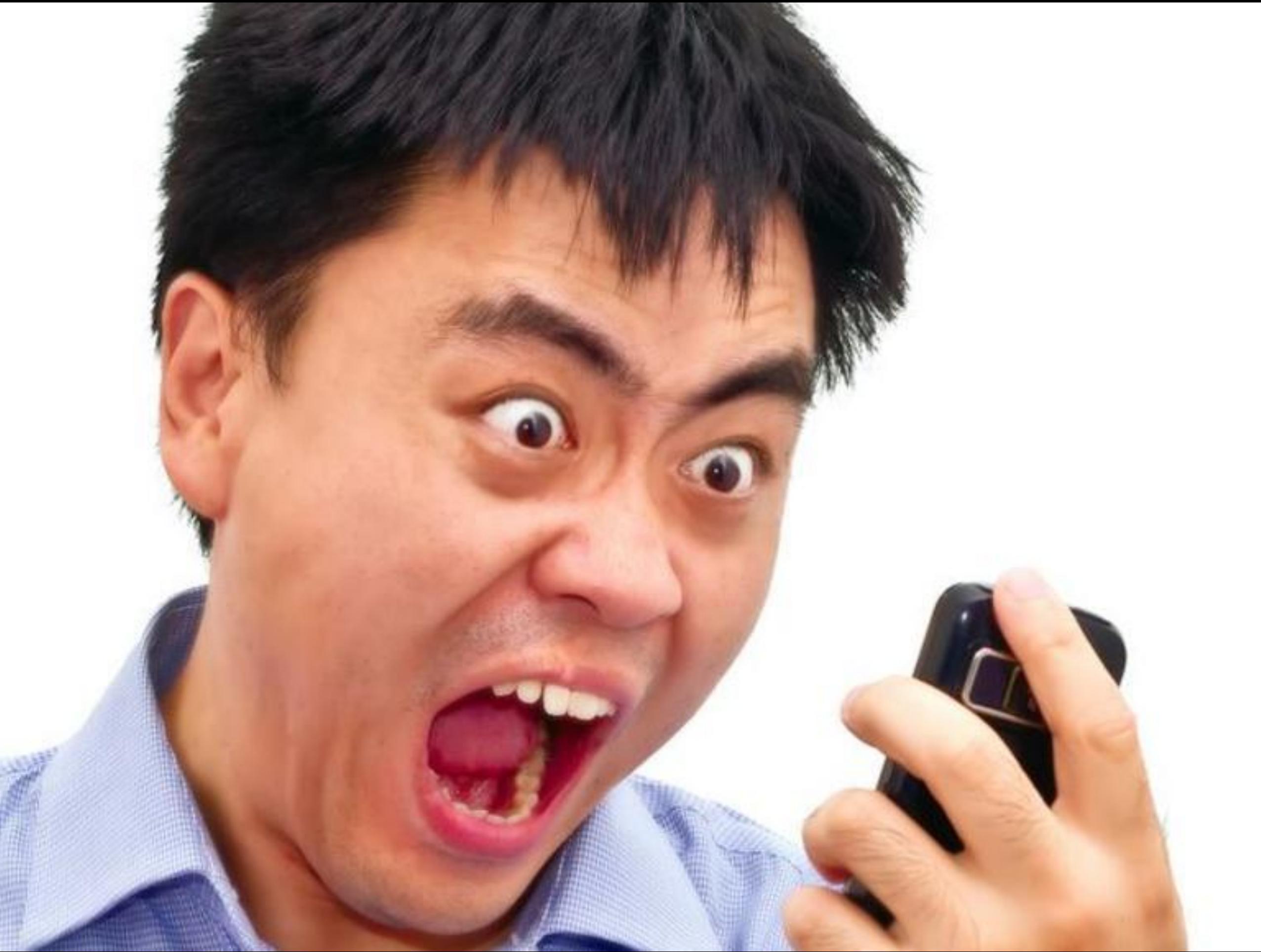


SoK: Everyone Hates Robocalls: A Survey of Techniques against Telephone Spam

Huahong Tu, Adam Doupé, Ziming Zhao, Gail-Joon Ahn
Arizona State University





NATIONAL
DO NOT CALL
REGISTRY

~200,000
robocall
complaints
every month

Telephone Consumer Protection Act of 1991



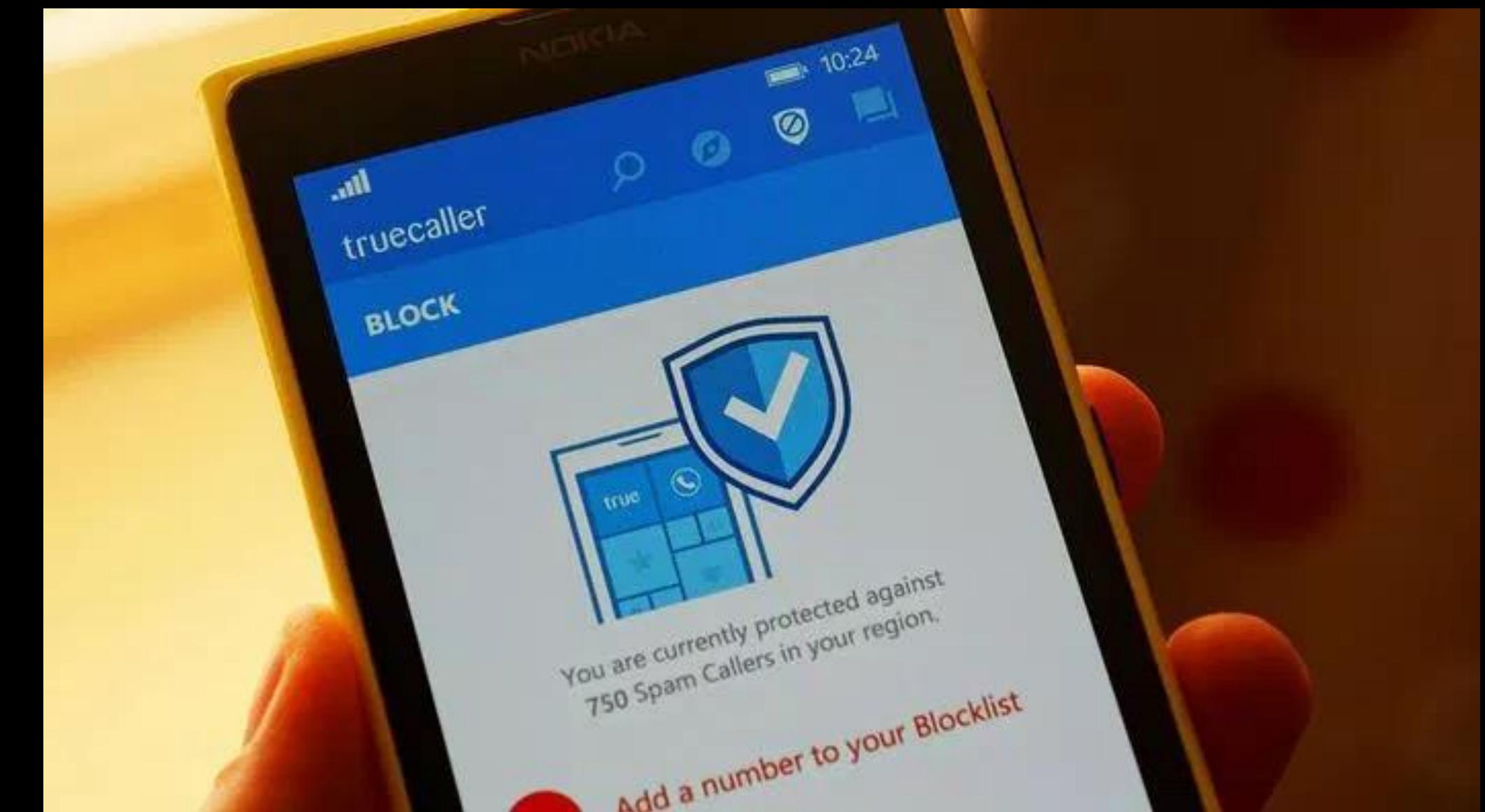
ROBOCALLS: HUMANITY STRIKES BACK

DEFCON23

DETECTAROBO

DEFCON V. RACHEL THE ROBOCALLER

A promotional banner for DEFCON 23. The top half has a dark, textured background with the text "ROBOCALLS: HUMANITY STRIKES BACK" in red and white, and "DEFCON23" below it. The bottom half has a dark, metallic background with the text "DETECTAROBO" in large, glowing blue letters. At the bottom, there's a banner with the text "DEFCON V. RACHEL THE ROBOCALLER" and an illustration of a small orange robot or ant-like character with antennae and a skull-and-crossbones symbol on its chest.



