Blockchain in Practice

KID/Online Studentkveld 23.09.2020

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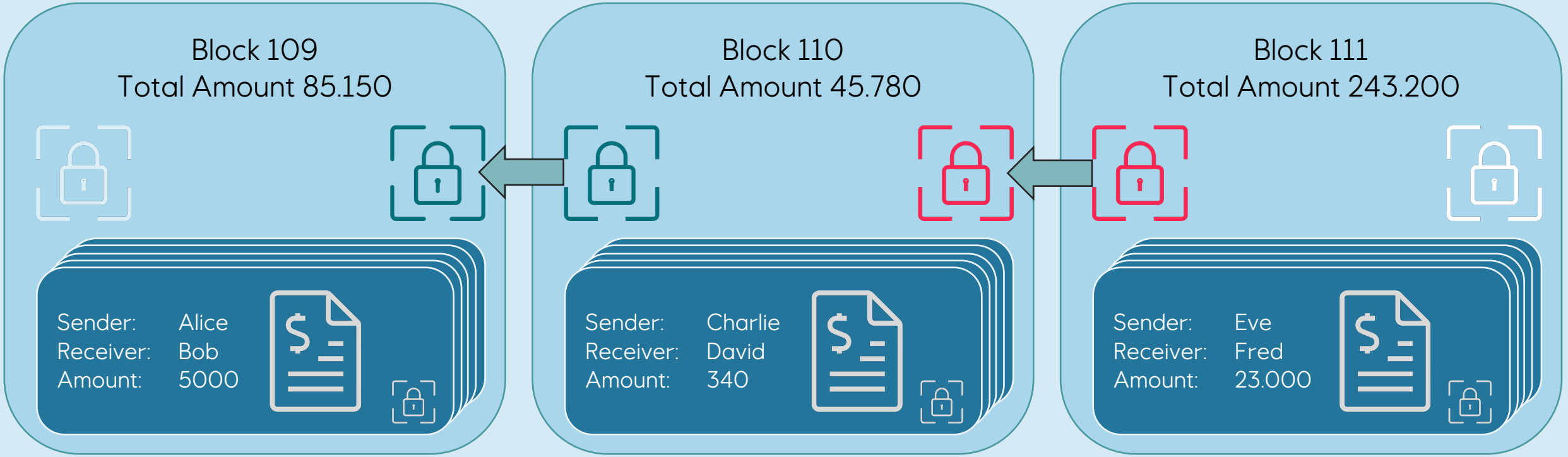
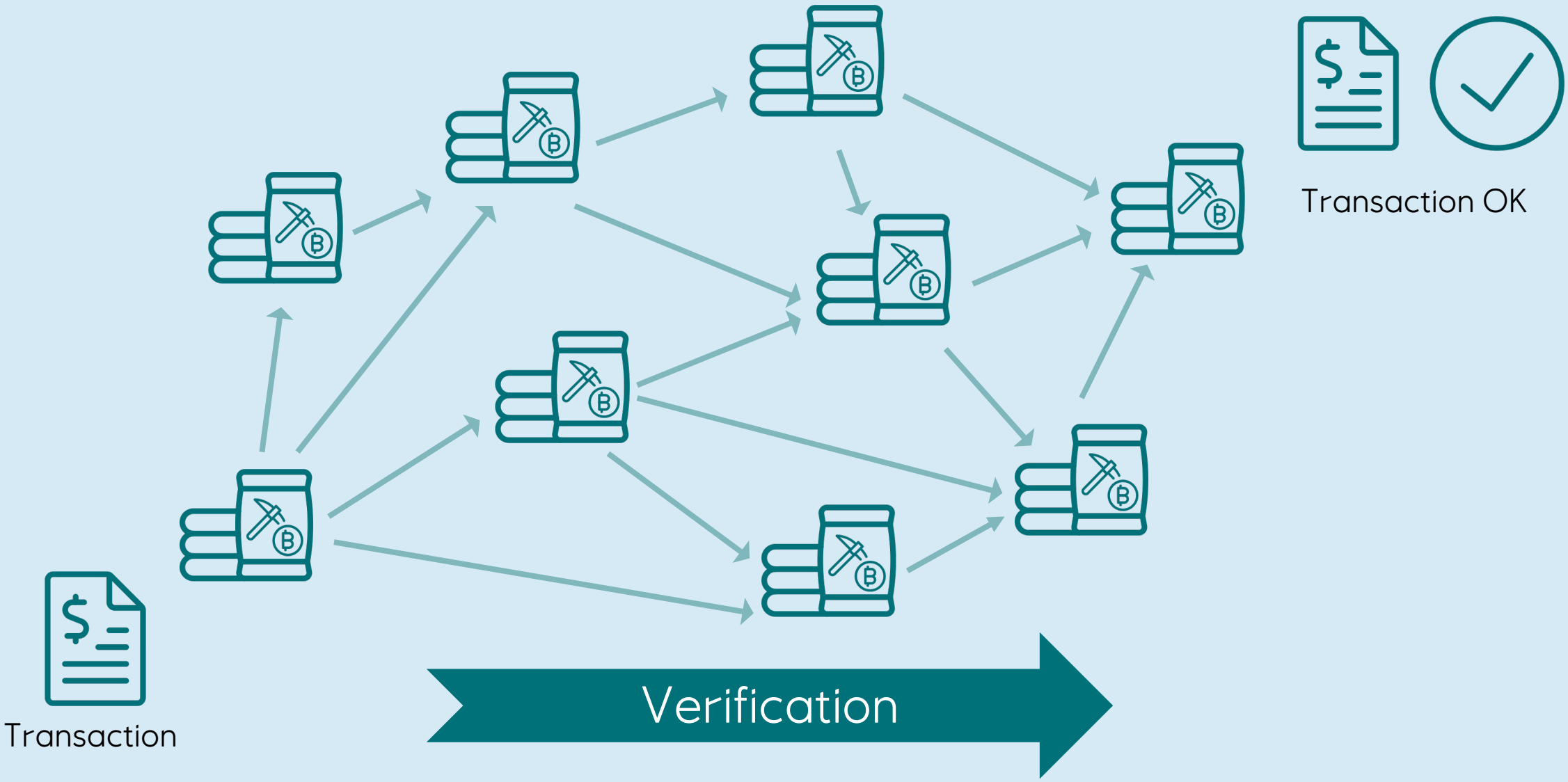
A chain of **transactions** grouped into **blocks**

