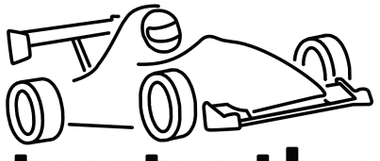
Concurrency:
It's harder (and easier) than you think



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The Pragmatic Programmers

Seven Concurrency Models in Seven Weeks

When Threads Unravel

Paul Butcher

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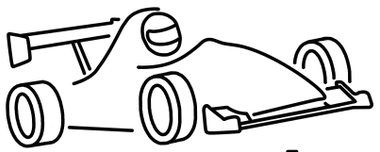
What Makes Threaded Code Hard to Get Right?

- Deadlock
- Livelock
- Lock Contention
- Scalability
- Priority Inversion
- ...
- **Memory Model**



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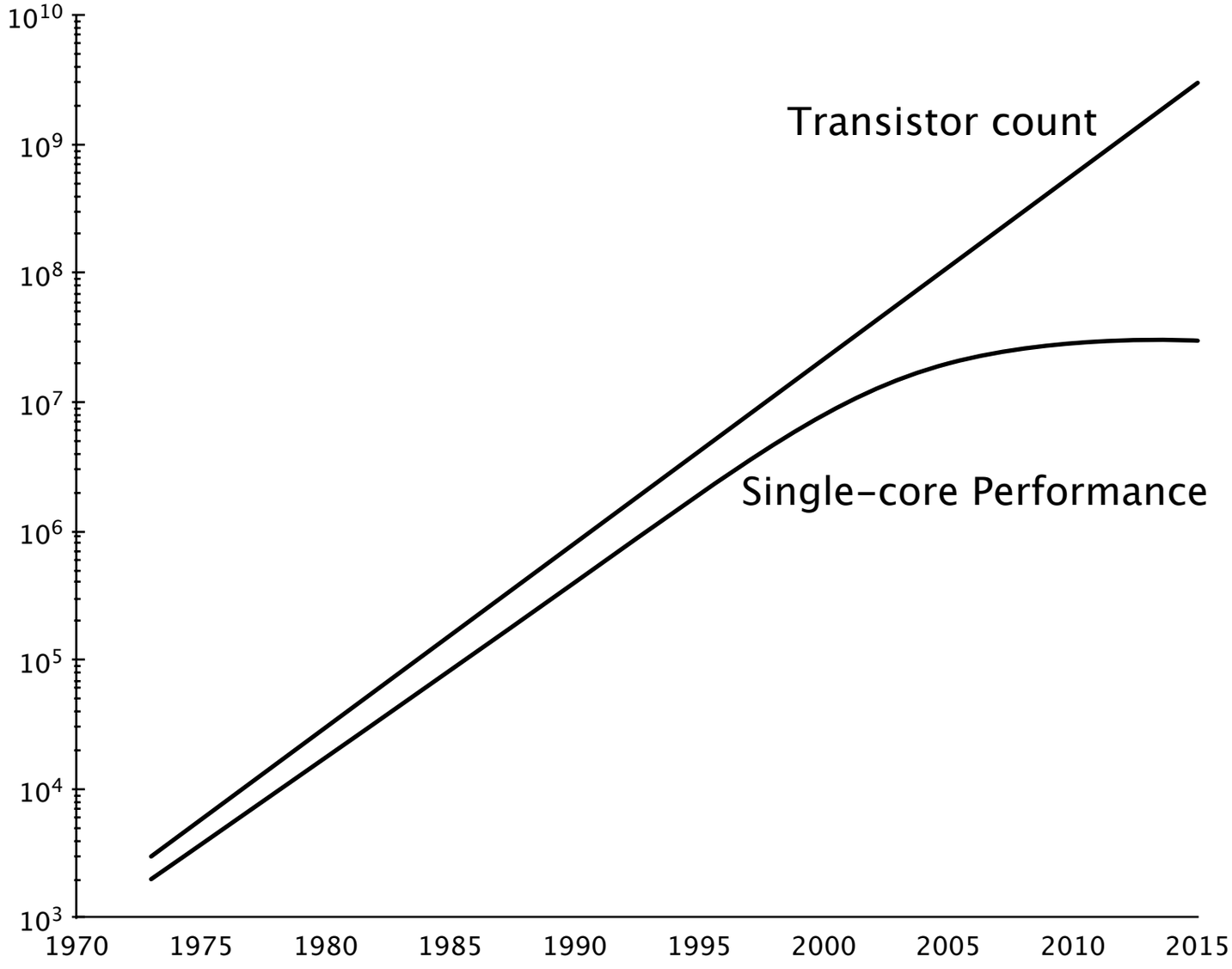

