Individual projects at VUSec

This document applies to individual projects supervised by VUSec. In particular, it is about the following types of projects:

- BSc CS
  - Bachelor Project Computer Science (XB_40001, 15 EC)
- MSc CS
  - Literature Study (XM_0131, 6 EC)
  - Master Project Computer Science (XM_0011, 30 EC)
- MSc CSec
  - Industrial Internship (XM_405080, 6 EC)
  - Master Project Computer Security (XM_0123, 30 EC)
  - Research Project in Computer Security (XM_0125, 6 EC)
  - Large Research Project in Computer Security (XM_0126, 12 EC)

General information

Expectations

What do we expect from you?

Background knowledge/skills: VUSec's research interests and expertise include systems security, systems software, networked systems, and formal verification. As such, any VUSec project typically requires a deep understanding of computer systems. Only sign up for a VUSec project if you performed well in courses related to these topics:

- Examples in the bachelor include Operating Systems, Secure Programming, and Compiler Construction.
- Examples in the master include Software Security, Network Security, Verification for Security, Hardware Security, Binary and Malware Analysis, and Advanced Operating Systems.

We generally do not supervise projects where we lack the necessary expertise.

We do not have a list of possible topics as it changes too often. We prefer to tailor projects to the students doing them. However, to get a better idea of the types of projects we do, you can take a look at our list of projects and list of published papers.

If it turns out you lack the background knowledge/skills necessary for your project, we may decide to stop supervising your project.

Full-time commitment. As all our study programs are full-time, *we expect students to work on their projects (almost) full-time*. A small side job, such as a TA position, is

allowed. However, we do not supervise students who have an (almost) full-time job. It has been our consistent experience that such students make little progress, and their project will drag on for an unreasonable amount of time. If during the project, you take up such a job and it badly affects your progress or availability for meetings, ***we may decide to stop supervising your project***.

Regular contact. We expect you to actively stay in contact with us on a weekly basis. You should regularly attend the weekly meetings (currently Fridays 11:00-12:00, remotely on Zoom). In weeks where you cannot attend, you should still write a progress report in our student progress document. You should also meet with your daily supervisor on at least a biweekly basis. We also expect you to actively inform us if there are issues that hinder your progress, and to respond promptly if we contact you by email. If you do not stay in contact, we may decide to stop supervising your project.

Progress monitoring. We expect you to actively monitor your own progress. Let your daily supervisor know in case you are stuck, and also report this in the weekly progress meetings. Actively let us know if it seems you cannot complete your project in a reasonable amount of time, so we can discuss whether we need to adjust the project's goals. Do not change the scope of your project without discussing it with us first.

Time spent. Each EC corresponds to 28 hours of work, so every 6 EC corresponds to a month of full-time work. This means that in principle, if you work on it full-time, a literature study should take 1 month, a bachelor's thesis 2.5 months, and a master's thesis 5 months. We do not expect you to spend more time than this, but we do expect you to at least meet the minimum requirements for the type of project you do in the end. As such, just spending the time is not enough.

We find that in practice, students often use much more time. While we do not penalize students who run over time, we encourage you to consider whether the extra effort you spend actually benefits the final result (that is, the grade) enough to be worth it. This is typically not the case, especially for literature studies. Don't try to make it perfect if it means running out of time, but instead focus on at least meeting the minimum requirements within the available time first. The main exception is if you intend to publish your work eventually, then it may be worth the extra time investment.

What can you expect from us?

Daily supervision. You will be assigned a daily supervisor when your project starts. This is typically one of the VUSec PhD students, but can be a postdoc or faculty member. Your daily supervisor is available to meet on at least a biweekly basis, able to help if you encounter roadblocks, and available to provide feedback on your research proposal, thesis outline, and thesis draft.

