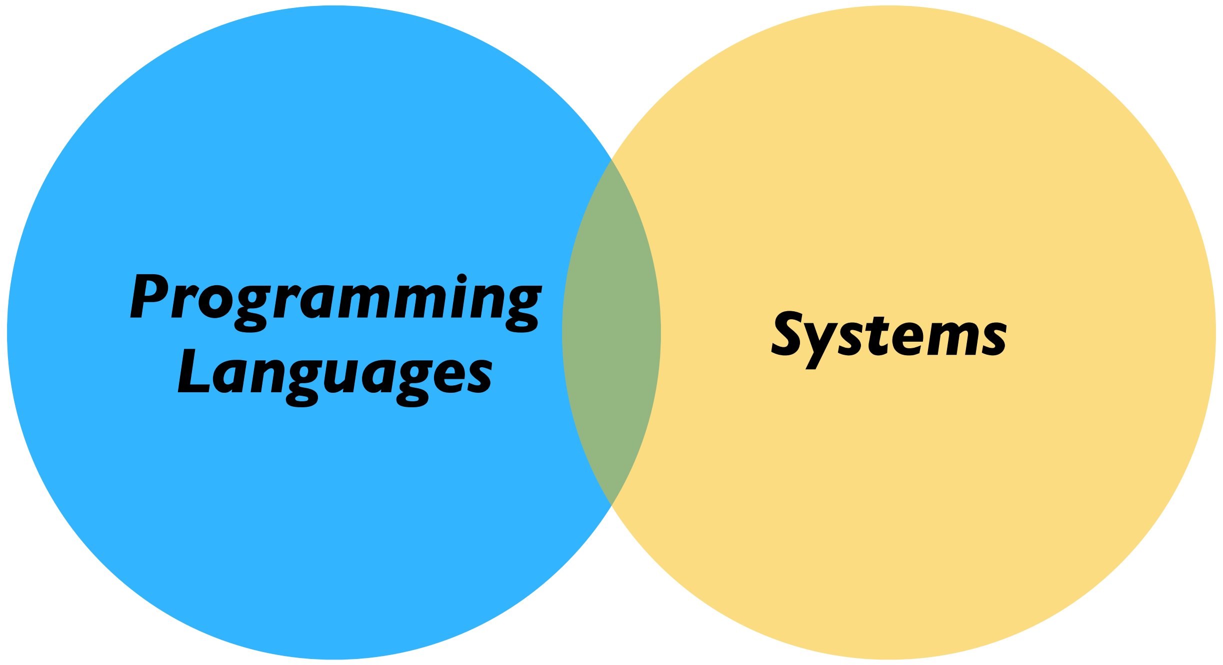
Multicore Support for Tezos Blockchain

KC Sivaramakrishnan
Computer Science and Engineering

My research

- PL has *central place* in solving computing problems

My research



Concurrent

Parallel

Distributed

Operating

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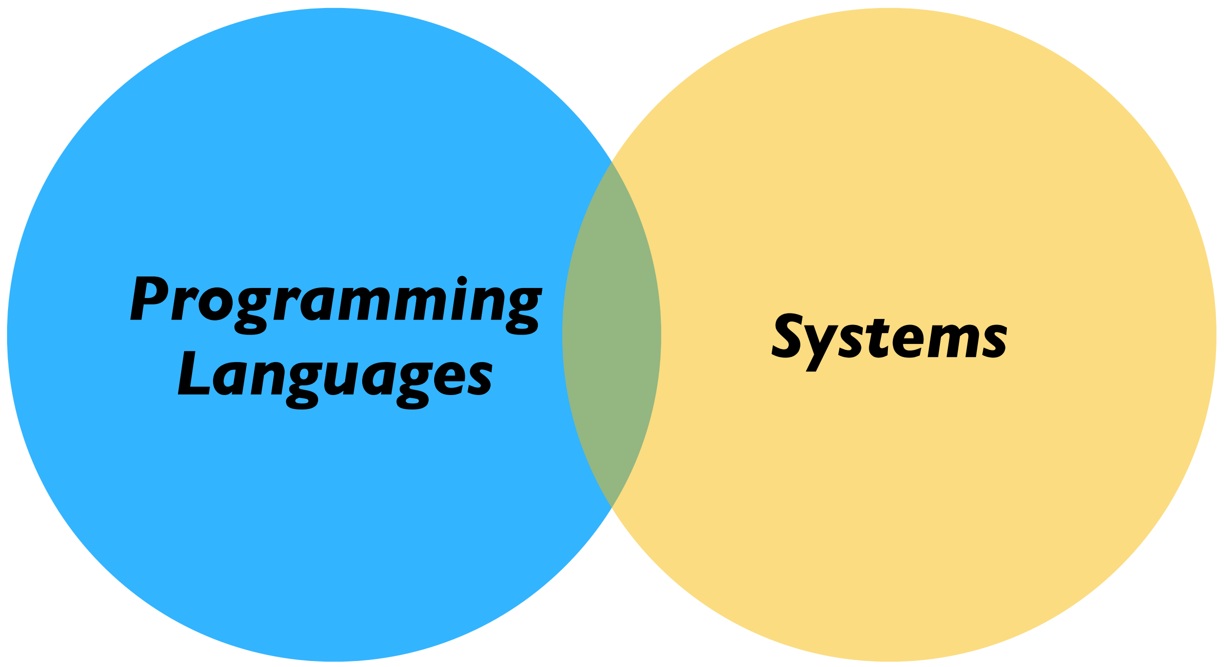

