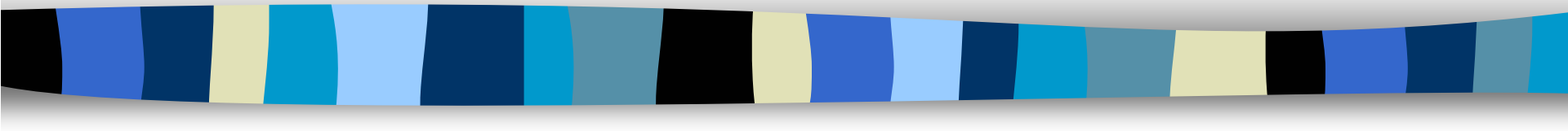
GSM or GPRS



JaeWon Kang, Badri Nath

Dataman Lab
Department of Computer Science
Rutgers University

Introduction

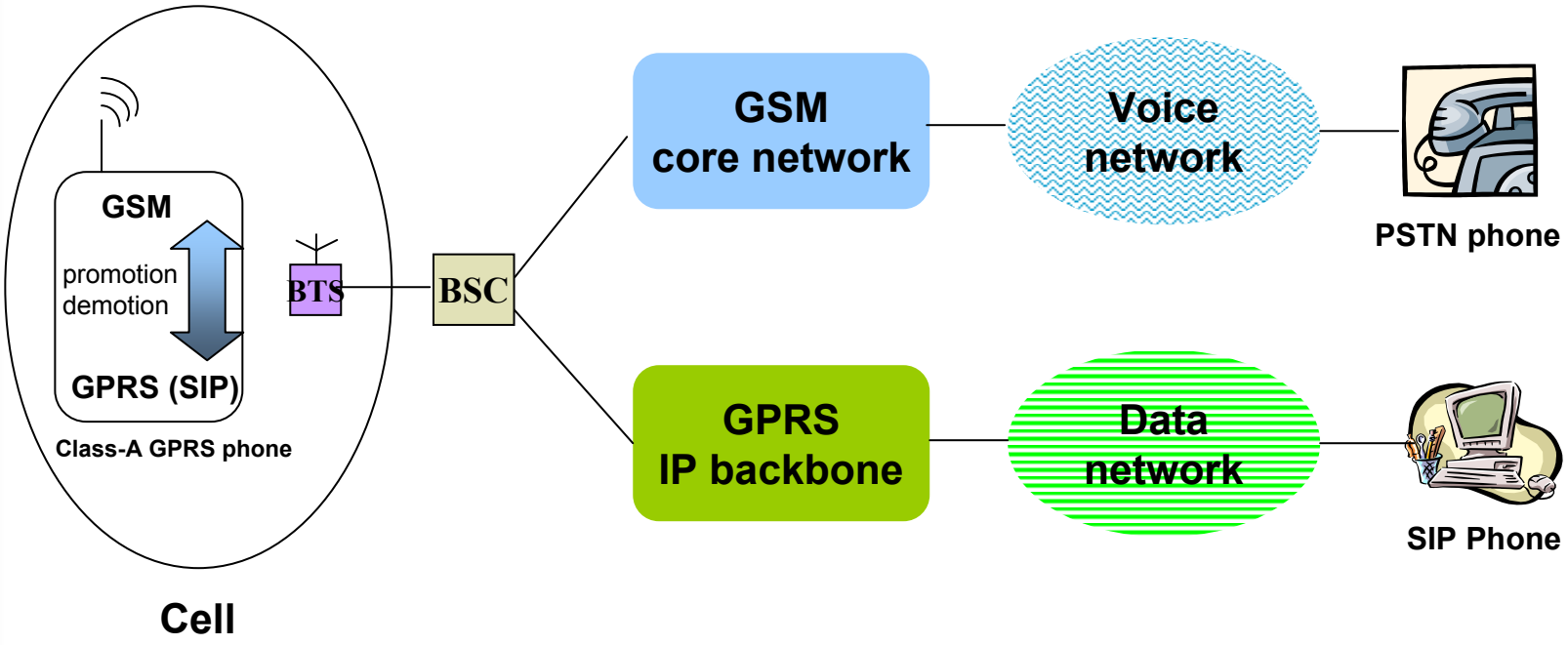
- The impressive growth : cellular mobile telephony + the number of Internet users

  → *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 ?

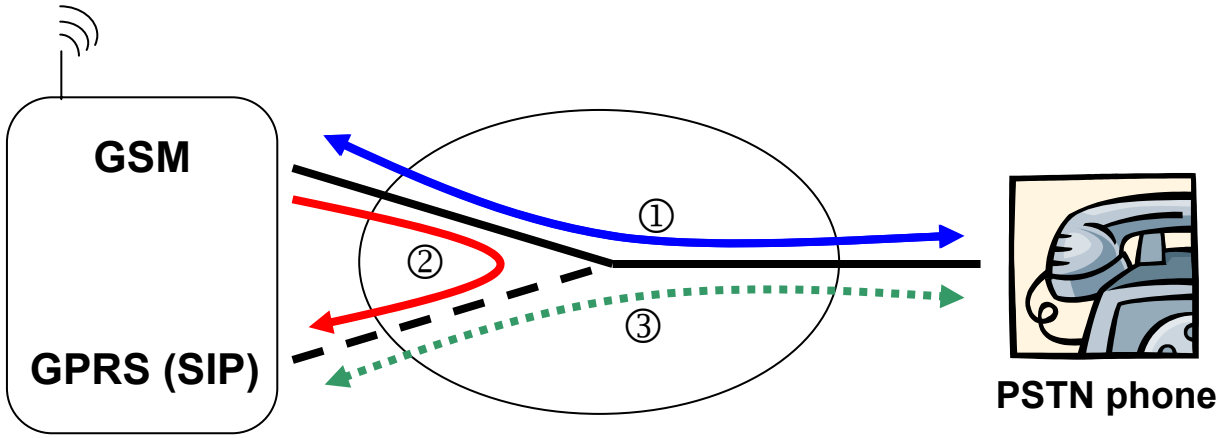
- GSM -> GPRS (VoIP over GPRS)
  - User
    - Less call block rate and less call drop rate
    - Lower call quality, but less charge
  - Network
    - Less (radio) bandwidth requirements
    - Accommodate more calls
  - Service provider
    - Increase revenue
- GPRS -> GSM
  - User
    - Willing to pay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