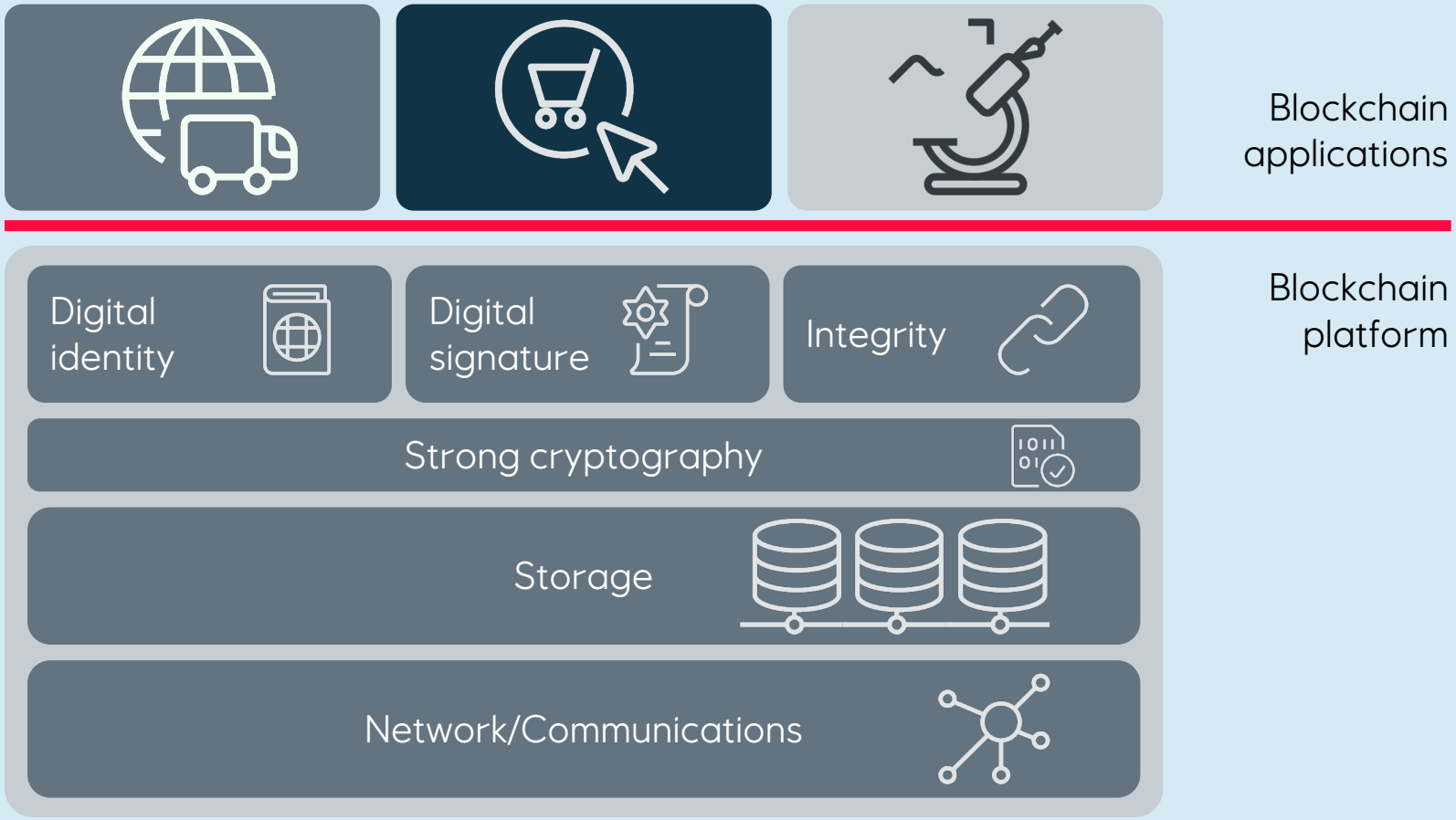


Anyone can join – everyone can see everything

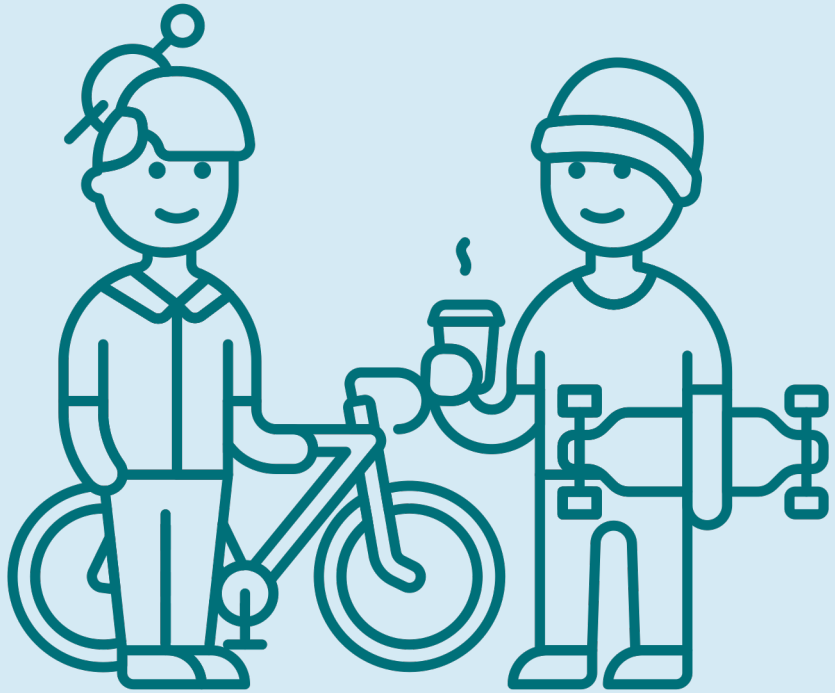

Transaction OK
Transaction
Verification

```
pragma solidity ^0.4.0;

import "./Afe.sol";

contract AfeManager is AfeEventSource{
    event NewTestAfe(
        address indexed operator,
        address[] partners,
        uint timeout,
        Afe afe
    );

    event Decision (
        address afe,
        address partner,
        uint8 statusCode
    );

    function createTestAfe(address[] partners, uint8 waitForDays) external{
        require(partners[0] == msg.sender, "First member must be operator");
        Afe afe = new Afe(partners, waitForDays, this);
        emit NewTestAfe(partners[0], partners, now +  waitForDays * 1 days, afe);
    }

    function emitDecision(address partner, uint8 status) external {
        emit Decision(msg.sender, partner, status);
    }
}
```

