Performance Analyses for Relaying LTE-A Connection Admission Control

國立雲林科技大學 資工系

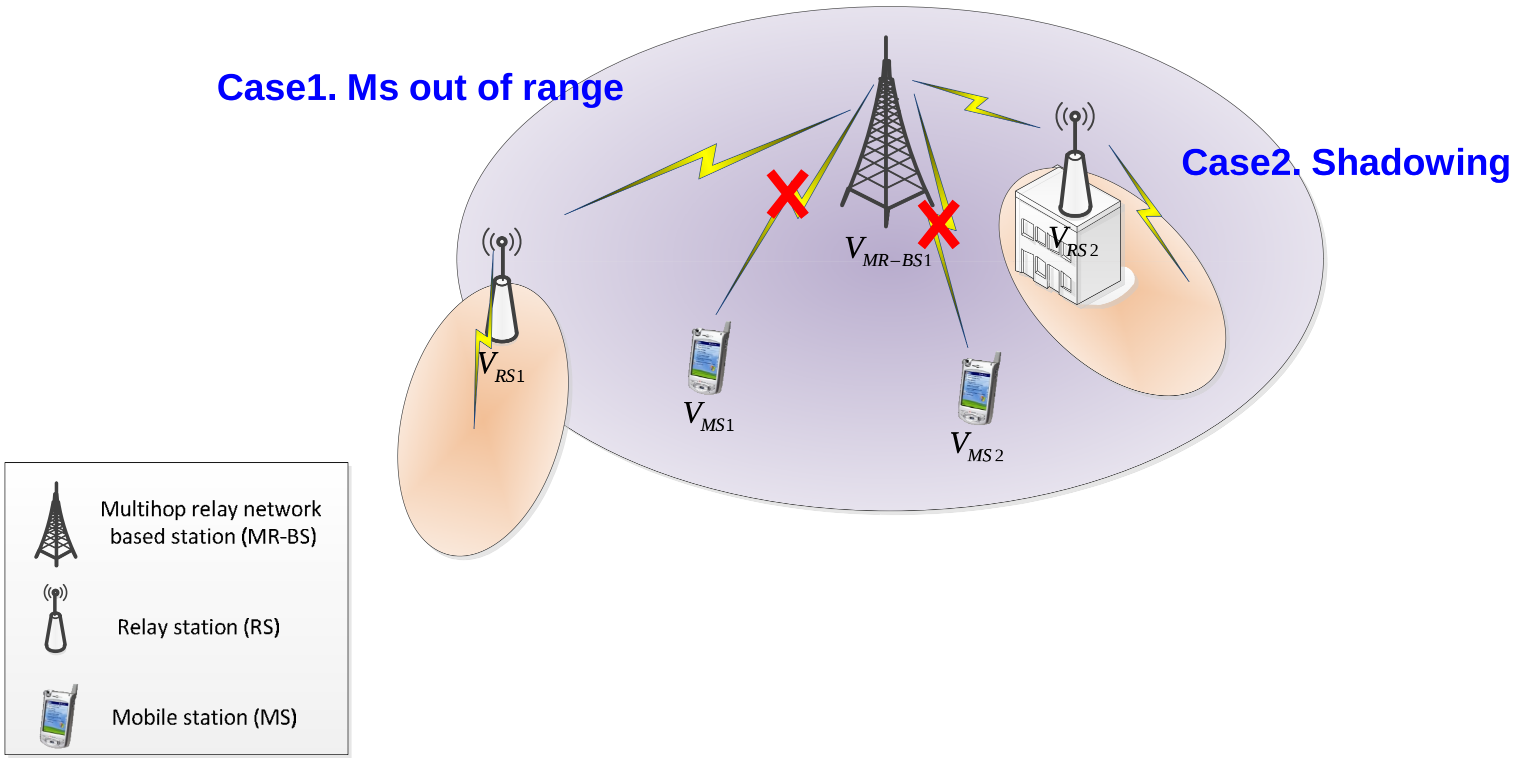
Ben-Jye Chang, Ph.D., Chair

張本杰 教授兼任系主任

Outline

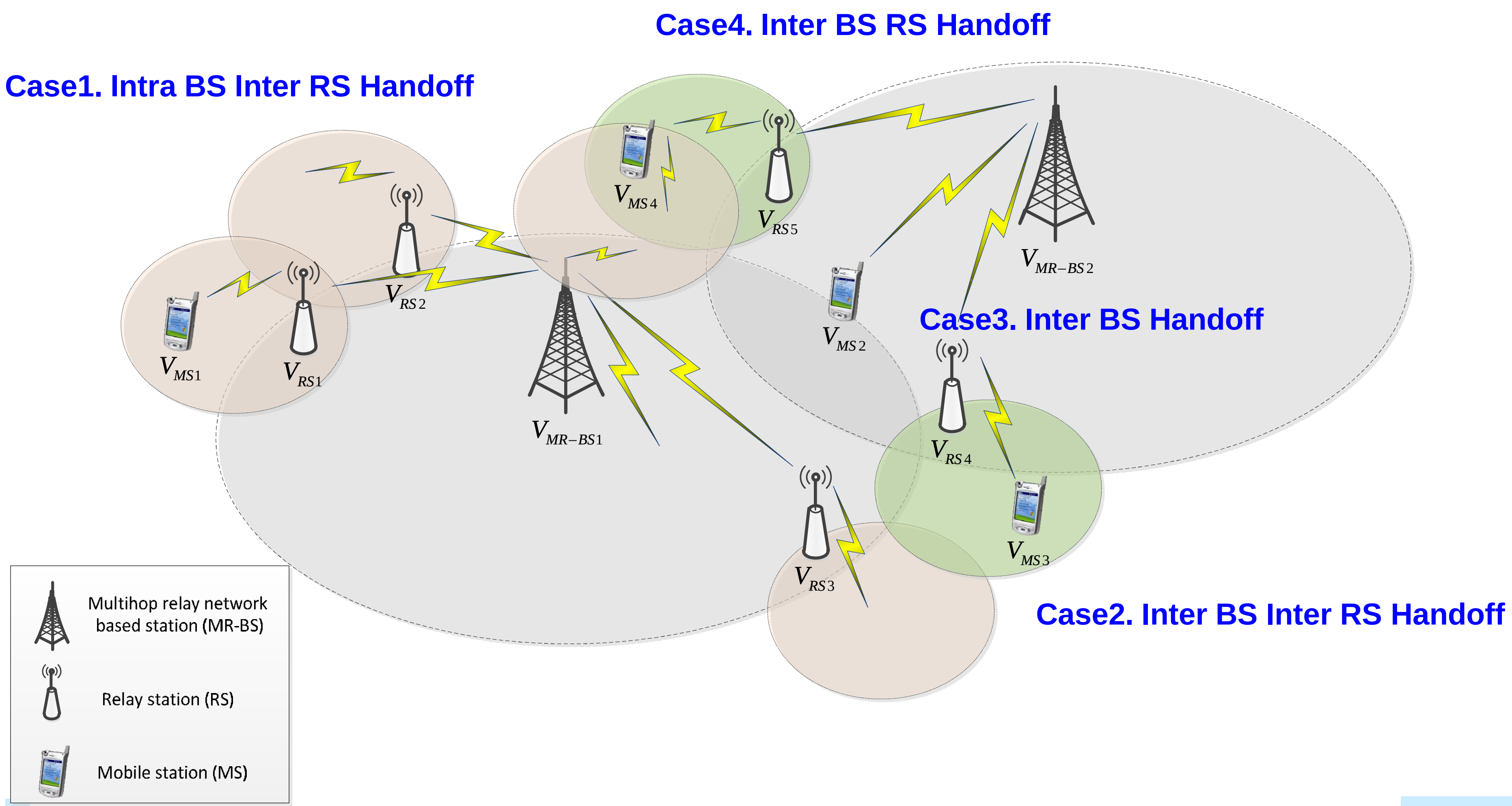
- Introduction
  - Overview
  - Handoff case in Multihop Relay Networks
- Issue
- Related works
  - Common Call Admission Control in wireless networks
  - Analysis of Call Admission Control in wireless networks
- Motivation & Goals
- Proposed Approach
  - Step 1. Calculate Bs Cost
  - Step 2. Calculate arrival call Reward
- Markov Chain Analyses
- Numerical Results
- Conclusions

