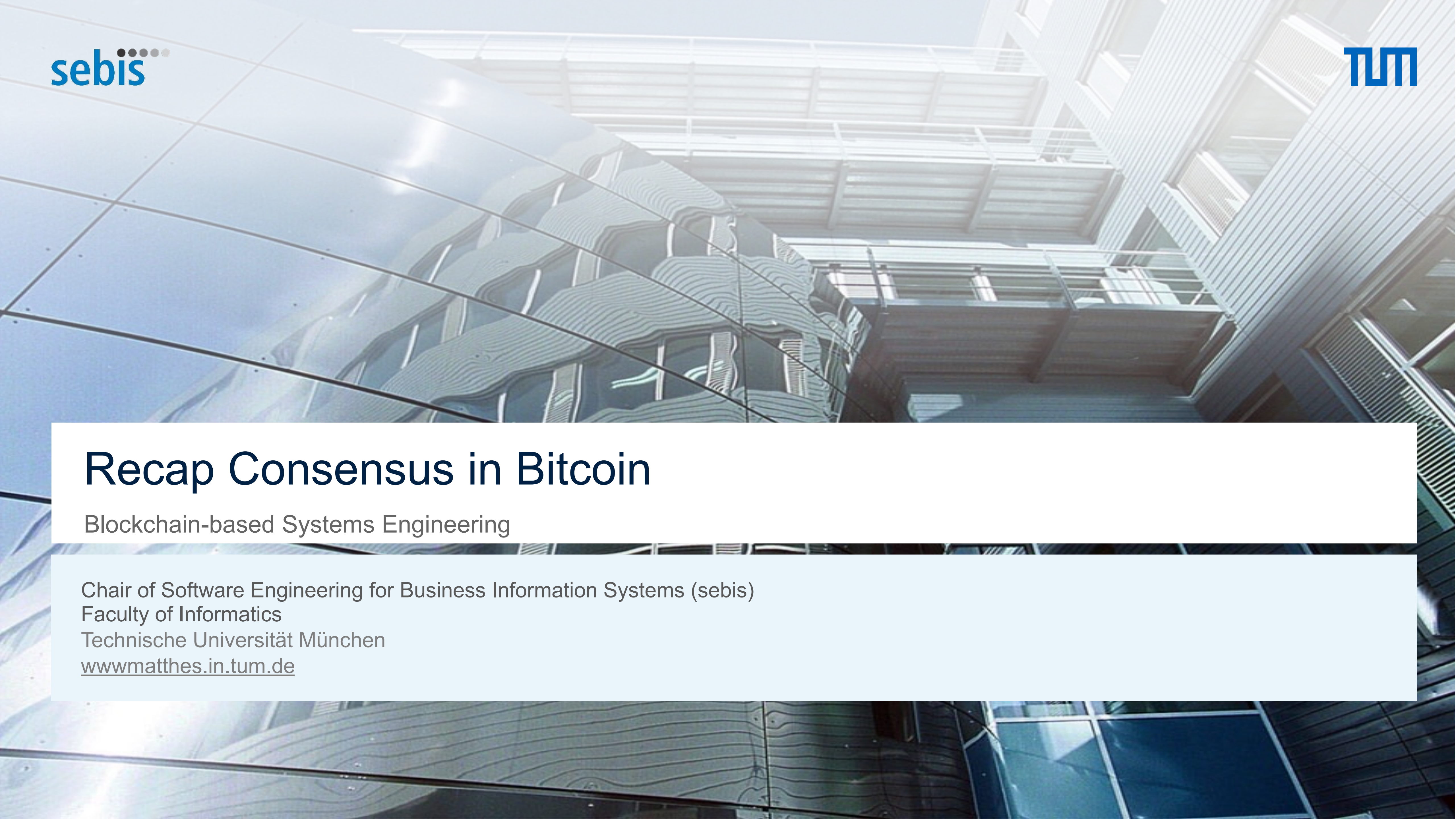

Recap Consensus in Bitcoin

Blockchain-based Systems Engineering

