

Adventures in Electronic Voting Research

Dan S. Wallach

Professor, Department of Computer Science
Rice Scholar, Baker Institute for Public Policy
Rice University



National Security

Russian hackers targeted Arizona election system

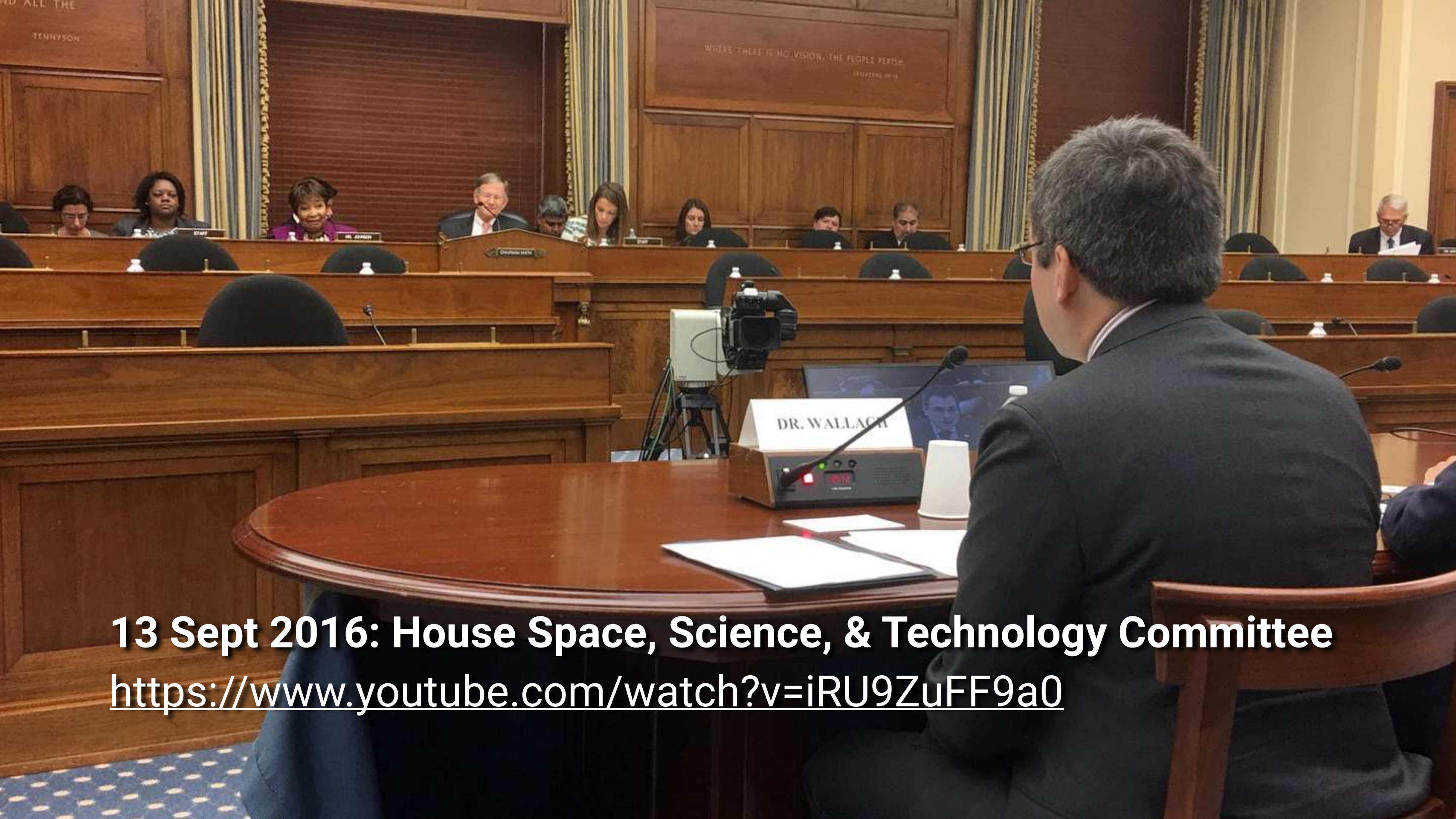


The FBI says it has found breaches in voter registration systems in Illinois and Arizona, and it's urging states to increase their computer security ahead of the November presidential election. (Reuters)

By **Ellen Nakashima** August 29

Hackers targeted voter registration systems in Illinois and Arizona, and the FBI alerted Arizona officials in June that Russians were behind the assault on the election system in that state.

