Internet voting by CHvote

@SwissCyberStorm

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Short Bio

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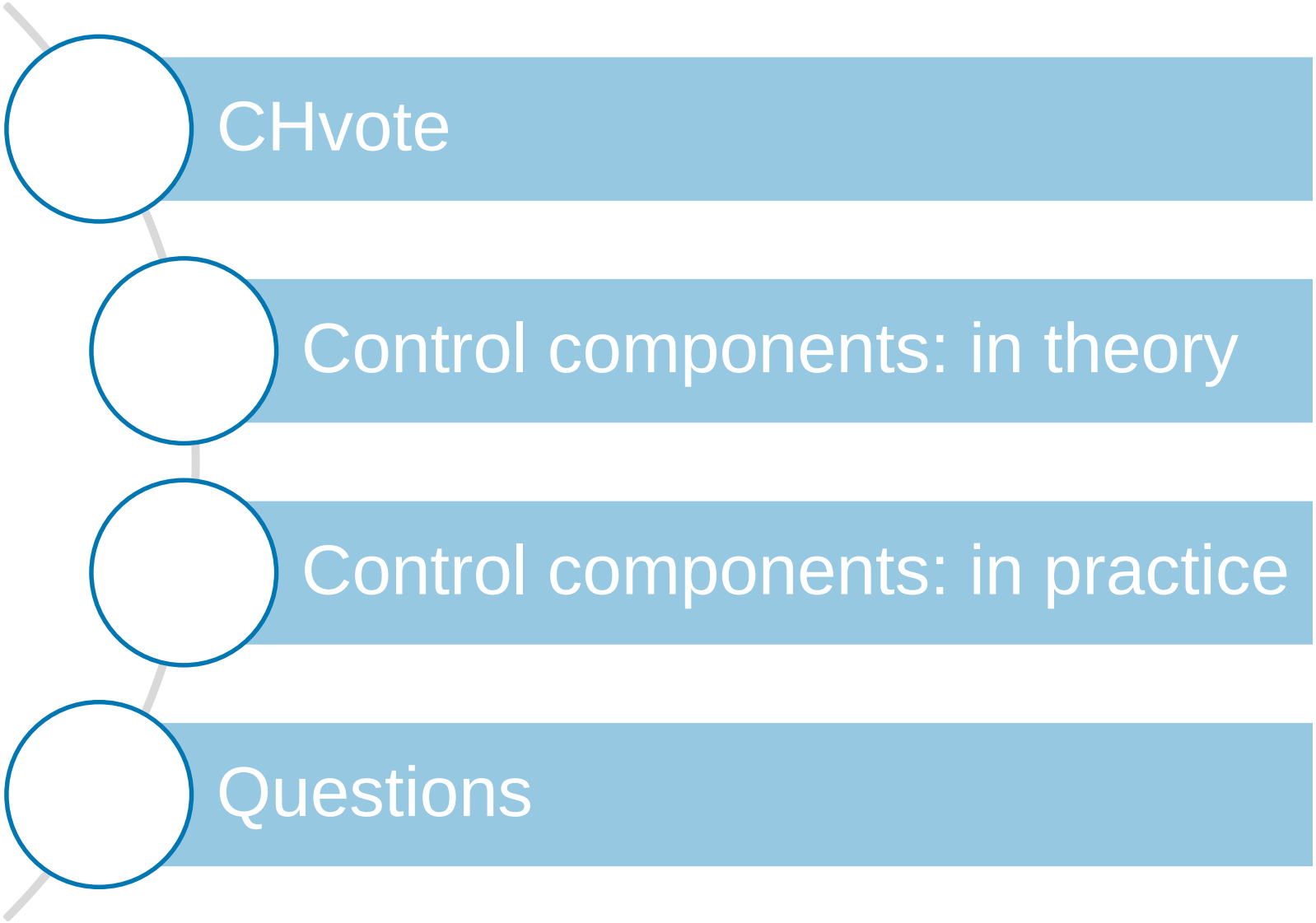
- EPFL MSc in IT
- Master thesis @ CERN Computer Security Team
- IT / Java consultant