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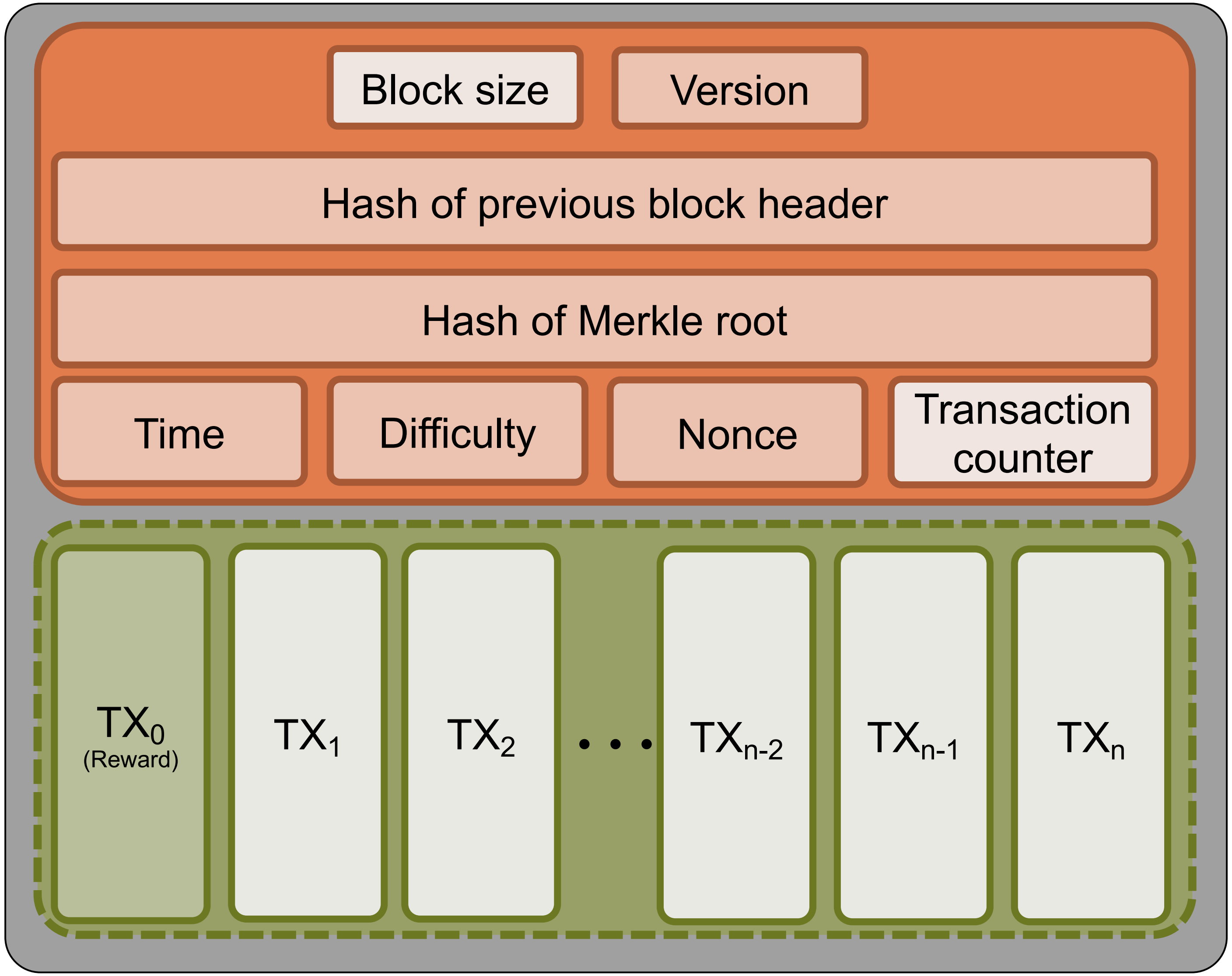
Block Details

