COMP9334
Capacity Planning for Computer Systems and Networks

Week 7A_2 ecify to improve system perfor

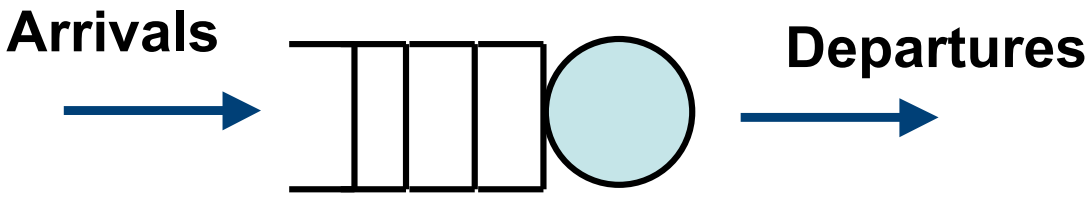
Applications of queueing

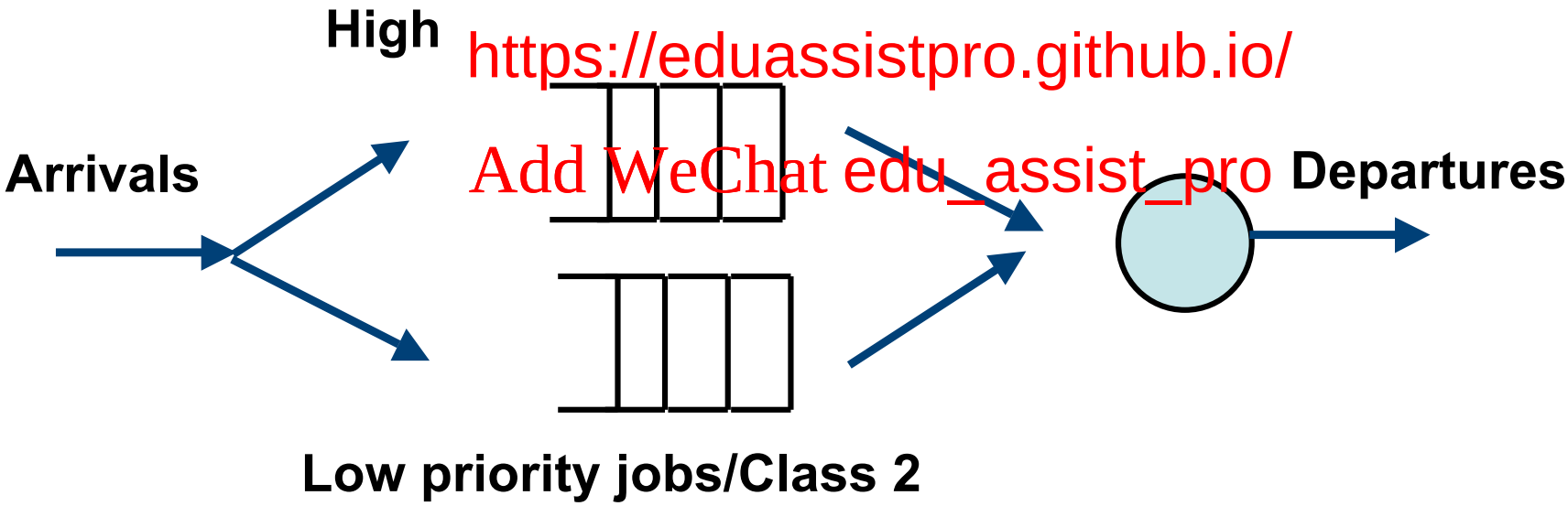
- There are plenty of examples on using queueing to improve system performance

- We will look at a few examples
  - The technical papers can be downloaded from the course website

- Good resource:
  - Sigmetrics
    - http://www.sigmetrics.org
    - A leading conference on performance evaluation of computer systems and networks
  - Performance evaluation
    - A journal devoted to the topic of performance evaluation

Priority queueing





Using priority queueing to reduce response time (1)

