Web3: A Decentralized Societal Infrastructure

for Identity, Trust, Money, and Data

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28 Feb 2022

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Outline

- Problems
- Usages
- Infrastructure
- Design & Implementation
- Analysis
- Platform Demo
- Conclusion

Problems

current online world

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What are the problems in current online world?

- no self-sovereignty of identity, money, and data
- centralization
- governments own and control identities
- platforms lack authentic trust in online conversations
- big-tech platforms **store** and **sell** personal user data
- financial system expensive, unfit for cross-border, no privacy

Usages

current online world

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What (self-sovereign) identity solutions are there?

Self-Sovereign Identity (SSI): identity that is controlled by its natural owner only

Current solution

DigiD

- authenticator
- central server
- industry-grade security
- expensive

SSI solution

IRMA

- local identity
- central server
- IRMA infrastructure
- no offline verification

SSI solution

sovrin

- permissioned blockchain
- local identity and info
- no offline verification
- central authority

local SSI

decentralization

offline-capable

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What are the characteristics of existing platforms?

centralized						decentralized			
client-server							peer-2-peer		
end-2-end encryption			-		end-2-end encryption				
requires and stores metadata					minimal metadata, no storage				
privacy-sensitive requirements						no requirements			
private information for trust enforcement						only forgeable information for trust			

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Infrastructure

of the platform

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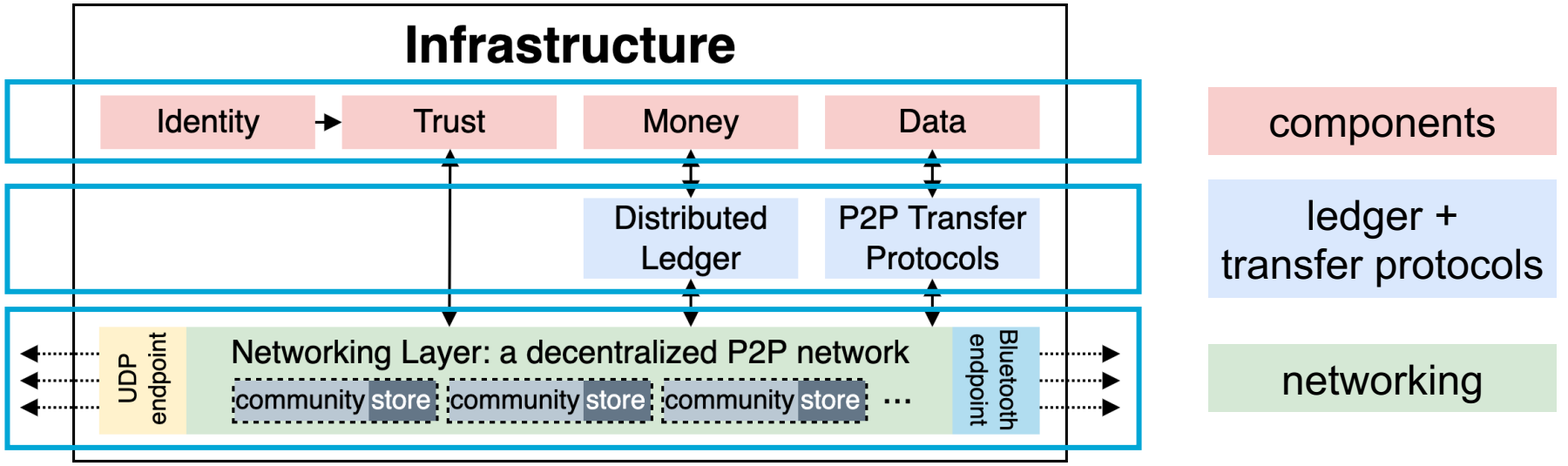
The infrastructure of our platform...

Characteristics:

- decentralized and P2P
- no storage and minimal metadata
- data confidentiality and integrity
- anonymous peer identification

Structure:

- networking layer
- distributed ledger
- data transfer protocols



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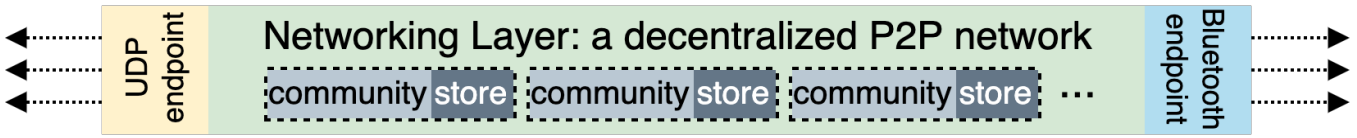
Networking layer: IPv8

