

# A Survey on Virtual Machine and Container Orchestration

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## Abstract

Data center administrators and site-reliability engineers create virtual machines or containers to run their applications, with desired redundancy requirements and automated coordination between the replicas. This is called the orchestration of the various computing, storage and network resources of the data center. To automate the orchestration process, different tools have been developed in the past couple of decades. Each tool was designed differently, with different intents and priorities but they also have a lot in common. This survey is on the various orchestration tools available to data center administrators, site reliability engineers and software engineers; and aims to be a comprehensive guide that helps data center administrators in choosing the cloud platform and the orchestration tool.

## 1 Introduction

With the advent and proliferation of virtualization, computing as a service has taken off. Now there are multiple cloud service providers such as Google Cloud, Amazon Web Service, Microsoft Azure etc. The operators of these cloud services typically have their own data centers, each consisting of thousands of physical machines connected via a high speed and very low latency network such as Infiniband (IB) [3]. Data center operators use various tools to automate the process of management, provisioning and scaling the resources for their customers.

Orchestration tools have been developed to ease the automation of operating a data center. Tools such as VMware vCenter Orchestrator and Microsoft System Center Orchestrator, and OpenStack's Heat have been used to manage VMware vSphere, Microsoft Hyper-V or Linux kernel virtual machines. Container Orchestration tools such as Docker Swarm, Kubernetes, Mesos have been developed to manage containers on mostly Linux

machines, but also increasingly on Windows machines as well.

## 2 Instructions

Please read the following instructions carefully. You may use this  $\text{\LaTeX}$  document as a template if you're using  $\text{\LaTeX}$  to prepare your document. There is also a Microsoft Word template if you prefer. However, you may use any word processor you like, as long as you follow the guidelines listed here. Note that all manuscripts must be in English.

### 2.1 Acceptable formats

Your paper *must* be submitted electronically. The only acceptable format for your final paper is PDF.

### 2.2 Margins and page numbering

All printed material, including text, illustrations, and charts, must be kept within a print area 6-7/8 inches (17.5 cm) wide by 8-7/8 inches (22.54 cm) high. Nothing should be printed outside this area, except for page numbers.

### 2.3 Formatting your paper

All text must be in a two-column format. The total allowable width of the text area is 6-7/8 inches (17.46 cm) wide by 8-7/8 inches (22.54 cm) high. Columns are to be 3-1/4 inches (8.25 cm) wide, with a 3/8 inch (0.95 cm) space between them. The main title (on the first page) should begin 1-3/8 inch (3.49 cm) from the top edge of the page. The second and following pages should begin 1.0 inch (2.54 cm) from the top edge. On all pages, the bottom margin should be 1-1/8 inches (2.86 cm) from the bottom edge of the page for 8.5 × 11-inch paper; for A4

paper, approximately 1-5/8 inches (4.13 cm) from the bottom edge of the page.

## 2.4 Type-style and fonts

Wherever Times is specified, Times Roman may also be used. If neither is available on your word processor, please use the font closest in appearance to Times that you have access to. If possible, use only Times, Helvetica, Courier, Symbol, and Dingbats fonts in your paper. Any other fonts must be embedded in your document to ensure that it will print properly. *L*<sup>A</sup>T<sub>E</sub>X users: you *must* use the `times` package. You can use the Computer Modern Roman font if you prefer, as long as you're careful to ensure that you're using the outline fonts so they show up well in Acrobat (PDF).

## 2.5 Main title

Center the title 1-3/8 inches (3.49 cm) from the top edge of the first page. The title should be in Times 14-point, bold-face type. Capitalize the first letter of nouns, pronouns, verbs, adjectives, and adverbs; do not capitalize articles, coordinate conjunctions, or prepositions (unless the title begins with such a word). Leave two blank lines after the title.

## 2.6 Author names and affiliations

Author names are to be centered beneath the title and printed in Times 12-point, non-boldface type. Affiliations and email addresses are to be below each author's name, and set in Times 12-point italic type. If all authors have the same affiliation, the affiliation can appear centered below all authors' names. This information is to be followed by two blank lines.

## 2.7 Paper body

The body of the paper (including the abstract) must be in a two-column format.

The main text should be set in 10-point Times, single-spaced. All paragraphs should be indented 1 pica (approx. 1/6 inch or 0.422 cm). Make sure your text is fully justified—that is, flush left and flush right. Please do not place any additional blank lines between paragraphs.

## 2.8 Figures and tables

Figure and table captions can be in any font, as shown in Figures 1 and 2. Short captions (single line) should be centered, as in Figure 1. Long captions should be aligned

Table 1: Sample table.

Level	Size	Style	Before	After
1	12 point	Bold	1 line	1 line

Stuff that goes into the figure itself.

Figure 1: Example of short caption.

Things that go bump in the night.

Figure 2: Example of long caption requiring more than one line.

Stuff that goes in the first subfigure.

(a) The first subfigure.

Stuff that goes in the second subfigure.

(b) The second subfigure.

Figure 3: Sample use of subfigures.

on both sides and indented 1 pica on both left and right, as demonstrated in Figure 2. Figure captions should be below their figures, while table captions should be *above* the table, as shown in Table 1.

Figures and tables must be centered, and should be placed in a single column if possible; however, large figures and tables may span the entire page if necessary. Page-spanning figures and tables should be at the top or bottom of the page. Figures and tables *must* be included as part of the PDF document—no cut and paste!

We will be printing the proceedings in black and white. However, color in your document is acceptable as long as the black and white version is still readable and comprehensible; the CD-ROM will allow readers to see color figures.

You can use subfigures, such as Figures 3(a) and 3(b), if you like, as shown in Figure 3.

## 3 First order headings

First-order headings should be Times 12-point boldface, flush left, with one blank line before, and one blank line after. Only the first word of first-, second-, and third-order headings should be capitalized. All numbers in the section number should be followed by periods.

### 3.1 Second order headings

Second order headings should be Times 11-point boldface, flush left, with one blank line before, and one after.

### 3.1.1 Third order headings.

If you require a third-order heading (we discourage it), use 10-point Times, boldface, flush left, preceded by one blank line and followed by one blank line.

## 3.2 Footnotes

Please use footnotes sparingly<sup>1</sup>; instead, include necessary peripheral observations in the text (within parentheses, if you prefer).

## 3.3 References

List and number all bibliographical references in 9-point Times, single-spaced, at the end of your paper. When referenced in the text, enclose the citation number in square brackets, for example [1]. Multiple citations [1, 2] should be in a single set of square brackets.

## 3.4 Conclusions

Please direct any questions to Professor Miller. Keep in mind that these instructions are taken from a conference, so soem of the instructions, particularly those for procedures rather than formatting, may not apply to you.

## References

- [1] I. M. Author. Some related article I wrote. *Some Fine Journal*, 99(7):1–100, January 1999.
- [2] A. N. Expert. *A Book He Wrote*. His Publisher, Erewhon, NC, 1999.
- [3] Mellanox Technologies. Introduction to InfiniBand. 2003.

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<sup>1</sup>Or, better still, try to avoid footnotes altogether. If you do use footnotes, place them at the bottom of the column on the page on which they are referenced using 8-point single-spaced Times.