Secure Origin Fallback Mechanism

draft-rescorla-callerid-fallback

(to be submitted)

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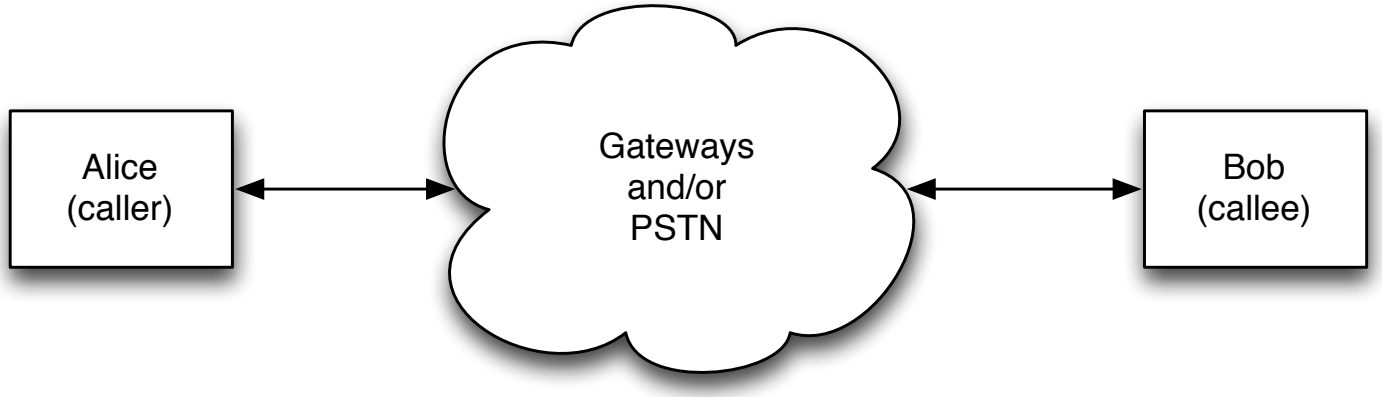
Not-so-secret workshop

May 31, 2013

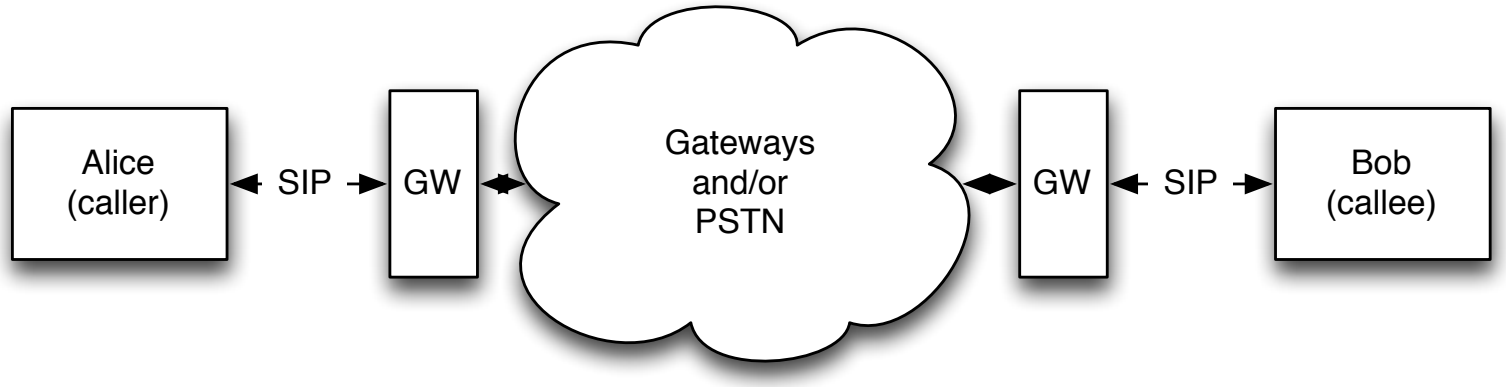
Overview

- RFC 4474 can provide secure origin information
- But SBCs and/or gateways break 4474
  - Change headers
  - Recreate call entirely
- Need to provide source authentication that can survive this
- Basic idea: "Call Detail Service" that validates existence of a call