The bureau described the threat as “credible” and significant, “an eight on a scale of one to 10,” Matt Roberts, a spokesman for Arizona Secretary of State Michele Reagan (R), said Monday. As a result, Reagan shut down the state’s voter registration system for nearly a week.



13 Sept 2016: House Space, Science, & Technology Committee
<https://www.youtube.com/watch?v=iRU9ZuFF9a0>

U.S. Says Russia Directed Hacks to Influence Elections

By DAVID E. SANGER and CHARLIE SAVAGE OCT. 7, 2016



President Obama in the Rose Garden on Wednesday. Al Drago/The New York Times

WASHINGTON — The Obama administration on Friday formally accused the Russian government of stealing and disclosing emails from the [Democratic National Committee](#) and a range of other institutions and prominent individuals, immediately raising the issue of whether [President Obama](#) would seek sanctions or other retaliation.



Election cyber threats: More states request DHS assistance



By **Tal Kopan**, CNN

⌚ Updated 12:29 PM ET, Tue October 11, 2016

**“33 states and 11 counties or local election officials” have requested help.
(October 2016)**

39 states compromised (June 2017)



WATCH
LIVE
🕒 1:23 PM

Attorney General Jeff Sessions Testifies to Senate

Russian Cyber Hacks on U.S. Electoral System Far Wider Than Previously Known

by **Michael Riley** and **Jordan Robertson**

June 13, 2017, 4:00 AM CDT

- Attackers said to take measure of voting systems, databases
- A 'red phone' warning to the Kremlin from Obama White House

Russians Breach 39 States in Election Cyberattack

UP NEXT

Most Read

- 1 Tim Cook Says Apple Focused on Autonomous Systems in Cars Push
- 2 Uber CEO to Take Leave, Diminished Role After Workplace Scandals
- 3 Flying Cows to Qatar Is One Man's Way to Beat the Saudis
- 4 Russian Cyber Hacks on U.S.