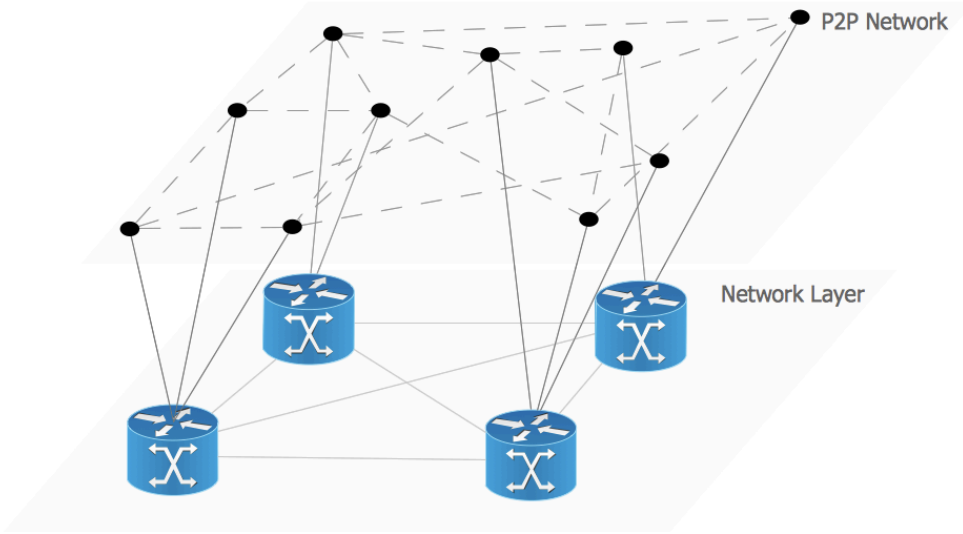
Characteristics:

- connectivity and communication
- decentralized and P2P
- zero-server infrastructure
- public-key cryptography for encryption and peer identification
- online and offline communication

Functionalities:

- network overlays / communities
- extends base layer
- community for conversations, SSI, money





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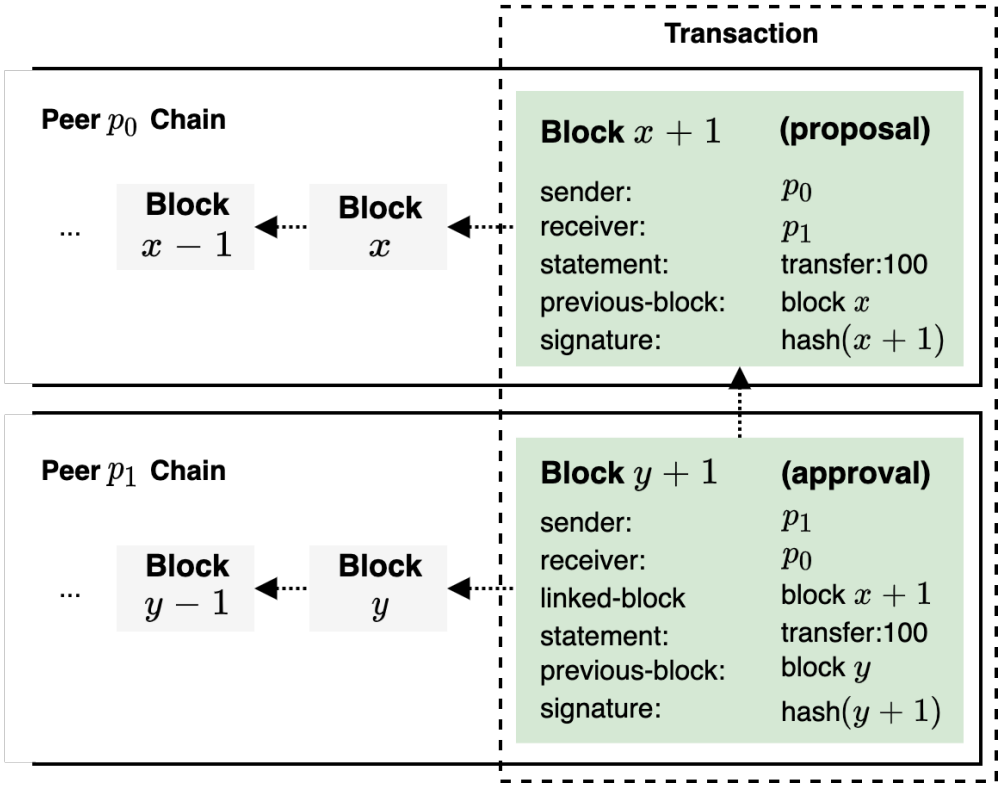
Distributed ledger: TrustChain

Characteristics:

- exchange and storage financial transactions
- permission-less and scalable blockchain
- personalized chain for each peer

Functionalities:

- send and receive blocks
- transaction = proposal + approval block
- transparent and pseudo-anonymous