Basic Setting



Alternate Setting



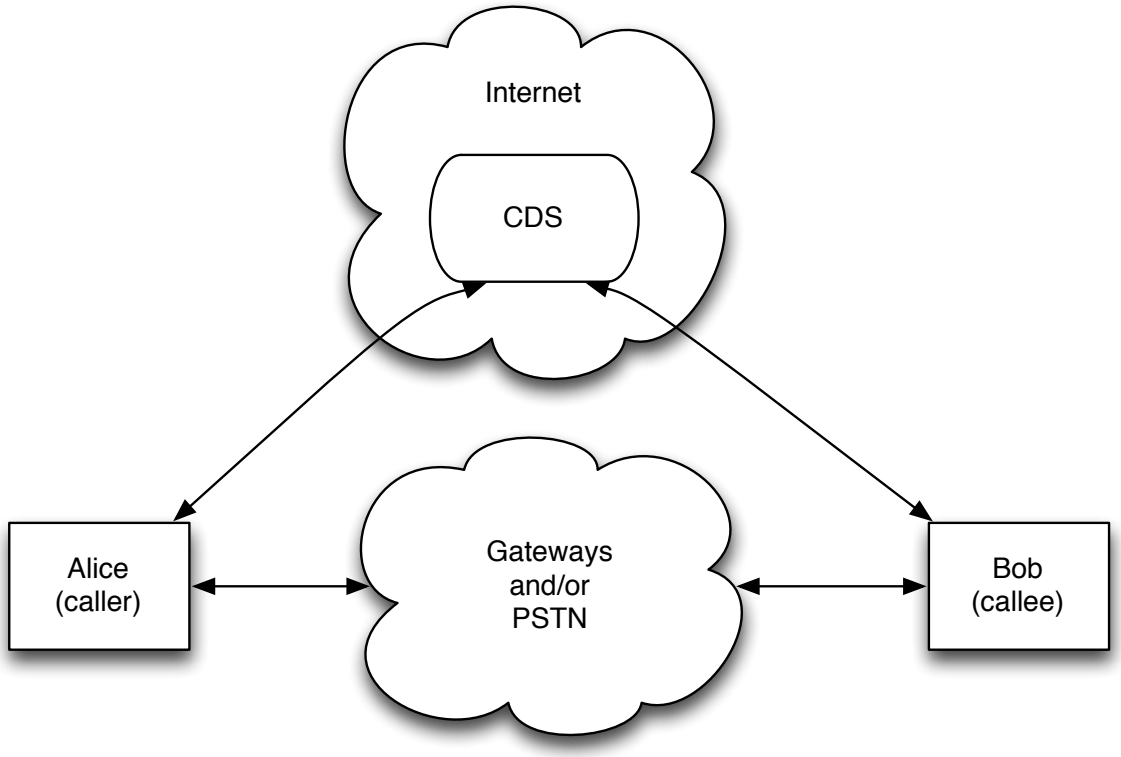
Assumptions (see Jon's talk)

- Endpoints are programmable
  - User has a smartphone, softphone, etc.
  - User has a dumb phone but is serviced by a programmable gateway
- Very restricted channel between endpoints
  - Effectively just a PSTN call
  - Caller cannot reliably control caller-id information (CIN field)
- Each E.164 is associated with cryptographic credentials
  - Usable for encryption, authentication, etc.