WATCH
LIVE
🕒 1:23 PM

Attorney General Jeff Sessions Testifies to Senate

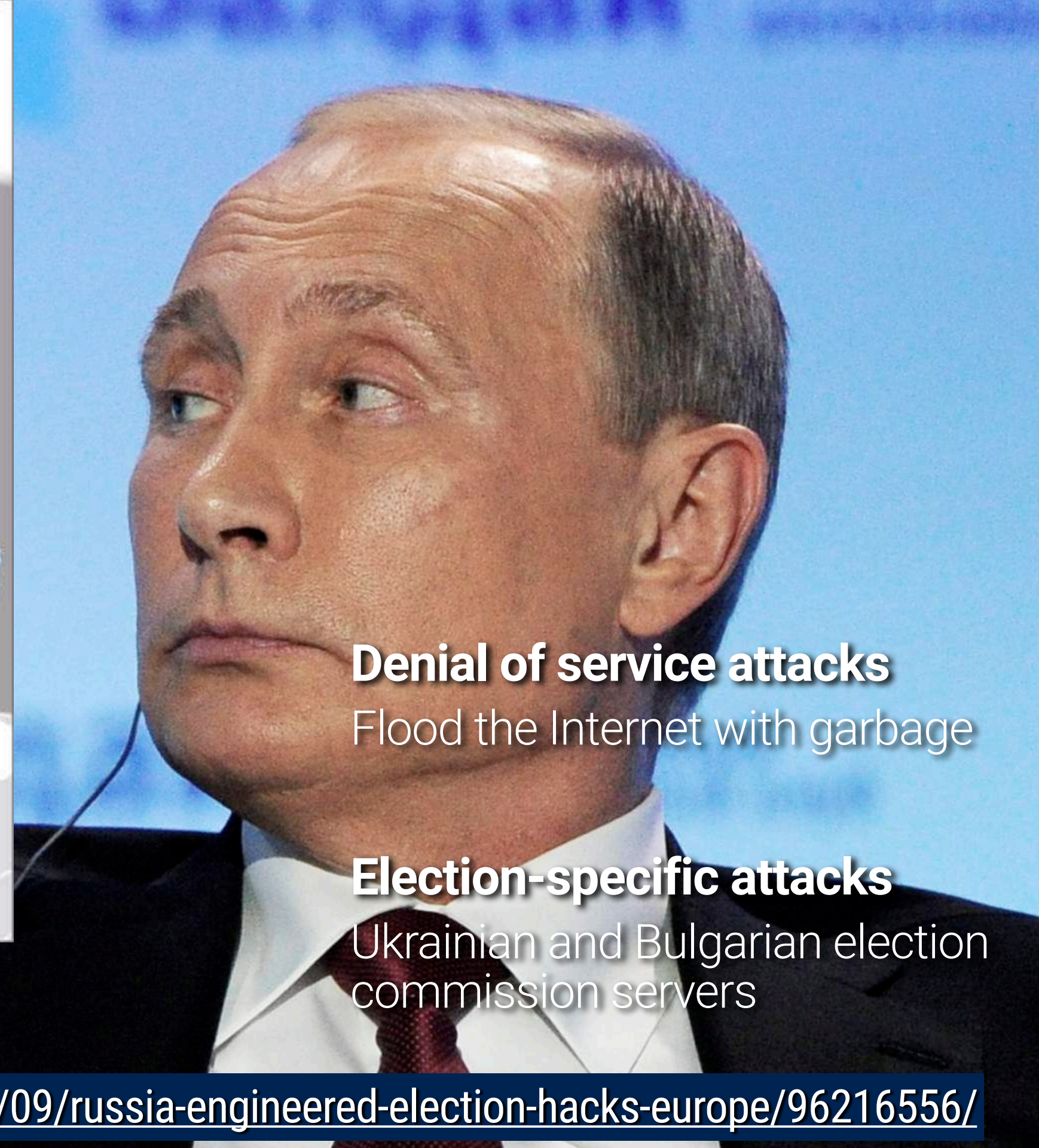
Russian Cyber Hacks on U.S. Electoral System Far Wider Than Previously Known

by **Michael Riley** and **Jordan Robertson**

June 13, 2017, 4:00 AM CDT

The scope and sophistication so concerned Obama administration officials that they took an unprecedented step -- **complaining directly to Moscow over a modern-day “red phone.”** In October, two of the people said, the White House contacted the Kremlin on the back channel to offer detailed documents of what it said was Russia’s role in election meddling and to warn that the attacks risked setting off a broader conflict.

RUSSIA ACCUSED OF CYBER MEDDLING IN EUROPEAN ELECTIONS, POLITICS



Denial of service attacks

Flood the Internet with garbage

Election-specific attacks

Ukrainian and Bulgarian election
commission servers

Voter registration databases are online!

Opportunity: selectively delete data, induce long lines, disenfranchise voters.

**VOTE
HERE / AQUÍ**



MARICOPA COUNTY ELECTIONS DEPT.



What about offline voting machines?

Stuxnet attacked
Iranian nuclear
centrifuges (offline!)

Insider threats?





Then the election happened.

A close-up photograph of Donald Trump speaking at a podium. He is wearing a dark suit, a white shirt, and a blue tie. He has a slight smile and is looking upwards and to the right. The background is a blurred blue and white pattern.

The winner is happy with the outcome

But the loser requires evidence.

Jill Stein requested recounts

Wisconsin recount: minor changes in election totals

Michigan recount: stopped by court order

Pennsylvania recount: never even got started



**What would a really good voting
machine look like?**

A rare opportunity

**Dana DeBeauvoir (Travis County Clerk),
Keynote speech, EVT/WOTE 2011**

We're going to design a new voting system from scratch and we need your help.

