Securing the Art Market with Public Ledgers

Marino Miculan, **Daniel Tosone**

DMIF, Università di Udine

DLT 2020 – Ancona, February 4, 2020

UNIVERSITÀ
DEGLI STUDI
DI UDINE

The art market

- Two main critical issues:
    - Authentication and provenance
    - Lack of transparency

- Four main actors
    - Artists: register and sell artworks
    - Collectors: buy, sell and ask for authentication of artworks
    - Brokers: sell artworks for third parties
    - Authenticators: authenticate artworks

- Non functional requirements:
    - Transparency
    - Integrity
    - Availability
   - Usability

Conflicts between requirements

- Provenance verification requires to know the chain of owners
- Law enforcement requires to know the identity of parts involved in the trade
- Confidentiality regarding the ownership and the purchase price

Solution:

- Ethereum addresses are used to represent users
- An *administrator,* which is required to
  - Certify the correspondence between address and name
  - Enforce law for private sales

General Architecture

- Private database
  - Collectors identity
  - Private selling prices

- Ethereum
  - System core

- IPFS
  - Artworks images
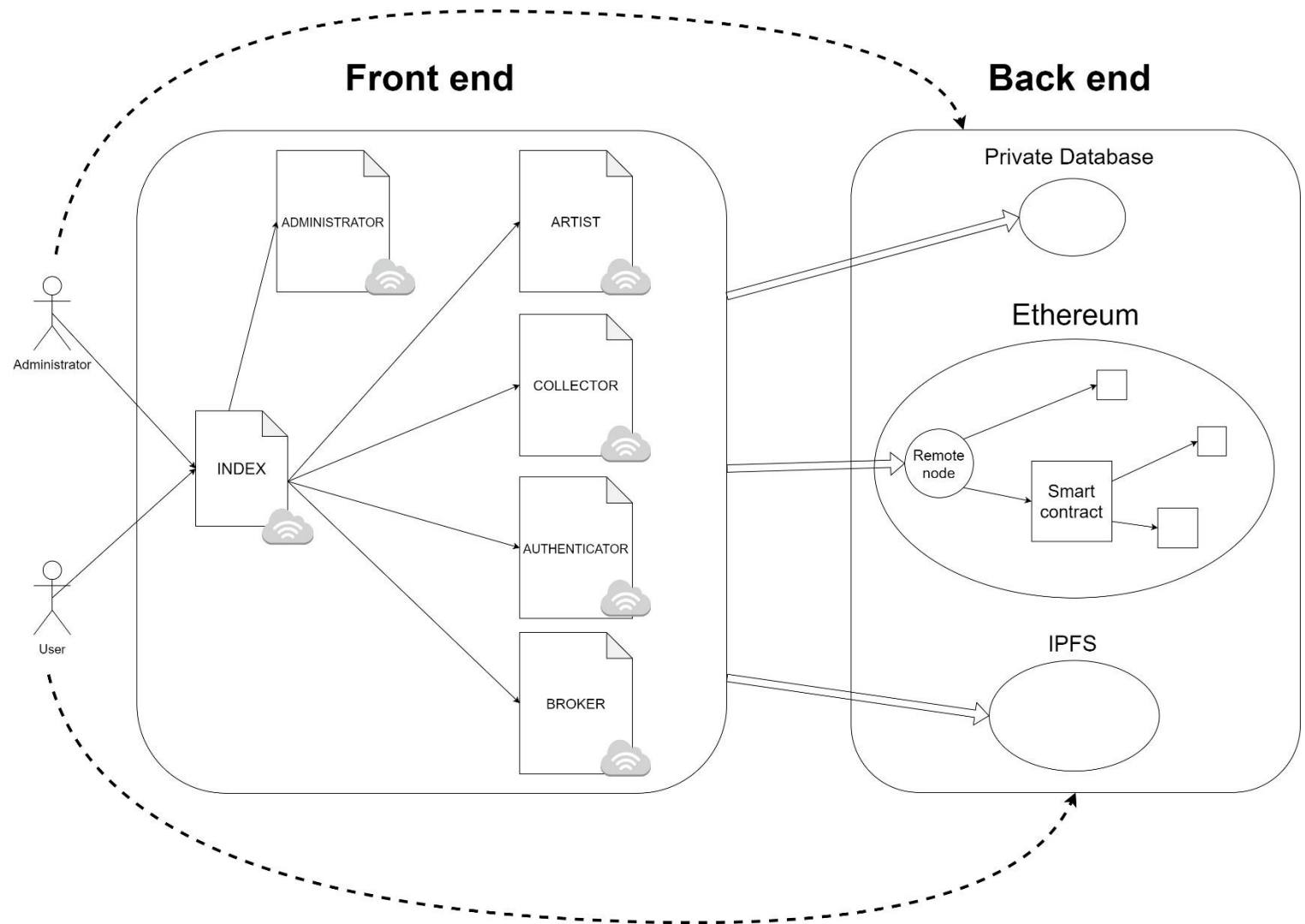
Most important back-end modules