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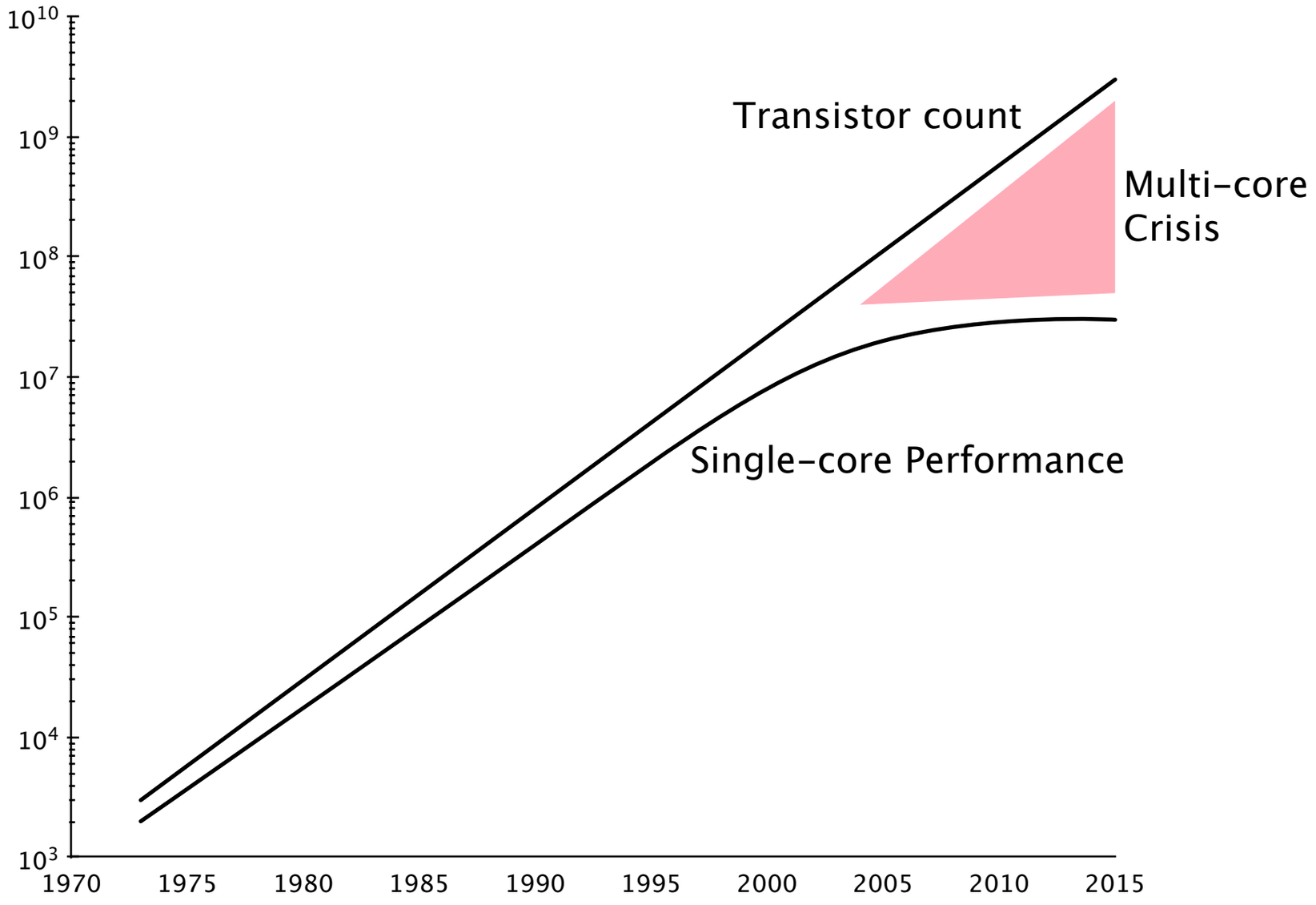

