An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol

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Agenda

- Introduction
- Key Components
- Communication
- Conferencing
- Comparison of Similar Clients
- Conclusion

Introduction

- Skype
  - Peer-to-peer (p2p) Voice-over-IP (VoIP) client
  - Created by makers of Kazaa
  - Overlay p2p Network
- Supports: voice, video, chat, and even text messaging

Introduction

- Overlay Network consists of two nodes
  - Ordinary Nodes
  - Super Nodes
- Their connections are arranged in according to “Neighbor Relationships”
- There is also a Skype login server and SkypeIn/SkypeOut servers for PC-to-PSTN and PSTN-to-PC communications

Introduction

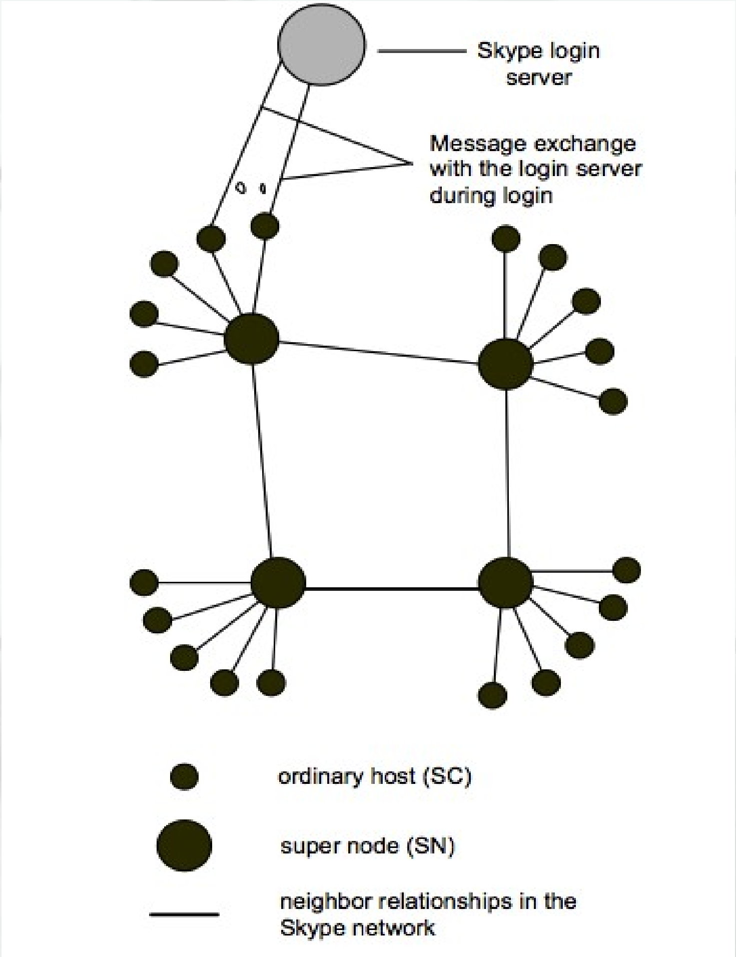

Skype login server
Message exchange with the login server during login
ordinary host (SC)
super node (SN)
neighbor relationships in the Skype network

Figure 1: Skype Network Configuration [1]

Introduction

- Ordinary Node (SC)
  - The Skype Client
  - Keeps a table of reachable nodes
  - Holds IP and port number of super nodes
  - Referred to as **host cache** (HC) in Skype
  - Stored in an XML file

Introduction

- Super Node (SN)
  - End-point for client
  - Has public IP
  - Requirements: Sufficient CPU, Memory, and Network bandwidth
  - Authentication is done separately with the login server
  - This helps Skype ensure a global credential database, ensuring SkypeID uniqueness

Key Components

- Ports
- Host Cache
- Codecs
- Buddy List
- Encryption
- NAT and Firewall

Key Components - Ports

- Skype opens two ports for listening to TCP and UDP protocols
- Port number is randomly selected when client is installed
- Ports 80 and 443 are also opened to accommodate HTTP and HTTP-over-TLS traffic