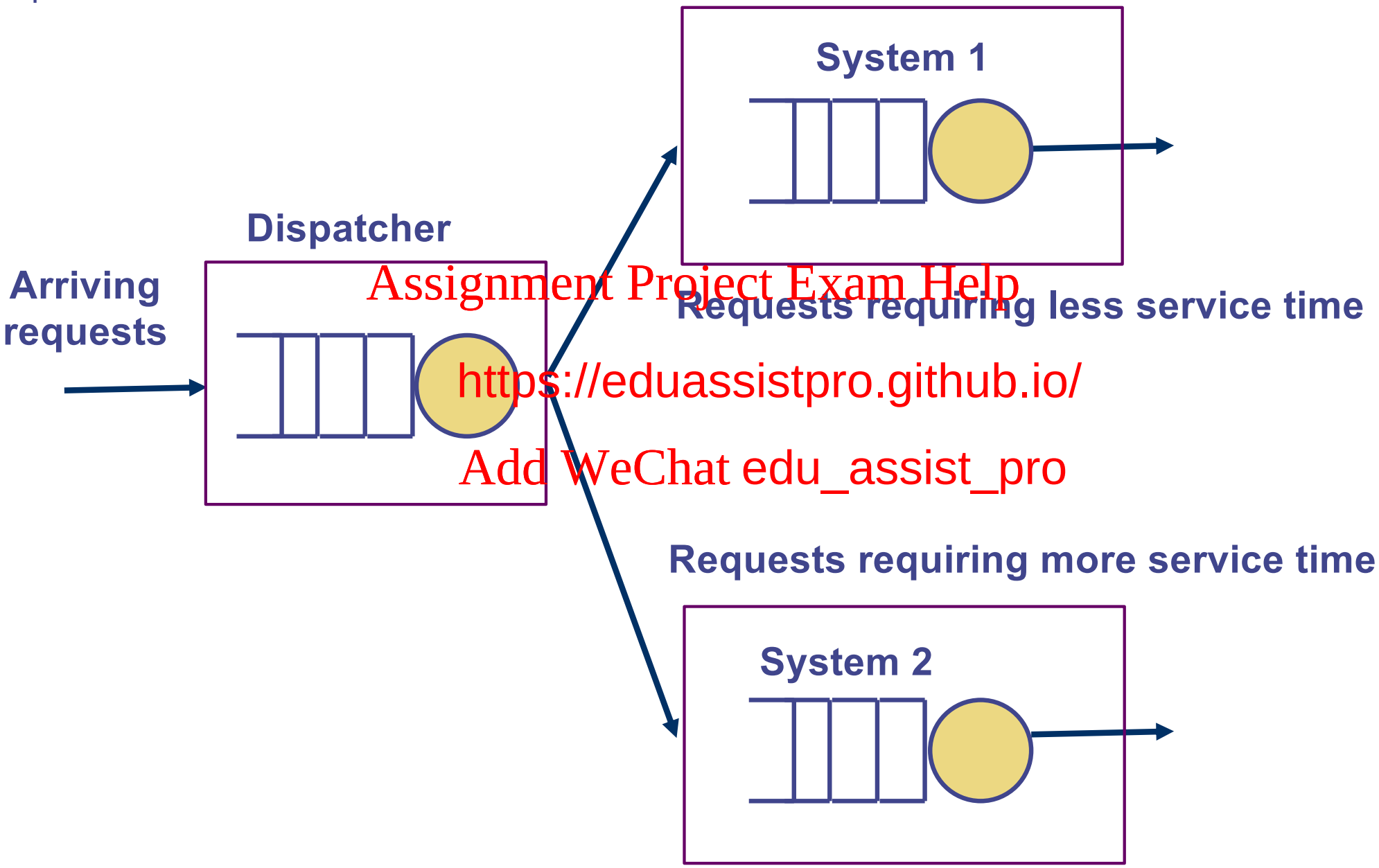
- Revision Problem 4A, Question 1
  - Customers arrive at a grocery store's checkout counter according to Poisson process with rate 1 per minute.
  - Each customer carries a number of items that is uniformly distributed between 1 and 40.
  - The store has 2 checkout counters, each capable of processing items at a rate
  - To **reduce** cust e, the store manager considers dedicating one of the s to customers with x items or less and dedicating the er to customers with more than x items.
  - Write a small computer program to find the value of x that minimises the average customer waiting time.

Using priority queueing to reduce response time (2)

- At a website, use a dispatcher to classify the HTTP requests depending on their service time requirement
  - Requests whose service time is below a threshold go to one server
  - The rests of the requests go to the other server
  - See diagram on the next slide
- Need prior knowledge on the e of the requests

- Reference: B. Schroeder and M. Harchol-Balter, "Web servers under overload: How scheduling can help", ACM Transactions on Internet Technology (TOIT), Volume 6 , Issue 1, pages 20 - 52, 2006. http://doi.acm.org/10.1145/1125274.1125276.