Smart contracts let users define behavior without involving the blockchain platform developers

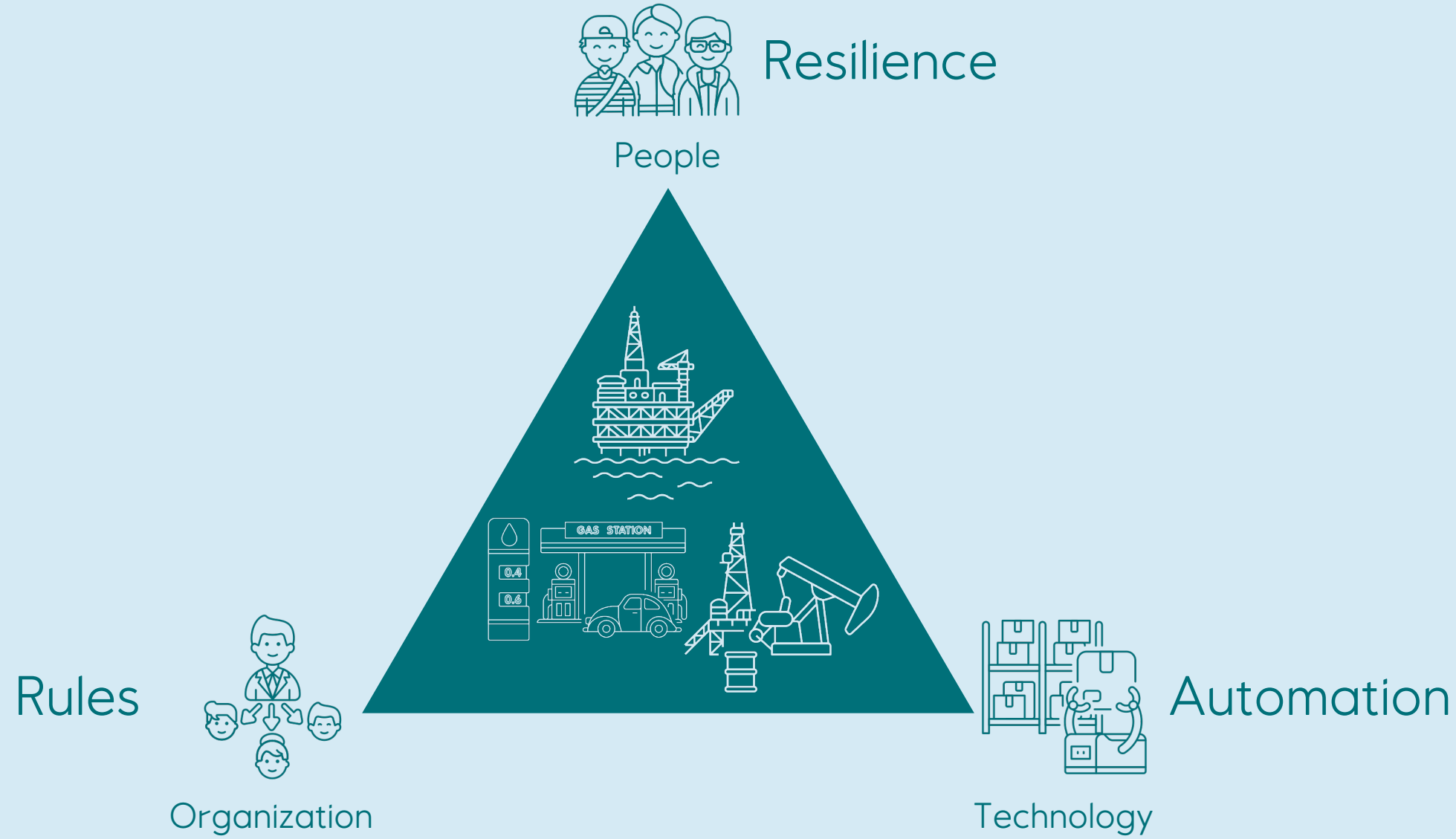

Blockchain applications
Blockchain platform
Digital identity
Digital signature
Integrity
Strong cryptography
Storage
Network/Communications

Who rides the bike?