600000

Fraud Complaints by Company's Method of Contacting Consumers 2013-2015

500000

400000

300000

200000

100000

0

386807

485481

230462

184469

166545

54089

Phone
Email

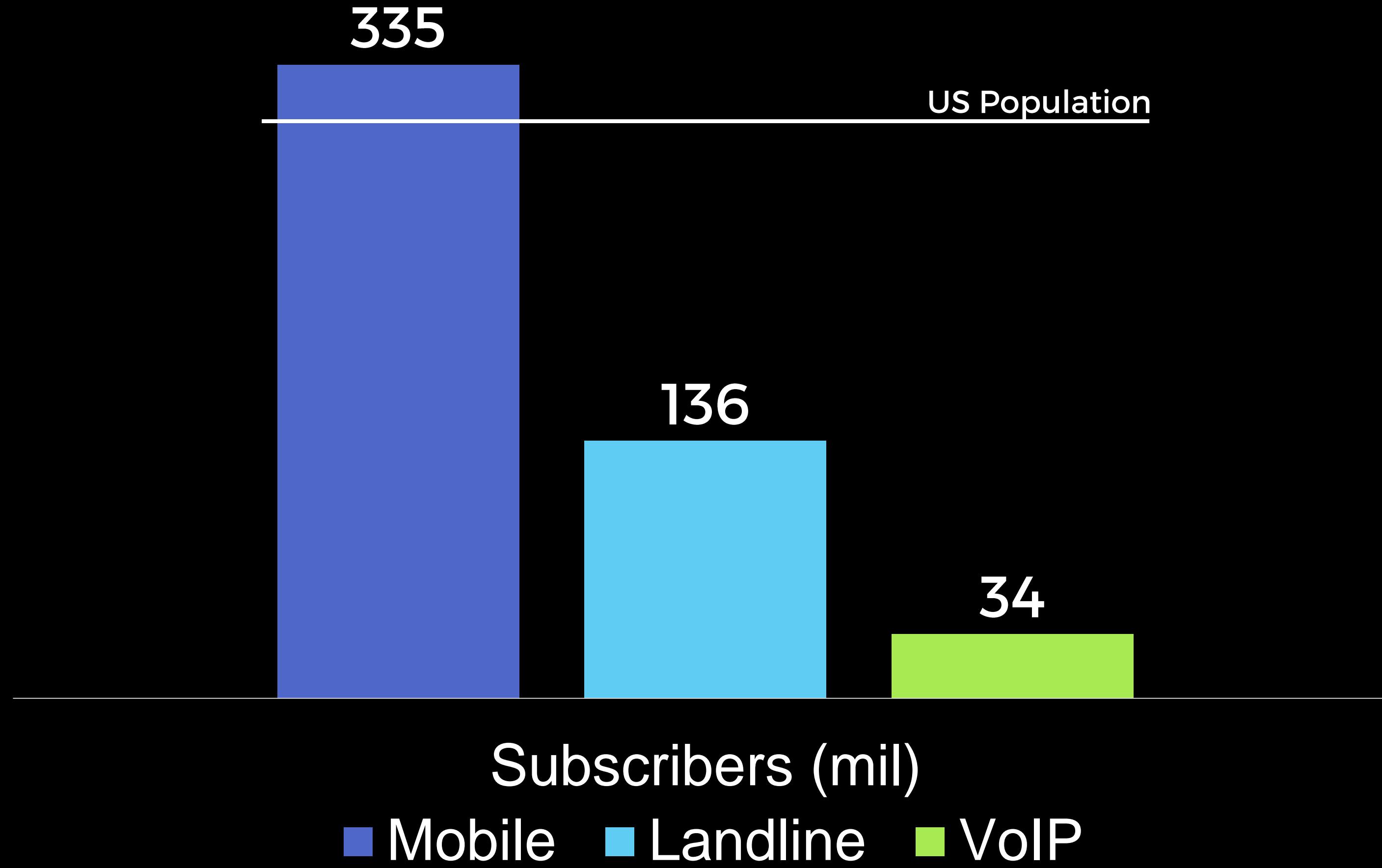
2013

2014

2015

Data source: Consumer sentinel data book CY2015





Data source: CTIA 2013, ITU 2013, Statistica 2013

Type	Price	Unit
US Local Number	\$0.3500	Per Month
Toll Free DID	\$0.7500	Per Month
Call Inbound	\$0.0055	Per Minute
Call Outbound	\$0.0100	Per Minute
Call Toll Free Inbound	\$0.0195	Per Minute
Call Toll Free Outbound	\$0.0100	Per Minute
SIP Call Inbound	\$0.0025	Per Minute
SIP Call Outbound	\$0.0100	Per Minute
SMS Inbound	\$0.0000	Per Message
SMS Outbound	\$0.0050	Per Message
SMS Short Code Outbound	\$0.0100	Per Message



One Call Now
A Send Word Now Company



The diagram consists of three main elements arranged in a flow. On the left, there is a square divided horizontally into two colored sections: dark