Evaluation of SIP Call-Feature Signaling for Usability in Voice Communication Systems

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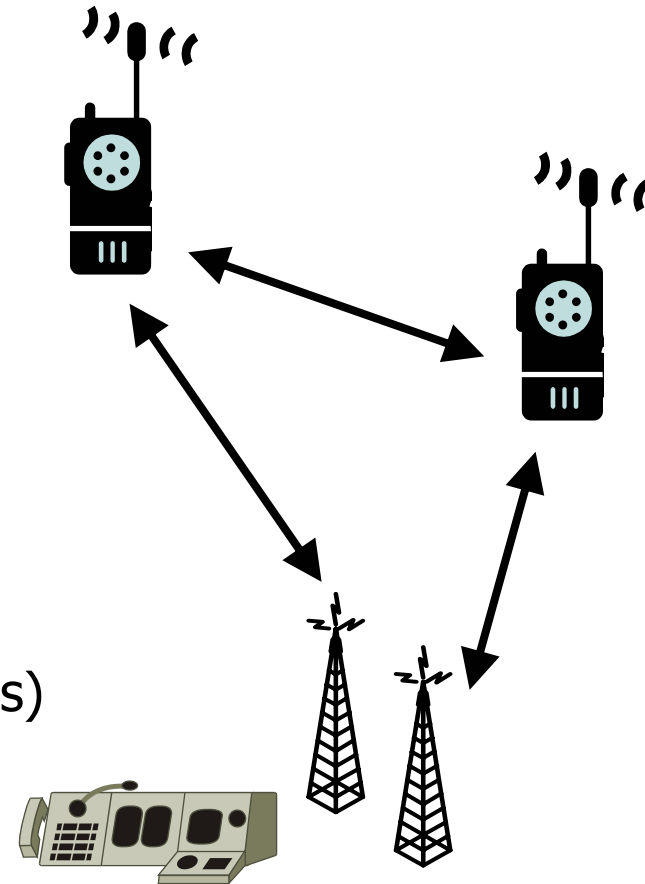
in cooperation with