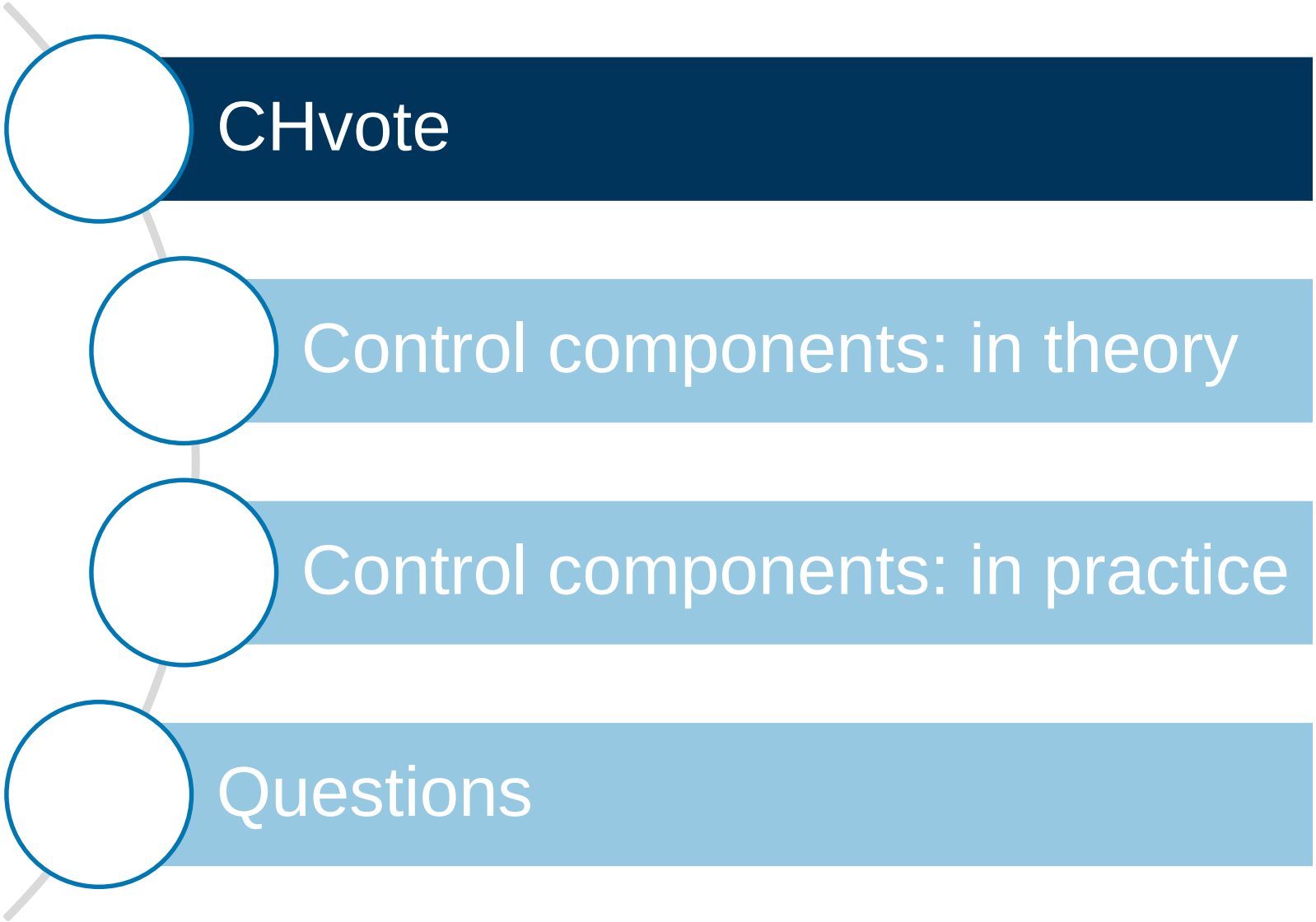
- Now
  - → Java DEV & AppSec
  - → Internet voting cryptography @ State of Geneva

