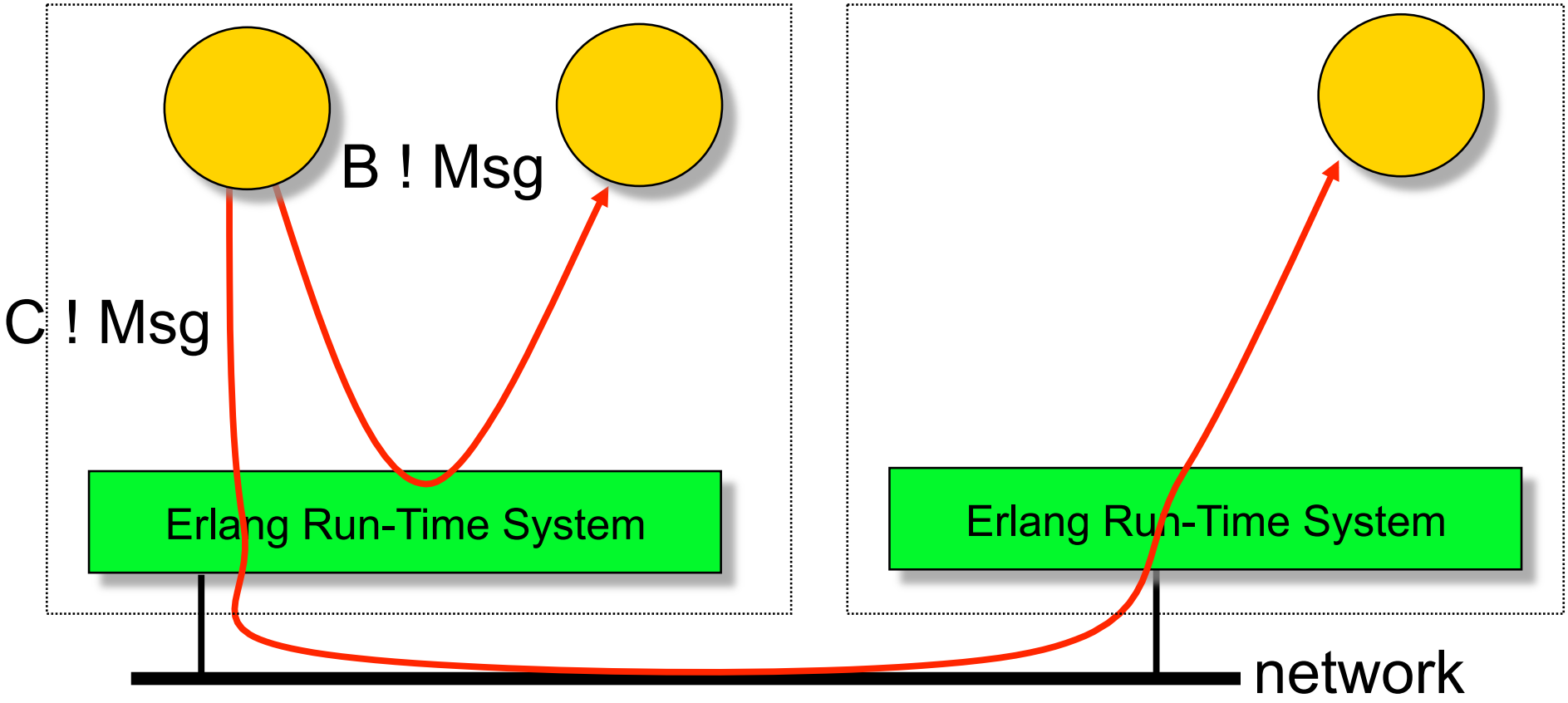
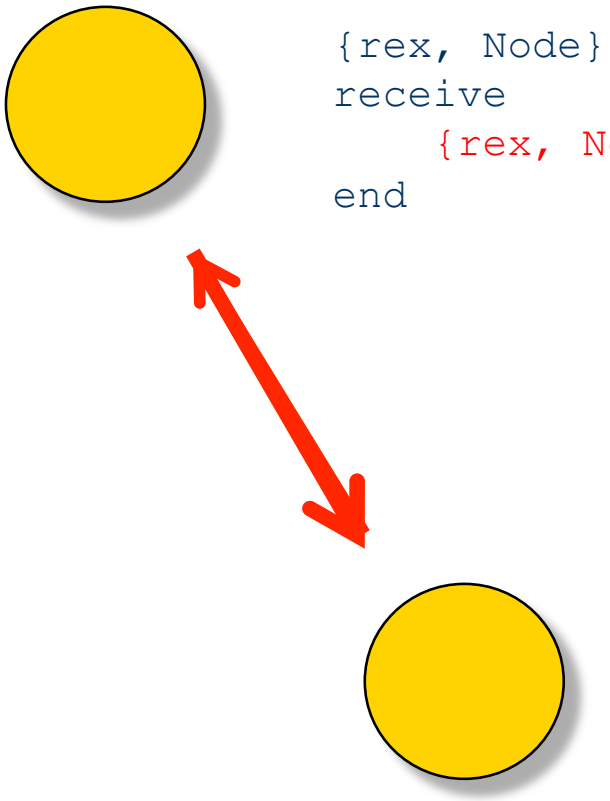
Erlang Highlights: Distribution