FREQUENTIS

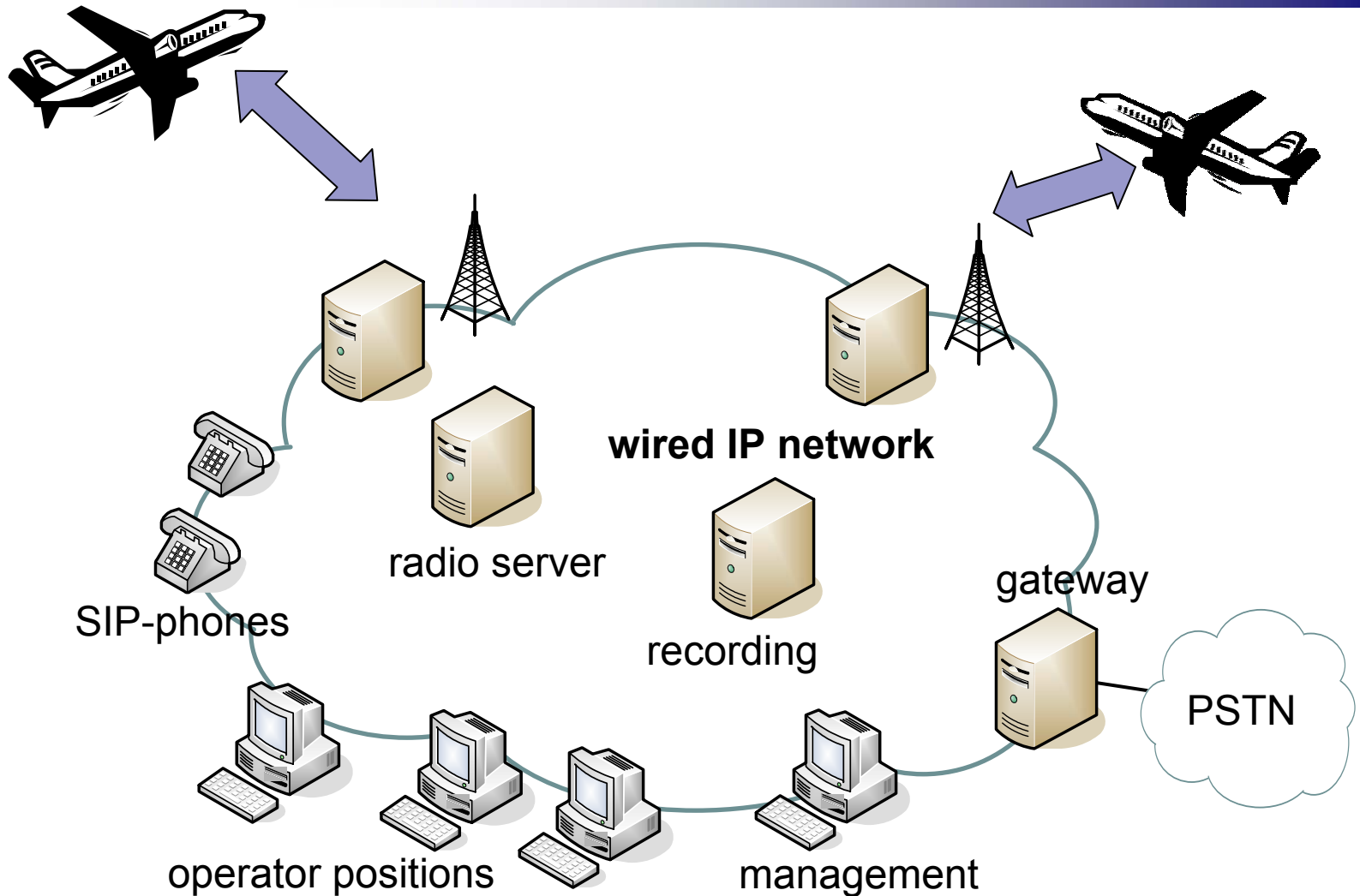# Radio Communication Properties

- area of application
  - air traffic control
  - public safety
  - disaster operation

- basic principles
  - usually AM-radios
  - shared medium (collisions)
  - half-duplex
  - listen before talk

Radio Communication

- like walkie talkies
- transmit a radio message
  - → press the "push-to-talk" button (PTT)
- incoming radio message
  - → squelch indicator (SQU)

- 2 signals required:
  - PTT (powers up transmitter)
  - SQU (indicates incoming radio messages)