Primary supervision. You will be assigned a primary supervisor when you hand in your final draft for feedback. The primary supervisor is typically a faculty member, but can be a postdoc for a bachelor's thesis. If your daily supervisor is allowed to be a primary supervisor, they will be your primary supervisor as well. Otherwise, we select a primary supervisor based on involvement in the project, expertise in the topic, and load balancing. The primary

supervisor decides the grade together with the second reader, who is typically picked when your presentation is scheduled. The second reader does not provide feedback on any drafts.

Feedback. Throughout your project, we provide feedback on three documents: your research proposal, your outline, and your draft. In each case, you get one round of feedback from your daily supervisor, then you revise the document, and then you get one round of feedback from your primary supervisor. In case your daily supervisor is also your primary supervisor, you get two rounds from the same person. Make sure you submit these documents in a good state to get the best use out of your feedback opportunities.

In terms of content:
- The research proposal indicates what research you will do and how. Provide intermediate steps and a tentative rough timeline for them. Carefully consider what needs to be done to execute your project and to evaluate it.
- The outline contains all sections and subsections in your paper, but rather than finalized text it includes short bullet lists in each (sub)section to indicate what you will write there. Use LaTeX and the thesis template (see below) to create your outline.
- The draft is a complete thesis, properly proofread and with no loose ends. Again, use LaTeX and the thesis template.

External projects. For internships, including both the Industrial Internship course and thesis projects that involve an internship, you will receive daily supervision from the organization you do the internship at. This typically means lighter supervision on our end, but do not hesitate to contact us if you need help.

Signing up

Steps to sign up for a VUSec project can be found here: https://www.vusec.net/student-projects/ . Please follow them carefully. We will contact you to discuss possible topics.

Writing an academic paper

We notice that some students struggle with academic writing, an important topic that in our opinion does not get the attention it deserves in the current curriculum. Writing readable texts is a critical skill that will help you both during your studies and afterwards, whether you continue in academia or start working in the industry. We highly recommend reading some resources on academic writing before and while writing your thesis and/or literature study. In particular, we wrote a checklist for writing a scientific paper, which is at. We highly recommend reading "The Elements of Style" by Strunk and White (also mentioned in the checklist), which is available online. This book provides very concrete and practically applicable advice that helps a beginning writer write readable texts.

Presentations

Giving a good presentation is an important skill. Please find below some advice we usually give students on this topic.

- Content
  - Aim for the right audience. Computer science students with no specific background in the topic should be able to understand it.
  - Your presentation is not a summary of the thesis/literature study. It rather highlights those parts that are most interesting for the audience. Parts that do not contribute for this purpose should be left out.
  - A teaser slide at the start to show what you did in less than one minute is often useful. This is not an overview/outline slide (which is not needed for a short presentation).
  - Early in the presentation, make clear why the topic is important, and why new research was needed.
  - Make sure the audience understands at least the core ideas behind what you did (your design). [note: not applicable for literature studies]
  - Show experimental results and explain their implications. [note: not applicable for literature studies]
- Timing
  - Stay within the time limit (not too many slides, practice timing)
- Making slides
  - Both each individual slide and the presentation as a whole should ideally convey a single clear message.
  - Examples make it easier to explain, especially a running example
  - 1 picture == 1000 words
- Consider accessibility
  - Not too much text on a slide (ideally no more than 6 top-level bullets)
  - Large font size (at least 20pt, preferably more)
  - Lots of contrast (even for color blind people)
  - Avoid transitions
  - Animations can be useful, but do not overdo it
- Layout
  - When using images, make sure the resolution is sufficient and there are no compression artifacts
  - If you use images with a different background color than your slides it can look very bad. Edit the image to have a transparent background (be sure to save with an image format that supports transparency, like PNG). If you have black-on-white diagrams and you use a black background, they can be color inverted.
  - Look whether your line breaks are in appropriate places. Don't break within words if you can avoid it, and try to avoid a situation where a single word is on a separate line. Soft line breaks can help.
  - When scaling images, preserve the aspect ratio. Stretched images look bad.
- Prepare for questions, the defense is part of the grading
- Add slide numbers to make asking questions easier.

