

# **COMP3221: Distributed Systems**

## **Introduction**

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School of Computer Science

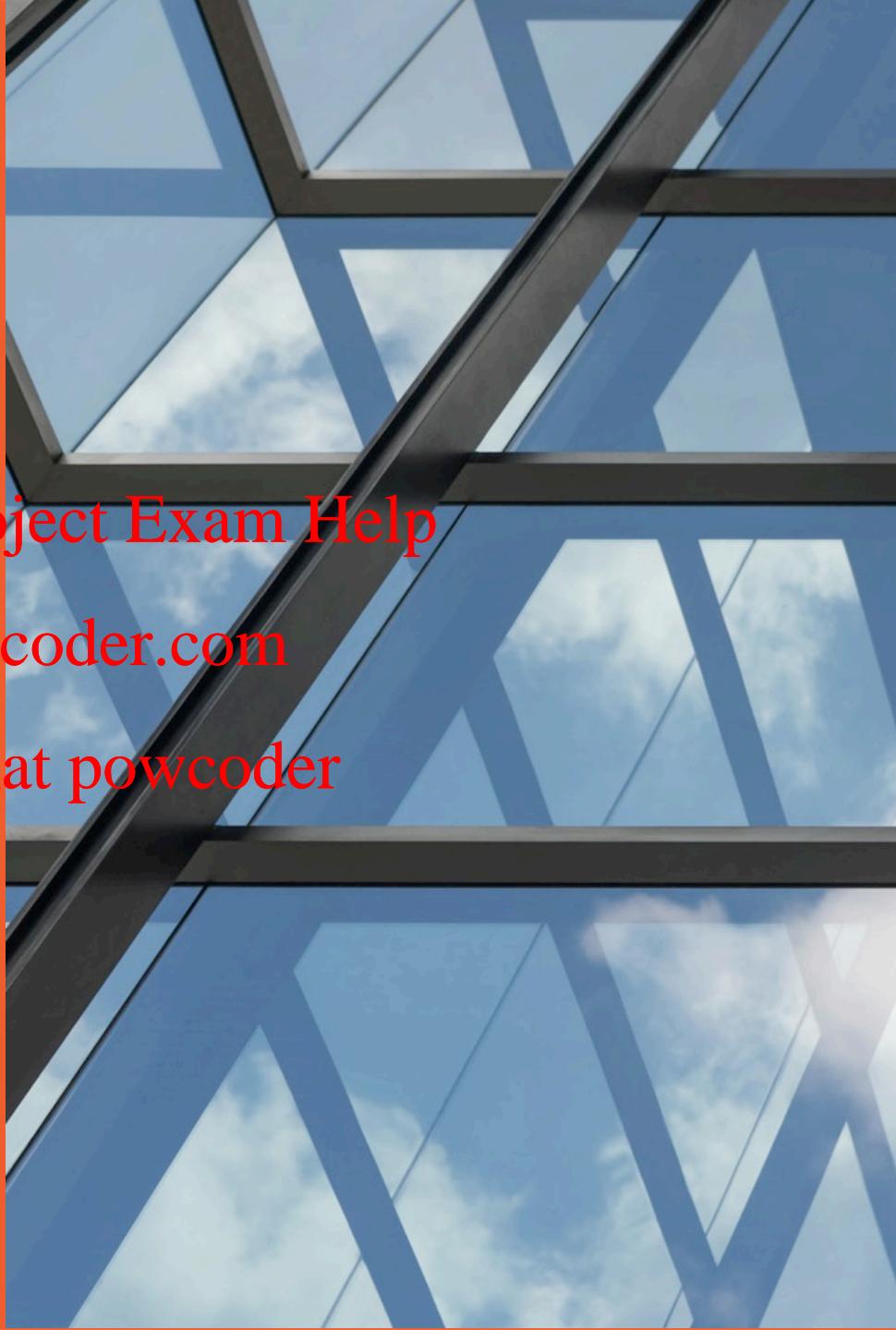


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# Outline

- Why this course ?
- What this course is about?
  - Definitions, Examples and Challenges of Distributed Systems
- Course Logistics
  - Lectures/Tutorials
  - Assessments
- Expectation and Outcomes
- Resources

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# Why this Course ?

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# What is a Distributed System?

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*“A collection of independent computers that appears to its users as a single coherent system.”*  
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# Cloud computing



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Google Cloud



Firebase



amazon  
web services™



Microsoft Azure

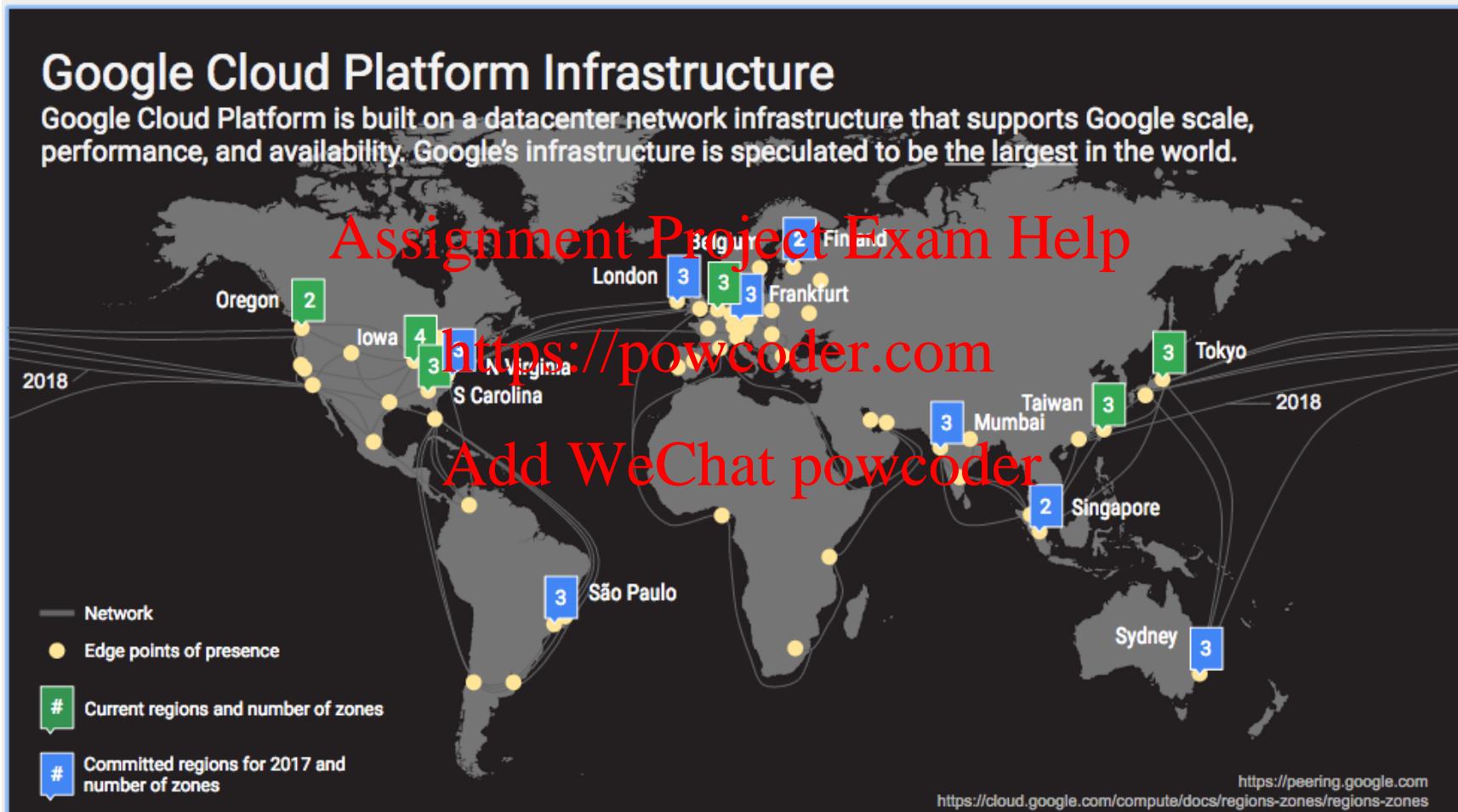


anypresence



Back4App

# Cloud computing



<https://cloud.google.com/about/locations/#regions-tab>

# Cluster



## CSIRO Bracewell

114 PowerEdge C4130 servers with Nvidia Tesla P100 GPUs, NVlink, dual Intel Xeon processors, and 100Gbps EDR InfiniBand interconnect.  
634,304 CUDA compute cores, 3192 Xeon compute cores, and 29TB of RAM, and runs both Linux and Windows.