wired IP network

radio server

SIP-phones

recording

gateway
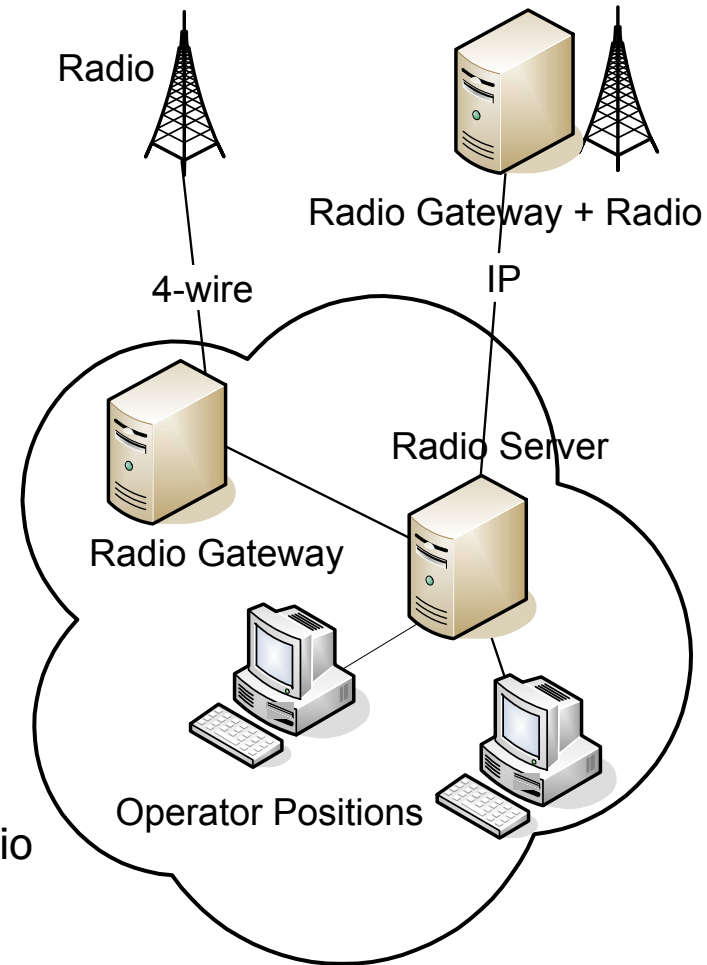
PSTN

operator positions

management

Radio Signalling using SIP

- **Signalling**
  - PTT/SQU via Event Notification
  - Floor Control Application
    (radio server = floor control server, floor chair)

- **Audio Transmission**
  - RTP, RTCP

- **Hardware**
  - COTS servers
  - COTS working positions
  - dedicated SIP servers
  - SIP phones

Radio Architecture Components

- **working position**
  - provides key-in to radio channels
  - PTT-button, SQU-display

- **radio senders and receivers**
  - typically on remote sites
  - one voice channel per radio
  - low bandwidth connection

- **radio server**
  - manages the access to the radios
  - distributes the received radio messages

- **radio gateway**
  - translates SIP signaling to radio control lines
  - translates RTP audio packets to analogue audio