- You can use notes, but use them very sparingly because you should keep eye contact with the audience. Powerpoint presenter mode can help (but does not work when presenting remotely).

In terms of timing:

- The total time slot is always 30 minutes, including both your presentation and questions asked by the audience.
- The presentation itself should be 20 minutes for a master thesis.
- The presentation itself should be 15 minutes for any other type of project.

In principle, presentations are given on-campus. If there are compelling reasons to do so, presentations may be given remotely, over Zoom. Presentations are public, and we encourage students to invite friends, family, and fellow students.

Template

We strongly recommend writing your reports in LaTeX, as otherwise it would be very hard to get the layout and bibliography right. If you want to use another tool to write your literature study, discuss it with us first. We will probably convince you not to do it.

Assuming you use LaTeX (and you should), use the [Latex template](#) on the Master Computer Security Canvas page for your report. Use the \thtype command to set the correct type. Note: using this template is mandatory for the Master Project Computer Security, as it includes an Artifact Evaluation template the thesis must use to document any research artifacts produced as part of the implementation and experimental evaluation (see also study guide).

Contacting us

You may reach us at the e-mail address faculty@vusec.net; emails to this address will be received by all VUSec faculty members.

Many students are struggling with isolation, finding a good work environment, and mental health during these coronavirus times. These issues are common and nothing to be ashamed of. It is important to address them quickly, however, as they might otherwise end up costing you a lot of time. If you struggle with any such issues, please contact us and/or your student advisor (for MSc students at the VU, please reach out to n.silvis-cividjian@vu.nl).

Thesis-specific information

Thesis grading

Requirements to pass

Each of the following are necessary conditions for your thesis to receive a sufficient grade:
- Your project work must be research. Project topics always require the permission, and you can safely assume that if we give our permission to your research proposal and you follow that proposal, that this criterion is met.
- Your thesis must make clear why your work is relevant and what it contributes. This is typically part of the Introduction section.
- Your thesis must include a description of the state-of-the-art of research related to your project. If there is very little directly related work, you need to extend the scope of this discussion so as to cover a significant number of papers. This is typically part of the Related Work section.
- Your thesis must provide a self-contained description of the work you did. This is typically part of the Design section.
- Your thesis must include a methodologically sound evaluation of all main characteristics of the work you did, especially with regards to your contributions. This is typically part of the Evaluation section.
- Your thesis must include a proper bibliography, contain literature references where needed, and be completely free of plagiarism.
- It must be clear from the thesis that the amount of work you did matches the number of ECs you receive for the thesis. In case you spent a lot of time on work that was not used in the end, you should still describe it to ensure this is clear.
- The thesis must be written in understandable and correct academic English.
- The work must be publicly orally presented, and this presentation must receive a sufficient grade.

How to get a good grade

To get a good grade (8.0 and higher), it helps to do the following:
- Bring a highly challenging/technically advanced project to a successful end.
- Show independence and initiative in solving the problems you encounter along the way. Note that independence does not mean not interacting with your supervisors or not asking for help, but rather being proactive in identifying problems and finding solutions while executing your project.
- Carefully address the feedback you get from your supervisors.
- Provide a convincing introduction that provides compelling arguments to the reader why the work is interesting/relevant/timely, and explains how it advances the state of the art, without being overly long.
- Provide a related work section that clearly and meaningfully compares your work against the state-of-the-art, highlighting similarities and differences and briefly explaining their significance. Avoid details that are not relevant to your work's position in the state-of-the-art.