Dispatcher



Determining Multi-programming level

How to determine a good multi-programming level for external scheduling

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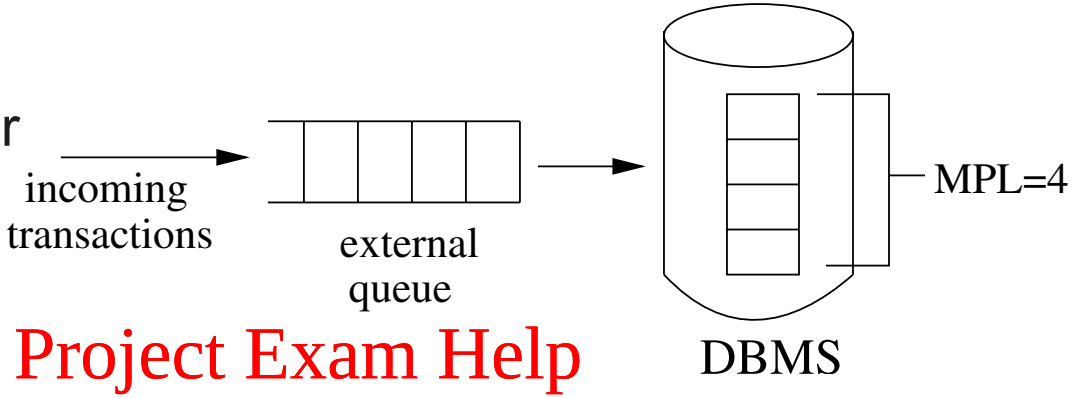
DB server – Multi-programming level

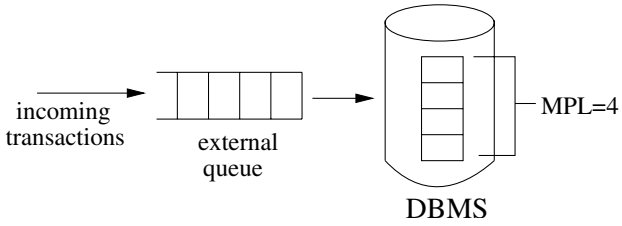
- Some database server management systems (DBMS) set an upper limit on the number of active transactions within the system
- This upper limit is called multi-programming level (M



view of the mechanism used in
actions (*ited number of trans-*
tancous *ed into the DBMS simul-*
taneously *ansactions are held back*
in an external queue. Response time is the time from when a transaction arrives until it completes, including time spent queueing externally to the DBMS.

- A help page from SAP explaining MPL
- http://dcx.sap.com/1200/en/dbadmin_en12/running-s-3713576.html
- Picture from Schroder et al. “How to determine a good multi-programming level for external scheduling”

The problem



- To choose a good MPL means you want to determine the mean response time for different choices of MPL
  - If MPL = 1, what
  - If MPL = 2, what
  - …
- Question: Let us assume that the arrival is Poisson and the service time is exponential, can you suggest how we can determine the mean response time?
  -

