COMP3004
ADVANCED COMPUTING AND NETWORKING INFRASTRUCTURES

20 CREDIT MODULE

ASSESSMENT: 100% Coursework **W1: 30% Set Exercises**
W2: 70% Report

MODULE LEADER: Dr. Lingfen Sun

MODULE AIMS

- To understand the concept and principles of virtualisation /softwarisation of computing and networking infrastructures in relation to the cloud computing and the future Internet.
- To deploy and analyse the performance of Internet services (such as web, video conferencing and video streaming) over SDN/NFV/Cloud platforms.
- To understand techniques for service provisioning, management, and performance improvement through automation, load balancing and resilience.

ASSESSED LEARNING OUTCOMES (ALO):

1. Apply the concepts of virtualization and/or softwarisation in cloud computing and advanced networking (the future Internet).
2. Provision common services on virtual machines over SDN/NFV/Cloud platforms through automation or scripting
3. Test and analyse performance based on load balancing and cache, under different networking conditions.

Overview

This document contains all the necessary information pertaining to the assessment of *COMP3004 Advanced Computing and Networking Infrastructures*. The module is assessed via **100% coursework**, across two elements: *30% Set Exercises* and *70% Report*.

The sections that follow will detail the assessment tasks that are to be undertaken. The submission and expected feedback dates are presented in Table 1. All assessments are to be submitted electronically via the respective DLE module pages before the stated deadlines.

	Submission Deadline	Feedback
Set Exercises (30%)	27/03/2023	Within 20 working days
Report (70%)	16/05/2023	Within 20 working days

Table 1: Assessment Deadlines

All assessments will be introduced in class to provide further clarity over what is expected and how you can access support and formative feedback prior to submission. Whilst the assessment information is provided at the start of the module, it is not necessarily expected you will start this immediately – as you will often not have sufficient understanding of the topic. The module leader will provide guidance in this respect.

Assessment 1: Set Exercises

This assignment contributes to **30%** of the overall module mark for COMP3004 and is an **individual assignment**.

Imagine a media service provider is growing fast with their online customers, and their company's web server is not able to cope. You are tasked to test the possibility of using Nginx for load balancing of web services to a farm of backend web application servers to balance the web traffic. To test the concept, you have decided to install Docker on an Ubuntu Linux server VM (e.g. Ubuntu 18.04 server) and use Nginx Docker Container as a software load balancer. To help recreate the same testing environment in the future, you will use automation methods efficiently, e.g. using Docker Compose to automate relevant configurations, Dockerfile to create specific images, and shell scripts to automate initial system setup/installation.

You need to demonstrate the consideration and the usage of the following:

1) As a proof of concept, you have decided to use one Nginx server as front-end load balancer and three backend web application servers (e.g. Nginx/PHP) to support a web application requiring dynamic data/content (e.g. display a hit counter).
2) You follow one container one service approach, so if one container is down, it only affects one service. You may have one container as frond-end load balancer, three containers for backend web application servers, and/or other containers depending on your design.
3) You will use Docker Compose and/or Dockerfile to automate the process.
4) For security reasons, only the front-end Nginx server is accessible from the outside of the company.
5) You will use shell scripts to automate the initial setup of the system (e.g. installation of relevant packages/dependencies)

You are required to write a report to cover the tasks above. The ***individual*** report should be no more than **1,500** words (excluding diagrams, images, tables, comments on the code, and references). The report should be organised as follows:

- Introduction/Background
  (about the tasks assigned, background information on Docker, Nginx, load balancing, and automation)
- Experiment/System setup
  (a systematic diagram and descriptions about the system designed, system setup steps to install relevant packages/dependencies (in shell scripts, e.g. install.sh), and some explanations)
- Automation Process
  (your written Dockerfiles, Docker Compose file, plus descriptions/explanations)
- Results and Discussion
  (evidence to show that the system works as you have designed/configured. This should include screenshots, plus descriptions/explanations, on e.g., load balancing and automation. Discussions should also cover what limitations are for the approaches taken).
- Conclusions & References

Assessment Criteria:

The report will be assessed based on the following criteria.