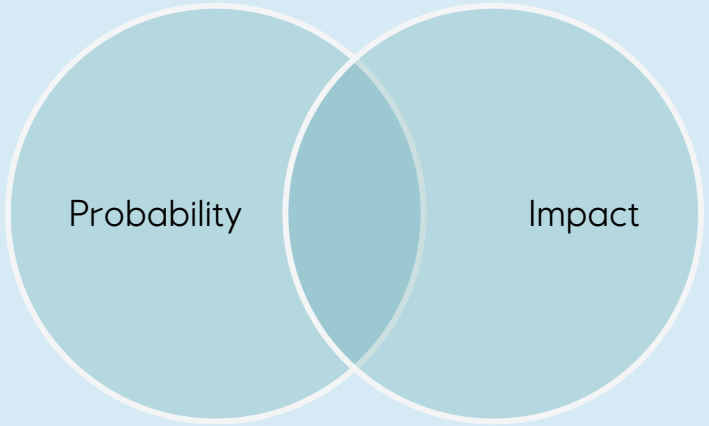
Blockchains can determine **who owns it**, but not **who rides it**


Predict
Prevent
Respond
Detect


Resilience
People
GAS STATION
0.4
0.6
Rules
Organization
Automation
Technology

Understanding risks

Unintended errors



Malicious intent

Safety

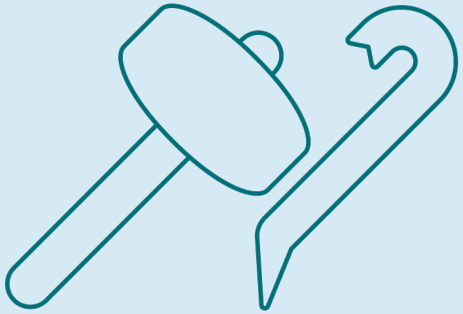
Security

25 minutes

400 USD

Medium

Drill through the locks



45 minutes

200 USD

Low

Destroy the door

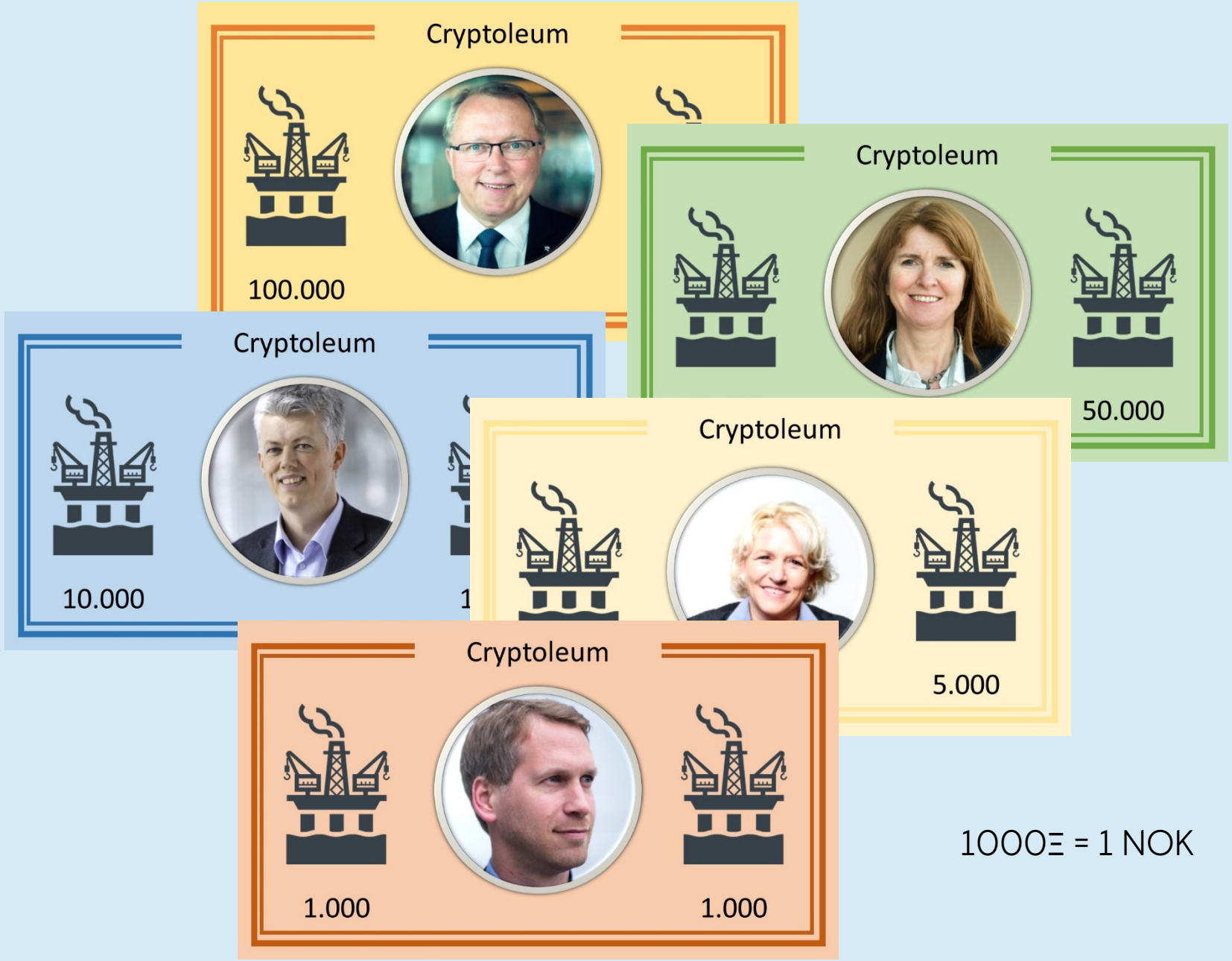
5 minutes

2000 USD

Low

Buy a copy of the keys

Practical exercise


Cryptoleum
100.000
Cryptoleum
50.000
Cryptoleum
10.000
Cryptoleum
5.000
Cryptoleum
1.000
1.000

1000Ξ = 1 NOK

2 miners

5 wallets

(Alice, Bob, Charlie, David, Eva)

Transaction 1

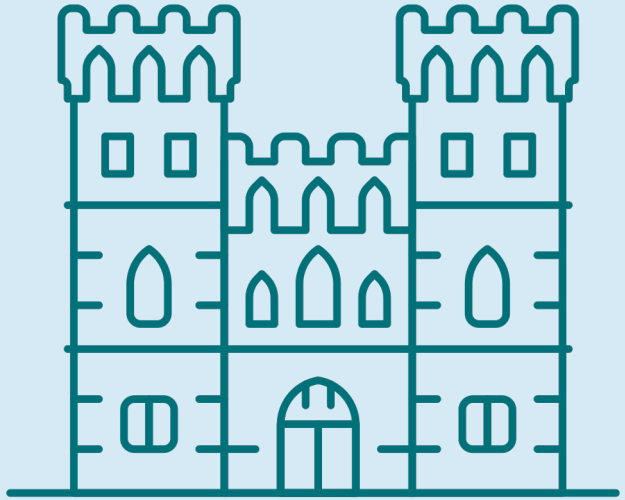
Alice pays Bob 5000Ξ

Kryptoleum transaction

Transaction number	1
Date	31.08.2017 12:27:33
Sender	Alice
Recipient	Bob
Amount	5000
Digital signature	3

Signature: Digit sum (#) + mod(count ([A...Z]);3)
Digit sum: 46 => 10 => 1
Count([A..Z])=8, mod(8;3)=2
Signature = 1+2 = 3

Consensus



Transaction 2

David pays Charlie 15000Ξ

Kryptoleum transaction

Transaction number	2
Date	31.08.2017 12:29:05
Sender	David
Recipient	Charlie
Amount	15000
Digital signature	4

Signature: Digit sum (#) + mod(count ([A...Z]);3)
Digit sum: 49 => 13 => 4
Count([A..Z])=12, mod(12;3)=0
Signature = 4 + 0 = 4

Transaction 3

Eva pays Alice 125000Ξ

Kryptoleum transaction

Transaction number	3
Date	31.08.2017 12:31:45
Sender	Eva
Recipient	Alice
Amount	125000
Digital signature	6