- The *hash of the previous* block creates the chaining.
- The hash of the Merkle root node of a Merkle tree structure with all transactions (as explained in Chapter 2).
- The *nonce* is required for the consensus mechanism in the network.
- The block‘s hash used for chaining is calculated from the *version* until the *nonce* field.
- The height of the block is stored in the coinbase transaction. (TX_0)



Difficulty Calculation & Block Time

- The block time defines the average time between the creation of two blocks (In Bitcoin, block time = 10 minutes)
- Why has the block time to be constant?
  - Too slow:
    - Transactions take longer to be included
    - Network capacity decreases
  - Too fast:
    - Higher possibility of chain forking, leading to multiple “realities”.
    - Network has to keep track of these forks even if many will be orphaned.
    - Empty blocks
- How do we design the search puzzle in such way that it keeps a constant block time?
- Every 2016 blocks, the difficulty of the puzzle is adapted to the current network speed.
- The longest chain is considered as the chain with the accumulated highest difficulty.

1 Measure, how long the last 2016 blocks took to get mined. (=T)

2 Calculate the factor of speed (two Weeks / T) (=F)

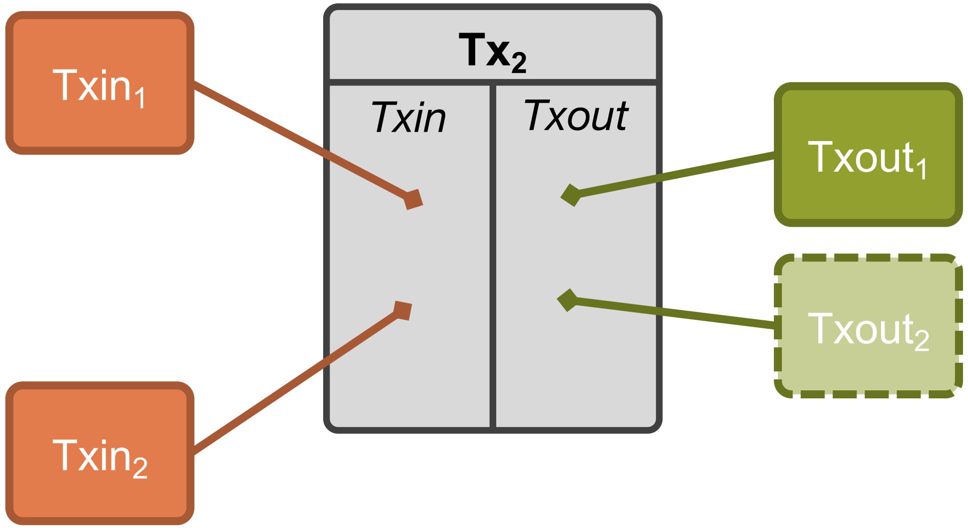
3 The difficulty gets increased (F > 1) or decreased (F < 1).

3a Maximum increase: 4. Maximum decrease: 0,25.