green on top and gold/yellow on the bottom. The word "Recipients" is written in white capital letters on the dark green section, and "Content" is written in white capital letters on the gold section. To the right of this square is a large blue arrow pointing to the right. The word "Mass" is written in white capital letters on the left side of the arrow, and "Distribution" is written in white capital letters below it, continuing the word from the first section.

Recipients

Content

**Mass
Distribution**



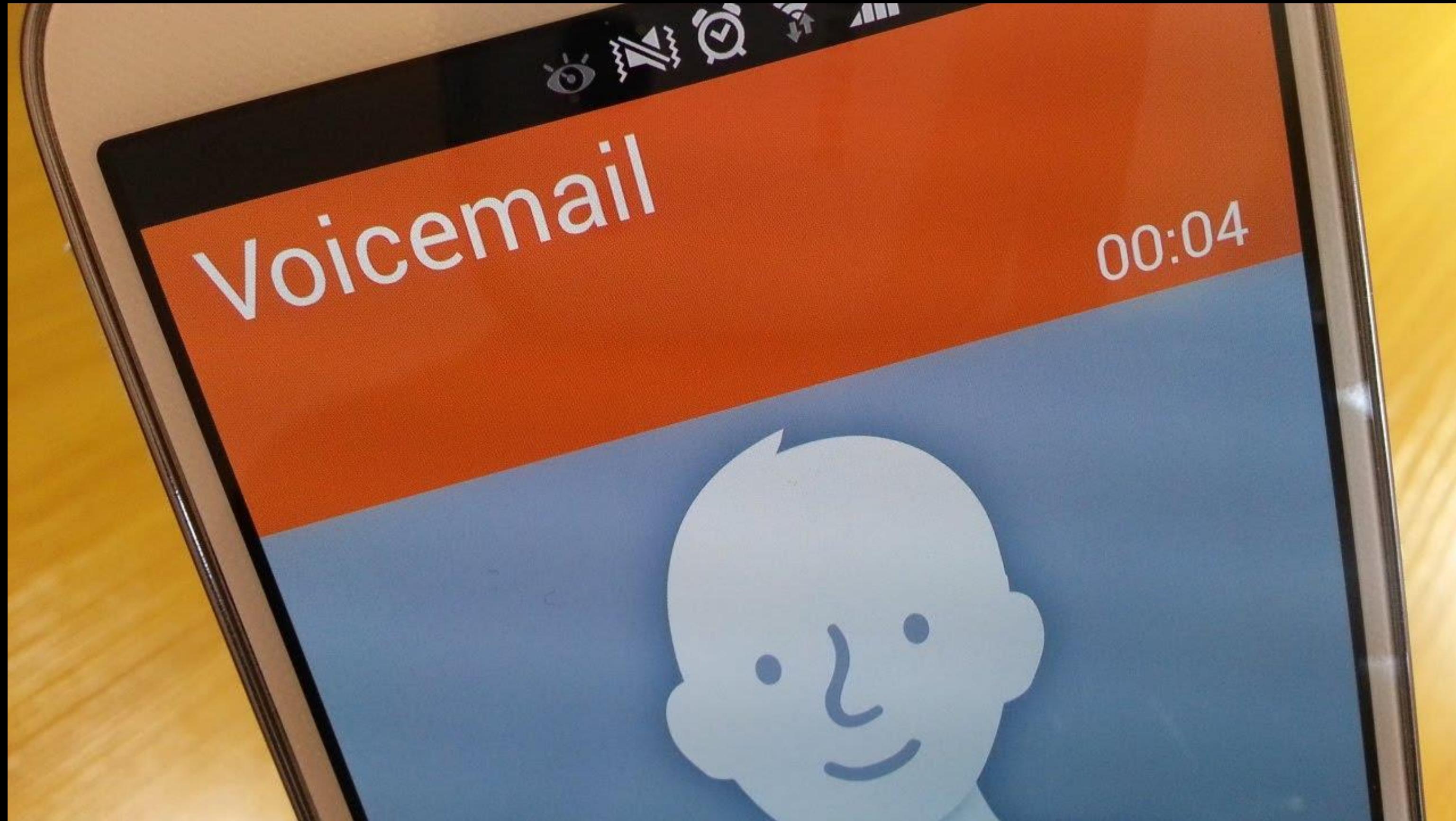
Phone number list



Audio content



Autodialer
+
VoIP Carrier



Step 1: What type of broadcast would you like to create?

Message Type Voice Only

1

Text Only

2

Voice & Text

Name this Broadcast Call-Em-All

3

Caller ID (214) 306-5601

4

Broadcast Type Announcement [?]

5

Survey [?]

Next

Step 2: Who would you like to receive this message?

Step 3: When would you like your broadcast to start?

