

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

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NATIONAL  
DO NOT CALL  
REGISTRY

~200,000  
robocall  
complaints  
every month

# Telephone Consumer Protection Act of 1991



**ROBOCALLS: HUMANITY STRIKES BACK**

DEFCON23

DETECTA**ROBO**

**DEFCON**  **V. RACHEL** THE ROBOCALLER



A CONTEST TO COMBAT ROBOCALLS



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

600000  
500000  
400000  
300000  
200000  
100000  
0

230462

184469

386807

166545

485481

54089

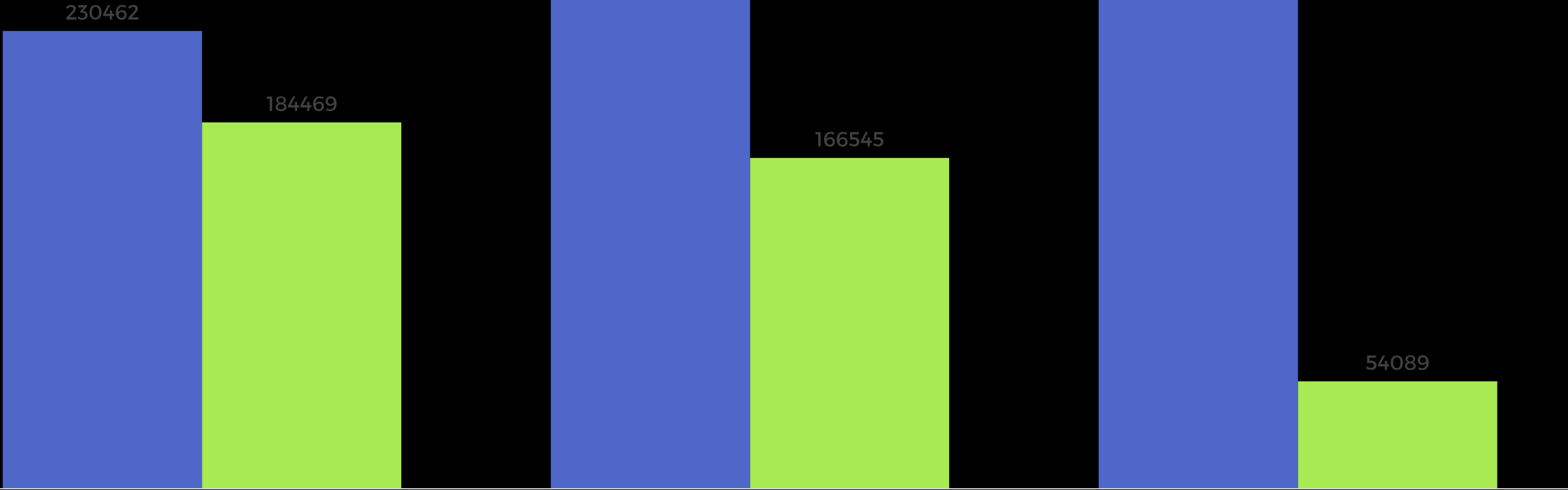
■ Phone  
■ Email

2013

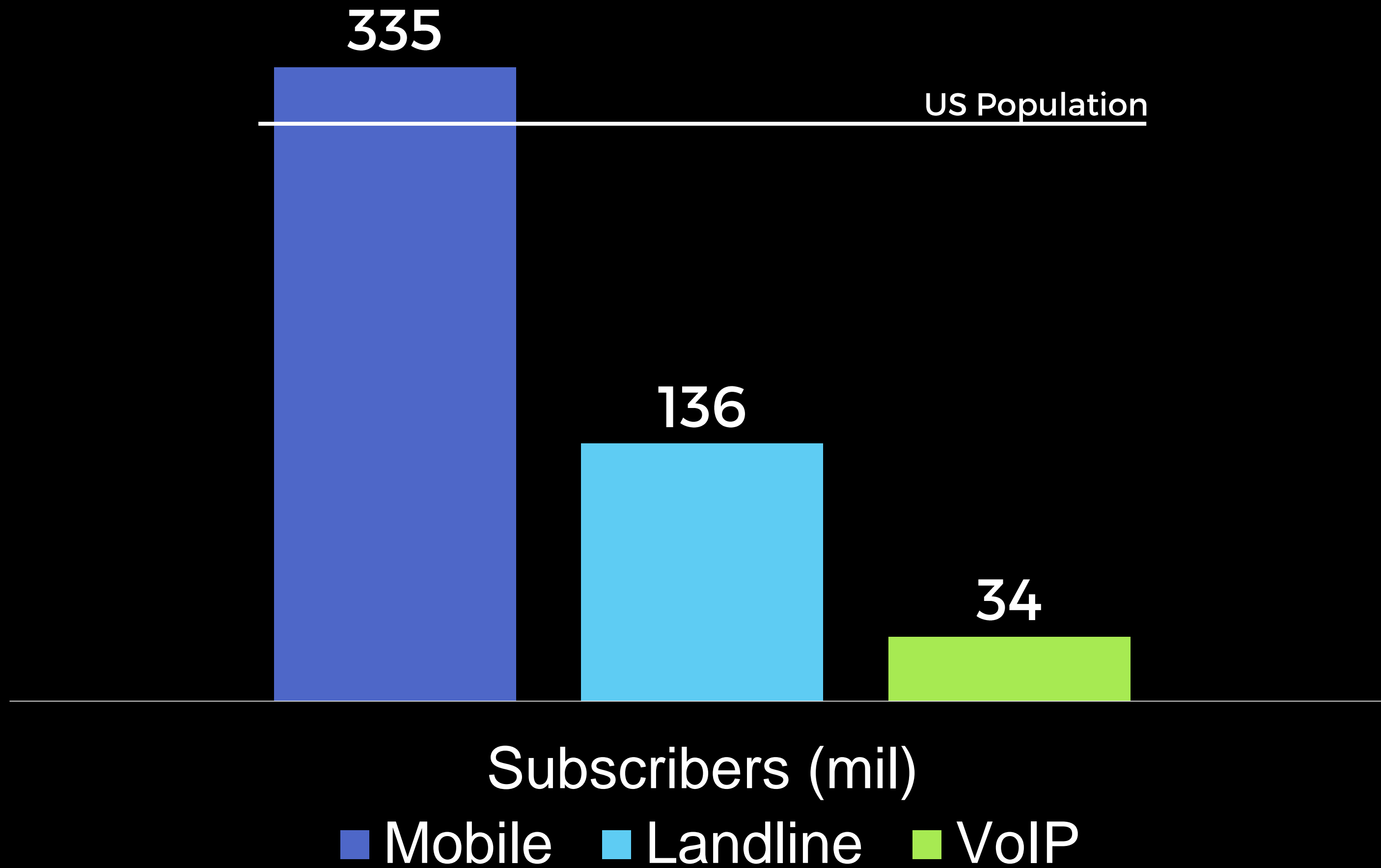
2014

2015

Data source: Consumer sentinel data book CY2015



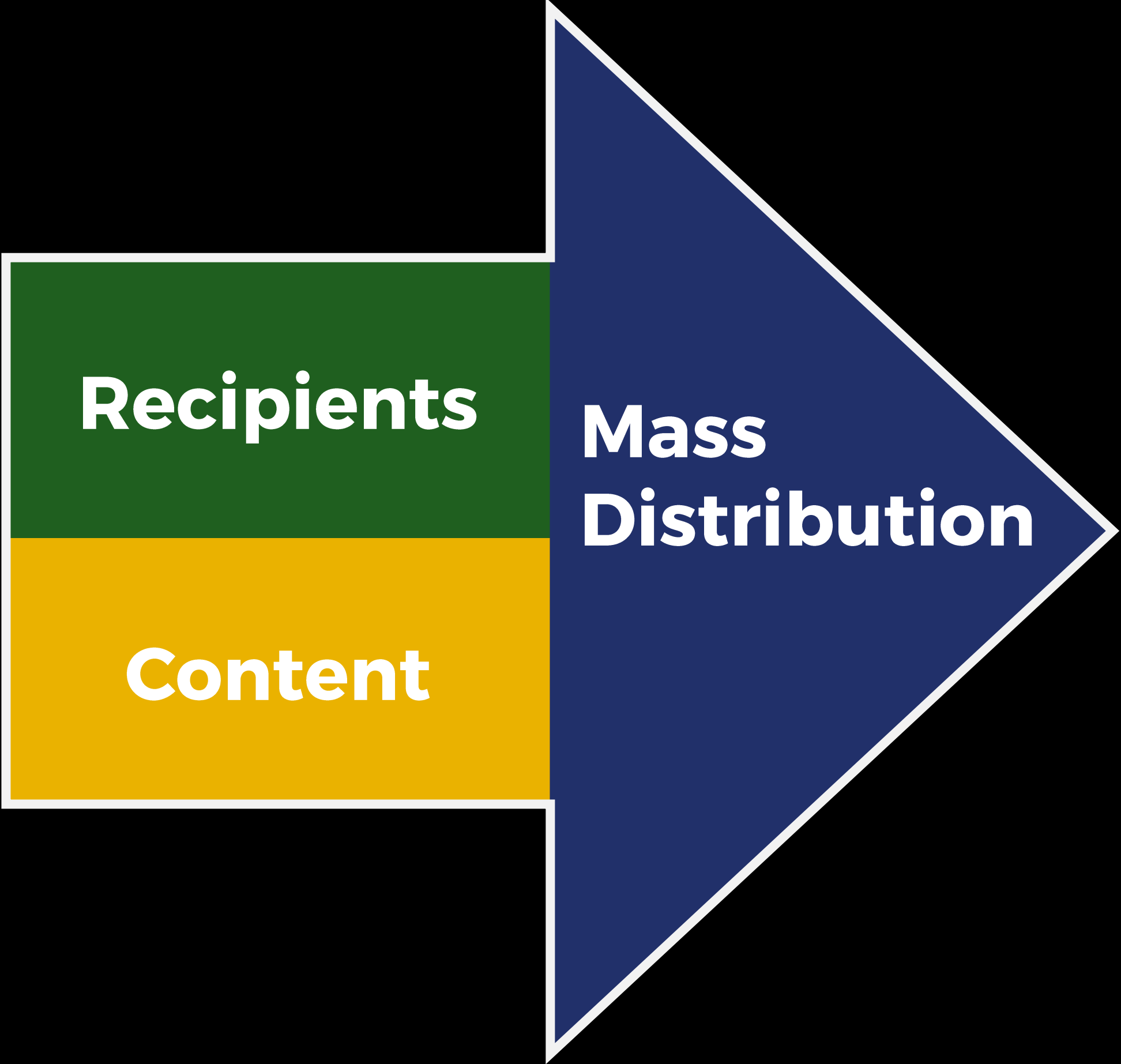






Type	Price	Unit
US Local Number	\$0.3500	Per Month
Toll Free DID	\$0.7500	Per Month
Call Inbound	\$0.0055	Per Minute
Call Outbound	\$0.0100	Per Minute
Call Toll Free Inbound	\$0.0195	Per Minute
Call Toll Free Outbound	\$0.0100	Per Minute
SIP Call Inbound	\$0.0025	Per Minute
SIP Call Outbound	\$0.0100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





**Recipients**

**Content**

**Mass  
Distribution**



Phone number list



Audio content



Autodialer  
+  
VoIP Carrier

Voicemail

00:04



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

Message Type  Voice Only

Text Only

Voice & Text

Name this Broadcast

Caller ID

Broadcast Type  Announcement [?]

Survey [?]