<https://www.csiro.au/en/Research/Technology/Scientific-computing/Bracewell>



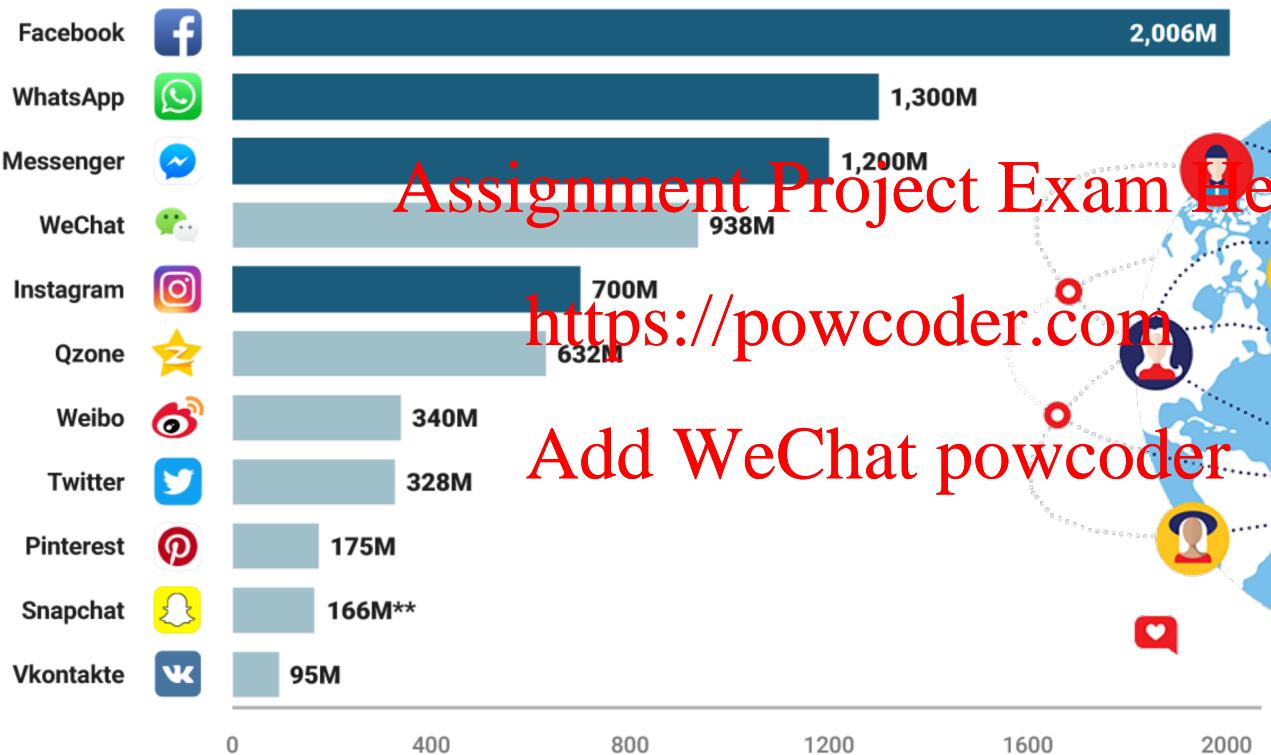
## USYD Artemis

## ACCESS TO ARTEMIS

[https://sydney.edu.au/research\\_support/hpc/access/index.shtml](https://sydney.edu.au/research_support/hpc/access/index.shtml)

# Social Networks

Monthly active users of selected social networks and messaging services\*



SOURCE: Company data \*Latest data (Dec '16–Jul '17) \*\*Daily active users

statista | BUSINESS INSIDER

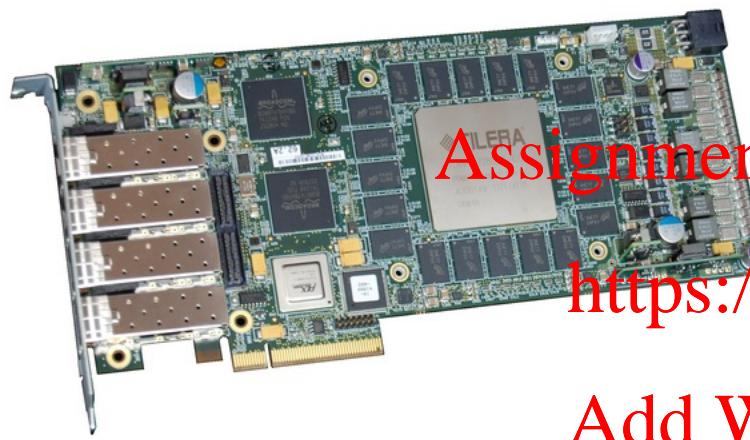
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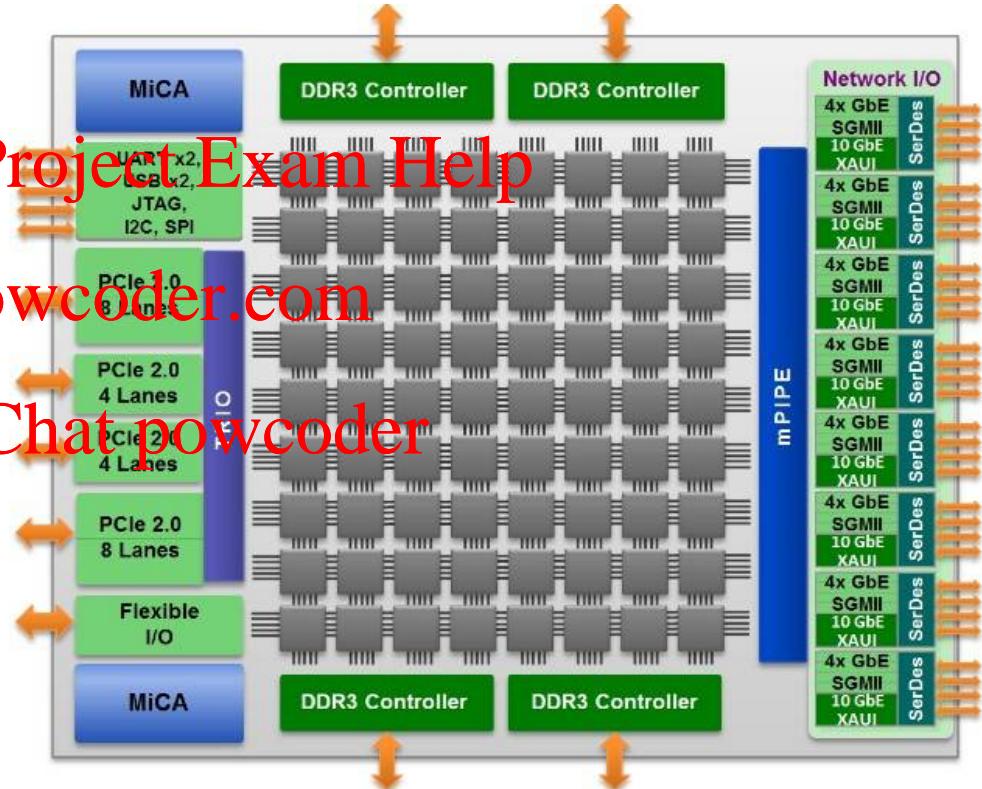
# Chip Multiprocessors



