P2PSIP, ICE, AND RTCWEB

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APPLICATIONS AND SERVICES IN INTERNET
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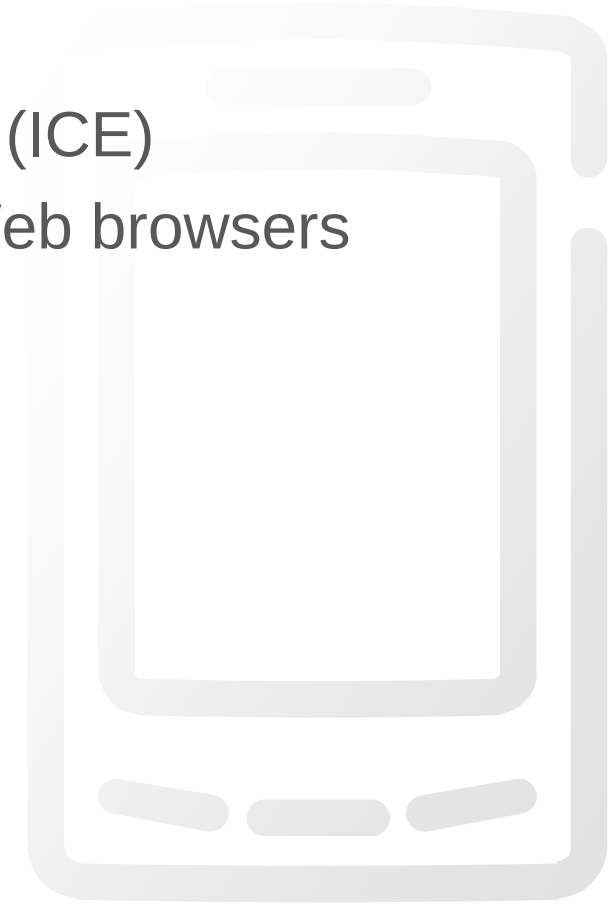
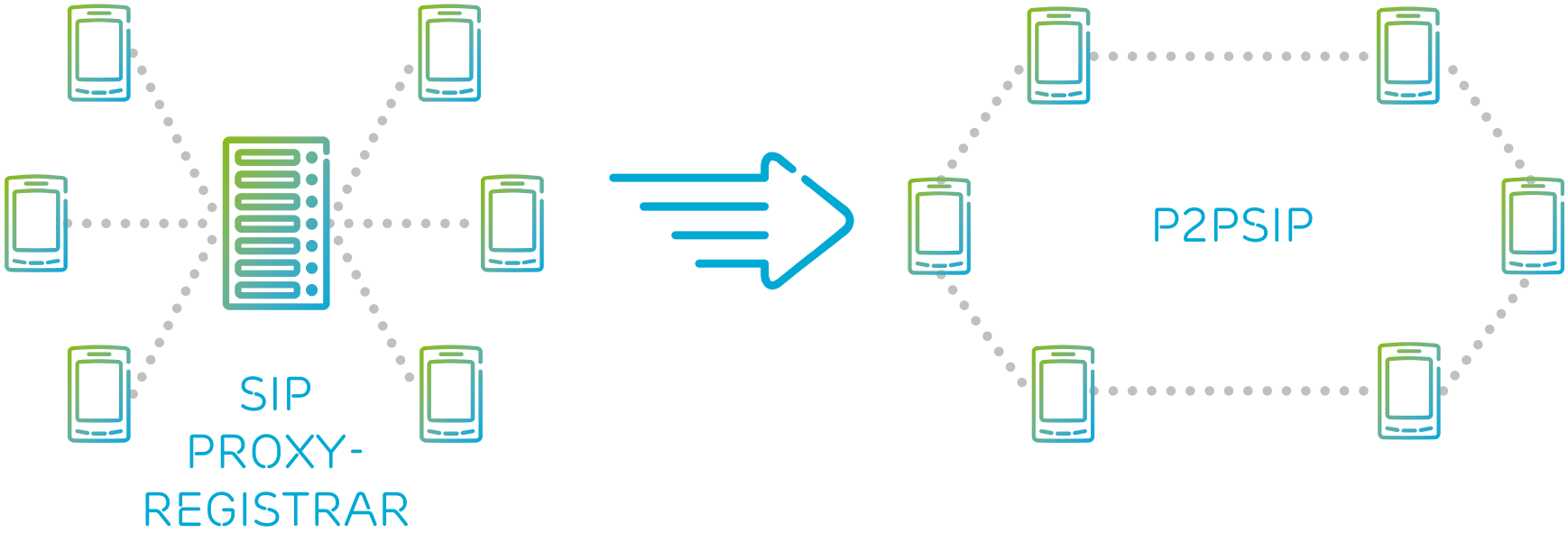
AGENDA

- Peer-to-Peer SIP (P2PSIP)
- Interactive Connectivity Establishment (ICE)
- Real-Time Communication between Web browsers (RTCWeb)
- Extending SIP
- SIP extensions