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Design & Implementation

of the platform

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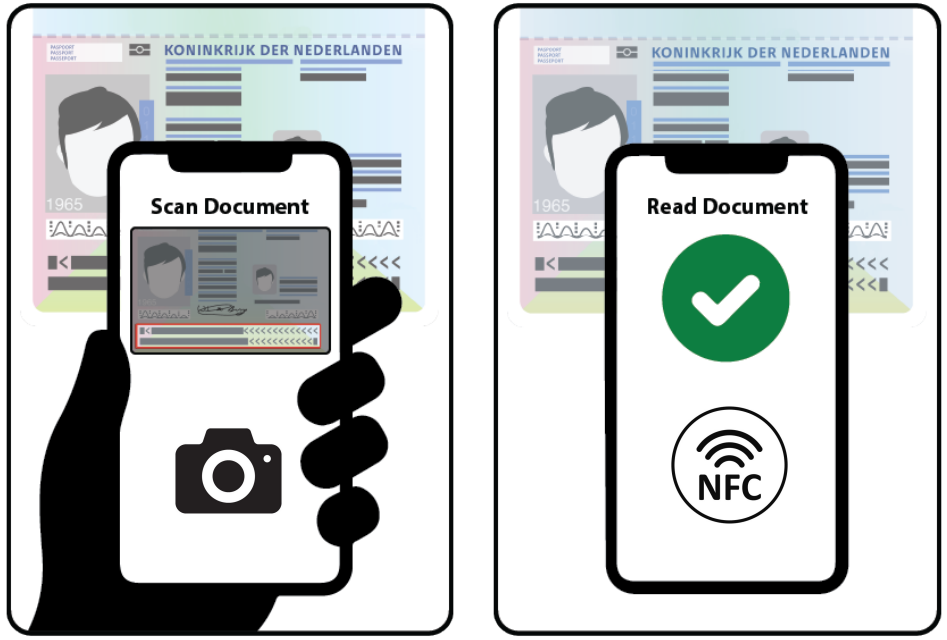
Self-Sovereign Identity (SSI) in our platform

Characteristics:

- authentic base for self-sovereignty
- authentication using local SSI
- private verifiable claims using identity attestations
- storage of validated diplomas, (COVID) certificates, …

How to get the self-sovereign identity?

- citizens possess passport or ID card
- identity in MRZ and biometric chip
- both required for authentic SSI
- scan MRZ with camera and AI
- read biometric chip with NFC



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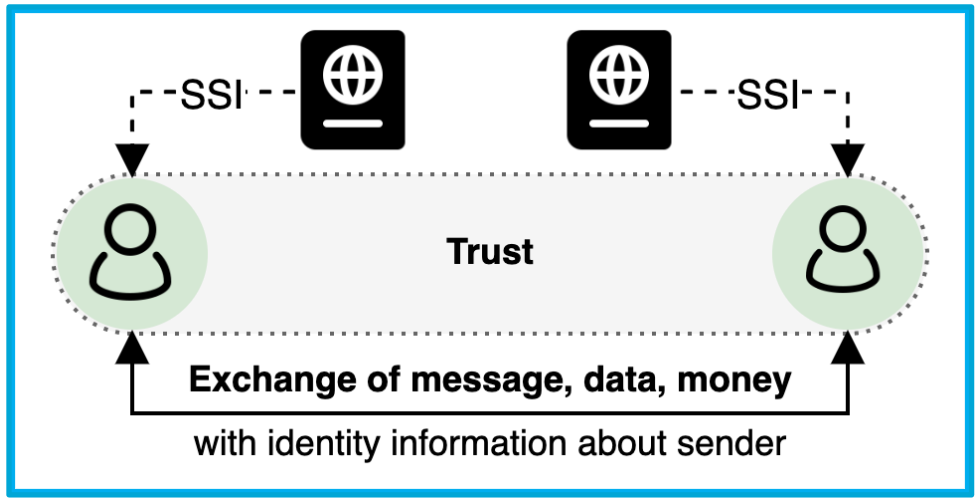
Enforcement of trust in our platform

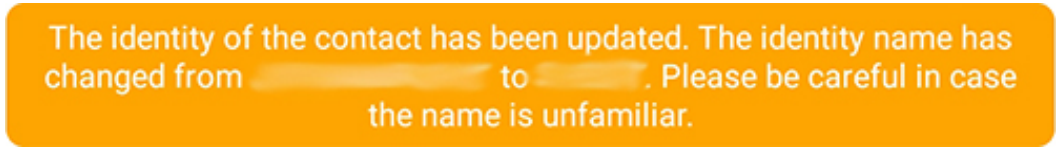
Characteristics:

- trust in platform with decentralization
- trade-off between privacy and trust
- trust using authentic information
- attributes from self-sovereign identity



How to enforce authentic trust?