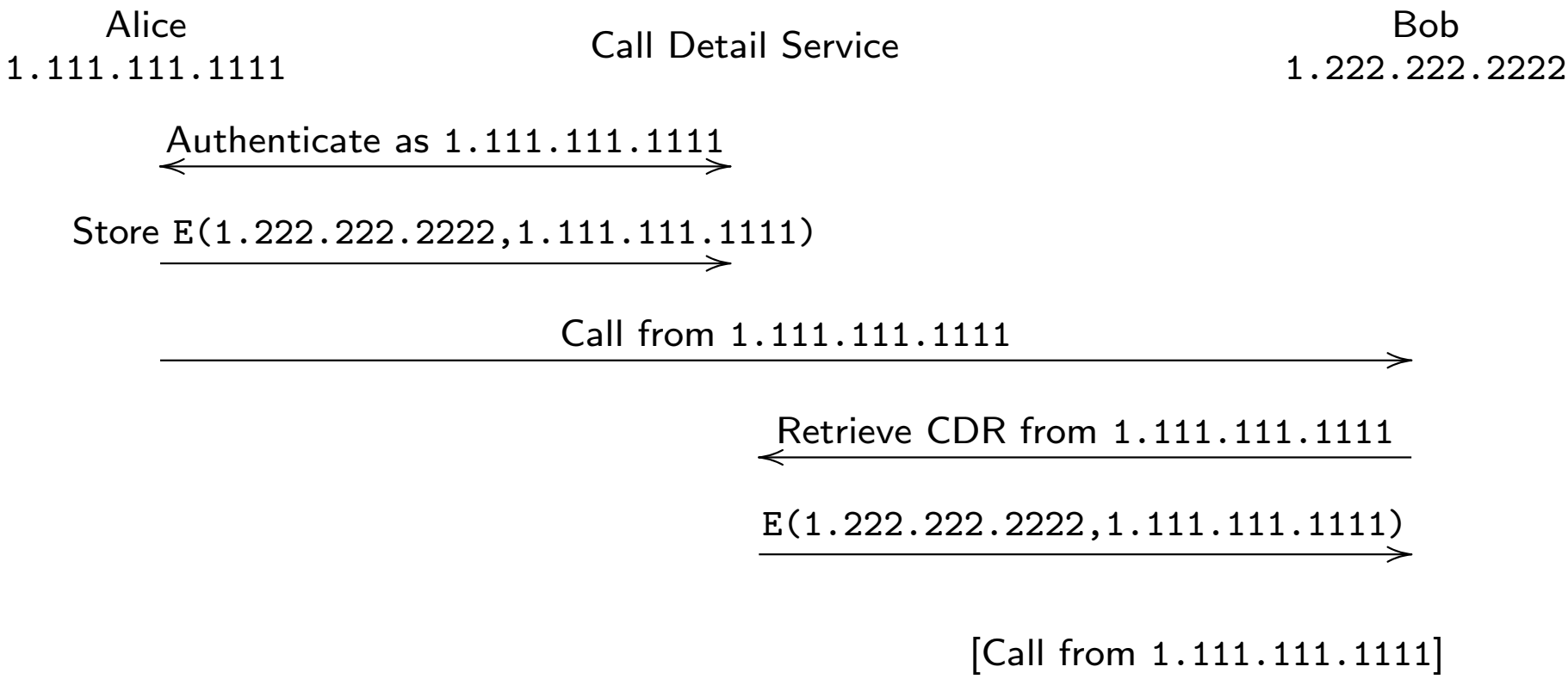
Credentials

- This assumes that each phone number is associated with credentials
- Requirements
  - Bind an E.164 number to key(s)
  - Suitable for both encryption and authentication
  - Possible to quickly retrieve the credentials for any number
- Example: a public key certificate with the E.164 number as subject

System Architecture



Call Flow


Alice
1.111.111.1111
Call Detail Service
Bob
1.222.222.2222
Authenticate as 1.111.111.1111
Store E(1.222.222.2222,1.111.111.1111)
Call from 1.111.111.1111
Retrieve CDR from 1.111.111.1111
E(1.222.222.2222,1.111.111.1111)
[Call from 1.111.111.1111]

Caller Behavior

- Look up callee's credentials (may be cached)
- Sign and encrypt CDR for callee*
- Contact the CDS
  - Authenticate as the caller
  - Store encrypted CDR
- Initiate call to callee

*Special formats needed; must not contain recipient's identity in the clear.