- Introduction, Presentation, and Structure (20%): are the introduction and background information described appropriately? Is the report well-presented and structured? Are the references sufficient and properly cited in the report?

- Experiment/System setup (25%): Have the experiment and system setup been explained appropriately? Is the explanation on the system setup steps clear and appropriate?

- Automation Process (30%): Is the automation process/configuration clearly described? Is it easy to follow? Is automation process complete and/or efficient?

- Results and Discussion (25%): Is evidence (e.g., screenshots) sufficient and well explained? Have the results been explained appropriately? Are discussions (e.g., on limitations of the approach taken) appropriate?

The report should have structure, i.e., it should contain table of contents, sections, and references. The Harvard referencing style is recommended. You should write your report as concisely as possible and it is important that you do not exceed or within 10% of the allowed word limit.

Please submit the report as a single PDF on the DLE.

Assessment 2: Project Report

This assignment contributes to **70%** of the overall module mark for COMP3004. It is an **individual assignment** based on a small project, which is an extension/integration of labs on SDN, and Adaptive Video Streaming over SDN.

Adaptive Video Streaming is one of the most popular media services over the Internet, provided by many Over the Top (OTT) service providers such as YouTube, Netflix and Twitch. In this small project, you will set up a testbed based on DASH.js, Apache server and mininet, and further investigate how network conditions (e.g. different network bandwidth) affect end-to-end video streaming quality.

The steps/tasks include:

1) Build up an SDN testbed in a VM (e.g., based on Ubuntu Desktop18.04) to support HTTP video streaming. This will include installation of mininet (network emulator), Apache server, DASH.js player, and supporting packages/dependencies (a shell script is required to automate the installation process).
2) Install an SDN controller (e.g., Ryu or OpenDaylight) in another VM.
3) Write python code to build up a network topology in mininet and connect it to an external SDN controller as set up in Step 2. Your network topology should include two virtual switches with a link between them and make sure this link is the bottleneck link of video streaming transmissions. You can make assumptions for other networking connections/settings in the network topology.
4) Prepare segmented video representations (including 3 different video representations) in H.264/AVC based on a sample test video (e.g. Big Buck Bunny) and create a combined MPD file to support adaptive video streaming.
5) Setup for video streaming over HTTP, e.g. you may set a host in mininet (e.g., h1) as a streaming server, and another host (e.g., h2) as a client to start a web browser (e.g. Firefox) to initiate the video streaming from the server.
6) Carry out experiments on video streaming over SDN networks under different network conditions (e.g. 3 different network bandwidth settings in the bottleneck link to emulate low/medium/high bandwidth network connections). Use 'iperf' to test the network bandwidth. Record and comment on quality variations based on statistics provided by DASH.js, e.g., bitrate downloading and dropped frames, and demonstrate that adaptive video streaming is working.
7) Provide evidence and comment on how the external SDN controller can collect/report on network statistics based on REST API and what these information can be used for in terms of network monitoring/management.

You are required to write a report to cover the tasks above. The ***individual*** report should be no more than **3,000** words (excluding diagrams, images, tables, comments on the code, and references). The report should be organised as follows:

- Abstract – maximum 150 words

- Introduction (including background information and literature on SDN, DASH, video streaming quality, tasks to be carried out, and structure of the report) - about 700 words
- Testbed Setup, configuration and code developed (about 600 words)
- Experiments, Results and Analysis (about 700 words)
- Discussions, network monitoring/management via REST API (about 700 words)
- Conclusions (about 150 words).
- References
- Appendix (e.g., python code, shell scripts).