STAR-Vote: Registration

Registration



STAR-Vote: Registration

Registration

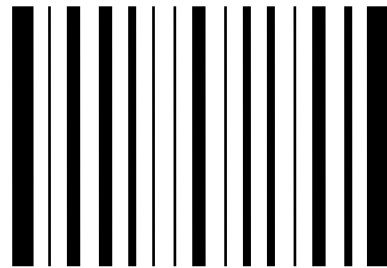


STAR-Vote: Registration

Registration



Precinct 101A



STAR-Vote: Authorization

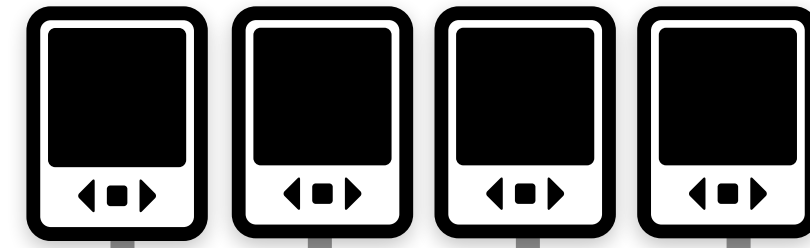
Registration



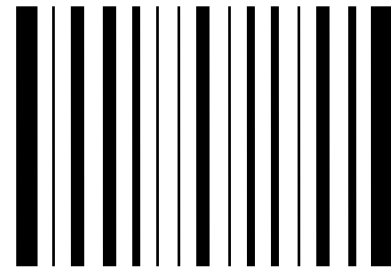
Controller



Voting terminals



Precinct 101A

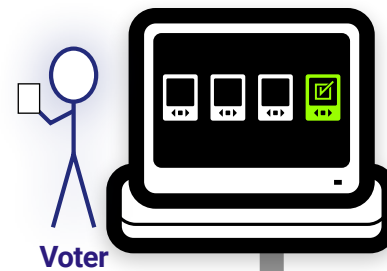


STAR-Vote: Authorization

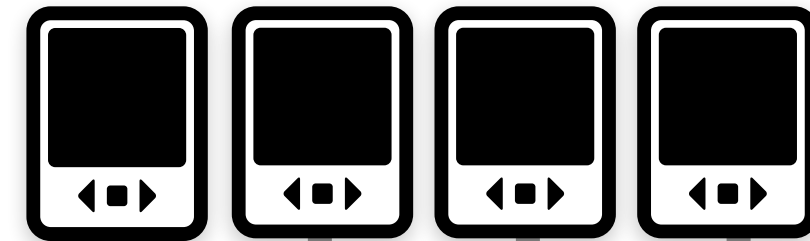
Registration



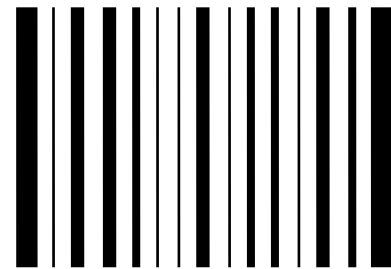
Controller



Voting terminals



Precinct 101A

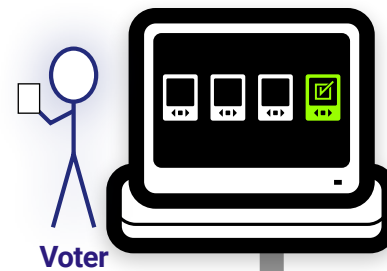


STAR-Vote: Authorization

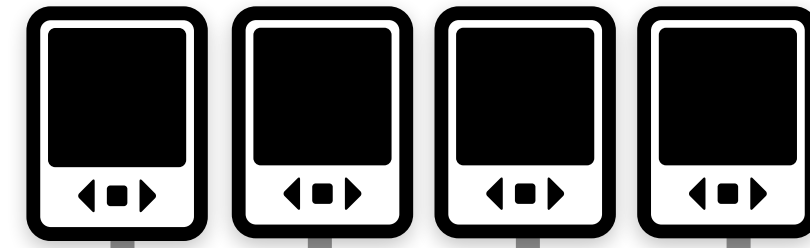
Registration



Controller



Voting terminals



Auth: 52794

Similar to Hart InterCivic eSlate