- Outside from work
  - → OWASP-Geneva co-chapter leader
  - → Married, 2 kids

Outline


CHvote
Control components: in theory
Control components: in practice
Questions

Outline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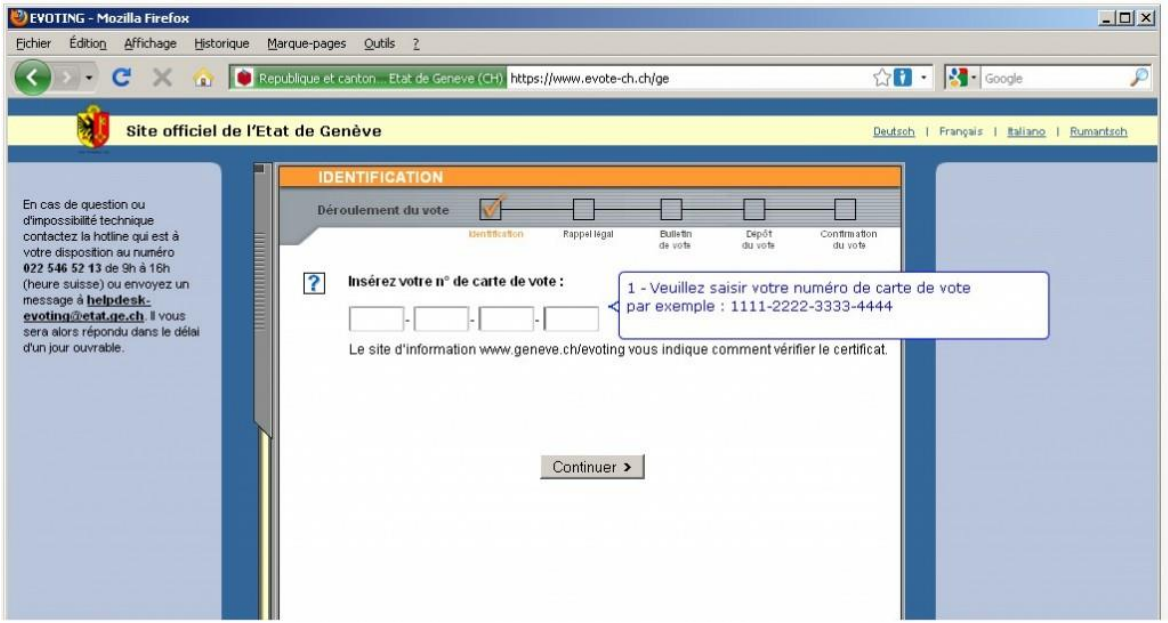
The past of CHvote

First generation E-Voting system

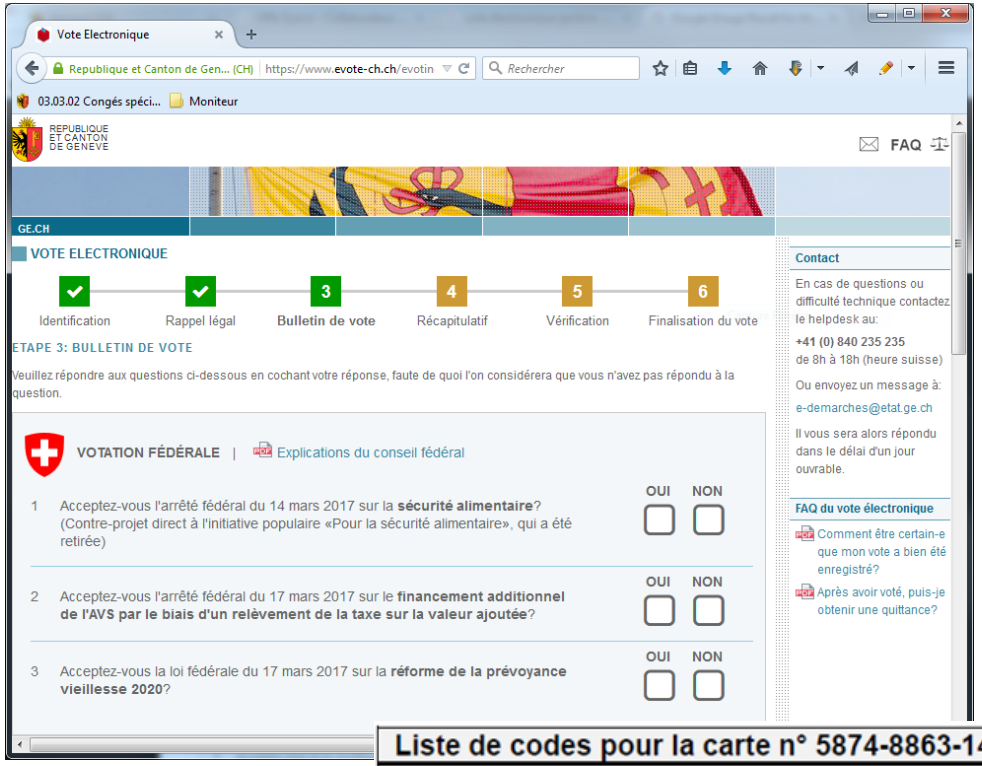
- 2001: start of project
- 2003: first use