- Provide well-structured overview and design sections that clearly explain the work you did, the choices you made, and why you made them.
- Provide an extensive in-depth evaluation, showing not just the core characerics of your approach as you measured them, but also providing in-depth understanding why the results are this way.
- Carefully design diagrams, tables, and figures in such a way that they make it as easy as possible for the reader to understand the core message.
- Carefully discuss the outcomes of your work, showing that you understand the limitations and their impact, ways in which those limitations can be addressed and/or reasons why those limitations may be fundamental.
- Use a writing style and paper structure that's pleasant to read, easy to understand, and succinct. Avoid unnecessary and irrelevant details.
- Give a good presentation (see elsewhere in this document).
- Ensure that your work is in such a state that it would potentially be publishable in a peer-reviewed academic conference. If this is your aim, discuss it with us when picking your topic, so that we can consider whether the topic is potentially publishable. This is particularly relevant if you aim to do a PhD or to get cum laude. We generally expect a thesis to be publication-worthy to be able to get a grade of 9.0 or higher, especially for a master's thesis. Note that a negative result would typically make a paper hard to publish, but we do not hold this against you for grading.

Non-requirements

There are some factors that students often think affect the grade, but that do not in fact (directly) affect the grade:
- If the scope has to be limited compared to the original plan because the project cannot be completed in time due to unforeseen research/technical challenges, this will not affect your grade. If it turns out that there are unexpected problems beyond your control that would make the original project unreasonable to do for the given amount of EC, feel free to discuss with us whether the scope can be reduced.
- If the research ends up with a negative result, this does not affect your grade. This risk is par for the course with research projects. However, it is still important to carefully evaluate your work. If you have nothing to evaluate (that is, your code is entirely broken), discuss ways to address this with us as soon as possible.
- The length of the thesis does not in itself affect the grade. A short thesis is allowed if it fulfills all criteria otherwise, and a long thesis is allowed if the content is not unnecessary/irrelevant/redundant. That said, practice shows that very short theses are often incomplete, and very long ones often contain unnecessary content. In these cases, that would negatively affect your grade.
- The work does not need to be novel. It is possible to get a good grade for a reproduction study if it is done well. In practice, such projects tend to still provide new insights.
- The work does not need to contain a large implementation component. It is possible to get a good grade for an experimental study if it is done well. In practice, this means the implementation effort is replaced by doing more effort on data collection and/or evaluation.
- Spending a lot of extra time on a project is not in itself rewarded, and not recommended. Typically the reward in terms of grade is not worth it compared to the

impact of the extra months you use. Obviously however if you need just a bit more time to get concrete improvements on the criteria listed for a high grade, that may be worth it.
- We will make an effort to ensure that personal circumstances beyond your control will not affect your grade. However, please report them to us and/or your study advisor as soon as possible to make sure we can do that.

Document structure

The structure of a thesis is largely similar to that of a published academic paper. This typically yields the following sections:
- **Abstract** - the shortest possible summary of the entire paper, typically taking about half a column in a two-column layout. Often, it contains one or two sentences for each section.
- **Introduction** - explain the relevance of the topic area, describe the problem the research intends to solve, and specify the scope and research question. Specifically list your contributions in a bullet list.
- **Background** - explain the background knowledge that a typical reader would need to understand the paper, but that is not part of the thesis itself. This section is optional, but in practice needed for almost all topics. Keep it as short as possible, and add only information that is required to understand the paper.
- **Related work** - discuss the state-of-the-art in relationship with your work and compare them. The instructions to do a literature study are also helpful in writing your related work section.
- **Overview** - a high-level overview of the system you built/approach you used. Show the components/steps in your system/approach using a diagram and briefly explain them. Also explain how the system can be used.
- **Design** - show how your approach works by explaining the design decisions you made. Subsections typically correspond to components/steps described in the overview. Your paper should provide a self-contained description even if you build on other work (but of course properly acknowledge this using references).
- **Implementation** - describe implementation choices you made (for example: which software/hardware do you build on) and implementation difficulties you faced to the extent that they might be interesting to the reader. The implementation section is optional, and typically/ideally short.
- **Evaluation** - evaluate the system you built on all relevant dimensions, such as effectiveness/security, performance (overhead), memory consumption (overhead), and false positives/negatives. Your benchmarks should be able to determine whether your contributions were indeed reached, and what trade-offs are involved. Be sure to use appropriate benchmarks (see our Benchmarking Crimes paper: https://arxiv.org/abs/1801.02381), and ideally run at least those benchmarks that are used in similar work.
- **Discussion** - here you contemplate on the results of your thesis, including in particular a careful consideration of potential limitations.
- **Conclusion** - this is a short section reiterating your main points and answering the research question. It provides no new information.

