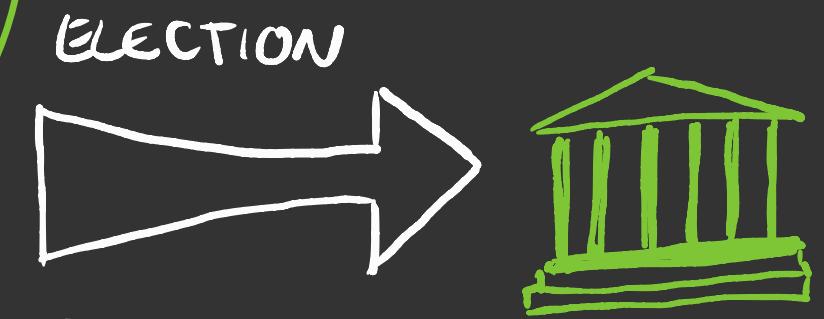
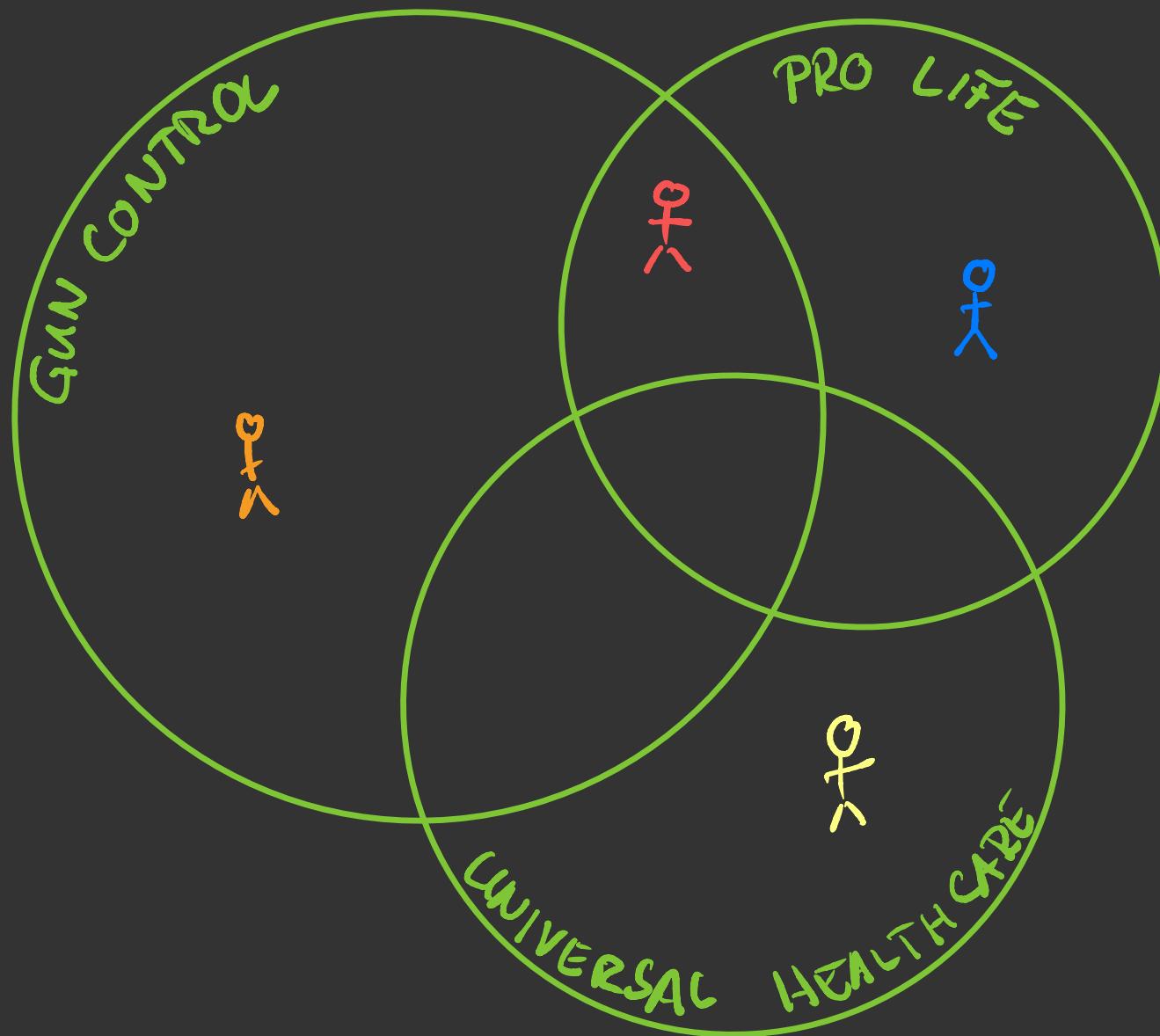