Overview



Case1. Ms out of range
Case2. Shadowing
V_{MR-BS1}
V_{RS1}
V_{RS2}
V_{MS1}
V_{MS2}
Multihop relay network based station (MR-BS)
Relay station (RS)
Mobile station (MS)

Handoff Cases in Relaying-based Cellular Networks



Issue

- Disadvantages of CAC in Relaying-based Cellular Networks (RCN)
  - 1. No efficient CAC in Relaying-based Cellular Networks
    - All of the handoff occur in both MR-BS and RS
  - 2. No adaptive CAC in Relaying-based Cellular Networks
    - Most CAC consider only the Ms type, and the user's bandwidth request or QoS

Related works

- Common Call Admission Control in wireless networks
  - **Complete sharing, Complete partition CAC**
    - **[5]** Salman A. AlQahtani and Ashraf S. Mahmoud, "**Dynamic radio resource allocation** for 3G and beyond mobile wireless networks," *Computer Communications*, Vol. 30, Issue 1, pp. 41-51, Dec. 2006.
    - Advantage
      - Can achieve high Utilization
    - Disadvantage
      - Low system receipts
  - **Resource reserved CAC**
    - **[7]** M. Salamah and H. Lababidi "Dynamically adaptive **channel reservation scheme** for cellular networks," *Computer Networks,* Vol. 49, Issue 6, pp. 787-796, Dec. 2005.
    - Advantage
      - Guarantee high priority user can use most resource
    - Disadvantage
      - It's hard to set the guard threshold

Related works (cont.)

– **Cost based CAC**
  - **[14]** Wei shen and Qing-An Zeng, "**Cost-Function-Based** Network Selection Strategy in Integrated Wireless and Mobile Networks," *IEEE Transactions on Vehicular Technology*, Vol. 57, Issue 6, pp.3778-3788, Nov. 2008.
  - Advantage
    – Reducing blocking probability of ongoing call
  - Disadvantage
    – The cost function weight was a static value

Related works (cont.)

- Analysis of Call Admission Control in wireless networks
  - **Analysis for Multi-service Networks**
    - **[15]** N. Lu and J. Bigham, “On utility-fair bandwidth adaptation for **multi-class traffic QoS** provisioning in wireless networks,” *Computer Networks*, Vol. 51, Issue 10, pp.2554-2564, July 2007.
    - **[16]** Yavuz E and V.C.M Leung, “Efficient Methods for Performance Evaluations of Call Admision control Schemes in **Multi-service** Cellular Networks,” *IEEE Transactions on Wireless Communications*, Vol. 7, Issue 9, pp. 3468-3476, Sep. 2008.
    - Advantage
      - Use multi-dimensional Markov chain to analysis multi-service class CAC in both CS and Guard channel
    - Disadvantage
      - It can’t analysis for more than two traffic class networks

Motivation & Goals

- **Motivations**
  - Proposed a **Dynamic Cost-Reward based CAC** for MMR networks
    - Adaptive CAC for MR-BS and RS.
    - Decreasing the dropping probability of high priority users.
    - Maintain the system Utilization and more network reward.

- **Goals**
  - Using the Dynamic Cost-Reward based CAC to reach the goals as follow
    - 1. Low dropping probability
    - 2. Low FRL and GoS
    - 3. Maximum network reward

Proposed Approach

- Proposed three steps to made decision
  1. Calculated BS cost
  2. Calculated inter arrival calls reward
  3. Compare Cost Reward to decision
     - Accept or reject

Step 1. Calculate BS cost

–**[19]** R. Gawlick, A. Kamath, S. Plotkin, and K. Ramarkrishnan, “Routing and Admission Control in General Topology Networks,” *Technical report STAN-CS-TR-95-1548*, Stanford University, 1995.

- Competitive On-Line (COL)