- **Bibliography** - automatically generated by LaTeX/BibTeX. Be sure to make the information you provide to BibTeX consistent, as Google Scholar exports are often messy. Always include the name of the conference in both the short ("CCS'20") and long form ("Proceedings of the 2020 ACM SIGSAC Conference on Computer and Communications Security. 2020"). Provide URLs only when necessary, so not for conference or journal publications. Ensure that each entry provides enough information to find the correct version of the publication online. Check the PDF for weird formatting issues after compiling the document.
- **Artifact Appendix** - CSec Master only, see instructions in the Latex template.
- **Additional thesis writing guidelines**. See:
  https://download.vusec.net/resources/thesis/guidelines/thesis-guide.pdf

Literature study-specific information

Topics

Students can come up with their own topic (assuming it fits our expertise), or we will suggest possible topics in a discussion with the student. We recommend picking a topic that is closely related to your intended M.Sc. thesis, as it will prepare you for the project and also help you with writing the "related work" section of your thesis.

Our expertise in VUSec is in systems security, including, for example, attacks and defenses against software and hardware vulnerabilities, fuzzing, reverse engineering, operating system security, embedded systems security, network security, and programming language security (including formal methods). We do not have much expertise on non-systems security topics, such as cryptography, machine learning, software engineering, or enterprise security. We would, however, be happy to supervise a literature study in our core areas as long as it has some overlap with our areas of expertise. In addition to systems security, we sometimes also supervise systems-related projects with *no security dimension*, on topics such as operating systems, networks, and compilers.

We do not have a list of possible topics as it changes too often. We prefer to tailor projects to the students doing them. However, to get a better idea of the types of projects we do, you can take a look at our list of projects and list of published papers.

Requirements

We have the following expectations of a literature study:
- The paper provides a systematic overview of the state-of-the-art within a particular well-defined topic area.
- We have no lower or upper bound on the number of pages. We suggest instead the following guideline: "Write as little as possible while still providing all the information you need to provide, but not less."
- A typical number of papers to cite in a literature study is around 20. If you are unable to find more than 10 relevant papers, it is typically an indication that you need to widen your scope.
- The literature study discusses papers in a systematic way, categorizing them in a sensible way and comparing them in terms of approaches, benefits and drawbacks, and advances over the state-of-the-art. You should not delve too deeply into individual papers. For example, you should omit implementation details that are irrelevant for the comparison. *A literature study should not be just a list of summaries of papers.*
- The paper is written in readable and correct academic English. Be sure to follow our guidelines on academic writing.
- The bibliography is complete and properly formatted.

In addition, you are required to give a presentation about the topic. The presentation lasts for 15 minutes (no longer!) and should include your main results. Note that you need *not* cover everything, and typically it would not be possible to do that well within the time slot. Please find more advice on how to give a presentation above.

The presentation is followed by approximately 15 minutes of answering questions from the audience. Both the presentation and the Q&A influence your grade.

Steps

Many students feel a bit lost in the process of writing a literature study. It helps to have a good idea of what needs to be done, and in what order to do it. The order described in this section is not strict, but you might find it generally good to follow for an efficient literature study writing process.

Getting started

The first goal is to find a topic and, within this topic, set the scope. This goal involves going through the available literature, but that can be very shallow at this point.
- Register with VUSec for doing your literature study (and probably also MSc thesis) by following the instructions at the top of our [page on student projects](#).
- We will contact you to schedule a meeting to pick a topic together. Please note in busy periods this might take some time, so please register well before the moment you need to start working on the project. While waiting, it might be a good idea to look around for interesting topics (see the Topics section).
- After picking the topic, start with gathering papers (see the section on this topic). Keep track of them in a spreadsheet where you can add additional information as your project progresses.
- If you find too many papers to reasonably work with (for example, you found over 50 papers and your list is not complete yet), narrow the scope of your topic. Feel free to consult us if you are unsure what would be a good way to do this.
- If you could not find enough papers to write a literature study on (at least about 30 should be expected), expand the scope of your topic and then find additional papers in your new scope. Feel free to consult us if you are unsure what would be a good way to do this.
- Formulate a research question that clearly sets the topic and delimits the scope.

