Proposed WebRTC Security Architecture

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Trust Model

- Browser acts as the *Trusted Computing Base* (TCB)
  - Only piece of the system user can really trust
  - Job is to enforce user's desired security policies
- Authenticated entities
  - Identity is checked by the browser (sometimes transitively)
- Unauthenticated entities
  - Random other network elements who send and receive traffic

Authenticated Entities

- Examples:
  - Calling services (known origin)
  - Identity providers
  - Other users (when cryptographically verified)
  - Sometimes network elements with the right topology (e.g., behind our firewall)
- Authenticated $\neq$ trusted: Dr. Evil is still evil even if I know it's him
  - But authentication is the basis of trust decisions
  - And maybe I want to call Dr. Evil after all...

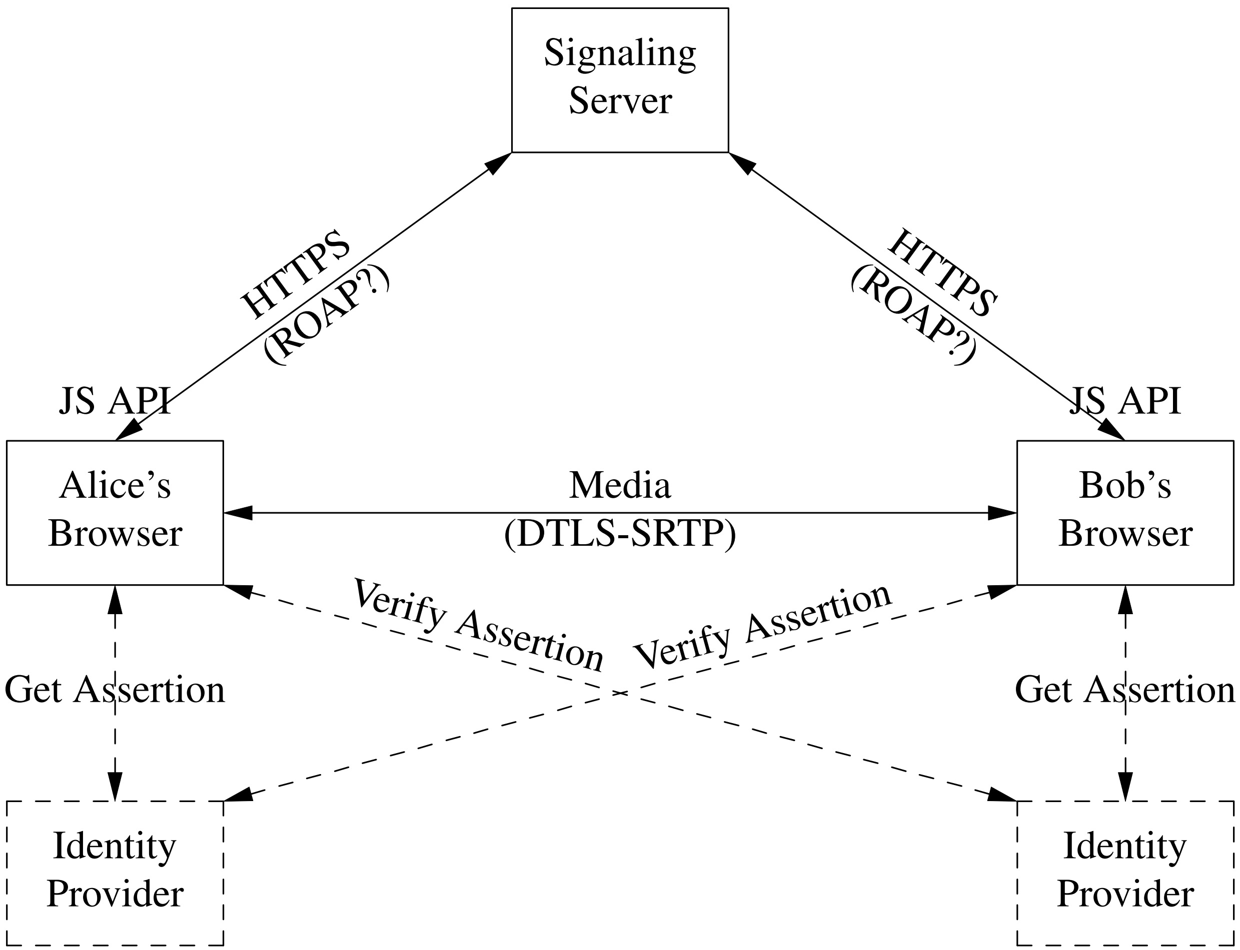
Unauthenticated Entities

- Pretty much anyone else
  - Generally cannot be trusted
- But can still be used when behavior can be verified
  - ICE reachability testing
  - Transit data which is cryptographically verified

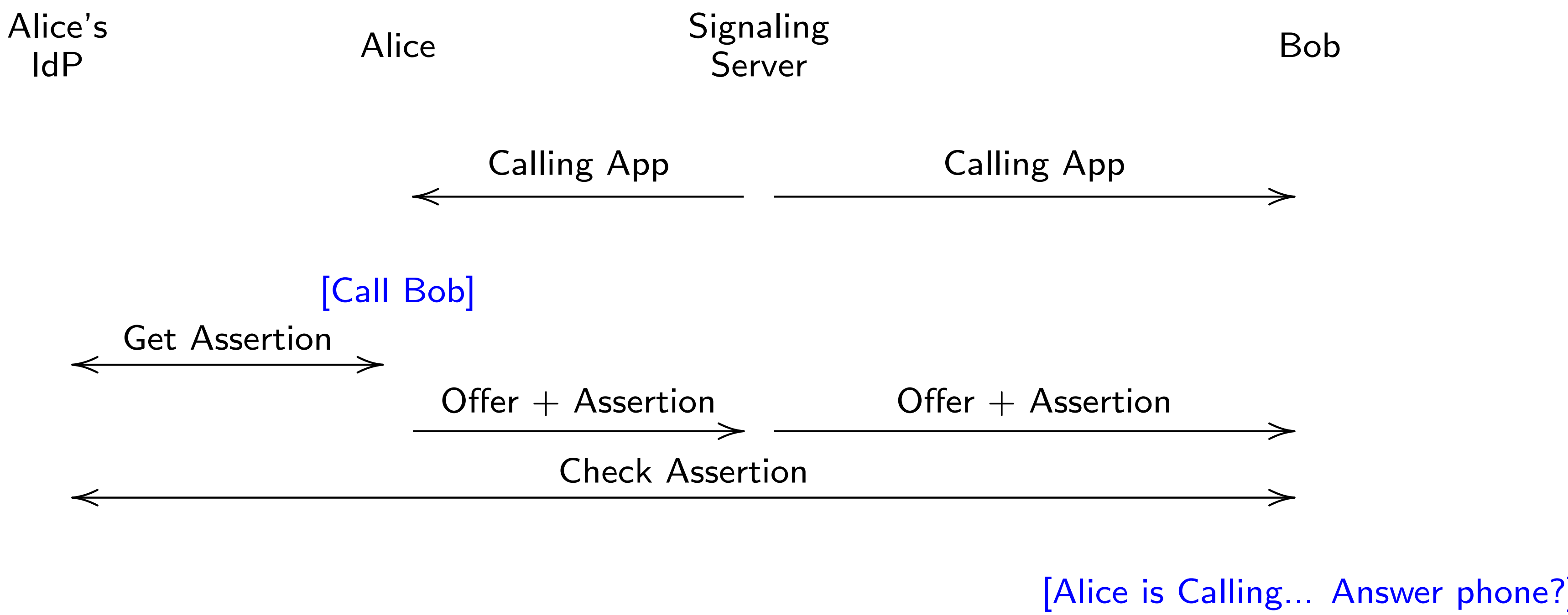
Basic Design Principle: As good a job as we can

