Initial Plan

Title – Private Browsing Forensics

Investigating if Private Browsing on the Web is truly Private

Cardiff University
School of Computer Science and Informatics

CM3203 – One Semester Individual Project – 40 Credits
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Project Description:

The aim of this Project is to investigate if Private Browsing on the web is truly Private. I will be conducting a thorough Investigation across each of the 4 major web browsers; Internet Explorer, Safari, Google Chrome and Mozilla Firefox to uncover any left-over data/information after a Private Browsing session highlighting that Private Browsing on the web is not truly Private.

The WorldWideWeb was first invented in 1989 by Sir Tim Berners Lee "to enable the sharing of knowledge by complex distributed teams" [1]. Shortly afterwards he created the first web client and server in 1990, allowing web pages to be displayed for the first time. This invention paved the way for innovative software companies like Netscape and Microsoft to debut their own Web Browsers known as Netscape Navigator and Internet Explorer in the 1990s [2]. From then onwards both companies competed however Microsoft at its peak was able to gain over 95% market share when they bundled Internet Explorer with their Windows operating system [3].

In the early 2000s Apple released their own web browser Safari in 2003 [4] and just shortly afterwards Netscape became Mozilla and launched Firefox in 2004. Firefox gained 28% market share by 2011, but despite Safari only being used on Apple devices it is still one of the most popular web browsers. In the late 2000s Google released its own web browser Chrome in 2008 [5] which took complete market share from Internet Explorer in 2012 and is still to this day the most widely used web browser across all platforms [6].

Private Browsing is an added privacy feature first introduced into Safari web browser in May 2005 to prevent any traces of browsing history being left on a user's computer for anyone else to examine when in private mode and also useful when "users may want to hide their identity from web sites they visit" [7]. The 4 Privacy Modes I will be investigating in this project are 'InPrivate Browsing' in Internet Explorer, 'Private Browsing' in Safari, 'Incognito' in Google Chrome, and 'Private Browsing' in Mozilla Firefox.

I will use a Virtual Machine to create a Snapshot for each Windows O/S based web browser and then use a Mac O/S for Safari web browser taking a forensic image and memory dump of each browsing session and outputting the result to an external drive. Using appropriate Forensic Toolkits for each image/memory dump I will be examining the data/information captured from the browsing session and come to a conclusion as to whether or not private browsing on a particular web browser is truly private.

Aims and Objectives:

1) **Understand how Private Browsing works across each web browser**
   - ❖ Research will be conducted to get an understanding of how private browsing mode works for Internet Explorer, Safari, Google Chrome and Mozilla Firefox keeping detailed notes on any relevant literature.
2) **To discover what data/information is stored on a local machine after private browsing.**
   - ❖ This will be achieved by creating a forensic image of each browsing session across the 4 web browsers and then analyzing the images using a forensic toolkit, recovering any data/information stored by the web browser highlighting whether or not private browsing is truly private.
3) **Determine which web browser is truly the most private.**
   - ❖ After Investigating each web browser and discovering how much data/information is stored about your browsing session whilst in private mode, I will determine which one out of the 4 web browsers is truly the most private.
4) **Be able to analyze the data/information effectively using a Forensic Toolkit.**
   - ❖ This will be achieved by gaining a deeper understanding of how to use a Forensic Toolkit platform to uncover data/information stored by a web browser when in private mode.

Project Constraints:

The main constraint to this project is the time limit and ensuring the project follows the work plan. It is also important to stay focused and complete all aims and objectives on time and stick to the original project idea instead of deviating and researching other possibilities that might not be completely relevant to the project in order to discover which web browser is truly the most private.

Project Deliverables:

At the end of this project the predicted outcome is to have a conclusive set of results and in-depth evaluation of the investigation, analyzing the data/information that is stored by the web browser when in private mode. Consequently, a section of the report will outline the methods used during the investigation to locate the evidence, with a critical discussion at the end. Any problems encountered during this project will be reflected on alongside any future work that could be researched in more depth in the future.

Ethical Considerations:

I have discussed ethical considerations with my supervisor Michael Daley and we both agreed that this project will only be using my own web browsing behavior and does not need to involve any other human participation e.g. interviews, observations, questionnaires or personal data to be stored and also doesn't require any collaboration with another school at Cardiff University. Therefore, there are no privacy concerns that would require this project to seek ethical approval from the department.