4 The process is done every 2016[1] blocks.

[1] 14 Days x 24 Hours x 6 (every 10 mins) = 2016

Transaction-based Ledger

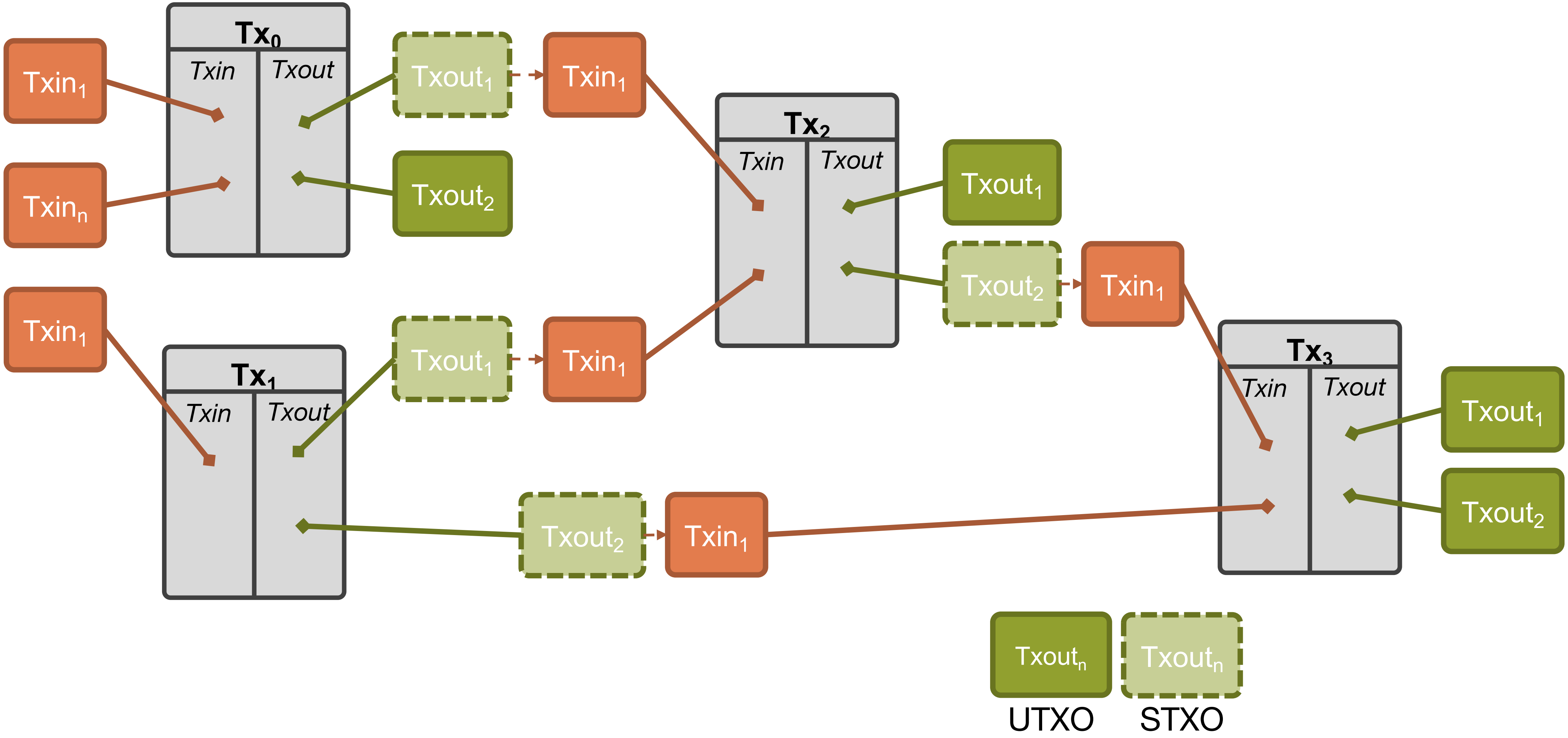


- Transactions (**Tx**) have a number of inputs and a number of outputs.
  - **Inputs (Txin)**: Former outputs, that are being consumed
  - **Outputs (Txout)**: Creation of new coins and transfer of coin ownership

- In transactions where **new coins** are created, **no Txin** is used (no coins are consumed)

- Each transaction has a unique identifier (**TxID**). Each output has a unique identifier within a transaction. We refer to them (in this example) as *#TX[#txout]*, e.g., 1[1], which is the second Txout of the second transaction.

