THE NETWORK

What is the current state of telephonic technology?

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ROBOCALLS
ALL THE RAGE

Things Were Once Simple...

Photo: Steven M. Bellovin @
Museum of Communications, Seattle

- You couldn't make very many calls

- You couldn't make them very quickly

- It was pretty easy to tell who called whom—look at the wires...

An Early iPhone?

- Or at least a phone in the shape of a letter "I"

- (This is actually a pay phone, with a slot in which you can deposit nickels.)

Photo: Steven M. Bellovin @ Museum of Communications, Seattle

Computing Was Simple, Too

Photo: Steven M. Bellovin @ Museum of Communications, Seattle

Way Back When, Signs of Growth

Photo: Steven M. Bellovin @ Museum of Communications, Seattle

A Panel Switch (invented 1915)

- Partially automatic switching (the Strowger switch goes back to 1889)

- Handled dialed and operator-assisted calls

- Dialed phone calls go back 25 years before that—calling volume was already too high for fully manual processing

Who Called Whom?

1920's
PEN REGISTER
This device recorded dial pulses.

Photo: Steven M. Bellovin @
Museum of Communications, Seattle

- Calls were coming from physical wire pairs, and going to physical wire pairs

- With the right equipment, it was very easy to see if somebody was making malicious calls

- A creature of the dial age— an operator would *know*

Data Communications

- Practical teleprinters and proto-fax machines go back almost 100 years
- Transmission speed no longer limited to human sending ability; information could be prepared offline and sent very quickly
- But—bits are still represented as *sounds*, because that's what the phone network can carry

ASR 33 Teletype, circa 1963.
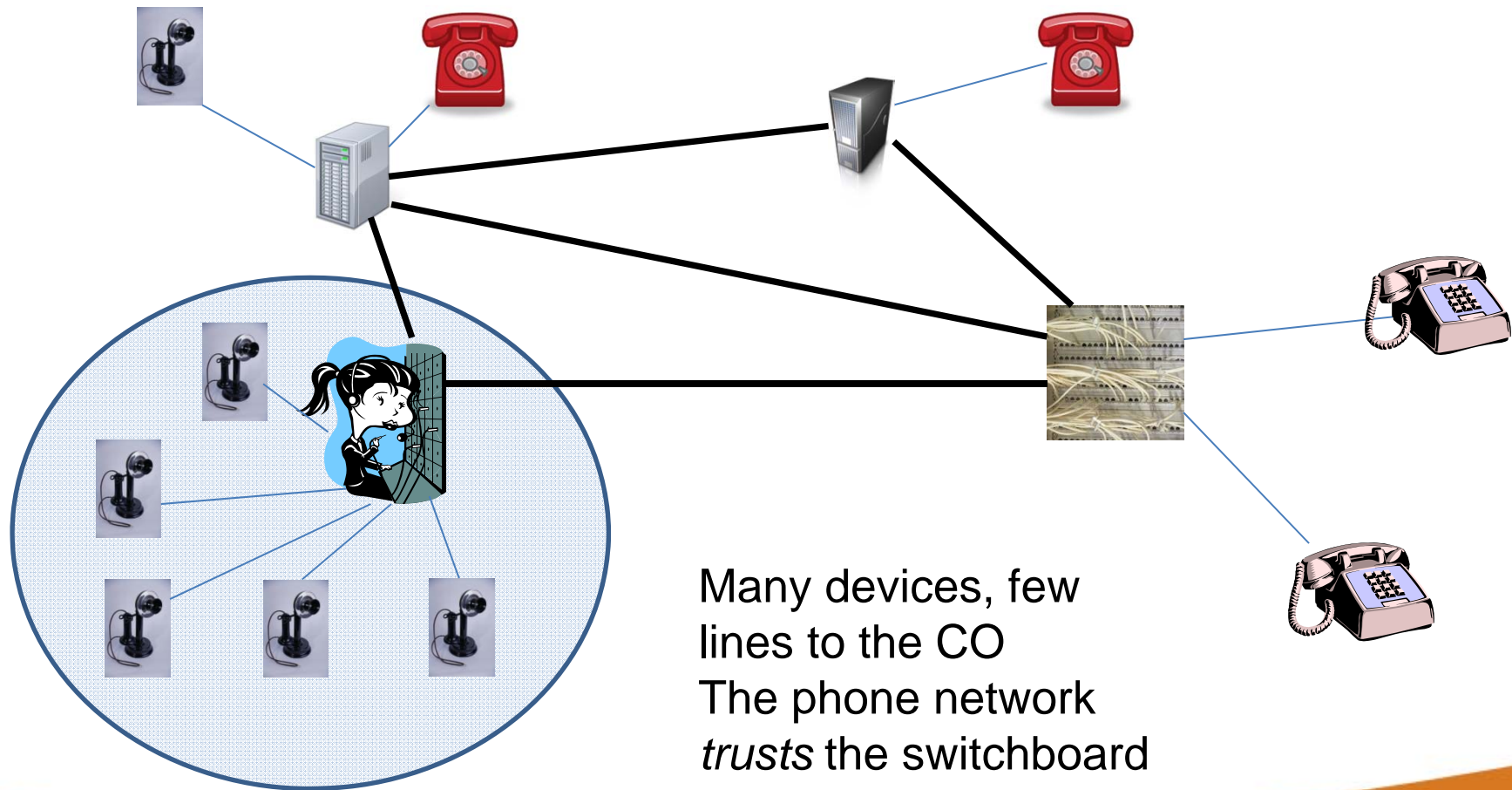Photo: Perry Metzger @ Bletchley Park, UK