Structuring your literature study

The next step is to go through the literature more carefully to determine the structure of your literature study.
- Now start skimming through the papers, looking only at the most important parts to get an idea of the different approaches, different techniques, different threat models, and so on. Keep track of them in your list. There is no need to read the paper fully at this point: skim through them and identify the key factors that distinguish each paper from the others.
- Based on the results, choose the main dimension(s) along which you will categorize the papers. Feel free to consult us on whether those are suitable criteria.

- Write an outline and send it to us for feedback. The outline contains the high-level structure (sections and subsections) and bullet lists to indicate which points you will be making where. Do not write any full paragraphs yet.

Wrapping up

In the final part, you read the papers thoroughly to be able to compare them within each category, and you do the main part of the writing and presentation.
- Now read the papers more carefully to find the relationships between individual papers for each category.
- Based on your reading of the papers, and our feedback on your outline, prepare a full draft of your literature study, proofread it, and send it to us for feedback. Be sure to read our advice on academic writing. Incorporate our feedback and send us the final version. Not that there is only a single round of feedback+revisions, so this final version will be graded.
- While waiting for feedback on your draft, start working on your presentation. Be sure to read our advice on presenting. Send your draft slides to us a few days before the presentation for feedback.

Timeline

The course is worth **6 ECTS**, which corresponds to **168 hours** or about one month of full-time work. It should be viable to deliver a high-quality literature study within this time span. To achieve this, we recommend the following time path:
- Day 0: This is the day you decide on your topic and can start working on your literature study.
- Day 0-6: You make a list of relevant literature without reading it, and use this to determine an appropriate scope and research question.
- Day 7: In the weekly meeting, we discuss your proposed scope and decide whether this is a suitable way to do your literature study.
- Day 7-13: You read the literature more extensively to find an appropriate categorization, which you use to write an outline.
- Day 13: you hand in your outline for our feedback.
- Day 14-25: You read the papers in-depth, while extending your outline to a full draft text. When you get our draft feedback, you adjust the paper to take it into consideration.
- Day 25: You hand in your draft literature study for our feedback.
- Day 26-27: You work on your presentation slides.
- Day 27: You hand in your presentation slides for our feedback.
- Day 28: In the weekly meeting, we schedule your presentation.
- At this point, most of the work is done, and you need to wait for our feedback. This would be a good time to start working on your master thesis.
- On the scheduled presentation day, You present your work.
- After you receive our draft feedback, You fix your draft and hand in the final version.

Which papers to include?

The literature study does not need to include every paper ever written on a particular topic, but should cover all papers that constitute the state-of-the-art. This guideline means that it should include recent papers as well as papers that have had a large impact on the field. One possible indicator of impact is the number of citations, though it should be noted that newer papers typically have very few citations, and that a large number of citations does not automatically mean it is a good paper that others are building on. Seminal papers have such high impact that they should be included even if they are now old, and their designs superseded by newer work. Papers published in top conferences are almost always considered impactful, and typically a literature study should include a number of such top publications.

In our areas of expertise, we generally prefer conference publications over journal publications, but both might be part of the state-of-the-art. You may also include workshop papers, technical reports, whitepapers, or Arxiv preprints. However, keep in mind these publications are only lightly reviewed or not peer reviewed at all, and only include those that are especially relevant.