References:

- Dash Industry Forum, https://github.com/Dash-Industry-Forum/dash.js/wiki
- Mininet: http://mininet.org/
- MPEG-DASH Content Generation with MP4Box and x264, https://bitmovin.com/mp4box-dash-content-generation-x264/

Assessment Criteria:

The assessment criteria is defined as below:

- Abstract, Introduction, Conclusions and References (20%)
- Testbed setup, code developed, and descriptions (35%)
- Experiments, Results and Analysis (25%)
- Discussions, REST API, and network management (20%)

The report should have structure, i.e., it should contain abstract, table of contents, sections, and references. The Harvard referencing style is recommended. You should write your report as concisely as possible and it is important that you do not exceed or within 10% of the allowed word limit.

Please submit the report as a single PDF on the DLE.

Threshold Criteria (these are indicative only):

< 40% Little or no analysis. Minimum of results, and results are largely incorrect. Little understanding of the subject. Almost no evidence of investigation, evaluation and research on answering the questions. The report is poorly written and structured.

40–49% (Third): Brief discussion and little analysis/investigation. Results are partially correct and/or complete. Little evidence of investigation, evaluation and research on answering the questions. The content and style of the report are mostly appropriate.

50–59% (Lower Second): The majority of the results are correct and complete. Answers are given at an appropriate level of detail and are explained clearly. Some evidence of investigation, evaluation and research on answering the questions. The report is reasonably well structured and the content and style are appropriate.

60 – 69% (Upper Second): A significant majority of the results are correct and complete. Answers are given at great details and are well explained. Clearly and concisely description of how results are obtained. Good evidence of investigation, evaluation and research on answering the questions. The report is of a good standard and structure.

> 70% (First): The results are correct and complete. Especially clear, ambitions and well justified analysis and description. Demonstrating ideas for original thoughts and stretched work. There is strong evidence of investigation, evaluation and research on answering the questions (e.g. deep analysis, fully investigation, good summarise of the investigation). The report is well presented and organised (focused and concisely).

General Guidance

Extenuating Circumstances

There may be a time during this module where you experience a serious situation which has a significant impact on your ability to complete the assessments. The definition of these can be found in the University Policy on Extenuating Circumstances here: https://www.plymouth.ac.uk/uploads/production/document/path/15/15317/Extenuating_Circumstances_Policy_and_Procedures.pdf

Plagiarism

All of your work must be of your own words. You must use references for your sources, however you acquire them. Where you wish to use quotations, these must be a very minor part of your overall work.

To copy another person's work is viewed as plagiarism and is not allowed. Any issues of plagiarism and any form of academic dishonesty are treated very seriously. All your work must be your own and other sources must be identified as being theirs, not yours. The copying of another persons' work could result in a penalty being invoked.

Further information on plagiarism policy can be found here:

Plagiarism: https://www.plymouth.ac.uk/student-life/your-studies/essential-information/regulations/plagiarism

Examination Offences: https://www.plymouth.ac.uk/student-life/your-studies/essential-information/exams/exam-rules-and-regulations/examination-offences

Turnitin (http://www.turnitinuk.com/) is an Internet-based 'originality checking tool' which allows documents to be compared with content on the Internet, in journals and in an archive of previously submitted works. It can help to detect unintentional or deliberate plagiarism.

It is a formative tool that makes it easy for students to review their citations and referencing as an aid to learning good academic practice. Turnitin produces an 'originality report' to help guide you. To learn more about Turnitin go to:
https://guides.turnitin.com/01_Manuals_and_Guides/Student/Student_User_Manual

Referencing
The University of Plymouth Library has produced an online support referencing guide which is available here: http://plymouth.libguides.com/referencing.

Another recommended referencing resource is Cite Them Right Online; this is an online resource which provides you with specific guidance about how to reference lots of different types of materials.

The Learn Higher Network has also provided a number of documents to support students with referencing:
References and Bibliographies Booklet:
http://www.learnhigher.ac.uk/writing-for-university/referencing/references-and-bibliographies-booklet/
Checking your assignments' references:
http://www.learnhigher.ac.uk/writing-for-university/academic-writing/checking-your-assigments-references/