Key Components – Host Cache

- List of super node IP and port pairings
- shared.xml
- Holds maximum of 200 entries
- If no entries in file Skype uses one of 7 hardcoded IPs

Key Components - Codecs

- Uses iLBC, iSAC, and iPCM
- Allows frequencies 50 to 8000 Hz

Key Components – Buddy List

- Stored as “config.xml”
- Unencrypted
- Stores Skype central login server
- Note: file is also replicated on the login server for better mobile service access
- Buddys are identified by their IDs

Key Components – Buddy list

```
<CentralStorage>
    <LastBackoff>0</LastBackoff>
    <LastFailure>0</LastFailure>
    <LastSync>1135714076</LastSync>
     <NeedSync>0</NeedSync>
    <SyncSet>
        <u>
        <skypebuddy1>2f1b8360:2</skypebuddy1>
        <skypebuddy2>d0450f12:2</skypebuddy2
```

Figure 2: config.xml [1]

Key Components - Encryption

- Skype uses AES 256-bit encryption
- 1.1 x 10^{77} possible keys
- Key Exchange facilitated through 1024-bit RSA
- RSA Certificates 1536 or 2048-bit

Key Components – NAT and Firewall

- Only hypotheses about technology behind
- Thought to use the STUN and TURN protocols
- Information stored in shared.xml
- A Skype client cannot prevent itself from becoming a super node (contrary to Kazaa)

Communication

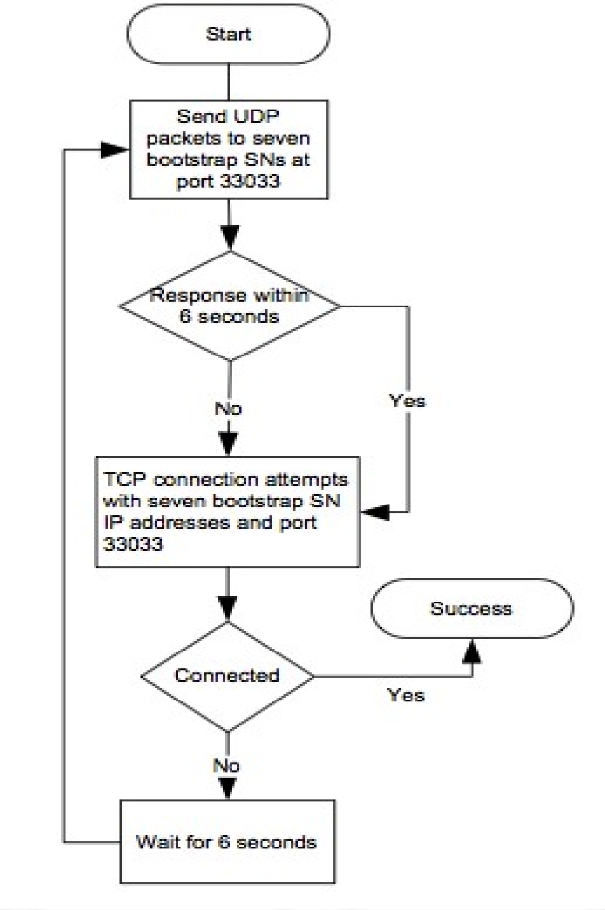

Start
Send UDP packets to seven bootstrap SNs at port 33033
Response within 6 seconds
No
Yes
TCP connection attempts with seven bootstrap SN IP addresses and port 33033
Success
Connected
Yes
No
Wait for 6 seconds

Figure 3: Skype Login process (with no entries in HC file) [1]

Communication

- HTTP is used because version information is shared through GET requests
- Calling and Tear down
    - Average of 3 Messages a Second
    - Voice Packet 70 to 100 bytes
    - Teardown is simply accomplished through a message with signaling information