- formal identity behind every sent message
- exchange identity information attributes:
  - initials + last name (**J.W. Bambacht**)
  - identity photo
  - verification status (**verified/unverified)**
- detection for changes in formal identity



Exchange of money in our platform

Characteristics:

- Central Bank Digital Currencies (CBDC)
- digital native currency on blockchain
- fast and cheap cross-border exchange
- transparent but still pseudo-anonymous
- no external dependence

How do we use this CBDC?

- EuroToken with TrustChain ledger and IPv8
- private P2P exchange
- EuroToken balance in wallet
- exchange portal for exchange of € and tokens
- Tikkie-like payment requests

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Exchange of data in our platform

Default IPv8 data transfer protocol:

- fast for messages and small data
- UDP packet delivery is unreliable
- limited in performance
- no delivery guarantees

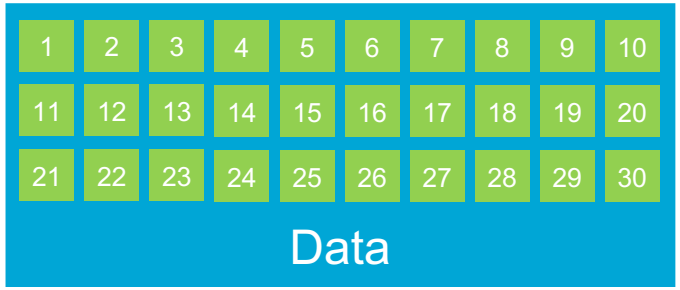
need for a reliable P2P data transfer protocol for large data

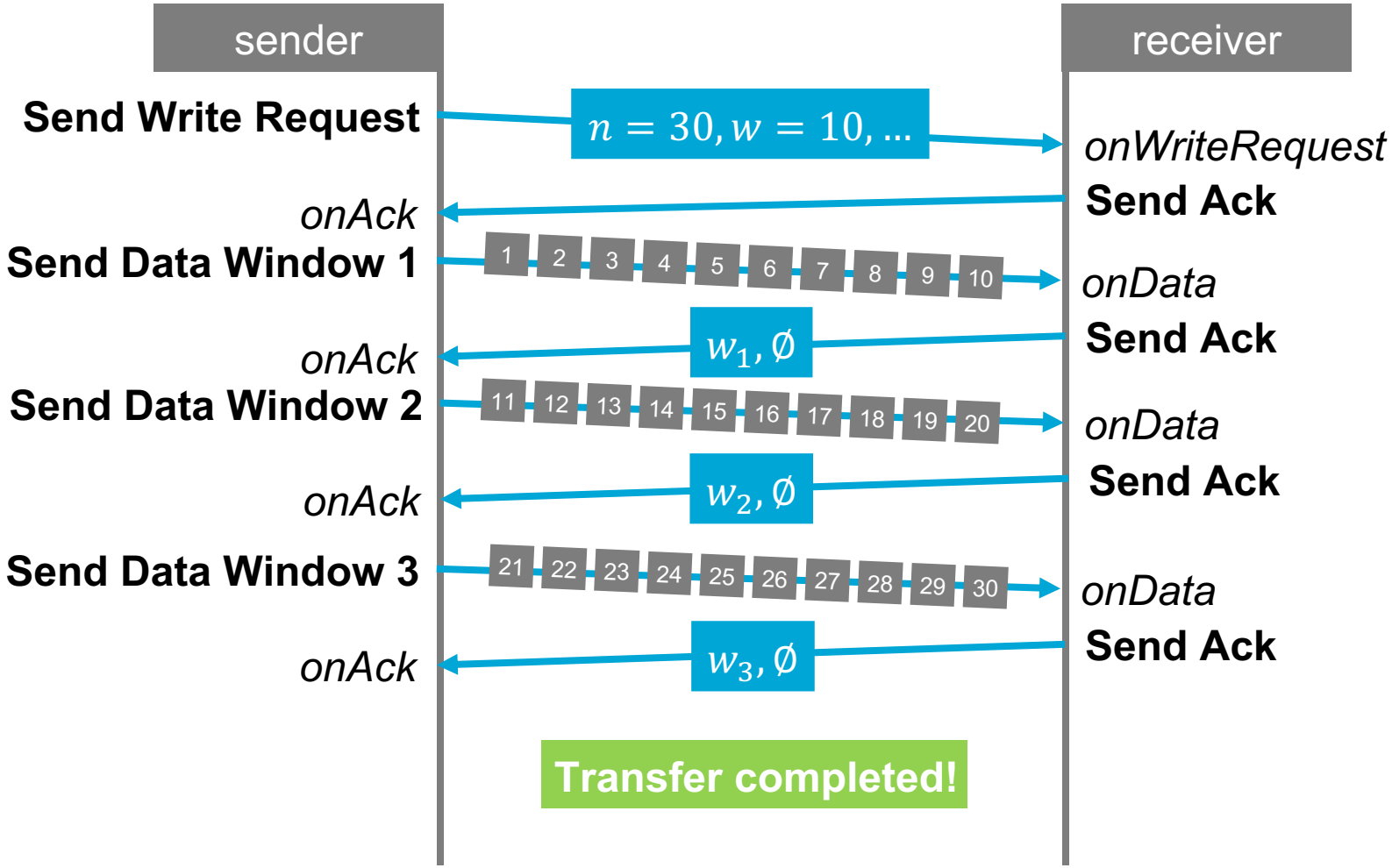
How to exchange large data?

