A! Appendix 1: Chapter Overviews and Summaries

In addition to clear aims for your thesis, it is also important that you not only clearly *preview* the **topics** in each chapter but also *justify* including this information in the chapter, as well as sometimes, individual sections within these chapters. This handout describes the language common to these previews.

Let's start with an example from a master's thesis written by a student of electrical engineering. The text (Figure 1.1) consists of two introductory paragraphs that come between the **chapter heading** ("*Chapter 2 Background*") and the first **section heading** (*"2.1 Mobile Networks"*). Note that individual sentences have been marked with *superscript numbers* (e.g., "[5]In") to allow discussion.

Chapter 2 Background

[1]Mobile networks are the part of communication networks that provide mobility to communications, i.e. the users do not need to be located at any fixed location in order to communicate [2]. [2]As the communication typically includes speech signal transmission, there is a need to provide as light and agile representation of speech as possible. [3]Consequently, different audio compression methods (also known as audio coding methods) have been developed to serve this purpose. [4]When these methods are combined to a framework, an entity called codec is formed.

[5]In this chapter, a broad overview of the mobile networks is introduced with a discussion of media processing in these networks. [6]In addition, general aspects of audio coding are presented with an emphasis on audio coding in mobile networks.

2.1 Mobile Networks

Figure 1.1 Introductory paragraphs in the literature review chapter of an engineering M.S. thesis.

The introductory paragraph in thesis chapters can typically serve two purposes: (1) to **justify** and **explain** <u>why</u> you have chosen to include this particular information in your thesis, and (2) to provide the readers with a 'road map' listing <u>what</u> topics will be covered within the text (e.g., chapter or section), commonly known as **chapter** and **section previews**.

(1) JUSTIFICATION OF CONTENT

As shown in Figure 1.1, the writer highlights in the first paragraph (sentences 1-4) the value or relevance of mobile networks or communication networks, thus justifying its inclusion in the chapter. However, the writer could have made this justification more explicit if he had referred back to the **aim** of the thesis. A typical strategy for linking the chapter contents to the thesis aim is to use a **purpose clause** *(In order to / To)* or a **cause-effect connector** *(Since / Because / As…)*.

In order to develop bleaching sequences for Kraft pulps*, it is important to understand* the chemical principles and parameters underlying the pulp bleaching.

In order to model the customer service management process (CEM)*, it is first necessary to understand* the customer experience.

Since this thesis aims to detect Web-Tracking*, it is necessary to present* detection mechanisms used in areas such as Data Mining or Knowledge Discovery in Databases. Section 2.1 provides general information about Data Mining and discusses the reasons why it has become so important nowadays.

Because the thesis focuses on the company's after-sales service department*, it is vital to understand* what is meant by 'service' and what the main characteristics of after-sales are. Furthermore, product and product lifecycle are introduced*, since* service business is applicable during the products' entire lifetime.

As this thesis aims to build a semantic search interface for demonstrating the behaviour of a statistical reasoner*, this chapter presents* background information about knowledge engineering, including concepts related to knowledge representation, Semantic Web technologies, and statistical reasoning.

Note in the example below how the writer justifies the chapter reviewing the *state of the art* by stating the need to compare his solution with those currently available:

Chapter 3
State of the Art

This chapter introduces the common impedance analysis from the literature to investigate lithium-ion cells and electrodes. It starts with the analysis of experimental cells and single electrodes via impedance spectroscopy and equivalent circuit modelling. Several studies will be introduced according to their impedance modelling approach. **The results of these studies will be compared later to the results obtained in this thesis in the corresponding discussion chapters.** Finally, this chapter concludes with a survey on the electrochemical analysis of commercially available lithium-ion cells.

Jörg Illig, "Physically based impedance modelling of lithium-ion cells," Dept. of Electrical Engineering, Karlsruhe Institute of Technology, Germany, 2014, Available at < https://books.google.com/books?isbn=3731502461 >

(2) CHAPTER AND SECTION PREVIEWS

Sentences 5-6 in Figure 1.1 provide a roadmap or what we will refer to as a **chapter preview**. This previewing of content is a typical feature of academic writing and can occur at the beginning of both *chapters* and *sections* in theses, research papers and technical reports. Chapter previews have a 'metatextual' function (i.e., they *describe* or *comment* on the text). **Metatext** not only helps the writer to draw the reader's attention to the structure of the text but also makes the information in the text more easily accessible to the reader.