Erlang Highlights: Distribution

Simple Remote Procedure Call



```
{rex, Node} ! {self(), {apply, M, F, A}},
receive
    {rex, Node, What} -> What
end
```

```
loop() ->
    receive
        {From, {apply, M, F, A}} ->
            Answer = apply(M, F, A),
            From ! {rex, node(), Answer}
            loop();
        _Other -> loop()
    end.
```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Erlang Highlights

Declarative

Concurrent

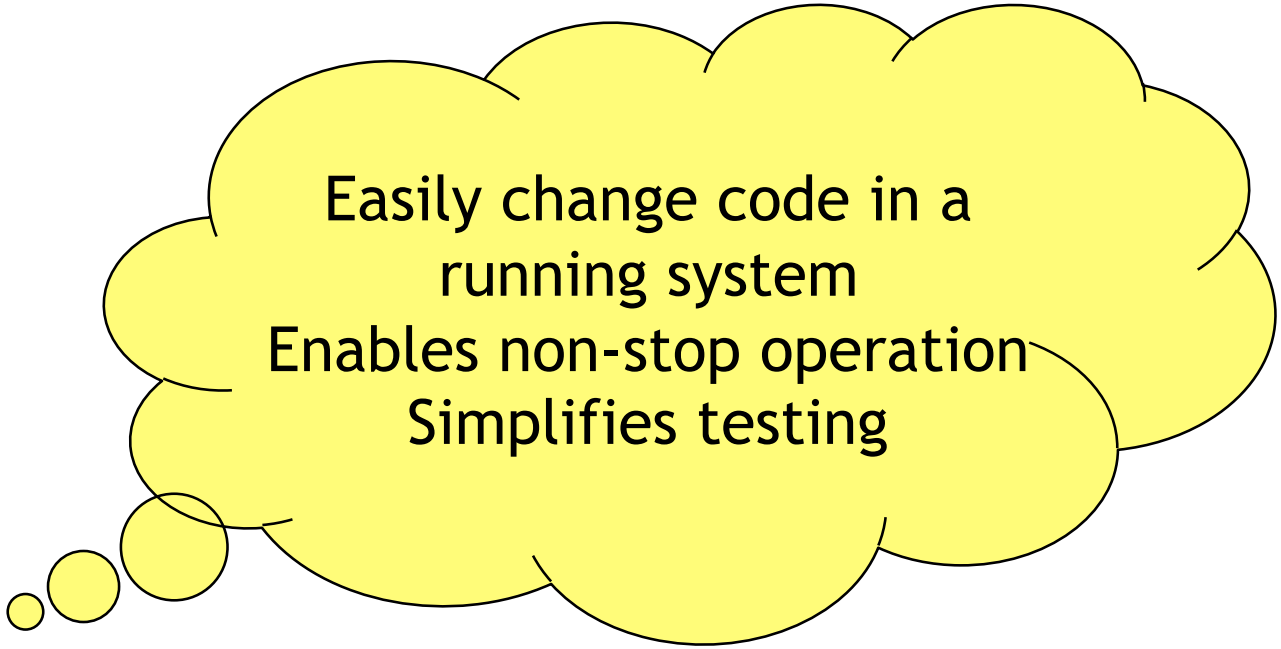
Robust

Distributed

Hot code loading

Multicore Support

OTP



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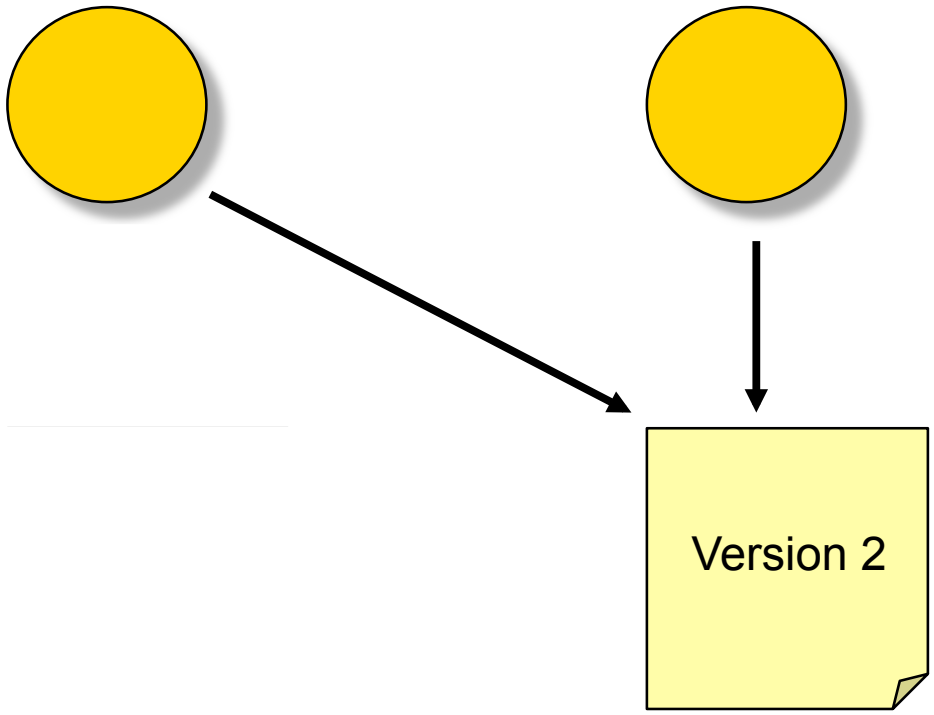
Erlang Highlights: Hot Code Swap