Work Plan:

Week 1: 28/1/19 – 3/2/19:

- ❖ Have a meeting with supervisor to discuss initial plan
- ❖ Work on Initial Plan
    - o Project Description
    - o Project Aims & Objectives
    - o Create a Work Plan & Gantt Chart
- ❖ Conduct background research
    - o Use Google Scholar to find relevant research papers/journals and books.
    - o Keeping Notes on Relevant Literature
    - o Get an overview/understanding of the problem
- ❖ Deliverable: Initial Plan Due 3/2/19

Week 2: 4/2/19 – 10/2/19:

- ❖ Have a supervisor meeting to discuss my approach to solve the problem
- ❖ Research required tools to use for investigation
    - o Forensic Toolkit FTK/Redline/Macquisition
    - o Google Chrome
    - o Internet Explorer
    - o Safari
    - o Mozilla Firefox
- ❖ Setup and install required tools
- ❖ Conduct further background research
    - o Summarizing research in own words and including reference

Week 3: 11/2/19 – 17/2/19:

- ❖ Meet first project milestone: complete background and investigation research
- ❖ Have a supervisor meeting to discuss first milestone
- ❖ Structure final report
    - o Following general guidance from PATS
- ❖ Start to write up Introduction for dissertation
    - o Using research found in Weeks 1 & 2
    - o Aims/Goals of the project
    - o Intended audience
    - o Scope of the project

Week 4: 18/2/19 – 24/2/19:

- ❖ Meet second project milestone: complete introduction to dissertation
- ❖ Have a supervisor meeting to discuss introduction
- ❖ Start to write up background for dissertation

- o Include all relevant information that the reader needs to know to fully understand and appreciate the rest of the report.
  - ▪ Wider context of the project
- ❖ Create an image for each browsing session/browser in preparation for the investigation

Week 5: 25/2/19 – 3/3/19:

- ❖ Continue write up of background for dissertation
  - o Methods and tools that the solution will be based on
  - o Research questions reflecting on the aims of the project
- ❖ Review Gantt Chart and make any adjustments if needed

Week 6: 4/3/19 – 10/3/19:

- ❖ Meet third project milestone: complete background for dissertation
- ❖ Have a supervisor meeting to discuss background
- ❖ Start to write up specification & design for dissertation
  - o Including in-depth details of my Approach
    - ▪ Equipment used to carry out Investigation

Week 7: 11/3/19 – 17/3/19:

- ❖ Meet fourth project milestone: complete specification & design for dissertation
- ❖ Have a supervisor meeting to discuss specification and design
- ❖ Conduct the Investigation using appropriate forensic toolkit software
- ❖ Start to write up Implementation for dissertation
  - o Including any Constraints/Methods used

Week 8: 18/3/19 – 24/3/19:

- ❖ Have a supervisor meeting to discuss the Investigation Results
- ❖ Start to write up Results and Evaluation for dissertation
  - o Step by step methodology
  - o Expected results
  - o Actual results
    - ▪ Critically analyzing the results and outcomes of the project based on previous research
    - ▪ Describe to what extent I achieved the original goals
    - ▪ Including any key evidence e.g. screenshots

Week 9: 25/3/19 – 31/3/19:

- ❖ Meet fifth project milestone: complete Implementation/results and evaluation for dissertation

- ❖ Have a supervisor meeting to discuss fifth project milestone
- ❖ Review Gantt Chart and make any adjustments if needed

Week 10: 1/4/19 – 7/4/19:

- ❖ Start to write up of conclusion for dissertation
  - ○ Summary of the aims of the project and a restatement of its main results
    - ▪ What has been learnt?
    - ▪ What has it achieved?

Week 11: 8/4/19 – 14/4/19:

- ❖ Meet sixth project milestone: complete conclusion for dissertation
- ❖ Have a supervisor meeting to discuss conclusion
- ❖ Start write up of Future Work and Reflection for dissertation
  - ○ State what you would do in the future if you had more time
    - ▪ Provide a starting point for someone else to continue the work which I have begun
  - ○ Reflect on your learning throughout the project
- ❖ Include all references related to the written report in the references section of the dissertation
  - ○ Following a set guideline's defined on PATS

Easter Week 1: 15/4/19 – 21/4/19:

- ❖ Meet seventh project milestone: Completion of all write up for dissertation
  - ○ Format and proof-read dissertation
  - ○ Review all chapters of dissertation
    - ▪ Implementing the final structure across the entire written report
    - ▪ Ensure all chapters are in order and include all relevant information
- ❖ Review Gantt Chart and make any adjustments if needed