Next

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

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

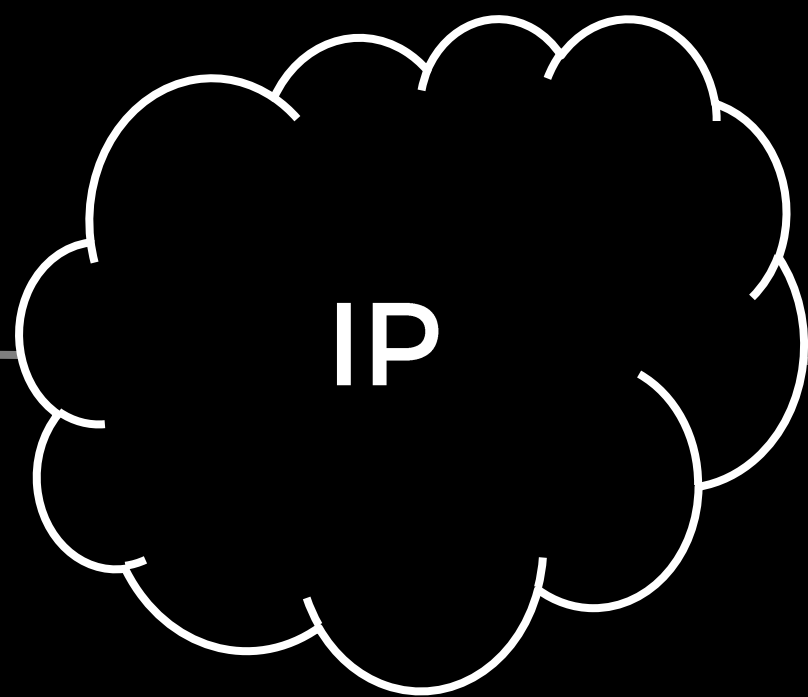
Step 4: What is your voice message?