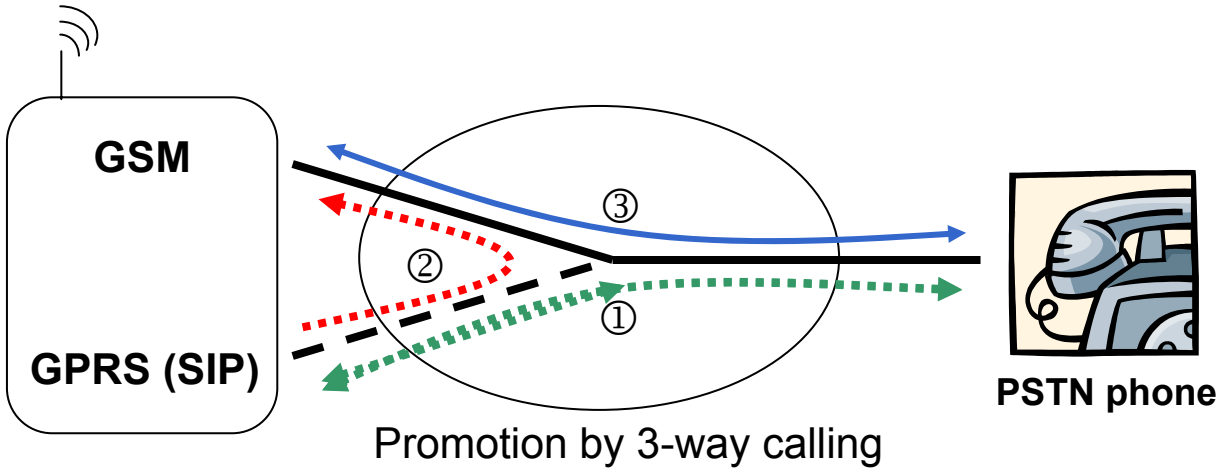
Scheme 1 : Circuit-based



Demotion by 3-way calling

- 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



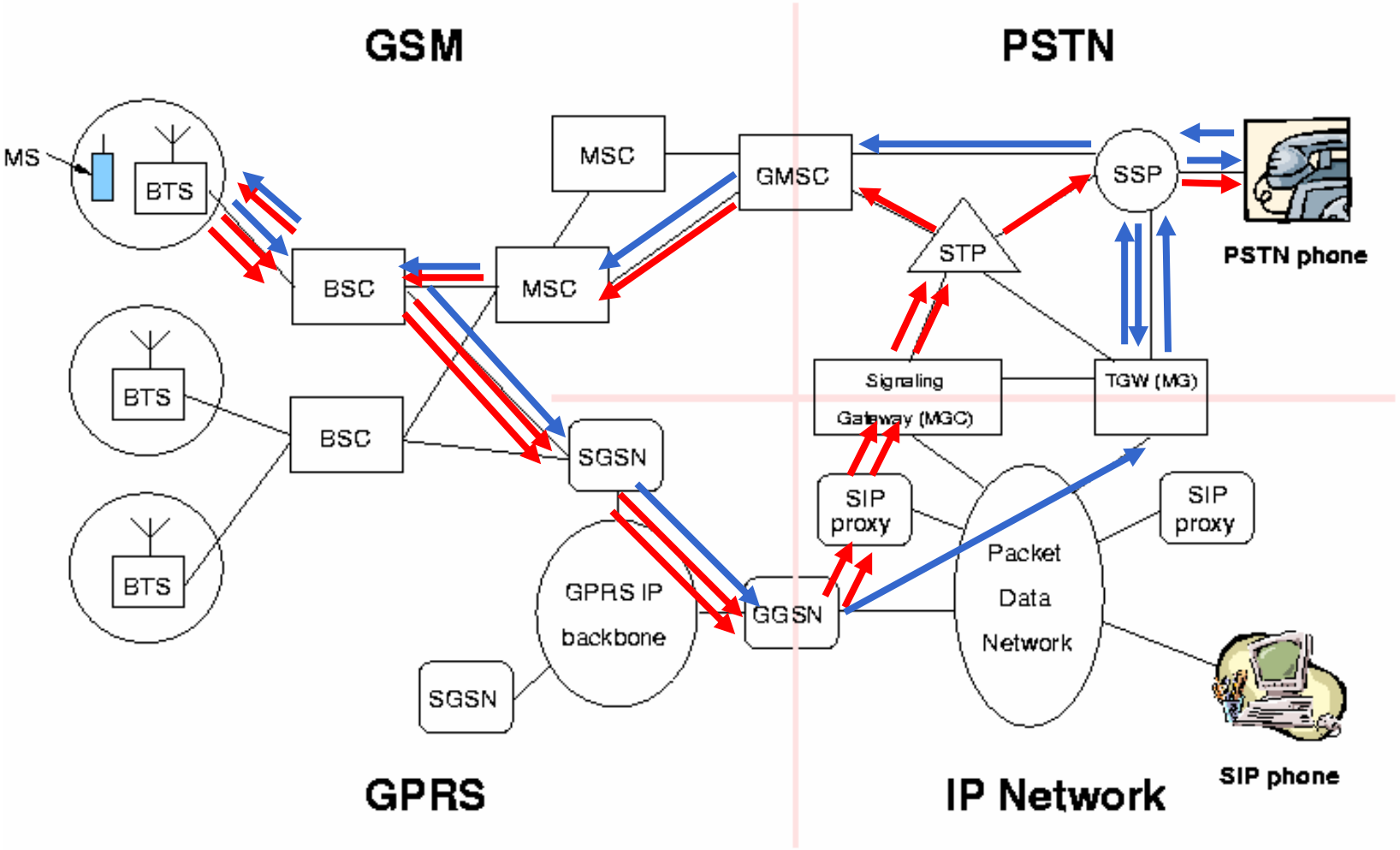
Promotion by 3-way calling