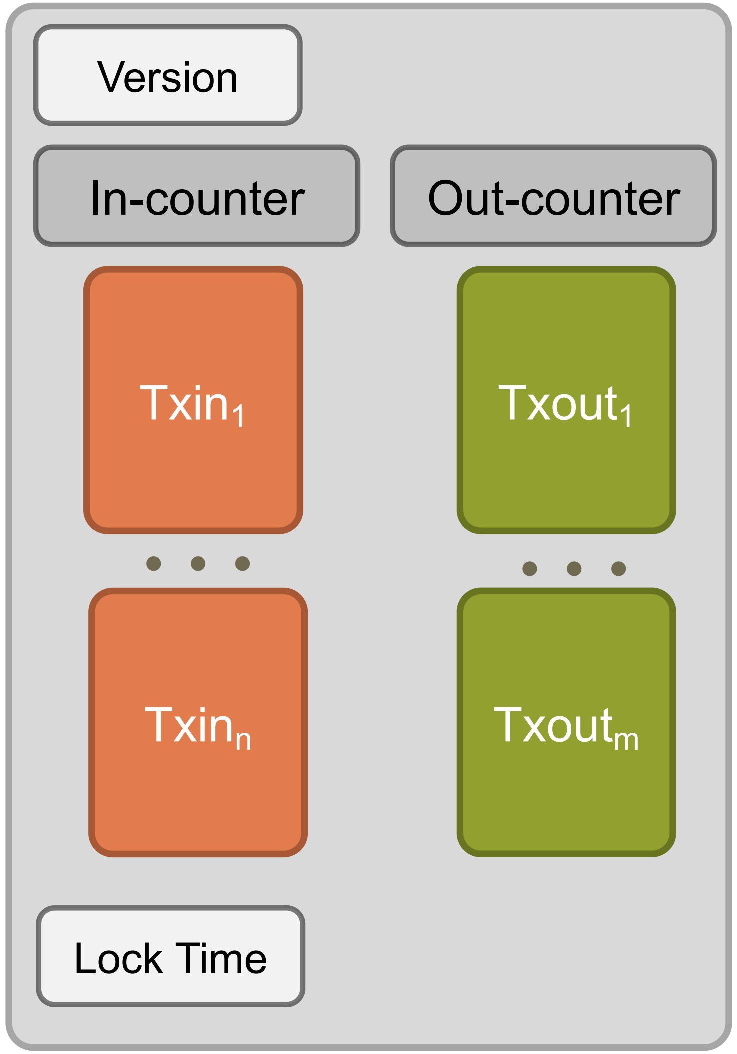
Transactions Connected by Inputs and Outputs



An Advanced Look at Transactions

As previously stated, transactions consist of inputs and outputs following these principles:

- All inputs reference an existing unspent output or a coinbase transaction.
- Inputs and outputs **contain scripts** (scriptSig, scriptPubKey) **for verification**.
- Output scripts (scriptPubKey) **specify the conditions to redeem their value**.
- Input scripts (scriptSig) **provide a signature** to redeem the referenced output.
- Only **outputs store** the **BTC value** and the **receiver‘s address**.
- **All coins have a history (inputs/outputs) up to the original coinbase transaction that created them.**