Step 5: Review and Submit



PSTN









IP  
+ VPN  
+ TOR

PSTN

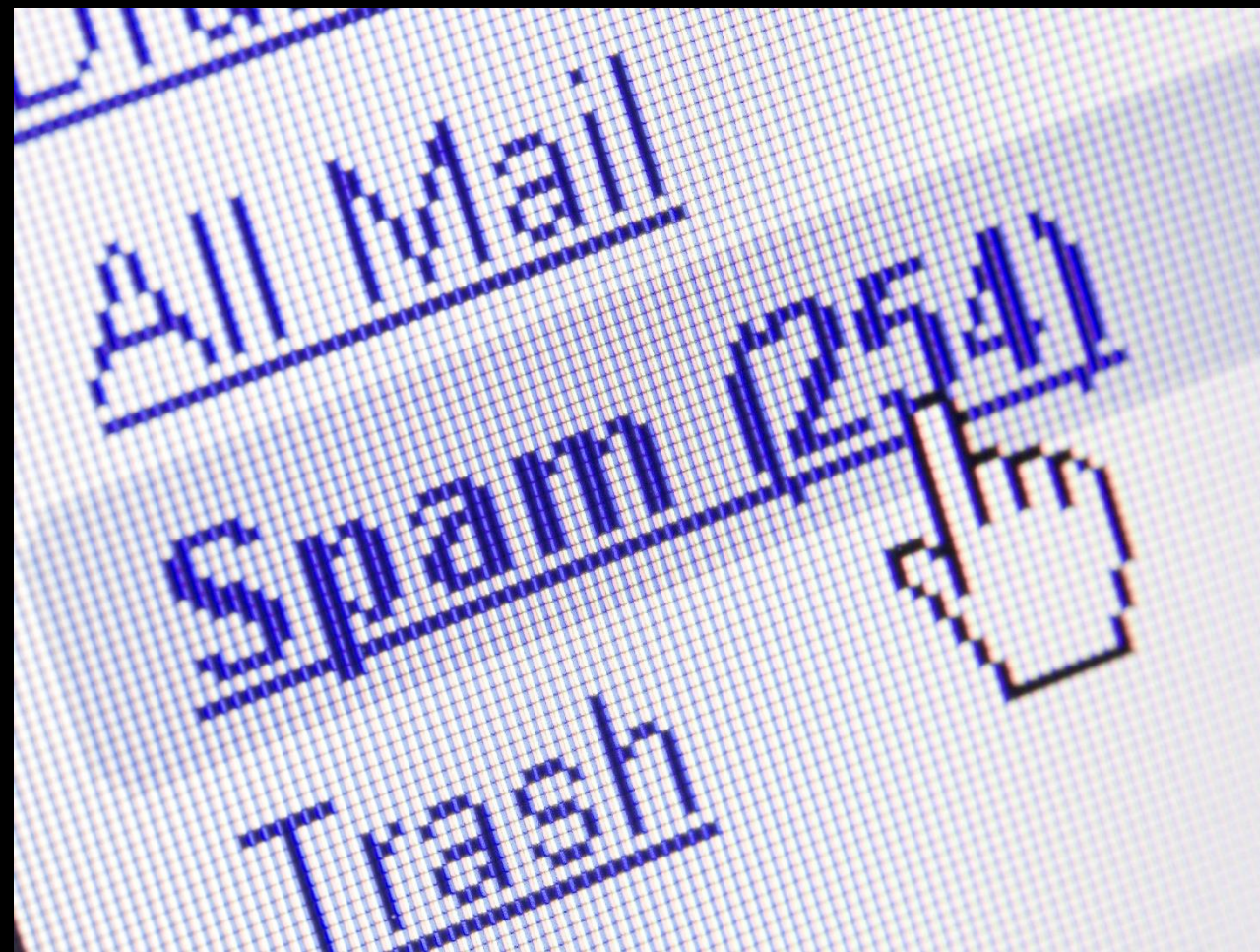




IP  
+ VPN  
+ TOR

PSTN







# Barack Obama

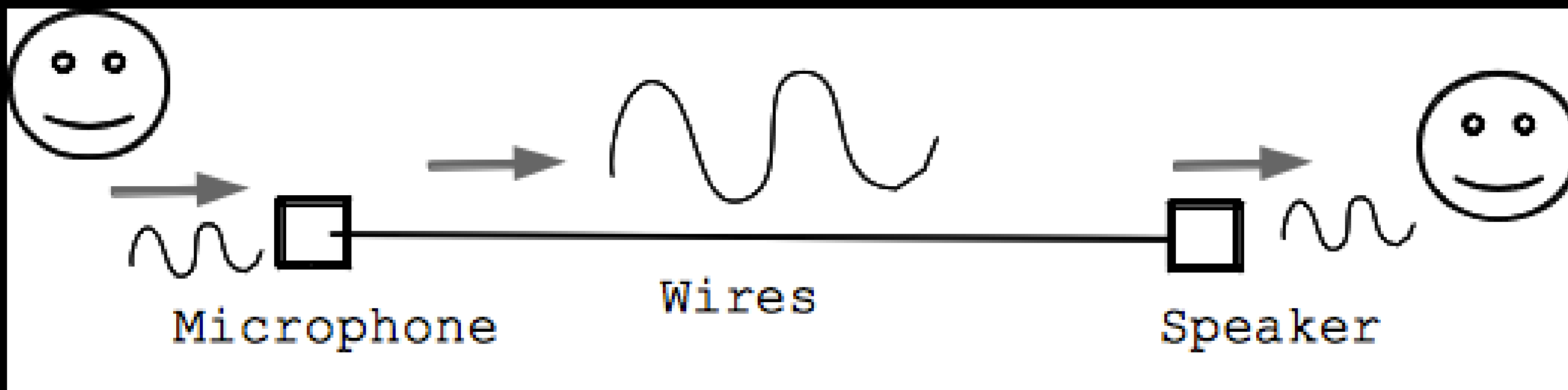
work



 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

		References	Usability						Deployability						Robustness					
			<i>No-Disturbance-to-Recipient</i>	<i>Scalable-for-Recipient</i>	<i>Effortless-for-Caller</i>	<i>Negligible-Delays</i>	<i>Permissive-for-VoIP-Callers</i>	<i>Permissive-for-Unknown-Callers</i>	<i>Negligible-Changes-to-Infrastructure</i>	<i>Negligible-Changes-to-Call-Setups</i>	<i>No-Third-Party-Involvement</i>	<i>Low-Maintenance</i>	<i>Low-Resource-Requirement</i>	<i>Negligible-Cost-per-Call</i>	<i>Effective-Against-Dynamic-Caller-ID-Spoofing</i>	<i>Effective-Against-Targeted-Caller-ID-Spoofing</i>	<i>Effective-Against-Unavailable-Caller-ID</i>	<i>Effective-Against-Multiple-Identities</i>	<i>Effective-Against-Answering-Machine-Detection</i>	<i>Effective-Against-Dynamic-Audio-Content</i>
<b>Call Request Header Analysis</b>	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]	●	●	●	●	◐	●	●	●	●	●	●	◐	●	○	◐	○	●	●
<b>Voice Interactive Screening</b>	Audio Fingerprinting	[61]–[67]	●	●	◐	○	●	●	●	●	◐	○	○	◐	●	●	●	●	◐	◐