PEER-TO-PEER SIP OVERVIEW

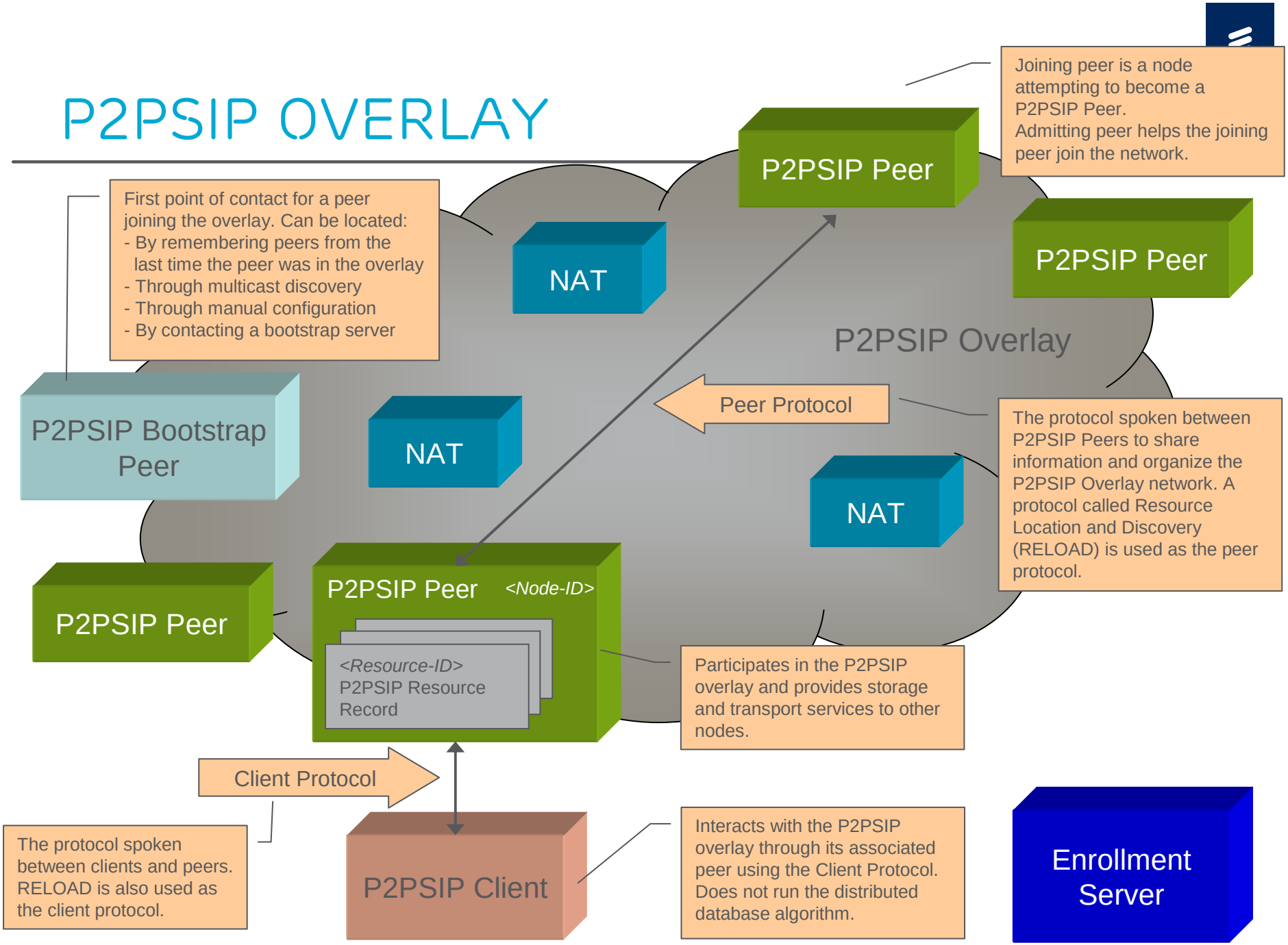
- Conventional **client/server SIP** relies on centralized proxy-registrar servers
- In Peer-to-Peer SIP (P2PSIP), SIP is used in an environment where the centralized functions are replaced by a **P2P overlay network**
- In the overlay network, address-of-record to contact URI mappings are distributed amongst the peers in the overlay
- P2PSIP is being standardized in the P2PSIP working group of the **IETF**
- ”Standardized Skype”



PEER-TO-PEER SIP IN IETF

- Standardized in the **P2PSIP Working Group** (WG) of the IETF
- The WG is responsible for:
  - Defining concepts, terminology, rationale, and use cases for P2PSIP
  - Standardizing a P2PSIP Peer and Client Protocols
  - Producing a usage document for P2PSIP
- Topics that are out of the scope of P2PSIP:
  - Issues specific to applications other than locating users and resources for SIP-based communications and presence
  - Research type of questions
  - Locating resources based on something other than URIs
  - Multicast and dynamic DNS based approaches as the core lookup mechanism

P2PSIP OVERLAY



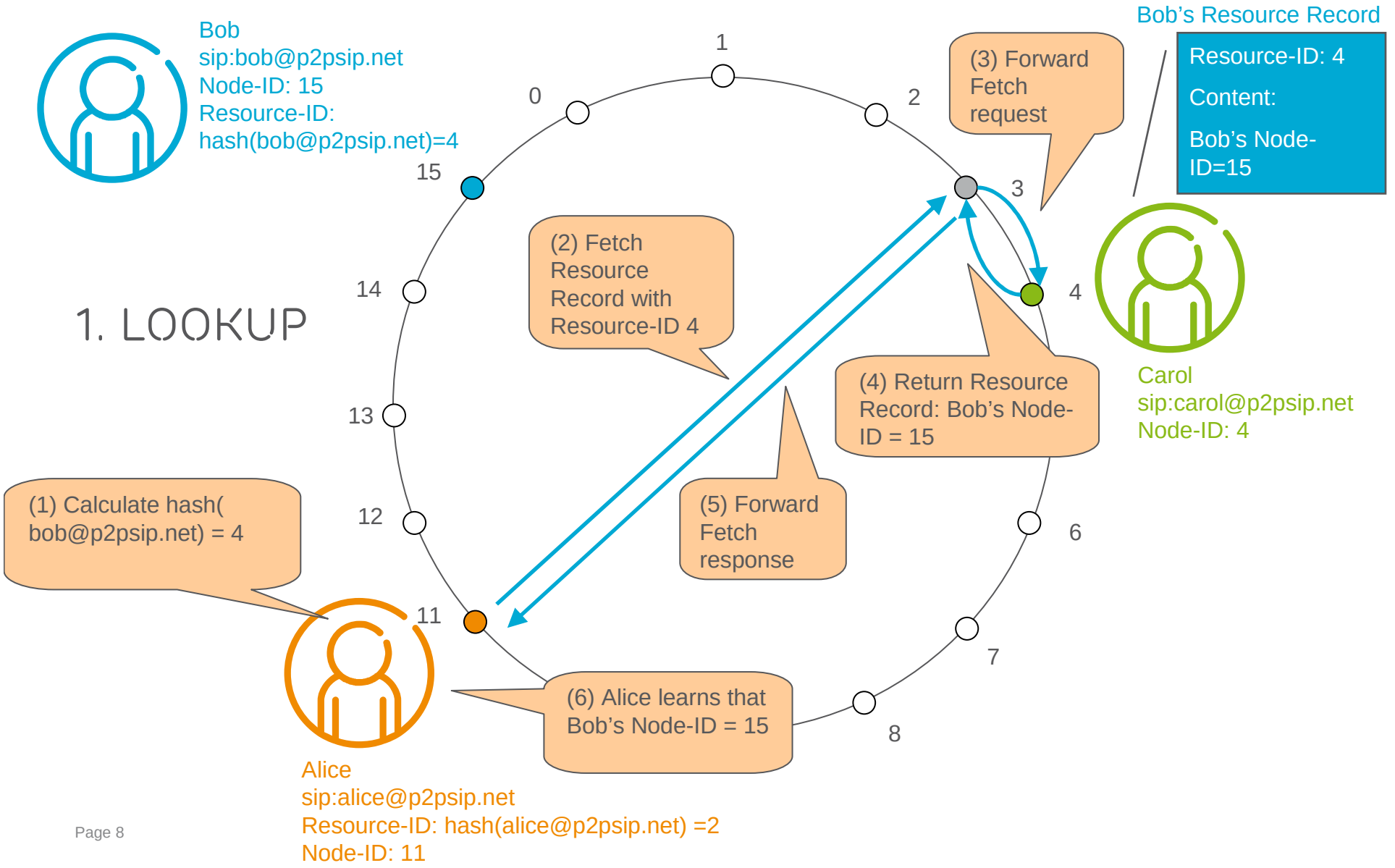
P2PSIP OPERATIONS (1/2)