CDS Behavior

- Only store credentials from authorized callers
  - This prevents spamming the CDS
- Provide CDR to any responder
- What if no CDR exists?
  - Generate a random CDR(s)
  - This helps mask the calling rate
    - Though not so well for high-rate callers such as call centers

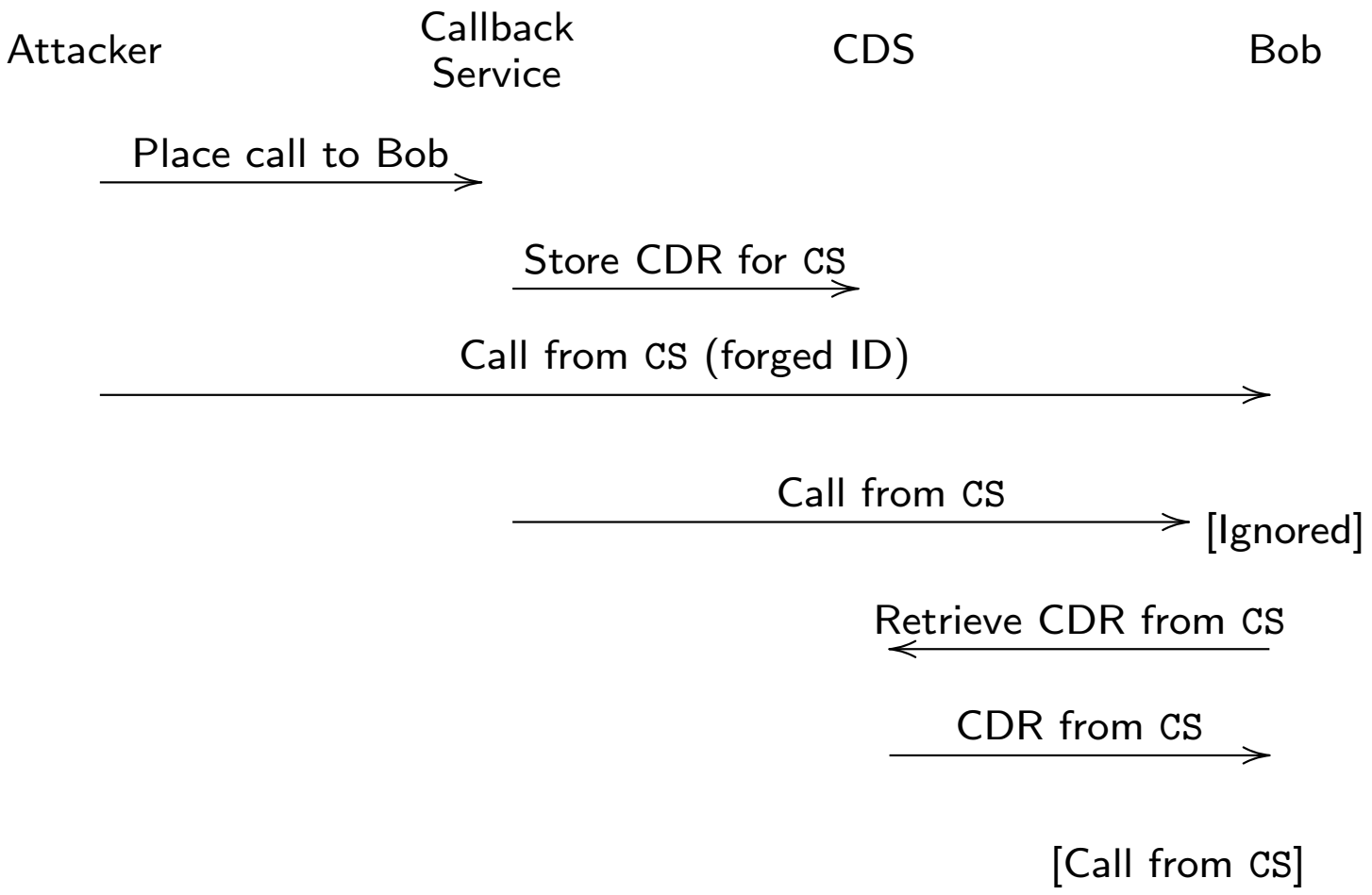
Callee Behavior

- Retrieve encrypted CDR from CDS using claimed caller number
- Decrypt CDR using private key
- Verify CDR signature matches caller's alleged identity
- Check timestamp for relevance (replay prevention)

What are the security guarantees?

- There exists a relatively recent call from caller to callee
  - Assuming credentials not compromised, etc.
- No guarantee that it is *this* call
- This defends against robocalling but not MITM attacks

Substitution Attack



Privacy Properties I: Off-path Attackers

- Cannot determine anything about who is calling who
- Cannot determine how many calls a callee is getting
- Limited information about how many calls a caller is generating
  - By polling caller number
  - Can tell if it is more than the minimum number of fake CDRs the CDS generates

Privacy Properties II: On-path Attackers (to CDS)

- Cannot directly tell who is calling who
  - Assuming communications to CDS are encrypted
- If call volumes are low, can do traffic analysis
  - Alice and Bob both contacted the CDS within a few seconds
- Can measure call volumes for caller and callee
  - Unless they are hidden behind some kind of proxy (Tor, etc.)

Privacy Properties III: CDS

- Anything an on-path attacker can do
- Can directly measure caller's call volume

Federated CDSs

- Don't need to have one giant CDS
- Each user can select their own CDS
  - Indicated in their credentials?
  - Or delegated from the master CDS?
- This does not need to be exact
  - Callers can fall back (or be bounced) to master CDS during transitions

What about the Credential Service?