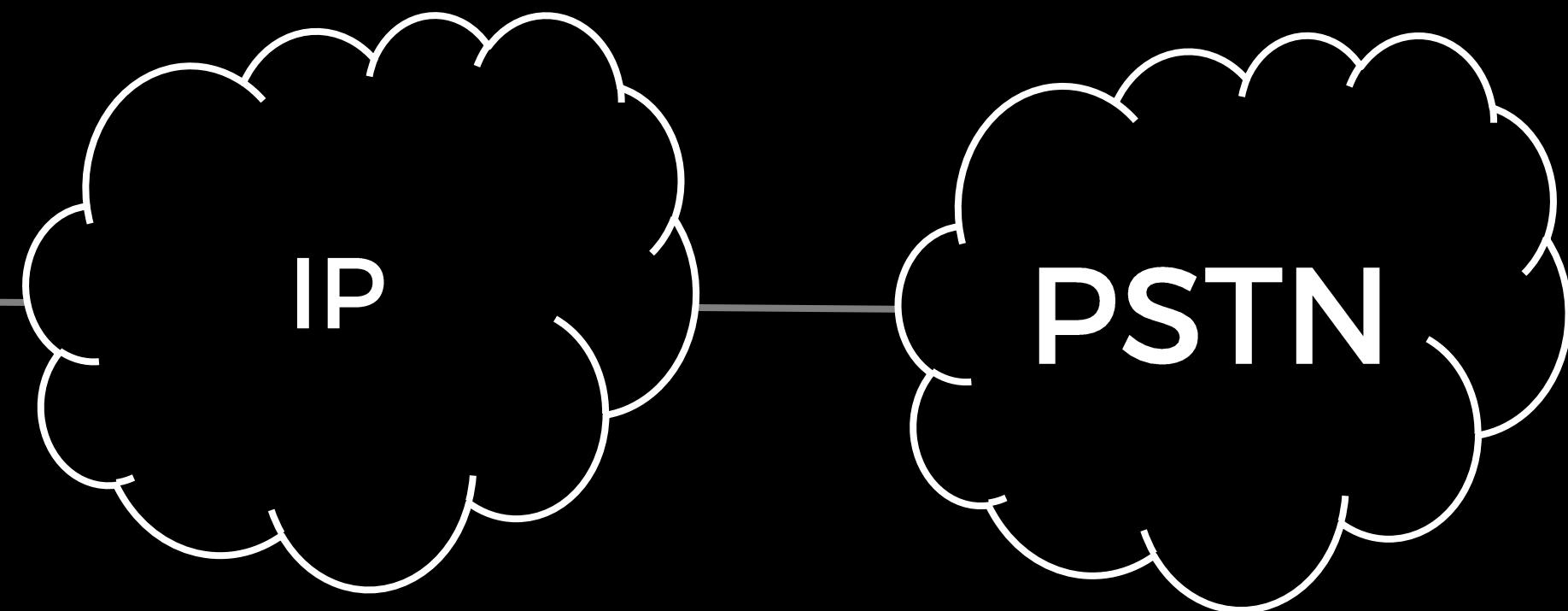
Step 4: What is your voice message?