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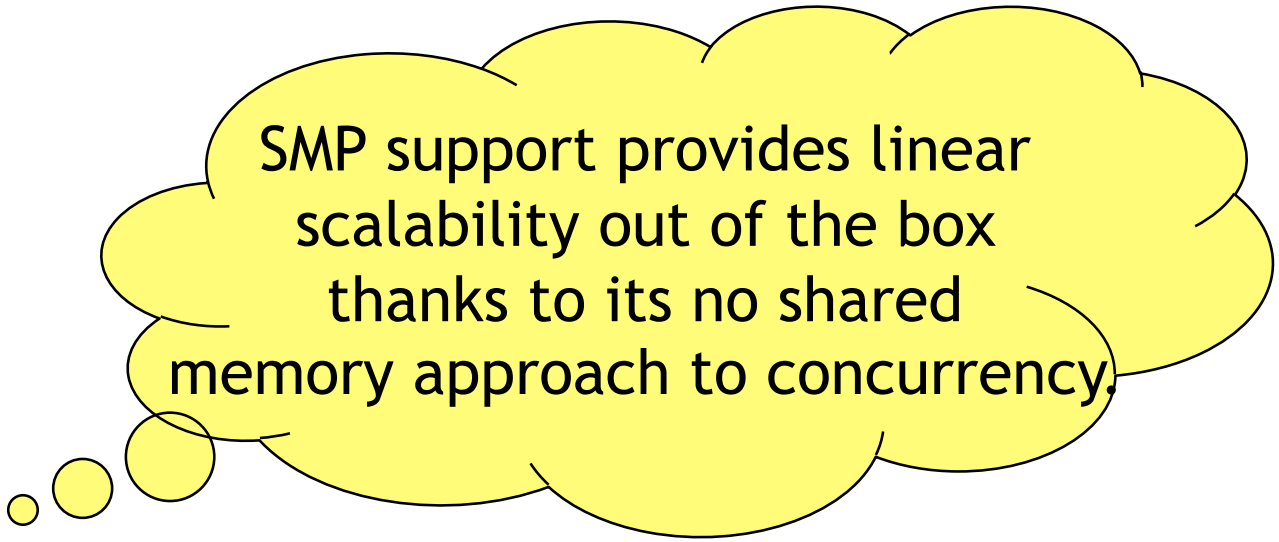

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Ericsson's strategy with SMP

Hide the problems and awareness of SMP from the programmer
Programmed in the normal style using processes for encapsulation and parallelisation