The Phone Network
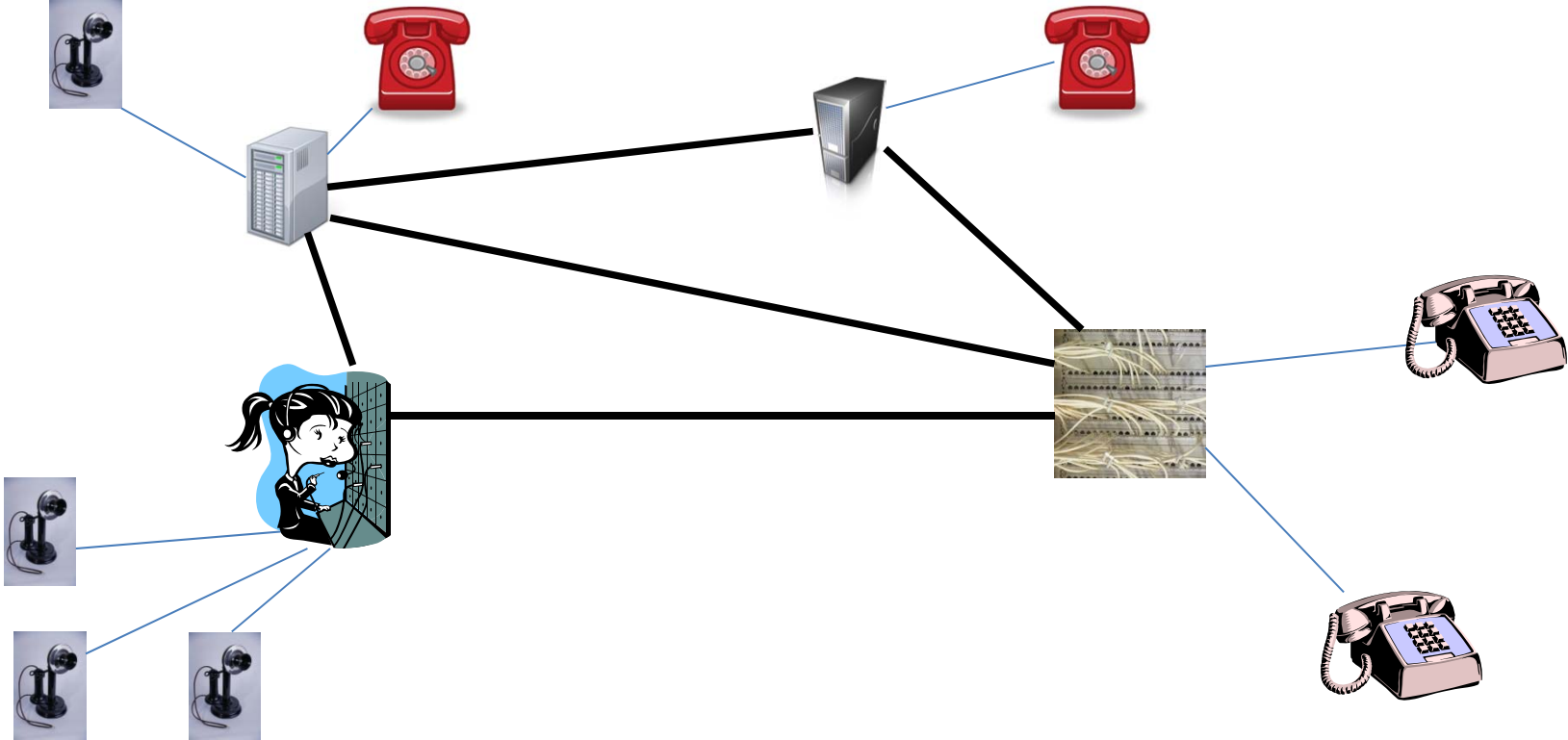
Elements of the Phone Network