ELECTION SECURITY

FROM BALLOTS TO TRUST

CARSTEN SCHÜRMANN

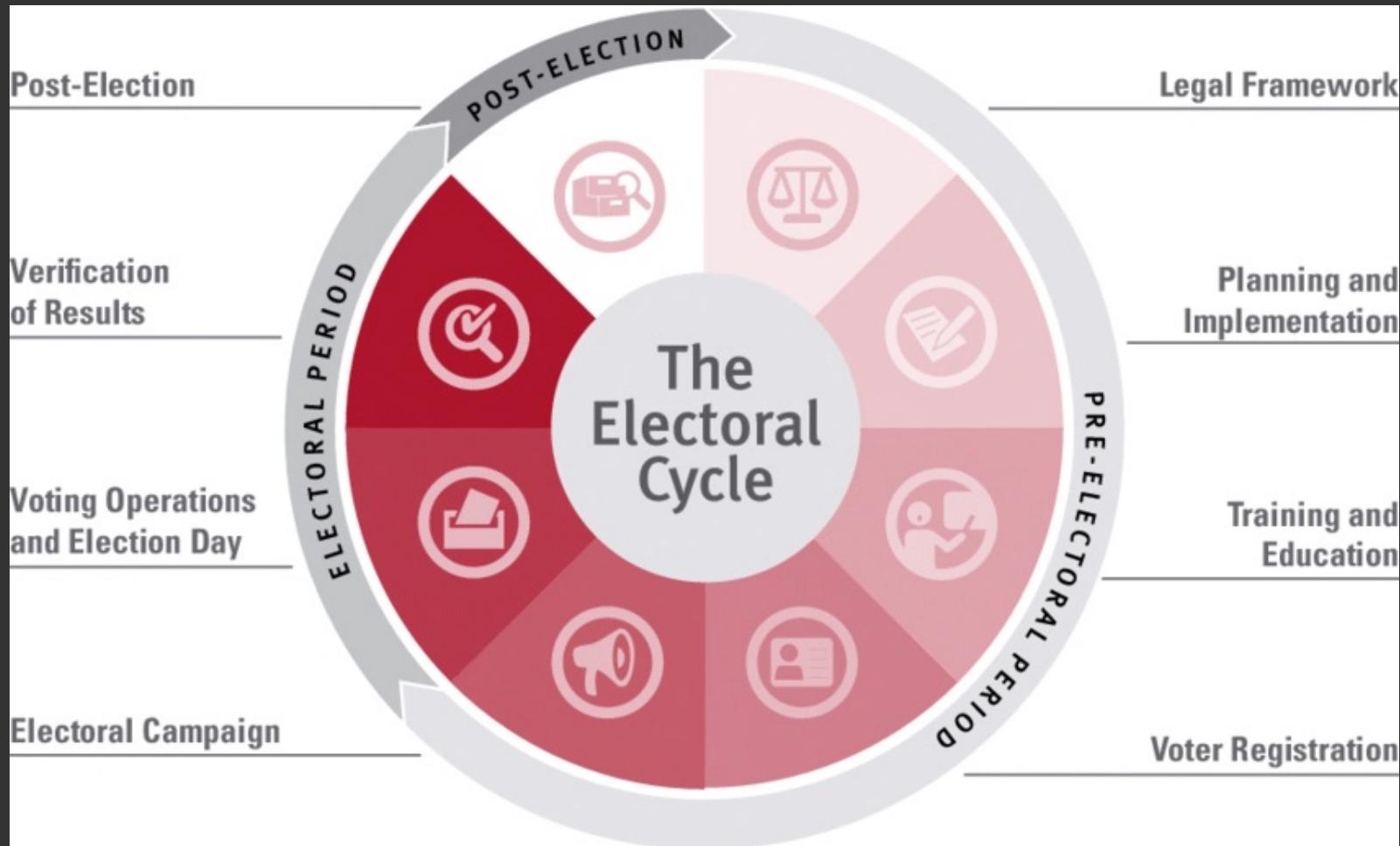
CENTER FOR INFORMATION SECURITY AND TRUST
IT UNIVERSITY OF COPENHAGEN



CIVIC BATTLE

GOVERNMENT

THE ELECTORAL CYCLE



SOURCE IDEA. INT

PUBLIC CONFIDENCE

TRUST [SIMON '13]

"TO CONVINCE THE LOSER,
THAT HE OR SHE LOST"

DAN WALLACH

TEXAS SENATE HEARINGS, 2008

"TO GUARANTEE A PEACEFUL RESOLUTION
OF THIS CIVIC BATTLE"