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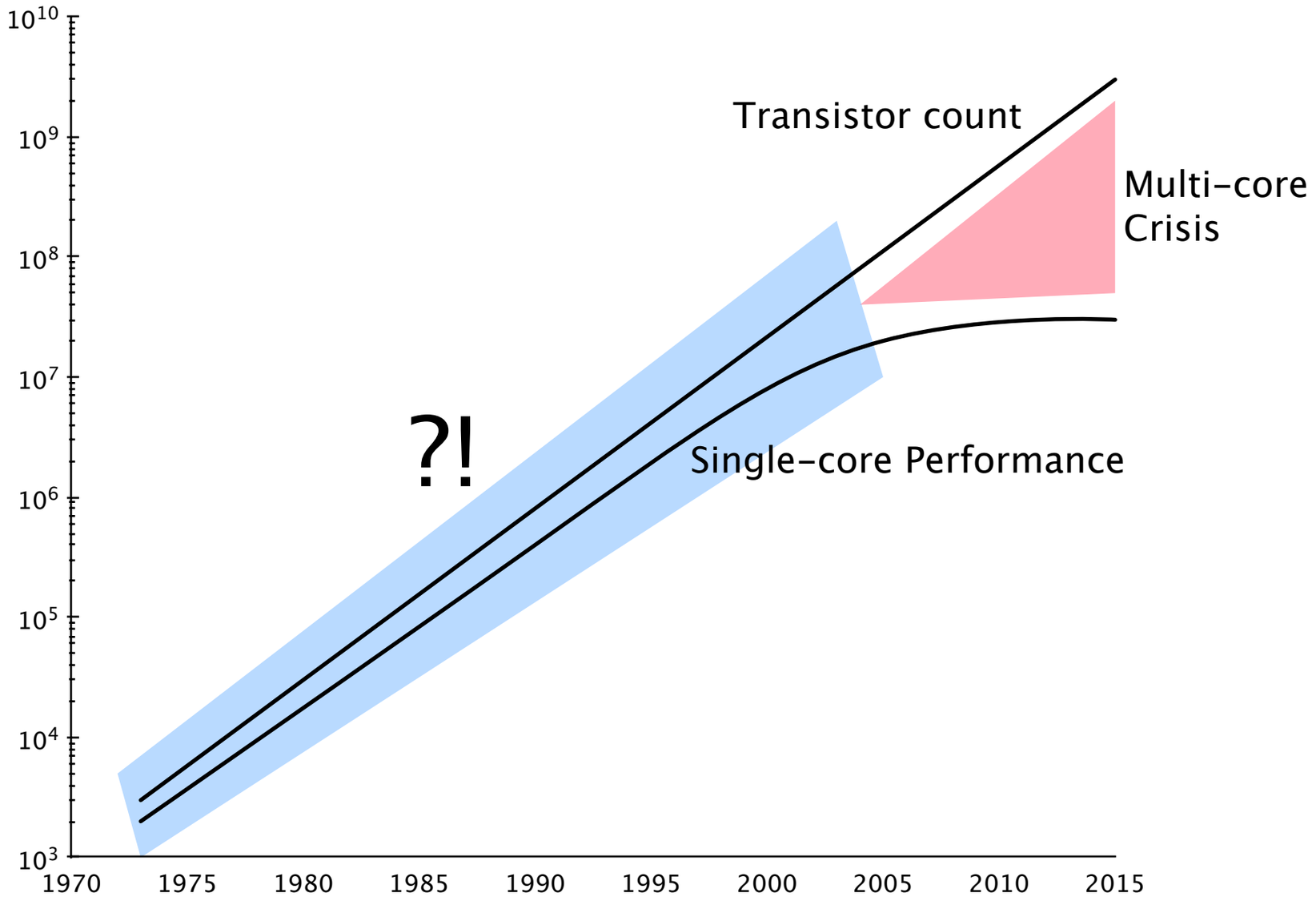