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- PL as a tool to *formally* reason about complex systems
    - ✦ Develop *abstractions* for simplifying systems

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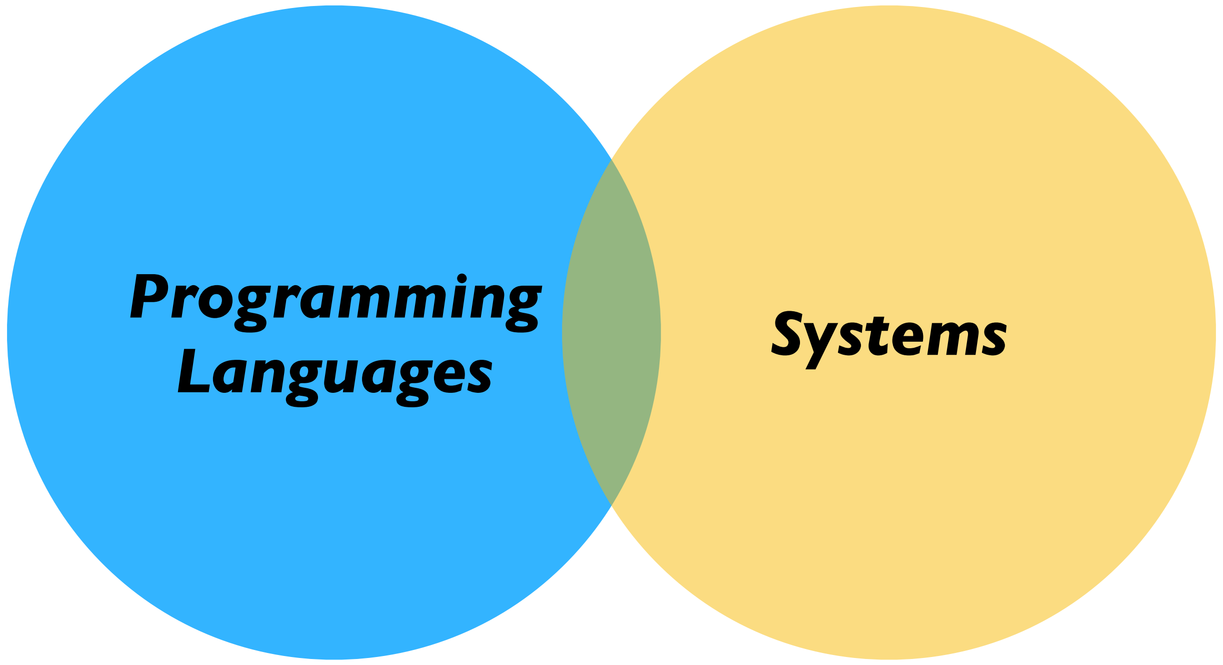

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- PL has *central place* in solving computing problems
- PL as a tool to *formally* reason about complex systems
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- **Interests:** programming language runtimes, distributed databases, concurrency, secure systems engineering

Tezos Blockchain

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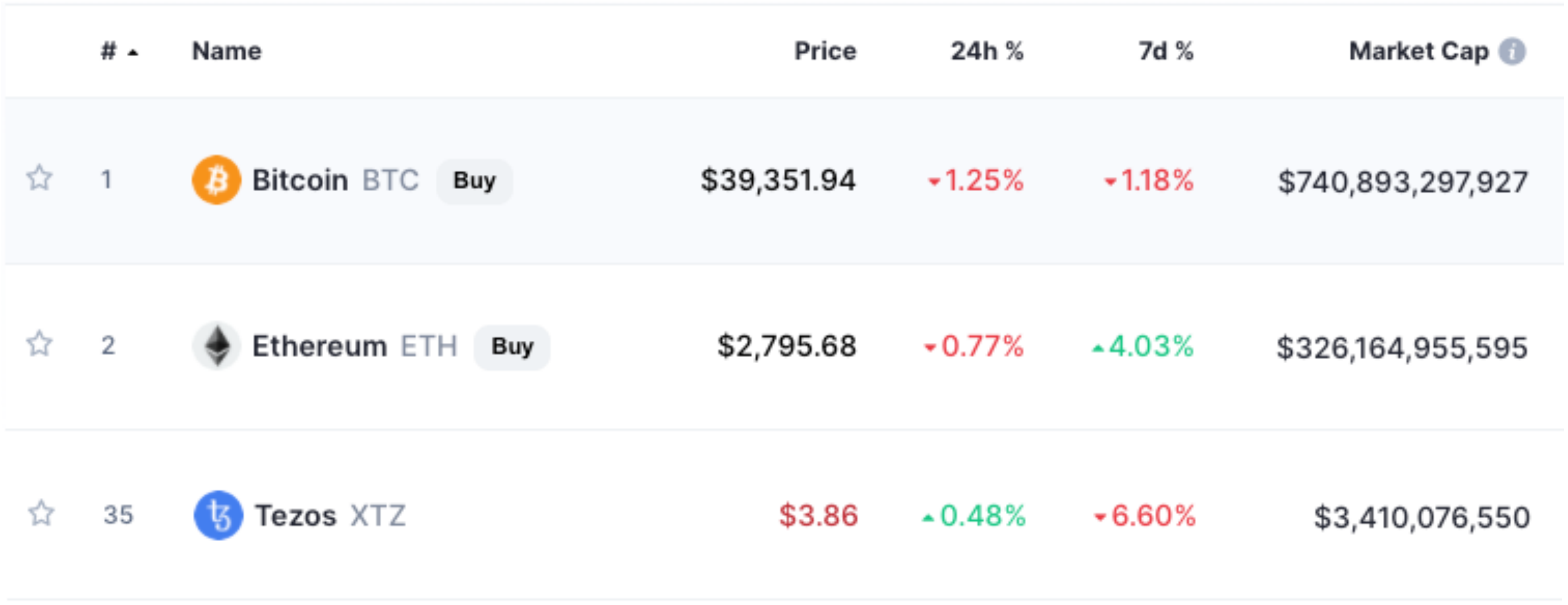
- Had the biggest ICO $232 million of its time