JORDI BARAT, 2018

PERSONAL COMMUNICATION

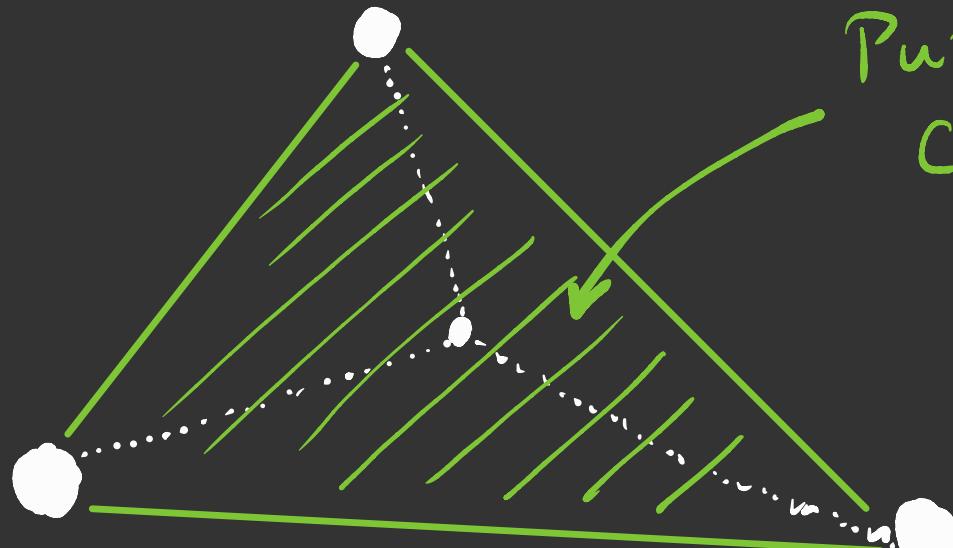
THE ANATOMY OF PUBLIC CONFIDENCE

- HAND-MARKED BALLOTS
- MACHINE-MARKED
- PROOFS OF KNOWLEDGE
- DIGITAL SIGNATURES

COLLECTION CURATION

- STORAGE & PROTECTION
- TEMPER-PROOFING
- TRANSPORT

EVIDENCE

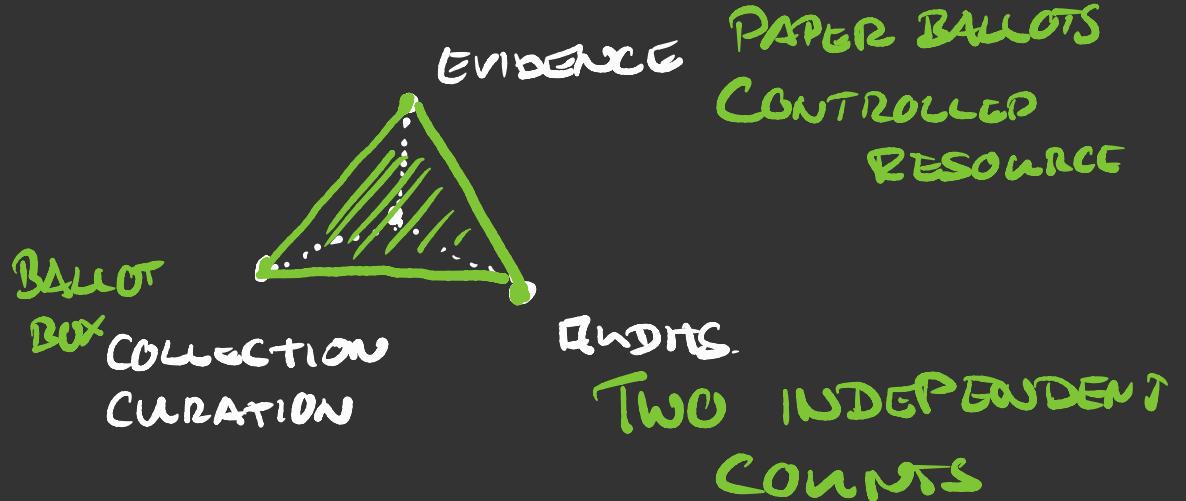
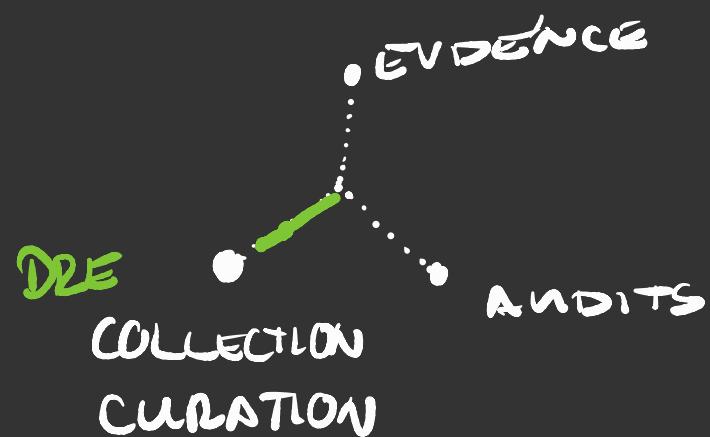


PUBLIC CONFIDENCE

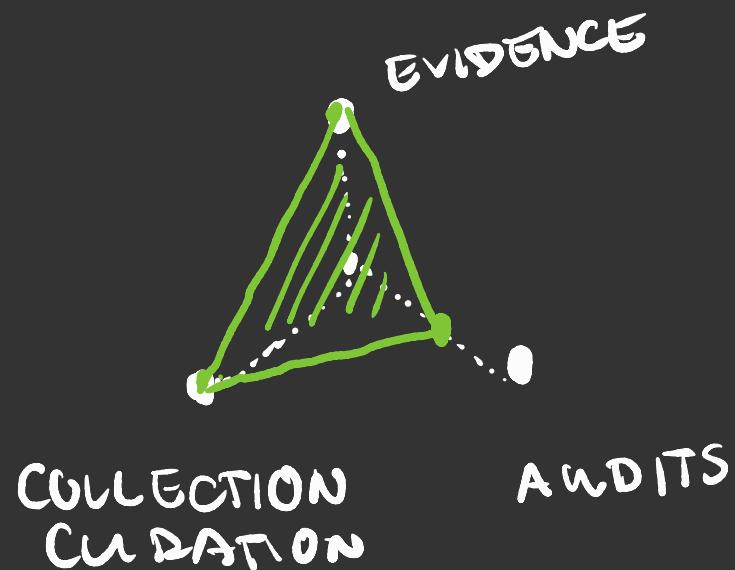
- RISK LIMITING AUDIT
- RECOUNTS
- POST ELECTION AUDITS

USA [GEORGIA 2018]