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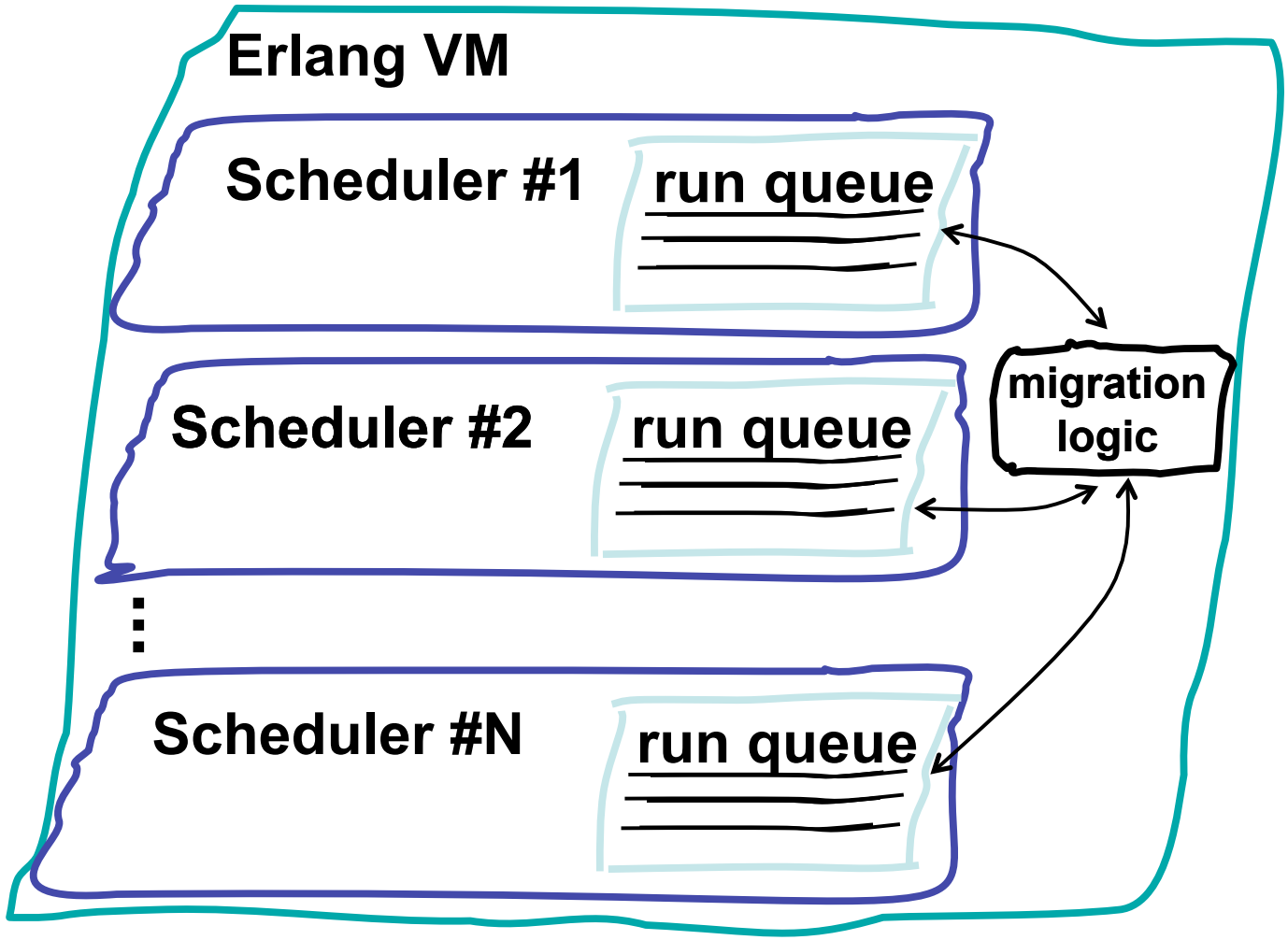
Multicore Erlang



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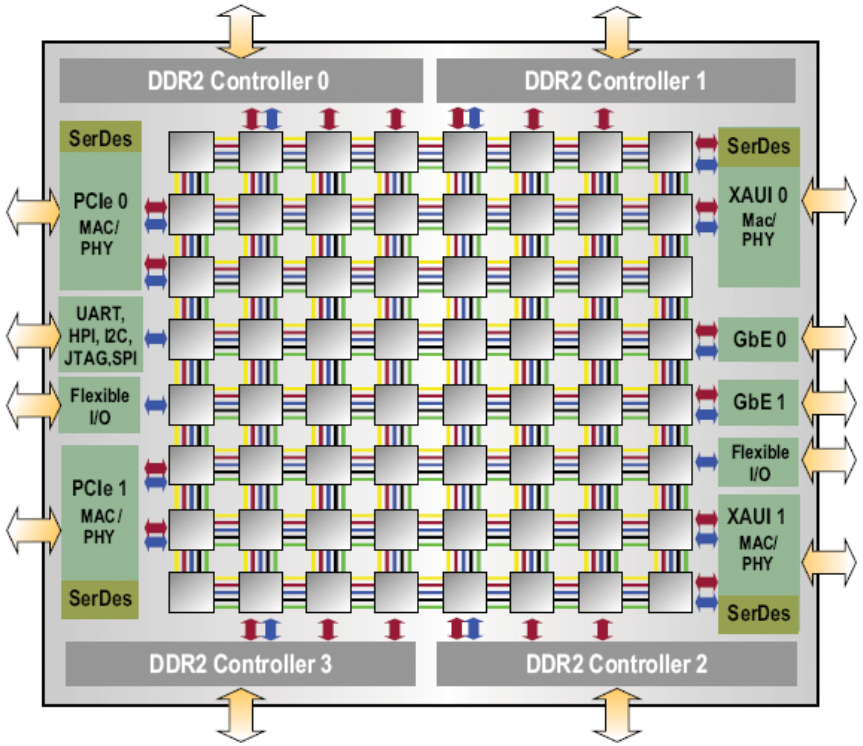
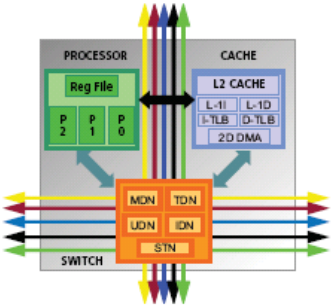
Tilera “Tile64”