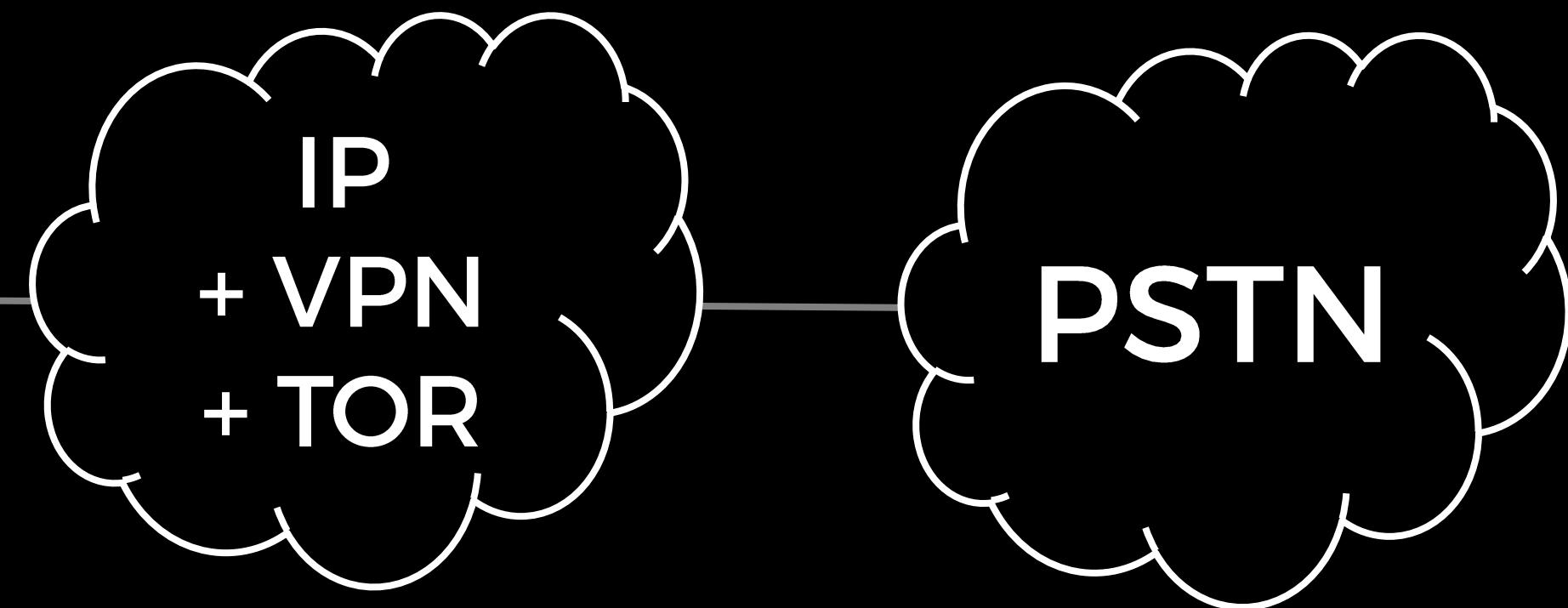
Step 5: Review and Submit



PSTN





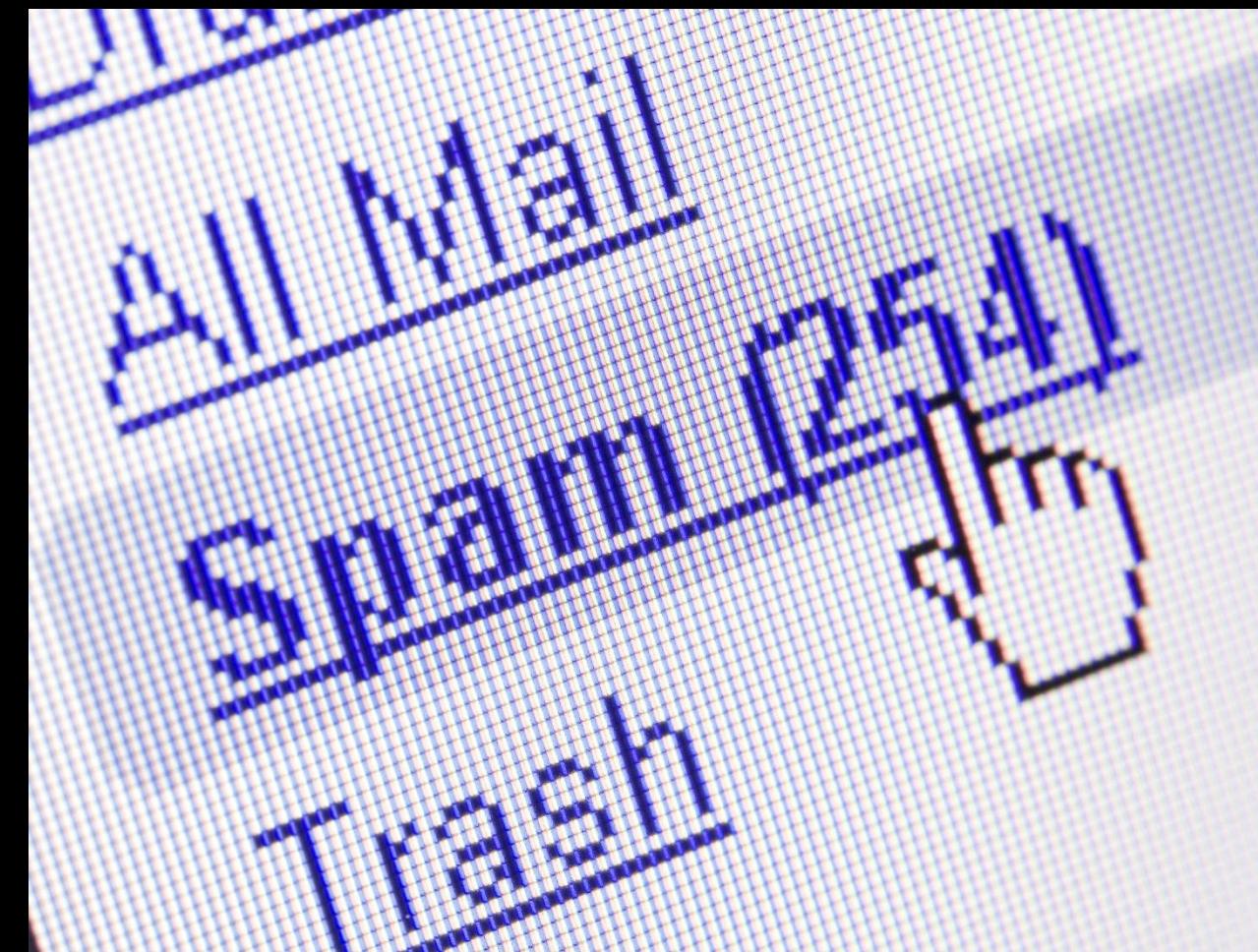




IP
+ VPN
+ TOR

PSTN





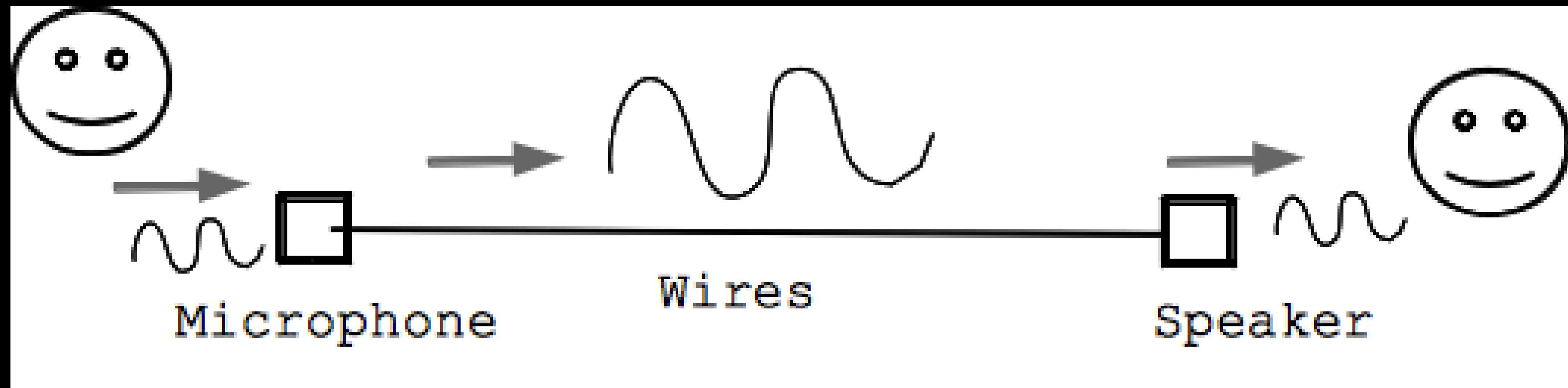
Barack Obama

work



 Answer

 Decline



UNDERSTANDING ONLINE STAR RATINGS:

★ ★ ★ ★ ★ [HAS ONLY ONE REVIEW]

★ ★ ★ ★ ★ EXCELLENT

★ ★ ★ ★ ★

★ ★ ★ ★ ★

★ ★ ★ ★ ★

★ ★ ★ ★ ★ CRAP

★ ★ ★ ★ ★

★ ★ ★ ★ ★

★ ★ ★ ★ ★



3 types of defenses

Call Request Header Analysis

Blacklisting

Caller behavior monitoring

Reputation system

...