request bandwidth

Link Capacity

Constant

Occupancy resource

BS Capacity

$$Cost_k = \sum_{j=1} C_l W_l(i)$$

$$W_l(i) = a^{BR_i / C_l} \ldots (i)/C_l) - 1,$$

link capacity

occupancy resource

$$0 \le W_l(i) \le 1$$

Step 2. Calculate arrival calls reward

- **Proposed a Dynamic Reward Equation**

- **Proposed Dynamic Reward Equation**

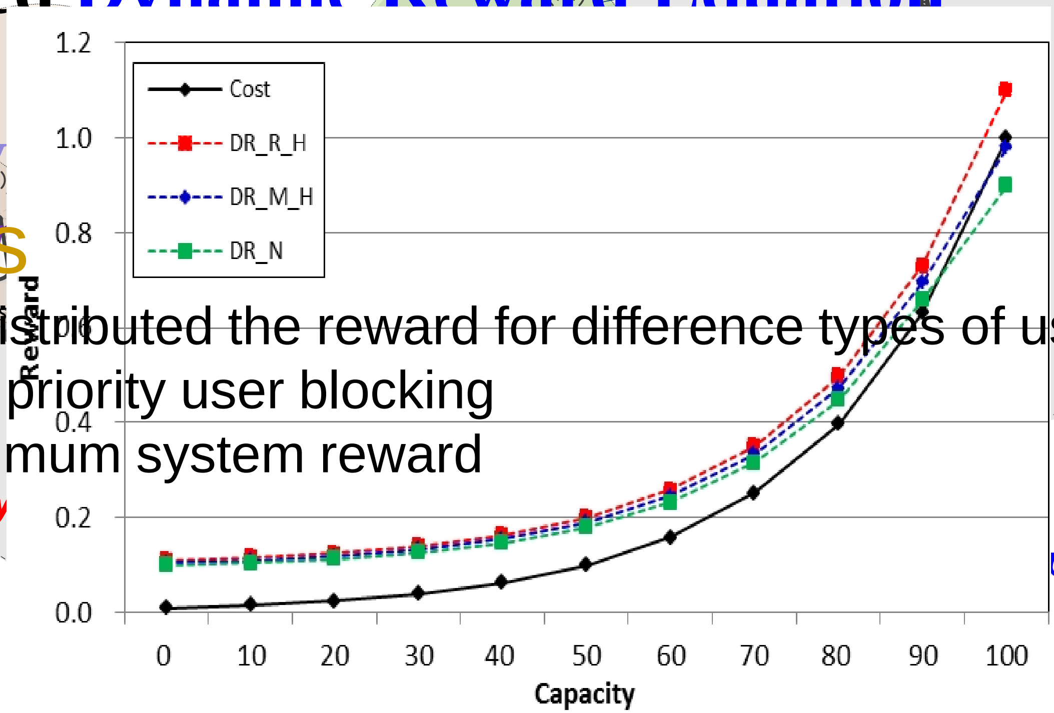
- Motiv
- Goals
  - By distributed the reward for difference types of user to decrease high priority user blocking
  - Maximum system reward

Connection ty

connection I in

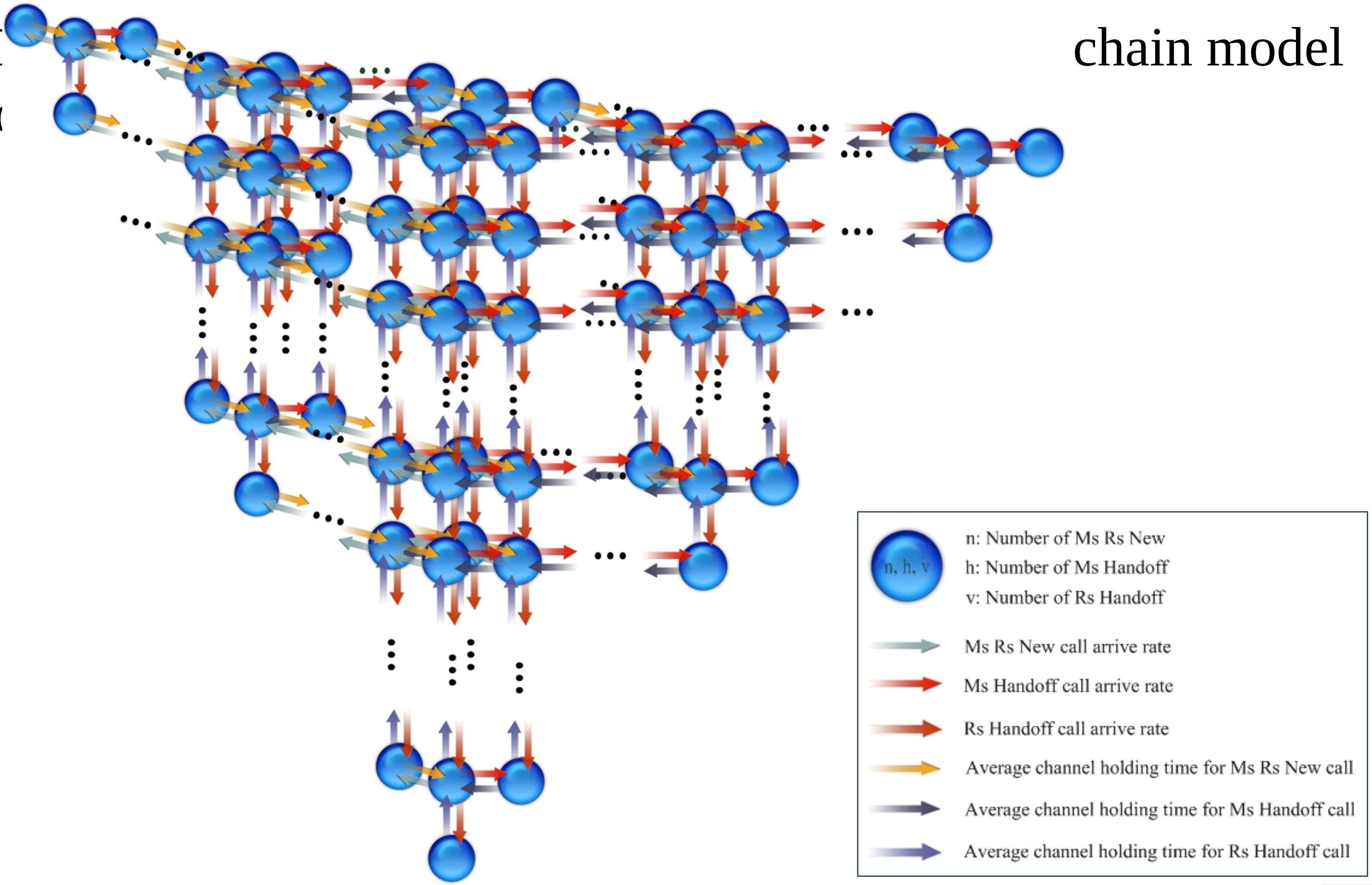
priority user

pacity



Markov Chain Analysis

- T chain model
  t



Transition cases in CS and Guard

- The transition of all cases in the proposed Markov Chain model.