#	Name	Price	24h %	7d %	Market Cap
1	Bitcoin BTC Buy	$39,351.94	▾1.25%	▾1.18%	$740,893,297,927
2	Ethereum ETH Buy	$2,795.68	▾0.77%	▴4.03%	$326,164,955,595
35	Tezos XTZ	$3.86	▴0.48%	▾6.60%	$3,410,076,550

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  - ✦ Proof-of-work is *energy intensive* — Bitcoin *129 TWH* ~= Norway
- Tezos is amenable for *formal verification*
  - ✦ *Michelson*, low-level smart contract language is expressed as a OCaml GADT
    - ✤ Rules out large classes of errors by construction
  - ✦ Many efforts around *full-functional verification* of Tezos smart contracts — Mi-Cho-Coq, Albert

Performance

	₿	Ξ	PayPal	VISA	ꜩ
Transactions per second:	7	30	200	3000	40
Confirmation Latency:	1 hour	10 minutes	Few seconds	Few seconds	30 minutes

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- **Strategy:** *Exploit multicore parallelism*

Tezos: Implementation Language

Recently turned 25!

OCaml

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OCaml

Industry

ahrefs

Jane Street

docker

FACEBOOK

Tarides

Bloomberg

Projects

The Astrée Static Analyzer

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hack

COMPCERT

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No multicore support!

Multicore OCaml

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OCaml Labs

Jane Street

Opsian

λ 0x1F42B Segfault Systems

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- Research
  - ✦ Concurrent and parallel garbage collector for OCaml [ICFP '20]
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funded by Tezos Foundation!