- 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

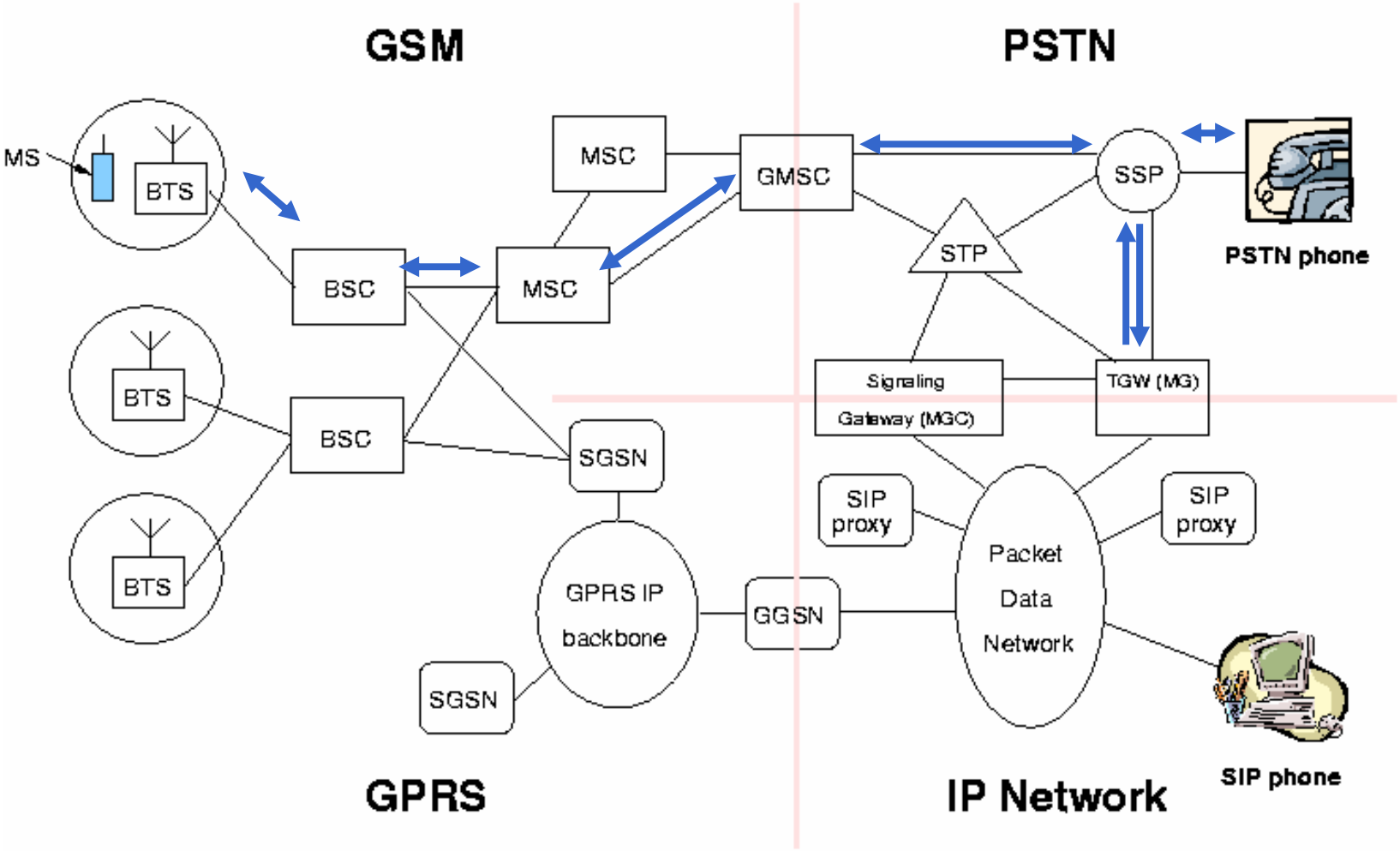
Scheme 3 : Hybrid

- 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



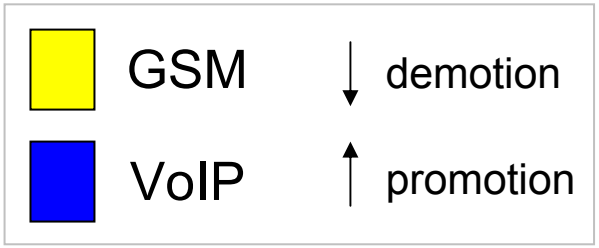
Internetworking – GSM/GPRS, PSTN, IP network