$$s(n,\ h,\ v\ ;\ n+1,\ h,\ v)\ =\ l_n^{Ms,Rs}$$

$$s(n,\ h,\ v\ ;\ n-1,\ h,\ v)\ =\ nm_n^{Ms,Rs}$$

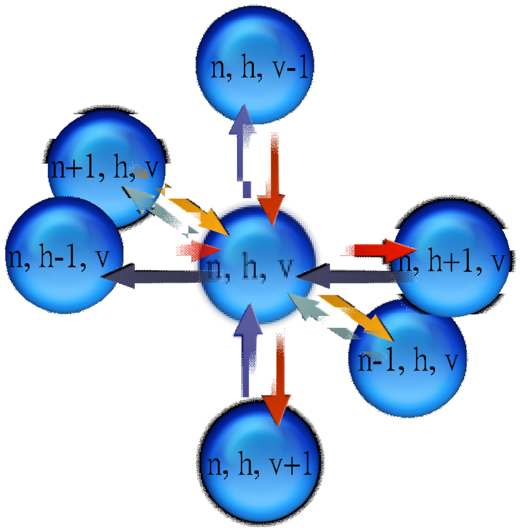
$$s(n,\ h,\ v\ ;\ n,\ h+1,\ v)\ =\ l_h^{Ms}$$

$$s(n,\ h,\ v\ ;\ n,\ h-1,\ v)\ =\ hm_h^{Ms}$$

$$s(n,\ h,\ v\ ;\ n,\ h,\ v+1)\ =\ l_h^{Rs}$$

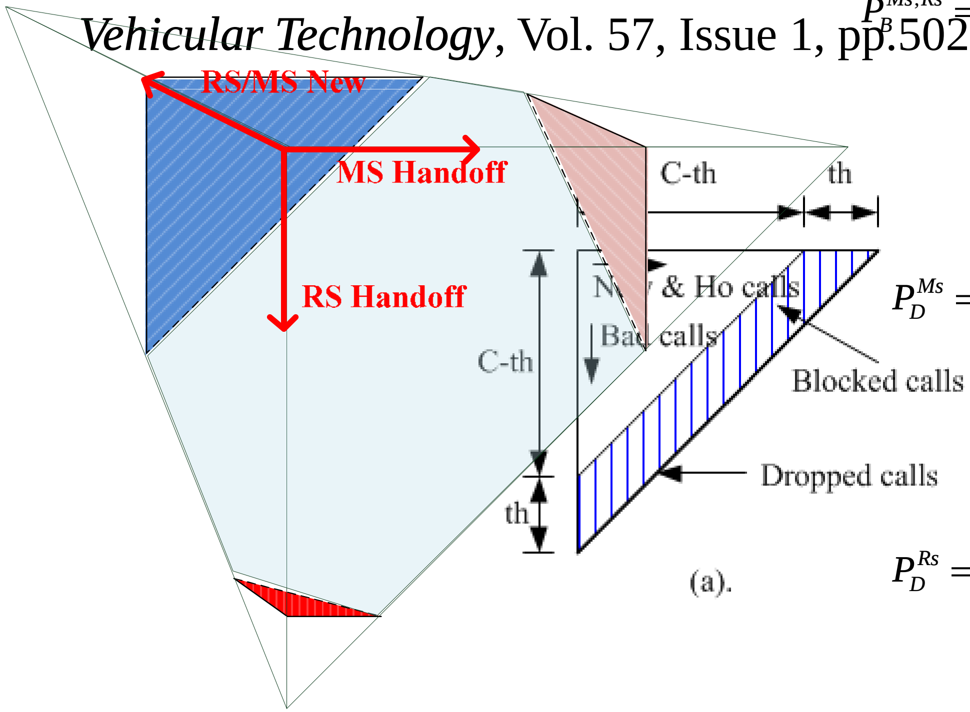
$$s(n,\ h,\ v\ ;\ n,\ h,\ v-1)\ =\ vm_h^{Rs}$$

$$0<n\le t_n^{Ms,Rs},\ 0<h\le t_h^{Ms}\ ,0<v\le t_h^{Rs},\ n+h+v\le Cap$$



Performance in CS and Guard

- Blocking probability and Dropping probability can be calculated as follow.
  - **[22]** B.B. Madan, S. Dharmaraja and K.S. Trivedi, "Combined Guard Channel and Mobile-Assisted Handoff for Cellular Networks," *IEEE Transactions on Vehicular Technology*, Vol. 57, Issue 1, pp.502-510, Jan. 2008.



(a).

$$P_B^{Ms,Rs} = \left\{ \sum_{v=0}^{t_h^{Rs}} \sum_{n=0, 0 \le Cap-v-n \le t_h^{Ms}}^{t_n^{Ms,Rs}} \frac{r_v^{\,v}}{v!} \frac{r_n^{\,n}}{n!} \frac{r_h^{\,Cap-v-n}}{(Cap-v-n)!} + \sum_{v=0}^{Cap-t_n^{Ms,Rs}-1} \sum_{h=0}^{Cap-t_n^{Ms,Rs}-v-1} \frac{r_n^{\,t_n^{Ms,Rs}}}{t_n^{Ms,Rs}!} \frac{r_v^{\,v}}{v!} \frac{r_h^{\,h}}{h!} \right\} P(0,0,0)$$

$$P_D^{Ms} = \left\{ \sum_{v=0}^{t_h^{Rs}} \sum_{n=0, 0 \le Cap-v-n \le_h^{Ms}}^{t_n^{Ms,Rs}} \frac{r_v^{\,v}}{v!} \frac{r_n^{\,n}}{n!} \frac{r_h^{\,Cap-v-n}}{(Cap-v-n)!} + \sum_{v=0}^{Cap-t_h^{Ms}-1} \sum_{n=0}^{Cap-t_h^{Ms}-v-1} \frac{r_h^{\,t_h^{Ms}}}{t_h^{Ms}!} \frac{r_v^{\,v}}{v!} \frac{r_n^{\,n}}{n!} \right\} P(0,0,0)$$

$$P_D^{Rs} = \left\{ \sum_{v=0}^{t_h^{Rs}} \sum_{h=0, 0 \le Cap-v-h \le t_n^{Ms,Rs}}^{{}_h^{Ms}} \frac{r_v^{\,v}}{v!} \frac{r_h^{\,h}}{h!} \frac{r_n^{\,Cap-v-h}}{(Cap-v-h)!} + \sum_{h=0}^{Cap-t_h^{Rs}-1} \sum_{n=0}^{Cap-t_h^{Rs}-h-1} \frac{r_v^{\,t_h^{Rs}}}{t_h^{Rs}!} \frac{r_h^{\,h}}{h!} \frac{r_n^{\,n}}{n!} \right\} P(0,0,0)$$

Original State $P(0,0,0)$

- Obtained above equations, the original state can be presented by the following equations :

$$P(0,0,0) = \left(\sum_{n=0}^{t_n} \sum_{h=0}^{t_h^{Ms}-n} \sum_{v=0}^{t_h^{Rs}-n-h} \frac{r_n^{\,n}}{n!} \frac{r_h^{\,h}}{h!} \frac{r_v^{\,v}}{v!} \right)^{-1},$$

$$0 < t_n^{Ms,Rs} < t_h^{Ms} < t_h^{Rs} \leq Cap,\ \ n+h+v \leq Cap,\ \ r_i = \frac{l_i}{m_i}$$