STAR-Vote: Voting

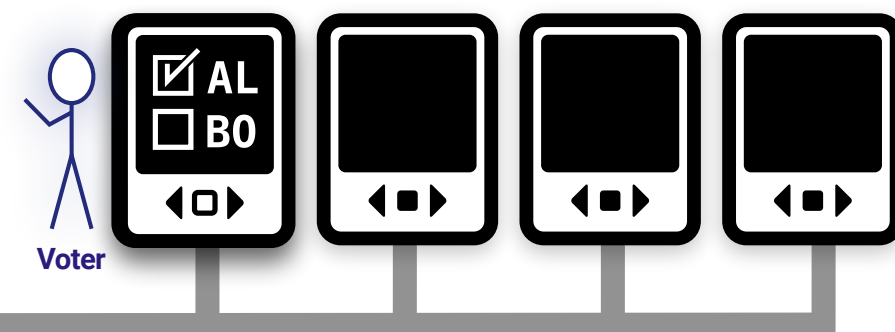
Registration



Controller



Voting terminals



STAR-Vote: Ciphertext copies distributed

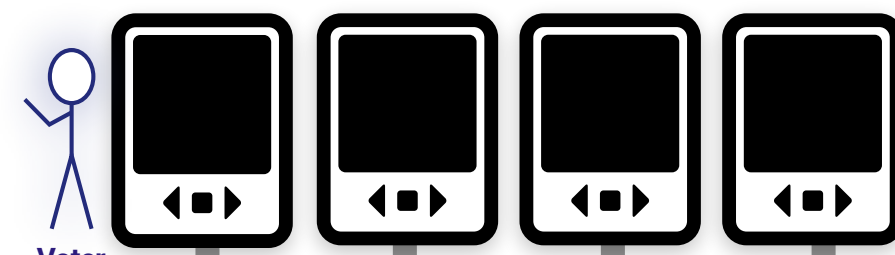
Registration



Controller



Voting terminals



STAR-Vote: Ciphertext copies distributed

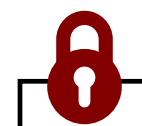
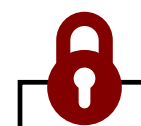
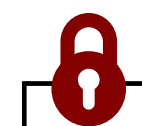
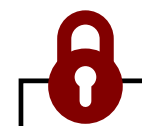
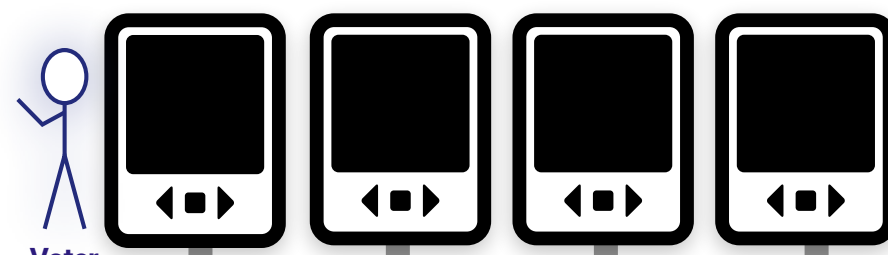
Registration



Controller



Voting terminals



STAR-Vote: Casting

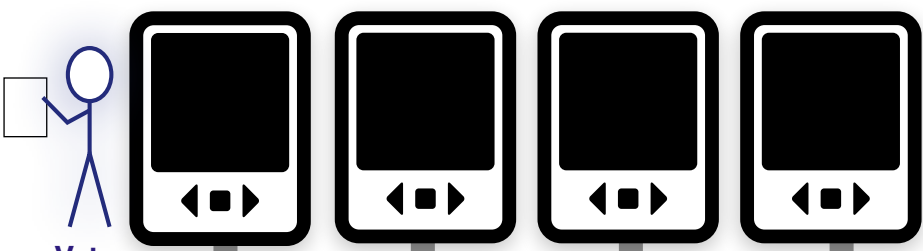
Registration



Controller



Voting terminals

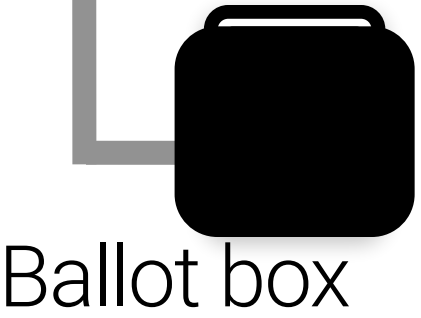


Official Ballot November 4, 2012
Joint General and Special Elections
Travis County, Texas Precinct 101A