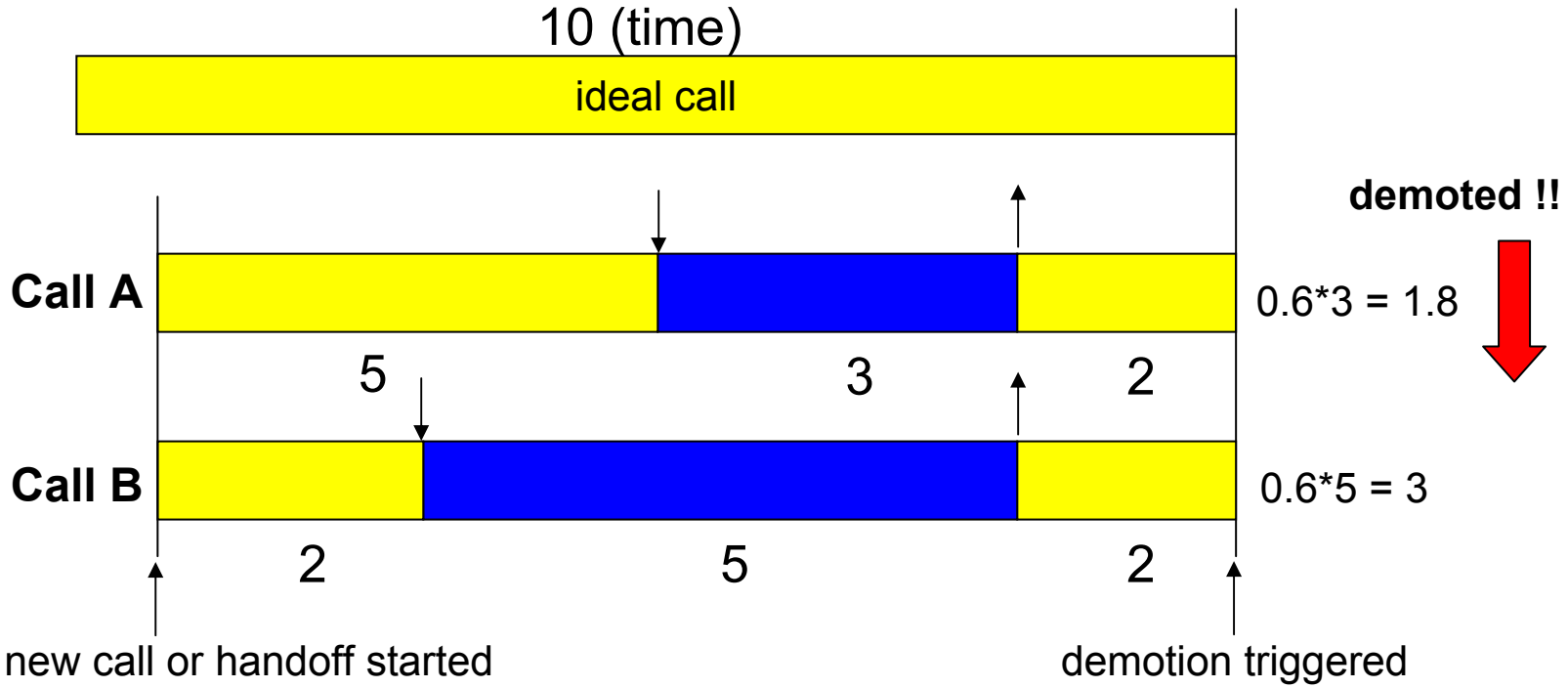


Whom to pro/demote …

Cumulative MOS

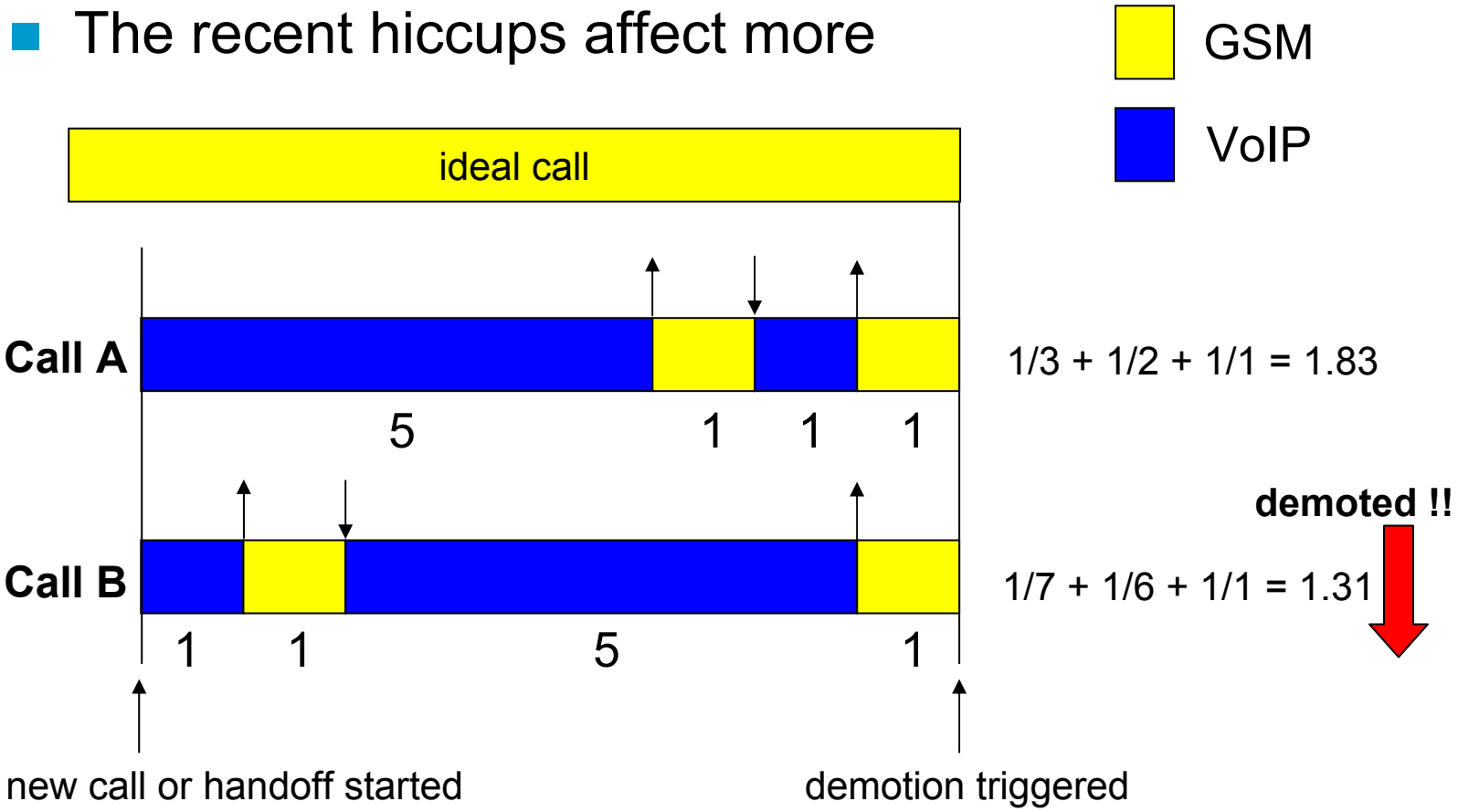
- Cumulative Mean Opinion Score (MOS)
  - GSM (EFR) = 4
  - VoIP (G.723.1) with 3% frame loss rate = 3.4
- $\sum((MOS_{GSM} - MOS_{VoIP})*t_i)$
- The lowest will be demoted





