Voice over IP (SIP)

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Introduction

- (1990s) a need for standard protocol which define how computers should connect to one another so they can share media and communicate
- Set up, modify, and terminate a connection between two or more computers and much more
- Programs that provide real-time communication between participants
  - instant messaging, voice over IP (VoIP), video teleconferencing, virtual reality, multiplayer games...
  - additional functions: call waiting, call transfer, and conference calling
Introduction (2)

- May change locations and use different computers, have several usernames or accounts, or communicate using a combination of voice, text, or other media
- Various network components to identify and locate these endpoints
- Runs on top of other protocols
  - may be used to transfer voice, text, or other media
- Text-based protocol
  - it uses Universal Resource Identifiers (URIs) for identifying users
OSI (Open Systems Interconnection)

- Mapped the protocol to the OSI reference model
  - associate protocols to different layers
  - uses the functions of the layer below it
  - exporting the information to the layer above it
- SIP is on Application Layer
SIP URI’s

- Existing standards that had already been proven on the Internet
- URI shows the domain where a user’s account is located, and a host name or phone number that serves as the user’s account.
  - sip: myaccount@mydomain.com
  - sip:+1-214-555-1212@gateway.com;user=phone
  - simple to connect someone to a particular phone number or username
- server can determine whether a particular username is available or not
- contain other information
  - port number, password, ...(SIPS: information over TLS)
SIP Component – User Agent

- Computer that is being used to make a call and the target computer that is being called
- User Agent Client (UAC)
  - user agent which makes a request (initiating a session)
- User Agent Server (UAS)
  - user agent responding to the request
- User agents switch back and forth between these roles throughout a session
  - send a message, and then respond to another
SIP Component – SIP Server

- Resolve usernames to IP addresses
  - requests sent from one user agent to another can be directed properly
- A user agent registers with the SIP server
  - username and current IP address
- Request is made to the SIP server to invite another user into a session
- The SIP server then identifies whether the person is currently online
- Compares the username to their IP address to determine their location.
- If the user isn’t part of that domain (uses a different SIP server) it will pass on requests to other servers.
SIP Component – SIP Server (2)

- **Register Server**
  - register the location of a user agent who has logged onto the network.
  - obtains the IP address of the user and associates it with their username

- **Proxy Server**
  - forward requests on behalf of other computers
  - can provide such functions as network access control, security, authentication, and authorization

- **Redirect Server**
  - redirect clients to the user agent they are attempting to contact
  - “fork” a call
    - splitting the call to several locations

- **Location Service**
  - up-to-date catalog of everyone who is online, and where they are located
  - If the Registrar accepts the request, it will obtain the SIP address and IP address of the user agent, and add it to the location service
A Simple Session Establishment Example

User Agent Client (UAC)

1: INVITE bob@lab.acme.com
2: 100/Trying
3: 180/Ringing
4: 182/Queued, 2 callers ahead
5: 182/Queued, 1 caller ahead
6: 200/OK
7: ACK

User Agent Server (UAS)

1: BYE bob@lab.acme.com
2: 200/OK
REQUEST MESSAGE
INVITE sip:bob@acme.com SIP/2.0
Via: SIP/2.0/UDP
alice_ws.radvision.com
From: Alice A.  
   <sip:alice@radvision.com>
To: Bob B.  <sip:bob@acme.com>
Call-ID:  2388990012@alice_ws.radvision.com
CSeq: 1 INVITE
Subject: Lunch today.
Content-Type: application/SDP
Content-Length: 182

v=0
o=Alice 53655765 2353687637 IN IP4 128.3.4.5
s=Call from Alice.
c=IN IP4 alice_ws.radvision.com
m=audio 3456 RTP/AVP 0 3 4 5

RESPONSE MESSAGE
SIP/2.0 200 OK
Via: SIP/2.0/UDP alice_ws.radvision.com
From: Alice A. <sip:alice@radvision.com>
To: Bob B.  <sip:bob@acme.com>;tag=17462311
Call-ID:  2388990012@alice_ws.radvision.com
CSeq: 1 INVITE
Content-Type: application/SDP
Content-Length: 200

v=0
o=Bob 4858949 4858949 IN IP4 192.1.2.3
s=Lunch
c=IN IP4 machine1.acme.com
m=audio 5004 RTP/AVP 0 3
SIP Registration

1. User Agent Registers with Registrar and provides SIP-address and IP address

2. Registrar responds to REGISTER request and adds User Agent information to database of addresses
Requests through Proxy Servers

1. INVITE request is made to Proxy Server to invite session with User Agent B

2. Proxy Server checks with Locator Service to determine IP address of User Agent B

3. INVITE request is passed to User Agent B

4. User Agent B accepts request and responds to User Agent A

5. Proxy Server passes response to User Agent A

6. Once invitation is accepted User Agent A and User Agent B can now establish a session
Requests through Proxy Servers (2)
Requests through Redirect Servers

1. INVITE request is sent to Redirect Server
2. Redirect Server checks Location Service to find IP address of User Agent B
3. Redirect Server sends information back to the requesting user agent
4. User Agent A sends invite to User Agent B
5. User Agent B responds to User Agent A
6. Once invitation is accepted, User Agent A and User Agent B can now establish a session
Requests through Redirect Servers (2)
Client/Server versus Peer-to-Peer Architecture

- Requests are processed in different ways
  - Dealing with SIP servers
  - Agents communicate with one another
- Two different types of architectures used in network communications
  - Client/Server
    - Request to register with a Registrar server, or makes a request to a Proxy Server or Redirect Server
  - Peer-to-peer
    - User agents act as both client and server, and are considered peers.
Protocols Used with SIP

- UDP (User Datagram Protocol)
  - transport units of data called *datagrams* over an IP network.
- TLS (Transport Layer Security)
  - provide security between applications communicating over an IP network
- SDP (Session Description Protocol)
  - send description information that is necessary when sending multimedia data across the network.
- RTP (Real-Time Transport Protocol)
  - transport real-time data across a network
- MGCP (Media Gateway Control Protocol)
  - provide access to the Public Switched Telephone Network
- RTSP (Real-Time Streaming Protocol)
  - control the delivery of streaming media across the network
SIP Pros and Cons

**Pros**
- SIP works independently of the type of session, or the media used, giving it flexibility.
- It is an open standard, allowing multivendor support and integration. Applications can be written to customize SIP uses.
- SIP messages are clear text, making troubleshooting easier.
- SIP can accommodate multiple users with differing capabilities.

**Cons**
- Processing text messages puts a higher load on gateways. The router must translate that text into a language that the router can understand.
- SIP is a fairly new protocol, so fewer people understand it than the older protocols.
Summary

- Provide communication between participants.
- Conjunction with a variety of other protocols
- User agent is able to find the location and availability of other users
  - allows participants to communicate directly
- Its architecture begins as a client/server changing the architecture to a distributed peer-to-peer.
Questionnaires

- Three kind of SIP servers?
  - Register server, proxy server, redirect server
- Two different types of architectures used in SIP network communications?
  - Client/server and peer-to-peer architecture
Questions?

Thank you very much for your attention