11042032 Pct 101A BID11042032 BCID3457894 Pg 1 of 2

Travis County General Election continued

Travis County General Election	
Straight Party	Purple <input checked="" type="radio"/>
District 210, United States Representative	Anna Alpha <input checked="" type="radio"/>
Governor	Betty Beta <input checked="" type="radio"/>
Lieutenant Governor	Gertrude Gamma <input checked="" type="radio"/>
Attorney General	Daniel Delta <input checked="" type="radio"/>
State Senator	Eric Epsilon <input checked="" type="radio"/>
Comptroller of Public Accounts	Zitta Zeta <input checked="" type="radio"/>
Attorney General	Derick Delta <input checked="" type="radio"/>
State Senator	Edith Epsilon <input checked="" type="radio"/>
Comptroller of Public Accounts	Zorro Zeta <input checked="" type="radio"/>
Commissioner of the General Land Office	Etta Eta <input checked="" type="radio"/>
Commissioner of Agriculture	Theodore Theta <input checked="" type="radio"/>
Railroad Commissioner	Onne Iota <input checked="" type="radio"/>
Place 334, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 445, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 549, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 223, Judge, Court of Criminal Appeals	NO SELECTION <input type="radio"/>
Place 552, Judge, Court of Criminal Appeals	NO SELECTION <input type="radio"/>
Railroad Commissioner	Iesha Iota <input checked="" type="radio"/>
Place 334, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 667, Judge, Court of Criminal Appeals	NO SELECTION <input type="radio"/>
District 589, Member State Board of Education	Kevin Kappa <input checked="" type="radio"/>
District 257, State Senator	NO SELECTION <input type="radio"/>
Precinct 145, Justice of the Peace	Nancy Nu <input checked="" type="radio"/>
District 147, State Representative	Xena Xi <input checked="" type="radio"/>
County Judge	Oscar Omicron <input checked="" type="radio"/>
County Court at Law 677, Judge	Peggy Pi <input checked="" type="radio"/>
County Probate Court Judge	Rhoda Rho <input checked="" type="radio"/>
District Clerk	Samuel Sigma <input checked="" type="radio"/>
County Clerk	Teresa Tau <input checked="" type="radio"/>
County Treasurer	Uma Upsilon <input checked="" type="radio"/>
District Clerk	Selena Sigma <input checked="" type="radio"/>
County Clerk	Thomas Tau <input checked="" type="radio"/>
County Treasurer	Ulysses Upsilon <input checked="" type="radio"/>
County Commissioner	Phillip Phi <input checked="" type="radio"/>
Railroad Commissioner	Charles Chi <input checked="" type="radio"/>
Place 332, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 554, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 998, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 221, Judge, Court of Criminal Appeals	NO SELECTION <input type="radio"/>
Place 155, Judge, Court of Criminal Appeals	NO SELECTION <input type="radio"/>
Place 166, Judge, Court of Criminal Appeals	NO SELECTION <input type="radio"/>
Place 332, Justice, Supreme Court	NO SELECTION <input type="radio"/>
Place 554, Justice, Supreme Court	NO SELECTION <input type="radio"/>
District 245, Member State Board of Education	Patrice Psi <input checked="" type="radio"/>
Place 442, Justice, 33rd Court of Appeals District	Orlando Omega <input checked="" type="radio"/>



Ballot box

STAR-Vote: Casting

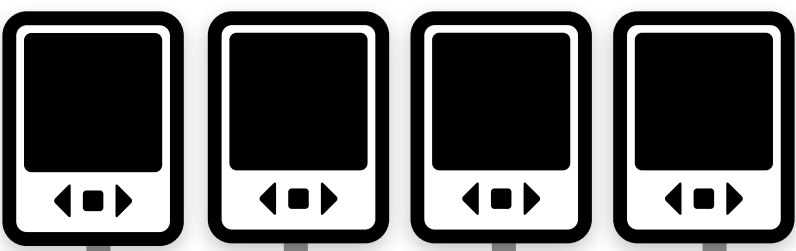
Registration



Controller



Voting terminals



Official Ballot November 4, 2012
Joint General and Special Elections
Travis County, Texas Precinct 101A

11042032 Pct 101A BID11042032 BCID3457894 Pg 1 of 2

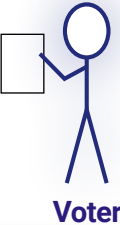
Travis County General Election continued