- reliable and optimal performance
- based on principles of TFTP
- authenticated and encrypted
- acknowledgement-based
- windowing for performance increase
- progressive delivery guarantees
- adaptive downscaling of performance

Normal operation of data transfer protocol

Data of $n = 30$ blocks and window of $w = 10$ blocks





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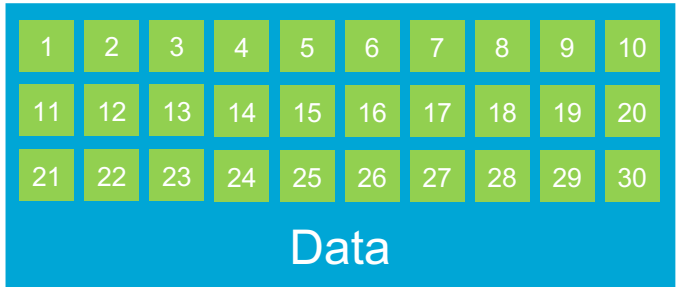
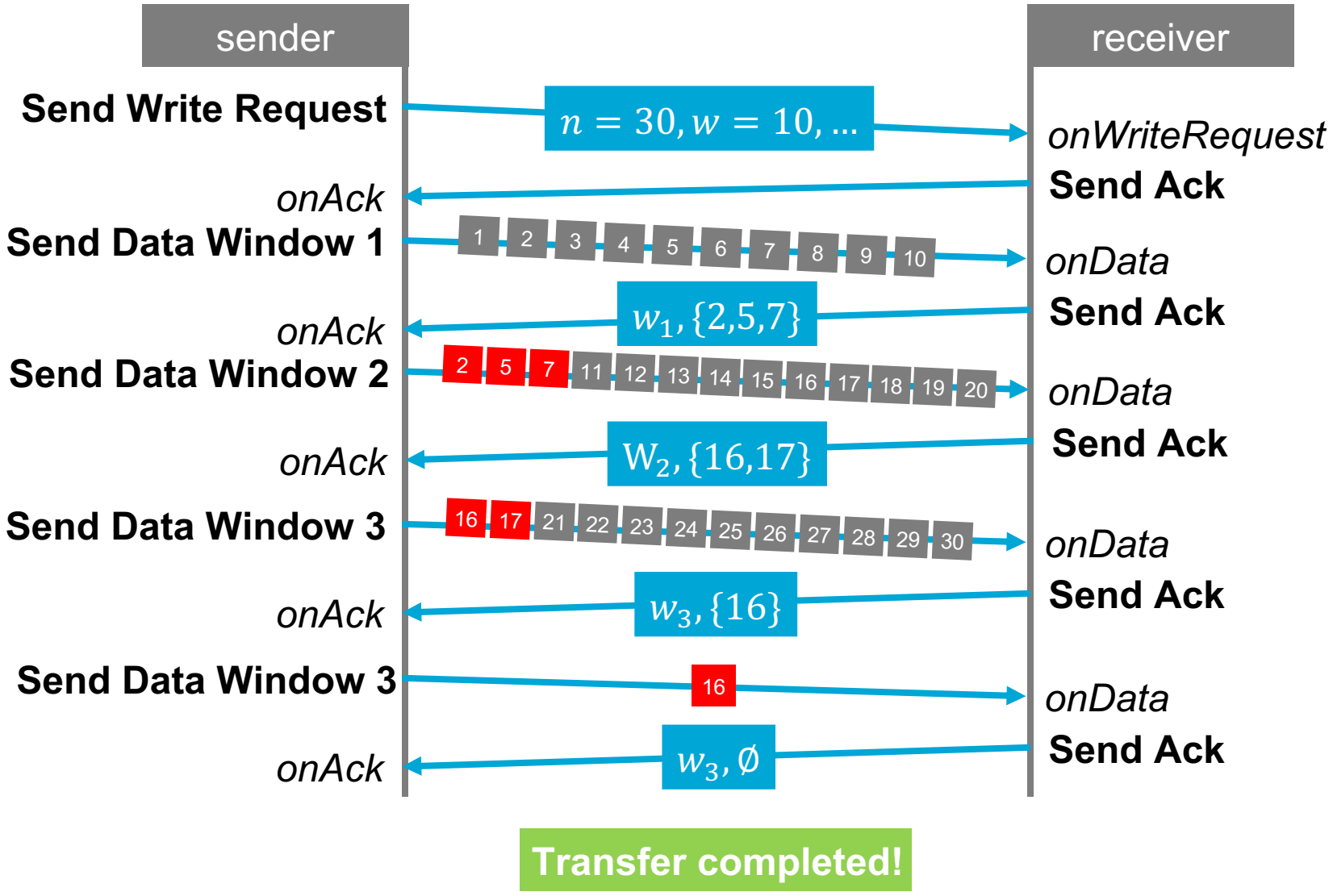
Progressively continue normal operation with packet loss

