AUDIO FEATURE INTERACTIONS

IN VOICE-OVER-IP

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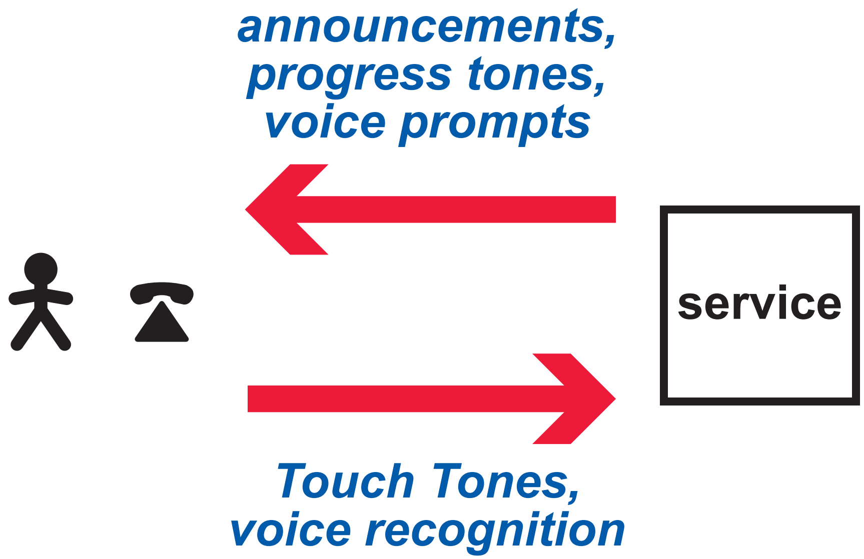
AUDIO SIGNALING + FEATURE INTERACTION

WHAT IS IT?

Audio signaling is the use of the audio channel for user-interface purposes.

It is control signaling between the service and its user.



announcements,
progress tones,
voice prompts

service

Touch Tones,
voice recognition

WHY DO WE (STILL) USE AUDIO SIGNALING?

- it is essential for interoperating with the circuit-switched telephone network, where there are no other extensible UI capabilities
- these devices are everywhere, and their UI is widely accepted ☎ 📱
- audio UIs can be made hands-free, eyes-free, and very small

currently,
most VoIP domains
are connected to each other
through the PSTN

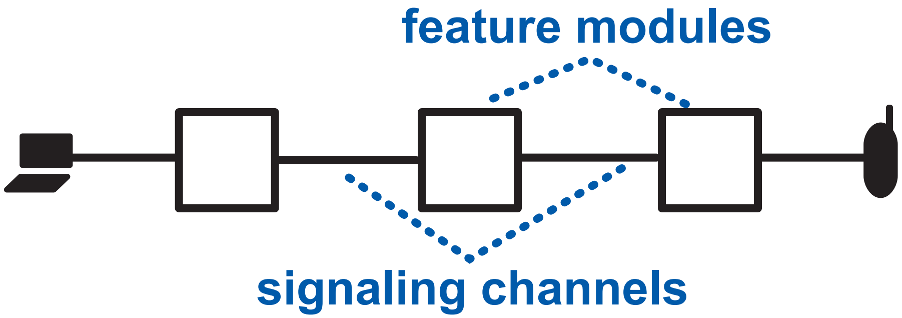
AUDIO SIGNALING + FEATURE INTERACTION

A feature is an increment of functionality.

To manage software complexity, we encapsulate features in software modules.

The inevitable by-product of feature modularity is feature interaction, because telecommunication features cannot be completely independent.

we assume a pipes-and-filters architecture that determines how features can interact



THE BEST WAY TO MANAGE FEATURE INTERACTION IS TO RELY ON COORDINATING PRINCIPLES

If every feature obeys the rules,

then the overall system behavior is . . .