- Phones
  - Wires from phones to central offices
  - One phone, one wire pair
- Central offices (phone switches), manual or automatic
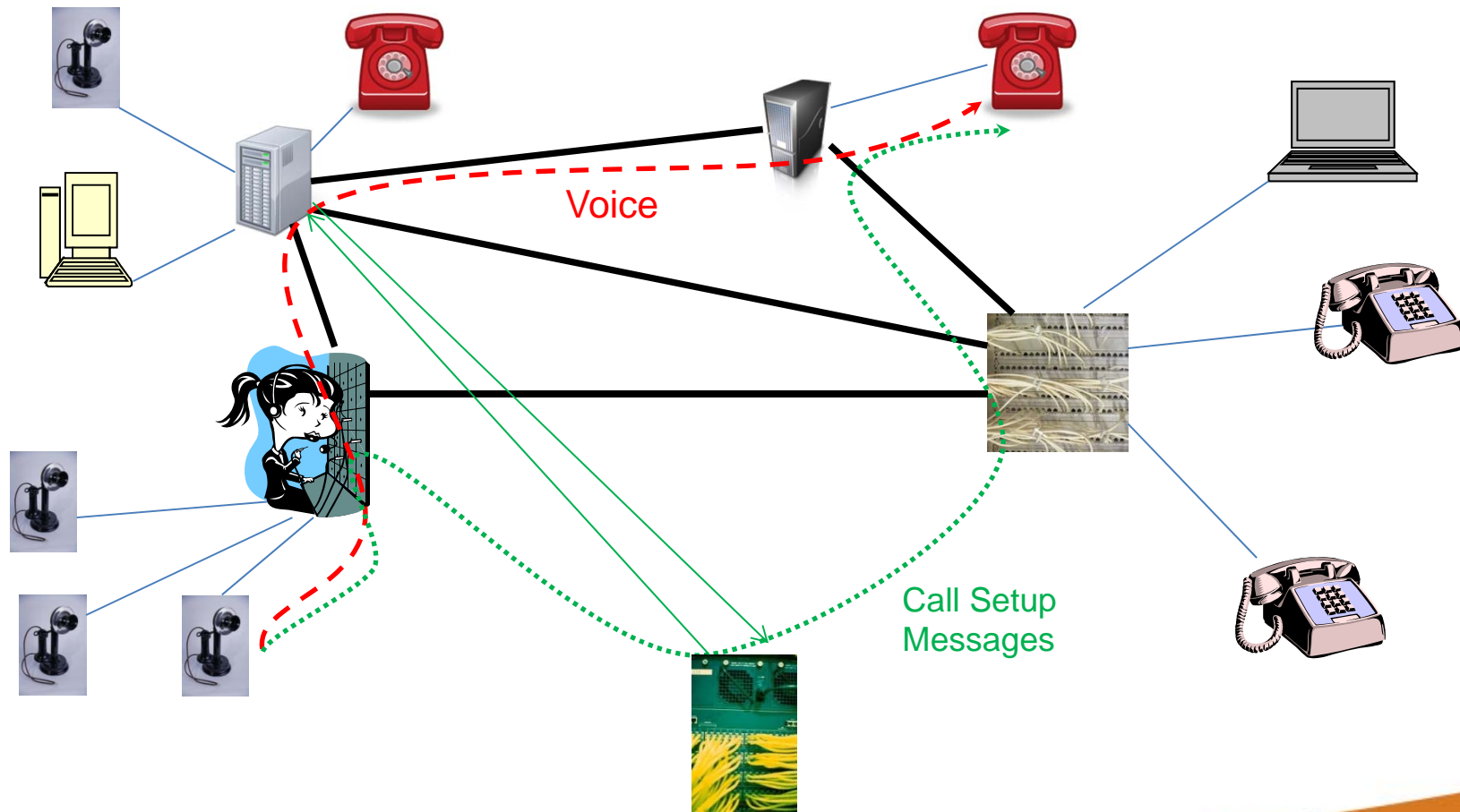- Trunks between central offices

What About Private Switchboards or Switches?

Many devices, few
lines to the CO
The phone network
trusts the switchboard

Signaling Path versus Voice Path: Original

Voice

Call Setup Messages
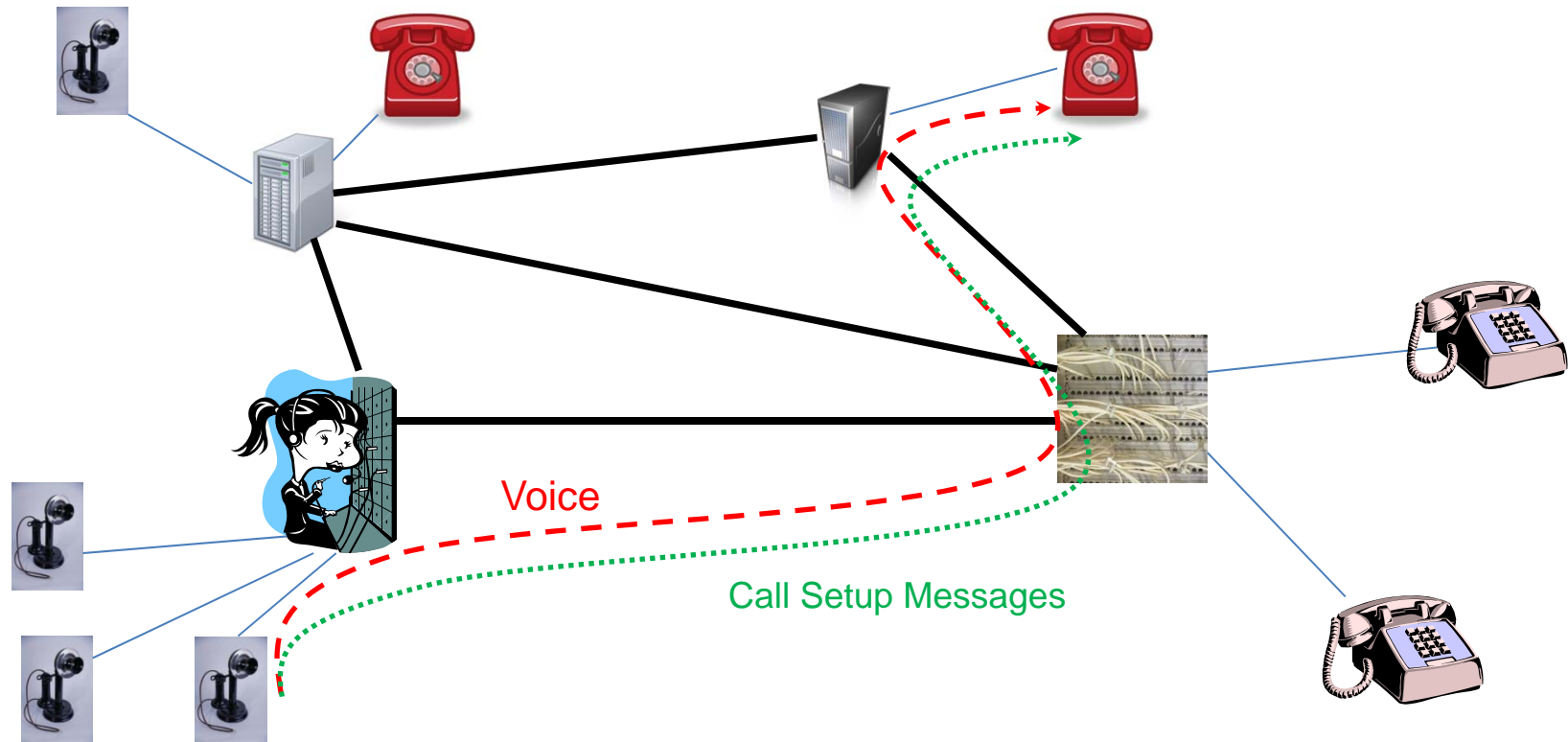
Signaling Path versus Voice Path: Today