Data of $n = 30$ blocks and window of $w = 10$ blocks





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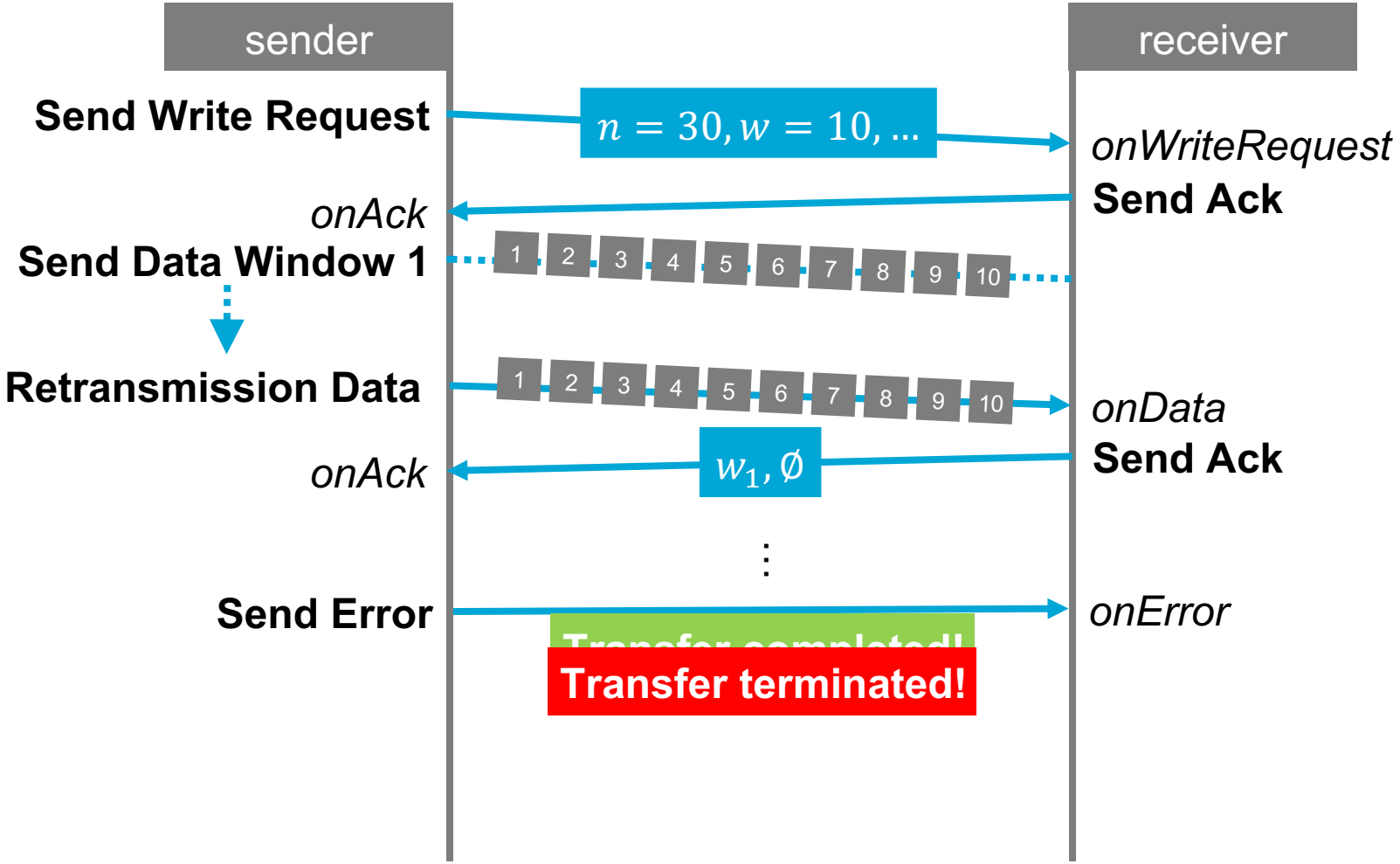
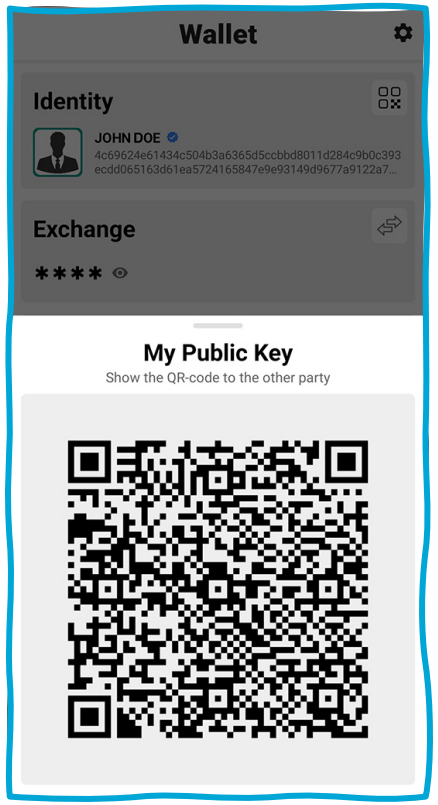
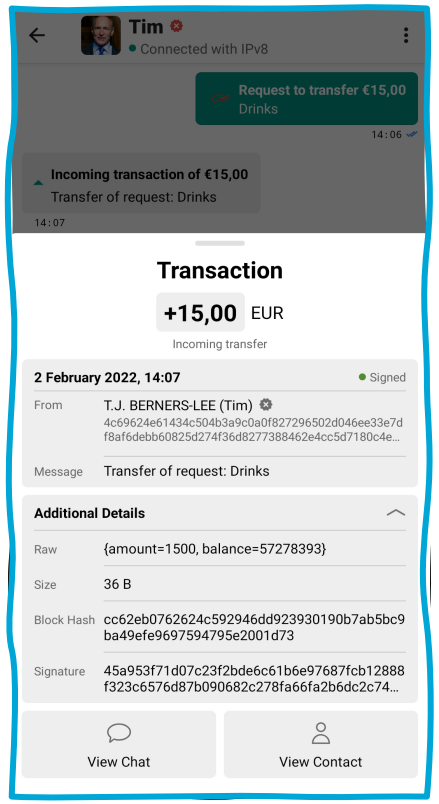
Retransmission and error

