Cloud Computing Paper (use style: *paper title*)

Subtitle as needed (style: *paper subtitle*)

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*Abstract*—Please provide an abstract for your paper. The abstract should introduce the cloud service(s) you studied, their major benefits, and some challenges associated with their adoption and use. Please state at least one research problem or challenge which relates to the experiments you performed. These challenges could relate to: variable performance, performance unpredictability, cost uncertainty, and/or scalability of the cloud service. For example, you may have tested “how scalable” a cloud service was. Scalability relates both to *how easy* it was to scale (horizontal or vertical), as well as *how performant* the service was once scaled, and how resilient it was for scaling needs. For example, did the service automatically scale? Or did the service require manual setup to scale? Other, non-functional challenges you could talk about in the paper include: adoption challenges related to usability, understandability (of documentation, examples) and adaptability. For “qualitative” discussions of non-functional challenges it is good to cite specific examples and use cases from experience. *\*CRITICAL: Do Not Use Symbols, Special Characters, or Math in Paper Title or Abstract*. (*Abstract*)

Keywords—This keywords for the paper: component; formatting; style; styling; insert (key words)

# Introduction

Please include an introduction for your paper. The introduction should describe the primary cloud service you studied. It should describe what benefits the cloud service provides, and cite existing cloud implementations. For example, if your service was relational database services, you would identify and describe commercial systems which provide RDS. (e.g. Amazon, Google, Microsoft), and describe and contrast them briefly.

You should clearly ***state the problem or goal(s) of your study***. What is it that you set out to explore? What did you look to measure and quantify, and why is it important to? For many of the projects, our goal was to compare and contrast the service quality offered by competing cloud service implementations provided by different cloud providers such as Amazon, Azure, and Google. For the term project, we are interested in measuring the average performance in terms of service turnaround time (roundtrip time) given particular test workloads. You may have performed stress tests, or scaling tests to investigate how adaptable or resilient cloud service implementations were for servicing increasing/dynamic workloads. In addition to performance testing, you can cite cost analysis as a challenging problem. At the end of your study it should be possible to convert your performance numbers into cost numbers which are then presented in tables and graphs in the paper. For example, if a given cloud service completes 1,000 runs per hour (16.67 per minute), and the cloud provider uses an hourly billing model, then what is the price per run?

## Research questions

For your paper, try to write one or two “research” questions which relate to the performance benchmarks you’ve performed. Essentially, your questions are about comparing the performance of competing cloud service implementations. These could be two (or more) commercial offerings, or your study may have compared a cloud service with a “self hosted” equivalent.

For a comparison study of competing commercial cloud service implementations of Blob storage for example, (e.g. Amazon S3 and Azure Blobstore), the question you may be trying to answer is, “What are the primary differences in performance among two or more commercial cloud (insert service name here) offerings?” From the user’s perspective, although we can recognize that Amazon Simple Storage Service (S3) and Azure Blob Storage are similar cloud service offerings, **it is very difficult to know which one is more performant, for specific use cases!** We are really interested in knowing: (1) are the prices charged for the competing services reasonable? And (2), is the performance afforded by the alternatives equivalent? Does one cloud provider appear to offer a superior service implementation? Please note that performance differences will always be use case specific and that **we do not want to** publish an academic paper which favors one particular vendor unless that is truly what the data says.

For a comparison study with a “self-hosted” cloud service equivalent, the question you may be looking to answer is: “What are the benefits of using the commercial cloud service in terms of performance and cost? What value-added features are provided by the cloud provider? And are these value-added features worth it? How did the commercial cloud service perform in comparison to your self-hosted “service”? Was there any difference in performance? Was the performance the same? In many cases, cloud services are more expensive than hosting the service yourself using Infrastructure-as-a-Service (IaaS) cloud resources such as the Amazon elastic compute cloud (EC2) for example. Ultimately, we are interested in quantifying real benefits to justify higher costs for platform-as-a-service (PaaS) and software-as-a-service (SaaS) offerings.

We investigate the following research questions: (Replace with your specific research questions)

1. How does the performance of commercial cloud blob storage services vary for different use cases? And how variable is performance for a given provider?
2. For commercial cloud providers, how does transaction cost (e.g. cost for each transaction) vary based on our observed performance for different use cases?

Please write or adapt the sample research questions and tailor them to your project. At the end of your paper, you should present data which tries to answer the questions. **Do not state questions which cannot be answered by your experiments and expected data.** Now given the small scope of the TCSS 562 study, I realize we may not have answered the questions completely, but please state the questions you set out to answer, regardless of how well the experiments ended up.

## Contributions

Identify applicable sponsor/s here. If no sponsors, delete this text box (*sponsors*).

The third paragraph of the introduction should state the key contributions of your study. Essentially the key contributions are what is unique about your performance and benchmarking study, as well as what conclusions you can now make as a result of the study. Hopefully you’ll have at least 1 or 2 contributions. One can be key contribution will be the results of the performance analysis. Your data helps to identify the better performing cloud service alternative for a given set of use cases. Another possible contribution will be the cost comparison that **can now** be completed by analyzing your transactional costs relative to performance.

# Related Work

## Subsections can group sets of related work

For the related work, you should cite the paper presented in class and write a couple sentences on how it relates to your project. If possible, you might cite related work from this paper, and also include 3-5 other references to related papers. The general idea is to group related papers together and summarize them in one paragraph. Separate paragraphs or sections can be used to consider how your work relates to different areas of related work. For your topic, it may be possible to classify related work into 2-3 categories. For each related paper, it is typical to summarize the key contributions in 1 or 2 sentences and briefly state how the paper (or reference) relates to your work, and also **very** briefly how your work is different. It is ok to just have one section (no sub-sections) if you don’t have many references. This related work section is typically expanded before submitting to a conference.