Precinct 145, Justice of the Peace

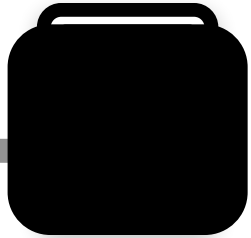
PURP	Nancy Nu	<input checked="" type="radio"/>
District 147, State Representative		
PURP	Xena Xi	<input checked="" type="radio"/>
County Judge		
PURP	Oscar Omicron	<input checked="" type="radio"/>
County Court at Law 677, Judge		
PURP	Peggy Pi	<input checked="" type="radio"/>
County Probate Court Judge		
PURP	Rhoda Rho	<input checked="" type="radio"/>
District Clerk		
PURP	Samuel Sigma	<input checked="" type="radio"/>
County Clerk		
GLD	Teresa Tau	<input checked="" type="radio"/>
County Treasurer		
PURP	Uma Upsilon	<input checked="" type="radio"/>
District Clerk		
PURP	Selena Sigma	<input checked="" type="radio"/>
County Clerk		
GLD	Thomas Tau	<input checked="" type="radio"/>
County Treasurer		
PURP	Ulysses Upsilon	<input checked="" type="radio"/>
County Commissioner		
PURP	Phillip Phi	<input checked="" type="radio"/>
Railroad Commissioner		
PURP	Charles Chi	<input checked="" type="radio"/>
Place 332, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 554, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 998, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 221, Judge, Court of Criminal Appeals		
	NO SELECTION	<input type="radio"/>
Place 155, Judge, Court of Criminal Appeals		
	NO SELECTION	<input type="radio"/>
Place 166, Judge, Court of Criminal Appeals		
	NO SELECTION	<input type="radio"/>
Place 332, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 554, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
District 245, Member State Board of Education		
PURP	Patrice Psi	<input checked="" type="radio"/>
Place 442, Justice, 33rd Court of Appeals District		
PURP	Orlando Omega	<input checked="" type="radio"/>

Travis County General Election

Straight Party	Purple	<input checked="" type="radio"/>
District 210, United States Representative		
PURP	Anna Alpha	<input checked="" type="radio"/>
Governor		
PURP	Betty Beta	<input checked="" type="radio"/>
Lieutenant Governor		
PURP	Gertrude Gamma	<input checked="" type="radio"/>
Attorney General		
PURP	Daniel Delta	<input checked="" type="radio"/>
State Senator		
PURP	Eric Epsilon	<input checked="" type="radio"/>
Comptroller of Public Accounts		
GLD	Zitta Zeta	<input checked="" type="radio"/>
Attorney General		
PURP	Derick Delta	<input checked="" type="radio"/>
State Senator		
PURP	Edith Epsilon	<input checked="" type="radio"/>
Comptroller of Public Accounts		
GLD	Zorro Zeta	<input checked="" type="radio"/>
Commissioner of the General Land Office		
PURP	Etta Eta	<input checked="" type="radio"/>
Commissioner of Agriculture		
PURP	Theodore Theta	<input checked="" type="radio"/>
Railroad Commissioner		
PURP	Onne Iota	<input checked="" type="radio"/>
Place 334, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 445, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 549, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 223, Judge, Court of Criminal Appeals		
	NO SELECTION	<input type="radio"/>
Place 552, Judge, Court of Criminal Appeals		
	NO SELECTION	<input type="radio"/>
Railroad Commissioner		
PURP	Iesha Iota	<input checked="" type="radio"/>
Place 334, Justice, Supreme Court		
	NO SELECTION	<input type="radio"/>
Place 667, Judge, Court of Criminal Appeals		
	NO SELECTION	<input type="radio"/>
District 589, Member State Board of Education		
PURP	Kevin Kappa	<input checked="" type="radio"/>
District 257, State Senator		
	NO SELECTION	<input type="radio"/>



Voter



Ballot box

STAR-Vote: “Version 2” prototype

HP printer guts

Reliable paper handling!