- It's always safe to browse the Web
  - Even to malicious sites
- Calls are encrypted wherever possible
  - At minimum between WebRTC clients unless the site takes direct action [Open issue warning]
- When available directly verify the far side
  - Minimizes required trust in calling site
  - Be compatible with as many identity providers as possible

Overall Topology

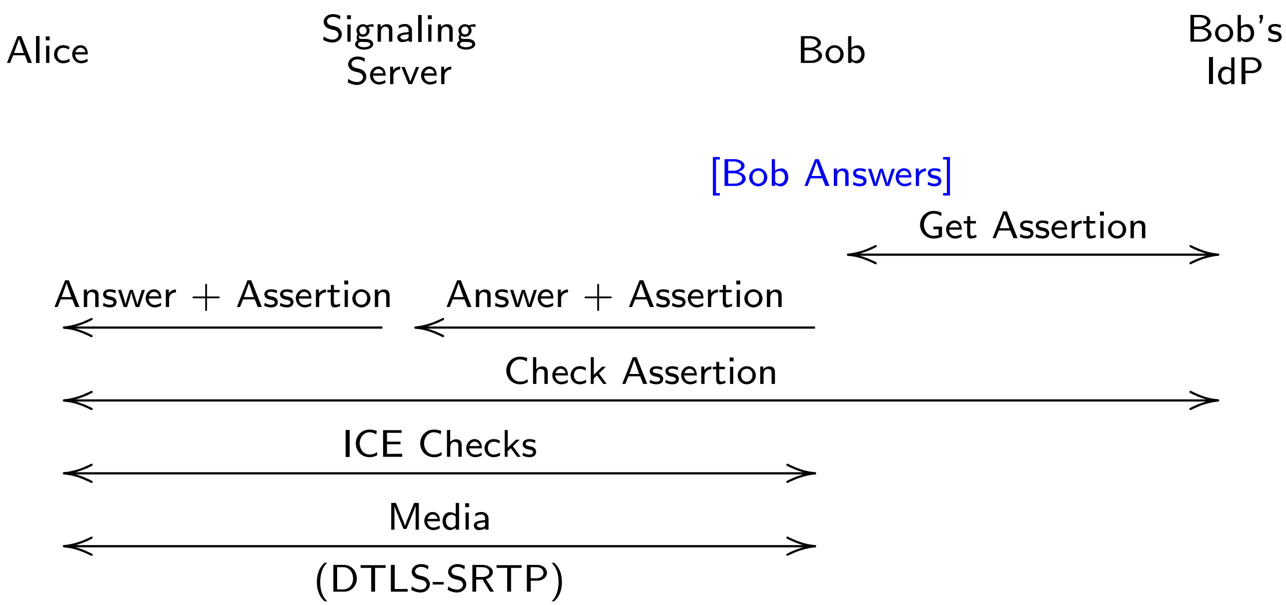


Call Flow (I)



- Bob knows Alice is calling [verified with IdP]
  - Browser can display trusted UI for Alice's identity
  - If in address book, maybe name, picture, etc.
- If no IdP, Bob knows signaling service claims Alice is calling

Call Flow (II)



- Alice knows Bob has answered
  - Verified with Bob's identity provider
- Alice and Bob know media is not flowing to innocent third parties (media consent)
- Alice and Bob know they have a secure call with each other
  - Security details displayed via trusted UI

Permissions Models

- One-time camera/microphone access [MUST]
- Permanent camera/microphone access (scoped to origin) [MUST]
- User-based permissions [SHOULD]
  - Allow calls to this verified user
  - Allow calls to any verified user in my system address book (on some set of sites?)