## Subsection 2 related work

Identify applicable sponsor/s here. If no sponsors, delete this text box (*sponsors*).

This section could describe a separate line of related work which is independent from the first section.

# Comparison Study

Section III of your paper should describe your term project. You should describe the tests you designed and conducted. You can also describe WHY you chose to use particular tests. For example, we often described using small, medium, and large datasets for testing. Why would you want to use them? What is the significance of the various boundaries between small, medium, and large test datasets? What typical use cases does a small test mimic? How about the medium test? And the large? Why do we believe these are ***representative*** tests of practical/real use cases? In the end, we are trying to convince the reader that our tests mimic real world use cases so that our data and results have more value and applicability. In some cases, we may even look to what test cases others have used to justify our choices.

You may have performed stress/load tests. For example, you may have benchmarked performance with a single client, and then tested how scalable performance was when increasing the load. If the cloud service offers auto-scaling / elasticity then your goal is to measure and compare how good the implementations were at automatic load detection and adaption. These scaling tests are really interesting for microservices as well as blob storage. For example, when you create a data blob, if multiple clients simultaneously request to download the blob, does performance vary for these parallel requests? Do all clients observe similar throughput and download speeds?

In section III, you should be sure to compare the configuration of the cloud services you are comparing. For example, if you are comparing relational database services, elastic cache, container services, etc. be sure to talk about the type, size, and quantity of the VM types used. As before, we’ll want to justify why we are interested in testing specific VM types. It is generally not possible to test ***every*** configuration or type. Especially within the scope of just one quarter. We must choose only a few tests to perform due to limit time and resources. We should say why we believe these tests are important, and why we hope to obtain HIGH VALUE from just these set of tests.

Section III should completely describe the test configurations, and tests that were performed so that in the future someone could repeat them. Repeating tests may help to verify our results and conclusions. Repeating tests can also help determine how public cloud service quality and implementations are changing over time. Are cloud providers addressing issues in class that we’ve talked about regarding performance variability? Is it easier from a user’s perspective to “know what you’re paying for”, let’s say in the future?

## Subsections

You may organize section III in subsections if it is helpful to break down and present the experimental design into different groups related to the specific research questions from section I for example.

## Another Subsection

* Here is an example of a bulleted list-
* In case you need it.
* This is a third bullet.

## Equations

Equations, if used, are usually offset in the text. The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled.

Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus ( / ), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in

*a**b* 

Note that the equation is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use “(1)”, not “Eq. (1)” or “equation (1)”, except at the beginning of a sentence: “Equation (1) is . . .”

## Some Common Mistakes

* The word “data” is plural, not singular.
* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
* A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
* Do not use the word “essentially” to mean “approximately” or “effectively”.
* In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
* Be aware of the different meanings of the homophones “affect” and “effect”, “complement” and “compliment”, “discreet” and “discrete”, “principal” and “principle”.
* Do not confuse “imply” and “infer”.
* The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
* There is no period after the “et” in the Latin abbreviation “et al.”.
* The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

An excellent style manual for science writers is [7].

# Experimental Results

Section IV should present the results of your study. This should include data tables and graphs with captions where appropriate. Here are some simple examples of captions:

1. Table Type Styles

| Table Head | Table Column Head | | |
| --- | --- | --- | --- |
| Table column subhead | Subhead | Subhead |
| copy | More table copya |  |  |

1. Sample of a Table footnote. (*Table footnote*)

We suggest that you use a text box to insert a graphic (which is ideally a 300 dpi TIFF or EPS file, with all fonts embedded) because, in an MSW document, this method is somewhat more stable than directly inserting a picture.

To have non-visible rules on your frame, use the MSWord “Format” pull-down menu, select Text Box > Colors and Lines to choose No Fill and No Line.

1. Example of a figure caption. (*figure caption*)

Any graphs should be included as figures. Data should be presented in table format. In addition to presenting the experimental results, Section IV should also provide a ***discussion and analysis*** of what the results mean. After completing the test, and collecting the data, what appears to be happening? Which cloud providers services are more performant? Less expensive? Please state any conclusions from your data and your observations that you can now make. Conclusions which are not backed by data or experience (use cases, experiences, etc.) are not good and should be avoided.

# Conclusions

Section V should summarize your study. It should reiterate what the research questions were, and restate what the key conclusions were from the experiments you ran. Ideally, there is one or two conclusions that summarize your observations for each research question. You can even identify the research question by number such as (RQ-1) when summarizing the key conclusion from your data. Someone reviewing your paper will look to see if in your conclusion section, you’ve answered the research questions proposed in the introduction. Good research papers **do not hide key results** from the reader. They also do not make the reader do the analysis. For example, the authors should never simply present data to the reader and then “discuss” passively what it ***might*** mean. Good research papers make assertive conclusions based on facts and data. The core components of the research paper should be accessible in the introduction (Section I) and the conclusion (section V). A reader wanting more detailed information can then read the intermediate sections if they find your paper of interest.

Optionally if your paper is running short, you may include as a new section, or as a paragraph at the end of the conclusion “future work”. Future work usually discusses possible next steps for the work. Planned work is usually mentioned first, followed by potential work.

##### Acknowledgment *(Heading 5)*

Acknowledgements may be included. We can cite the use of AWS Educate cloud credits.

##### References

This section describes the format for the references. You should have at least 5!!! The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

1. G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
2. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
3. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
4. K. Elissa, “Title of paper if known,” unpublished.
5. R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.
6. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
7. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.