- P2PSIP peers are capable of performing operations such as:
  - Joining and leaving
  - Store and fetch
  - Storing information on behalf of the overlay
  - Transporting messages
- **Joining**: to join a P2PSIP overlay, a joining peer needs to:
  - Contact an **enrollment server**
    - To obtain an overlay configuration document, **certificate** and **Node-ID**
    - Central enrollment process vs. self-generated certificates
  - Contact a **bootstrap peer**
    - The bootstrap peer will refer the joining peer to an **admitting peer**
  - Contact an admitting peer
    - The admitting peer will help the joining peer learn about other peers in the overlay and establish connections to them as appropriate

P2PSIP OPERATIONS (2/2)

- **Storing data**: to perform a user registration (i.e. to insert the user's contact information into the overlay), a user needs to:
  - Calculate a hash of her user name (e.g., *alice@example.com*) to produce a **Resource-ID:** hash(*alice@example.com*) = 32B4A7F02C
  - Locate the peer that is responsible for that Resource-ID
  - Store a <Resource-ID, Node-ID> mapping in the **responsible peer**
- **Fetching data**: to initiate a call:
  - Calculate a hash of the callee's user name to produce a Resource-ID
    - hash(*alice@example.com*) = 32B4A7F02C
  - Locate the peer that is responsible for that Resource-ID in the P2PSIP overlay
    - A P2PSIP Resource Record with contact information is obtained: *alice@example.com* → Alice's Node-ID
  - Establish a direct connection with the callee across NATs
  - Send a SIP INVITE request to the callee

EXAMPLE: ALICE CALLING BOB (1/3)



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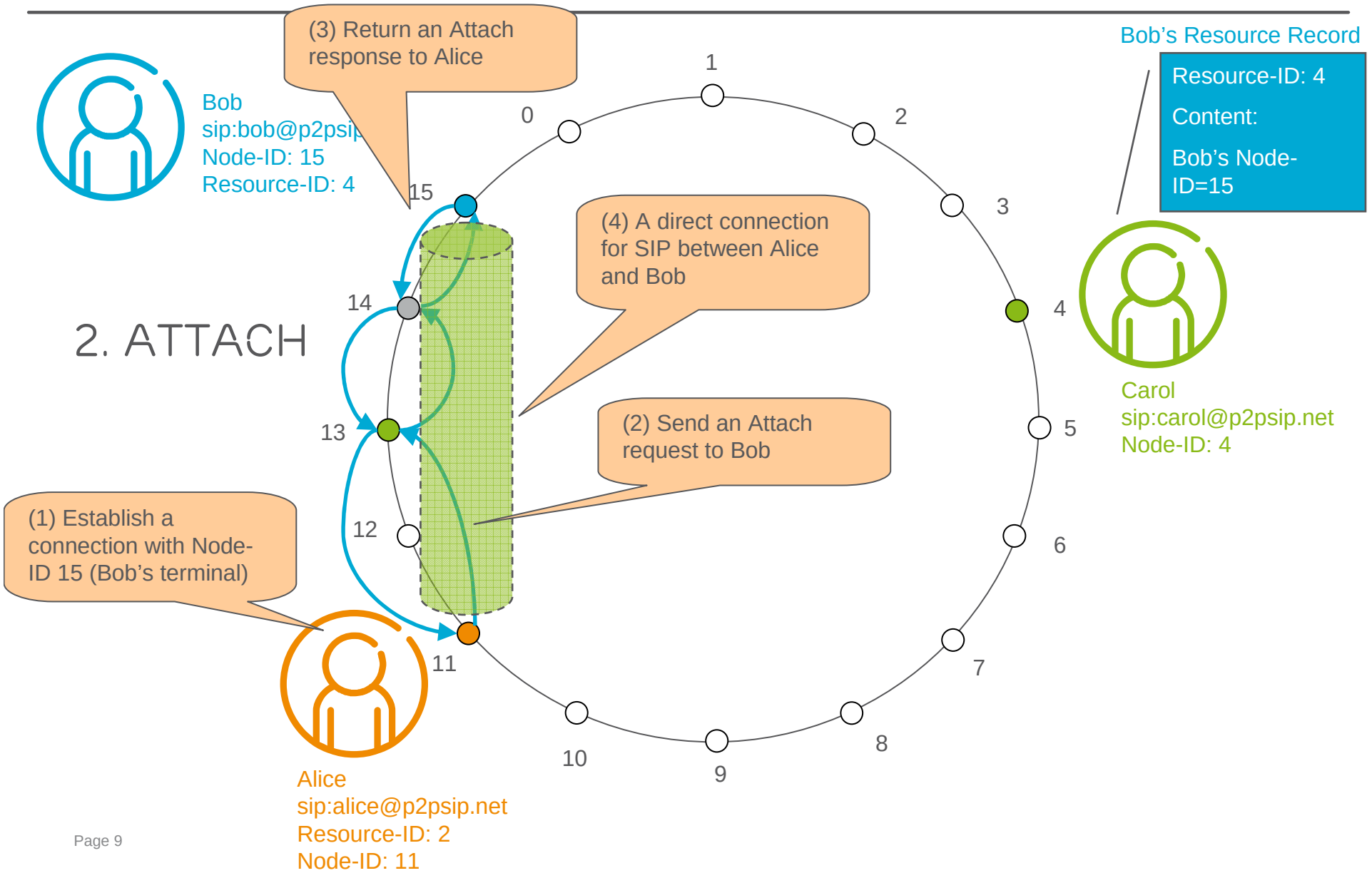
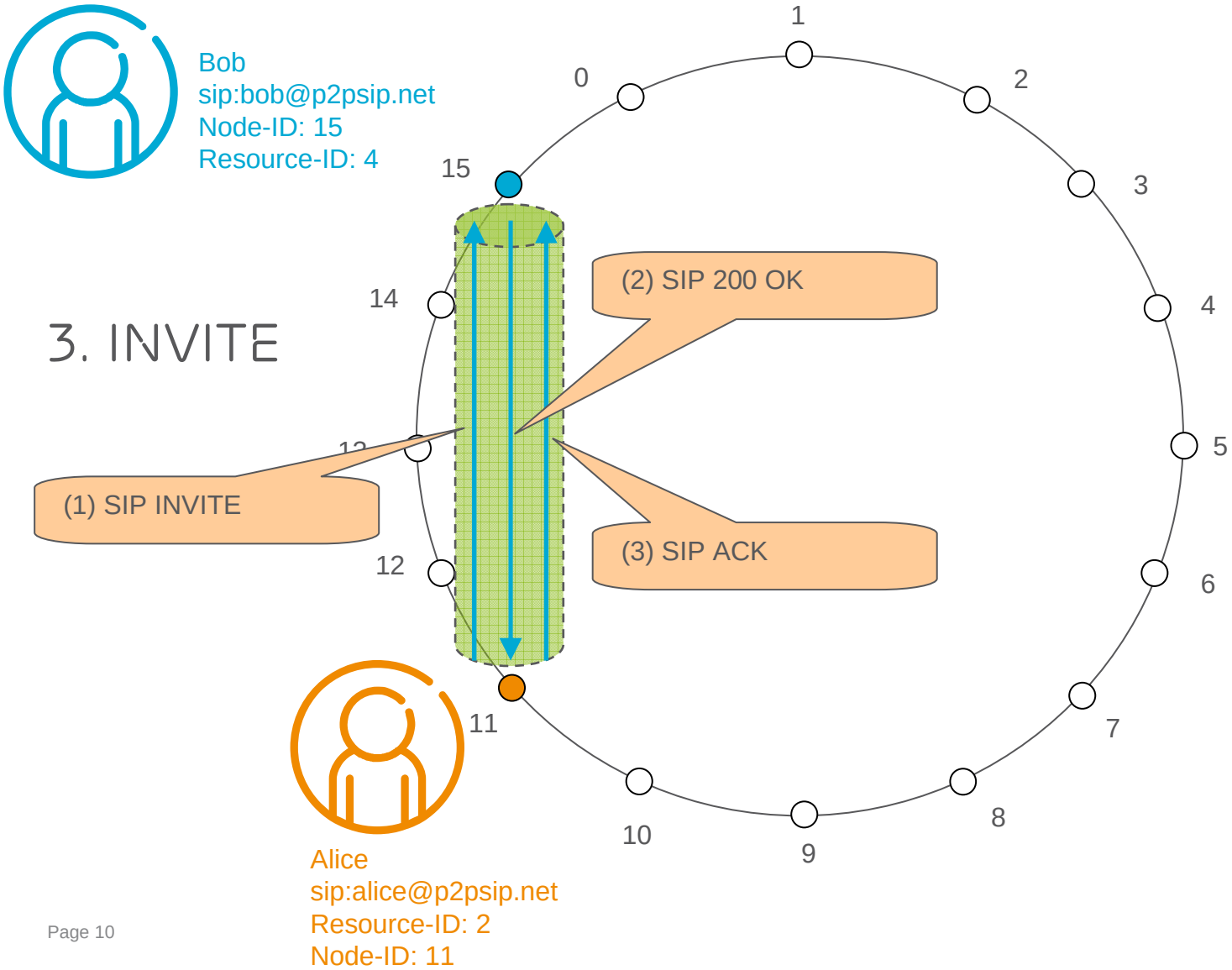


