I Want My Voice to Be Heard:

IP over Voice-over-IP for Unobservable Censorship Circumvention

Amir Houmansadr (The University of Texas at Austin)
Thomas Riedl (University of Illinois at Urbana-Champaign)
Nikita Borisov (University of Illinois at Urbana-Champaign)
Andrew Singer (University of Illinois at Urbana-Champaign)

Internet Censorship

- The Internet is a big threat to repressive regimes!
- Repressive regimes **censor** the Internet:
 - IP filtering, DNS hijacking, Deep packet-inspection, etc.
- Circumvention systems



New stage in the arms race

The threat model has changed

Past: detect circumvention end-pointsNow: detect circumvention traffic also

We need traffic unobservability against passive, active, or proactive analysis

A recent approach

- A promising approach: hide circumvention traffic within popular Internet protocols
 - Censors are unlikely to completely block that protocol
- A new trend: **mimic** the target protocol
 - SkypeMorph, Stego Forus, and CensorSpoofer (CCS'12)
- It's hard to imitate network protocols
 The Parrot is Dead: Observing Unobservable Network
 Communications [Oakland'13]

Our approach

- We seek the same objective, but take a different approach:
 Run the target protocol
- By running the target protocol no need to worry about implementation quirks, bugs, protocol details
- Challenge: how to *efficiently* encapsulate traffic into the target protocol

FreeWave: IP over Voice-over-IP

Target protocol: Voice-over IP (VoIP)

- Why VolP
 - Widely used protocol (only 663 Million Skype users)
 - Collateral damage to block
 - Encrypted
- How to hide?
 - The dial-up modems are back!





System components



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MoDem component

- A typical acoustic modem
 - QAM modulation
- Reliable transmission
 - Turbo codes
 - Use Preambles



Evaluations

Client location	M	oDem parar	neters	Data rate	Packet
	Q	1/T	R_C	Data Tate	drop rate
Berlin, Germany	4	8 kHz	0.5	16000 bps	0
Frankfurt, Germany	4	8 kHz	0.5	16000 bps	0
Paris, France	4	8 kHz	0.5	16000 bps	0
Maidenhead, UK	4	8 kHz	0.5	16000 bps	0
Manchester, UK	4	8 kHz	0.5	16000 bps	0
Lodz, Poland	4	8 kHz	0.5	16000 bps	0.06
Chicago, IL	4	9.6 kHz	0.5	19200 bps	0.01
San Diego, CA	4	9.6 kHz	0.469	18000 bps	0

FreeWave's unobservability

• Comprehensive unobservability at the protocol level

- Traffic analysis (packet rates and sizes)
- ➢ Fixed rate codecs (e.g., G.7 series)
 - Not an issue 🙂
- ➢ Variable bit-rates (e.g., Skype's SILK)
 - Simple analysis

Pattern	FreeWave over Skype	Skype-Speak	Skype-Silent
Average packet rate (pps)	49.91	50.31	49.57
Average packet size	148.64	146.50	103.97
Minimum packet size	64	64	64
Maximum packet size	175	171	133

Superimpose with recoded conversation







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Future directions

... IP over Voice over IP over Voice-over-IP

• Embed into Video of VoIP

- Find other protocol to tunnel
 - Look for better **efficiency**

Questions!

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