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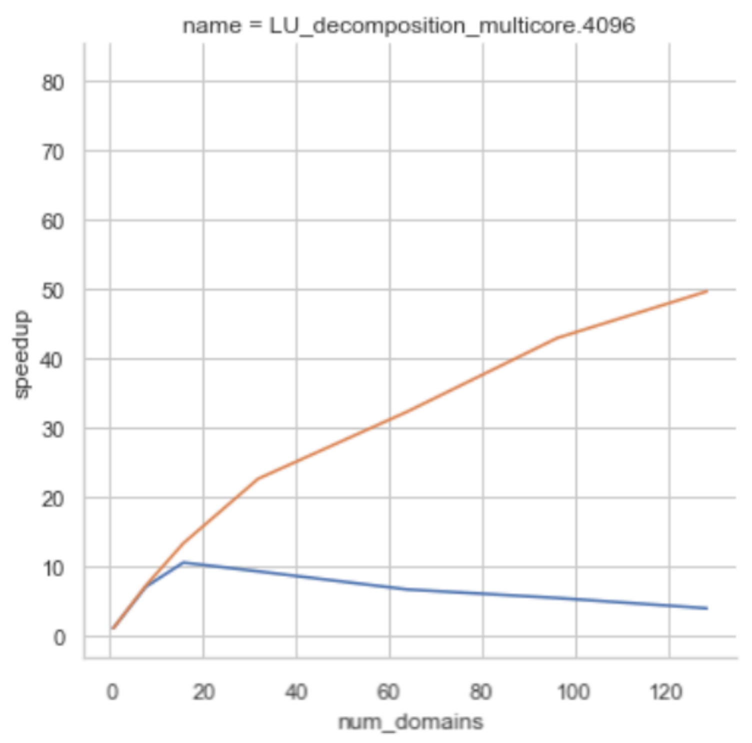
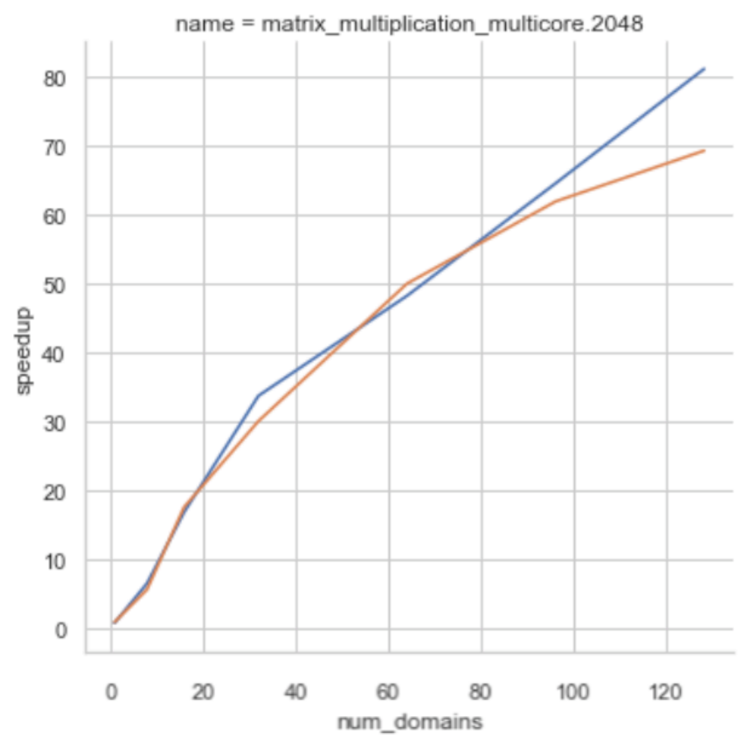
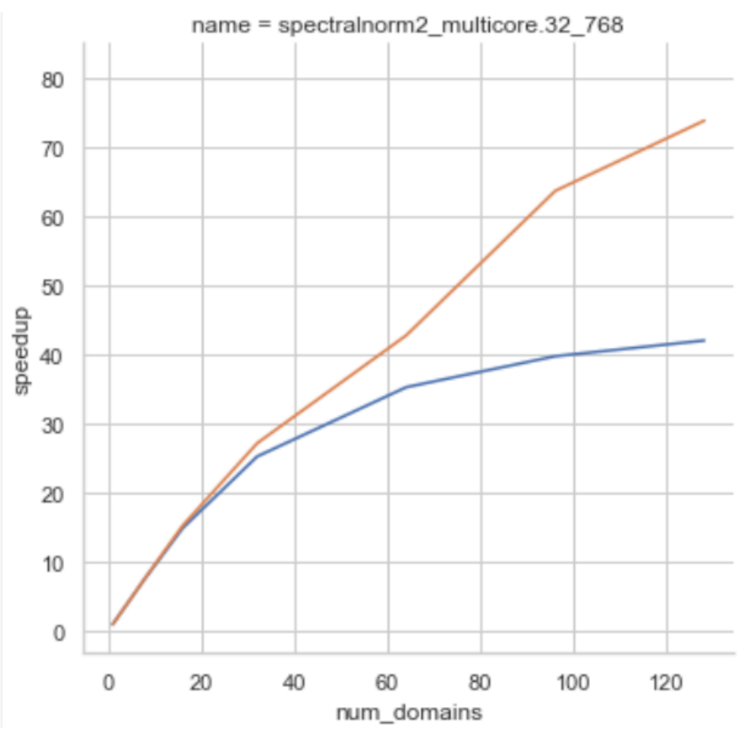
Parallel Scalability

Hot off the presses!