Radio

Radio Gateway + Radio

4-wire

IP

Radio Server

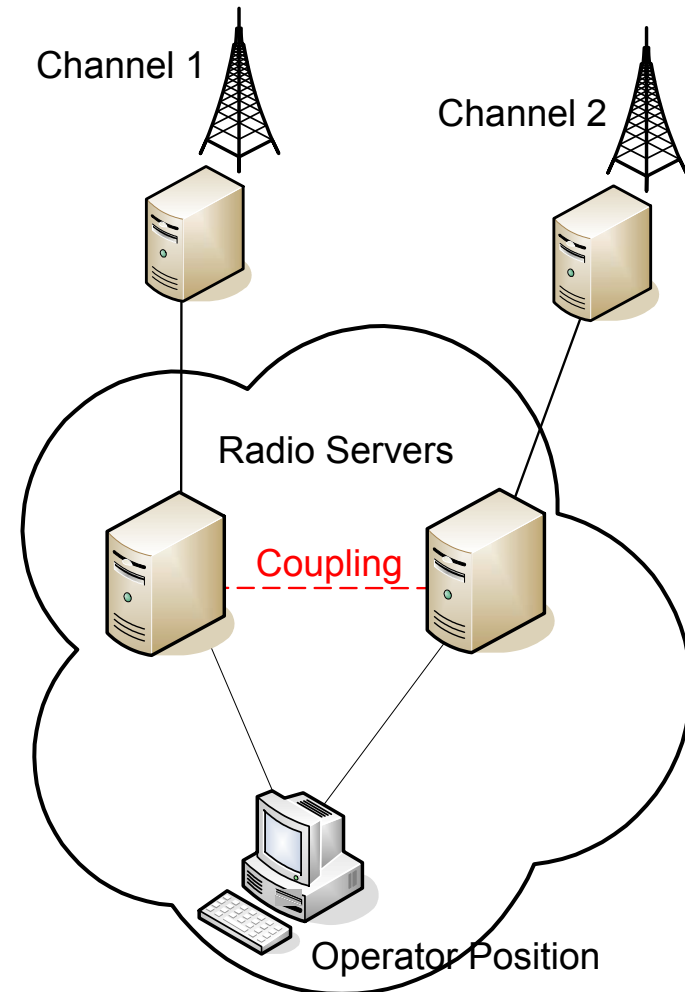Radio Gateway

Operator Positions

Radio Features

- emerged over the years
- necessary for executing an operator's task
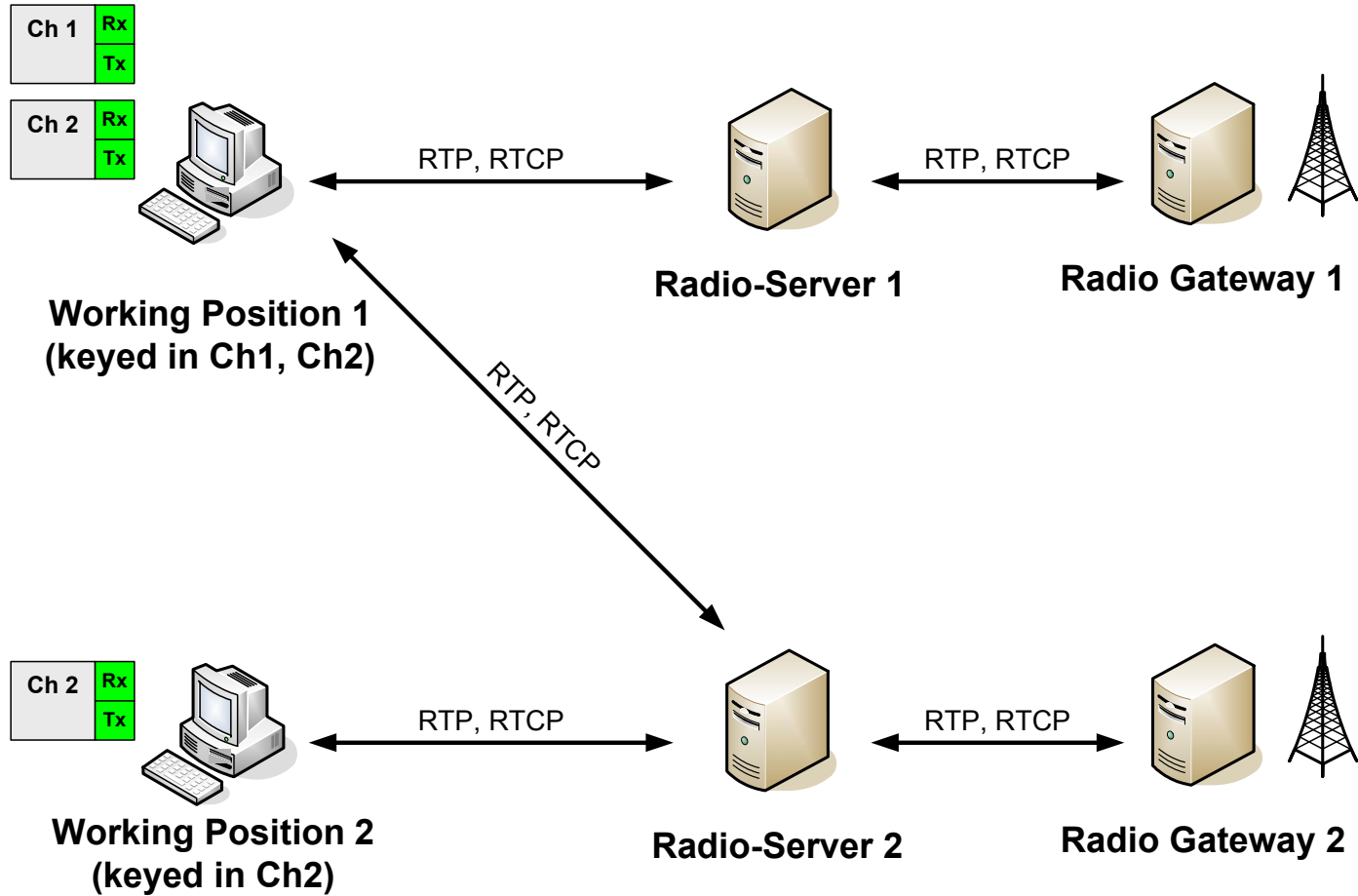- features well proven

- Features:
  - Frequency Cross Coupling
  - Frequency Forward
  - Frequency Intercom
  - Radio Remote Control
  - Status Information
  - Availability Concepts (Redundancy, Main/Backup Systems)