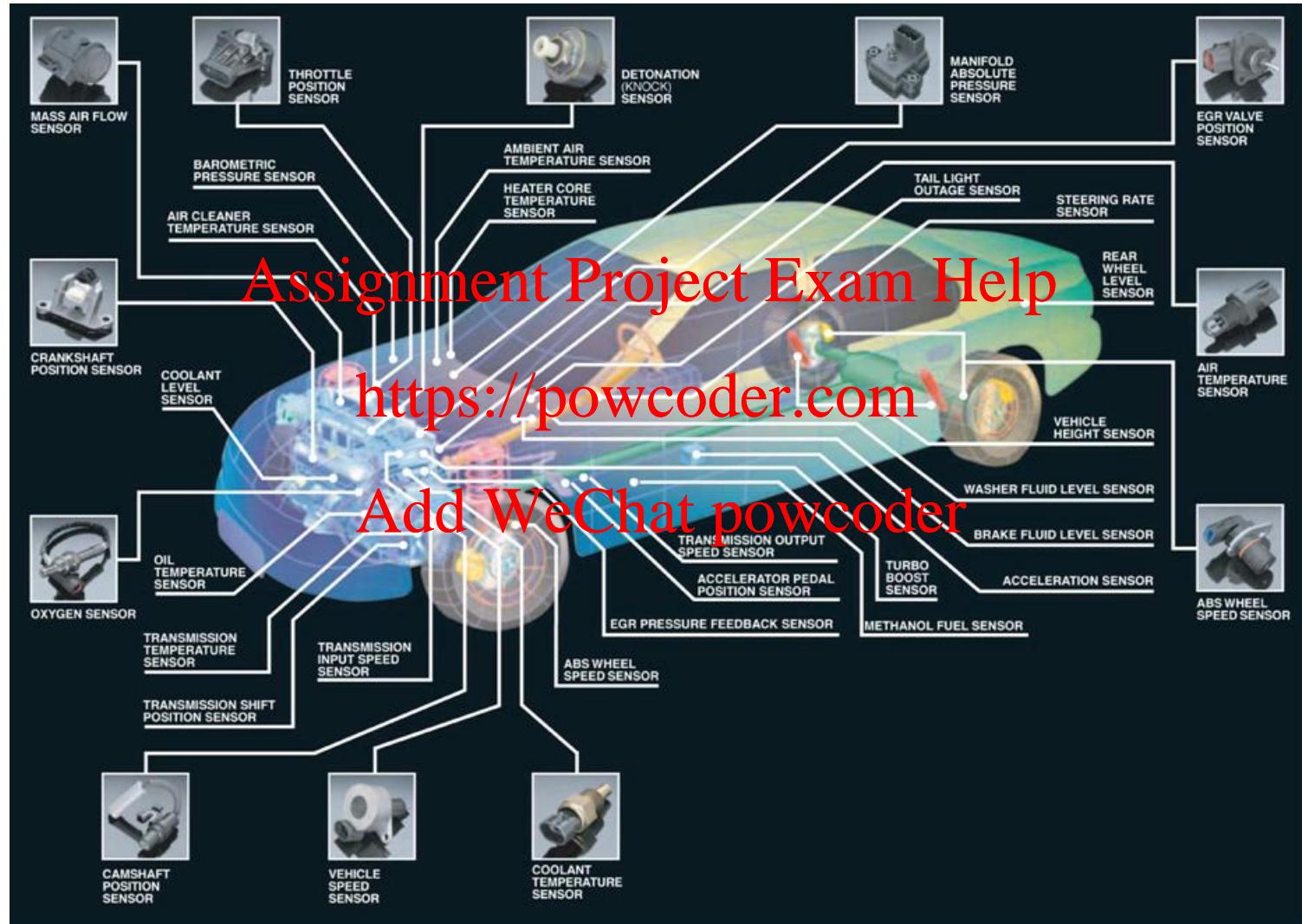
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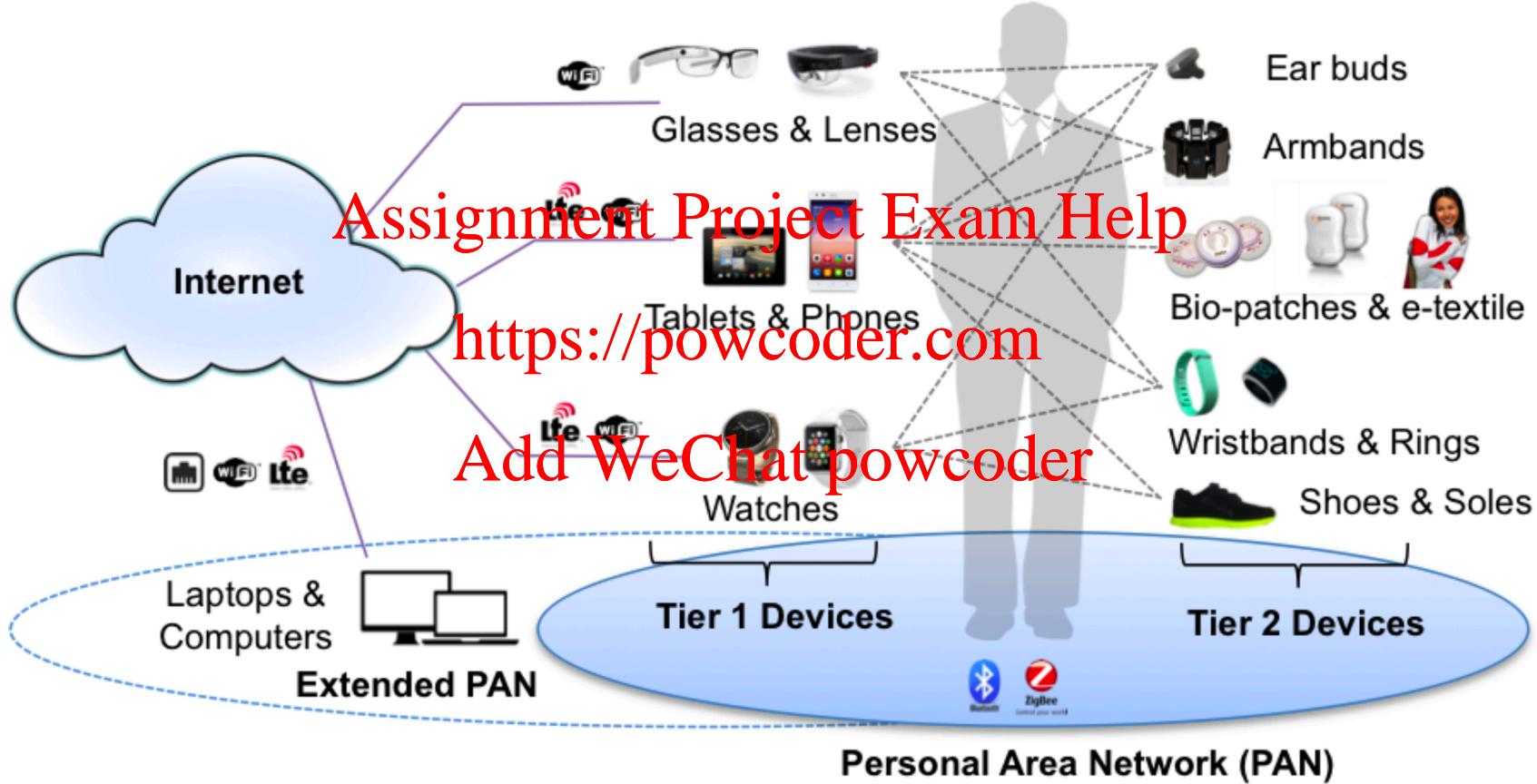
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# Sensor Networks