- predictable
- manageable
- desirable

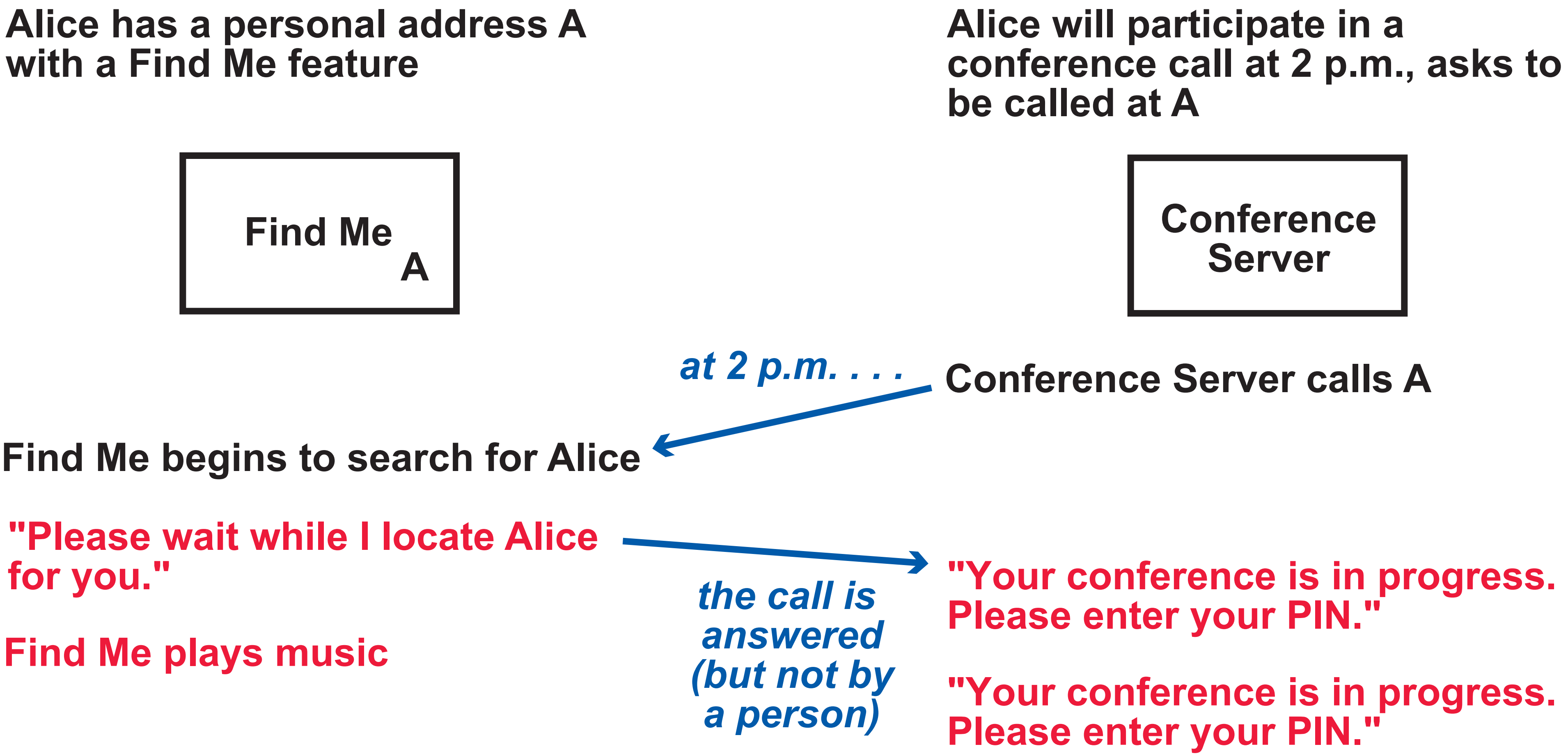
with some managing

COORDINATING PRINCIPLES . . .

- are often applied locally
- are a cheap and easy solution to problems
- are a valuable source of domain knowledge
- help to simplify the software

COORDINATING PRINCIPLE:

SEPARATE OUTCOME FROM MEDIA CONTROL



Alice has a personal address A with a Find Me feature

Alice will participate in a conference call at 2 p.m., asks to be called at A

Find Me
A

Conference Server

at 2 p.m. . . .

Conference Server calls A

Find Me begins to search for Alice

"Please wait while I locate Alice for you."

Find Me plays music

the call is answered (but not by a person)

"Your conference is in progress. Please enter your PIN."