- All callers and callees need to have credentials
- Must be possible for any caller to get callee credentials
  - Quickly
  - Somewhat privately
  - Possible design approaches
    - Pre-fetch plus pub-sub
    - Caching servers/proxies (a la DNS)
- Caller can provide the callee with his credentials

How important is credential timeliness?

- Attacker has caller's credentials
  - Can forge calls from attacker
- Attacker has callee's credentials
  - Can poll for calls to callee
  - But probably only for a small number of callers
- Compromise versus reassignment?
  - Can we not reassign during credential validity window?
  - This lets us make validity windows longer
  - Doesn't do anything for compromise
- What is the minimum detection time?

Escalation to VoIP

- Everything here has assumed that calls are carried through PSTN
  - What about VoIP?
  - Provides more features and better security (See Jon's talk)
- CDRs can contain more than just the caller/callee number
  - For instance, a SIP URI
    - Similar concept to VIPR
- How aggressive should we be about this kind of upgrade?

Why not store under callee's number? (Barnes)

- No need for CDS to verify caller
- Avoids trial decryption stage
- Hard to avoid spamming of CDS
  - Could be mitigated by authenticated proxies?
- Doesn't let callee control privacy properties
  - If caller doesn't use a proxy then CDS can do traffic analysis

Why not...?

- Insert a correlation token in the caller's number
  - Could use it to store CDR
  - Assumed not to be possible
- Store under a hash of the caller's number
  - Better privacy but requires sending more traffic from CDS-¿callee
- Store under a hash of the caller + callee's number
  - May make privacy situation worse
  - Unless hash is shorter than either number
  - Very weak if either side is known
- Is there a practical Private Information Retrieval (PIR) protocol we can use here?

Questions?