# Personal Area Networks

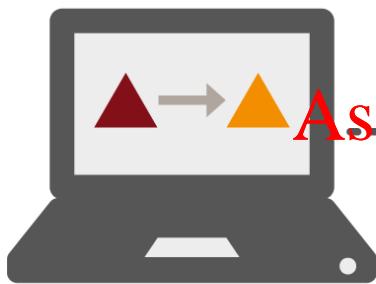


# Blockchain

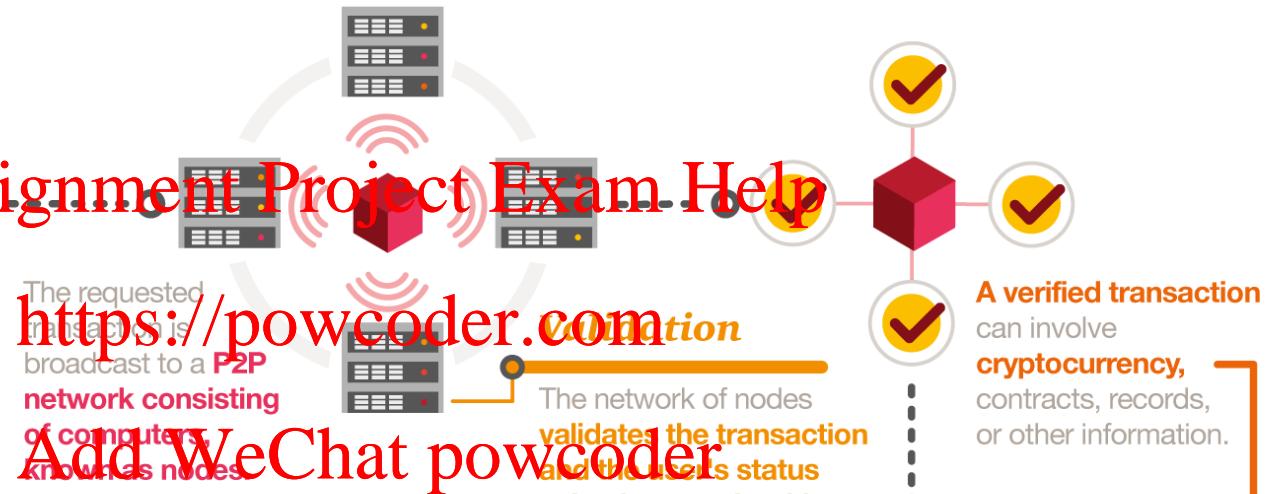
## What is it?

The **blockchain** is a decentralized ledger of all transactions across a peer-to-peer network. Using this technology, participants can confirm transactions without the need for a central certifying authority. Potential applications include fund transfers, settling trades, voting, and many other uses.

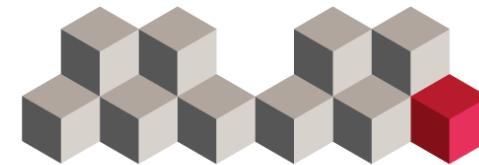
### How it works:



Someone requests a transaction.



The transaction is complete.



The new block is then added to the existing blockchain, in a way that is permanent and unalterable.



Once verified, the transaction is combined with other transactions to create a new block of data for the ledger.

<https://www.pwc.com/us/en/industries/financial-services/fintech/bitcoin-blockchain-cryptocurrency.html>

# Blockchain applications



## Potential applications



### Automotive

Consumers could use the blockchain to manage fractional ownership in autonomous cars.



### Financial services

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<https://powcoder.com>

Faster, cheaper settlements could shave billions of dollars from transaction costs while improving transparency.



### Voting

Using a blockchain code, constituents could cast votes via smartphone, tablet or computer, resulting in immediately verifiable results.



### Healthcare

Patients' encrypted health information could be shared with multiple providers without the risk of privacy breaches.

Sources:

"Money is no object: Understanding the evolving cryptocurrency market," PwC, 2015  
"A Strategist's Guide to Blockchain," strategy+business, January, 2016  
"How Blockchain Technology Is Disrupting Everything," TechDay, 2016



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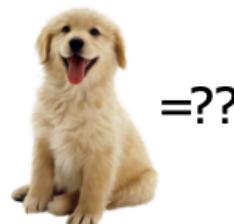


# Distributed Machine Learning

*Cat or dog?*



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input: cats & dogs

learn:  $x \rightarrow y$  relationship

predict:  $y$  (categorical)

# Why this course ?

- **Distributed Computing Systems are everywhere !**
  - Practically you can not avoid them.
- Knowledge and experience in Distributed Systems will be useful; **Assignment Project Exam Help**
  - For your final year thesis project
  - To improve your productivity
  - Pursue your passion as a hobby
  - Just for Fun ! **Add WeChat powcoder**
  - **Improve your chances of getting a better job**
- COMP3221 is about;
  - **What is a distributed system?**
  - **How it works?**
  - **How to run yours?**

# COMP3221 – Course Description

- The unit will provide a **broad introduction** to the principles of distributed systems and their design; provide students the fundamental knowledge required to **analyse and construct** various types of distributed systems; explain the common architectural principles and approaches used in the design of **networks** at different scales (e.g. shared medium access and routing); introduce the programming skills required for developing **distributed applications**, and will cover the use of **Python** class libraries and APIs; cover common approaches and techniques in distributed resource management (e.g. task scheduling, machine learning)

# What is a Distributed System?

*“A collection of independent computers that appears to its users as a single coherent system.”*

- Transparency helps the users observe a single coherent system
- The different forms of transparency in a distributed systems

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Transparency	Description
Access	Hide differences in data representation and how a resource is accessed
Location	Hide where a resource is located
Migration	Hide that a resource may move to another location
Relocation	Hide that a resource may be moved to another location while in use
Replication	Hide that a resource is replicated
Concurrency	Hide that a resource may be shared by several competitive users
Failure	Hide the failure and recovery of a resource

# Challenges of Distributed Systems

Understanding the associated challenges to learn **how it works** and **how to run yours.**

- **Network communication** [Assignment](#) [Project](#) [Exam](#) [Help](#)
- **Scalability** <https://powcoder.com>
- **Consistency** [Add WeChat powcoder](#)
- **Fault-tolerance**
- **Machine Learning**
- **Security**

# Scalability

Concept	Example
Centralized services	A single server for all users
Centralized data	A single on-line telephone book
Centralized algorithms	Doing routing based on complete information

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- Scalability of a distributed system: the ability for the system to preserve some properties as the system grows in
  - the number of requests or participants,
  - the distance between resources and users, or
  - the heterogeneity.

# Scalability Example – DNS



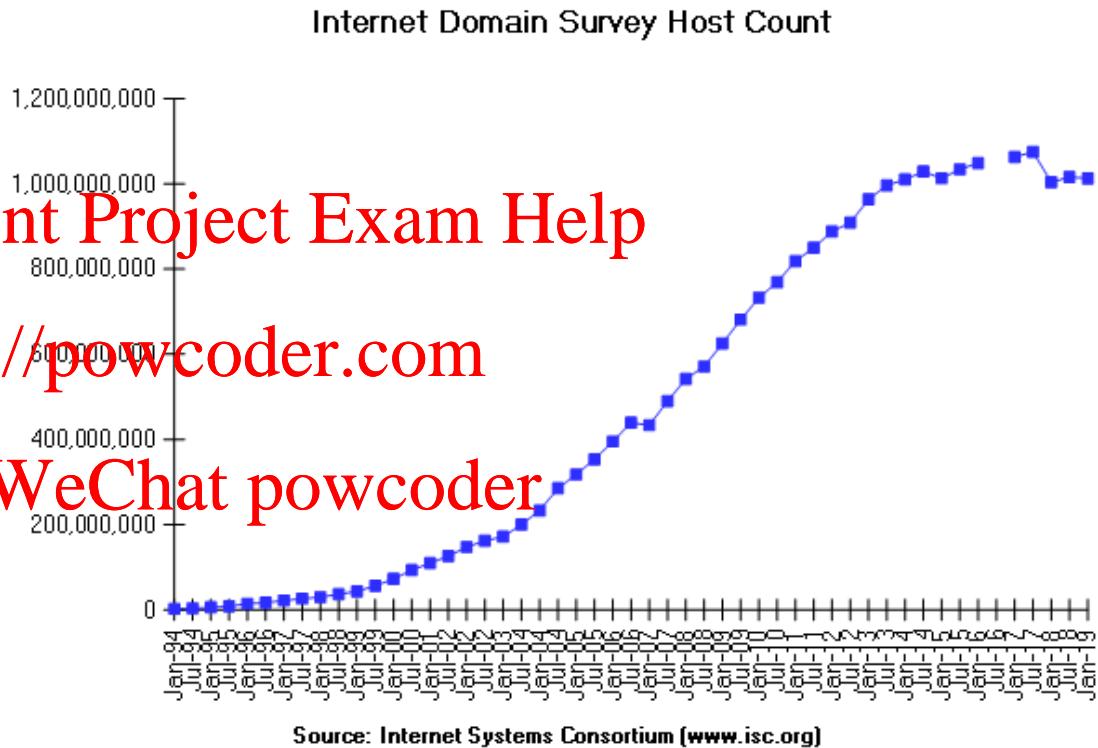
Hostname to IP address  
translation

Why not centralized DNS?