Communication

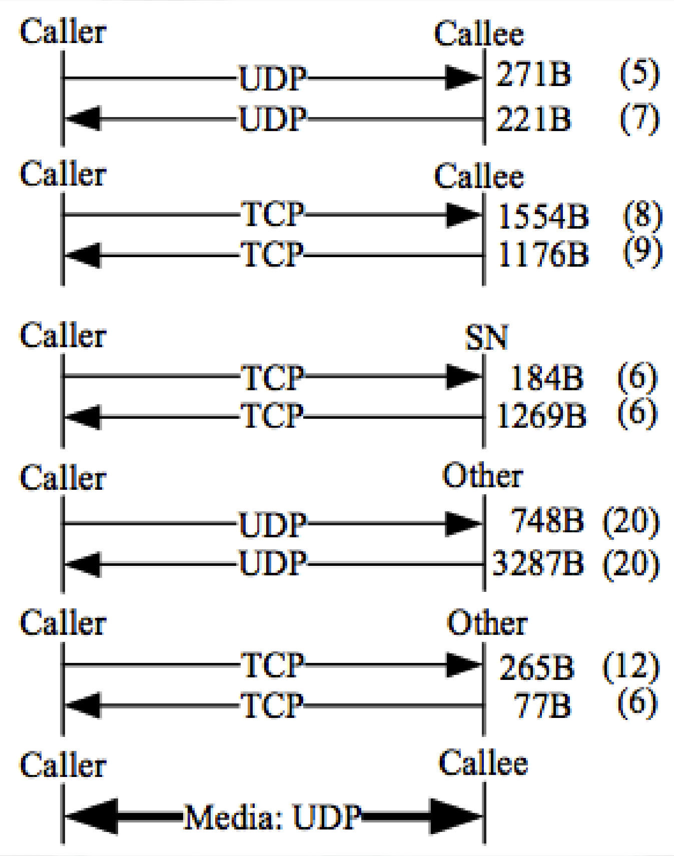


Figure 4: Skype Call (caller to callee) [1]