Raspberry Pi

Off-the-shelf accessories

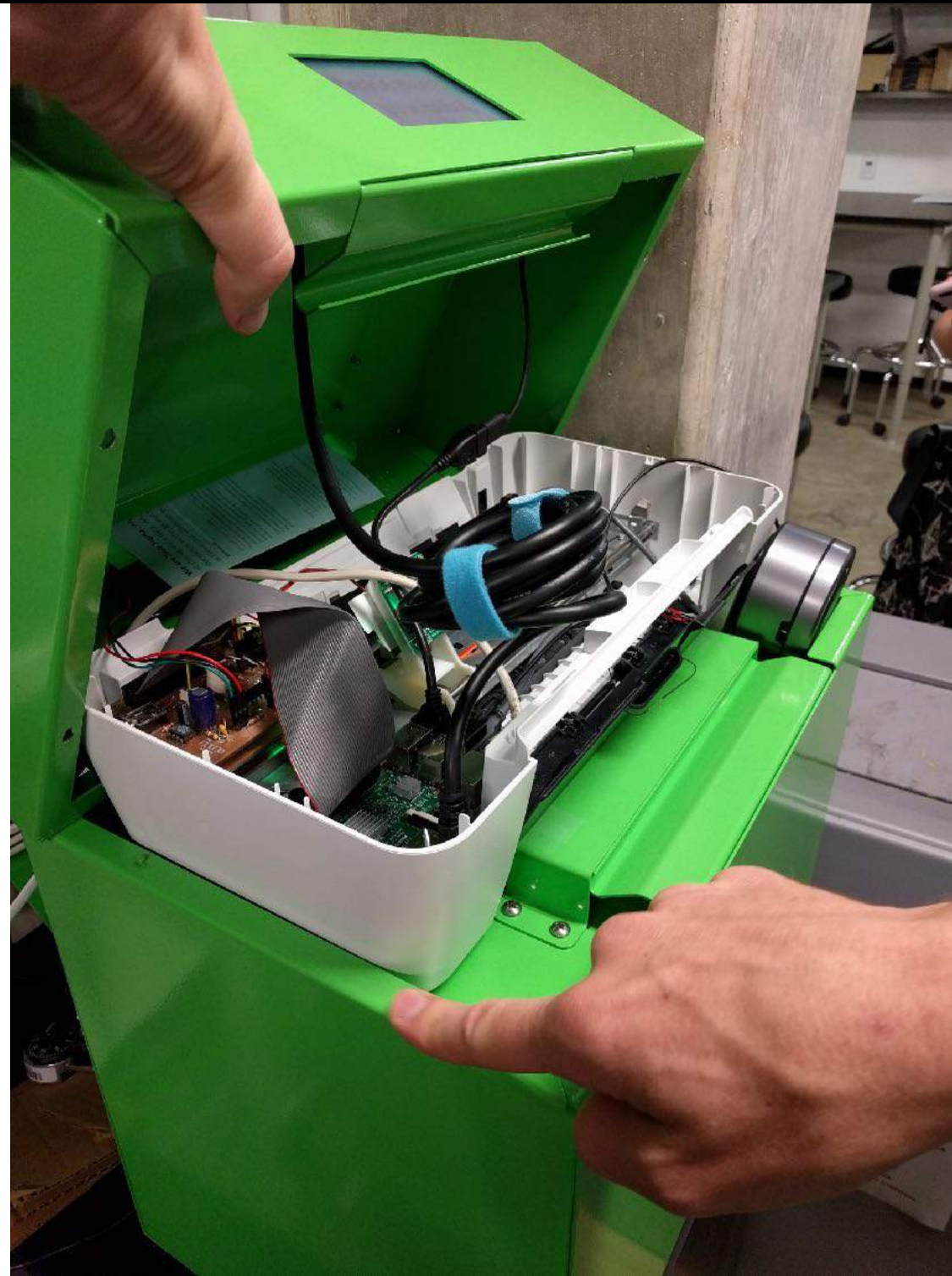
Cheap USB barcode scanner

Printed plastic scanner bracket

Custom driver board for motors

Steel ballot box

Local Houston fabrication



Open challenges

Online voter registration databases are a vulnerability

Necessary for “vote center” / “early voting” models

Research challenge 1: replicated, history-preserving, sometimes-offline voter databases

Voter credentials currently not associated with votes (privacy!)

But *provisional voting* retains a connection (voter is adjudicated, ballot is still private)

Research challenge 2: scalable, usable, secure provisional voting

Cyber attacks are hard to attribute to their source

Russia still denies these attacks, IC cannot share “sources and methods”

Research challenge 3: attribution and provenance on the Internet