- single point of failure
- traffic volume
- distant centralized database
- maintenance

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A: doesn't scale!

# Scalability Example – Twitter



- **Burst of load:**
  - 436 tweets per second (TPS) when Michael Jackson died (June 25, 2009).
  - 6,939 TPS after midnight in Japan on 2011 New Year's day.
- **Increase in participation:**
  - +182%: Increase in number of mobile users in 2010.
  - >500,000 new accounts created on a single day.

Source: <http://blog.twitter.com/2011/03/numbers.html>

# Consistency

- Consistency; a property applying to a collection of data items that are accessed by distributed participants.

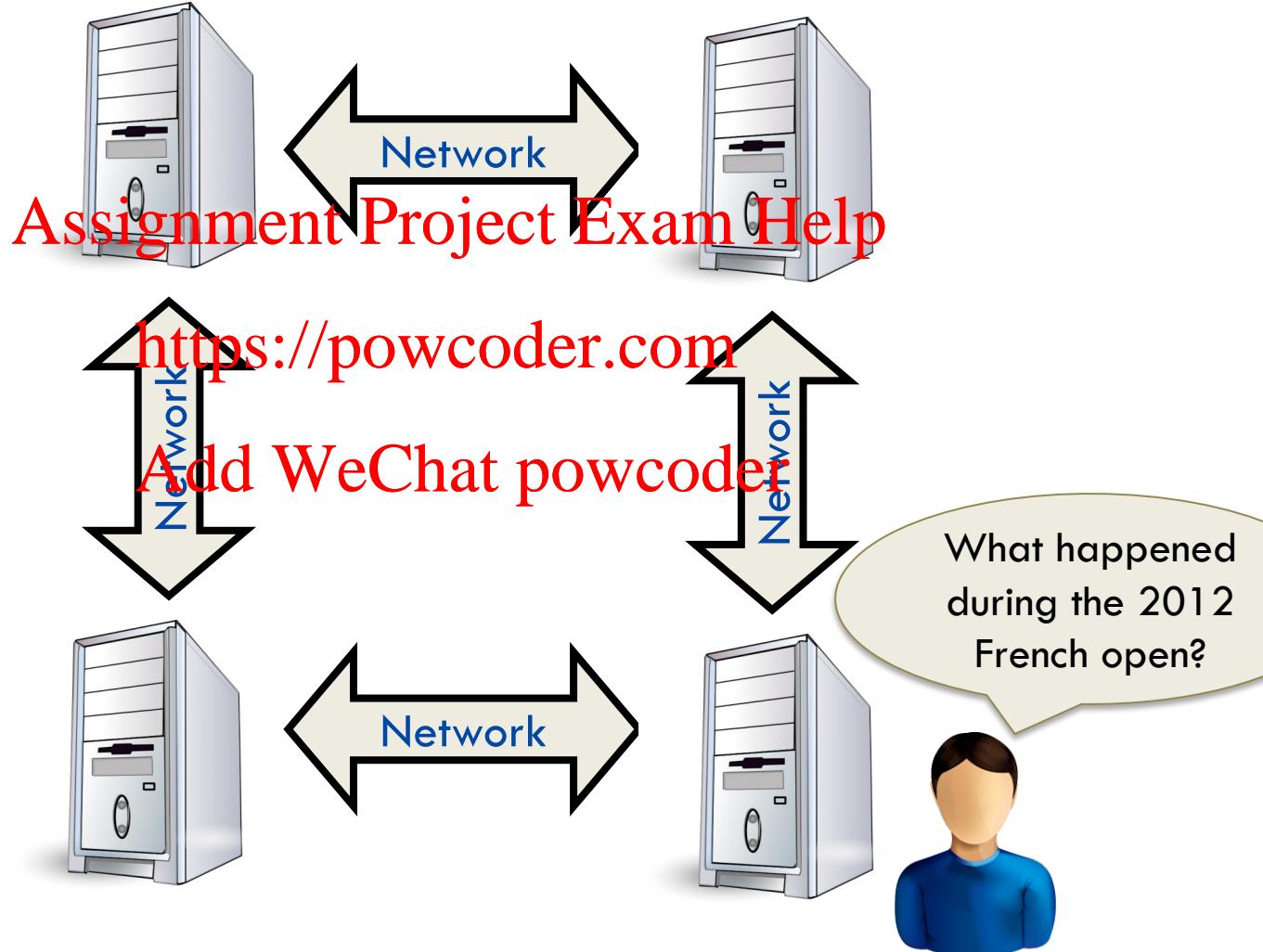
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- Examples of inconsistencies. As a participant, I observe that Djokovic lost against Nadal but then Djokovic won against Federer in the 2012 French Open.

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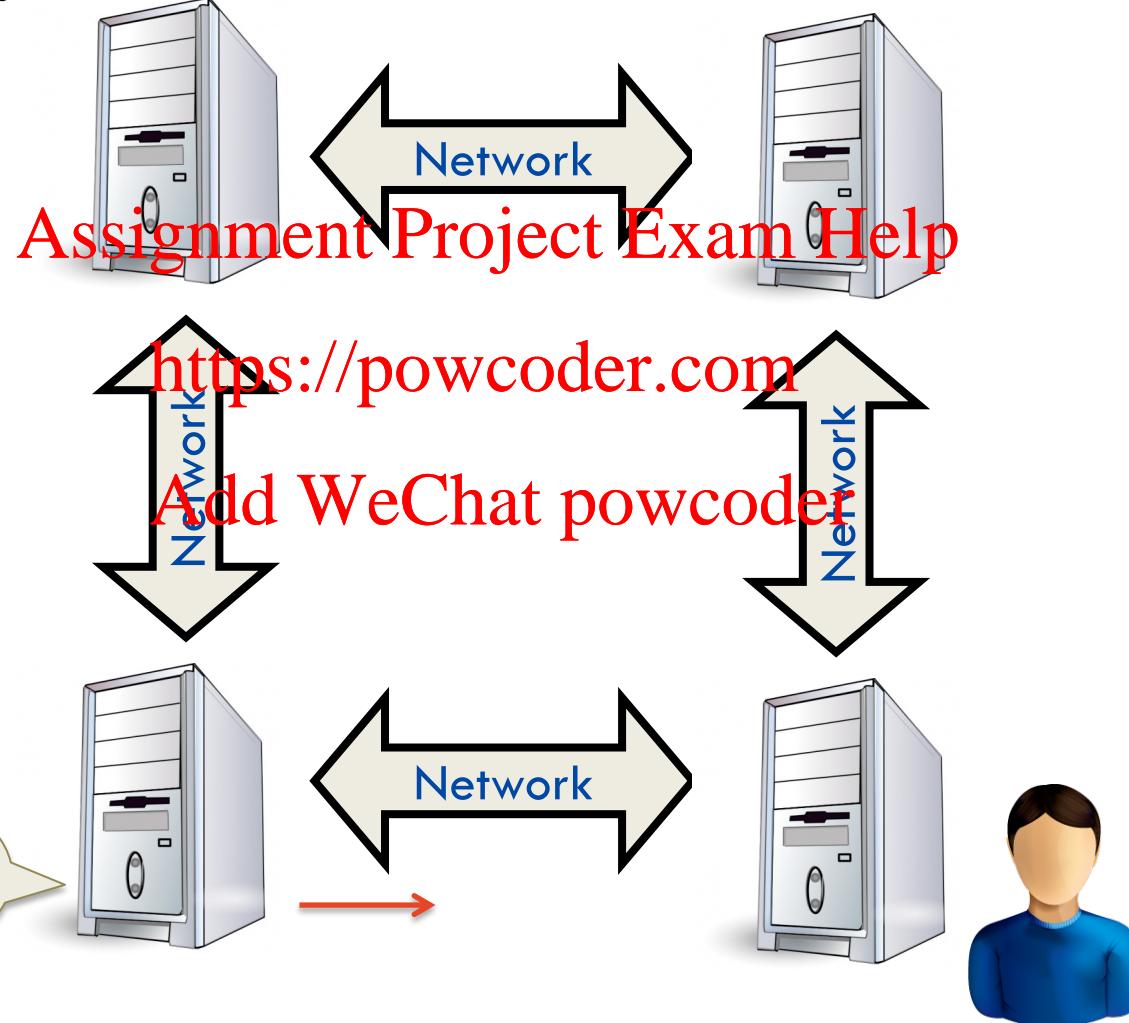
# Consistency Example