PASSIVE VERB:

    In **this chapter**, a broad overview of the mobile networks **is introduced** together with a **discussion** of media processing in these networks.

ACTIVE VERB:

    This chapter presents a broad overview of the mobile networks **and discusses** media processing in these networks.

Figure 1.2 Typical chapter previews

As can be seen in Figure 1.2, chapter and section previews use the **present tense** and can be written using both active and passive verbs. However, the preferred strategy is to use the **active form** and an **inanimate agent** (e.g., *this chapter* or *Chapter 2*), since *parts of your document* act as default subjects that are always topical.

In contrast, using passive verbs requires that you take the extra effort to link the **subject** back to information mentioned previously in order to **stay on topic** and maintain the flow of **given and new** information. Moreover, the passive verb can lead to two other problems (Fig. 1.3):

TOP-HEAVY SENTENCE (Bad!):

    A broad overview of the mobile networks with a discussion of media processing in these networks **is presented** in **this chapter**.

END VERB (WORST!):

    In this chapter, a broad overview of the mobile networks with a discussion of media processing in these networks **is presented**.

ACTIVE VERB (BEST!!)

    This chapter presents a broad overview of the mobile networks **and discusses** media processing in these networks.

Figure 1.3 Two problems commonly encountered when using passive verbs and their solution using an active verb.

Common verbs used in Chapter / Section Previews

A quick-and-dirty analysis using **Google Scholar** < http://scholar.google.fi > revealed the following twenty-one verbs to be commonly used in **IEEE Journals** to describe the purpose of Chapter/ Sections in **previewing metatext**. The verbs are arranged in <u>descending</u> order of frequency of occurrence ("hits"). The frequency of each verb was obtained by searching with the "wildcard" search phrase **"section * VERB"**. For example, searching with the wildcard phrase **"section * PRESENTS"** yielded the highest frequency at 296,000 occurrences.

Chapter 2	**presents**	[296,000 hits]	**MOST COMMON**
This chapter	**describes**	[273,000 hits]	
Section 2.3	**reviews**	[205,000 hits]	
This section	**discusses**	[147,000 hits]	
The next section	**provides**	[113,000 hits]	
	introduces	[111, 000 hits]	
	summarizes	[37,100 hits]	
	explains	[26,900 hits]	
	proposes	[11,500 hits]	
	outlines	[11,500 its]	
	reports	[8,650 hits]	
	analyzes	[8,500 hits]	
	defines	[7,900 hits]	
	evaluates	[6,200 hits]	
	derives	[3,620 hits]	
	examines	[2,850 hits]	
	surveys	[1,930 hits]	
	explores	[1,770 hits]	
	validates	[1,050 hits]	
	verifies	[646 hits]	
	assesses	[326 hits]	**LESS COMMON**

Avoid the following verbs, since they only announce the **topic** area of the thesis, not the **purpose** or real **aim** of what your chapter intends to accomplish:

This chapter **contains**…

be about	contains	explore	have to do with	make clear
be related to	covers	focus on	investigate	research
clarify	deal with	find out about	involve	shed light on
concentrate on	delve into	go over	look at	study
consider	elucidate	handle	look into	

Common problems:

Each of the examples below suffers from either imprecision (i.e., the writer has not specified the location in the document) or has used the wrong term to describe a part of the thesis.