Signature: Digit sum (#) + mod(count ([A...Z]);3)
Digit sum: 49 => 13 => 4
Count([A..Z])=8, mod(8;3)=2
Signature = 4 + 2 = 4

Transaction 4

Bob pays Charlie 37000Ξ

Kryptoleum transaction

Transaction number	4
Date	31.08.2017 12:32:17
Sender	Bob
Recipient	Charlie
Amount	37000
Digital signature	8

Signature: Digit sum (#) + mod(count ([A...Z]);3)
Digit sum: 52 => 7
Count([A..Z])=10, mod(10;3)=1
Signature = 7 + 1 = 8

From transactions to block

Kryptoleum block

Block number	15
Date	31.08.2017 12:33:12
Previous block	14
Previous block signature	8
Transaction numbers	1,2,3,4
Total amount	182000
Digital signature	2
Proof-of-work	

Signature:
Mod (
Digit sum (transaction sig) +
Digit sum (total amount) +
Digit sum (block number) +
Digit sum (transaction #);10)

Digit sum (sig) = 3+4+6+8 =>
21 => 3
Digit sum ($) = 11 => 2
Digit sum (blck #) = 6
Digit sum (trn #) = 10 => 1
Mod (3 + 2 + 6 + 1; 10) = 2

Proof of work

Find the number that together with the block signature opens the lock

Kryptoleum block

Block number	15
Date	31.08.2017 12:33:12
Previous block	14
Previous block signature	8
Transaction numbers	1,2,3,4
Total amount	182000
Digital signature	2
Proof-of-work	4

Digit sum (2, 4) = 6

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Let´s do this in code

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Follow the code

https://github.com/hwes/BlockchainCourse

Blockchain security fundamentals

Public key cryptography

Challenge

How can I exchange information with someone I have never met?

One-way functions

A one-way function is a mathematical function
that is easy to do in one direction but
“impossible” to do in the other direction

Modular arithmetic

Clock arithmetic
6 AM + 8 hours => 2 PM
6+8 = (14 mod 12) = 2

x	1	2	3	4	5	6
3^x	3	9	27	81	243	729
$3^x \pmod 7$	3	2	6	4	5	1

$453^x \pmod{21\,997} = 5787$, x=?

Diffie-Hellman

Use the function $Y^x \pmod P$

1: Call Alice calls Bob. Agree on Y and P, e.g. 7 and 11

2: Choose a number A (e.g. 3)

3: Put A into the one-way function $7^A \pmod{11}$

$\alpha = 7^3 \pmod{11} = 343 \pmod{11} = 2$

4: Call Bob and tell him α

2: Choose a number B (e.g. 6)

3: Put B into the one-way function $7^B \pmod{11}$

$\beta = 7^6 \pmod{11} = 117\,649 \pmod{11} = 4$

4: Call Alice and tell her β

Eve intercepts the number 2 and 4

5: Calculate $\beta^A \pmod{11} = 64 \pmod{11} = 9$

5: Calculate $\alpha^B \pmod{11} = 64 \pmod{11} = 9$

9 is the key

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Run time for increasing A and B