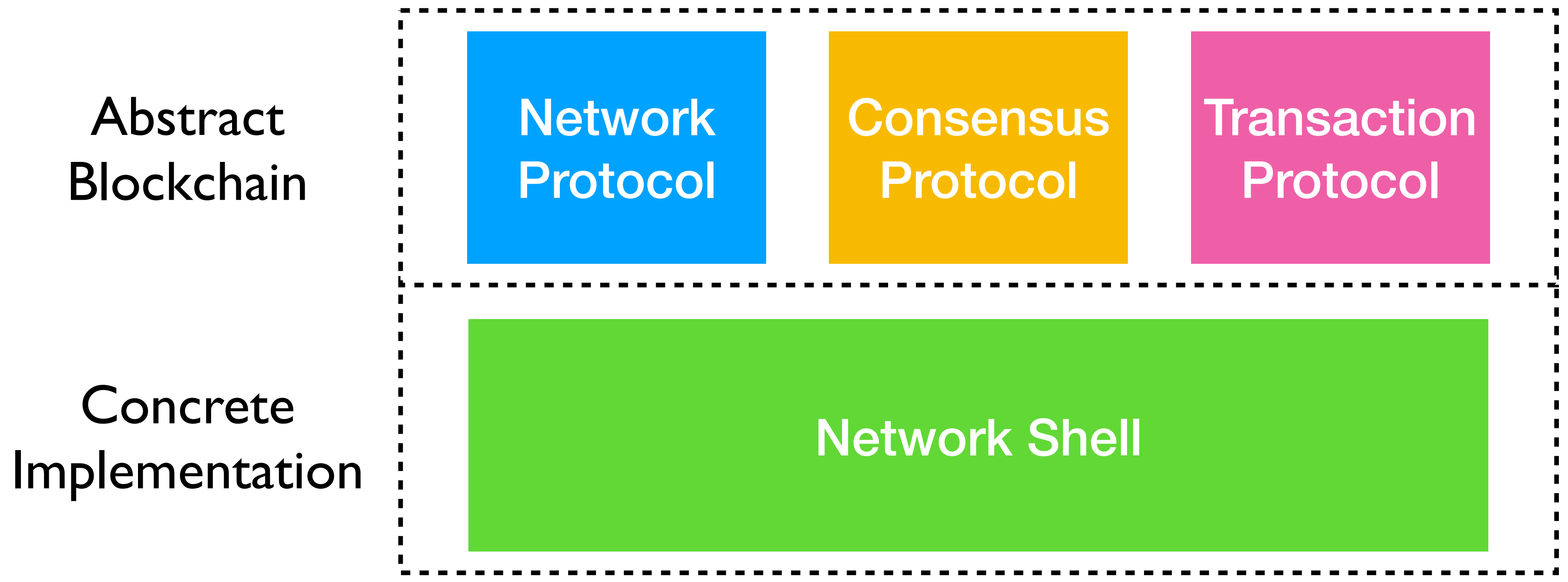






50x — 80x speedup on 128-core machine

Tezos Protocol



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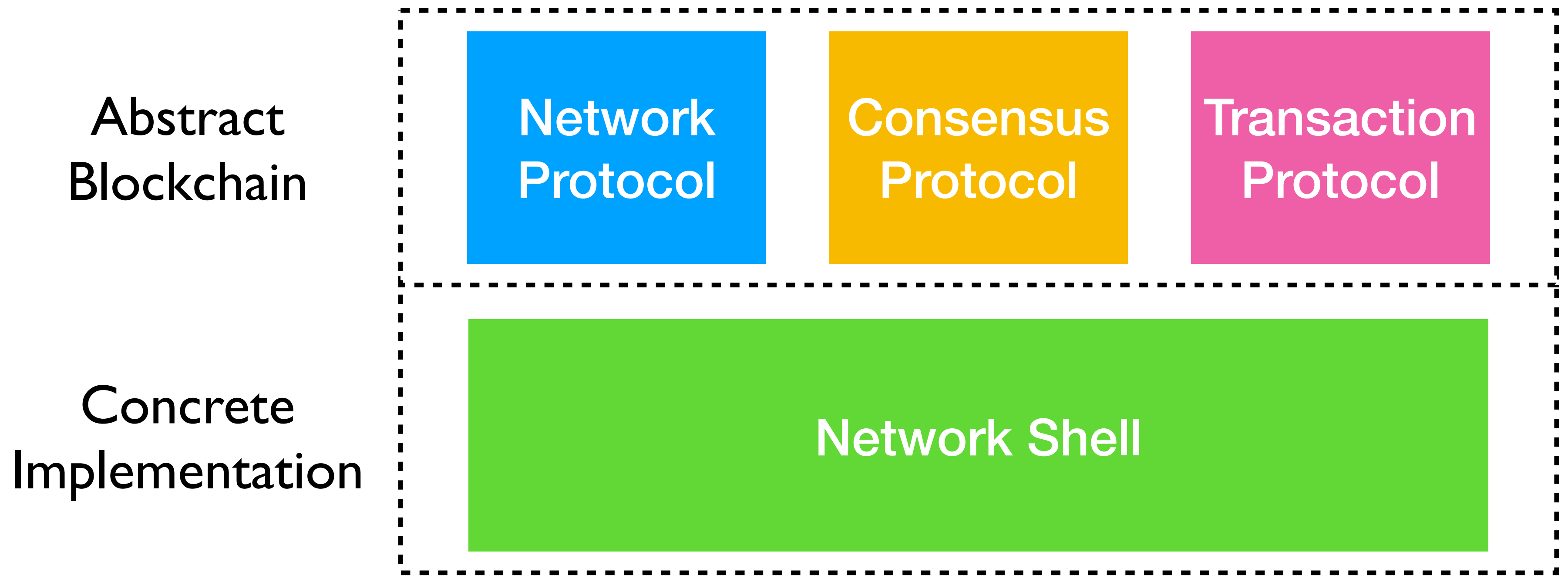