VAGUE	PRECISE
This chapter reviews the signal processing platforms used in the network elements. **First,** a generic overview of a processor IS INTRODUCED by observing the common features that all the processors share. **Second,** both the DSP and GPP ARE INTRODUCED in more detail, after which they are compared in terms of performance. **Third,** the compilation of the source code to machine language IS DISCUSSED, as it affects the performance of an application. **Finally,** the concept of a virtual machine IS REVIEWED, as it introduces certain differences compared to the native processing on the same hardware.	This chapter reviews the signal processing platforms used in the network elements. **Section 4.1 PROVIDES** a generic overview of a processor by identifying the common features shared by all processors. **Sections 4.2 and 4.3 DESCRIBE** in more detail DSP and GPP, after which their performance **IS COMPARED** in **Section 4.4**. **Section 4.5** DISCUSSES the compilation of the source code to machine language, as this affects the performance of an application. **Finally, Section 4.6 REVIEWS** the concept of a virtual machine, as it introduces certain differences compared to the native processing on the same hardware.
Chapter 3 This chapter DESCRIBES the methods used in this thesis. **The chapter is divided into two parts: the first part** DESCRIBES the methods used in the ship design process, concept evaluation and the synthesis model. **The second part** DISCUSSES weight estimation, cost calculation, and other criteria used to assess the concepts.	**Chapter 3** This chapter PRESENTS the methods used in this thesis. **Sections 3.1, 3.2 and 3.3 DESCRIBE** the methods used in the ship design process, concept evaluation and the synthesis model. **Sections 3.4, 3.5 and 3.6 DISCUSS** weight estimation, cost calculation, and other criteria used to assess the concepts.
Chapter 5 **This chapter EXTENDS** the results for the **probability of success** to a probabilistic graphical model using the AgenaRisk software DISCUSSED earlier in **the methodology chapter**.	**Chapter 5** **This chapter EXTENDS** the results for the probability of success**, DESCRIBED in Chapter 4,** to a probabilistic graphical model using the AgenaRisk software DISCUSSED earlier in **Chapter 3**.
4.5.2 Finnish Market This **subchapter** PRESENTS two scenarios concerning the Finnish market. These scenarios can reveal insights into the model when applied to the Finnish market…	**4.5.2 Finnish Market** This **section** PRESENTS two scenarios concerning the Finnish market. These scenarios can reveal insights into the model when applied to the Finnish market…

RESTATE-FORECAST

Metatext can also clarify links between different ideas. For example, later sections or chapters in the report can provide a **logical 'bridge'** between chapters/ sections by first **restating** the previous topic and explaining its relevance to the next topic, and then next previewing the next section. The more difficult or complex the text is, the more important it is that writers provide readers with this 'assistance.' Examples of this bridging metatext would include

> [1]**The previous chapter DESCRIBED** the basic properties, applications, up-to-date distribution and storage techniques of hydrogen, as well as the classification of raw materials for the production of bio-hydrogen gas. [2]**This chapter PRESENTS** an overview of hydrogen production technologies from biomass.
>
> [1]**As DESCRIBED in the previous section,** bio-photolysis is associated with the plant-type photosynthesis process, occurring among cyanobacteria that use light to split water for hydrogen production under anaerobic conditions. [2]**This section PRESENTS** the mechanisms underlying bio-photolysis to produce hydrogen.

CHAPTER SUMMARIES

Often, writers will choose to add an extra section, such as **"discussion"** or **"summary"**, to the end of thesis chapters. This is a good reader-friendly strategy that your thesis supervisor will find hard to resist, as it makes his job easier and shows that you really do understand your topic. Unlike chapter previews that rely on either the present or future tense, chapter summaries can use both the **past** and the **present perfect** tenses:

Past tense	This chapter examin**ed**…
Present perfect tense	This chapter **has** examin**ed**…

In the case of a **theory/literature review chapter**, chapter summaries also offer you an opportunity to demonstrate what you learned by presenting the main conclusions that should be drawn based on your review. In your chapter summary, you should aim to answer questions such as the following:

1. **What new information did you find out?**

2. **How will knowing this information contribute to the solution proposed in your thesis?**

3. **How could this information be used or applied to your own thesis? To the next chapter?**

4. **What does your review indicate should be the next step?**

5. **What is missing or unclear from current research/solutions?**

Samu Toimela, "Containerization of telco cloud applications [Online]," M.S. thesis, School of Elect. Eng., Aalto Univ., Espoo, Finland, 2017. Available: https://aaltodoc.aalto.fi/bitstream/handle/123456789/26710/master_Toimela_Samu_2017.pdf

2 Mobile network infrastructure

Mobile networks are a necessity in the modern world where everything is connected. **Because of increasing the number of devices and amount of mobile data traffic,** mobile networks have had to evolve. **This chapter presents** the structure of radio access network **and discusses** its evolution. The requirements and properties of radio access networks **are also presented**.

2.1 Radio access network

Radio access networks (RAN) consist of…

2.3 Summary

Radio access network **consists of** base stations and their controllers. The evolution of the radio access network technologies **has led to** a separation of remote radio heads and baseband units. Because of this, BBUs can be clustered into centralized locations to make their management easier. Clustering has also enabled the possibility to virtualize BBUs to improve computing resource utilization. Radio access networks have very tight requirements for example for latency and high availability. Also, because of the varying traffic patterns of the mobile networks, the network should be scalable. This means that computing resources can be allocated to each cell based on their utilization.