DENMARK



PHILIPPINES



CHALLENGES TO PUBLIC CONFIDENCE

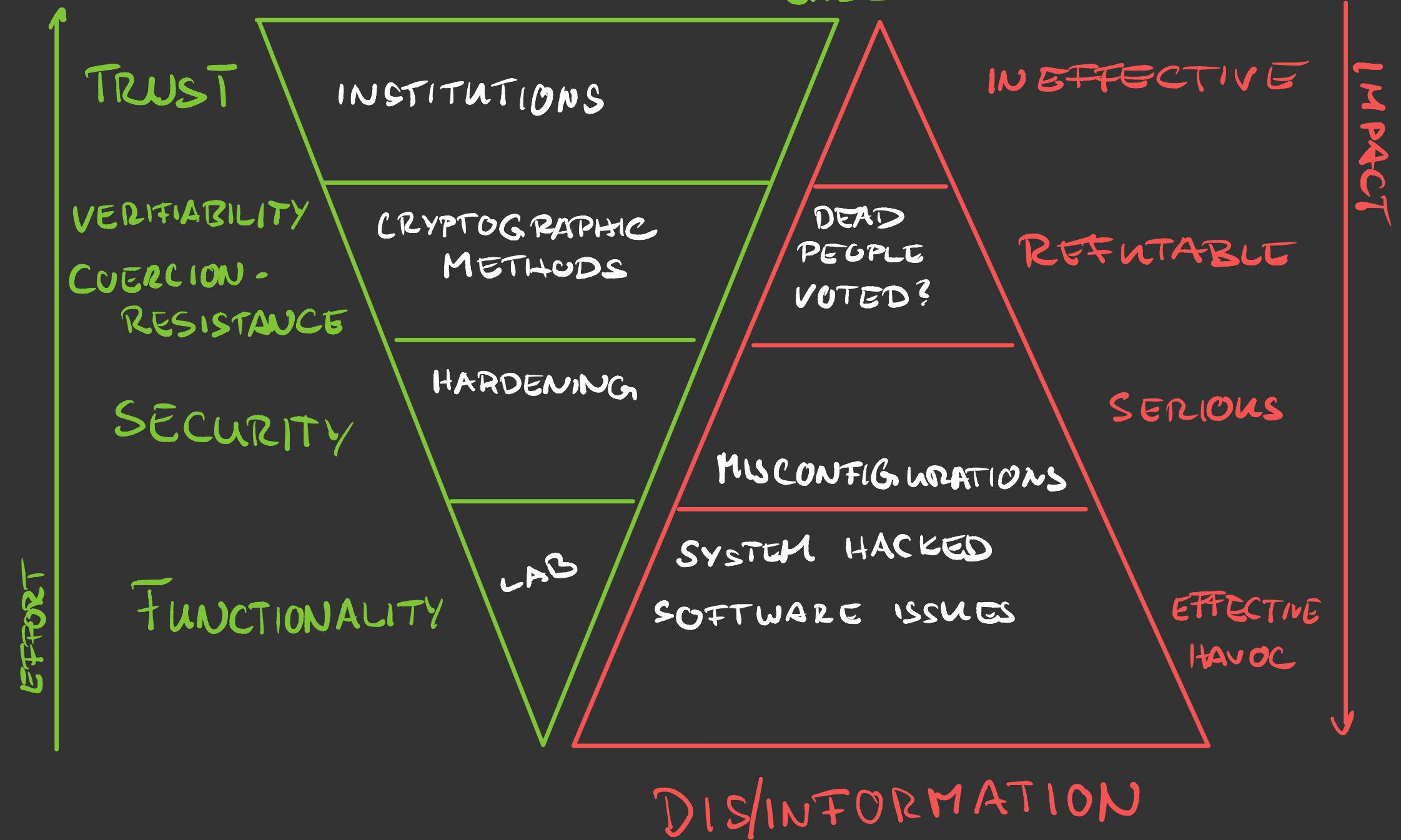
1) ELECTION TECHNOLOGIES

- COMPLEX
- UNOBSERVABLE

2) DISINFORMATION CAMPAIGNS

- POLITICALLY MOTIVATED
- NEW MEDIA
- GLOBAL INSTANTANOUS DISTRIBUTION

ELECTION TECHNOLOGIES



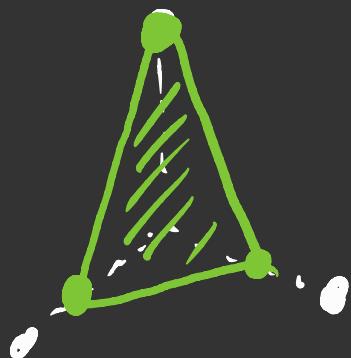
VOTING TECHNOLOGIES

OPTICAL
SCANNERS

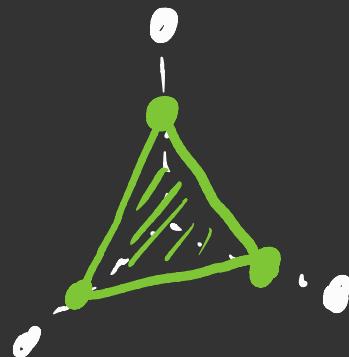
BALLOT
MARKERS

INTERNET
VOTING

COLORADO 2020



GEORGIA 2020



SWITZERLAND 2022



KENYA 2017

REACTIONS OF THE WINNER / LOSER



[Oct 27]

Kenya election 2017: Raila Odinga says election systems hacked

9 August 2017

Kenya general election 2017



Kenya's day of tension after polls

[Aug 05]

