Mechanisms for Robust Multimedia Conferencing Using SIP

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Background

- The Session Initiation Protocol (SIP) is the most widely used Internet telephony standard
- Multimedia conferencing using SIP is steadily increasing
  - Still, there are no built-in mechanisms in the SIP protocol to ensure the robustness of conferencing services
Objectives

- **Theoretical part of the thesis**
  - Propose mechanisms for improving the robustness of SIP conferencing

- **Practical part of the thesis**
  - Implement the SIP conferencing functionality on a Session Border Controller (SBC)
    - SBC is a device that can be used in Voice over IP (VoIP) networks to control both signaling and media streams

- **Research methods**
  - Literature survey
  - Prototype implementation
Conferencing

- Conferencing can be done in several ways:
  
  **Fully distributed**
  
  **Loosely coupled**
  
  **Tightly coupled**
  
  Used in SIP
Conferencing frameworks

- There are two conferencing frameworks defined by the IETF (Internet Engineering Task Force)
  - The SIPPING conferencing framework
  - The XCON conferencing framework

- Frameworks define the logical entities and terminology to be used for conferencing

- SIPPING uses SIP as the signaling protocol, XCON does not depend on any particular signaling protocol
  - The XCON framework is SIPPING compatible
Conferencing frameworks (cont.)

- The central component of the conferencing model is a conference server called focus
  - Has a signaling relationship with every conference participant
  - Is responsible e.g. for the media streams of the session, conference policy, notifications about the state changes of the conference.
  - Participants contact the focus by using a unique conference URI
    - e.g. sip:discussion_on_travel@conference.com
Prototype implementation

- Session Border Controllers are used for managing the signaling and media streams of VoIP calls.
- The objective of the prototype was to implement conference focus functionality on an existing Session Border Controller (SBC)
  - Support small-scale SIP conference sessions.
Session setup

Diagram showing the sequence of events during session setup:
1. User A sends an INVITE request.
2. Server responds with a 100 Trying status code.
3. H.248 Add Req is sent.
4. H.248 Add Reply is sent.
5. 200 OK is received.
6. ACK is sent.

Communication flow is indicated by arrows between User A, Session Controller, SBC, and Media Proxy.
Example message

INVITE sip:conference@131.160.36.15:5060 SIP/2.0
Via: SIP/2.0/UDP 127.0.0.2:5062
From: sippl <sip:sippl@127.0.0.2:5062>;tag=15
To: <sip:conference@131.160.36.15:5060>
Call-ID: 1-18098@127.0.0.2
CSeq: 1 INVITE
Contact: sip:sippl@127.0.0.2:5062
Max-Forwards: 70
Subject: Conference Call
Content-Type: application/sdp
Content-Length: 134

v=0
o=user1 53655765 2353687637 IN IP4 127.0.0.1
s=-
c=IN IP4 131.160.36.15
t=0 0
m=audio 30106 RTP/AVP 0
a=rtpmap:0 PCMU/8000
Robustness in SIP conferences (1)

- A robust system will continue operating normally even if there is a failure or incorrect input is passed into the system.
- To improve the robustness of SIP conferencing we need a mechanism for:
  - replicating the state of the conference session into the system
  - detecting the failure of the focus
  - identifying nodes capable of acting as a focus
  - electing the next focus
  - transferring the session to the new focus
Robustness in SIP conferences (2)

2) Run algorithm for selecting next focus. If it is this node, replace dialogs

1) Failure detection

SIP Dialog A

3) INVITE Replaces: Dialog B

X

4) 200 OK

4) 200 OK

3) INVITE Replaces: Dialog C

Participant A

Participant B

Focus

SIP Dialog B

SIP Dialog C

SIP Dialog A

Participant C

X

X

X
Robustness in SIP conferences (3)

- For state replication and for identifying possible backup focus candidates we use two existing SIP extensions with slight modifications
  - As a participant joins, it indicates its conferencing capabilities in the INVITE message
    - Participants have different roles in the conference
    - The focus informs every node that is “possible focus” about the state changes in the conference
    - The backup focus candidates then have the needed information to re-establish signaling and media streams
Robustness in SIP conferences (4)

- For detecting the failure we use periodic session refreshes as already defined in SIP
- For electing the focus we use a simple deterministic algorithm
  - Every backup focus candidates runs independently
Conclusions

- **Theoretical part**
  - Most of the needed functionality for robust conferencing using SIP is already defined
    - Only slight modifications were needed in two specifications

- **Practical part**
  - The SIP conferencing functionality was successfully implemented, the concept was proved to true

- **Suggestions for future work**
  - How the mechanisms could be used for load balancing of conferencing foci
  - Large-scale conferences
  - More advance algorithms for backup focus election