Communication

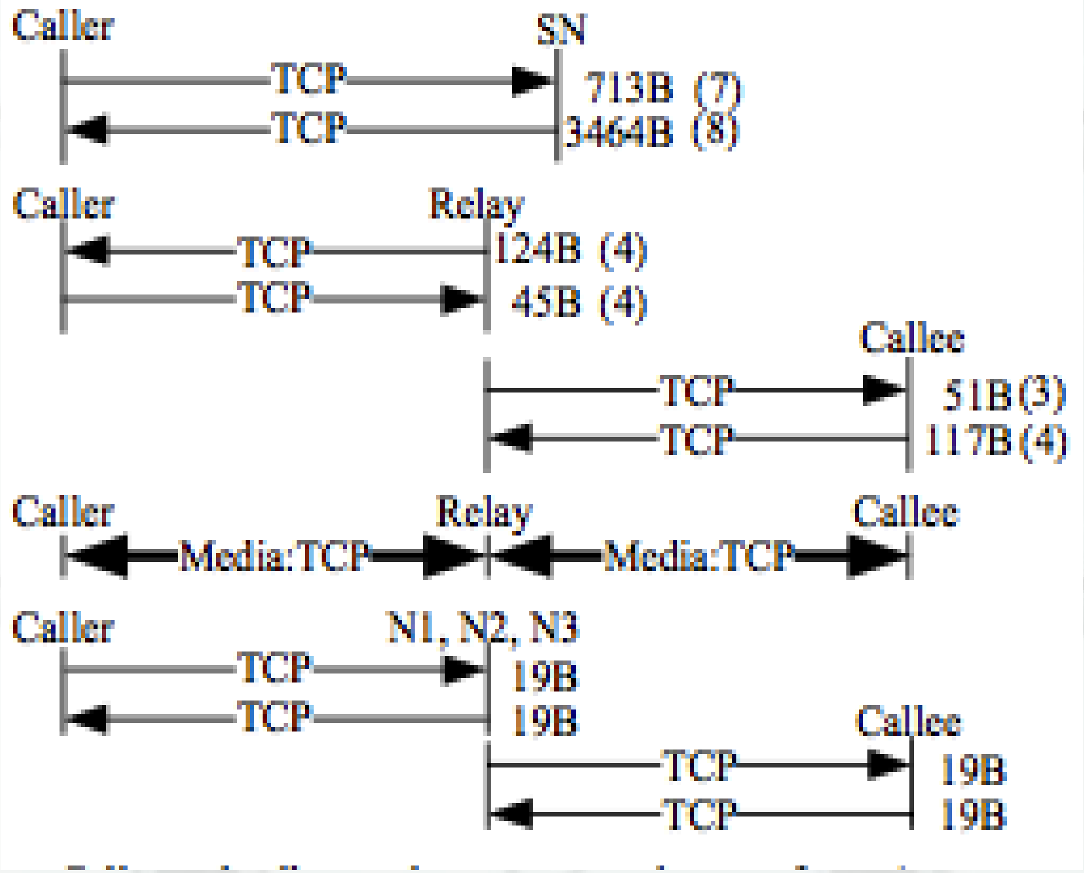


Figure 5: Skype call through NAT and Firewall [1]

Conferencing

- Skype uses a “Mixer” approach to message passing
- A central client sends out its and the remaining messages to their respected recipients
- It is assumed that at some point in the size of a conference Skype would use full mesh conferencing

Conferencing

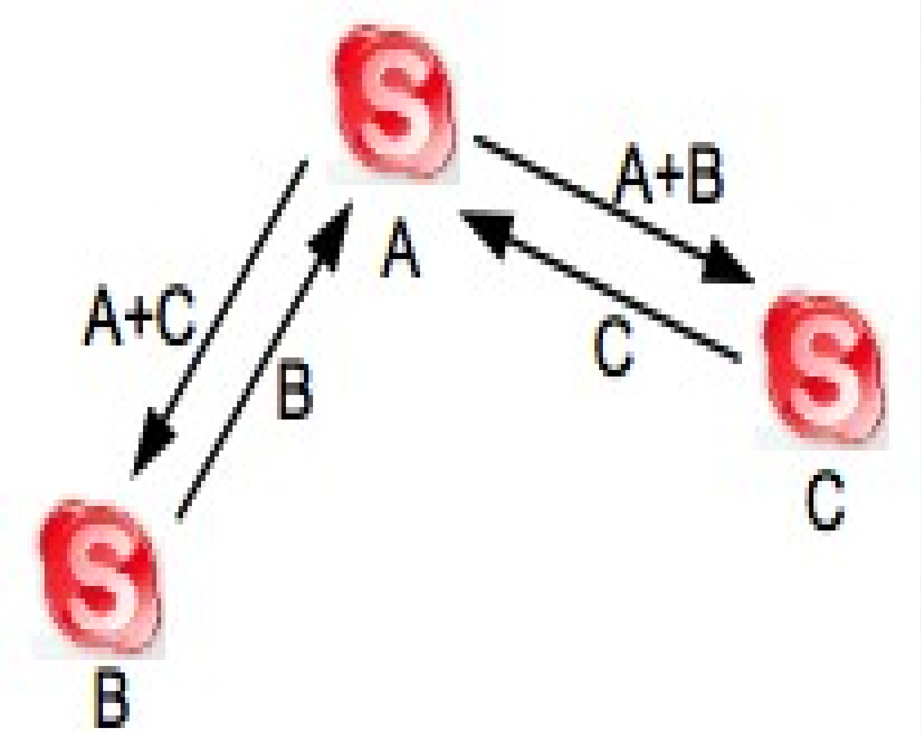


Figure 5: Example of conference between 3 clients (A,B,C) [1]

Comparison of Similar Clients

- Yahoo
- MSN
- Google Talk
- Benchmarks were conducted on three laptops over a period of three days
- Data on these tests is limited

Comparison of Similar Clients

- Over the other 3 applications, Skype had the lowest mouth-to-ear latency time of the services.
- It is believed that this is the case due to a decentralized network with minimal centralized needs
- Skype makes arrangements with OS to give it highest priority on CPU and Network bandwidth