Chatty

500 processes created

Each process randomly sends messages and receives a response from all other processes





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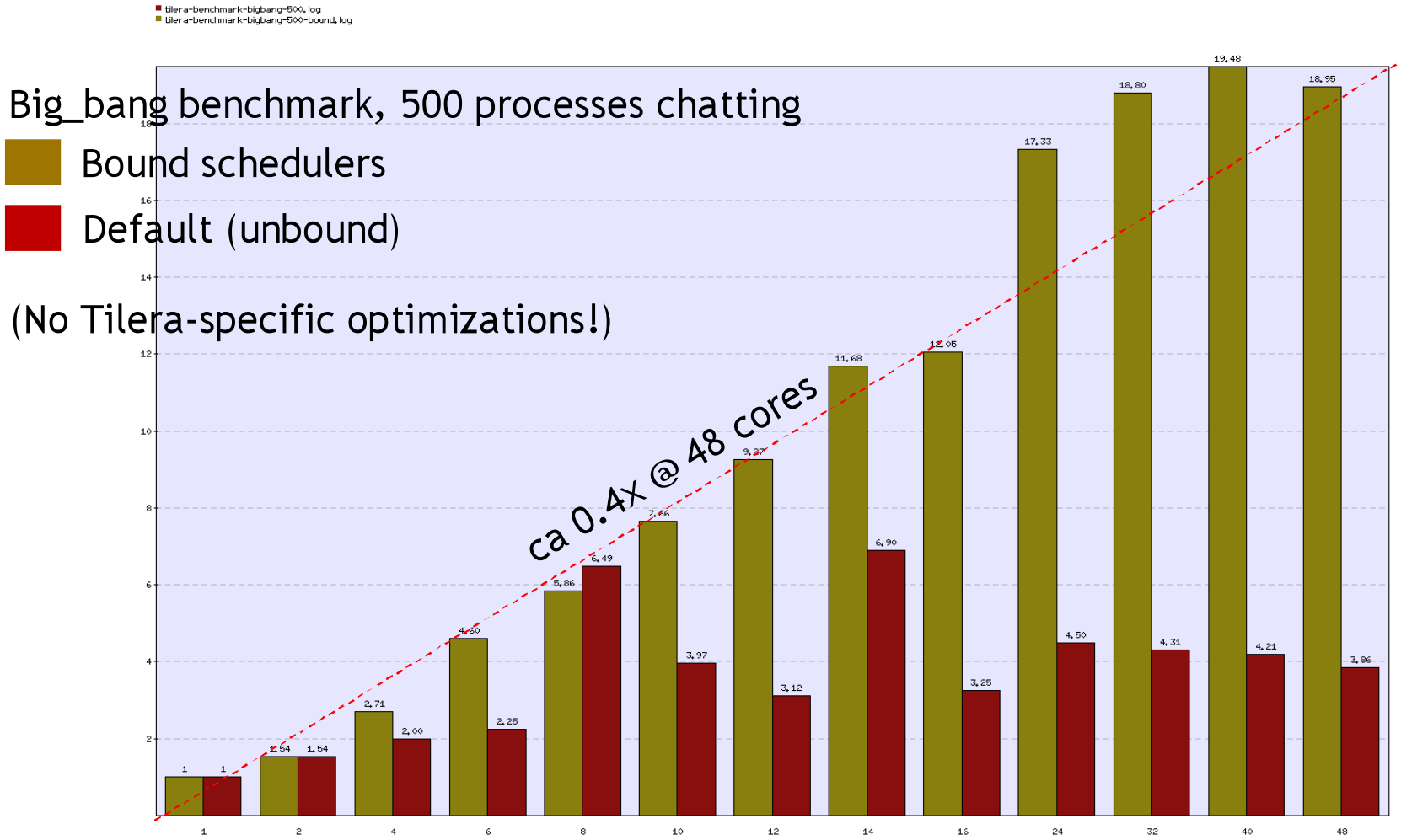
Multicore Benchmark – Big Bang