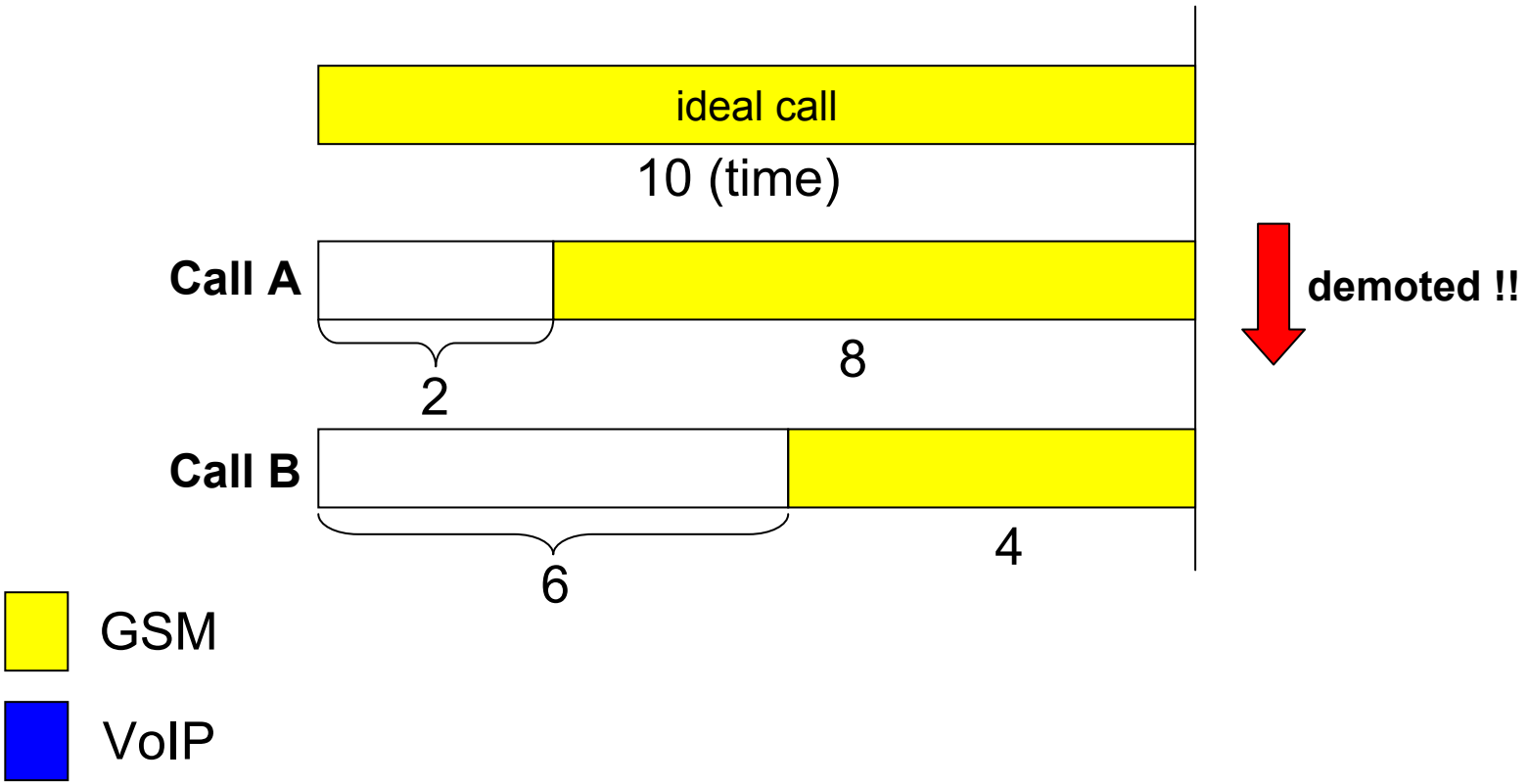
Hiccups

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

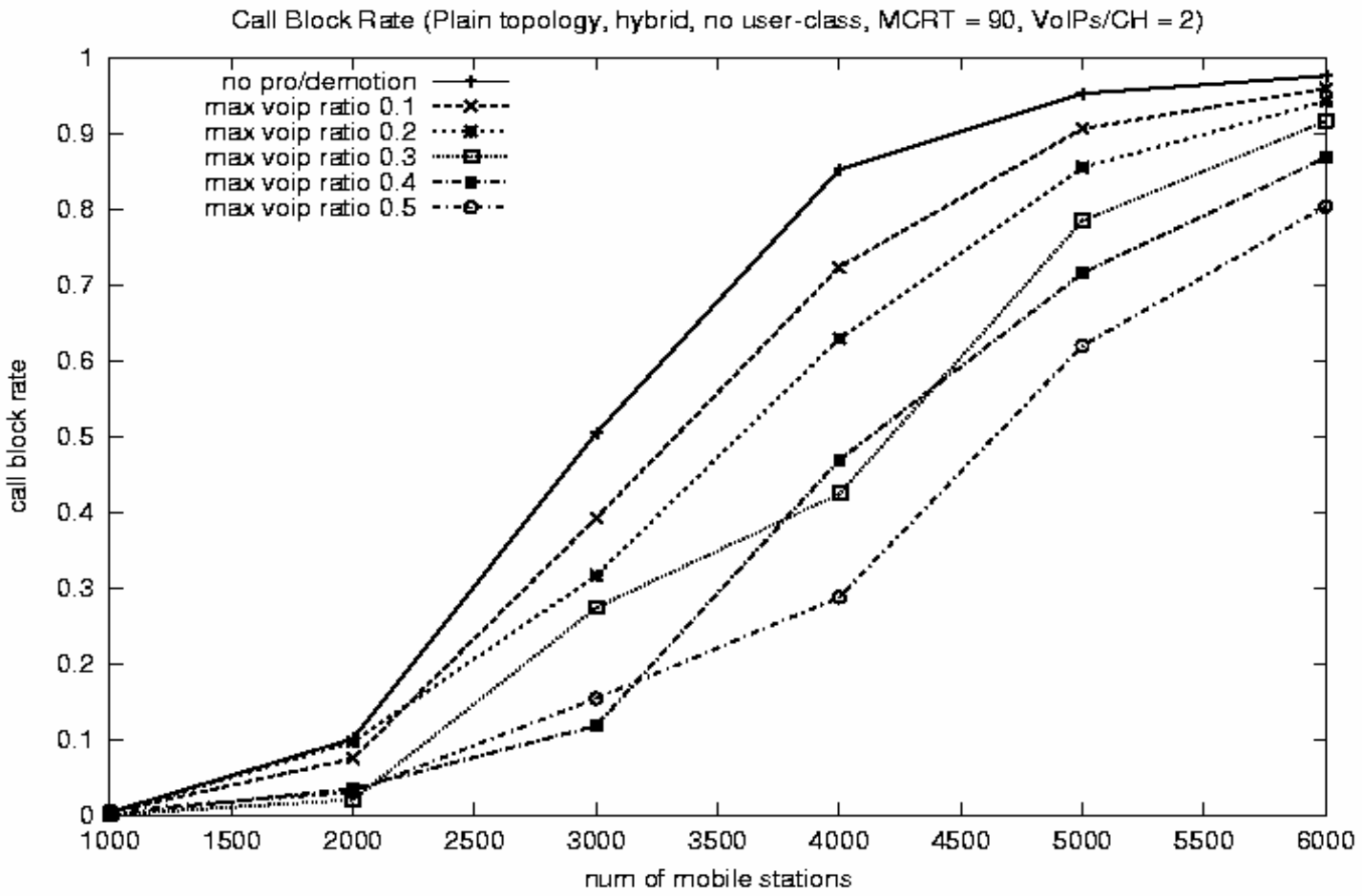


Call Duration