EXAMPLE: ALICE CALLING BOB (3/3)



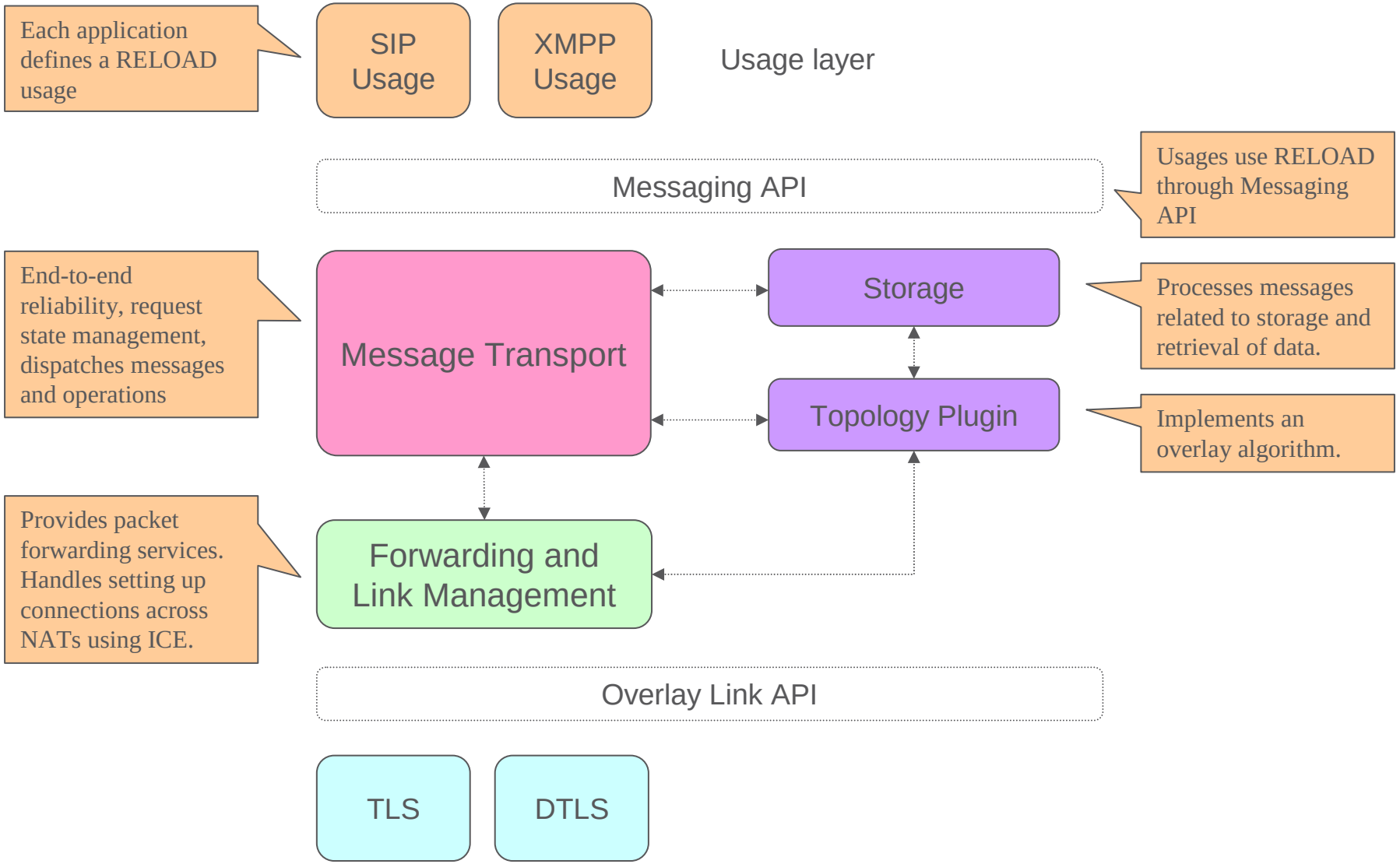
SOME CHALLENGES FOR P2PSIP

- Security and identity assertion
  - No fully distributed system for security exist which would be as robust as a centralized solution
  - Solution: RELOAD uses a centralized entity contacted at enrollment time
- Network Address Translators (**NATs**)
  - Most peers can be located behind NATs
  - Solution: use of standardized NAT traversal protocols
    - Session Traversal Utilities for NAT (STUN)
    - Traversal Using Relays around NAT (TURN)
    - Interactive Connectivity Establishment (ICE)
- Regulatory issues
  - Lawful intercept, emergency calls

RESOURCE LOCATION AND DISCOVERY (RELOAD)

- A **P2P signaling protocol** specified by the P2PSIP WG
- Used between peers forming an overlay network to provide a self-organizing overlay network service, including
  - Distributed storage
  - Message forwarding
- Allows access from **client nodes** which don't route traffic or store data
- Provides the following features
  - Security framework
  - Usage model
  - NAT traversal
  - Routing
  - Pluggable overlay algorithms

RELOAD ARCHITECTURE

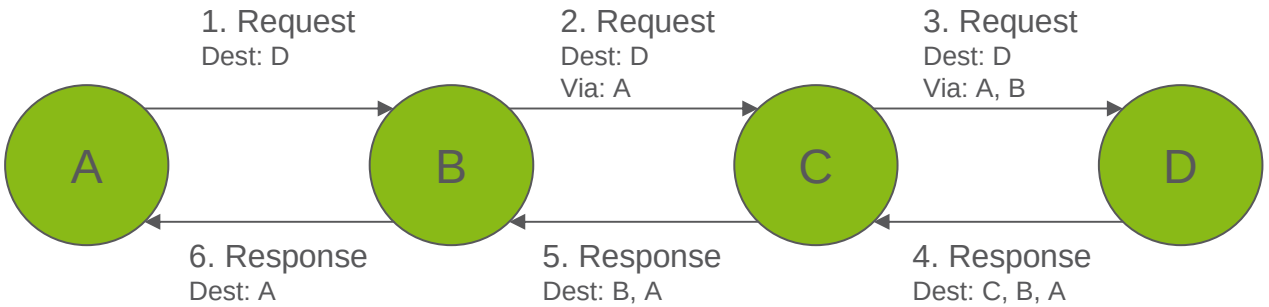


RELOAD FEATURES (1/2)

- **Security framework**
  - Node-IDs and certificates are assigned by a central enrollment server
  - Also self-signed certificates can be used
  - Security at three levels: connections, messages, stored objects
- **Usage model**
  - Allows the definition of new application usages
  - RELOAD can be used also by other applications than P2PSIP
- **NAT traversal**
  - Allows RELOAD to function in environments with NATs and firewalls
  - Interactive Connectivity Establishment (ICE) is used to establish new RELOAD and application protocol connections

RELOAD FEATURES (2/2)

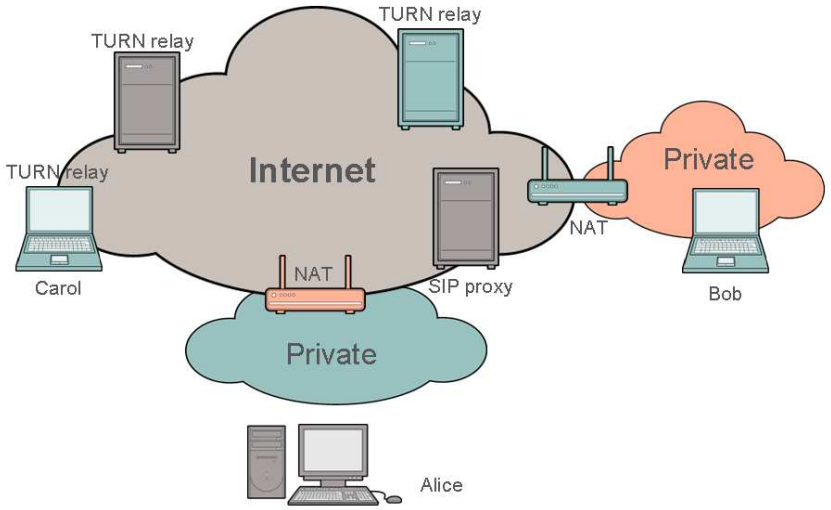
- Routing
  - A lightweight forwarding header to minimize the load of intermediate peers
    - Via list and destination list
  - Basic routing mechanism is symmetric recursive
- Pluggable overlay algorithms
  - RELOAD has an abstract interface to the overlay layer
  - Each overlay can select an appropriate overlay algorithm
    - All algorithms rely on the common RELOAD core protocol
  - RELOAD defines three methods for overlay maintenance: Join, Leave and Update
  - Chord DHT is mandatory to implement



INTERACTIVE CONNECTIVITY ESTABLISHMENT (ICE)