- Partners

The present of CHvote

Individual verifiability & major appearance overhaul



Liste de codes pour la carte n° 5874-8863-1400-8743

Votation fédérale

Question 1

	Oui	Non	Blanc
Acceptez-vous l'arrêté fédéral du 20 juin 2013 portant règlement du financement et de l'aménagement de l'infrastructure ferroviaire (Contre-projet direct à l'initiative populaire "Pour les transports publics", qui a été retirée) ?	A2B4	J5B9	Z8H5

The future of CHvote

End-to-end verifiable internet voting protocol

- New academic partnerships
  - → Berner Fachhochschule
  - → INRIA / Bristol
  - → ITU Copenhagen
  - → …
- New cryptographic protocol
  - → End-to-end encryption
  - → Universal Verifiability
  - → Control Components
- Currently in development, ETA: 2019

Outline

- CHvote
- **Control components: in theory**
- Control components: in practice
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Federal requirements

New Ordinance on Electronic Voting

- Published in 2013, enacted 2014
  - → Collaborative work between lawmakers, academia and operating staff
- Compliance levels
  - → The higher the compliance, the more voters allowed
- Reference
  - → https://www.bk.admin.ch/themen/pore/evoting/07979/index.html

Federal requirements

Control Components

The trustworthy part of the system includes either one or a small number of groups of independent components secured by special measures (control components). Their use must also make any abuse recognisable if per group only one of the control components works correctly and in particular is not manipulated unnoticed. – *VEleS, art. 5, par. 6*

- i.e. trust splitting in "anytrust" mode: only 1-of-k needs to be honest, all k need to be available
- Control components must use different OS

Outline

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- **Control components: in practice**
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Security role of control components

A brief overview

- Homomorphic encryption (El Gamal)
- Public / private credentials per voter
  → Each Control Component holds a share
- 1 key pair per Control Component
  → "system" public key is the product of public keys
- 1 ballot-box shuffle per Control Component

Voter authentication

In the context of trust splitting

- Private credentials:
  - → Signed and encrypted for printing authority
  - → Used for signing the ballot
- Public credentials:
  - → Shared and combined
  - → Each Control Component must verify credentials

Ballot encryption

How ?

- Voting client uses "system" key to encrypt ballot
  - → "system" key is product of each CC's public key
- All Control Components are required for decryption
- (partial) Decryption by CC is not allowed until:
  - → Ballot box has been shuffled by all CCs
  - → Each shuffle has been verified to be valid

Oblivious Transfer

What does it mean and why is it useful?