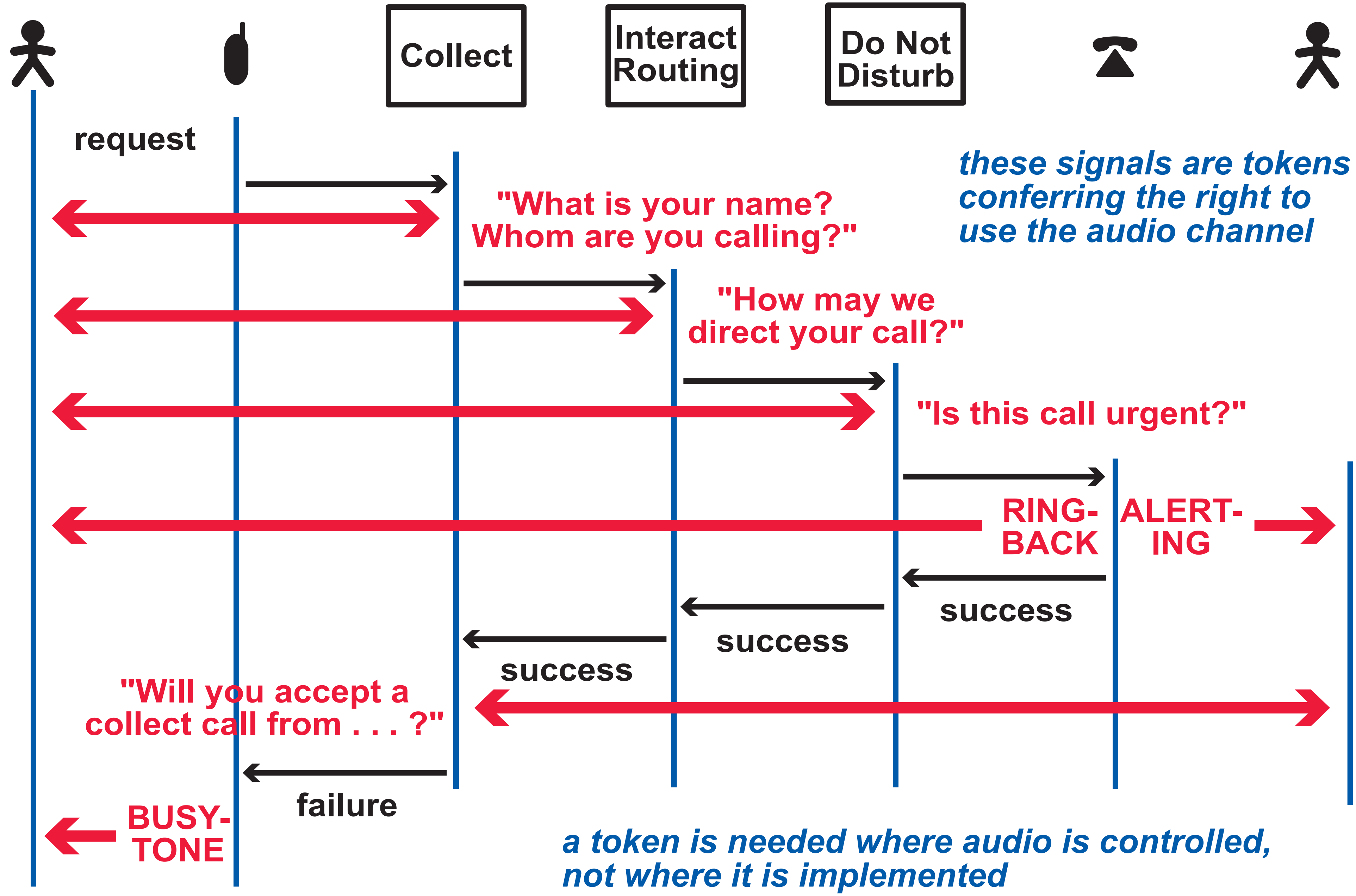
"Your conference is in progress. Please enter your PIN."

Conference Server disconnects

this BAD FEATURE INTERACTION occurs because the signals used to set up an audio channel are interpreted by the Conference Server as a successful outcome to the search for Alice

COORDINATING PRINCIPLE:

USE REQUEST/OUTCOME SIGNALS AS TOKENS

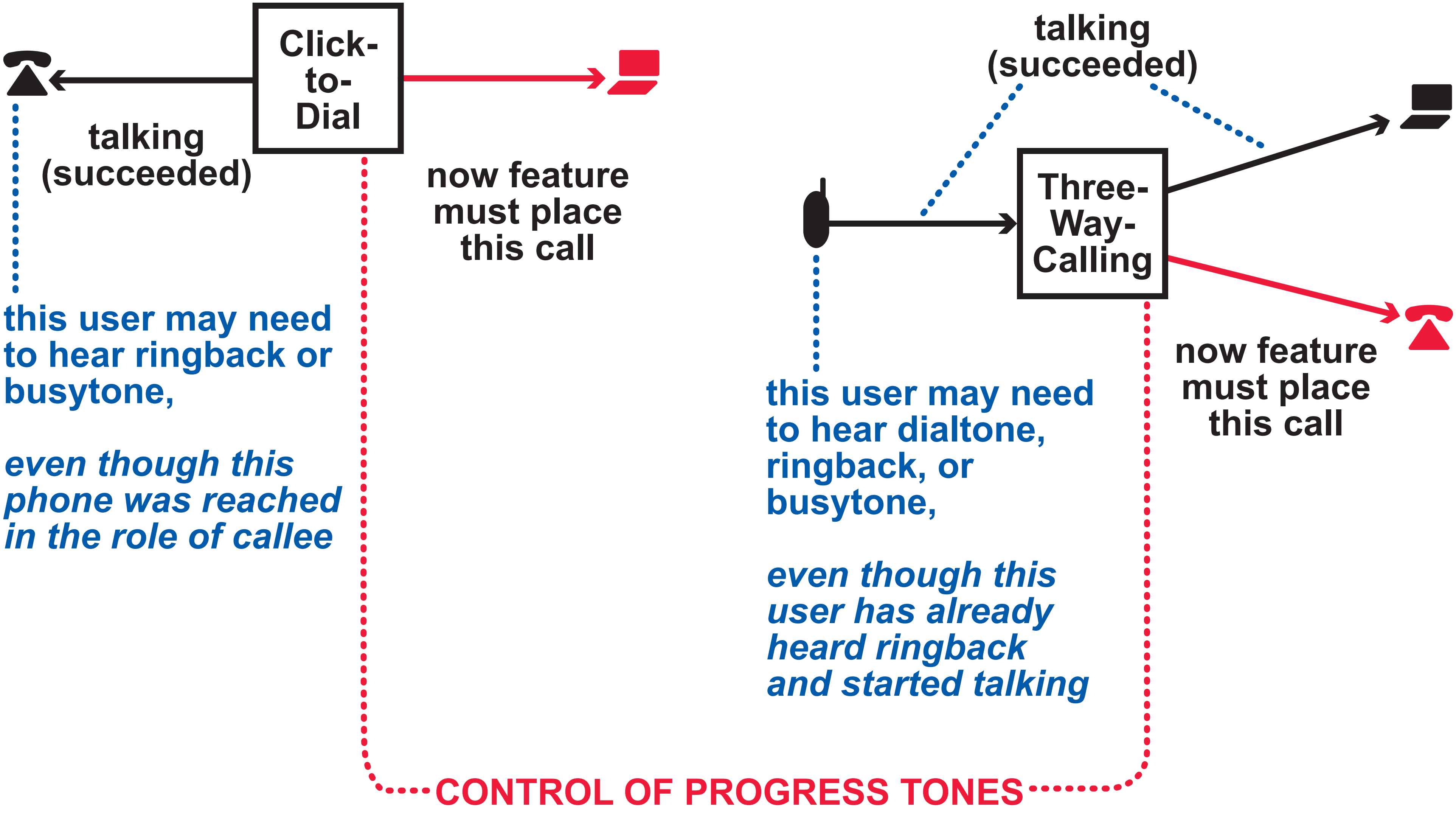


these signals are tokens conferring the right to use the audio channel

a token is needed where audio is controlled, not where it is implemented

COORDINATING PRINCIPLE:

IF A FEATURE ADDS A CALL AFTER SUCCESS, THE FEATURE MUST SUPPLY THE USER INTERFACE



Click-to-Dial

talking
(succeeded)

now feature
must place
this call

this user may need
to hear ringback or
busytone,

*even though this
phone was reached
in the role of callee*

talking
(succeeded)

Three-Way-Calling

this user may need
to hear dialtone,
ringback, or
busytone,

*even though this
user has already
heard ringback
and started talking*

now feature
must place
this call

CONTROL OF PROGRESS TONES

SUMMARY OF COORDINATING PRINCIPLES

- Separate outcome from media control.

  prevents miscommunication between features

- Use request/outcome signals as tokens.

  prevents audio contention

- If a feature adds a call after success, the feature must supply the user interface.

  ensures that there will be a user interface to what is happening

HOW DO WE IMPLEMENT THEM IN SIP?

