GSM or GPRS

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Introduction

- The impressive growth: cellular mobile telephony + the number of Internet users
  → wireless(cellular) data services

- But, Voice is still the killer application
  - Revenue in 1999
    • Amazon ($1.6 B), yahoo ($588.6 M)
    • BellSouth ($25 B), BellAtlantic ($33 B), Net2Phone, Dialpad

What about Voice over IP (VoIP) over wireless packet network?
GSM/GPRS network
Circuit or Packet for Voice traffic?

- GSM -> GPRS (VoIP over GPRS)
  - User
    - Less call block rate and less call drop rate
    - Lower call quality, but less charge
  - Network
    - Less (radio) bandwidth requirements
    - Accommodate more calls
  - Service provider
    - Increase revenue

- GPRS -> GSM
  - User
    - Willing to pay more for the quality call
  - Network
    - Provide quality call when enough bandwidth is available
  - Service provider
    - Offer quality call to the premium users
Agenda

- Motivation
- Objectives
- Pro/demotion
  - 3 schemes
  - Whom to pro/demote
- Evaluation
- Implementation
- Conclusion
3 pro/demotion schemes using 3-way calling
Scheme 1: Circuit-based

- A new call is always made from circuit mode assuming normally most cells are not overloaded
- Pros
  - Suitable when the cell is rarely overloaded
- Cons
  - Users are put on hold during promotion & promotion
  - 3-way calling mechanism should be modified
  - 3-way calling should be handled both at the GMSC and at the Signaling Gateway
  - New calls are not likely to be admitted when the cell is overloaded
Scheme 2: Packet-based

- A new call is always made from packet mode
  - Packet connection is maintained until the end of the call by sending a GPRS attach refresh packet periodically (keep the GPRS state in READY or STANBY)

- Pros
  - Put on hold only during promotion
  - No modification of 3-way calling mechanism
  - New calls are likely to be admitted even when the cell is overloaded

- Cons
  - When the cell is not overloaded, most of new calls will be promoted right after they are established
Scheme 3: Hybrid

- A new call is made from either circuit or packet mode depending on the cell load.
- Packet-based scheme is enabled only when the cell is overloaded.
  - When the cell is NOT overloaded
    - Packet-based scheme is disabled
    - Same as normal GSM operation
- No demotion is allowed for the GSM calls established when packet-based scheme is disabled.
- Small number of switch-able calls (established from packet-based scheme) can alleviate the cell overloading.
Internetworking – GSM/GPRS, PSTN, IP network
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Whom to pro/demote …
Cumulative MOS

- Cumulative Mean Opinion Score (MOS)
  - GSM (EFR) = 4
  - VoIP (G.723.1) with 3% frame loss rate = 3.4
- $\sum((\text{MOS}_{\text{GSM}} - \text{MOS}_{\text{VoIP}}) \times t_i)$
- The lowest will be demoted

10 (time)

- ideal call
- Call A
  - 5
  - 3
  - 2
  - 0.6*3 = 1.8
  - demoted !!
  - new call or handoff started
- Call B
  - 2
  - 5
  - 2
  - 0.6*5 = 3
  - demotion triggered

GSM  ↓ demotion
VoIP  ↑ promotion
Hiccups

- $\sum(1/t_i)$
- The recent hiccups affect more

Call A
- ideal call
- $1/3 + 1/2 + 1/1 = 1.83$

Call B
- new call or handoff started
- $1/7 + 1/6 + 1/1 = 1.31$

demoted !!

demotion triggered
Call Duration

- Demote the GSM call whose duration \textit{in the cell} is longer.
- The short-duration calls experienced the hand-off or newly started \textit{recently}.
Call Block Rate

Call Block Rate (Plain topology, hybrid, no user-class, MCRT = 00, VoIPs/CH = 2)

- no pro/demotion
- max voip ratio 0.1
- max voip ratio 0.2
- max voip ratio 0.3
- max voip ratio 0.4
- max voip ratio 0.5

num of mobile stations vs. call block rate
Average Promotions

Average Number of Promotions per Call (plain topology, no user-class, MCRT = 90, VoIPs/CH = 2)

- circuit-initiated (MCRV 0.1)
- packet-initiated (MCRV 0.1)
- hybrid (MCRV 0.1)
- circuit-initiated (MCRV 0.5)
- packet-initiated (MCRV 0.5)
- hybrid (MCRV 0.5)

Number of mobile stations vs. average number of promotions per call.
Revenue

Revenue (Plain topology, hybrid, no user-class, MCRT = 90, VoIPs/CH = 2)
Implementation

- Using a VoiceStream GPRS phone

![Diagram showing implementation with various phones and call types]
Conclusion

- Small number of switch-able calls alleviate the cell overloading
- High adaptability
  - provides quality of service to the users while maximizing the revenue to the service providers
- Fairness
  - provides fairness among the users based on the utility function which can be configured by the service providers
- Immediate deployment
Thank you!

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