Transition cases in Cost-Reward based CAC

- The transition of all cases in the proposed Cost-Reward based CAC.
- Not only satisfy by transition in CS and Guard, but also satisfy by the Cost Reward.

$$r_{n+1,h,v} \geq C_{n+1+h+v}$$

$$s(n,\ h,\ v\ ;\ n+1,\ h,\ v)\ =\ l_n^{Ms,Rs}$$

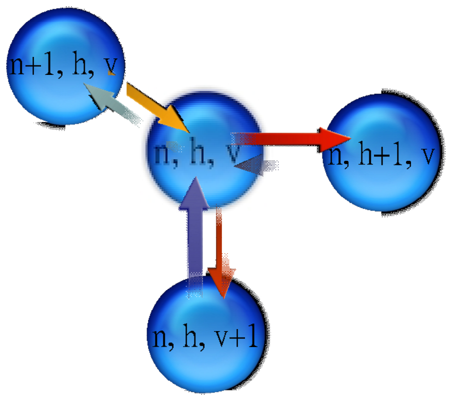
$$r_{n,h+1,v} \geq C_{n+h+1+v}$$

$$s(n,\ h,\ v\ ;\ n,\ h+1,\ v)\ =\ l_h^{Ms}$$

$$r_{n,h,v+1} \geq C_{n+h+v+1}$$

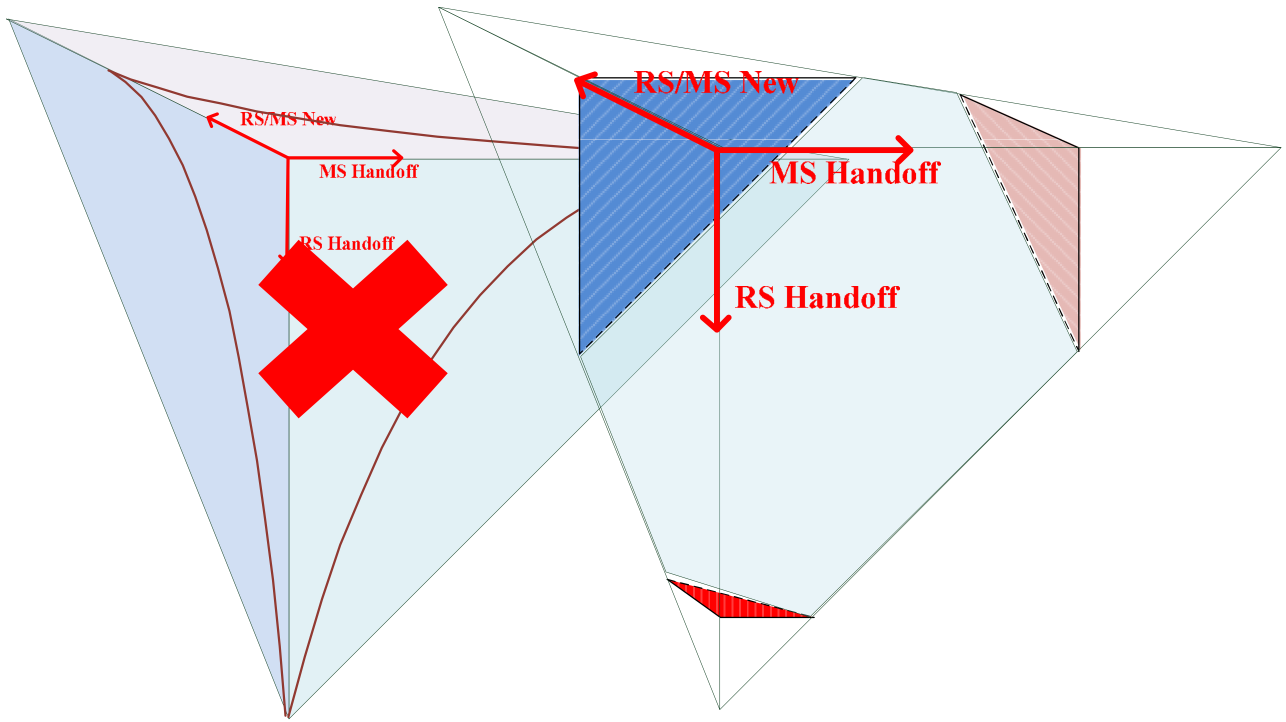
$$s(n,\ h,\ v\ ;\ n,\ h,\ v+1)\ =\ l_h^{Rs}$$

$$0 < n \leq t_n^{Ms,Rs},\ 0 < h \leq t_h^{Ms}\ ,0 < v \leq t_h^{Rs},\ n+h+v \leq Cap$$



Performance in Cost-Reward based CAC

- Blocking probability and Dropping probability can not be calculated.



Performance in Cost-Reward based CAC (cont.)

–**[23]** V.B. Iversen et al. "Teletraffic Engineering. Handbook," *ITU–D SG 2/16 & ITC*, Jan. 2005.

- State probability can be calculated as follow.

$$P(i, j) = P(i) * P(j) = Q\frac{A_1^i}{i!}\frac{A_2^j}{j!}$$

- and

$$Q(n) = \sum_{i=0}^{n} q(i),$$

$$q(x) = \frac{1}{x}\sum_{j=1}^{N} A_j \cdot q(x-1), \quad q(0) = 1,$$

Performance in Cost-Reward based CAC (cont.)