Undersea Cables Were Expensive

- Underwater phone cables had limited capacity and were expensive to lay

- Calls using them were very, very costly

- Fiber optics and the Internet have changed all that

What Does This Mean?

- There is no longer "one phone, one wire pair"
- The paths are no longer simple
  - There is complex data flow
  - Signaling is decoupled from the voice—data—path
  - Mobile phones add a whole new layer of complexity
- Distance and location are no longer cost factors
- Endpoints are no longer just phones
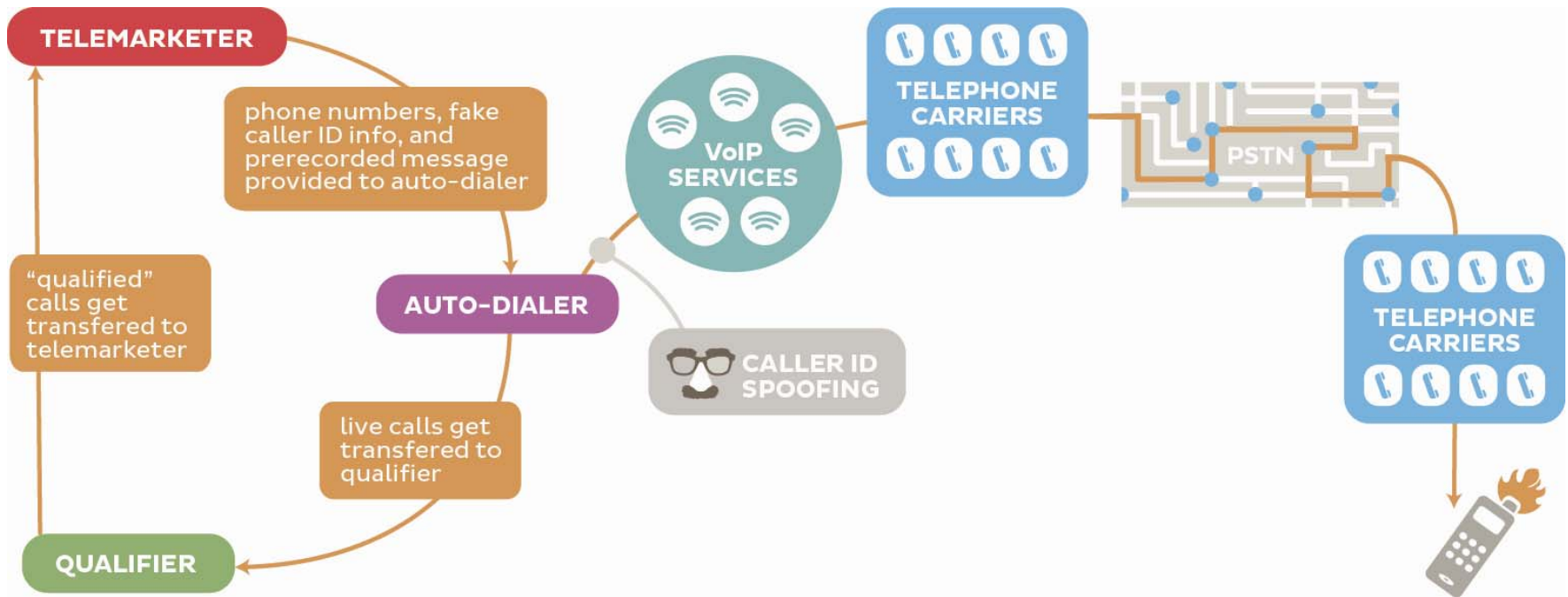
Robocalling in the VoIP Age