Voice Interactive Screening

Audio fingerprinting

Speech content analysis

CAPTCHA / Turing test

...

Caller Compliance

Do-not-call registry

Call back verification

Proof of identity

...

Assessment Criteria

-  Usability
-  Deployability
-  Robustness

				Usability	Deployability	Robustness
		References		No-Disturbance-to-Recipient	Negligible-Changes-to-Infrastructure	Effective-Against-Dynamic-Caller-ID-Spoofing
				Scalable-for-Recipient	Negligible-Changes-to-Call-Setups	Effective-Against-Targeted-Caller-ID-Spoofing
				Effortless-for-Caller	No-Third-Party-Involvement	Effective-Against-Unavailable-Caller-ID
				Negligible-Delays	Low-Maintenance	Effective-Against-Multiple-Identities
				Permissive-for-VoIP-Callers	Low-Resource-Requirement	Effective-Against-Answering-Machine-Detection
				Permissive-for-Unknown-Callers	Negligible-Cost-per-Call	Effective-Against-Dynamic-Caller-ID-Spoofing
Call Request Header Analysis	Caller ID Blacklisting	[24], [25]	●	●	●	○
	Caller ID Whitelisting	[26], [27]	●	●	●	○
	Caller Reputation System	[28]–[42], [90]	●	●	●	○
	Caller Behavior Analysis	[29], [32], [33], [35], [39], [41], [43]–[54], [91], [92]	●	●	●	○
	Device Fingerprinting	[55]	●	●	●	○
	Caller ID Anomaly Detection	[56], [57]	●	●	●	○
	ANI-CPN Matching	[58]	●	●	●	○
	ANI-II Filtering	[58]	●	●	●	○
Voice Interactive Screening	Audio Fingerprinting	[61]–[67]	●	●	●	○
	Speech Content Analysis	[62], [68]	●	●	●	○
	Acoustic Pattern Analysis	[71]–[74]	●	●	●	○
	CAPTCHA/Turing Test	[75]–[77]	●	●	●	○
Caller Compliance	Do Not Call Registry	[22]	○	●	●	○
	Graylisting	[74], [79]	●	●	●	●
	Consent-based Communication	[80]–[82]	○	○	●	○
	Call Back Verification	[83], [84]	●	●	●	●
	Weakly Secret Information	[85]	●	●	●	●
	Payment at Risk	[38]	●	○	●	●
	Proof of Work	[86], [93]–[95]	●	●	●	●
	Proof of Identity	[83], [87]–[89]	●	●	●	●

●= satisfy the criteria ○= may satisfy the criteria ○= does not satisfy the criteria

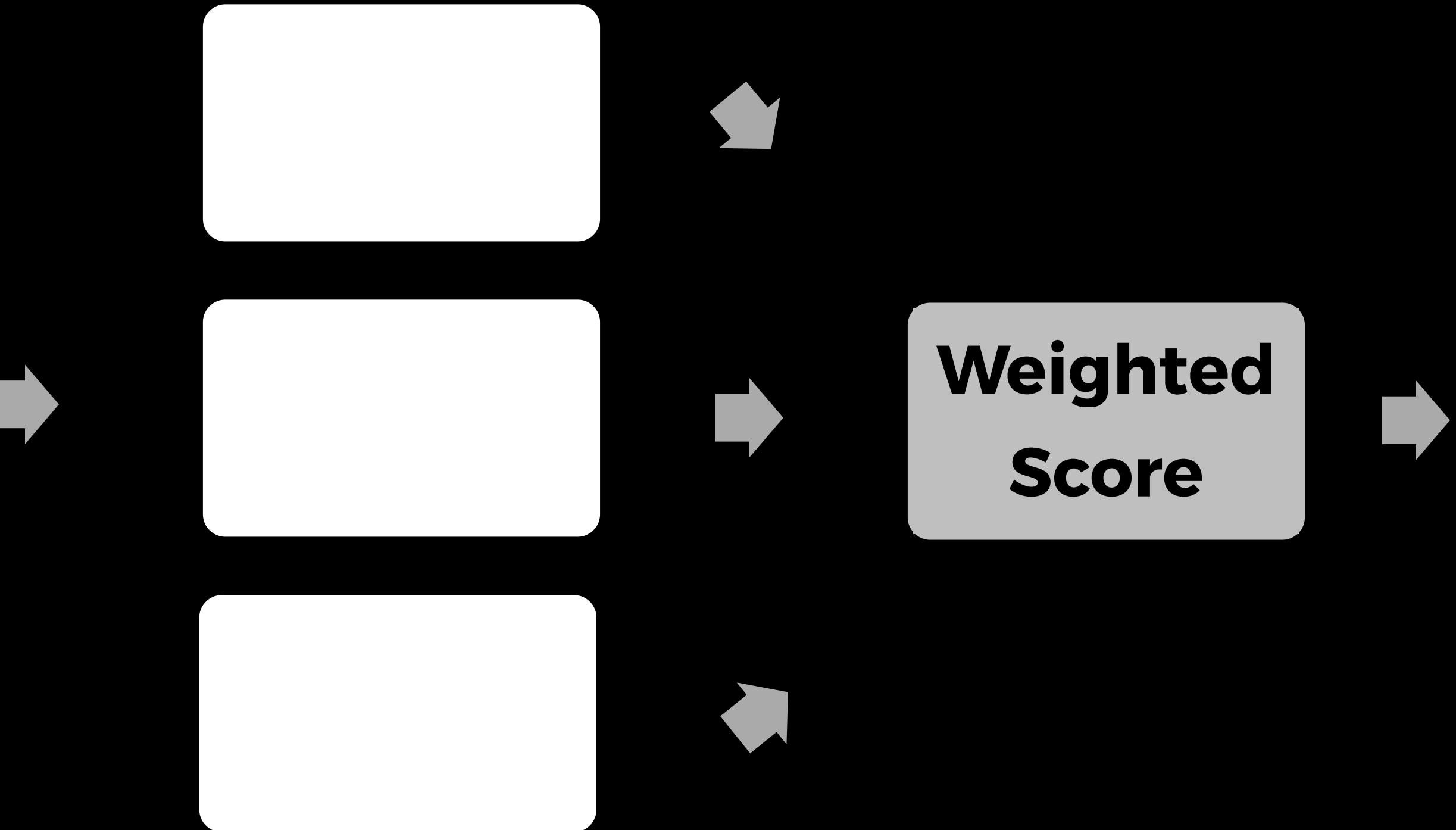
	 Usability	 Deployability	 Robustness
Call Request Header Analysis	★★★	★★★	★
Voice Interactive Screening	★	★★	★★
Caller Compliance	★★	★★	★★★