Aug 8: GENERAL ELECTIONS

Aug 28: SUPREME COURT HEARS ODINGA's CASE

- SUSPICIOUS LOG FILES
- NO ACCESS TO SERVERS

Sep 1: SUPREME COURT NULLED RESULT
ORDERS FRESH ELECTION

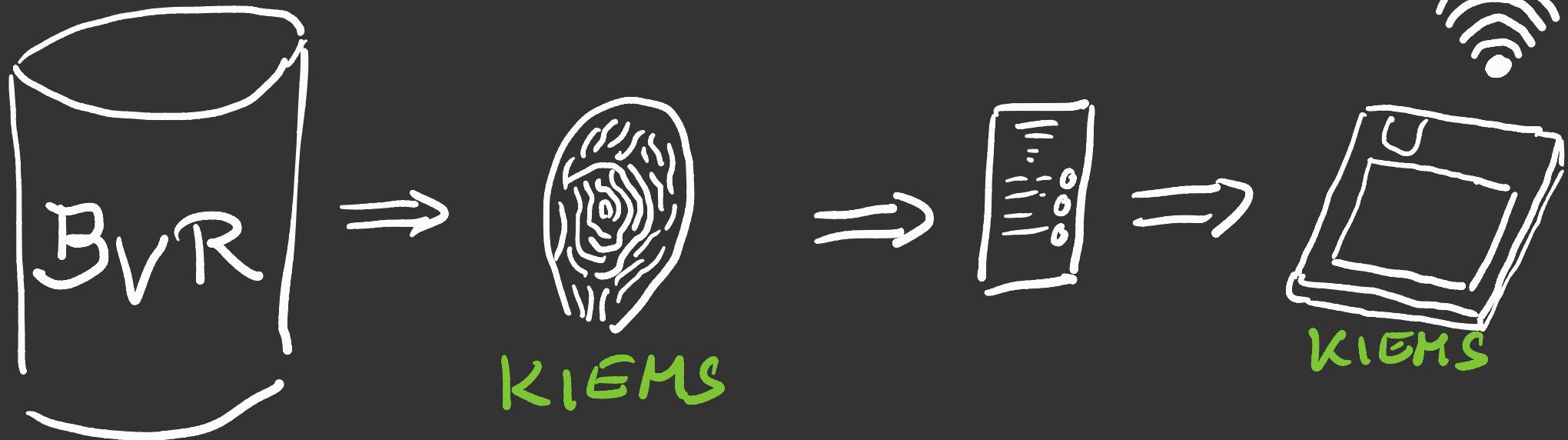
Oct 26: FRESH PRESIDENTIAL ELECTION

EVIDENCE

MAINTENANCE
KPMG 2017

- FINGERPRINT
- ID + FINGERPRINT
- FORM 32A

- IMAGE
- DIGITAL DATA



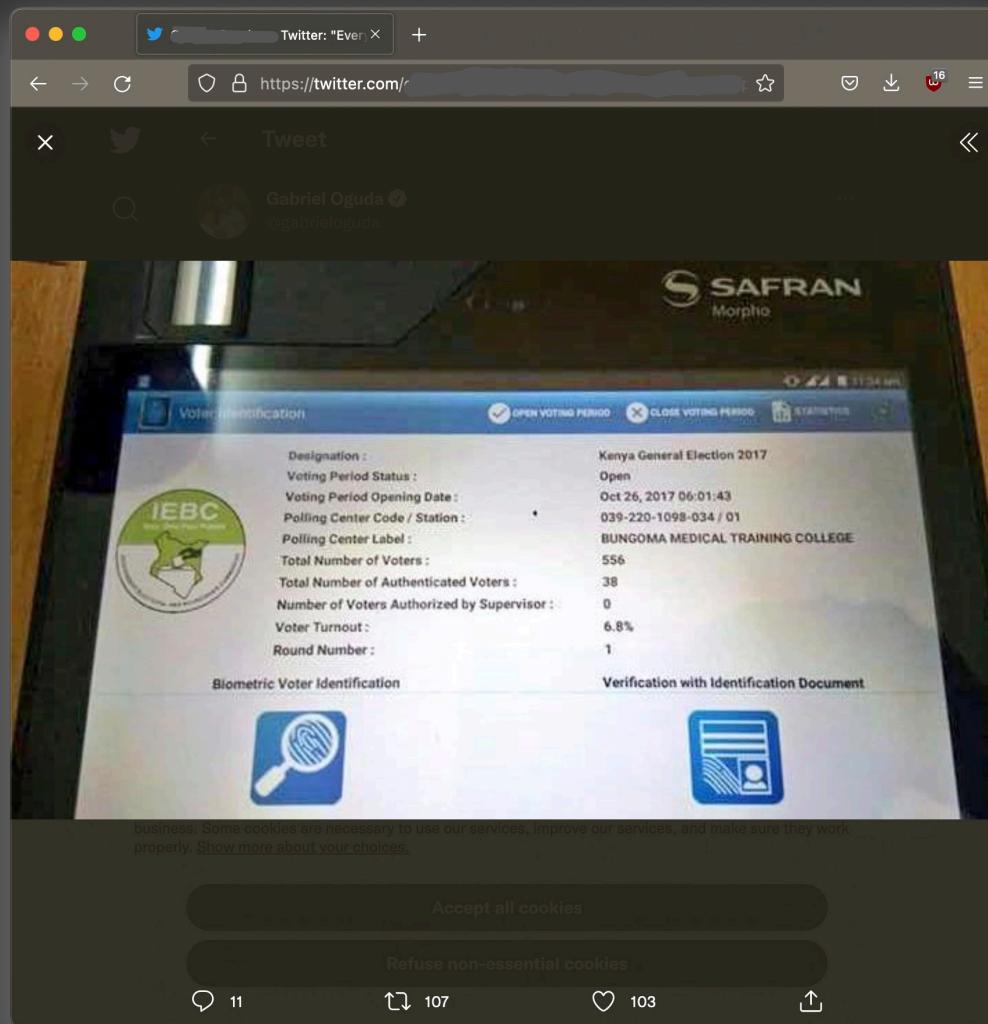
BIOMETRIC
VOTER
REGISTER

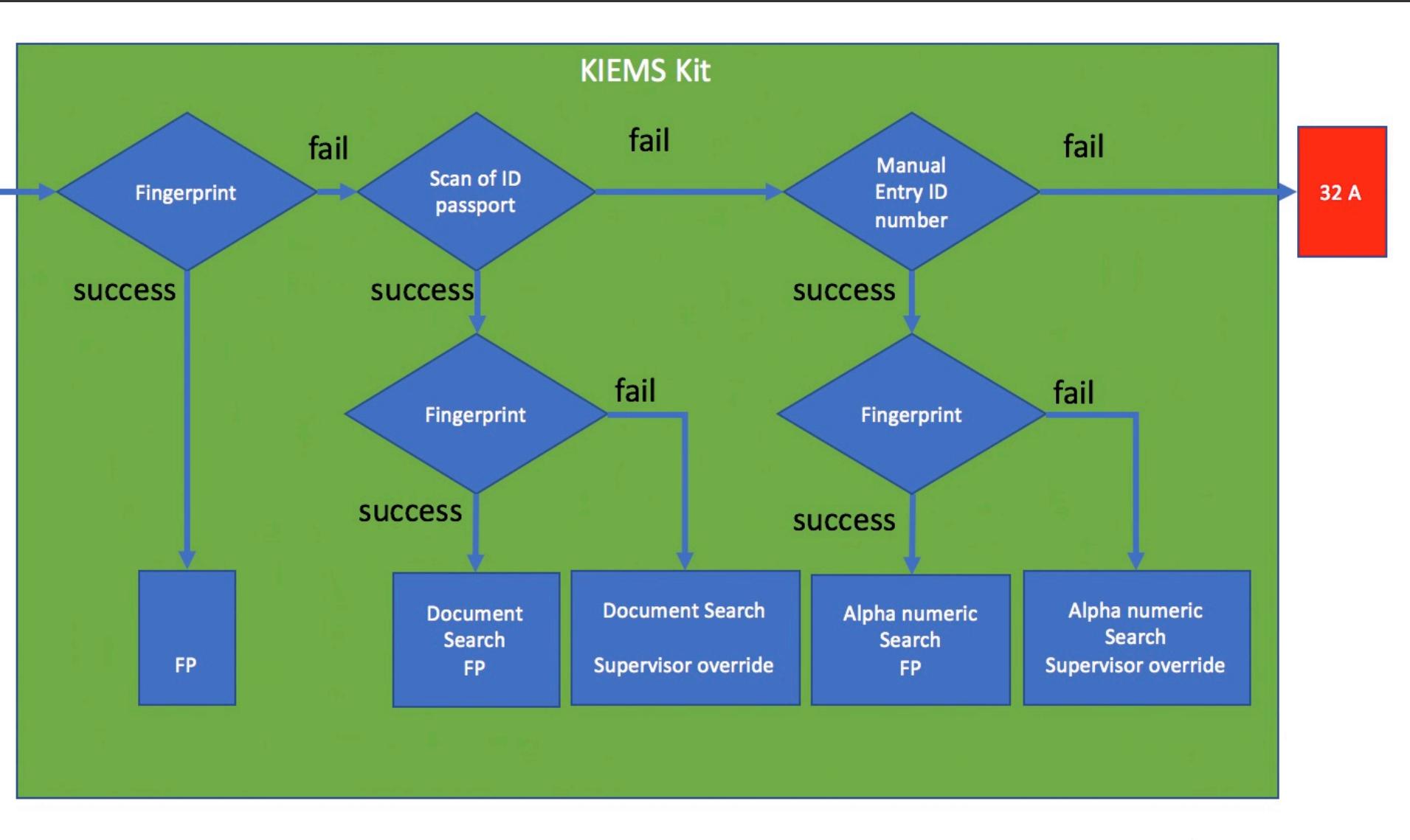
VOTER
REGISTRATION

PAPER
BALLOTS

RESULTS
TRANSMISSION
SYSTEM
RTS

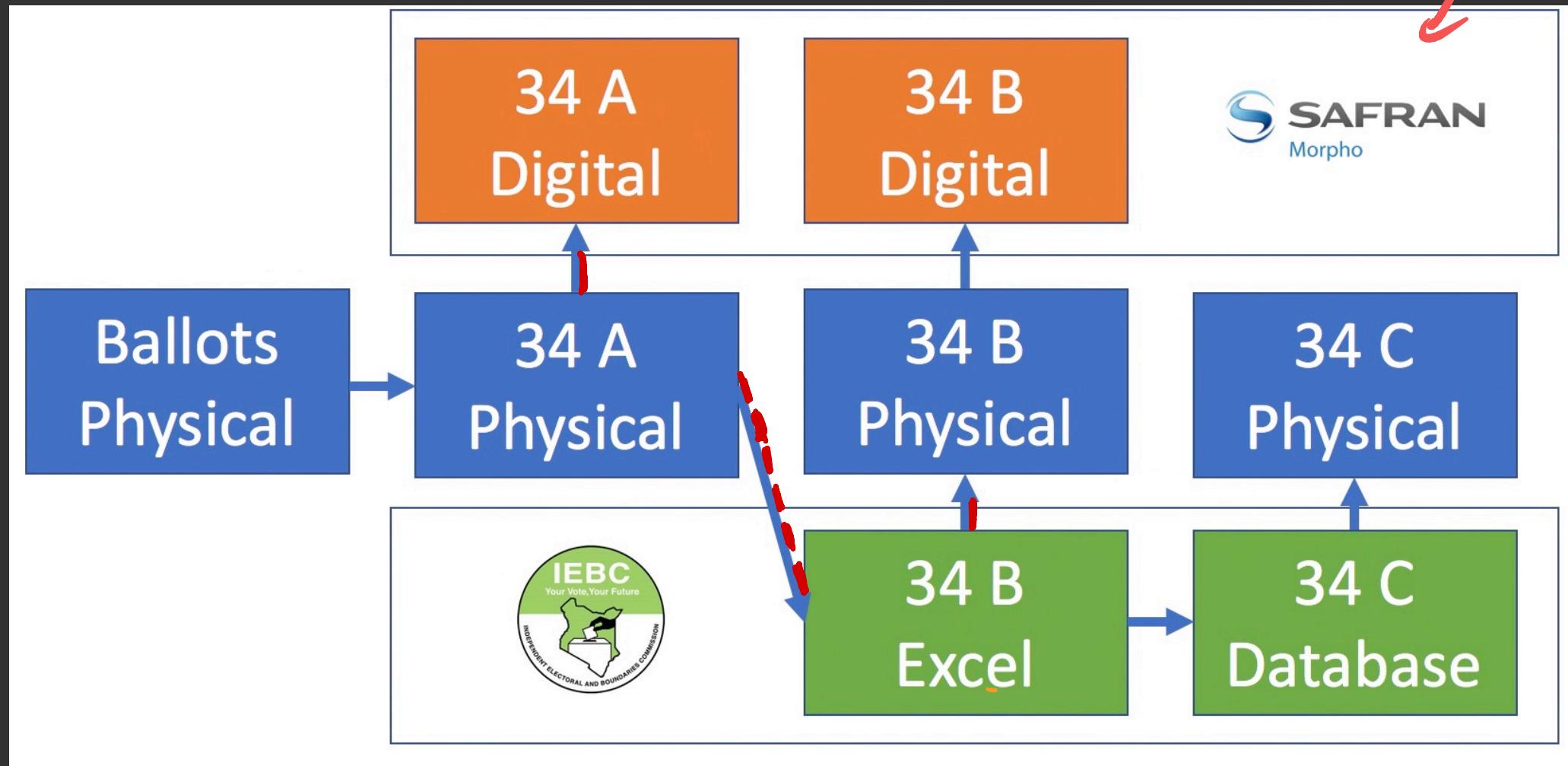
KENYA INTEGRATED MANAGEMENT SYSTEM





FROM BALLOT TO RESULT

SERVERS IN
FRANCE



FRESH PRESIDENTIAL ELECTION

Oct 26. 2017

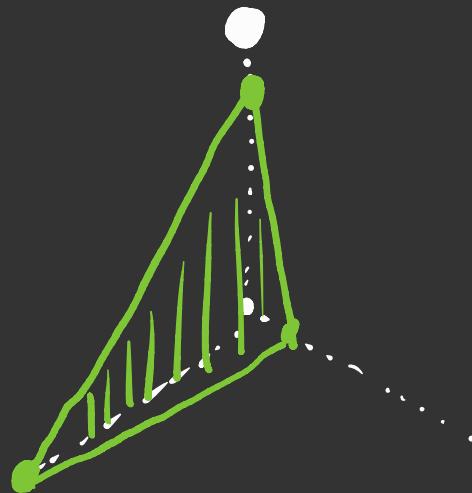
EVIDENCE

- BVR
- PAPER BALLOTS
- 34A, 34B, 34C FORMS