Optimal power allocation

Optimal Power Allocation in Server Farms

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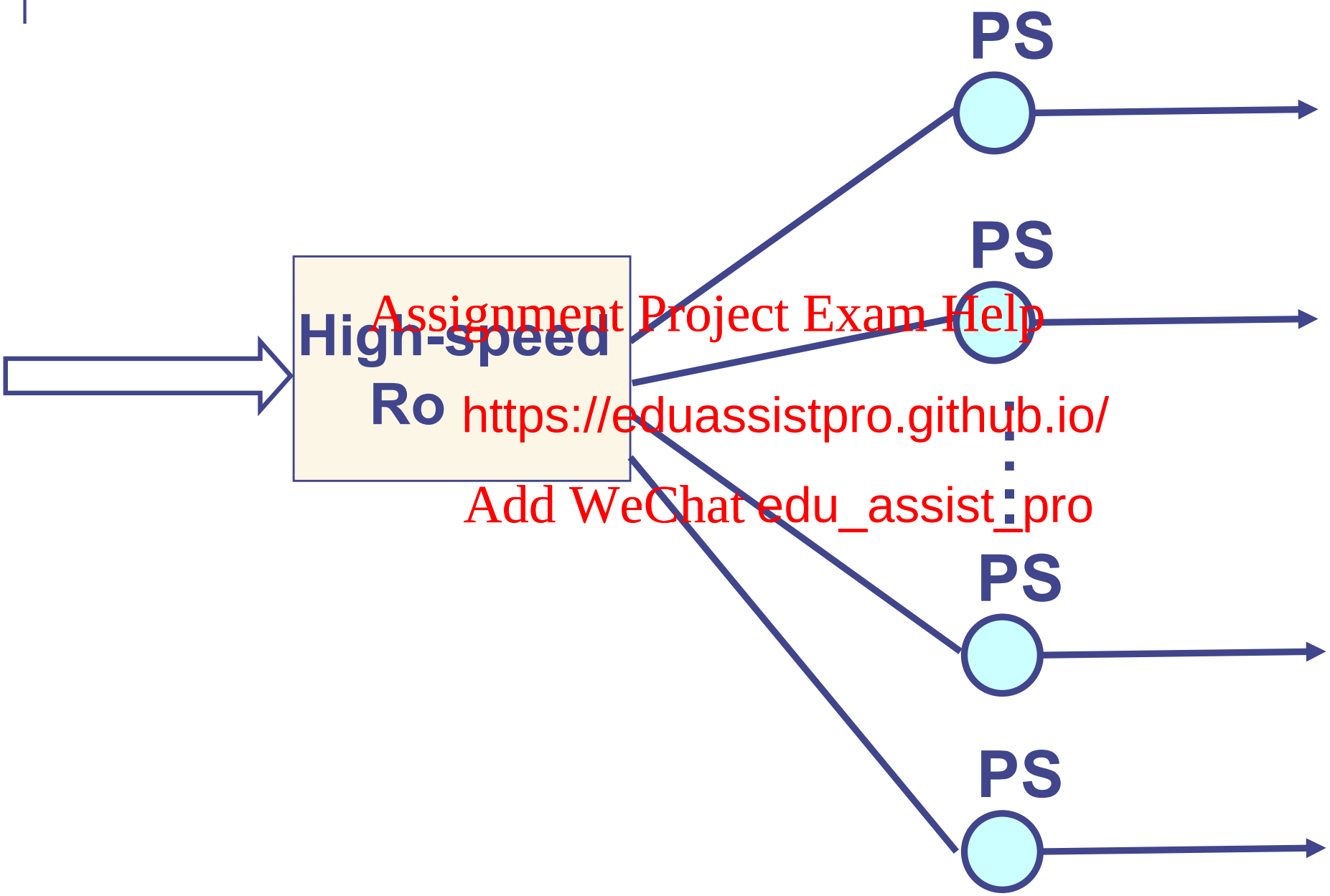
Server farm power allocation: Introduction

- A server farm consists of multiple servers
  - See next slide
- The servers can run at
  - Higher clock speed with higher power
  - Lower clock speed with lower power
  - Illustration: The slide after next
- Ex: Given
  - Higher power = 300W
  - Power budget = 3000W
  - You can have
    - 12 servers at highest clock speed
    - 20 servers at lowest clock speed
    - Other combinations
  - Which combination is best?

Server farm

Servers at the back-end



CPU Power-speed tradeoff

(a) DFS and DVFS

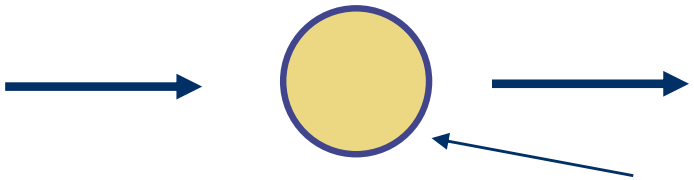
(b) DVFS+DFS

Power-to-frequency curves for DFS, DVFS, and DVFS+DFS for the CPU bound LINPACK workload. Fig.(a) illustrates our measurements for DFS and DVFS. In both these mechanisms, we see that the server frequency is linearly related to the power allocated to the server. Fig.(b) illustrates our measurements for DVFS+DFS, where the power-to-frequency curve is better approximated by a cubic relationship.