- Token
  - ERC-721 smart contract
  - Main register for artworks operations

- Marketplace
  - Contract for selling and buying
  - Automatic payments on Ethereum

- IPFS
  - Distributed file system based on a DHT

Interface to Ethereum and Traceability

Metamask extension

- Wallet (generates private key and address)
- (Possibly) linking to a remote node

Etherscan page of the token

	Transfers	Holders	Read Contract	Write Contract	

A total of 11 transactions found

First < Page 1 of 1 > Last

Txn Hash	Age	From		To	TokenID
0x7beec8ec6de993…	7 days 22 hrs ago	0xc418d023161ff01…	→	0x6e76f2f9967a6ea…	0
0xf91fbbb0ac73efed…	7 days 23 hrs ago	0x6e76f2f9967a6ea…	→	0x75fe5c0b04bb9e2…	3
0x66218a7553aa9c…	7 days 23 hrs ago	0xc418d023161ff01…	→	0x6e76f2f9967a6ea…	3
0x22dcba6888d634…	7 days 23 hrs ago	0x75fe5c0b04bb9e2…	→	0xc418d023161ff01…	3
0x1f2cccc948f1013…	7 days 23 hrs ago	0xc418d023161ff01…	→	0x75fe5c0b04bb9e2…	3
0x9cd44f4d550dd0c…	8 days 19 mins ago	0x00000000000000…	→	0xc418d023161ff01…	3
0xa31e87cff2732fb5…	8 days 30 mins ago	0x742fb233cbbb46b…	→	0xc418d023161ff01…	0
0x9b9310bccbc176…	8 days 34 mins ago	0x742fb233cbbb46b…	→	0x6e76f2f9967a6ea…	1
0x1e2a352cc74dc1f…	8 days 53 mins ago	0x00000000000000…	→	0x742fb233cbbb46b…	2
0x7258a4e5a3ab83…	8 days 59 mins ago	0x00000000000000…	→	0x742fb233cbbb46b…	1
0x0780b3d90339b1…	8 days 1 hr ago	0x00000000000000…	→	0x742fb233cbbb46b…	0

Tokenization

- Crucial: how to connect the virtual token to the physical artistic object

- Connection realised through a non-tamperable, non-duplicable tag
  - Applied by the author or authenticator
  - E.g. RFID applied on or within the canvas

- Provides permanent reference to Ethereum token

- Easy authentication and provenance check

- If an authentication is discovered to be wrong, a new token is created and a new RFID is applied

Testing and cost analysis

- Solution tested on Ropsten test network

- Waiting time rarely over 2 minutes

- 1 ETH = 186.82 €

- Gas price: 10/21/32 Gwei

Operation	Cost (€)		
	slow	average	fast
addArtist()	0.309	0.649	0.989
addAuthenticator()	0.224	0.471	0.718
addBroker()	0.233	0.490	0.746
addInvestor()	0.182	0.382	0.582
registerArtwork()	0.587	1.232	1.877
startOpenSale()	0.190	0.399	0.608
startClosedSale()	0.252	0.529	0.806
buy()	0.249	0.522	0.796
buy() - *with broker*	0.330	0.692	1.055
sellPrivately()	0.201	0.422	0.643
entrustArtwork()	0.213	0.447	0.681
askForAuthentication()	0.237	0.498	0.759
addProposal()	0.426	0.895	1.364
authenticate()	0.139	0.293	0.446
registerAuthenticatedArtwork()	0.571	1.200	1.828
withdraw()	0.055	0.115	0.175