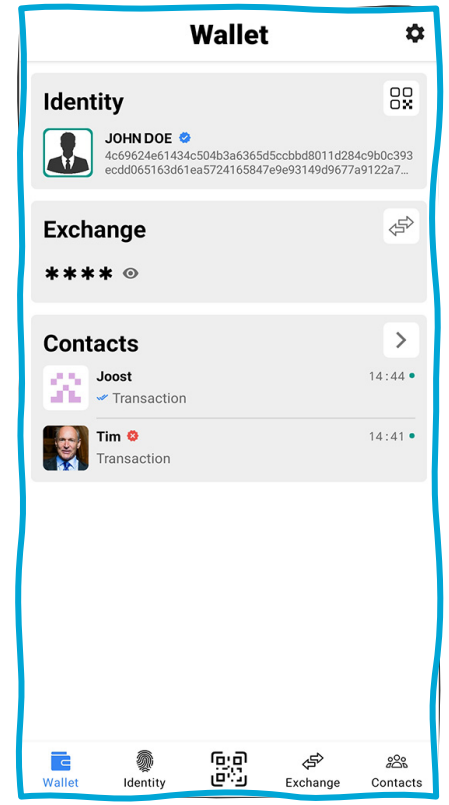


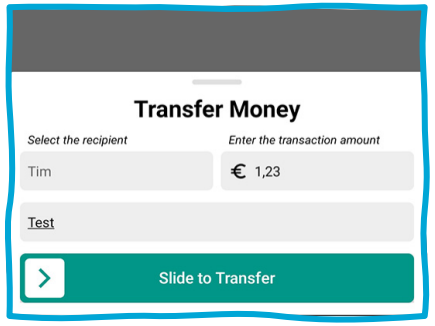
UX and UI Design

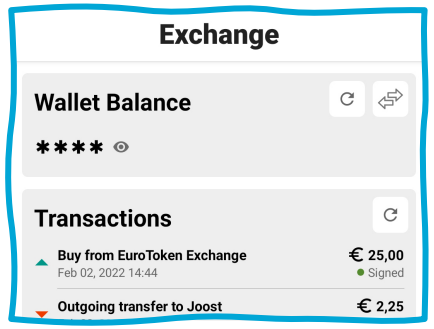
- user experience and layout
- simple and consistent design
- master-detail interface
- QR-codes
- protection mechanisms
- download status