M/G/1/PS

- Poisson arrivals with mean arrival rate λ
- General service time distribution with mean rate μ
- Processing sharing (PS)
- Mean response time

$$= \frac{1}{\mu - \lambda}$$



Processor sharing

Power allocation for 2 servers

- To be worked out during the lecture

Server farms with setup costs

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Performance Evaluation

journal homepage: www.elsevier.com/locate/peva

Server farms with setup

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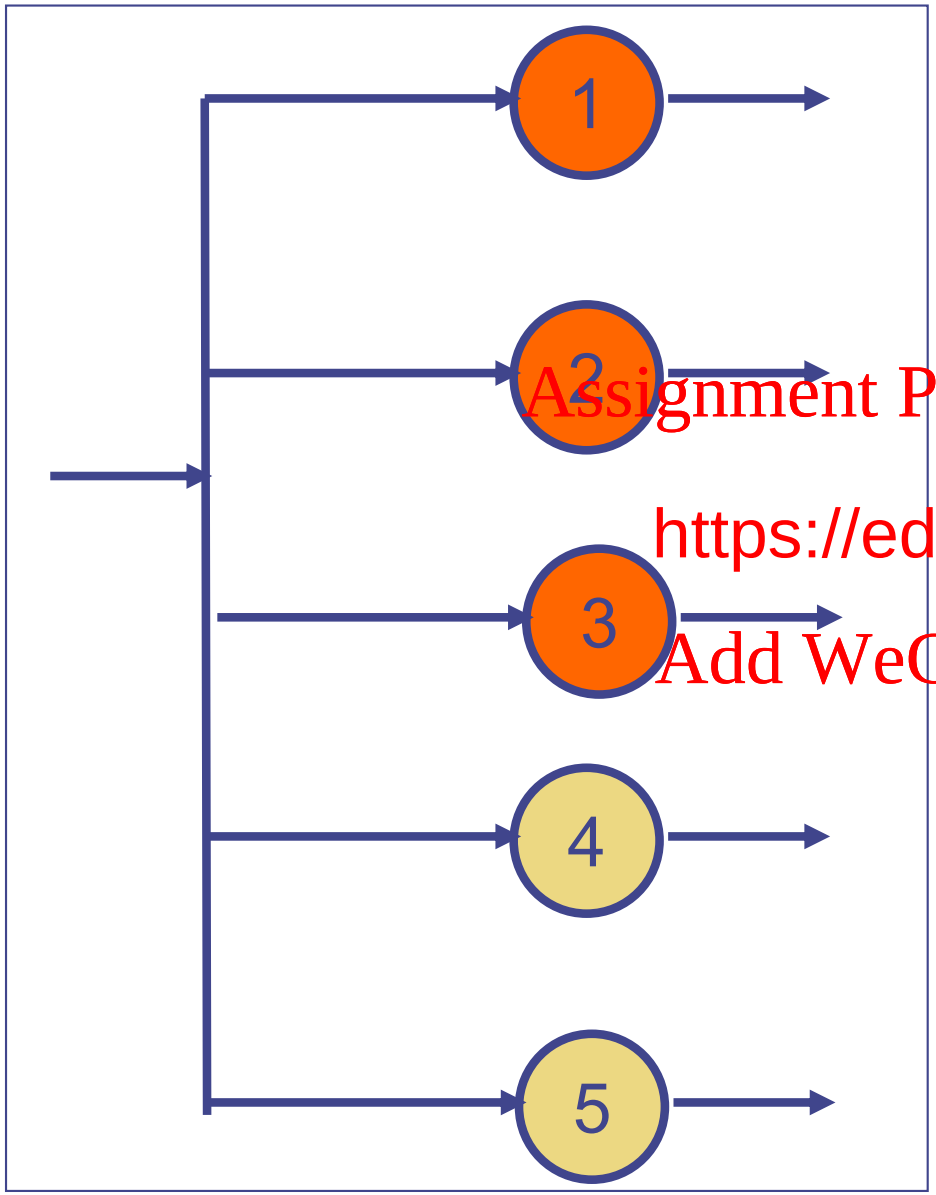
Server farm with setup cost: The problem

- A data centre consists of many servers
- An ON server consumes peak power
- An idling server consumes 60% of peak power
- Not all servers are needed all the time