3 ways to combine
techniques

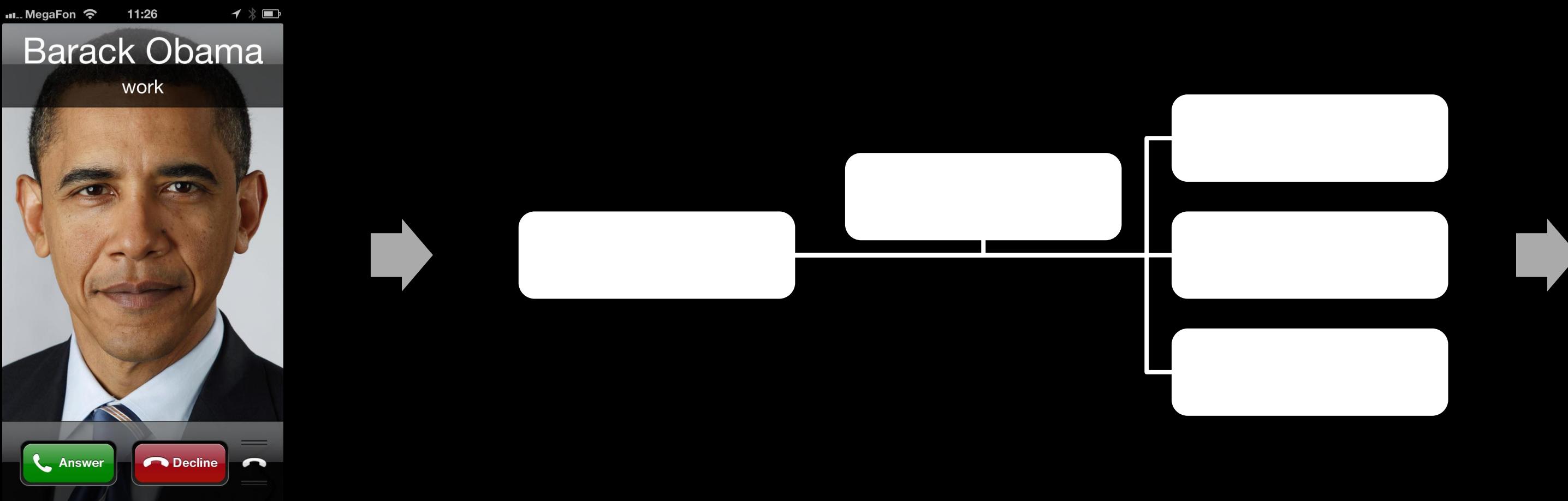
Phased Decisions



Weighted Scoring



Conditional Procedures



	[96], [97]	[98]	[99]	[100]	[101]	[102]	[103]	[104]	[105]	[106]
Phased Decisions	✓	✓	✓	✓						✓
Weighted Scoring	✓	✓			✓	✓	✓	✓		
Conditional Procedures								✓	✓	✓
Caller ID Blacklisting	✓	✓	✓	✓	✓	✓	✓		✓	✓
Caller ID Whitelisting	✓	✓		✓	✓	✓	✓		✓	
Caller Reputation System	✓		✓	✓	✓	✓			✓	✓
Caller Behavior Analysis	✓	✓	✓		✓	✓	✓		✓	✓
Device Fingerprinting										✓
Caller ID Anomaly Detection										
ANI-CPN Matching										
ANI-II Filtering										
Audio Fingerprinting				✓						
Speech Content Analysis	✓									✓
Acoustic Pattern Analysis	✓									
CAPTCHA/Turing Test	✓	✓	✓	✓		✓		✓		✓
Do Not Call Registry										
Graylisting	✓					✓	✓			✓
Consent-based Communication	✓		✓							✓
Call Back Verification										
Weakly Secret Information	✓									
Payment at Risk										
Proof of Work	✓							✓		
Proof of Identity			✓	✓					✓	