- Data channels MAY be created without user consent

Permissions API

- MUST provide a mechanism to distinguish permissions type
  - E.g.,
    `new PeerConnection({permission:'PERMANENT', ...})`
  - Allows the browser to display different UIs for each permissions level
- MUST provide a mechanism to relinquish any media stream access
  - E.g., via `MediaStream.record()`
  - Allows a site to commit not to observing your data
  - Needs to be reflected in a trusted UI

Who "owns" the permissions"

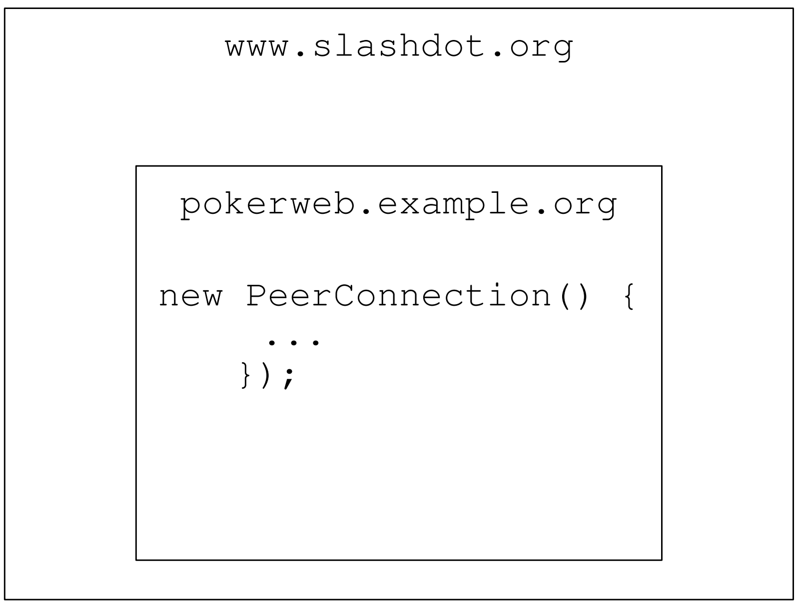
- Question: which operation triggers the permissions check?
  - `mediaStream` creation
  - `peerConnection.addStream()`
  - `peerConnection.setLocalDescription()`
  - `peerConnection.setRemoteDescription()`
- This has UI and programmer implications
- An even bigger issue if API doesn't work in terms of SDP at all

Permissions UI

- MUST clearly indicate when the camera/microphone are in use
- SHOULD stop camera and microphone when UI indicator would be masked
  - E.g., window overlap
- SHOULD provide a distinctive UI when user's identities are directly verifiable

Why HTTP origins are a problem

- Assumption: I've authorized `http://www.example.com`
- I'm in an Internet Cafe and visit any URL
  - Attacker injects IFRAME pretending to be PokerWeb
  - But calls go to him



- Result: attacker has bugged your computer
- Violates the Web security model

Web Security Issues

- MUST treat HTTP and HTTPS origins as different permissions domains
  - e.g., `http://example.com/` and `https://example.com/` are different
- Active mixed content MUST NOT be treated as if it were the HTTPS origin
  - **[OPEN ISSUE]**: How do we do this exactly?

Web Security and State Machine in JS

- Proposal is to split up state machine logic
  - ICE in browser
  - SDP/Media negotiation in JS
  - Develop a library to assist in SDP/Media negotiation
- Where to JS libraries come from?
  - Standard procedure is to download from a CDN
  - E.g.,

    `<script src="http://ajax.googleapis.com/ajax/libs/jquery/1.7.0/jquery.min.js">`
  - At minimum you want HTTPS (not all CDNs do this)
  - CDN is now inside security boundary
- Not clear how different this is
  - Lots of sites use JQuery, underscore, etc. anyway

Communications Consent

- All direct communications MUST be verified via ICE
- The ICE stack MUST be constructed so that the JS cannot obtain the transaction id
  - This means that at minimum STUN must in browser
- Implementations MUST verify continuing consent at least every 30 (?) seconds
- **OPEN ISSUE**: How to verify continuing consent?
  - ICE keepalives are STUN Binding Indications (one-way)
  - Proposal: use STUN Binding Requests instead