	Speech Content Analysis	[62], [68]	●	●	◐	○	●	●	●	●	◐	◐	○	◐	●	●	●	●	◐	◐
	Acoustic Pattern Analysis	[71]–[74]	●	●	◐	○	●	●	●	●	◐	◐	◐	◐	●	●	●	●	◐	◐
	CAPTCHA/Turing Test	[75]–[77]	●	●	○	○	●	●	●	●	●	◐	◐	◐	●	●	●	●	●	●
<b>Caller Compliance</b>	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

	 <b>Usability</b>	 <b>Deployability</b>	 <b>Robustness</b>
<b>Call Request Header Analysis</b>	★ ★ ★	★ ★ ★	★
<b>Voice Interactive Screening</b>	★	★ ★	★ ★
<b>Caller Compliance</b>	★ ★	★ ★	★ ★ ★

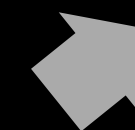
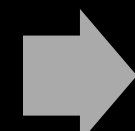
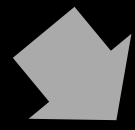
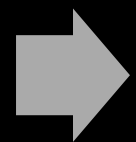
**3 ways to combine  
techniques**

# Phased Decisions

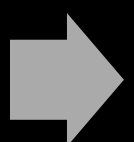




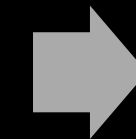
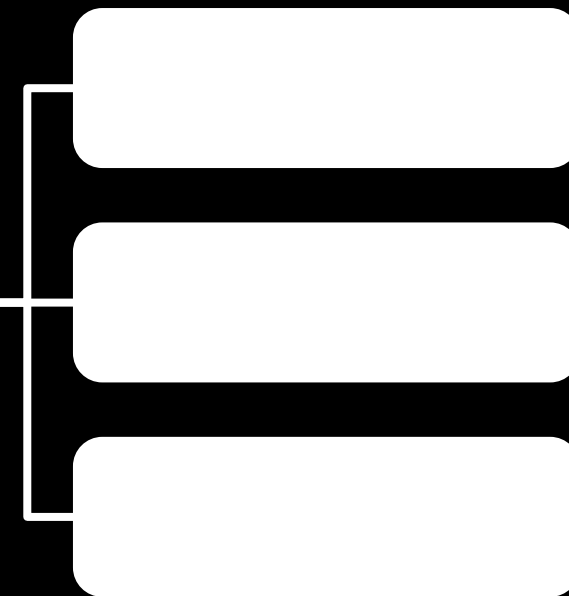
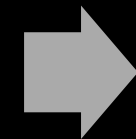
# Weighted Scoring



**Weighted  
Score**



# Conditional Procedures



	[96], [97]	[98]	[99]	[100]	[101]	[102]	[103]	[104]	[105]	[106]
<b>Phased Decisions</b>	✓	✓	✓	✓						✓
<b>Weighted Scoring</b>	✓	✓			✓	✓	✓	✓		
<b>Conditional Procedures</b>								✓	✓	✓
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			✓	✓					✓	