Erlang/OTP R13B on Tilera Pro 64-core

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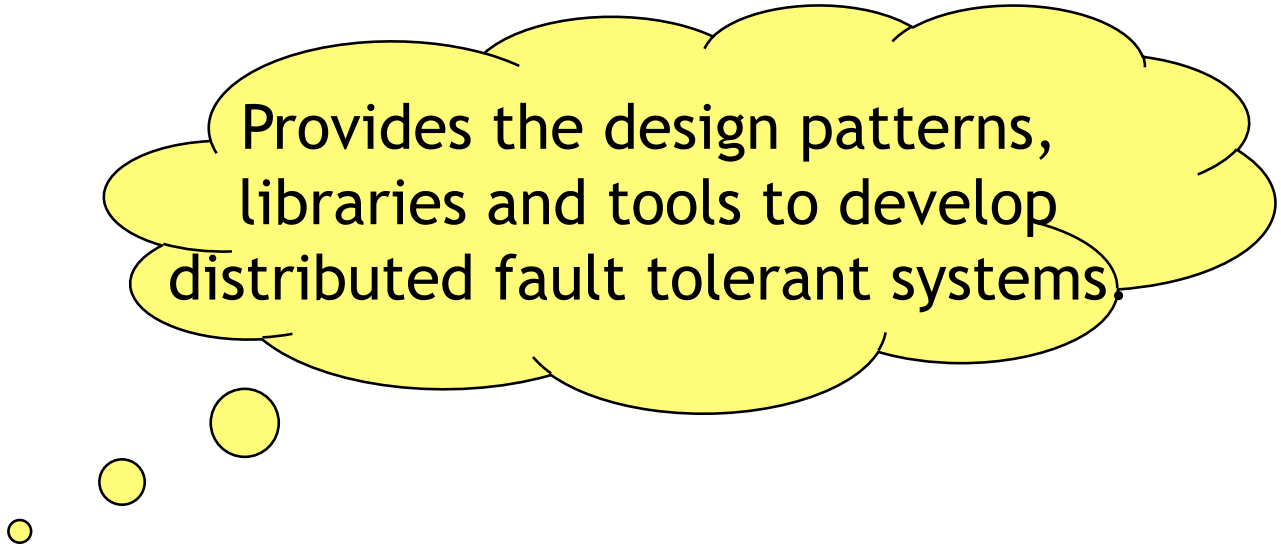

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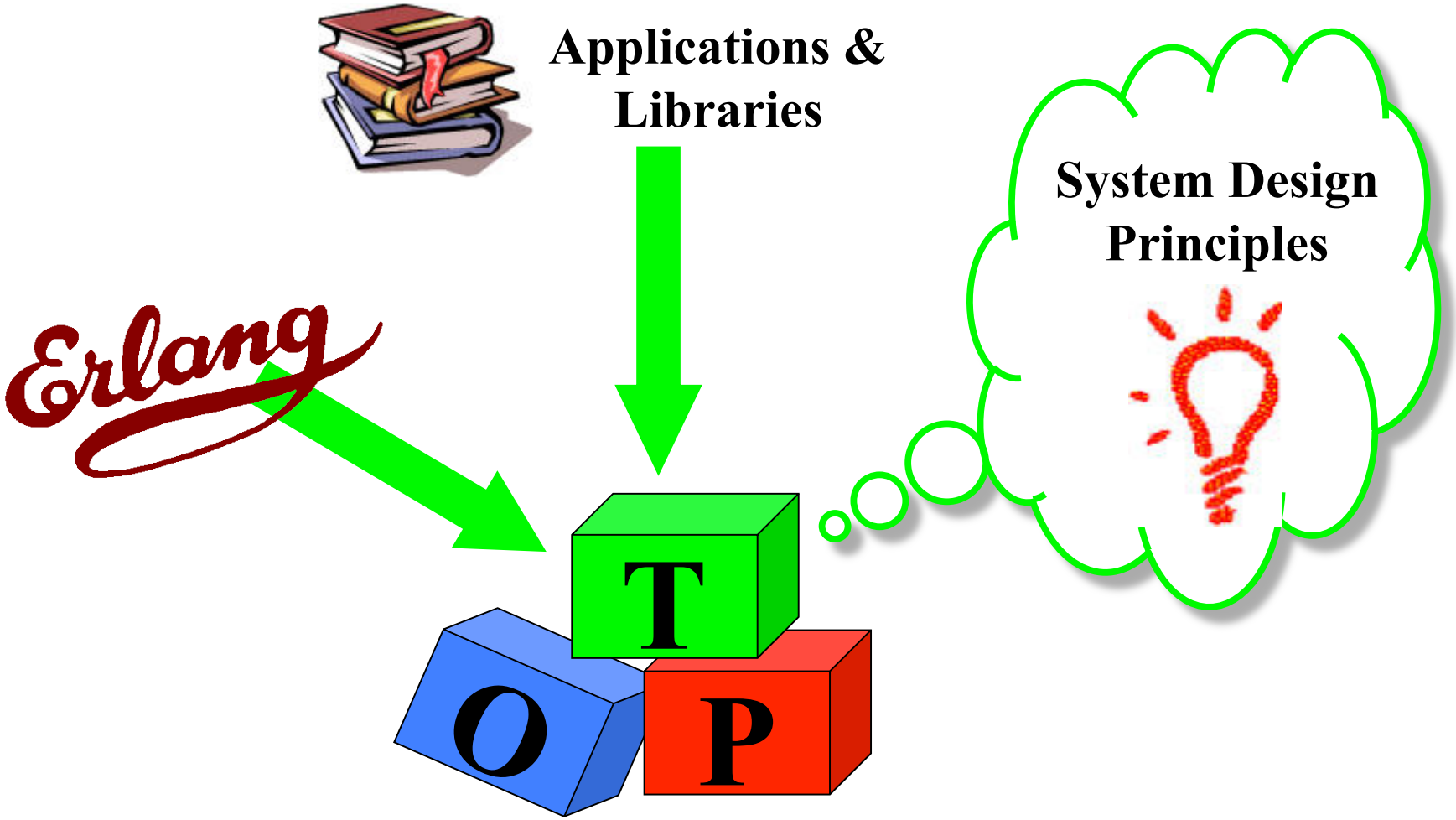
Open Telecom Platform