Combining techniques
create synergy

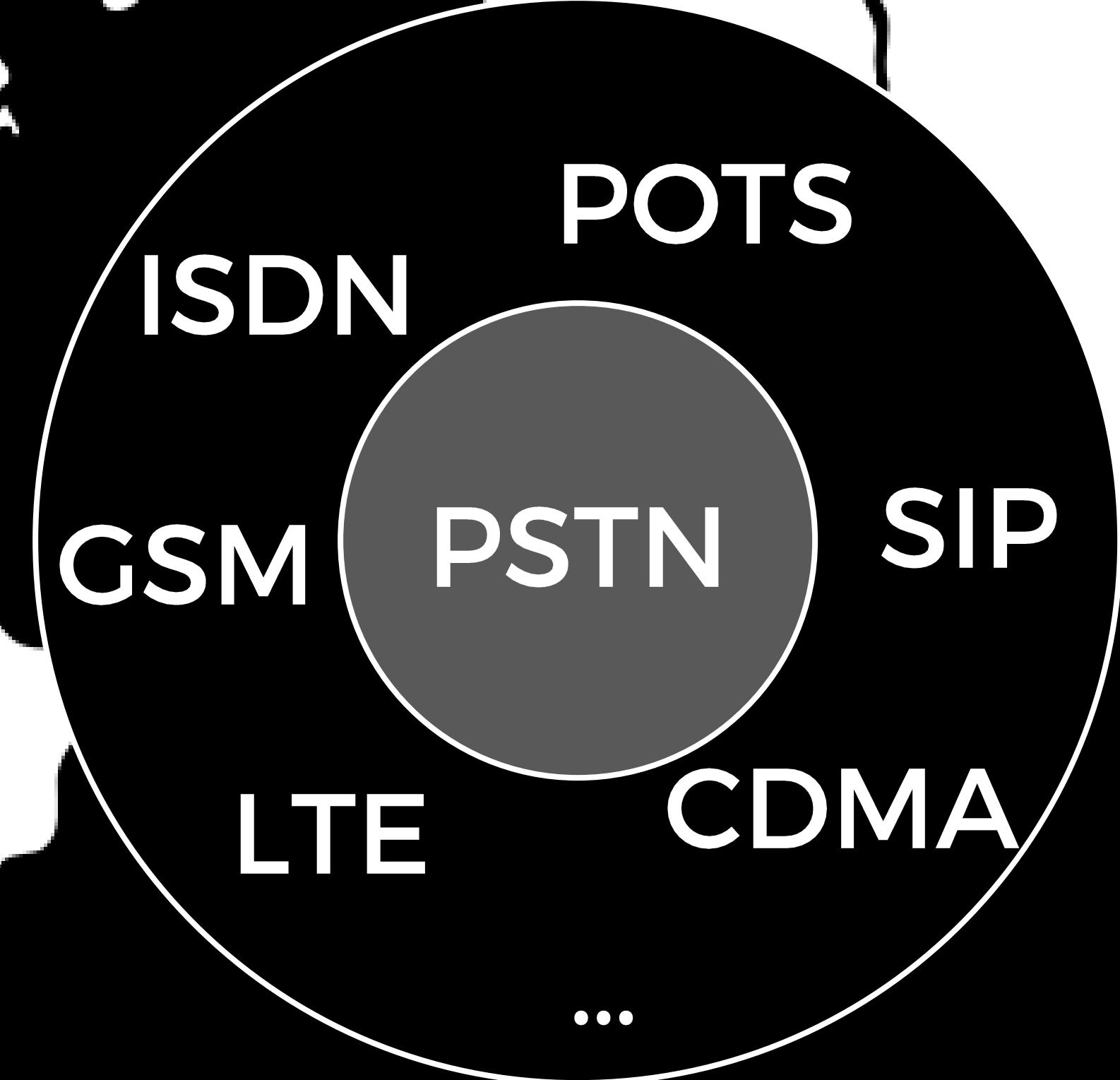
However...



SIMPLICITY
IS THE ULTIMATE
SOPHISTICATION.

- LEONARDO DA VINCI

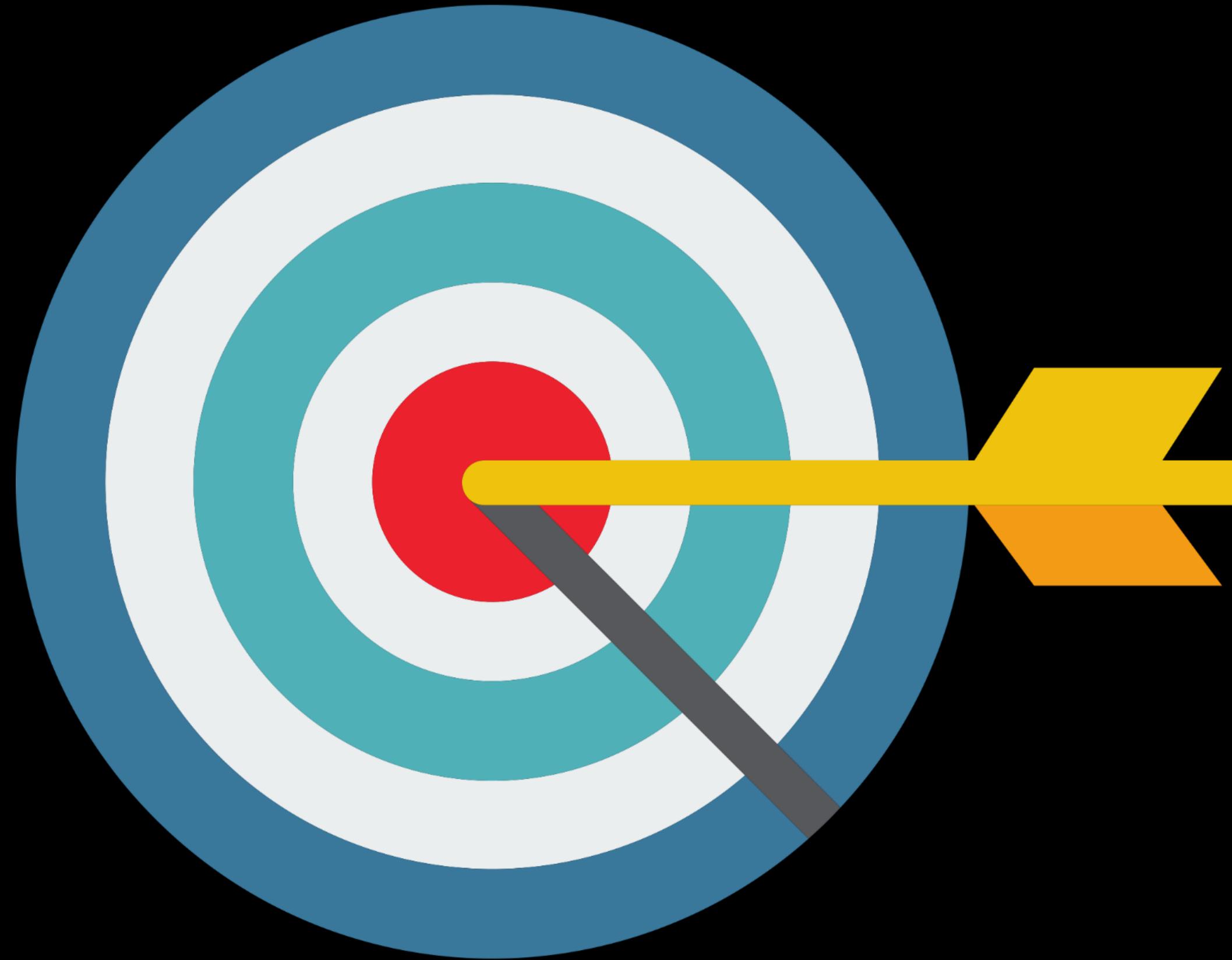
Conclusion



Core robustness

=

Effective prevention of caller ID spoofing



Acknowledgments



Thank you!

Questions?

Huahong Tu (Raymond)
[tu@asu.edu](mailto:tuh@asu.edu)

PS: We're looking for shared access to SS7/SIGTRAN.