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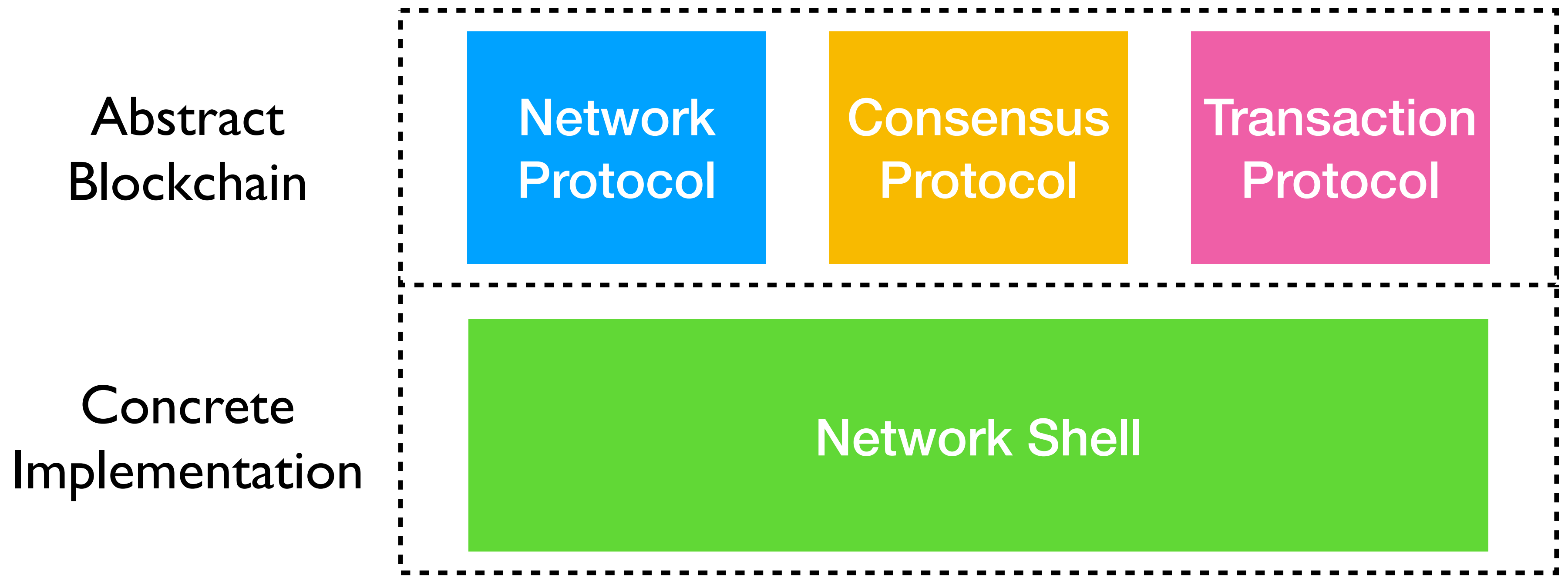

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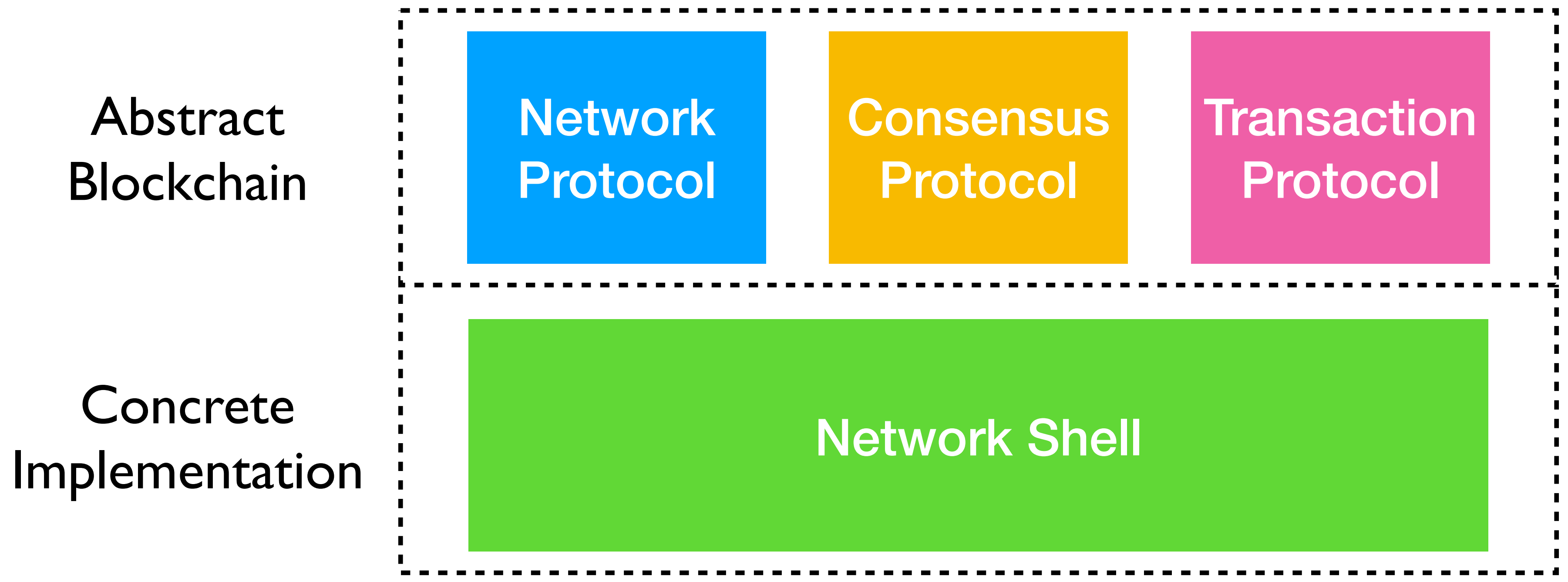
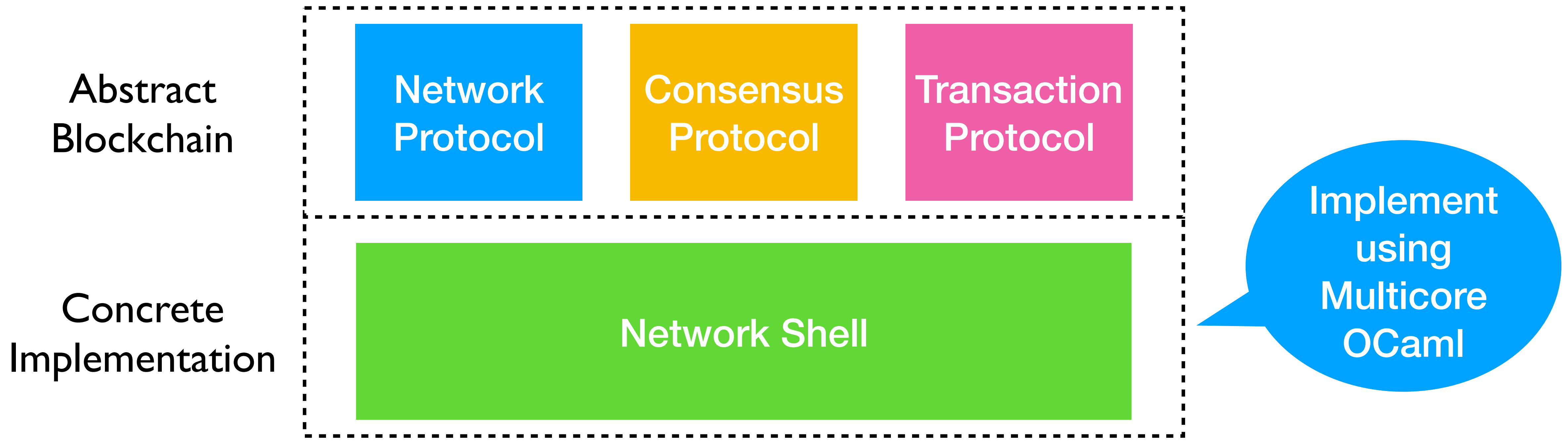