3 Containers and virtualization

Virtualization technologies have been around for over 50 years [8]. The term "virtualization" was first used by IBM when they researched efficient time sharing methods for hardware resource usage. Virtualization became popular again…

This chapter focuses on virtualization and mostly discusses operating system-level virtualization and containers. **First,** hypervisor-based virtualization and its main properties **are explained**. **Then,** operating system-level virtualization **is discussed** and underlying technologies enabling it **are presented**. **After that,** a comparison of 9 hypervisor-based virtualization and operating system-based virtualization **is discussed**. **Finally,** a few popular container managers **are introduced**.

3.1 Hypervisor-based virtualization

Hypervisor allows multiple virtual machines…

3.5 Summary

In this chapter, two different virtualization methods, hypervisor-based virtualization and operating system-level virtualization, **were introduced and compared.** Both of these methods are used to optimize the computing resource usage by running multiple instances on a same physical computer. From an application point-of-view, hypervisor-based virtual machines and operating system-level virtual instances act similarly. Major differences are that the hypervisor-based virtualization causes some overhead, because it contains an additional operating system. Hypervisor-based virtualization also causes some performance loss in most of the operations. Operating system-level virtualization is more lightweight and its performance is almost native. On the other hand, operating system-level virtual instances, containers, can only run applications that are compatible with the host operating system. In comparison, traditional virtual machines can run almost any operating system. Also, in the operating system-level virtualization, the host kernel is shared between the virtual instances so the isolation is weaker. Multiple container managers have been developed to make the operation of containers easier. They offer simple tools for basic container operations, such as for creating and deleting containers. Docker is one of the most popular container managers.

4 Distributed container-based applications

Containers are usually used to manage a large, distributed application because of their flexibility and isolation. Because the overhead of additional operating systems does not exist in operating system-level virtualization, multiple containers can be deployed on a single node. As Docker documentation suggests [56], containers should only contain a small logical part of the application. Distributed applications can then consist of multiple small services, which are running in separate containers. System with multiple containers can be managed by using a container orchestrator, which centrally manages the containers. **This chapter explains** container orchestration **and presents** a few popular container orchestrators. **After this,** microservice-based architecture **is presented** and it **is compared to** the traditional monolithic architecture. Also, the advantages and the disadvantages of both the approaches **are explained**.

4.1 Container orchestration

A container is a relatively small unit in large…

4.3 Summary

This chapter focused on distributed applications that are utilizing containers. **To manage multiple containers efficiently,** a container orchestrator **is required**. A container orchestrator can centrally manage the containers across multiple hosts. Containers are most suitable for running small entities, such as microservices. Microservices are small independent services that perform a single function and communicate with each other using well-defined interfaces. Microservices can be also developed and deployed separately. Distributed applications can then consist of multiple microservices.

5 Running telco application in containers

To study the benefits and requirements of containers, a practical proof-of-concept **was conducted**. In the proof-of-concept, a generic telco application was used as an example, and the plan was to move the application functionality into containers. **In this chapter,** the practical implementation **is explained**. **First,** the example application and the containerization approach **are discussed**. **Then,** the process of moving the application services into containers **is presented**. **Finally,** the supporting platform services **are explained**.

5.1 Containerization approach

To study containers in practice, a generic telco application was used as…

5.5 Summary

This chapter discussed practical implementation of a telco application that was utilizing containers. **For this implementation,** Docker **was selected** as a container manager and Kubernetes was selected as a container orchestrator. The practical implementation **was based on** an existing telco application, which was modified to utilize containers. Functional parts of the application **were moved** into containers, which were running on top of the old virtual machines. **In addition,** a separate virtual machine **was deployed** to the stack and it contained a Kubernetes and Docker registry. Orchestrator **was used to** make management of multiple containers easier.

6 Evaluation

This chapter discusses the advantages and considerations related to telco application containerization. The practical implementation in the previous chapter is used as an example. First, the containerization advantages such as software update, performance and scaling are discussed. Then, general guidelines for container-based application design are presented, and container security is discussed. Finally, the future work is presented.

6.1 Software update

An update of a service is a slow and heavy process….

[No summary]