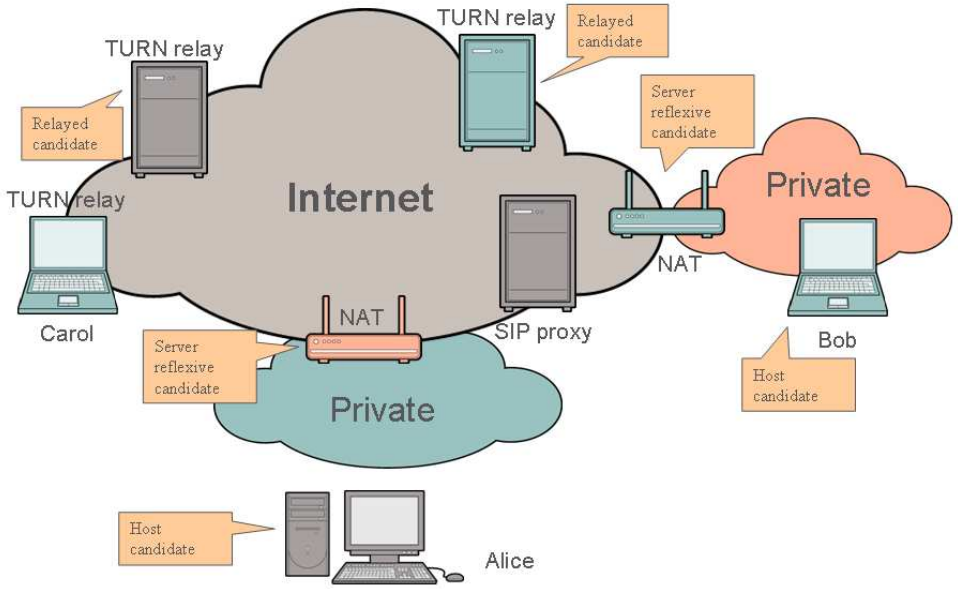
NETWORK ADDRESS TRANSLATION (NAT)

- Network Address Translation (**NAT**)
  - Mapping of IP addresses from one realm to another
  - E.g., connect an isolated address realm with **private addresses** to an external realm with **globally unique addresses**
  - Thanks to NAT, a host in a private network can transparently communicate with destinations on an external network
    - And vice versa
- Types of address and port **mapping**
  - Endpoint independent mapping
  - Address dependent mapping
  - Address and port dependent mapping
- Types of **filtering**
  - Endpoint-independent filtering
  - Address-dependent filtering
  - Addess and port dependent filtering

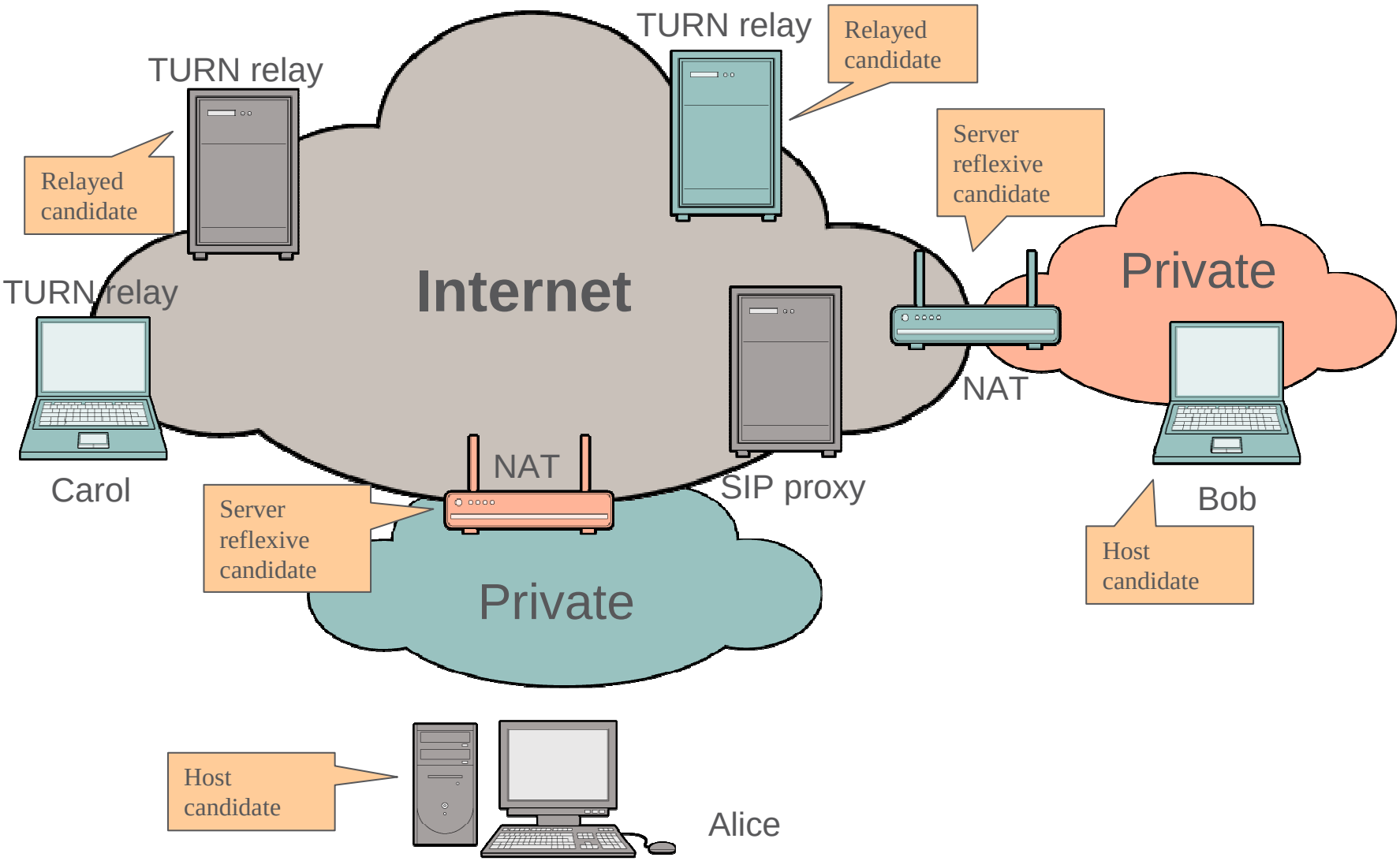


INTERACTIVE CONNECTIVITY ESTABLISHMENT (ICE)