- Network protocol — Peer discovery & publishing blocks
- Consensus protocol — Block acceptance, miner reward schedules
- Transaction protocol — Validity of transaction, blocks

Tezos + Multicore OCaml



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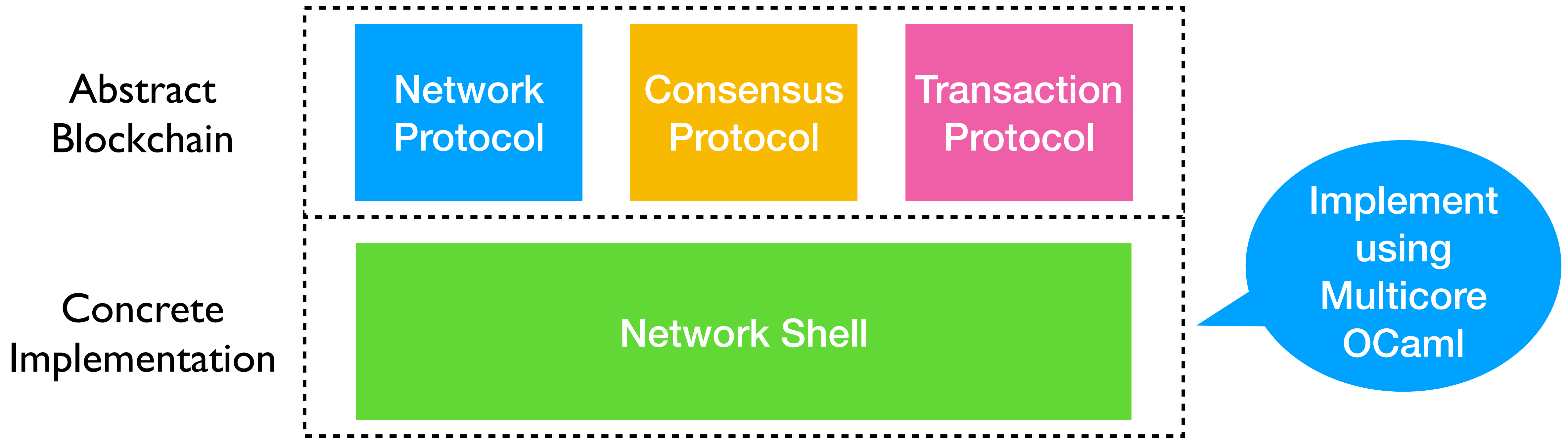