Commodity clusters



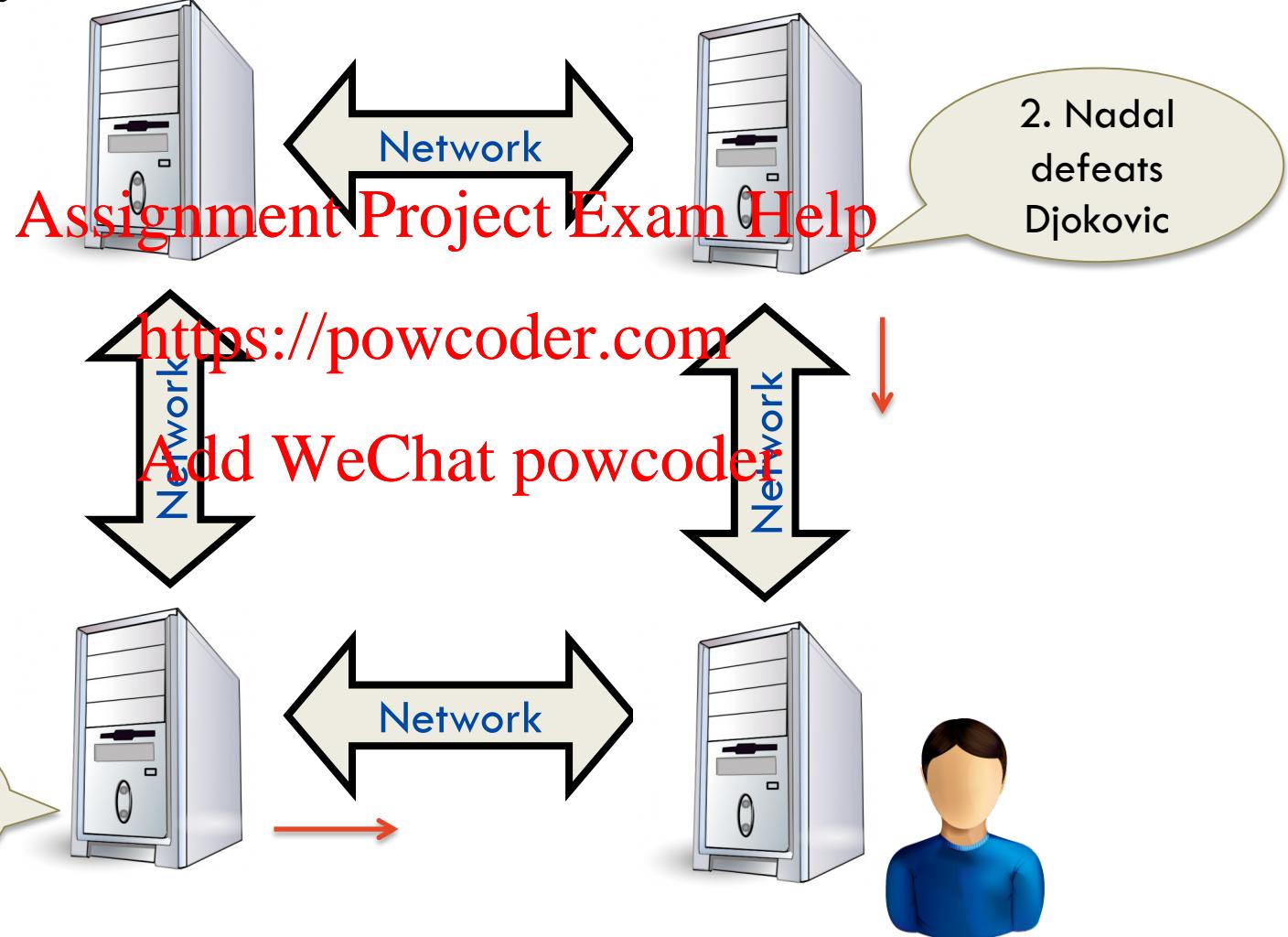
# Consistency

Commodity clusters



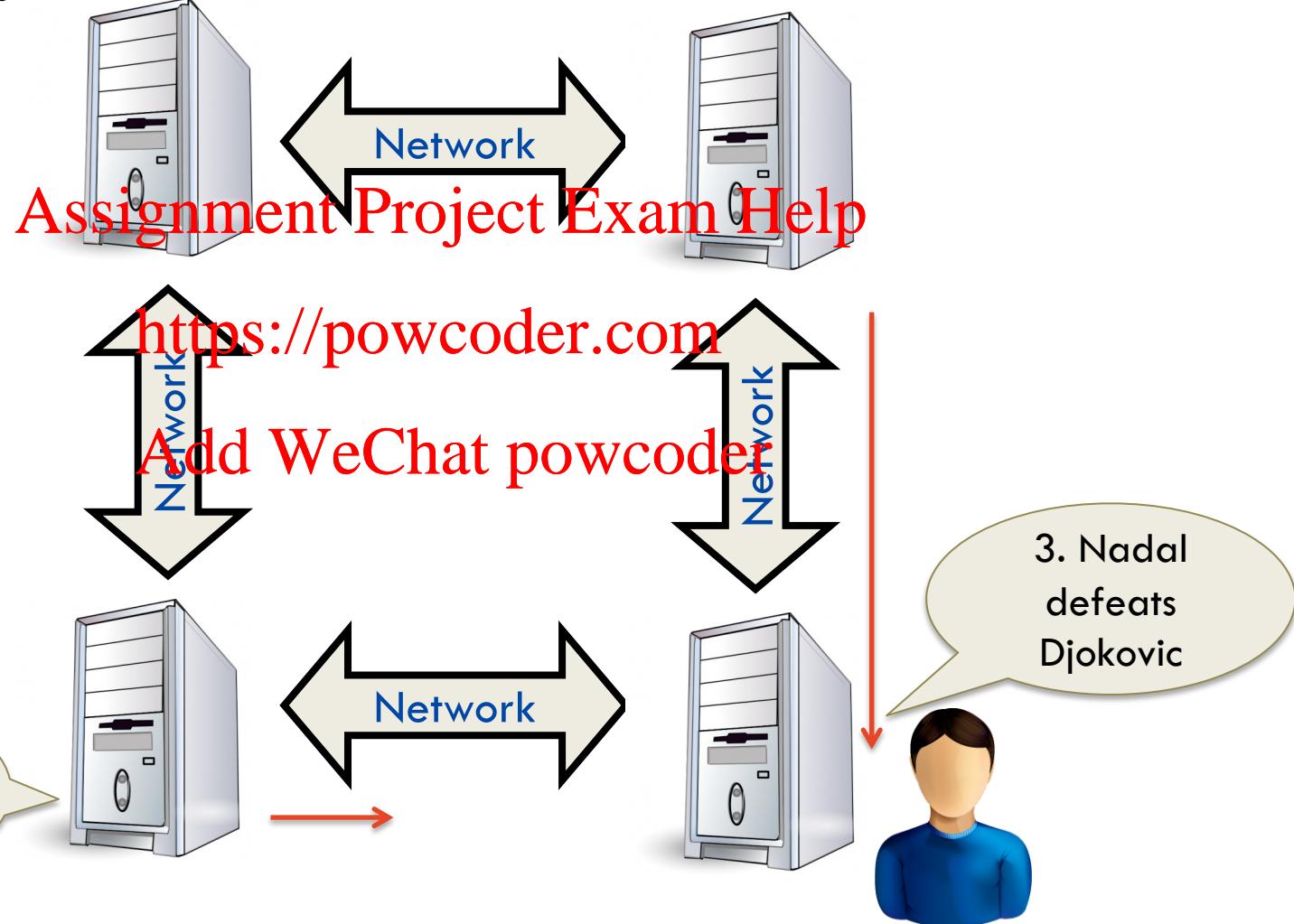
# Consistency

Commodity clusters



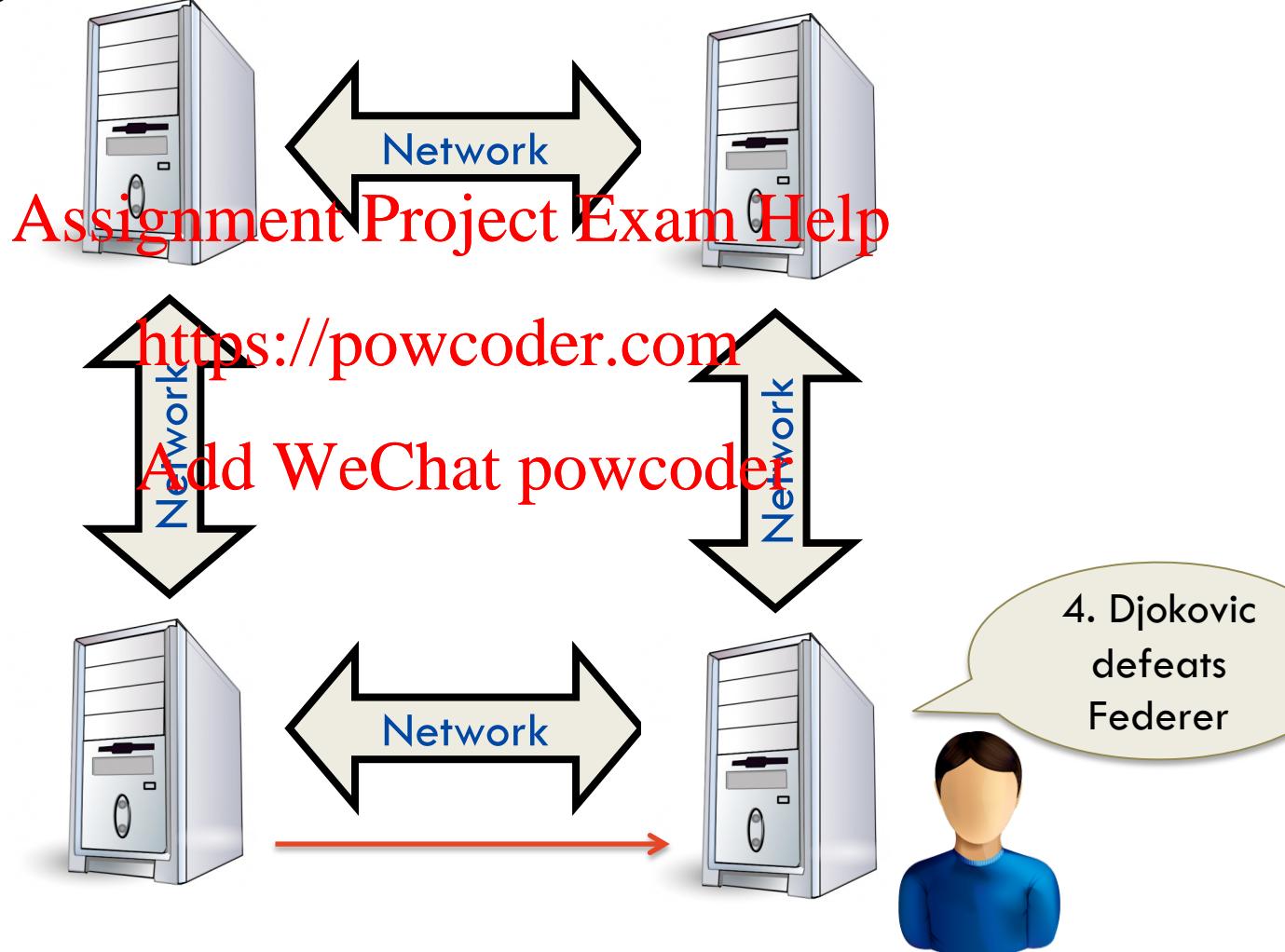
# Consistency

Commodity clusters



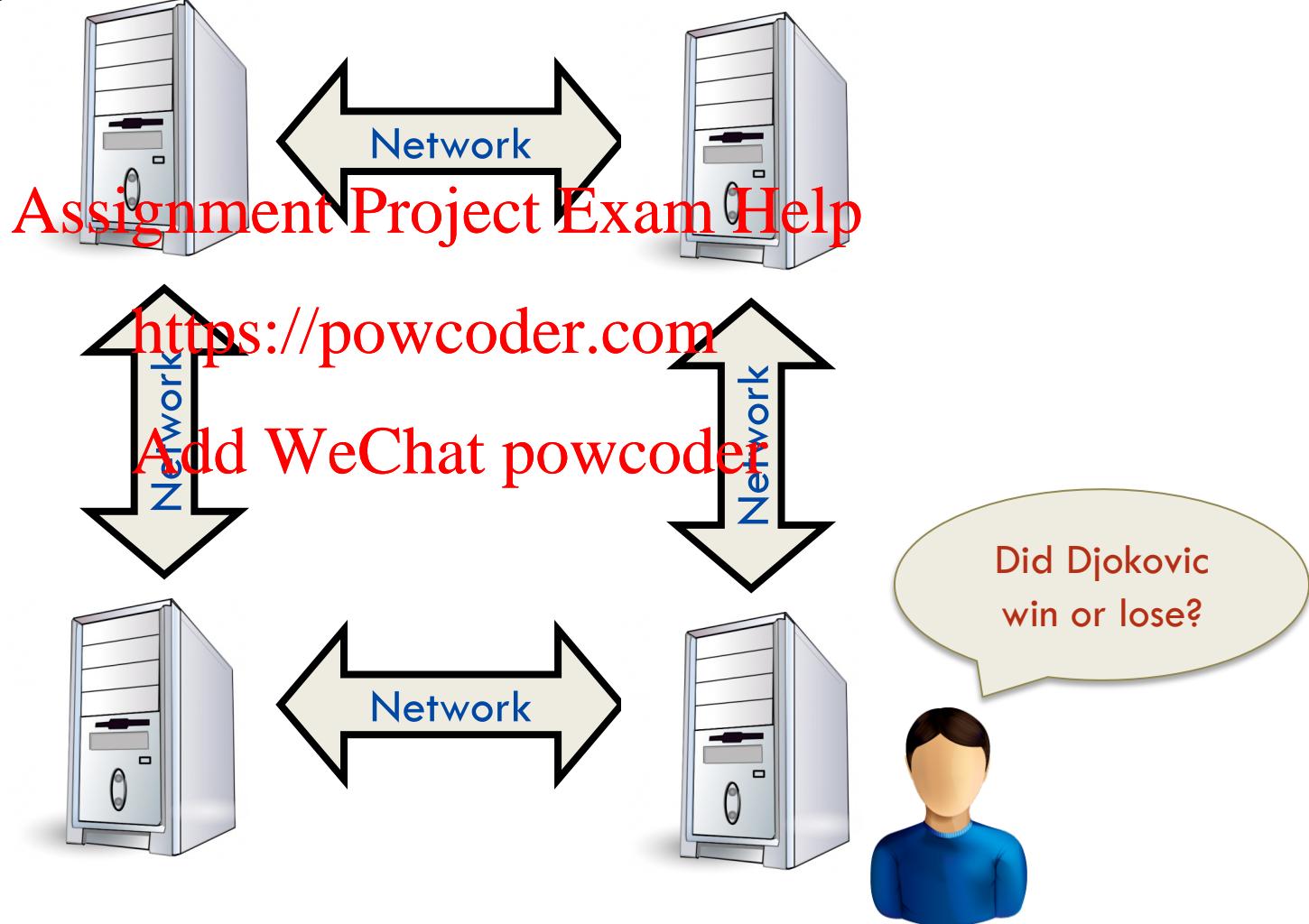
# Consistency

Commodity clusters



# Consistency

Commodity clusters



# Fault-Tolerance

- *Fault-tolerance of a distributed system:* the ability for the system to recover from partial failures.
- How to keep the distributed system up and running, thereby appearing as a single running system to its users?