- State probability:

$$p(x) = \frac{q(x)}{Q(n)}, \quad 0 \le \mathrm{x} \le \mathrm{n},$$

- We modify the Equation to appropriate the model:

$$p(n,h,v) = \frac{q(n,h,v)}{Q(n,h,v)},$$

$$0 < n \le t_n^{Ms,Rs},\ 0 < h \le t_h^{Ms}\ ,0 < v \le t_h^{Rs},\ n+h+v \le Cap,$$

Numerical Results

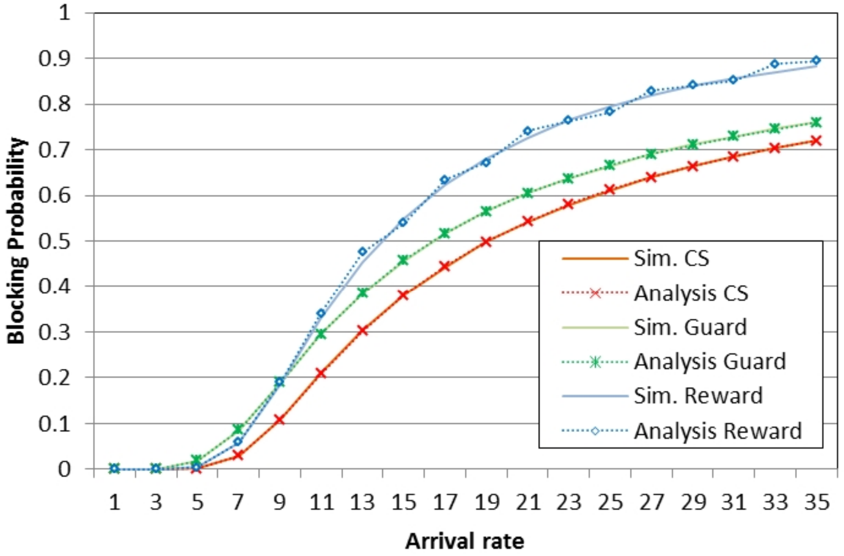
- The proposed approach will compare with these approaches as follow
  - 1. Complete Sharing CAC(CS)
  - 2. Resource reserved CAC(Guard_th)
  - 3. Complete Partition CAC(CP)
  - 4. Static Reward CAC (SR)

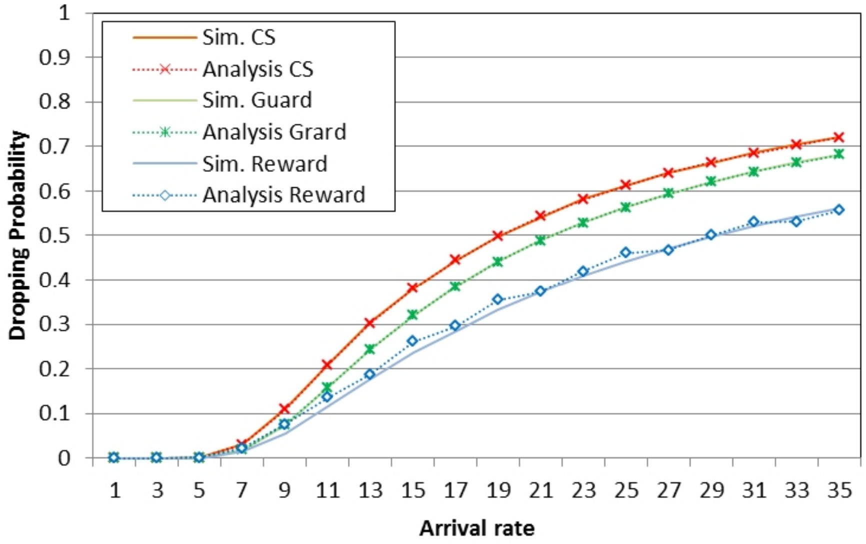
- Compare Performance Metrics as follow
  - 1. FRL
  - 2. Grade of Service
  - 3. Reward
  - 4. Utilization

Simulation & Analysis Parameters

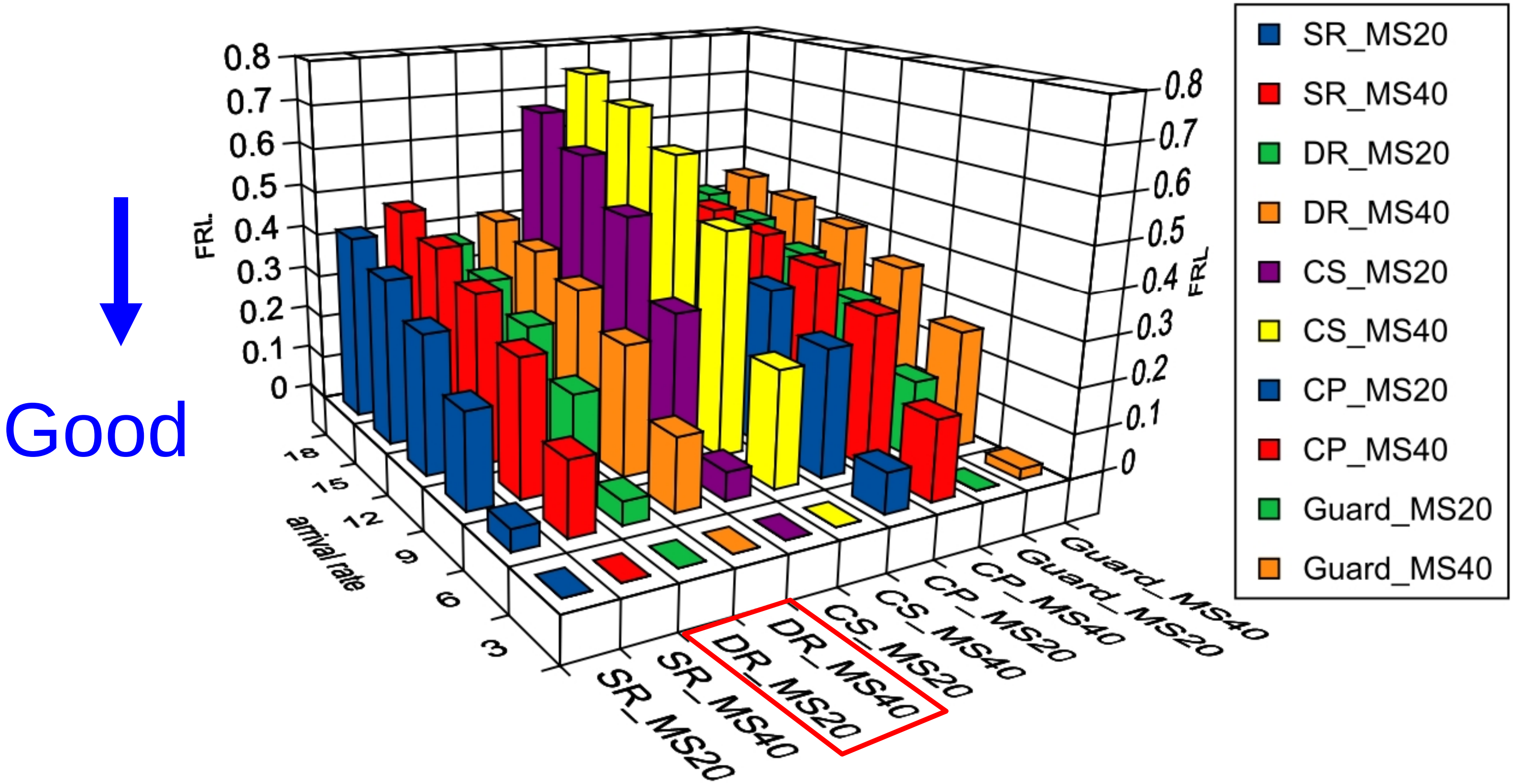
Parameter	Value
Simulation time (Seccond)	1000
BS network capacity	40 Mbps
Number of Mobile nodes (M_NDS)	20, 40
Number of Mobile nodes (M_NDS) *l*	10
Arrival rate of Poisson distribution ,	3-18
Average holding *m* time of Exponential distribution,	1
Guard threshold	0.7
CP threshold (High, Low)	0.6, 0.4