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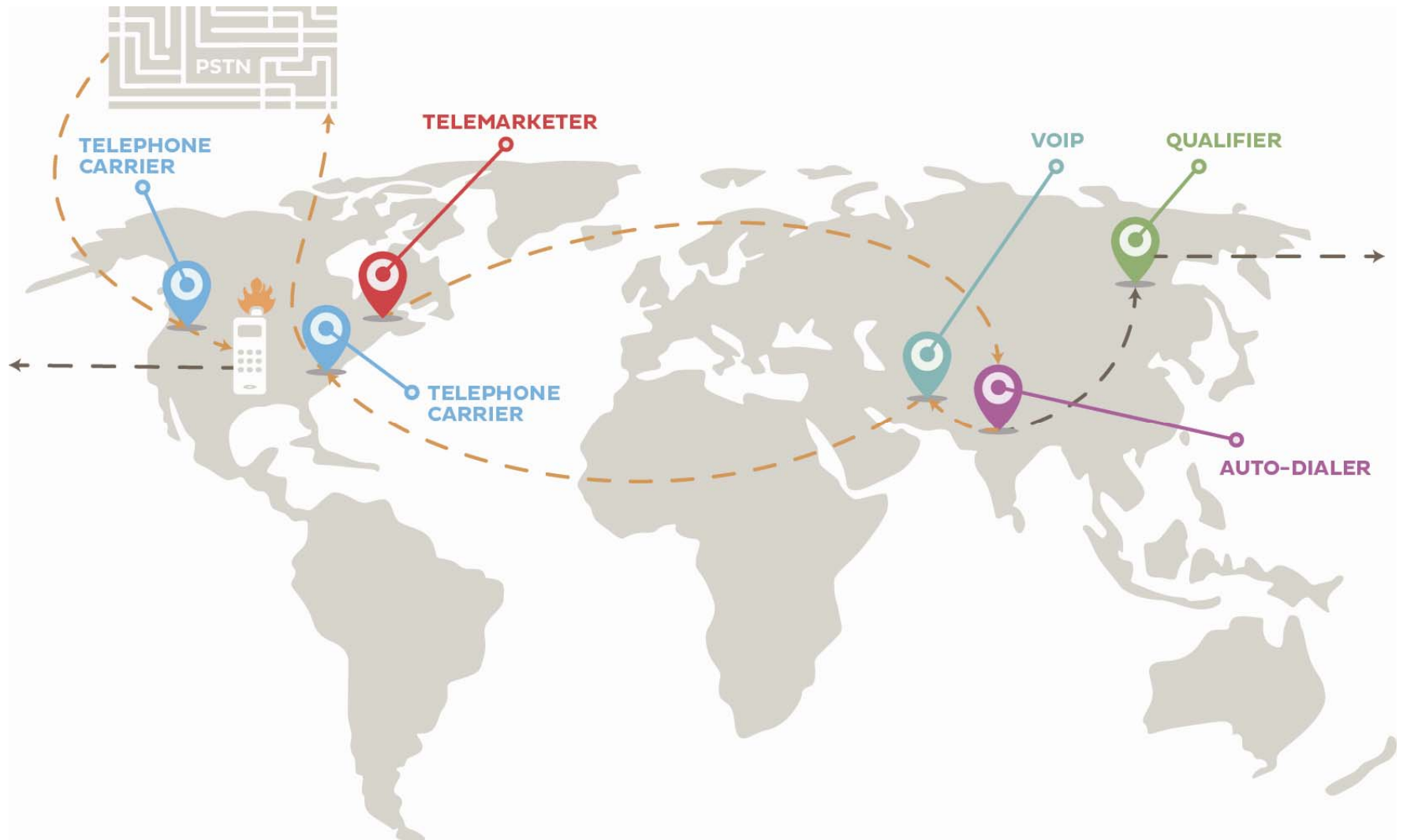
ROBOCALLS
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Overview

- What does VoIP offer to robocallers?

- We (kind of) solved the email spam problem – why not robocalls?

- What can consumers do?

- How *can* we address the problem?

Money flows in many directions within a robocall operation.