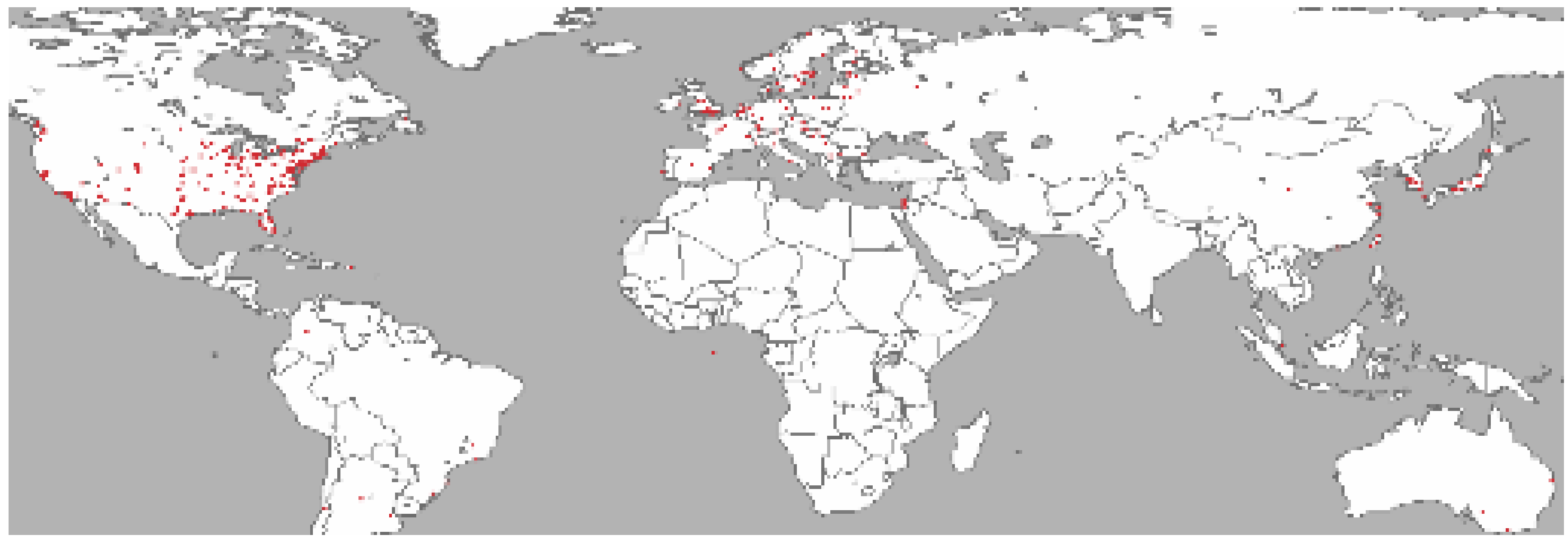
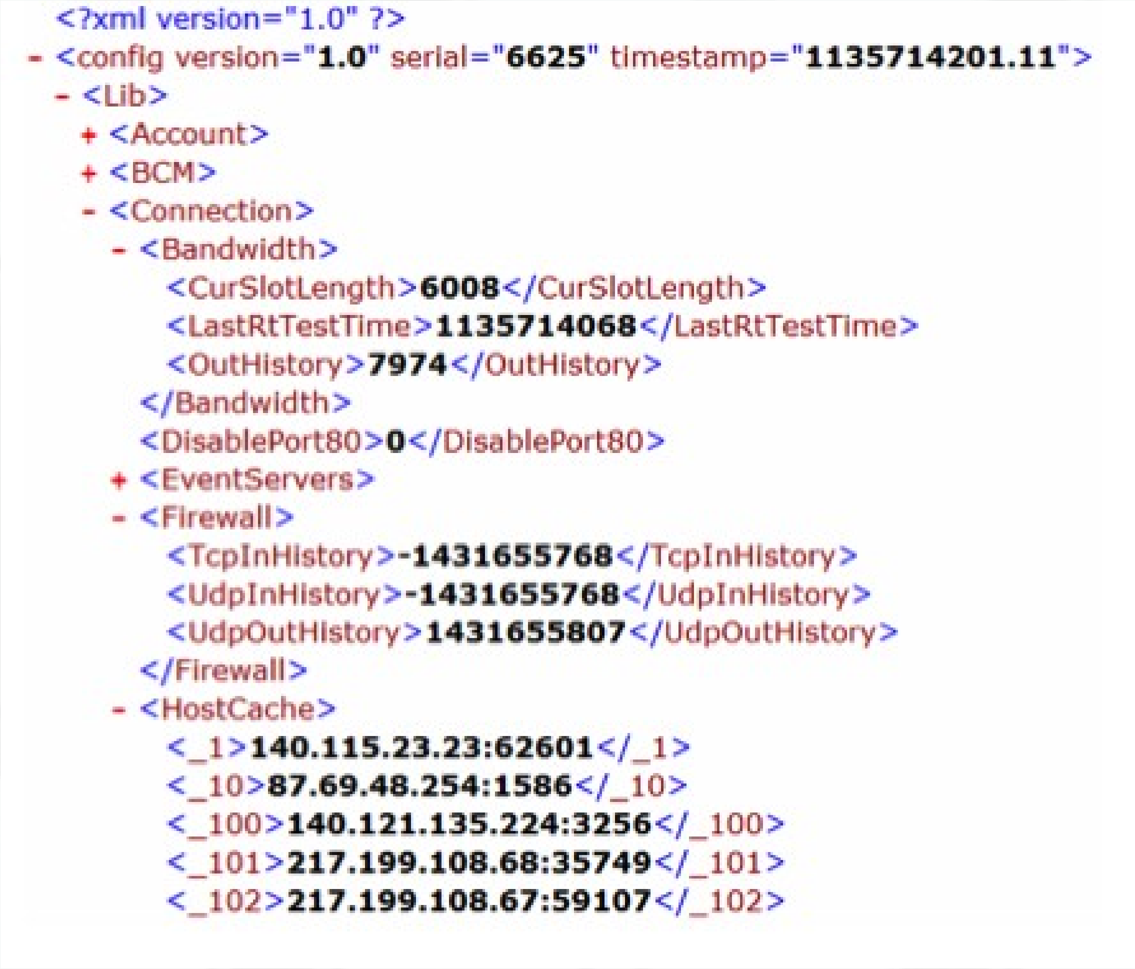