Frequency Cross Coupling

- **coupling multiple channels**
  accessible like a single virtual channel
  by all users keyed-in at a frequency involved
- **initiated by**
  - any operator
  - master operator
  - management system
- **Compatibility** with standard SIP-phones
- **Radio Repeater functionality**
- **Area of application**
  - different missions
  - larger fields of activity in times
    of reduced traffic

Channel 1

Channel 2

Radio Servers

Coupling

Operator Position

Ch 1 | Rx
      | Tx

Ch 2 | Rx
      | Tx

RTP, RTCP

**Working Position 1
(keyed in Ch1, Ch2)**

Radio-Server 1

Radio Gateway 1

RTP, RTCP

RTP, RTCP

Ch 2 | Rx
      | Tx

RTP, RTCP

**Working Position 2
(keyed in Ch2)**

Radio-Server 2

RTP, RTCP

Radio Gateway 2

Ch 1 | Rx / Tx

Ch 2 | Rx / Tx

Working Position 1
Initiates coupling
Ch1, Ch2

1. PUBLISH
coupling RS1, RS2

2. PUBLISH coupling RS1, RS2

3. INVITE (inactive)

4. INVITE

**Radio-Server 1
(master)**

RTP, RTCP

Radio Gateway 1

Ch 2 | Rx / Tx

Working Position 2

5. NOTIFY
coupling RS1, RS2

**Radio-Server 2
(slave)**

RTP, RTCP

Radio Gateway 2
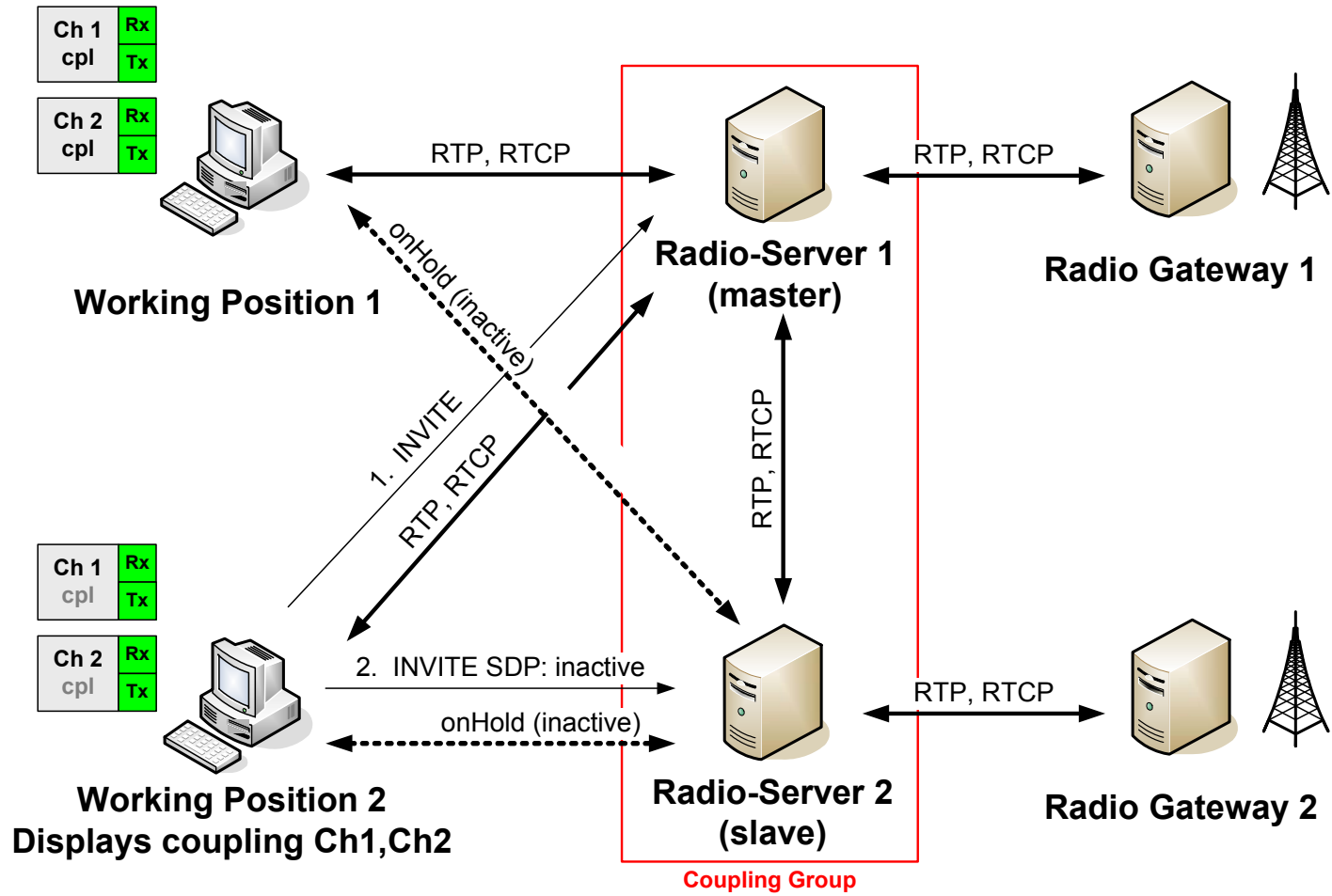
Coupling Group

```
PUBLISH sip:operator12@pc44.atc-center.org SIP/2.0
Via: SIP/2.0/UDP 128.131.80.6:5062
From: "radio34" <sip:radio34@atc-center.org>;tag=F68
To: "operator12" <sip:operator12@atc-center.org>;tag=1ec23337
Contact: "radio34" <sip:radio34@128.131.80.6:5062;transport=udp>
Call-ID: 3c9196445d5240bfb7b660a16ee6d390@128.131.80.223
CSeq: 10 PUBLISH
```