The enablers

Number spoofing

Cheap VoIP

Cheap labor
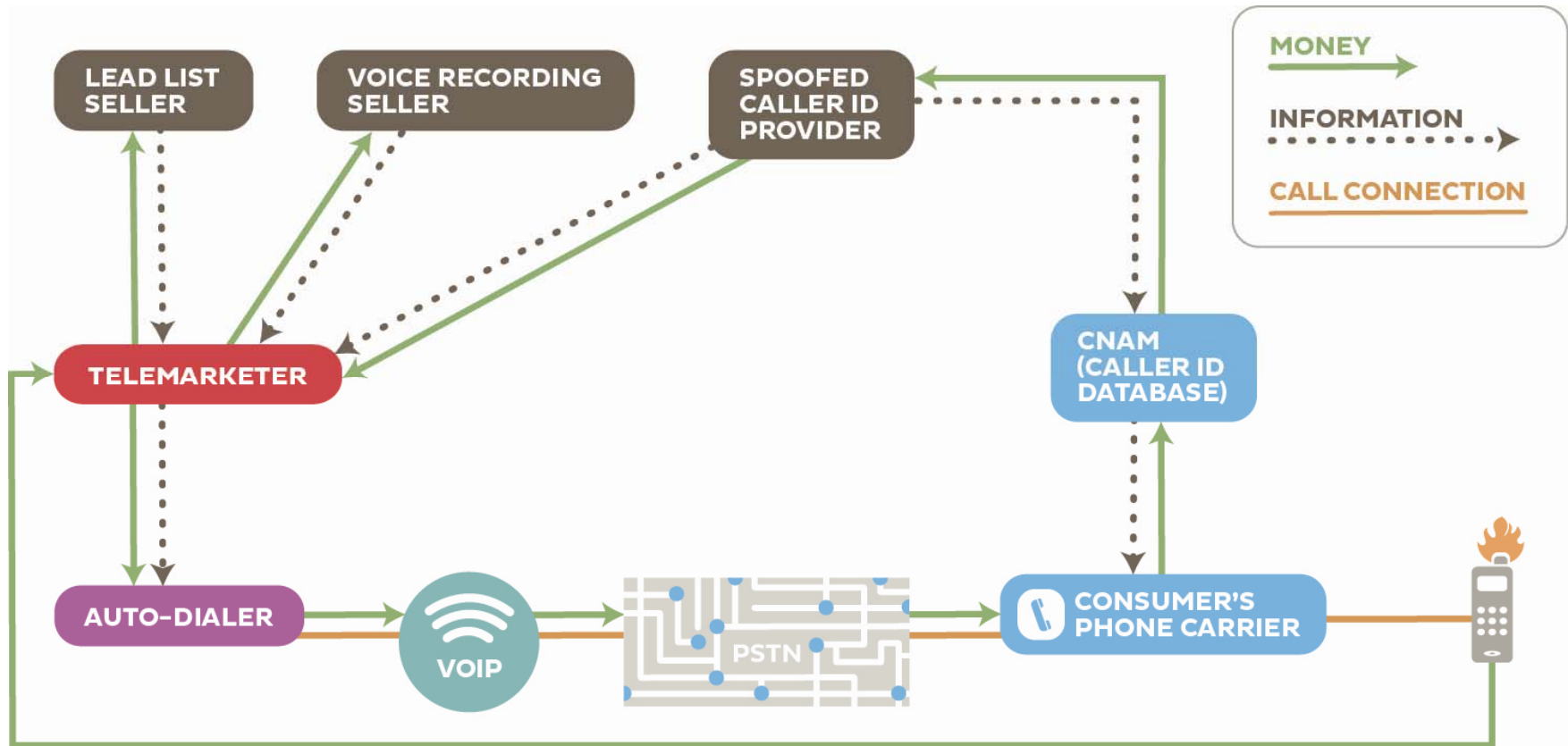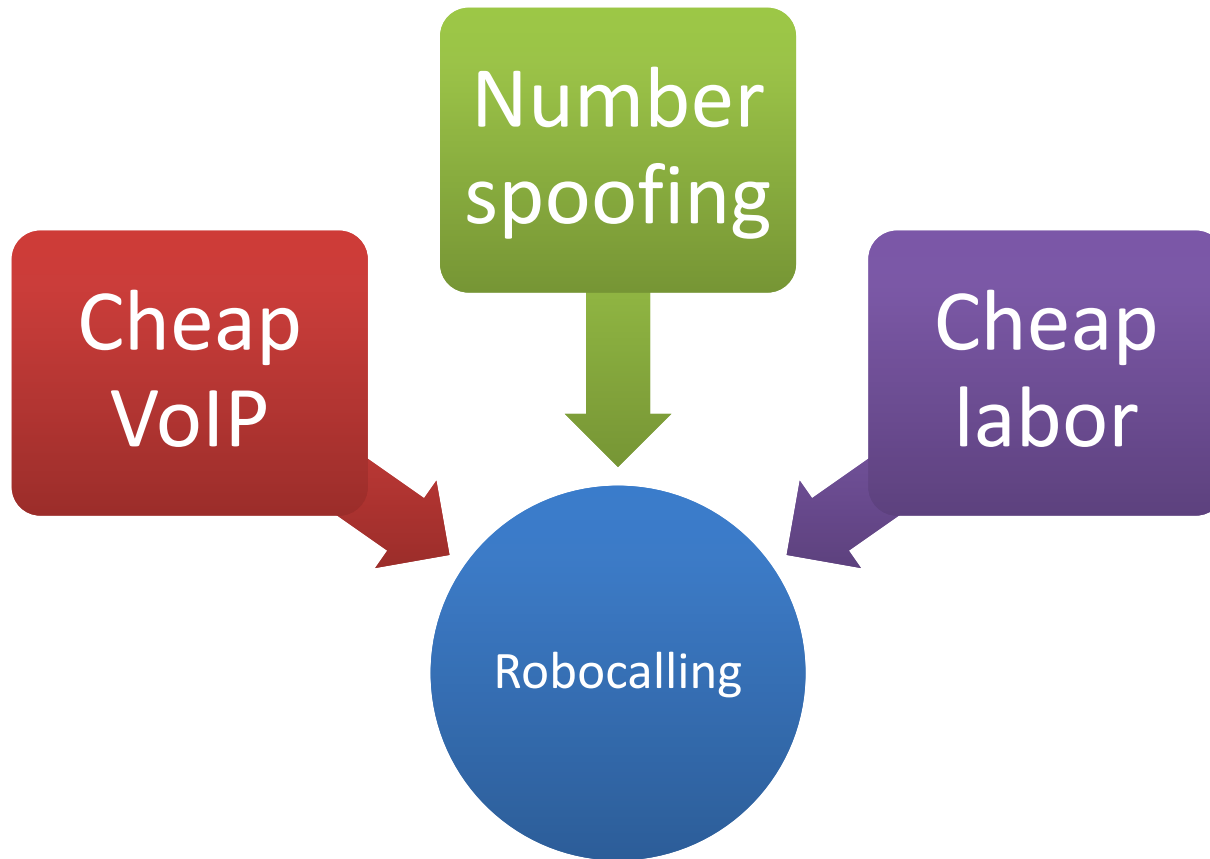
Robocalling