Conclusions and future works

- Transparency, availability and integrity granted by smart contracts and public ledgers

- Usability obtained by means of web frontend

- Future improvements:

  - Match exchange of token to exchange of the physical artwork

  - Investigate legal recognition

  - Integration with IoT devices

Thanks for the attention

Daniel Tosone
daniel.tosone@gmail.com

Marino Miculan
marino.miculan@uniud.it

A complex regulatory framework

- Sales and provenance certificates: must contain information about the artwork, its authenticity and its provenance

- Circulation of artworks: high historical and cultural value artworks may be protected by the State and therefore they cannot leave the country

- Resale right: artists are entitled to a remuneration for each sale of their artworks following the first

Sequence diagram of *Registration by artist*
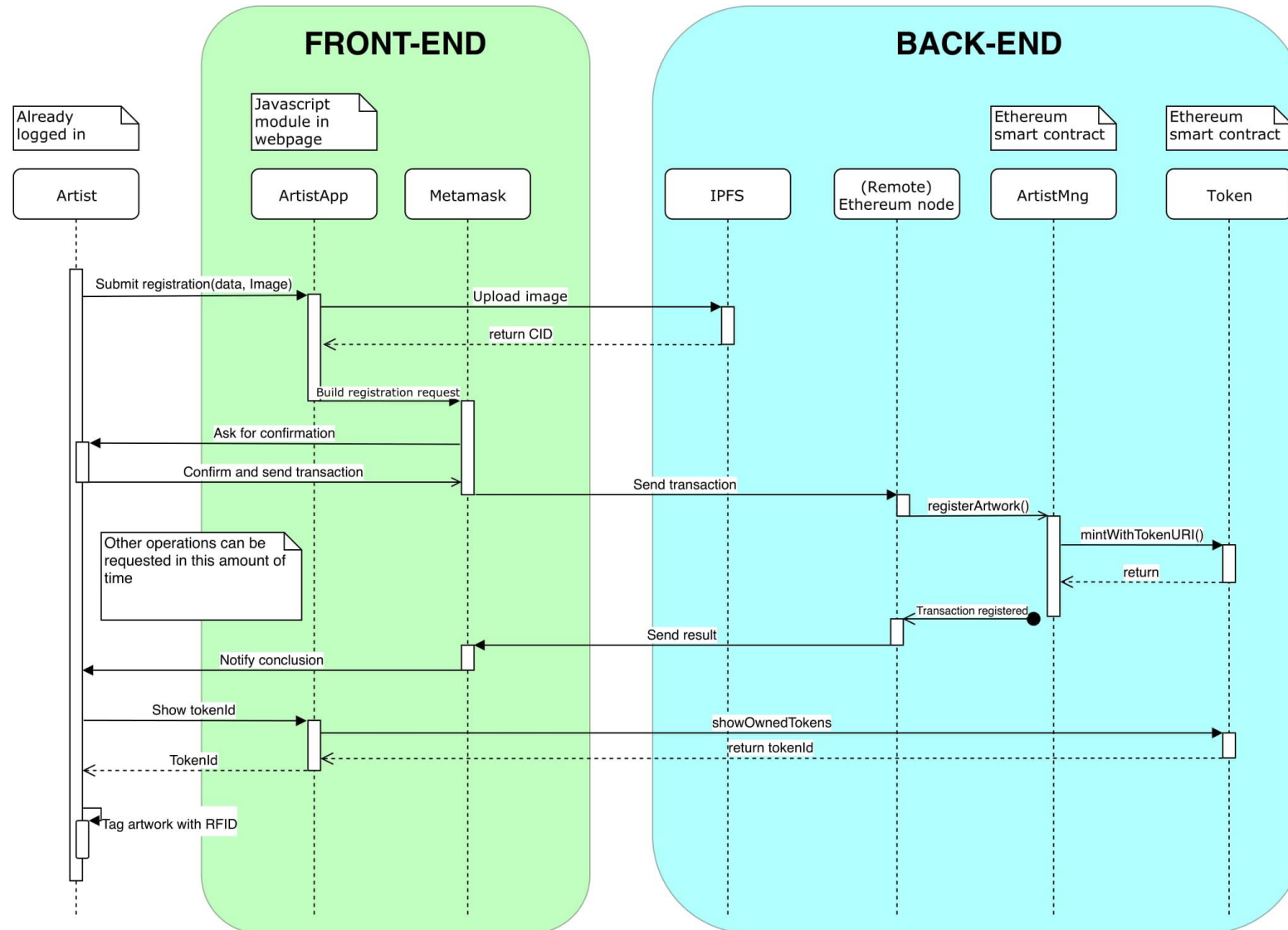
Sequence diagram of *Registration by collector*
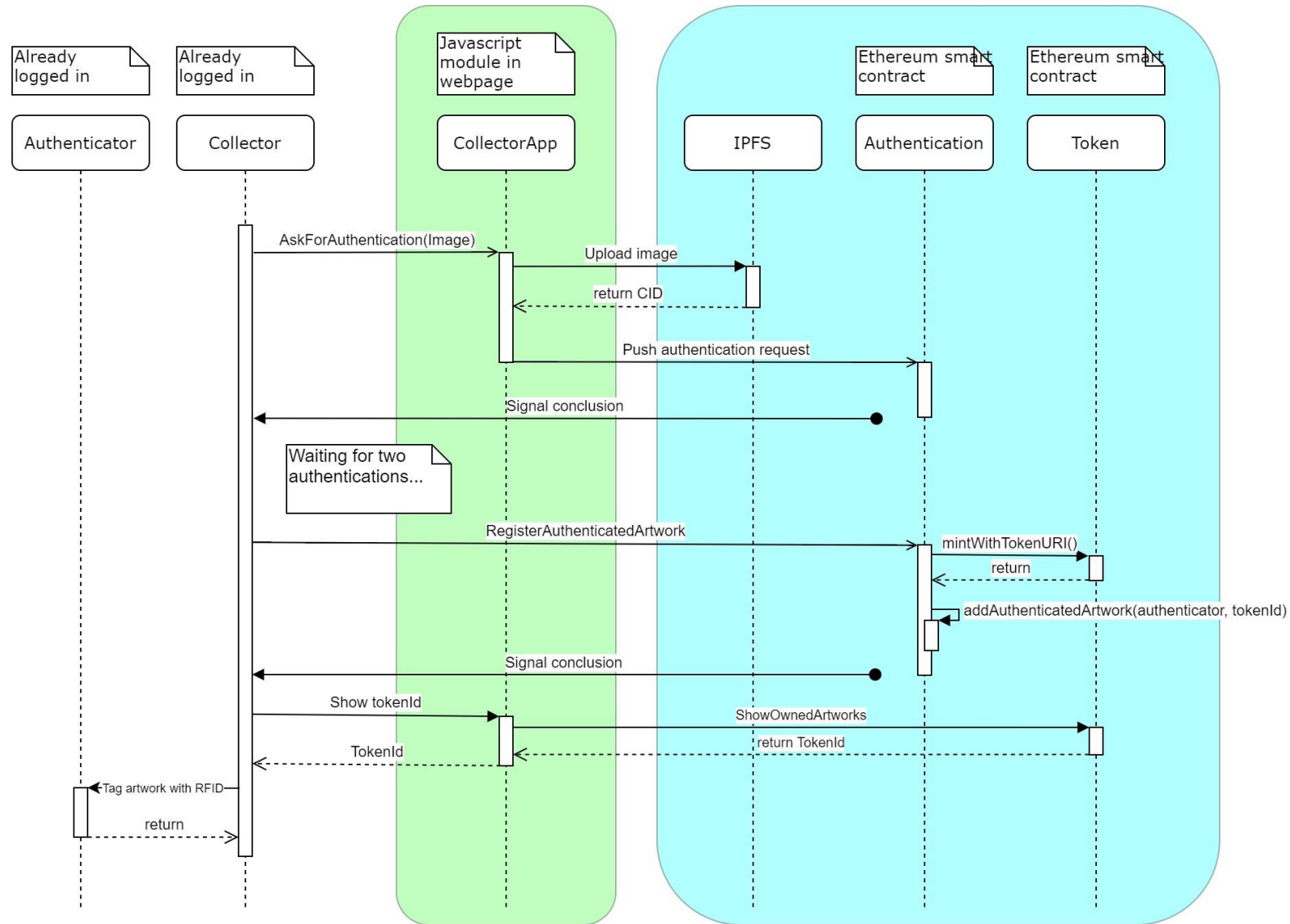
Sequence diagram of *Selling*
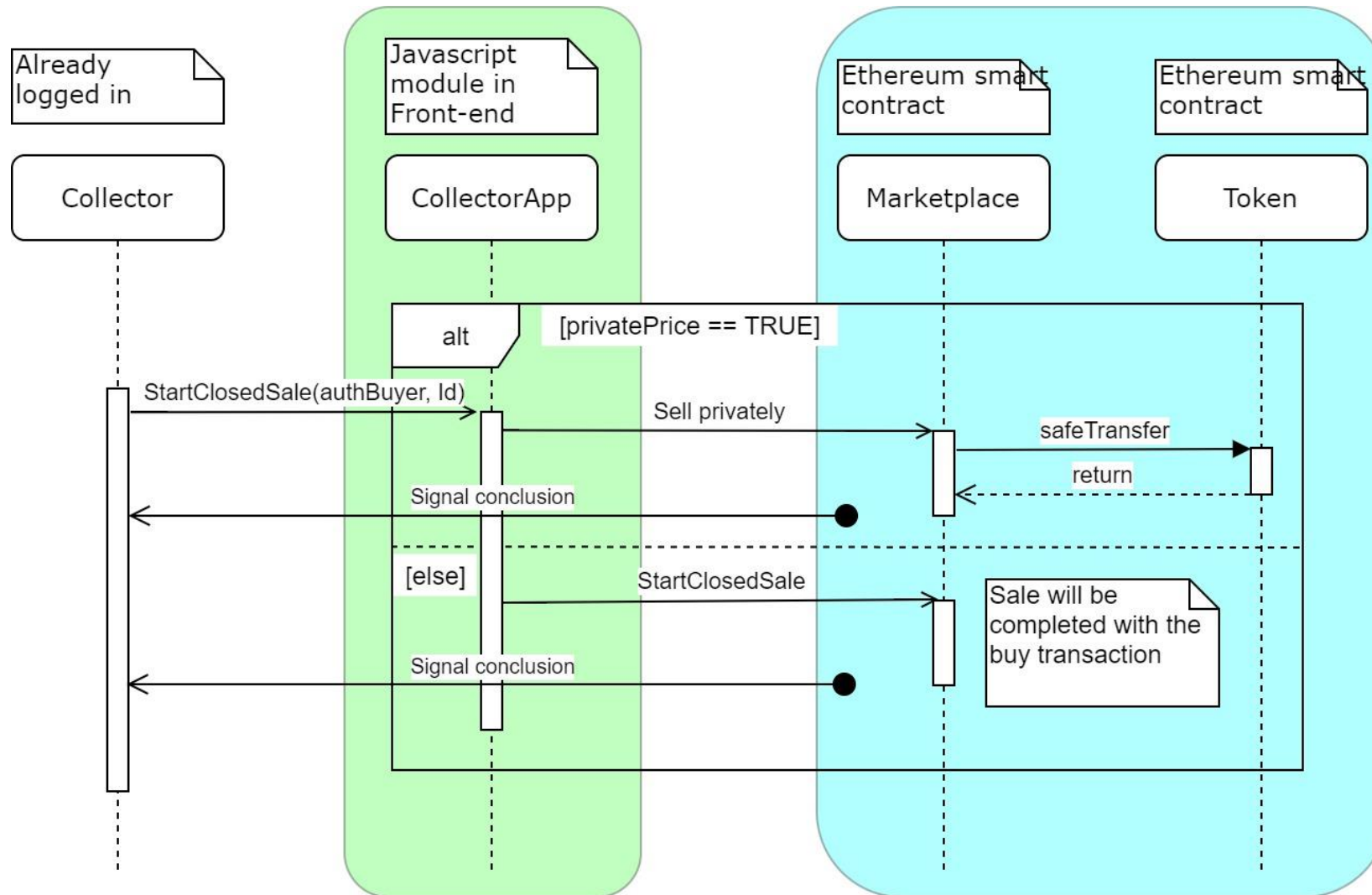
Sequence diagram of *Buying*
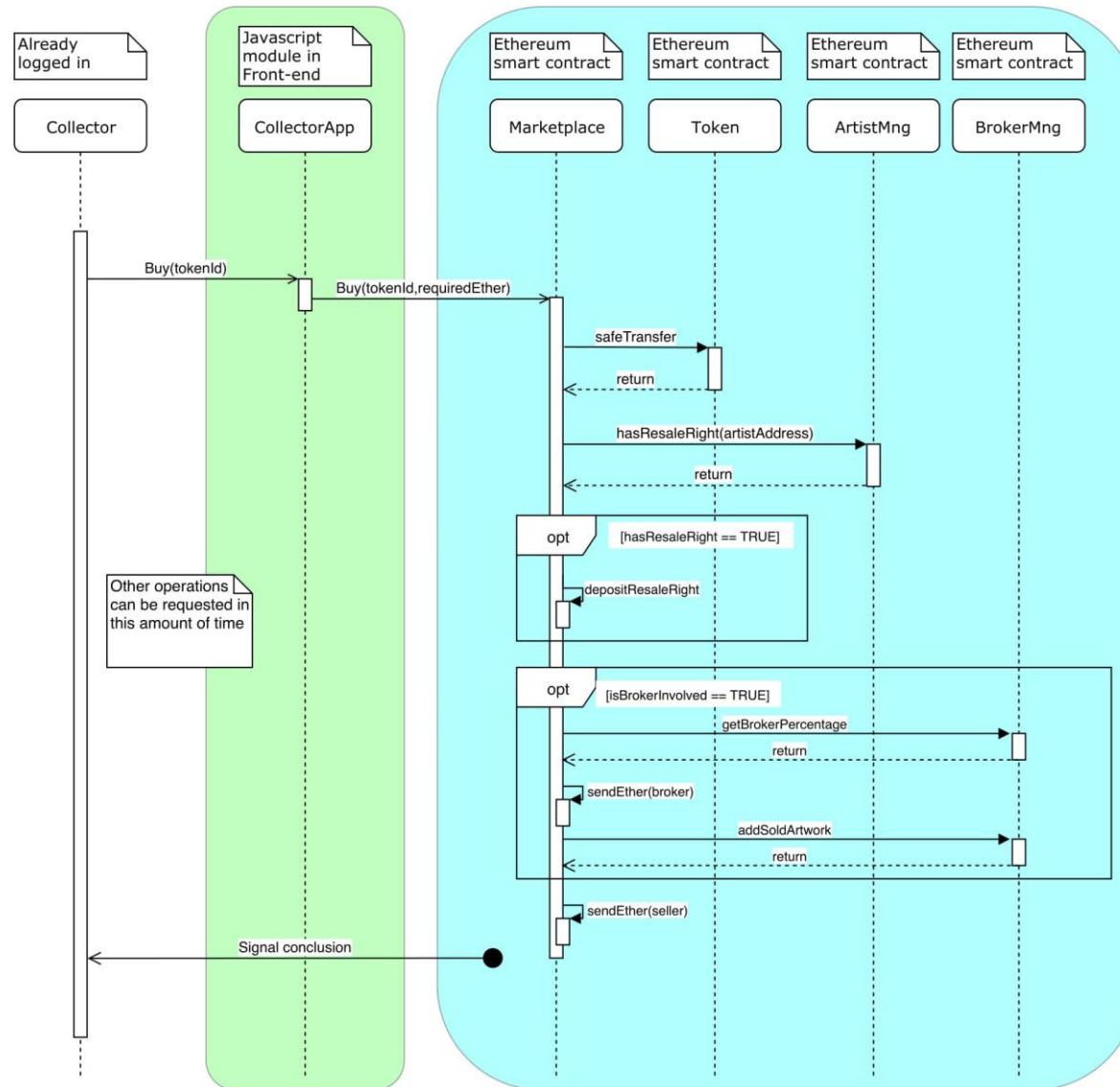
Front-end example: artist web page