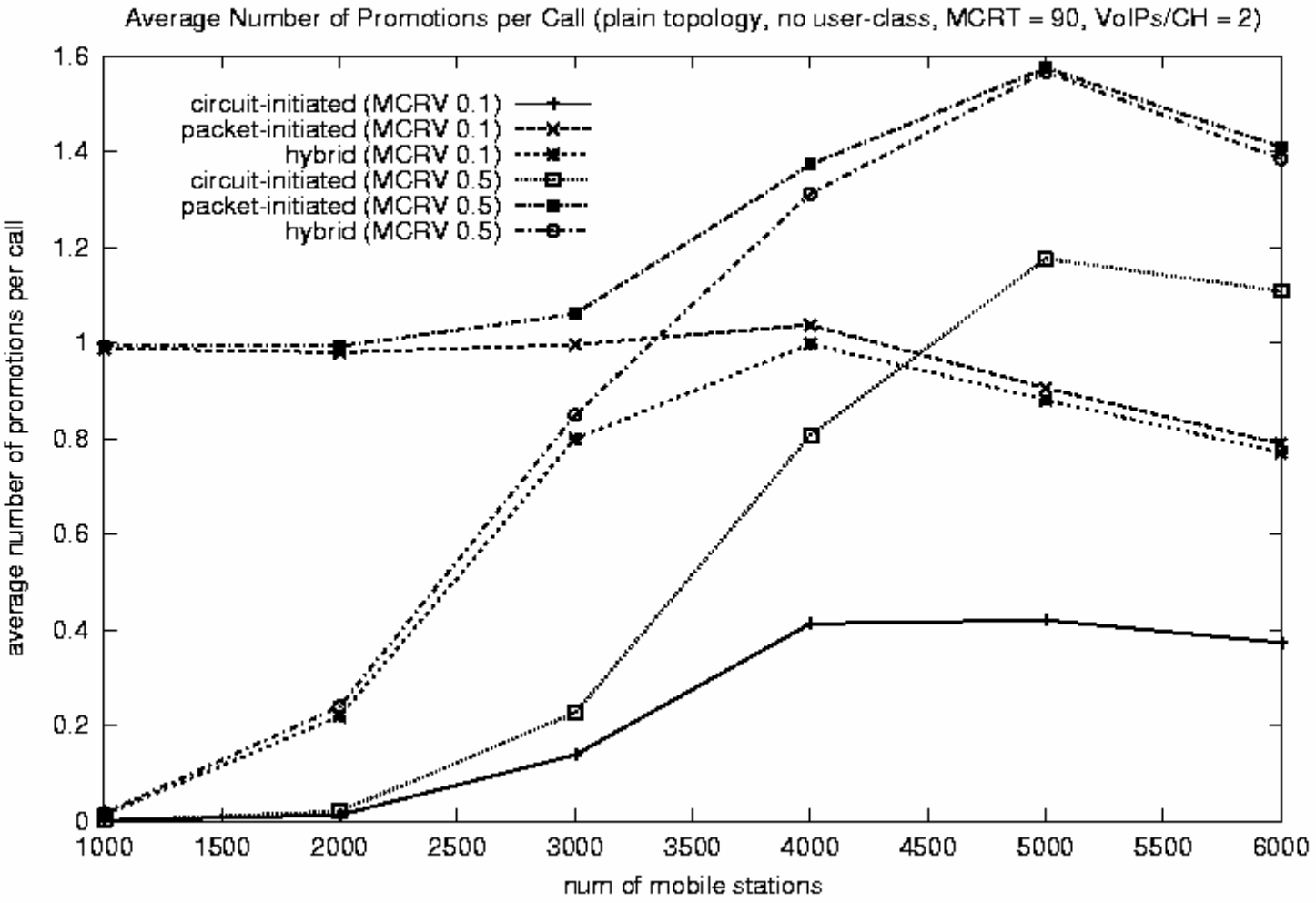
- Demote the GSM call whose duration **in the cell** is longer
- The short-duration calls experienced the hand-off or newly started *recently*