- RESULTS TRANSMISSIONS

DIGITAL

COLLECTION CURATION

- VOTER STATION
- JURISDICTION WAREHOUSE
- SECURE CLEAR BALLOT BOXES



AUDITS

- DIGITAL DATA VS
PAPERTRAIL
- NO AUDIT OF BALLOID

RISK-LIMITING AUDITS

A BETTER WAY
TO AUDIT

[LINDEMANN & STARK 2012]

EVIDENCE

RESULT



UHURU KENYATTA	8,223,369
RAILA ODINGA	6,822,812
JOSEPH NYAGALT	36,029
ABDUBA DIDA	36,004
EKURU AUKOT	27,400
INVALID/BLANK	411,510
TOTAL	15,593,050
ELIGIBLE	19,611,423

RISK LIMITING AUDIT (RLA)

PROCEDURE THAT
HAS A LARGE
PRE-SPECIFIED
CHANCE OF
CORRECTING AN
ERRONEOUS RESULT

STEP 2 : SIZE
OF RANDOM SAMPLE

Initial sample size

Contest information

Ballots cast in all contests: 15593050 Smallest margin (votes): 1,400,557. Diluted margin: 8.98%.

Contest 1. Contest name:
2017 Kenya Presidential Election August 8, 2017

Winners: 1

Reported votes:

Candidate 1 Name: Uhuru Kenyatta	Votes: 8223369
Candidate 2 Name: Raila Odinga	Votes: 6822812
Candidate 3 Name: Joseph Nyagah	Votes: 38029
Candidate 4 Name: Abduba Dida	Votes: 38004
Candidate 5 Name: Ekuru Aukot	Votes: 27400
Candidate 6 Name: Japheth Kaluyu	Votes: 11774
Candidate 7 Name: Cyrus Jirongo	Votes: 11282
Candidate 8 Name: Michael Wainaina	Votes: 8870

Add candidate to contest 1 Remove last candidate from contest 1

Add contest Remove last contest

Audit parameters

Risk limit: 0.1%

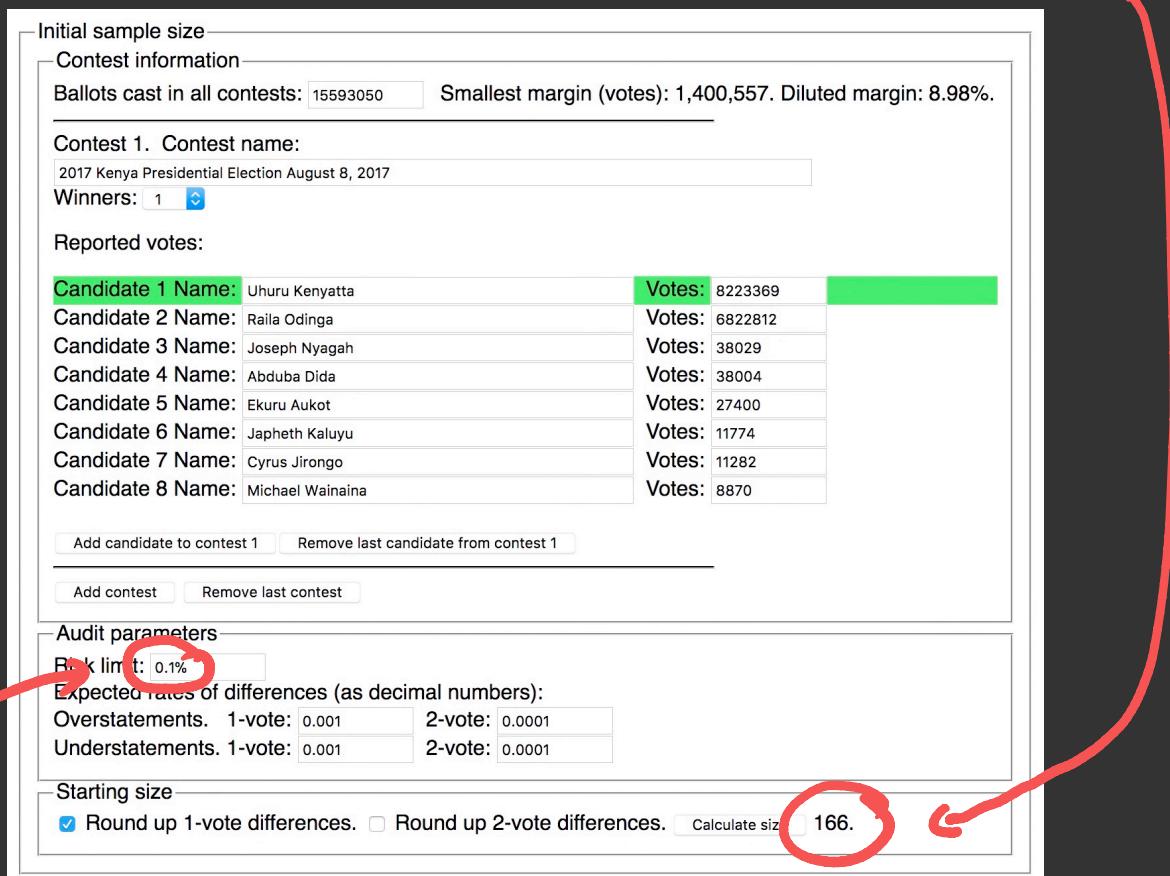
Expected rates of differences (as decimal numbers):

Overstatements. 1-vote: 0.001 2-vote: 0.0001

Understatements. 1-vote: 0.001 2-vote: 0.0001

Starting size

Round up 1-vote differences. Round up 2-vote differences. Calculate size 166.