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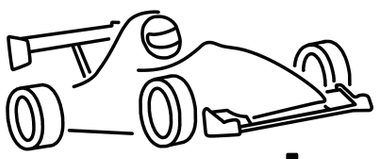
- Increasing clock speed
- Bit-level **parallelism**
- Instruction-level **parallelism**



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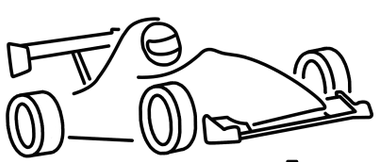
The Elephant in the Room

Testing!



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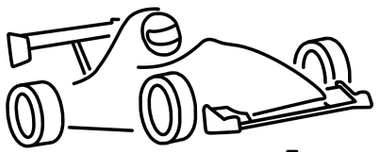
Bottom Line

Multi-threaded programming is **hard**.



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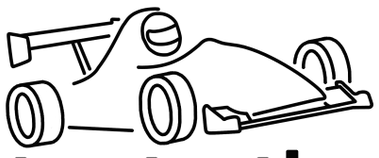
Bottom Line

Multi-threaded programming is

really, really hard.



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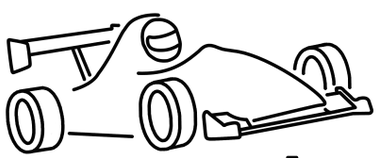
The problem is **shared**, **mutable** data



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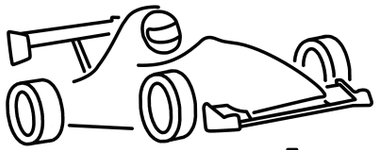
Functional Programming

The problem is **shared**, ~~**mutable**~~ data



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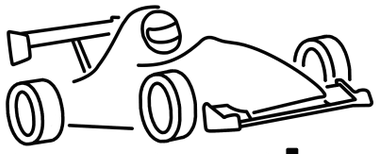
Message Passing:

Actors

Communicating Sequential Processes

The problem is ~~shared~~, **mutable** data



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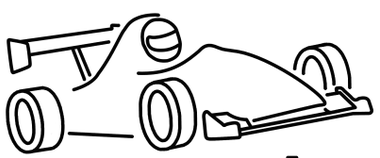
The problem is **shared**, **mutable** data

Software Transactional Memory
Clojure's "Unified Succession Model"



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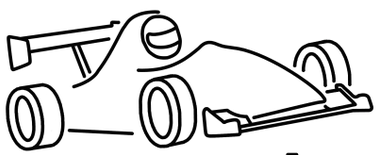
I’m sorry that I long ago coined the term “objects” for this topic, because it gets many people to focus on the lesser idea.

The big idea is “messaging”.

–Alan Key



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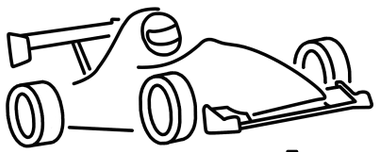
Concurrency is hard



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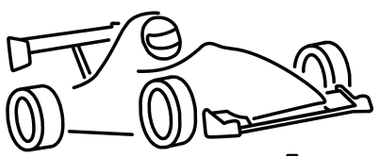
~~Concurrency is hard~~

Threads and Locks are hard



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Concurrency

Good Tools

Fast

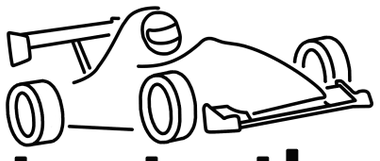
Scalable

Resilient

…

Simple

Correct



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