Input format

Txin

- previous transaction hash
- previous Txout-index
- script length
- *scriptSig*

Output format

Txout

- value in *Satoshi (=10^{-8} BTC)*
- script length
- *scriptPubKey*

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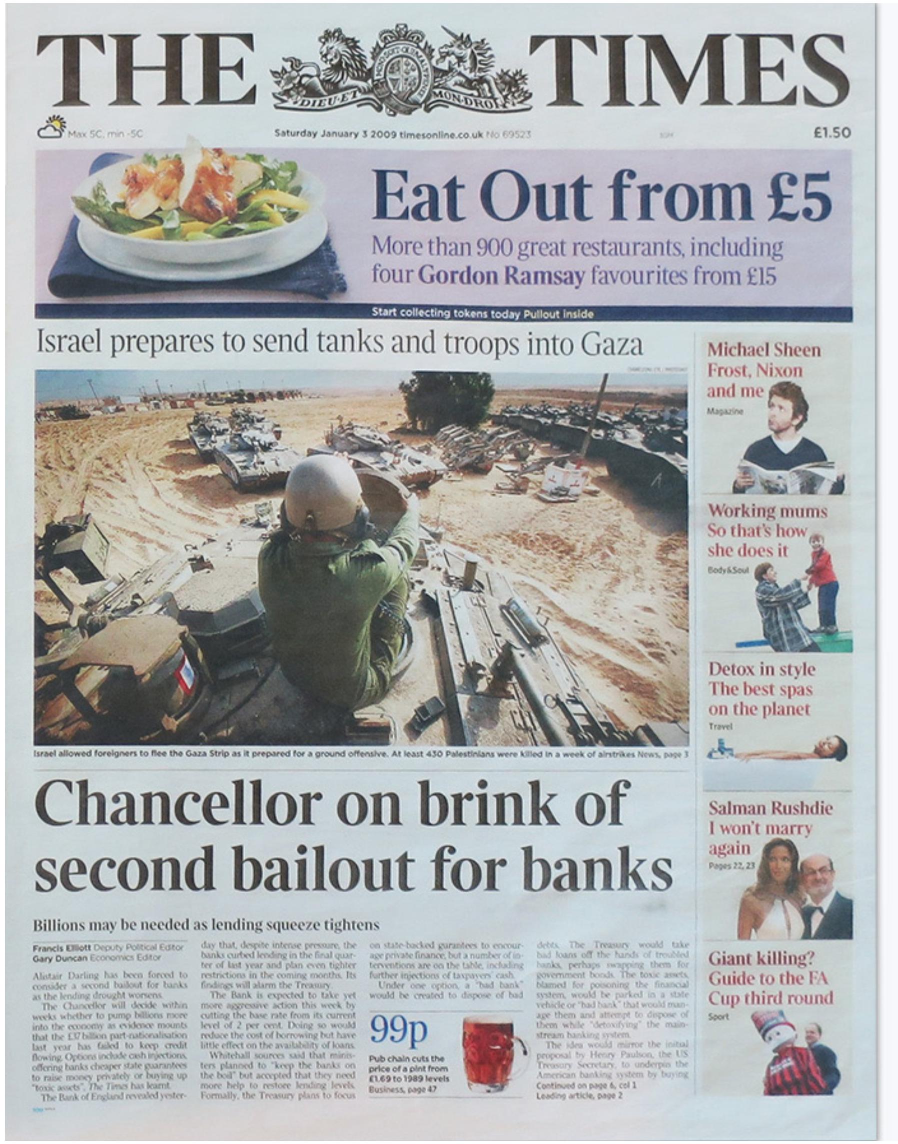
Data Contained in the Genesis Block



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Israel prepares to send tanks and troops into Gaza

Israel allowed foreigners to flee the Gaza Strip as it prepared for a ground offensive. At least 430 Palestinians were killed in a week of airstrikes News, page 3

Chancellor on brink of second bailout for banks

Billions may be needed as lending squeeze tightens

Francis Elliott Deputy Political Editor
Gary Duncan Economics Editor

Alistair Darling has been forced to consider a second bailout for banks as the lending drought worsens.

The Chancellor will decide within weeks whether to pump billions more into the economy as evidence mounts that the £37 billion part-nationalisation last year has failed to keep credit flowing. Options include cash injections, offering banks cheaper state guarantees to raise money privately or buying up "toxic assets", *The Times* has learnt.

The Bank of England revealed yesterday that, despite intense pressure, the banks curbed lending in the final quarter of last year and plan even tighter restrictions in the coming months. Its findings will alarm the Treasury.

The Bank is expected to take yet more aggressive action this week by cutting the base rate from its current level of 2 per cent. Doing so would reduce the cost of borrowing but have little effect on the availability of loans.

Whitehall sources said that ministers planned to "keep the banks on the boil" but accepted that they need more help to restore lending levels. Formally, the Treasury plans to focus on state-backed guarantees to encourage private finance, but a number of interventions are on the table, including further injections of taxpayers' cash.

Under one option, a "bad bank" would be created to dispose of bad debts. The Treasury would take bad loans off the hands of troubled banks, perhaps swapping them for government bonds. The toxic assets, blamed for poisoning the financial system, would be parked in a state vehicle or "bad bank" that would manage them and attempt to dispose of them while "detoxifying" the mainstream banking system.