- In short
  - → Server knows n secret messages
  - → Client allowed to retrieve k secret messages
  - → Server cannot know which messages the client asked for
  - → *Enables individual verifiability combined with end-to-end encryption*

- In detail
  - → Cast-as-Intended Verification in Electronic Elections Based on Oblivious Transfer

Ballot-box shuffling

Why is it complicated and how does it work

- Re-encrypting mix-net
  - → Each CC **re-encrypts** each ballot and **shuffles** them

- Shuffled → simple pre-image proofs would not work
- Re-encrypted → ciphertexts are not equal

- Need for a specific proof that the cryptographic shuffle is valid

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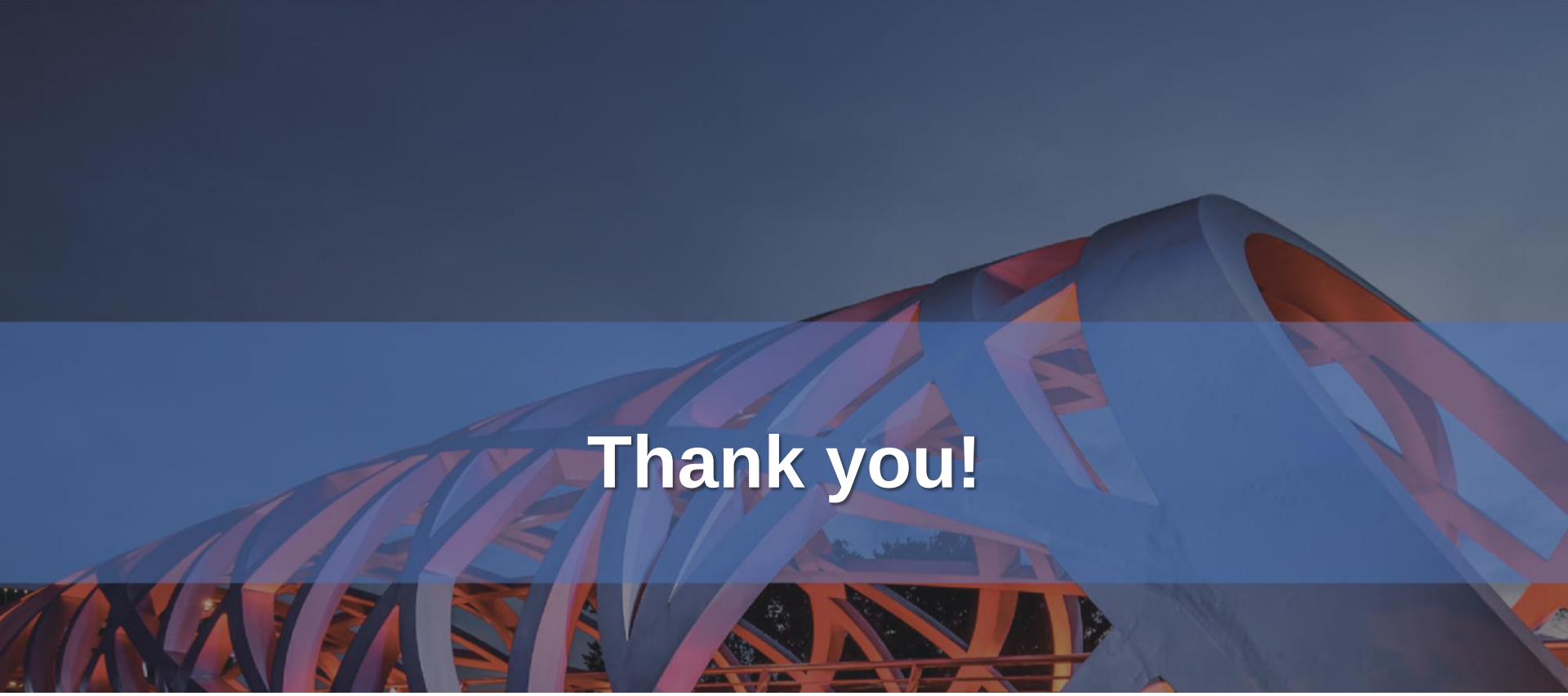
Further reading

And references

- Published protocol specification
  → https://eprint.iacr.org/2017/325
- Published PoC code
  → https://github.com/republique-et-canton-de-geneve/chvote-protocol-poc
- Federal requirements
  → https://www.bk.admin.ch/themen/pore/evoting/07979/index.html



Thank you!

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