Law enforcement vs. robocallers

- Agile numbering
- Automated customer acquisition
- Transnational

- One faxed subpoena at a time
- Manual trace-back
- Largely domestic

What has changed?

one assigned number

customer

local exchange carrier

can't tell end user from provider → can use any number

Why not use email spam filtering techniques?

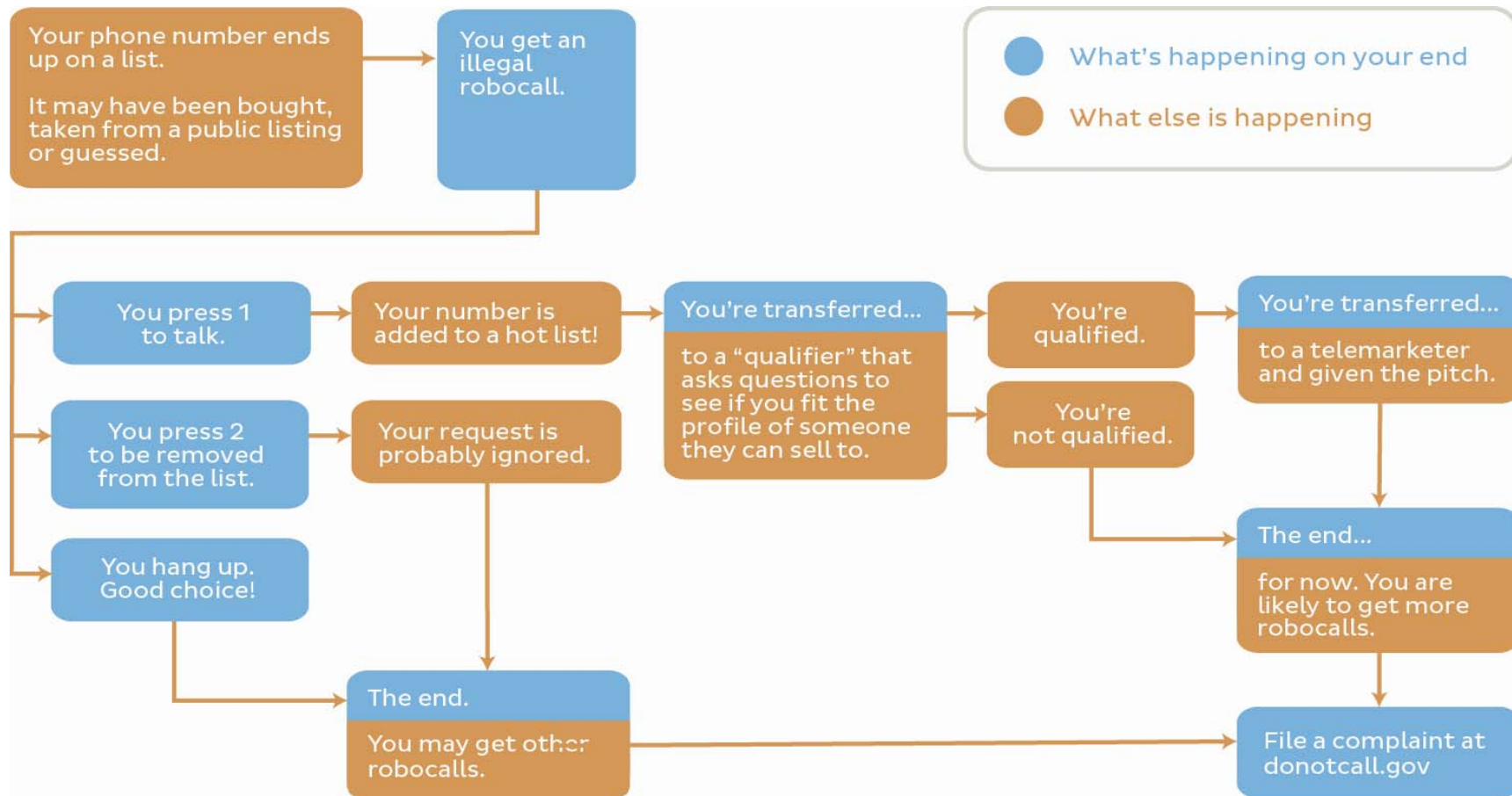|	Email	Phone calls
Name space	infinite	relatively small
Content inspection	common	not possible
Addresses	*IP address* – non-spoofable for TCP *Email address* – easily spoofable	*Phone number* -- spoofable
Delivery	filtered by provider: • block lists (e.g., Spamhaus) • SPF, DKIM	interconnection and delivery obligations
Delivery trace	**Received-by** headers	**Via** headers – only for end-to-end VoIP calls
Limited-use address	easy (e.g., web mail)	not feasible
Consent-based	CAPTCHA systems (not common)	likely too annoying

see also RFC 5039

Most robocalls follow one of these paths.