Figure 6: World Map of Super Nodes
[1]



```
  <?xml version="1.0" ?>
- <config version="1.0" serial="6625" timestamp="1135714201.11">
  - <Lib>
    + <Account>
    + <BCM>
    - <Connection>
      - <Bandwidth>
          <CurSlotLength>6008</CurSlotLength>
          <LastRtTestTime>1135714068</LastRtTestTime>
          <OutHistory>7974</OutHistory>
        </Bandwidth>
        <DisablePort80>0</DisablePort80>
      + <EventServers>
      - <Firewall>
          <TcpInHistory>-1431655768</TcpInHistory>
          <UdpInHistory>-1431655768</UdpInHistory>
          <UdpOutHistory>1431655807</UdpOutHistory>
        </Firewall>
      - <HostCache>
          <_1>140.115.23.23:62601</_1>
          <_10>87.69.48.254:1586</_10>
          <_100>140.121.135.224:3256</_100>
          <_101>217.199.108.68:35749</_101>
          <_102>217.199.108.67:59107</_102>
```

Figure 7: Host Cache File (shared.xml) [1]

Conclusion

- Skype is a highly distributed VoIP client
- Communication is performed with quality security practice
- Skype reduces messages when conferencing
- Skype has the lowest call latency time of the four largest free VoIP services

Conclusion

- Interesting Symptom described in papers conclusion
- If every clients bandwidth was capped, Skype would starve for Super Nodes and the network would effectively be broken
- I felt that this was a well written technical paper that utilized images and diagrams well

references

[1] S. Baset, H. Schulzrinne, An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol, Colombia University, New York, NY.

Thank You!