Blocking / Dropping Probability – Simulation & Analysis

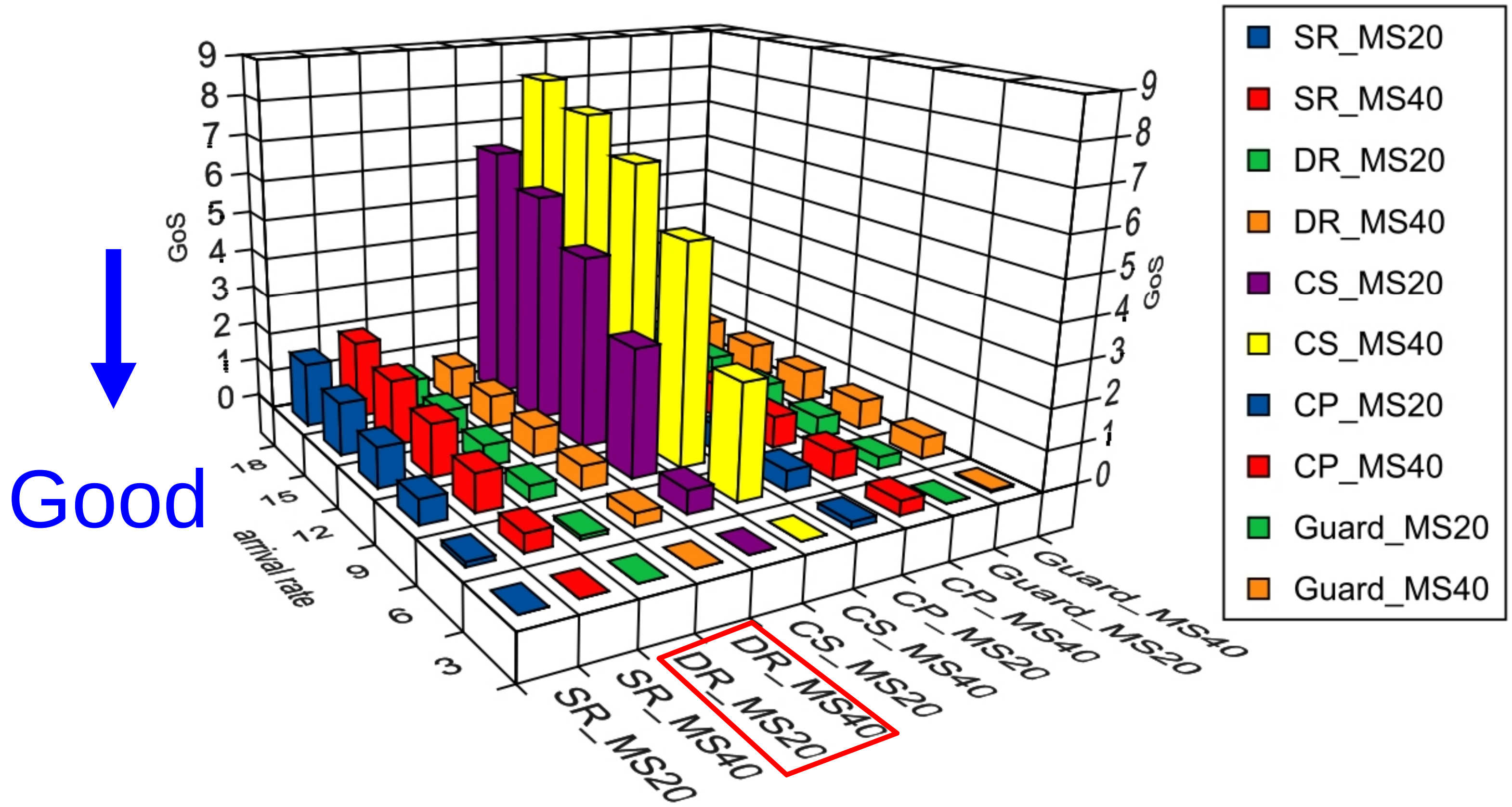




Performance － FRL

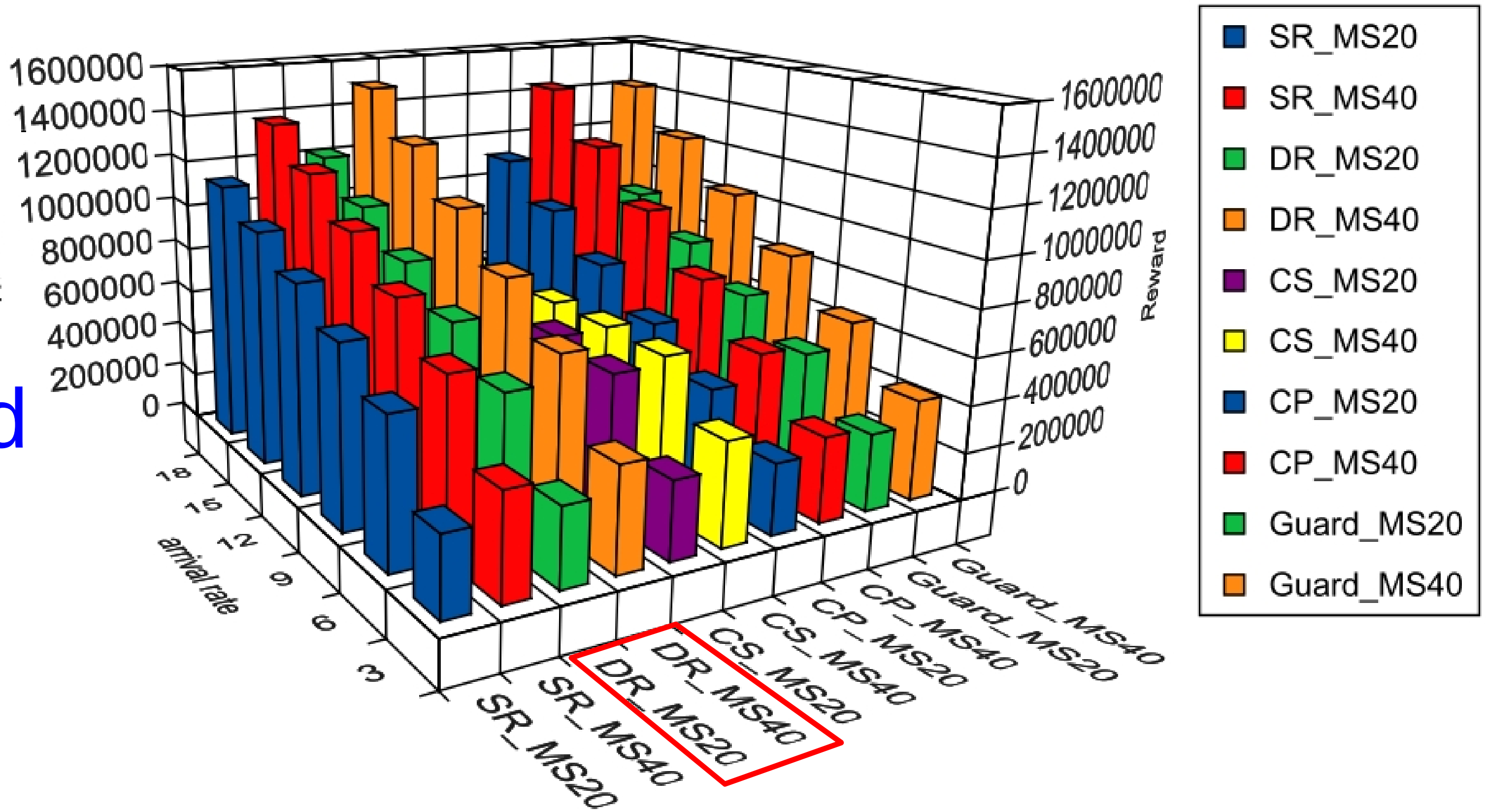


Performance – GoS

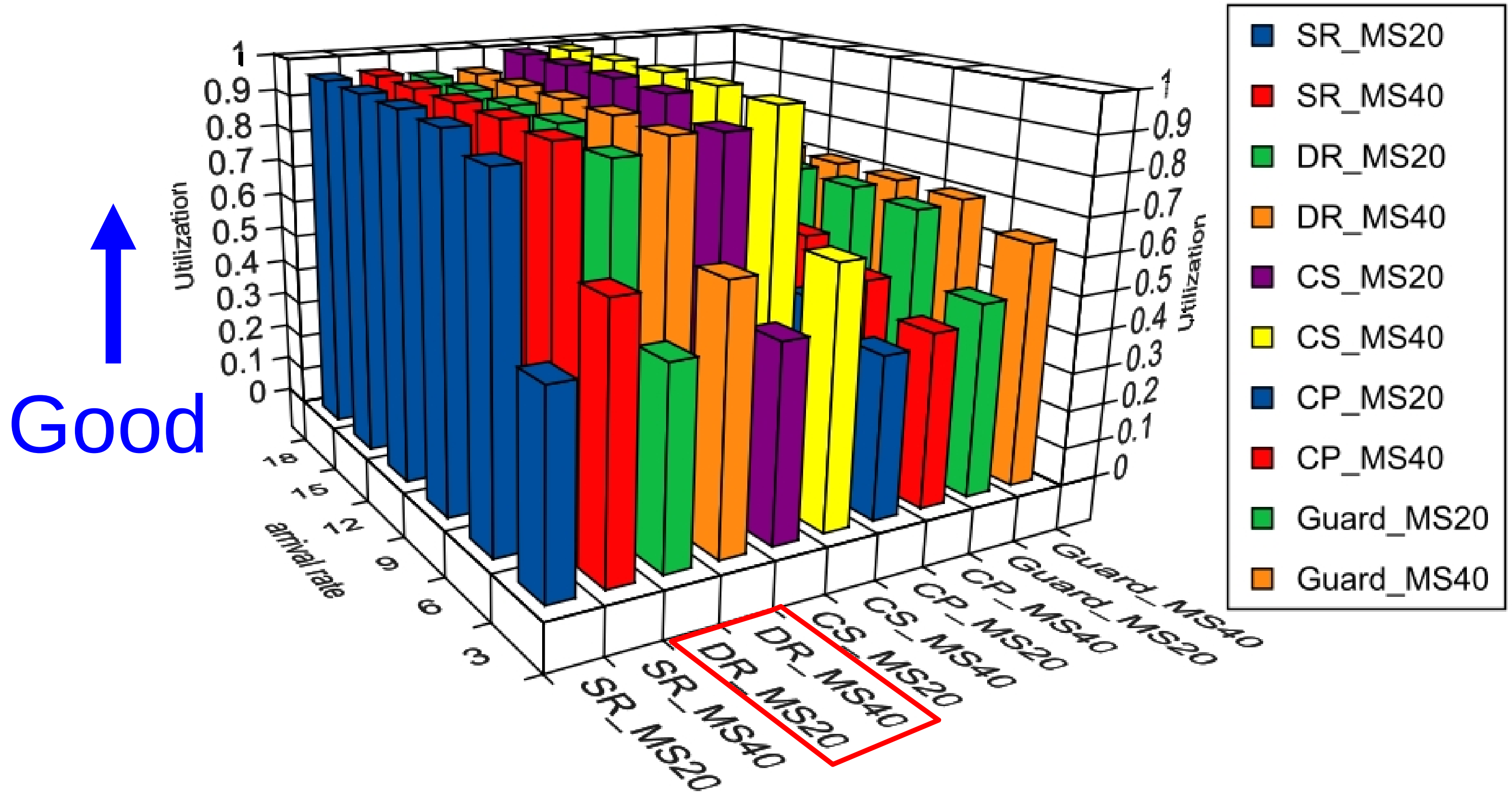


Performance － Reward

Good



Performance – Utilization



Conclusions

- Step 1. Calculate Bs Cost
- Step 2. Calculate arrival call Reward
- Step 3. Compare Cost Reward to decision

- Reaches goals :
  - 1. Dropping probability (Dynamic cost-reward based CAC)
  - 2. Reward (Dynamic cost-reward based CAC)
  - 3. Performance analysis(Multi-dimensional Markov chain model)

- This research not only simulation the network condition but also analysis the currently of performance metrics

- The numerical results to show the requests of simulation is closed to mathematical analysis

Q & A
Thanks

changb@yuntech.edu.tw