The idea would mirror the initial proposal by Henry Paulson, the US Treasury Secretary, to underpin the American banking system by buying

Continued on page 6, col 1
Leading article, page 2

99p

Pub chain cuts the price of a pint from £1.69 to 1989 levels
Business, page 47

Michael Sheen
Frost, Nixon and me
Magazine

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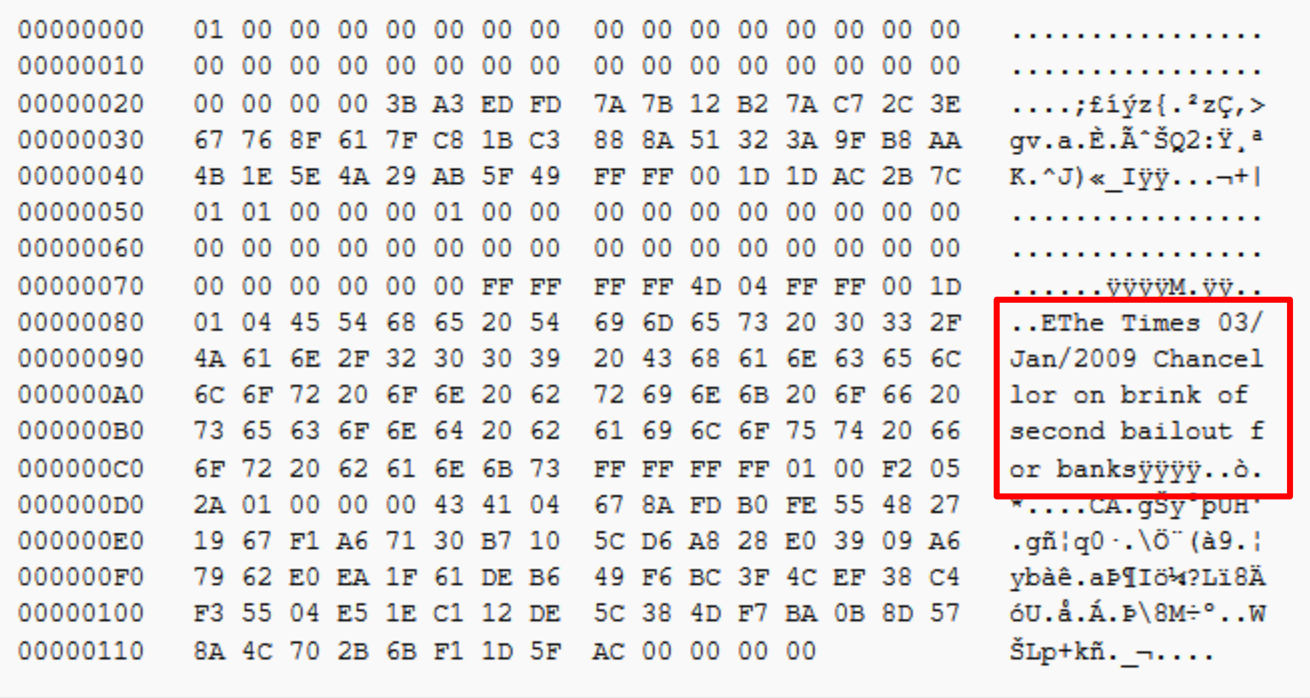
Guide to the FA Cup third round
Sport



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The data highlighted is stored in the *scriptSig* field of the first transaction (=coinbase transaction).

A possible motivation to put this headline into the genesis block is to prove that no "pre-mining" has happened.

Bitcoin Invented a New Approach

- Bitcoin's approach to decentralized consensus was completely new and very different from older approaches that resembled traditional voting and scaled very poorly to more than a handful of nodes.

Ongoing consensus

Sybil Control Mechanism

Incentives

Probabilistic consensus:
The consensus mechanism is an ongoing process in Bitcoin. Therefore, the order of blocks or transactions is never 100% final.

Proof-of-Work:
The network selects a random node to propose a new block using Proof-of-Work. As we will see later, this ensures that probabilistic consensus can be reached assuming over 50% are honest.

Incentivized nodes:
The network incentivizes nodes to participate in the consensus algorithm. They receive Bitcoins for created blocks which are included in the longest chain.