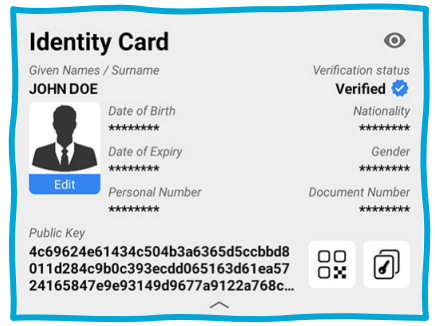


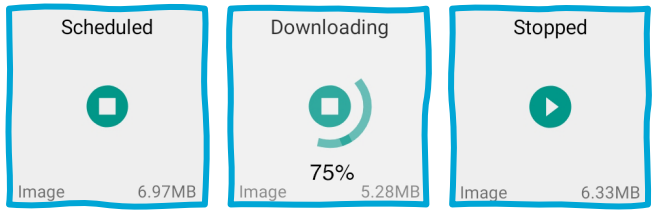












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Analysis

data transfer protocol

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Experimental analysis of data transfer protocol

Analysis:

- optimal parameters for **normal** operation:
  - I. max transfer speed
  - II. min lost packets
  - III. min retransmissions
- ideal situation, no latency, no packet loss
- optimize block size B and window size W

Setup:

- 2 Android phones
- local WiFi network
- $B = \{600, 700, 800, 900, 1000, 1100, 1200\}$ bytes
- $W = \{16, 32, 48, 64, 80, 96, 112, 128\}$ blocks
- 5 iterations
- 2 file sizes

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Experimental results of data transfer protocol

Observations:

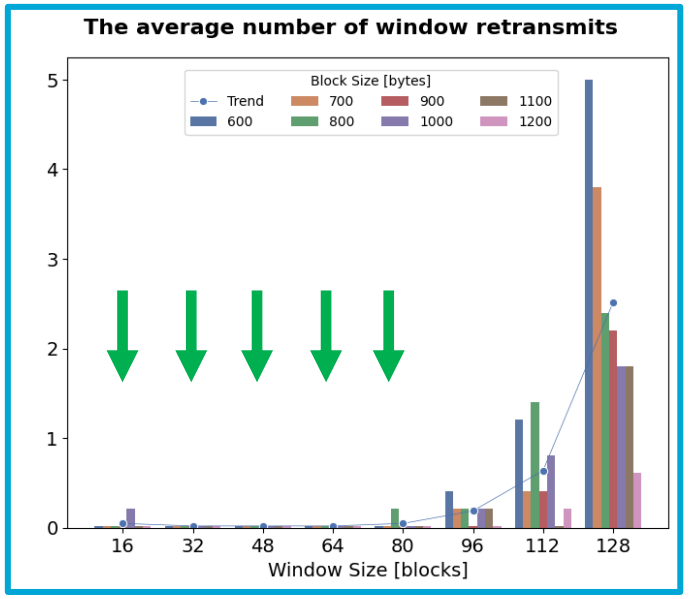
I. maximal transfer speed:
   - B: higher size = higher speed → 1200 bytes
   - W: 80 or 96 blocks optimum

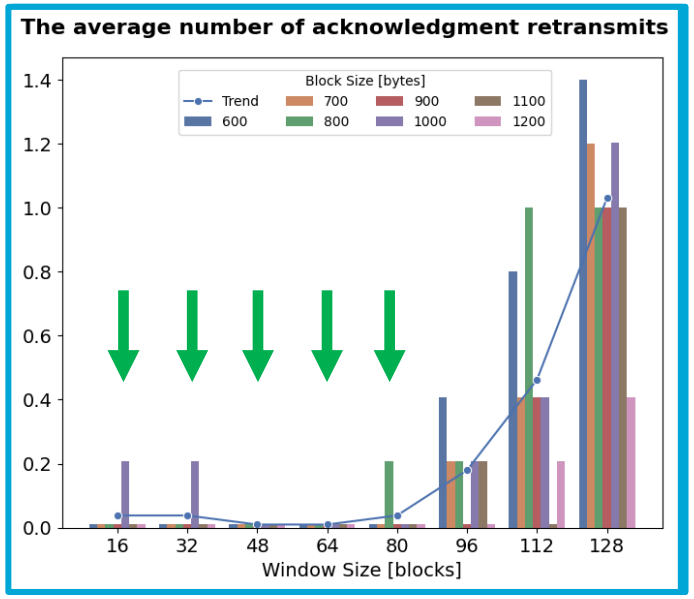
II. minimum lost packets:
   - B: no optimum
   - W: 80 or **96** blocks optimum

III. minimum retransmissions:
   - B: no optimum
   - W: <96 blocks optimum

What can we conclude?

- optimal block size B of 1200 bytes
- optimal window size W for 80 blocks
- independent on file size





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Platform Demo

Conclusion

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What can we conclude?

- no self-sovereignty with centralization
- decentralization ⇏ self-sovereignty
- P2P for privacy and security
- reliable, private and secure P2P data transfer protocol
- first Self-Sovereign Identity in social platform
- authentication, attestations, trust enforcement, …
- private exchange euro Central Bank Digital Currency euro

BIG-TECH COMPANIES, GOVERNMENTS, AND BANKS NEED TO STEP UP FOR SELF-SOVEREIGNTY!

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Questions?

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