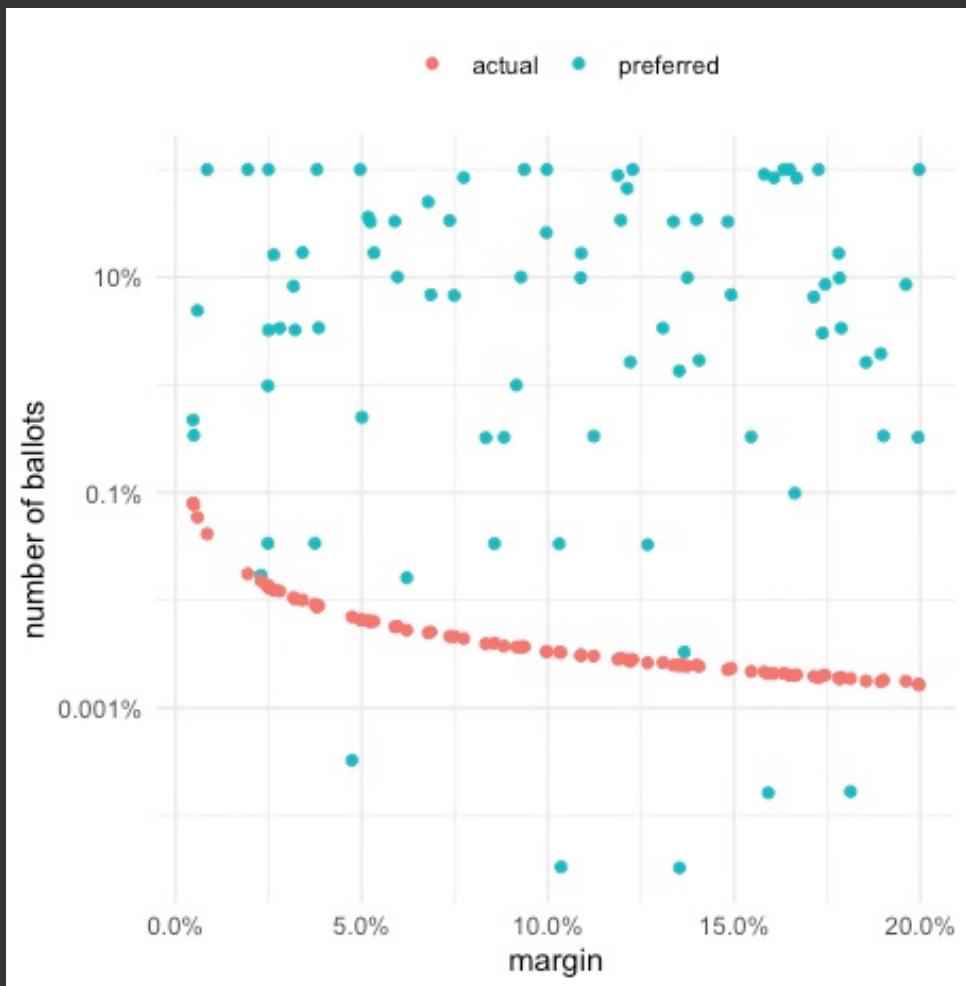


Step 1

SET THE CHANCE
(RISK-LIMIT)

99.9% CERTAINTY

RLAs & DISINFORMATION



- PROLIFIC PLATFORM
- US DEMOGRAPHIC
- 105 PARTICIPANTS

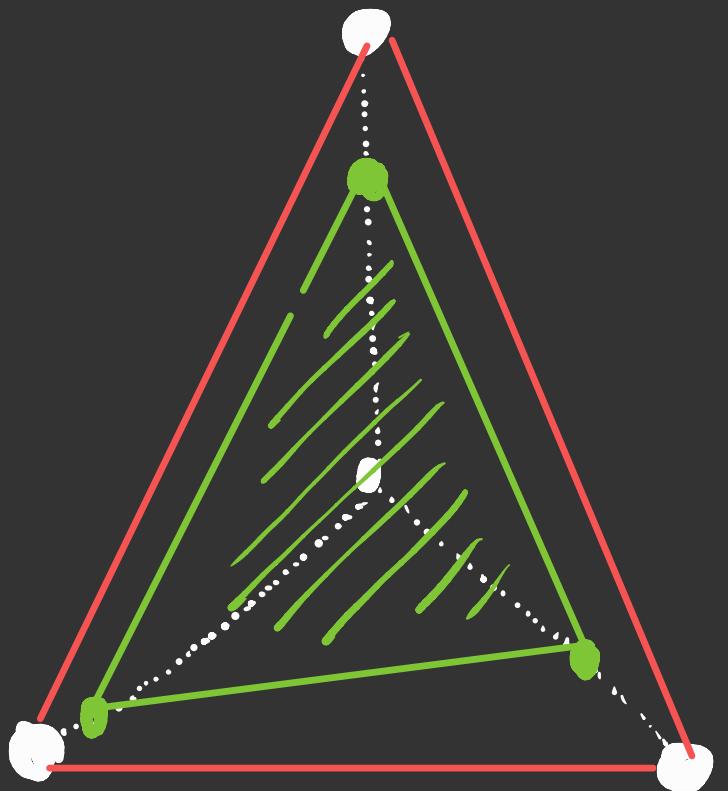
HYPOTHESIS:

WHEN ASKED ABOUT
BALLOTS TO AUDIT
PARTICIPANTS ANSWER
HIGHER THAN RLA.

[DALELA, KUYK, CS '21]

Conclusions

EVIDENCE



DISINFORMATION

PUBLIC CONFIDENCE

COLLECTION
CURATION

AUDIT

#1 BAD ELECTION TECHNOLOGY
IMPLIES HIGHER RISK OF
DISINFORMATION

#2 UNDERESTIMATING RISKS OF
ELECTION TECHNOLOGIES
CAN DESTABALIZE
DEMOCRACIES