IP Location Privacy

- Setting up a direct connection leaks an agent's IP address
  - And hence information about its location
- API MUST allow suppression of ICE negotiation until the user accepts session
- API MUST provide a mechanism to do TURN-only candidates
  - SHOULD allow conversion to non-TURN once peer identity is verified [Jesup]
- No need to have browser enforce user consent
  - A malicious site can get your IP address anyway
  - If you are running Tor, you want the browser to do media through Tor, though

Communications Security: Implementation Requirements (Proposed)

- MUST implement DTLS-SRTP (for media) and DTLS (for data)
- MAY implement RTP(?) and SDES(??) for backward compatibility purposes
- Security MUST be default state
  - Implementations MUST offer DTLS and/or DTLS-SRTP for every channel
  - MUST accept DTLS and/or DTLS-SRTP whenever offered *

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*Somewhat harder with a low-level API, but still possible with the right design.

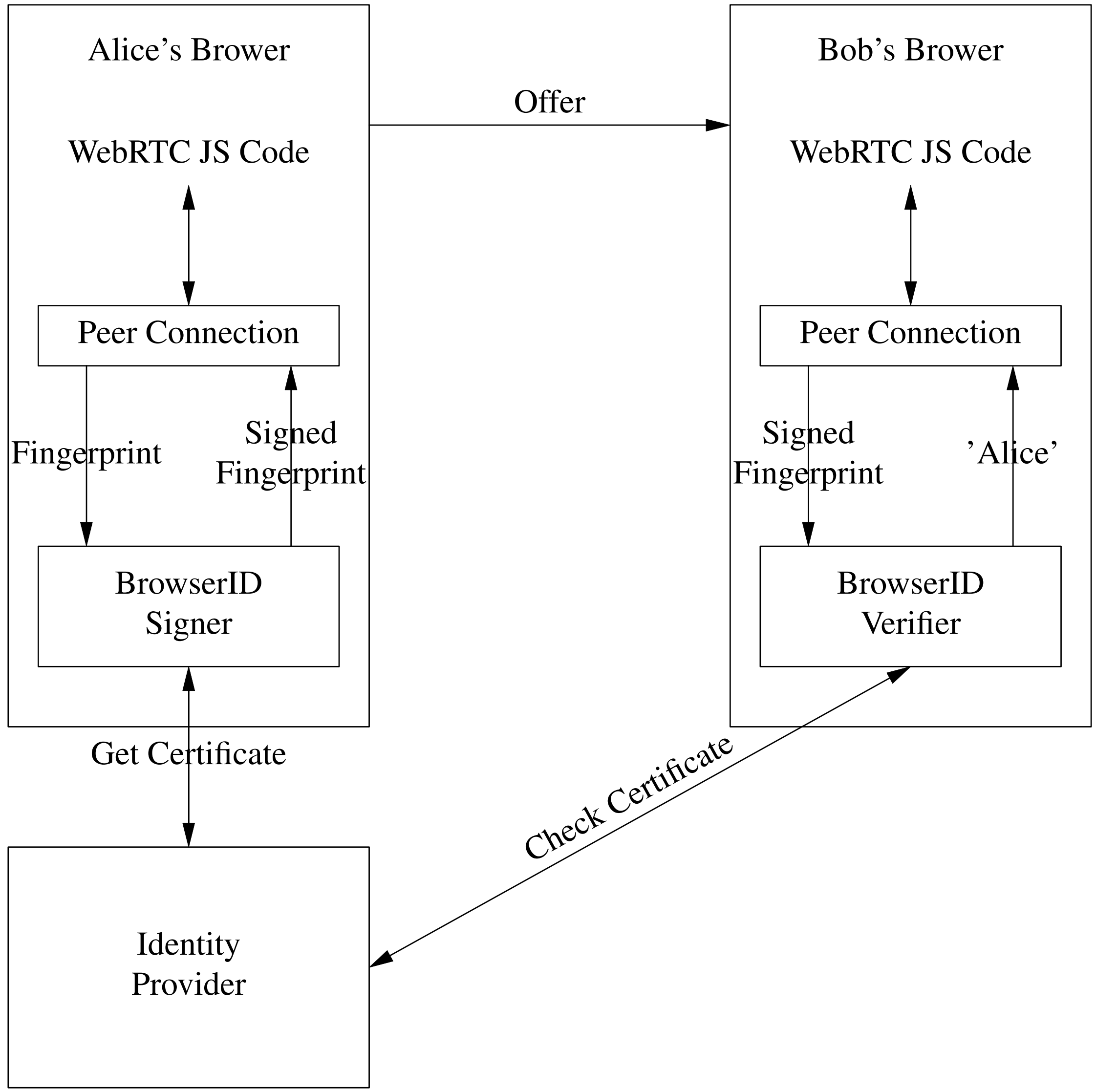
Communications Security: API Requirements