Alternative 1: Idling servers remain ON all the time

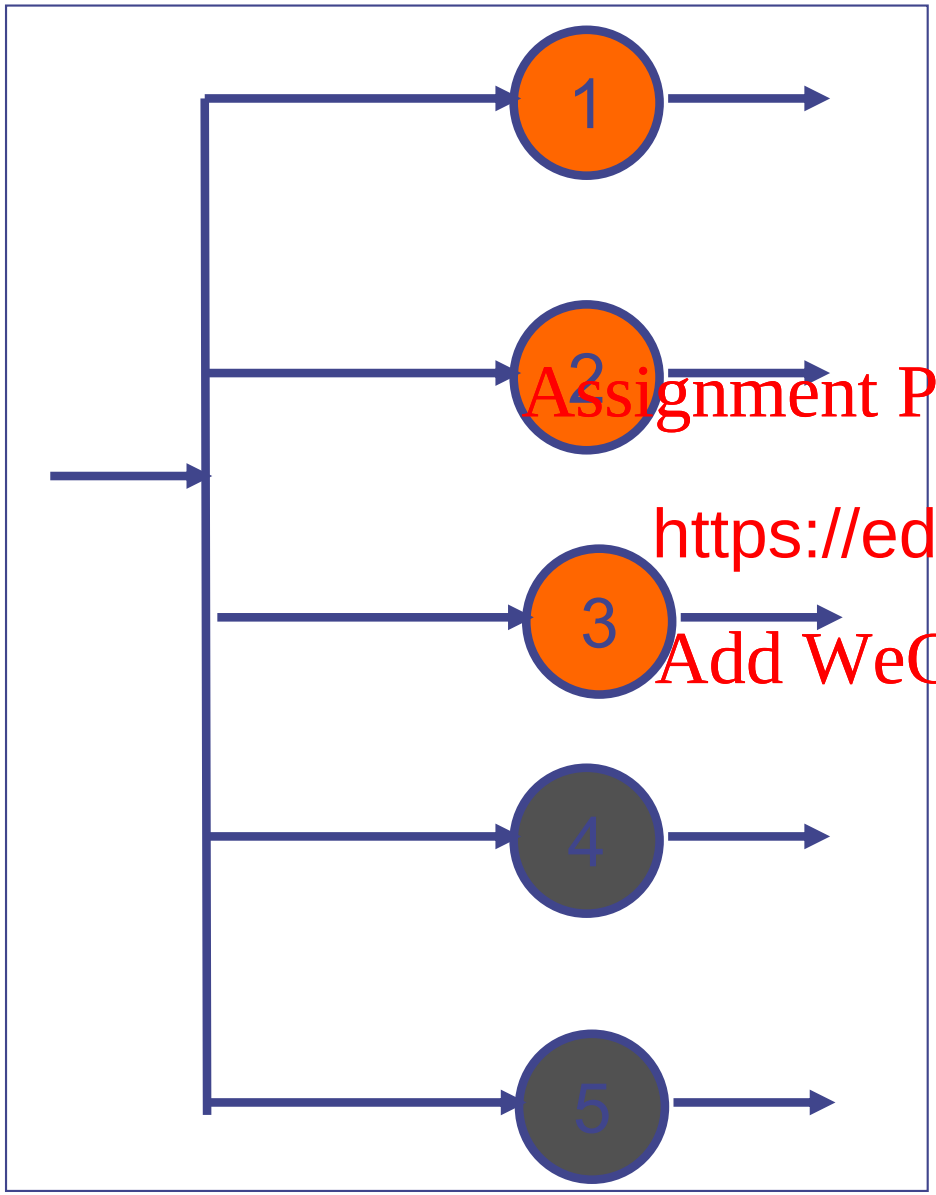


- Servers 1-3 are ON
- Servers 4-5 are idling
- When a new job arrives, it is allocated to an idling server immediately

time delay

g servers consume

Alternative 2: Turn idling server OFF



- Servers 1-3 are ON
- Servers 4-5 are OFF
- Once a server becomes idle, turn it off immediately to save power.

new job arrives, turn an OFF server

- Longer time delay
- Consumes less power

Trading off between power consumption and delay

- Alternative 1: Keep idling server ON
  - Short delay but high power consumption
- Alternative 2: Turn idling server OFF immediately
  - Long delay but lower power consumption

- Can you sugges
- Given what you ou carry out a study on this problem?

Conclusions

- Queueing theory has many applications
- You have learnt the basics of analysis and simulation
- The are a lot of advanced theory and methods that we cannot cover but the basics will enable you to learn more