ROBOCALLS
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Legend:
- (blue) What's happening on your end
- (orange) What else is happening

Flowchart:

Your phone number ends up on a list.

It may have been bought, taken from a public listing or guessed.
→ You get an illegal robocall.

You press 1 to talk. → Your number is added to a hot list! → You're transferred... to a "qualifier" that asks questions to see if you fit the profile of someone they can sell to. → You're qualified. → You're transferred... to a telemarketer and given the pitch.

→ You're not qualified. → The end... for now. You are likely to get more robocalls.

You press 2 to be removed from the list. → Your request is probably ignored. → The end. You may get other robocalls.

You hang up. Good choice! →

→ File a complaint at donotcall.gov

Future, part 1: trustable phone numbers
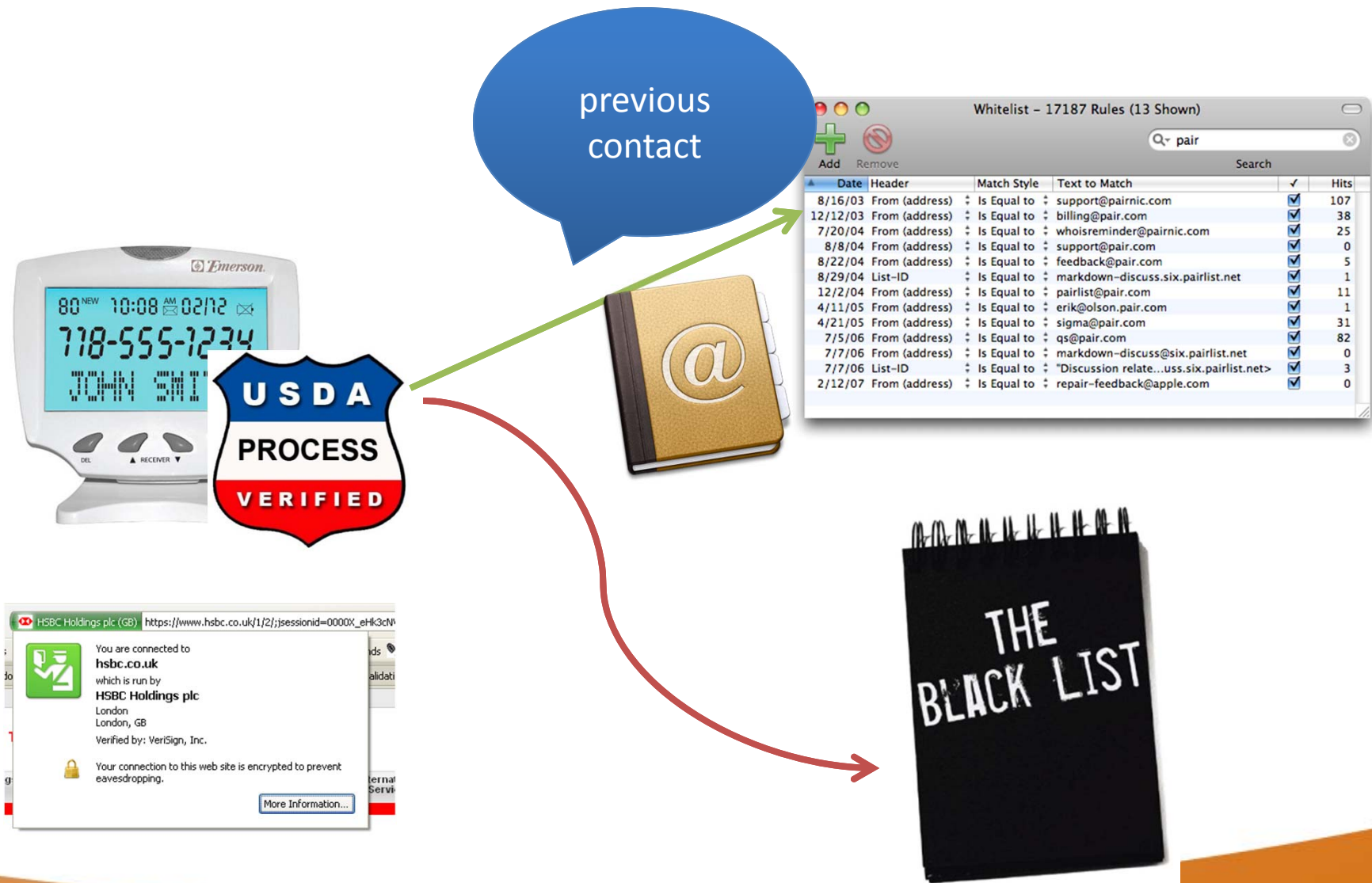
Via: SIP/2.0/TLS client.biloxi.example.com:5061;branch=z9hG4bKnashds7
;received=192.0.2.201

trace call route

VoIP provider A

VoIP provider B

§ § §

automatically route subpoena

SHERIFF

Conclusion

- VoIP advantages (low cost, distance-insensitivity) also help robocallers

- Limited consumer remedies
  - number spoofing

- Difficult law enforcement
  - trans-national robocaller ecosystem
  - manual and tedious traceback

- Need to address both caller authentication and traceback