- Implementations MUST support PFS modes
- Implementations MUST allow JS to force new long-term key generation
  - E.g., `new PeerConnection({new_authentication_key:true,...})`
  - This allows unlinkability
- Implementations SHOULD allow JS to set authentication key lifetime
  - This allows key continuity
- When DTLS is used, API MUST NOT provide access to the traffic keying material

Communications Security: UI [based on draft-kaufman-rtcweb-security-ui]

- MUST provide a security inspector interface in browser chrome
- Up-front items
  - Security characteristics of incoming stream
  - Security characteristics of outgoing A/V
  - Whether the transmission keys were pairwise derived or provided by a server
  - Verified far endpoint identity if available
- With drill-down
  - Cipher suites
  - PFS yes or no
  - Out-of-band verification mechanism such as fingerprint or SAS

Example IdP Interaction: BrowserId



Example ROAP OFFER with BrowserID

```
{
  "messageType":"OFFER",
  "callerSessionId":"13456789ABCDEF",
  "seq": 1
  "sdp":"
v=0\n
...
4A:AD:B9:B1:3F:82:18:3B:54:02:12:DF:3E:5D:49:6B:19:E5:7C:AB\n",
 "identity":{
    "identityType":"browserid",
      "assertion": {
      "digest":"<hash of fingerprint and session IDs>",
      "audience": "[TBD]"
      "valid-until": 1308859352261,
     }, // signed using user's key
     "certificate": {
       "email": "rescorla@gmail.com",
       "public-key": "<ekrs-public-key>",
       "valid-until": 1308860561861,
     } // certificate is signed by gmail.com
     }
}
```

Example JSEP Transport Info with BrowserID

```
{
 "name":"audio",
 "fingerprint":{
    "algorithm":"SHA-1",
    "digest":"4A:AD:B9:B1:3F:82:18:3B:54:02:12:DF:3E:5D:49:6B:19:E5:7C:AB"
 },
 "identity":{
    "identityType":"browserid",
      "assertion": {
      "digest":"<hash of fingerprint>",
      "audience": "[TBD]"
      "valid-until": 1308859352261,
     }, // signed using user's key
     "certificate": {
       "email": "rescorla@gmail.com",
       "public-key": "<ekrs-public-key>",
       "valid-until": 1308860561861,
     } // certificate is signed by gmail.com
  },
  "candidates:[...]
}
```

Generic Third-Party Identity Assertions [Warning: hard-hat area]

- We don't want to be tied to any identity provider or protocol
- Best case scenario: accomodate BrowserID, OAuth, OpenID, etc.
  - Without changing browser code
- Basic idea
  - Generic fixed downward interface from `PeerConnection`
  - IdPs provide adaptation layers to their own protocols
  - Potential avenues:
    * Load JS from a defined place on the site
    * Web intents
- Still working on this part (lots of help from Mozilla guys)

Questions?