OTP: System Design Principles

A set of abstract principles and design rules.

- They describe the software architecture of an Erlang System
- Needed so existing tools will be compatible with them
- Facilitate understanding of the system among teams

A set of generic behaviours.

- Each behaviour is a formalisation of a design pattern
- Contains frameworks with generic code
- Solve a common problem
- Have built in support for debugging and software upgrade
- Facilitate understanding of the sub blocks in the system

Erlang Highlights

Declarative

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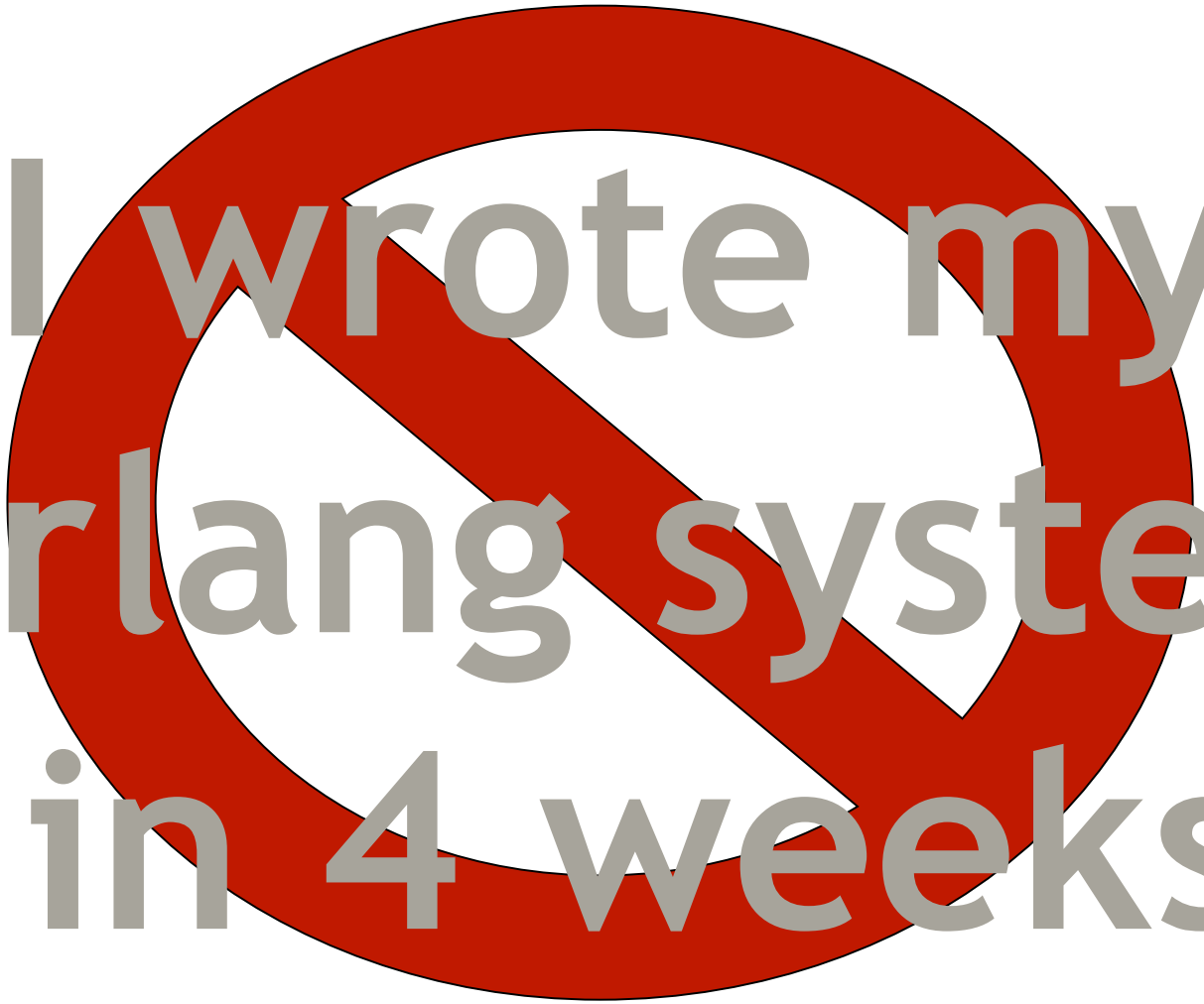

I wrote my Erlang system in 4 weeks!