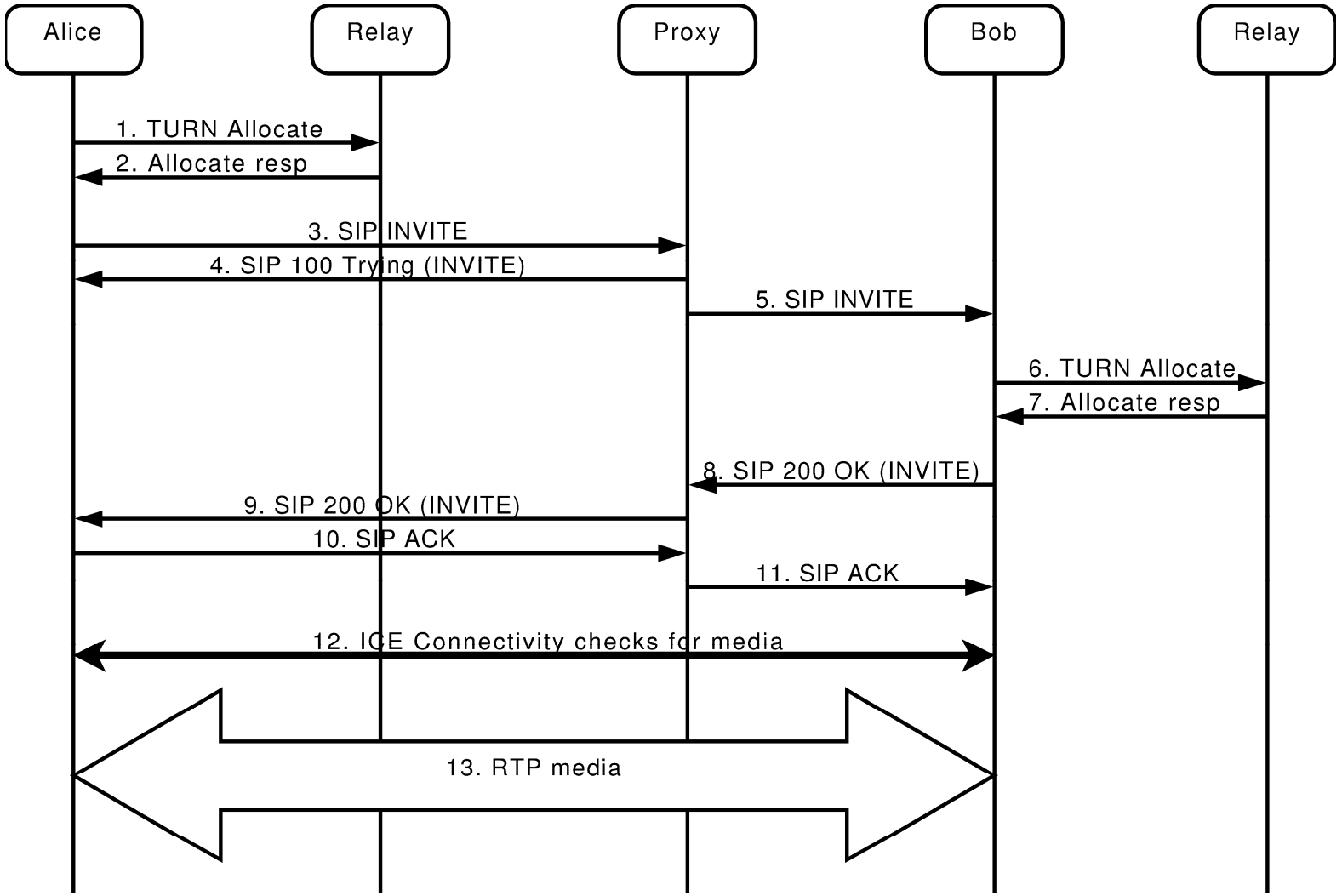
- SIP, RELOAD, and RTCWeb use Interactive Connectivity Establishment (**ICE**) to set up connections across NATs
- ICE makes use of **STUN** and **TURN** protocols
- STUN – Session Traversal Utilities for NAT
  - Determine IP address and port allocated by NAT
  - Check connectivity
  - Keep-alives
- TURN - Traversal Using Relays Around NAT
  - Obtain a relayed address
  - Control the operation of a relay
- ICE is used to discover a working path through NATs
  - (1) Gather candidate addresses
  - (2) Exchange candidates
  - (3) Perform connectivity checks



COMMUNICATION SCENARIO FOR ICE



NAT TRAVERSAL FOR MEDIA IN SIP (1/2)



NAT TRAVERSAL FOR MEDIA IN SIP (2/2)

- **1-2:** Alice gathers ICE candidates
- **3-5:** Alice sends her ICE candidates to Bob
- **6-7:** Bob gathers ICE candidates
- **8-11:** Bob sends his candidates to Alice
- **12:** Alice and Bob perform ICE connectivity checks
- **13:** ICE has found a working path, RTP media starts flowing between Alice and Bob

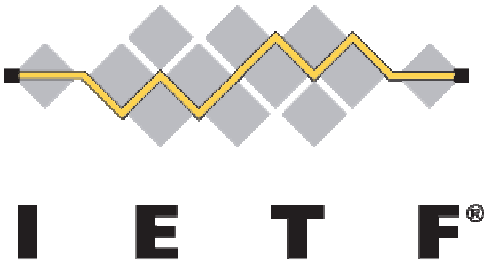
REAL-TIME COMMUNICATION BETWEEN WEB BROWSERS (RTCWEB)