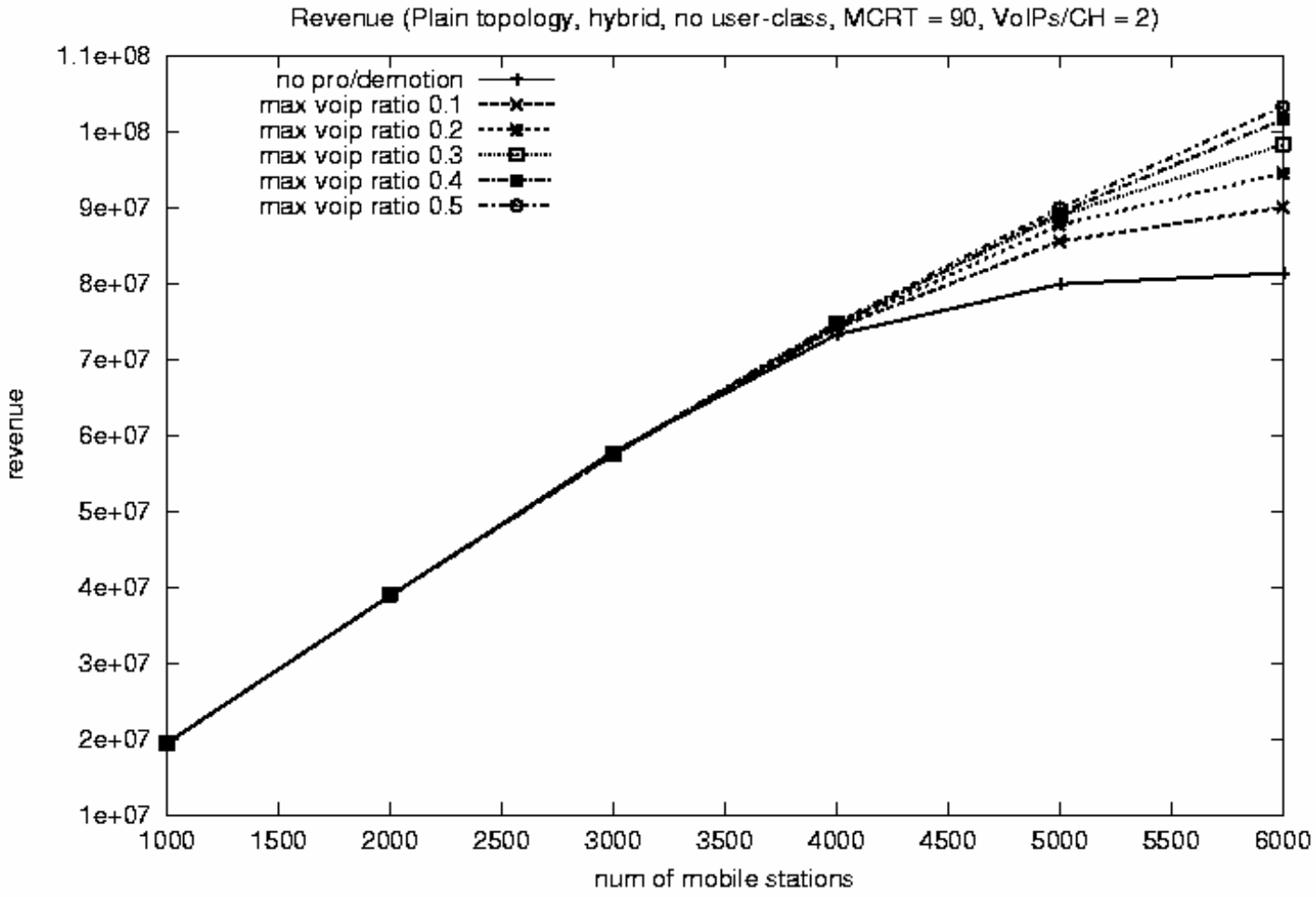
Call Block Rate



Average Promotions

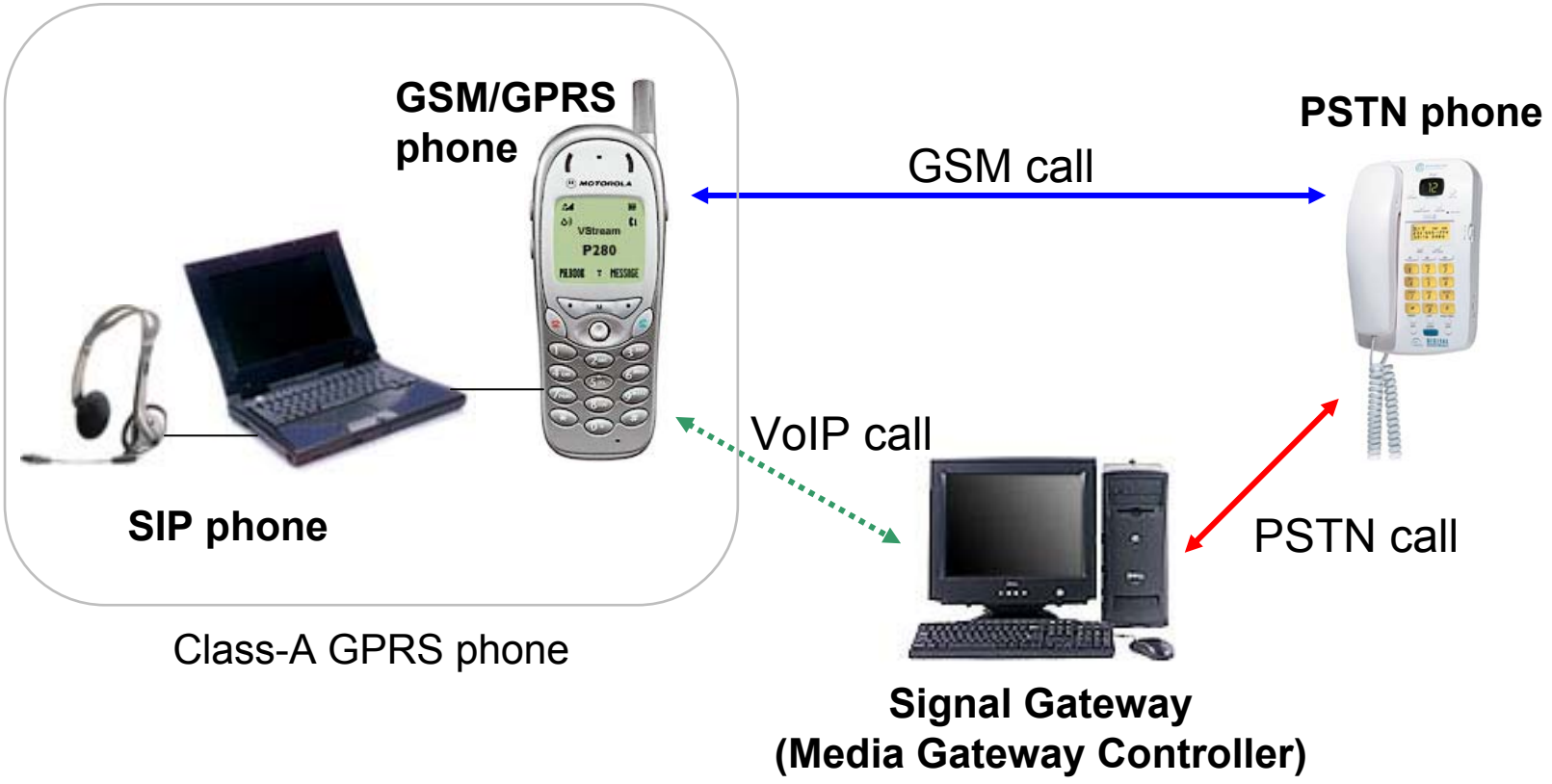


Revenue


Revenue (Plain topology, hybrid, no user-class, MCRT = 90, 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
revenue
1.1e+08
1e+08
9e+07
8e+07
7e+07
6e+07
5e+07
4e+07
3e+07
2e+07
1e+07
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
num of mobile stations

Implementation

- Using a VoiceStream GPRS phone



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 !

Jaewon Kang

jwkang@cs.rutgers.edu