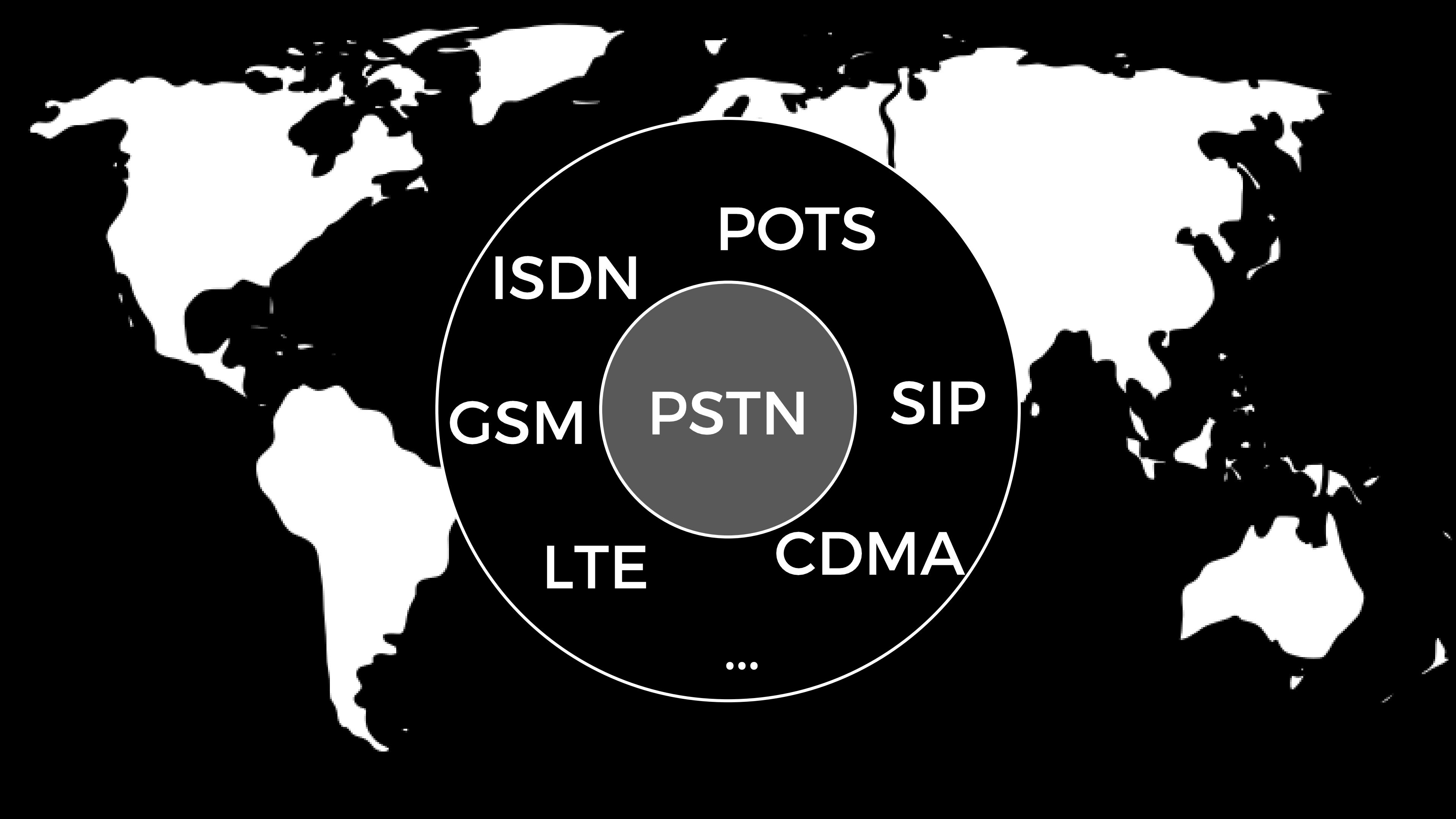
Combining techniques  
create synergy

However...