The most impactful papers are typically (but not always) published in top conferences:
- Top conferences in the area of security (not specific to systems) are IEEE Security&Privacy, ACM CCS, NDSS, and USENIX Security. Other conferences include EuroS&P, ACSAC, RAID, and DIMVA, and interesting workshops include EuroSec and WOOT.
- Top systems conferences (not specific to security) include SOSP, OSDI, USENIX ATC, ASPLOS, and EuroSys.
- Top conferences specific to networking are SIGCOMM, NSDI, IMC, WWW, and HotNets. Other good conferences or workshops include CoNEXT, PAM, TMA, SOSR, SoCC, HotCloud, and the journal IEEE ToN.
- Top conferences specific to programming languages are POPL and PLDI. Other good conferences in this area include CAV, OOPSLA, and ICFP.
- The top conference in dependability research is DSN.

Gathering papers

After picking a topic, we typically provide one or more "seed" papers. Additionally, you can search for papers by keyword on Google Scholar. However, searching by keyword typically gives many irrelevant results, and it is hard to find all relevant papers in this manner. Instead, use the seed papers and papers found using keyword as a starting point, and proceed as follows:
- Look for better/additional keywords in the papers you found.
- Look for papers cited by the papers you found, especially those referenced in the "Related Work" section. This helps you find related papers that are older.
- Look up the papers you found in Google Scholar, and use the "cited by" feature to find related papers that are newer.

Obviously you can also apply these same techniques to the additional papers you find, rapidly expanding the scope of the search to cover (hopefully) all relevant papers.

Note that this approach often yields so many results that you cannot check them all. Look at the title and abstract to determine whether the papers are sufficiently relevant. Additionally, prioritize papers that are in top conferences, have many citations, and/or have been published recently.

Our guidelines here are inspired by the "three-pass approach" from "[How to Read a Paper](#)" by Srinivasan Keshav.

Document structure

The structure of a literature study is largely similar to that of an academic paper or thesis, except that it typically lacks the sections about related work and evaluation. You use the section(s) that typically describe your approach to describe the available literature in a systematic way. This typically yields the following sections:

- **Abstract** - the shortest possible summary of the entire paper, typically taking about half a column in a two-column layout. Often, it contains one or two sentences for each section.
- **Introduction** - explain the relevance of the topic area, describe the problem the research intends to solve, and specify the scope and research question. It is typically a good idea to introduce the categories you identified in this section.
- **Background** - explain the background knowledge that a typical reader would need to understand the paper, but that is not part of the literature study itself. This section is optional, but in practice needed for almost all topics. Keep it as short as possible, and add only information that is required to understand the paper.
- **Content** - typically the main content consists of several sections, for example one for each category that you identified. Make sure that you present a systematic comparison, not just a list of paper summaries.
- **Discussion** - here you contemplate on the results of your literature study, for example: which are the most promising approaches, which are threat models are covered by the work you discussed, and what are promising directions for the future? If possible, it could be nice to have a table comparing the work on important dimensions (think for example of performance overhead, thread models, false negatives/positives, and so on).
- **Conclusion** - this is a short section reiterating your main points and answering the research question. It provides no new information.
- **Bibliography** - automatically generated by LaTeX/BibTeX. Be sure to make the information you provide to BibTeX consistent, as Google Scholar exports are often messy. Always include the name of the conference in both the short ("CCS'20") and long form ("Proceedings of the 2020 ACM SIGSAC Conference on Computer and Communications Security. 2020"). Provide URLs only when necessary, so not for conference or journal publications. Ensure that each entry provides enough information to find the correct version of the publication online. Check the PDF for weird formatting issues after compiling the document.

Examples

To get some idea of what a good literature study looks like, we have made available some recent examples:

- [Automated Firmware Re-hosting for Security Analysis](#)
- [Determining Patch Correctness Through Testing and Verification](#)
- [Flawless by Design: On Proving Code Correct](#)

Another good example of a literature study done at VUSec is [Memory Errors: The Past, the Present, and the Future](#). In fact, it was so good that it ended up getting published at the security conference Research in Attacks, Intrusions, and Defenses (RAID) in 2012.