Event: Coupling

Expire: 60

```
Content-Type: text/plain
Content-Length: 76
```

master-radio=sip:ch100@atc-center.org

slave-radio=sip:ch24@atc-center.org

slave-radio=sip:ch36@atc-center.org

Final Coupling Signaling

Ch 1 cpl — Rx / Tx
Ch 2 cpl — Rx / Tx

Working Position 1

Ch 1 cpl — Rx / Tx
Ch 2 cpl — Rx / Tx

Working Position 2
Displays coupling Ch1,Ch2

RTP, RTCP

onHold (inactive)

1. INVITE

RTP, RTCP

2. INVITE SDP: inactive

onHold (inactive)

Radio-Server 1 (master)

RTP, RTCP

Radio-Server 2 (slave)

RTP, RTCP

RTP, RTCP

Radio Gateway 1

RTP, RTCP

Radio Gateway 2

Coupling Group

```
NOTIFY sip:operator12@pc44.atc-center.org SIP/2.0
Via: SIP/2.0/UDP 128.131.80.6:5062
From: "radio34" <sip:radio34@atc-center.org>;tag=F68
To: "operator12" <sip:operator12@atc-center.org>;tag=1ec23337
Contact: "radio34" <sip:radio34@128.131.80.6:5062;transport=udp>
Call-ID: 3c9196445d5240bfb7b660a16ee6d390@128.131.80.223
CSeq: 522 NOTIFY
```
Event: Coupling
Expire: 60
```
Content-Type: text/plain
Content-Length: 76
```

master-radio=sip:ch100@atc-center.org
slave-radio=sip:ch24@atc-center.org
slave-radio=sip:ch36@atc-center.org

Performance Aspects

- **Signaling Delay**
  not as important as with phone-calls or intercom services

- **Audio Delay**
  no jitter buffers, simple RTP forwarding
  (no conferencing required)

- **Failsafe Operation**
  - SIP expiry mechanism
  - Additional keep-alive messages

Future Work

- ## WAN measurements
  - remote radio server (additional PTT delay)

- ## reliability
  - especially bandwidth reservation for WANs
  - interaction of QoS mechanisms with SIP

- ## combination of enhanced radio services

- ## security aspects
  - audio encryption

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