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The Myths of Erlang….

Is it Documented?

Is the developer supporting it?

What visibility does support staff have into what is going on?

- SNMP
- Live Tracing
- Audit Trails
- Statistics
- CLI / HTTP Interface

How much new code was actually written?

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The Myths of Erlang….

Yes, it is easy for

- Simple patches
- Adding functionality without changing the state

Non backwards compatible changes need time time

- Database schema changes
- State changes in your processes
- Upgrades in distributed environments

Test, Test, Test

- A great feature when you have the manpower!

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The Myths of Erlang….

"As a matter of fact, the network performance has been so reliable that **there is almost a risk that our field engineers do not learn maintenance skills**"

Bert Nilsson, Director NGS-Programs Ericsson

Ericsson Contact, Issue 19 2002

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The Myths of Erlang….

99,999 (Five Nines) is a more like it!

- Achieved at a fraction of the effort of Java & C++

Upgrades are risky!

Non Software related issues

- Power Outages
- Networking
- Hardware Faults

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The Myths of Erlang….

99,999 (Five Nines) is a more like it!

- Achieved at a fraction of the effort of Java & C++

Upgrades are risky!

Non Software related issues

- Power Outages
- Network Failures, Firewall Configurations
- Hardware Faults

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Questions

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More Information

Programming Erlang

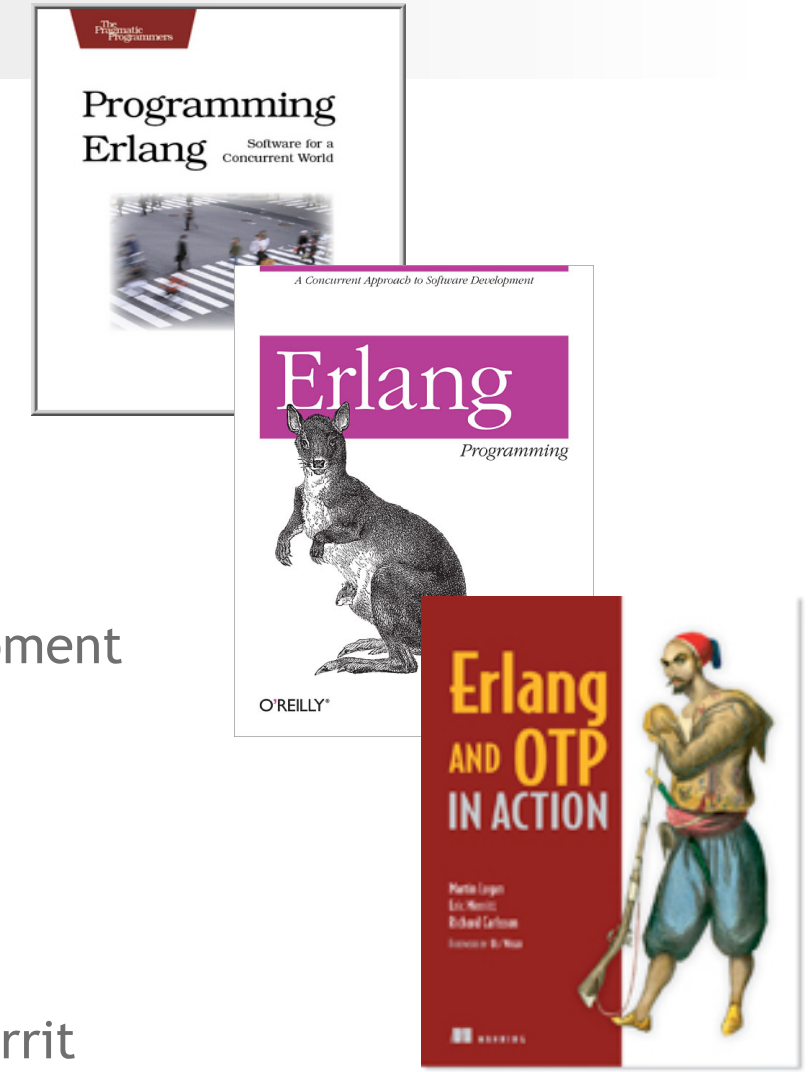
- Software for a Concurrent World
- by Joe Armstrong

Erlang Programming

- A Concurrent Approach to Software Development
- by Francesco Cesarini & Simon Thompson

Erlang and OTP in Action

- Large-scale software design with OTP
- by Richard Carlsson, Martin Logan & Eric Merrit



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Thank You!

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francesco@erlang-solutions.com

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