RTCWEB/WEBRTC

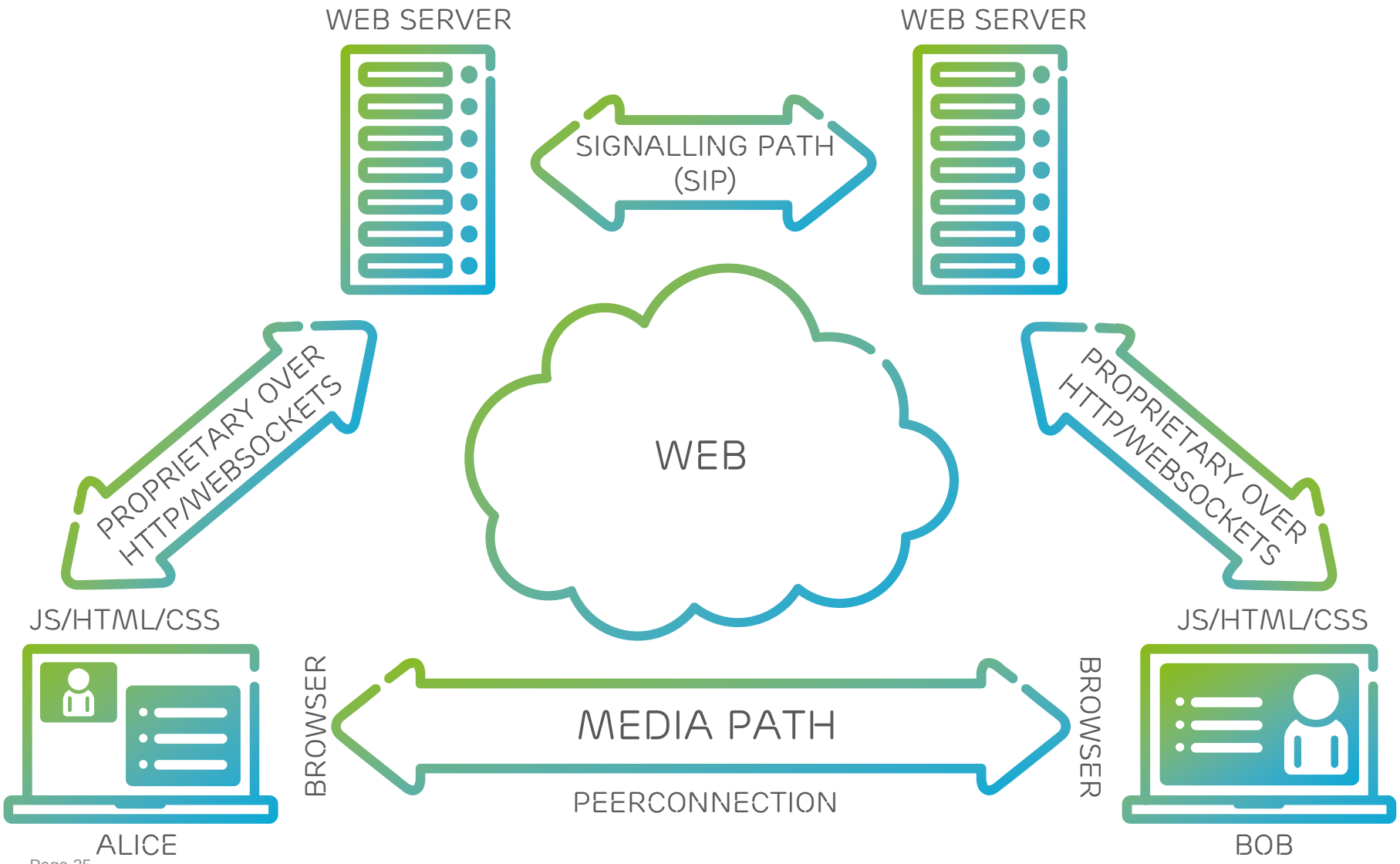
- Voice and video telephony and conferencing in **HTML5**
  - HTML5: the 5th revision of the HTML standard
  - Interoperable, no plugins required
- Some aspects of video conferencing in HTML5
  - Getting multimedia streams from local devices
  - Recording streams locally
  - Connecting to remote peers using NAT traversal
  - Sending streams to remote peers and receiving streams
  - Displaying the streams using HTML5 **<video>** or **<audio>** elements
  - Sending arbitrary data to remote peers
- **RTCWeb** WG in the **IETF**
  - Scope: the protocols that browsers talk to each other
  - For WG charter, see [1]
- **WebRTC** in **W3C** (World Wide Web Consortium)
  - Scope: APIs that are offered to Javascript applications to take advantage of the browser's functionality
  - For current API draft, see [2]

RTCWEB

- IETF RTCWeb WG focuses on the protocols
- Functionality groups
  - **Data transport** – sending and receiving data, NAT traversal
  - **Data framing** – RTP and SRTP (Secure Real-Time Protocol)
  - **Data formats** – codecs, format specifications
  - **Connection management** – setting up, negotiating, and tearing down connections
  - **Presentation and control** – W3C API effort, user control over browser's interaction with input/output devices
  - **Local system support functions** – e.g., echo cancellation, volume control

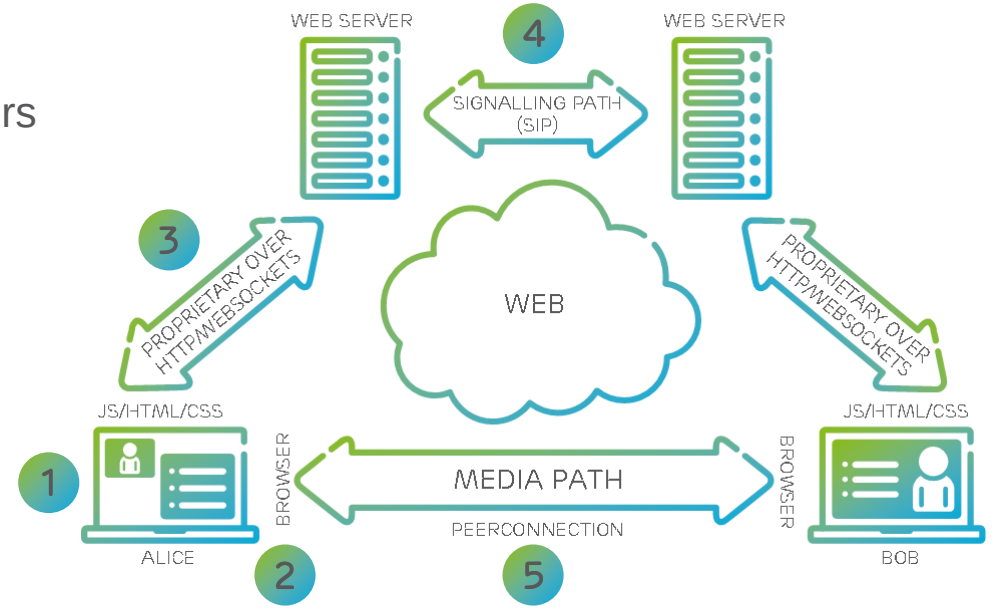


RTCWEB TRAPEZOID



CALL ESTABLISHMENT IN RTCWEB

1. **Download** a video communication web application (Javascript)
2. **Open a PeerConnection** (among other things)
   - Allows two users to communicate directly, browser-to-browser
   - *new PeerConnection(configuration, signalingCallback)*
     - *configuration*: address of a STUN/TURN server
3. **Use a signaling protocol** over bidirectional HTTP or WebSocket to talk to server
   - Bidirectional HTTP: e.g., long polling, HTTP streaming
   - WebSocket: bi-directional, full-duplex communication channel over a single TCP socket
     - Implemented in web browsers and web servers
   - The signaling protocol could be a subset of SIP
   - Support for SDP and offer/answer model is mandatory
     - ICE candidates in SDP
4. **Servers** may talk **SIP** to each other
5. **Media path** directly between browsers
   - Over PeerConnection
   - ICE negotiation
   - RTP (Real-Time Protocol) for media transport



REFERENCES

- [1] RTCWeb charter
  - http://tools.ietf.org/wg/rtcweb/charters
- [2] RTCWeb API
  - http://dev.w3.org/2011/webrtc/editor/webrtc.html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