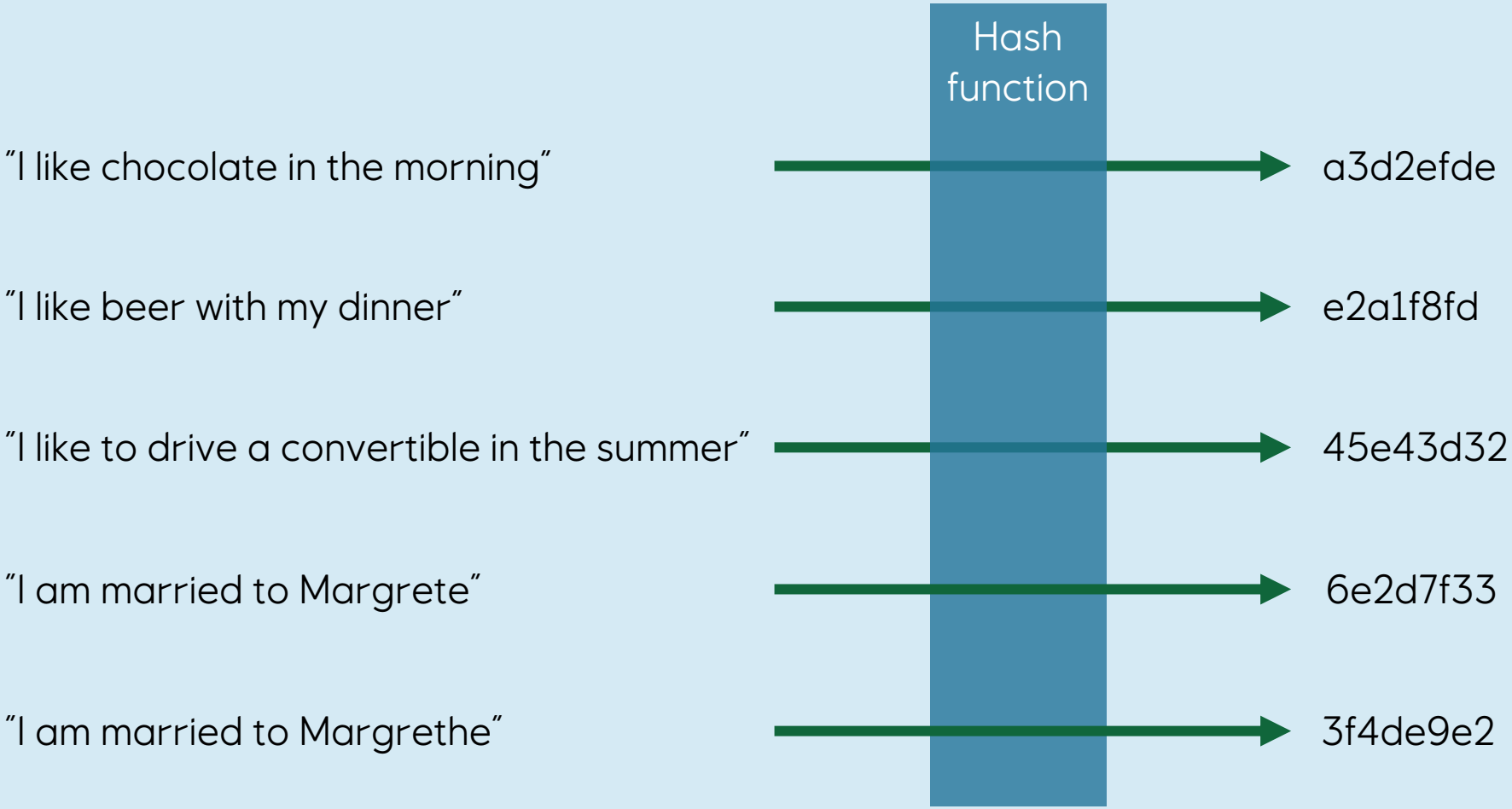
A and B	Run Diffie Hellman	Break Diffie Hellman
Less than 10	0.09 ms	0.09 ms
Less than 50	0.09 ms	3.31 ms
Less than 100	0.09 ms	16.42 ms
Less than 500	0.09 ms	1300 ms
Less than 1000	0.09 ms	12861 ms

What happens when A and B becomes really large?

Public key cryptography is the foundation of "all" security on the internet. The algorithms are much more complex, but the principles remain the same.

Hashing algorithms

Hashing functions are one-way functions that for any input text maps to a fixed length text, where the fixed length text is “unique” and dependent on the input text


Hash function
"I like chocolate in the morning"
"I like beer with my dinner"
"I like to drive a convertible in the summer"
"I am married to Margrete"
"I am married to Margrethe"
a3d2efde
e2a1f8fd
45e43d32
6e2d7f33
3f4de9e2

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Pearson 8-bit hash algorithm

Using the message C and the permutation table T

```
h := 0
for each c in C loop
    h := T[ h xor c ]
end loop
return h
```

The nonce

A nonce is a number (or text) that is added to a string so that the computed hash result satisfies certain properties

Bringing it all together

- Hashing is used to give each transaction a unique identity
- Alice, Bob, Charlie, David and Eve signs the hash using public key cryptography, creating a transaction signature for the Miner to verify
- The Miner take a group of transactions to create a block
- The miner must find a nonce so that the hash from block and the nonce satisfies certain properties
- The Miner signs the block including the nonce for Alice to verify

Never,
ever,
under any circumstance,
roll your own crypto

Blockchain in practice