**SIMPLICITY  
IS THE ULTIMATE  
SOPHISTICATON.**

**- LEONARDO DA VINCI**

Conclusion



POTS

ISDN

PSTN

SIP

GSM

CDMA

LTE

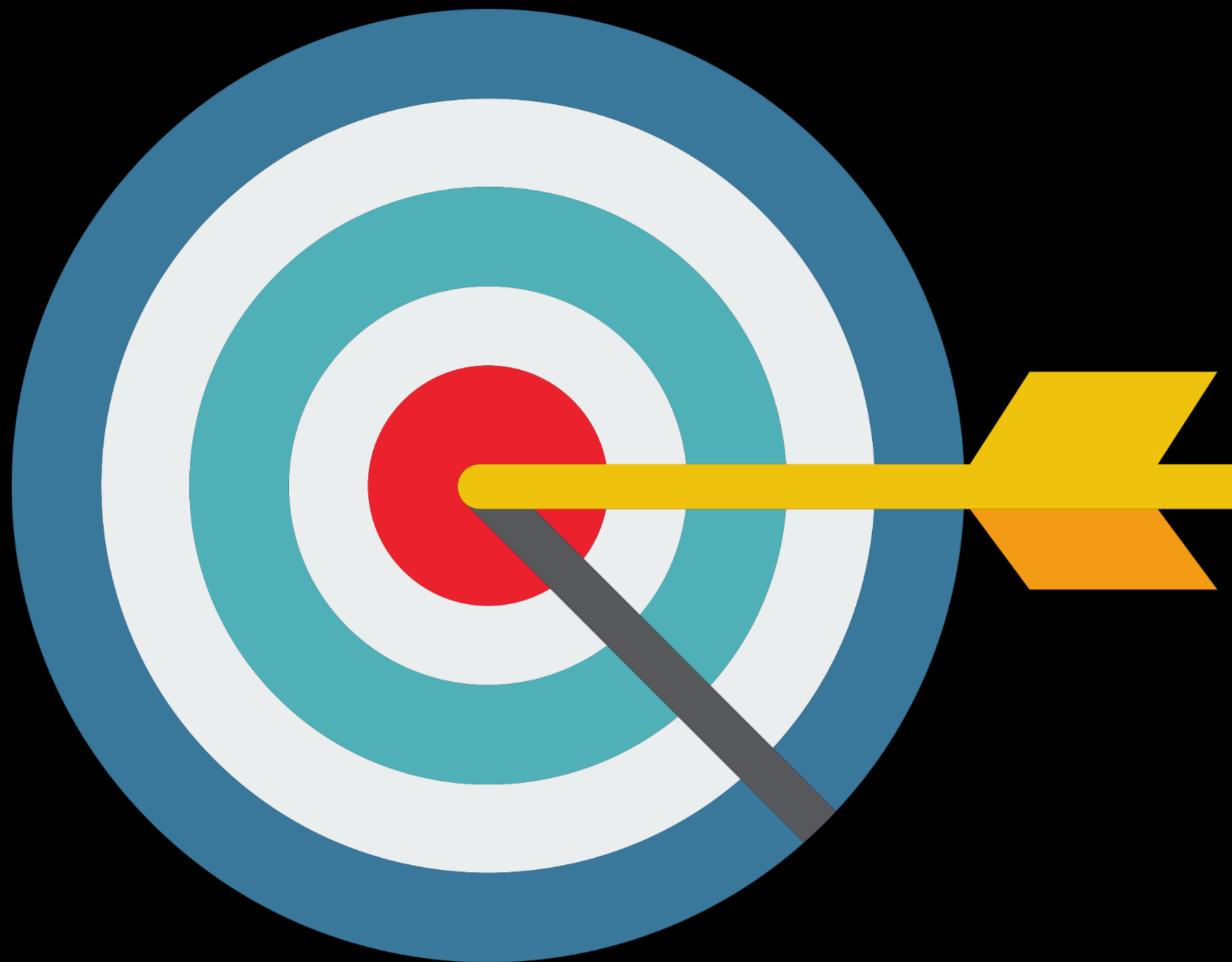
...

Core robustness

=

Effective prevention of  
caller ID spoofing





# Acknowledgments



**Thank you!**

# Questions?

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