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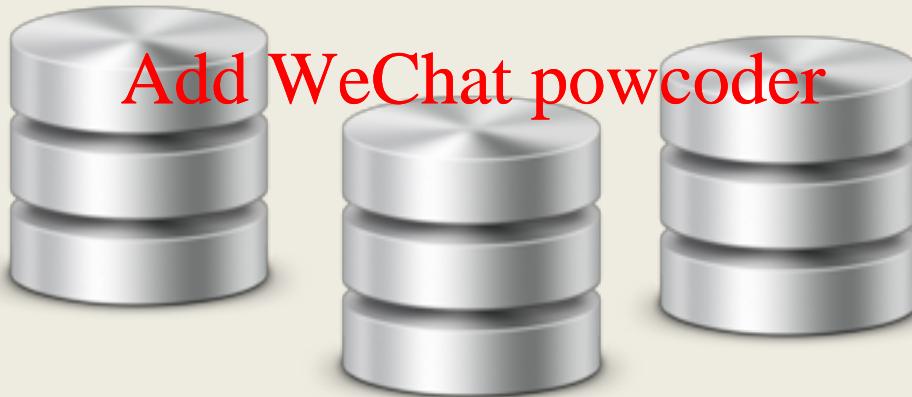


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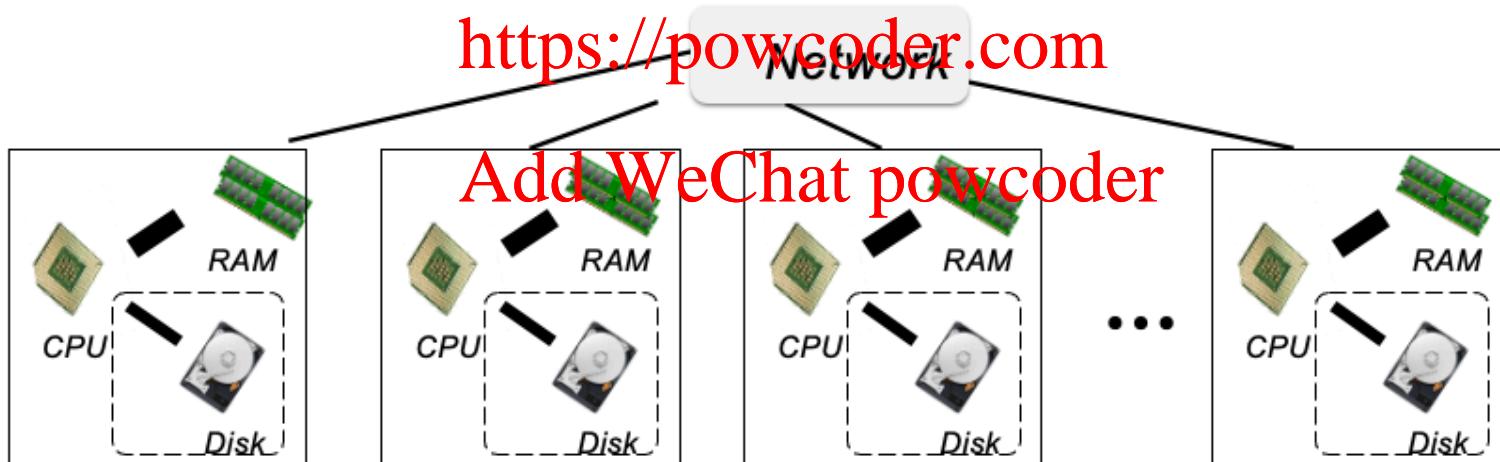
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# Distributed Machine Learning

Scale-out (distributed, e.g., cloud-based)

- ✓ Commodity hardware, scales to massive problems
- ✗ Need to deal with network communication



# COMP3221: Resources

- Canvas: <https://canvas.sydney.edu.au/>
  - Login using Unikey and password
  - Link to Units website: <https://sydney.edu.au/units/>
    - Official schedule, list of learning outcomes, etc
  - Copies of slides
  - Lab instructions <https://powcoder.com>
  - Assignment instructions
  - Lecture videos [Add WeChat powcoder](#)
    - We will record the lectures, but the technology is not reliable
  - *Submit official assignment work here;*
  - see your grades; etc
  - Discussion forum: on Edstem, link from Canvas site

# Prerequisites

- Python Programming
  - (INFO1103 or INFO1113) OR (INFO1105 or INFO1905)
- Algorithms and Data Structures **Assignment Project Exam Help**
  - COMP2123 OR COMP2823  
<https://powcoder.com>
- Prohibitions
  - COMP2121 – Older version of this course
- You need to go through Special Permission to enroll if you do not have the above requirements

# COMP3221 - Schedule

Week	Lectures	Labs/Tutorials
1	Introduction	-
2	Architecture & Processes	Multithreading
3	Communication (Routing)	Routing
4	Communication (TCP) & Sharing	Client - Server
5	Synchronization	Time
6	Consistency	Consistency
7	Blockchain	Mid-term Quiz
8	Fault tolerance	Consensus
9	Distributed Linear Regression	Linear Regression
10	Distributed Optimization	Distributed Optimization
11	Distributed Logistic Regression	Logistic Regression
12	Security	Security
13	Course Review	-

Schedule  
may  
Change

# Assessment

Task	When	Marks
Mid-term Quiz	Week 07 Tutorial Time	15%
Final Exam	TBA	50%

## Assignment Project Exam Help

- The mid-semester quiz and final exam will test the students' understanding of the theoretical material and concepts and ability to put it in the appropriate context of solving problems.

- What I hear, I forget;
- What I read, I remember;
- What I do, I understand.

-- Confucius

# Academic Dishonesty & Plagiarism

- Academic Integrity
  - Plagiarism: NO
  - Outsourcing: NO

## Assignment Project Exam Help

- Academic dishonesty means seeking to obtain or obtaining academic advantage for oneself or for others (including in the assessment or publication of work) by dishonest or unfair means.
  - Plagiarism means presenting another person's work as one's own work by presenting, copying or reproducing it without appropriate acknowledgement of the source.<sup>1</sup> [from site below]
- <https://powcoder.com>  
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- Submitted work is compared against other work (from students, the internet, etc.)
    - Turnitin for textual tasks (through eLearning), other systems for code
  - Penalties for academic dishonesty or plagiarism can be severe

# Resources

## Textbook

**Distributed Systems – Principles and paradigms** by Tanenbaum and Van Steen. 2<sup>nd</sup> Edition.



- This and other relevant works can be found in the university library and also in the bookshop.

# Resources

- Canvas UoS website: <https://canvas.sydney.edu.au/>
  - Login using Unikey and password
  - Submit official assignment work here or on PASTA
  - Copies of slides and tutorials
  - Assignment instructions
  - Lecture recording <https://powcoder.com>
- Discussion forum is linked on the eLearning website (invitations sent):
  - Ed
  - Post questions online (on this forum)
  - Everyone is welcome to answer and rate answers

# Expectations

- Students attend scheduled classes, and devote an extra 6-9 hours per week
  - doing assessments
  - preparing and reviewing for classes
  - revising and integrating the ideas
  - practice and self assessment
- Pre-requisites      **Add WeChat powcoder**
  - All programming will be done in Python and knowledge and experience in Python programming is expected

# Expectations

- Students are responsible learners
  - Participate in classes, constructively
    - Respect for one another (criticize ideas not people)
    - Humility: none of us knows it all; each of us knows valuable things
  - Check Ed and Canvas sites at least once a week!
  - Notify academics whenever there are difficulties
  - Notify group partners honestly and promptly about difficulties

# Get help... !

- Consultation
    - By appointment
  - Tutors: Assignment Project Exam Help
    - Check on Canvas  
<https://powcoder.com>
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## Advice

- Lectures notes are for help
- You should understand in-depth  
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- Practice your reasoning by re-doing the examples at home  
**<https://powcoder.com>**
- Think about implications, ask questions  
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- Re-read your notes or the lecture notes at home after the class to memorize easily

# What's Next ?

- Time management
  - Watch the due dates
  - Start work early, submit early

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- Networking and community-formation
  - Make friends and discuss ideas with them
  - Know your tutor, lecturer, coordinator
  - Keep them informed, especially if you fall behind
    - Don't wait to get help
- Enjoy the learning!

<https://powcoder.com>

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