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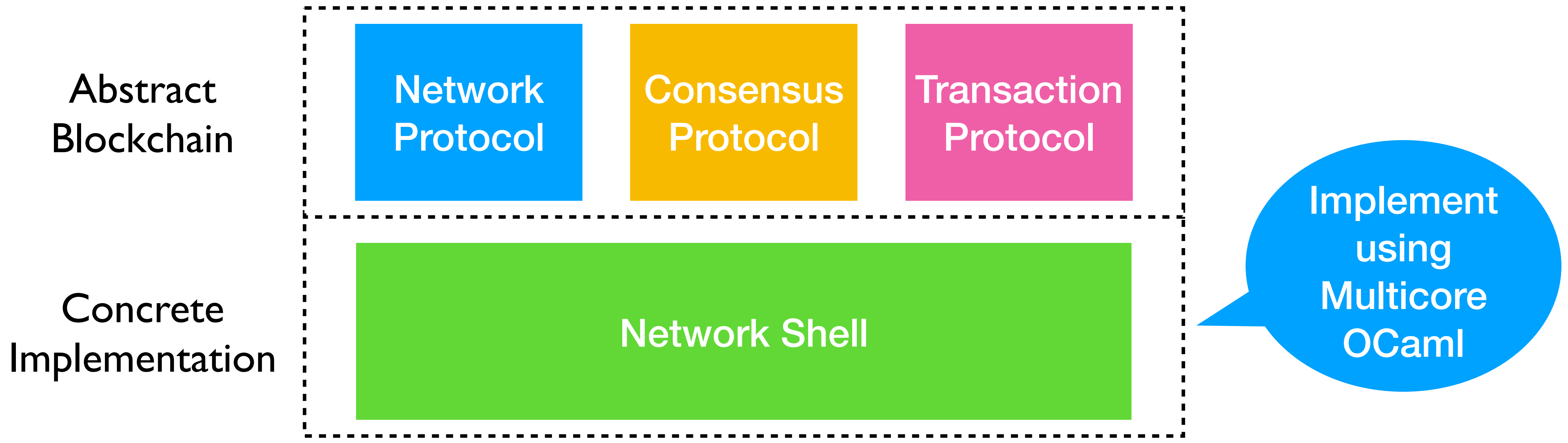

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- Exploit *deterministic parallelism* in inter-contract calls

Inter-contract call semantics

```
C1

storage = …

fun a () =
  call c2.b()
  call c3.c()
```

```
C2

storage = …

fun b () =
  call c4.d()
```

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C3

storage = …

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C4

storage = …

fun d () =
  //modify local storage
  return
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Finished b : [d1, c]

Finished d1: [c]

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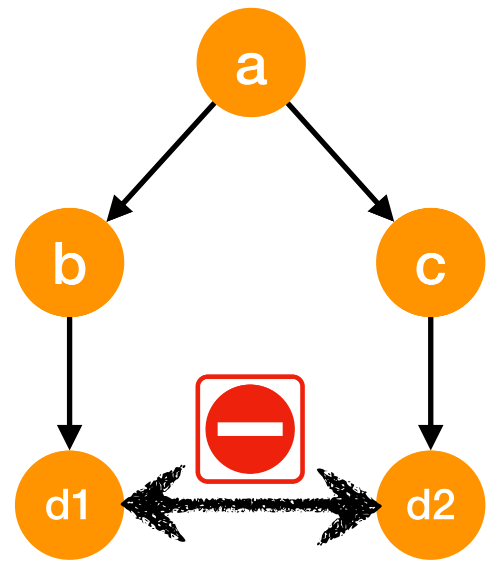

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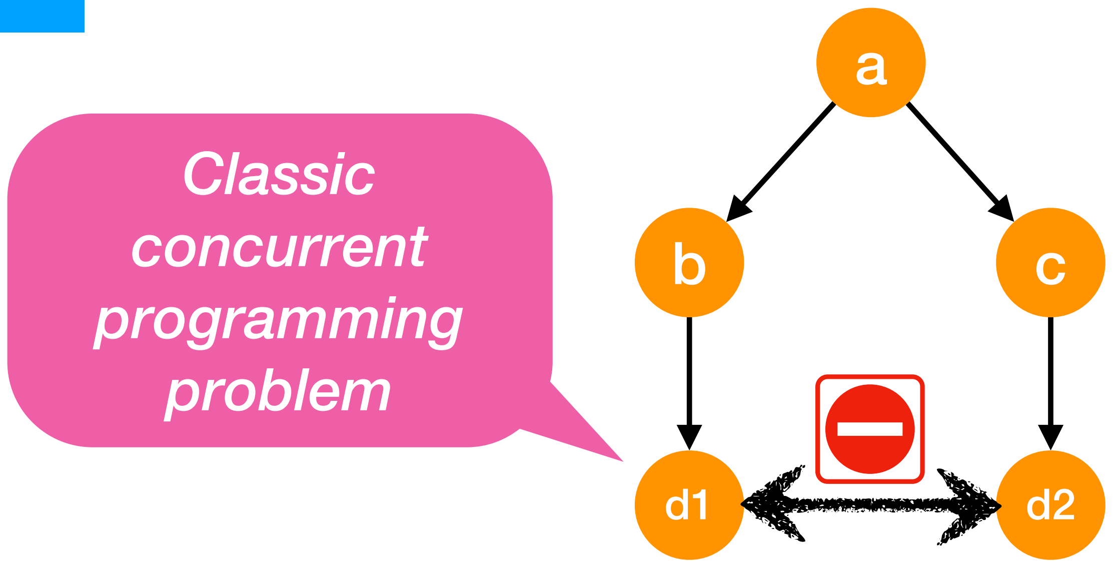

Thanks!

github.com/ocaml-multicore