SIP does not make this distinction, at least not for multiple features

use a "preliminary" tag on SIP messages that control media but do not indicate success

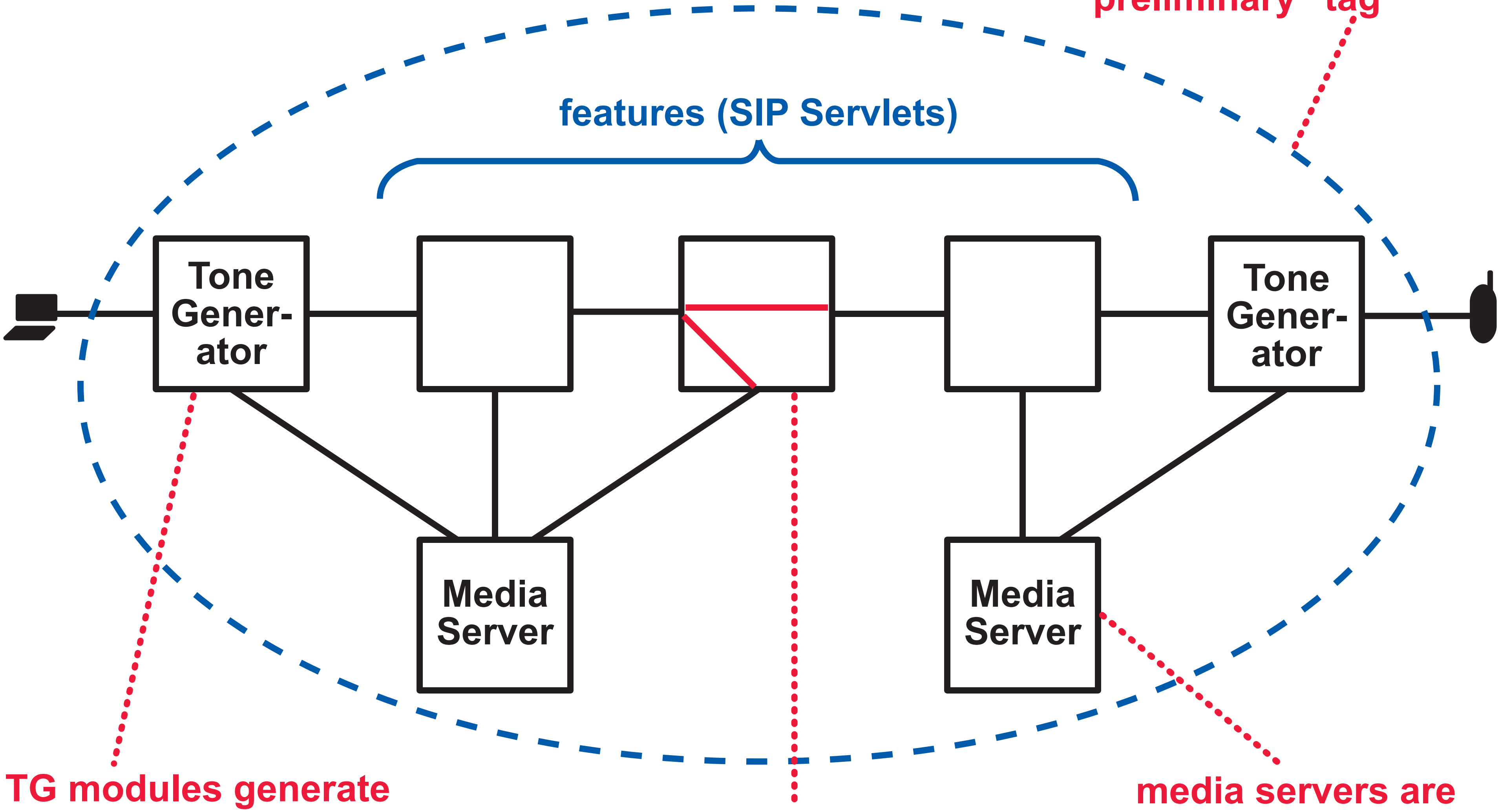
programming conventions, based on the distinction between media control and outcome

devices cannot generate these progress tones, because SIP does not allow it

use tone-generator modules and "info" signals

IMPLEMENTATION ARCHITECTURE

within this island, all modules understand the "preliminary" tag



TG modules generate necessary tones when the device cannot

feature switches media connection according to its state

media servers are shared resources for implementing audio signaling

THE GOOD NEWS: THIS REALLY WORKS!

we used these techniques to implement the advanced features of AT&T's CallVantage^{SM} VoIP service

they are completely compatible with 3261 SIP

SOME BAD NEWS

IT IS REALLY DIFFICULT TO PROGRAM THESE FEATURE MODULES

they are highly concurrent B2BUAs

the modules must work correctly in any context, so they make no assumptions about what other system components are doing

MORE GOOD NEWS

our forthcoming high-level language StratoSIP automates all the difficult concurrent programming

StratoSIP offers a combination of declarative and sequential programming

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