Easter Week 2: 22/4/19 – 28/4/19:

- ❖ Continue to proof-read dissertation and make any additional changes
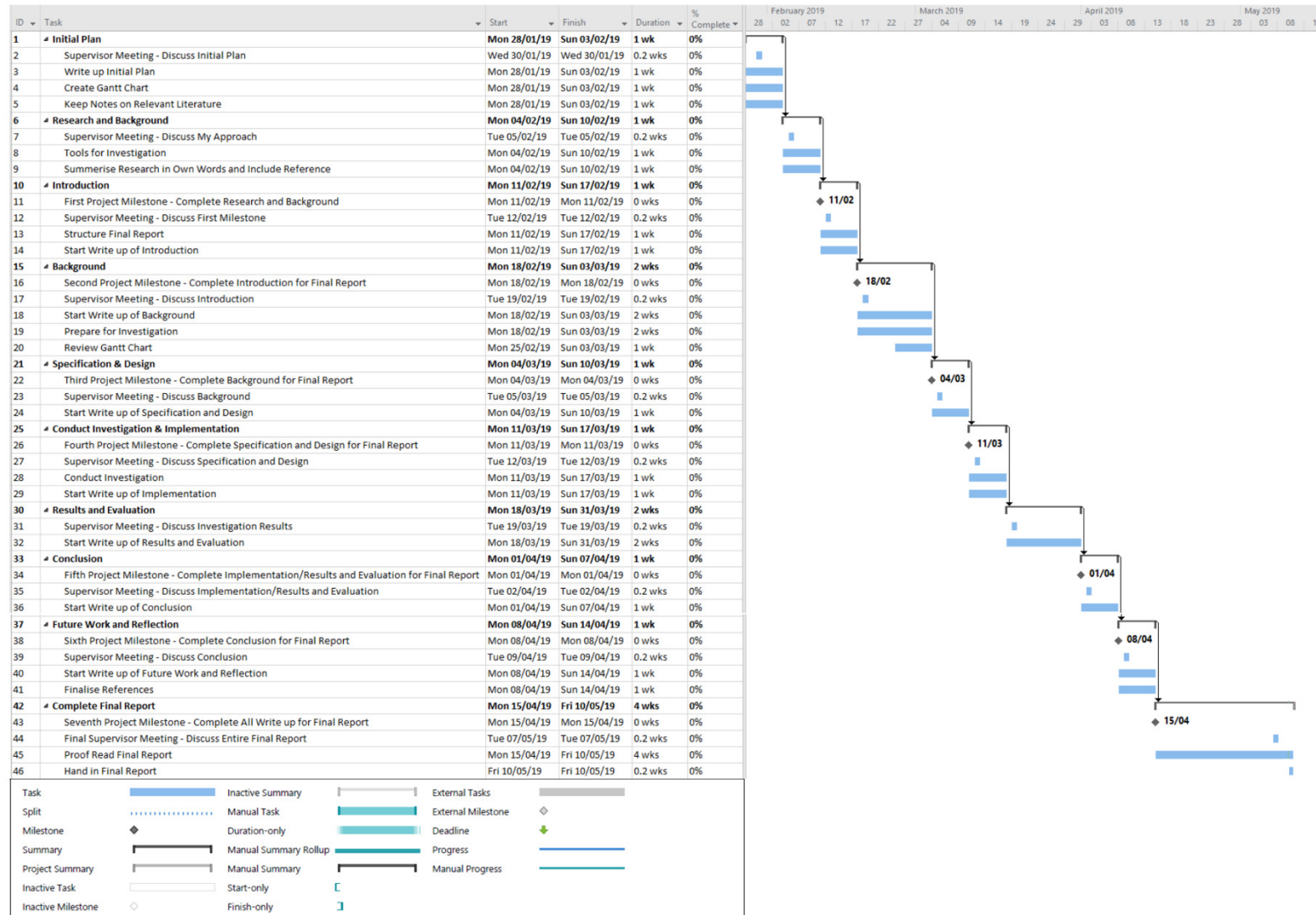
Easter Week 3: 29/4/19 – 5/5/19:

- ❖ Continue to proof-read dissertation and make any additional changes

Week 12: 6/5/19 – 12/5/19:

- ❖ Have a final supervisor meeting before handing in dissertation project
  - ○ Discussing the entire written report
    - ▪ Making any final changes before submission
- ❖ Deliverable: Hand in dissertation project 10/5/19

Gantt Chart:

ID	Task	Start	Finish	Duration	% Complete
1	◢ Initial Plan	Mon 28/01/19	Sun 03/02/19	1 wk	0%
2	Supervisor Meeting - Discuss Initial Plan	Wed 30/01/19	Wed 30/01/19	0.2 wks	0%
3	Write up Initial Plan	Mon 28/01/19	Sun 03/02/19	1 wk	0%
4	Create Gantt Chart	Mon 28/01/19	Sun 03/02/19	1 wk	0%
5	Keep Notes on Relevant Literature	Mon 28/01/19	Sun 03/02/19	1 wk	0%
6	◢ Research and Background	Mon 04/02/19	Sun 10/02/19	1 wk	0%
7	Supervisor Meeting - Discuss My Approach	Tue 05/02/19	Tue 05/02/19	0.2 wks	0%
8	Tools for Investigation	Mon 04/02/19	Sun 10/02/19	1 wk	0%
9	Summerise Research in Own Words and Include Reference	Mon 04/02/19	Sun 10/02/19	1 wk	0%
10	◢ Introduction	Mon 11/02/19	Sun 17/02/19	1 wk	0%
11	First Project Milestone - Complete Research and Background	Mon 11/02/19	Mon 11/02/19	0 wks	0%
12	Supervisor Meeting - Discuss First Milestone	Tue 12/02/19	Tue 12/02/19	0.2 wks	0%
13	Structure Final Report	Mon 11/02/19	Sun 17/02/19	1 wk	0%
14	Start Write up of Introduction	Mon 11/02/19	Sun 17/02/19	1 wk	0%
15	◢ Background	Mon 18/02/19	Sun 03/03/19	2 wks	0%
16	Second Project Milestone - Complete Introduction for Final Report	Mon 18/02/19	Mon 18/02/19	0 wks	0%
17	Supervisor Meeting - Discuss Introduction	Tue 19/02/19	Tue 19/02/19	0.2 wks	0%
18	Start Write up of Background	Mon 18/02/19	Sun 03/03/19	2 wks	0%
19	Prepare for Investigation	Mon 18/02/19	Sun 03/03/19	2 wks	0%
20	Review Gantt Chart	Mon 25/02/19	Sun 03/03/19	1 wk	0%
21	◢ Specification & Design	Mon 04/03/19	Sun 10/03/19	1 wk	0%
22	Third Project Milestone - Complete Background for Final Report	Mon 04/03/19	Mon 04/03/19	0 wks	0%
23	Supervisor Meeting - Discuss Background	Tue 05/03/19	Tue 05/03/19	0.2 wks	0%
24	Start Write up of Specification and Design	Mon 04/03/19	Sun 10/03/19	1 wk	0%
25	◢ Conduct Investigation & Implementation	Mon 11/03/19	Sun 17/03/19	1 wk	0%
26	Fourth Project Milestone - Complete Specification and Design for Final Report	Mon 11/03/19	Mon 11/03/19	0 wks	0%
27	Supervisor Meeting - Discuss Specification and Design	Tue 12/03/19	Tue 12/03/19	0.2 wks	0%
28	Conduct Investigation	Mon 11/03/19	Sun 17/03/19	1 wk	0%
29	Start Write up of Implementation	Mon 11/03/19	Sun 17/03/19	1 wk	0%
30	◢ Results and Evaluation	Mon 18/03/19	Sun 31/03/19	2 wks	0%
31	Supervisor Meeting - Discuss Investigation Results	Tue 19/03/19	Tue 19/03/19	0.2 wks	0%
32	Start Write up of Results and Evaluation	Mon 18/03/19	Sun 31/03/19	2 wks	0%
33	◢ Conclusion	Mon 01/04/19	Sun 07/04/19	1 wk	0%
34	Fifth Project Milestone - Complete Implementation/Results and Evaluation for Final Report	Mon 01/04/19	Mon 01/04/19	0 wks	0%
35	Supervisor Meeting - Discuss Implementation/Results and Evaluation	Tue 02/04/19	Tue 02/04/19	0.2 wks	0%
36	Start Write up of Conclusion	Mon 01/04/19	Sun 07/04/19	1 wk	0%
37	◢ Future Work and Reflection	Mon 08/04/19	Sun 14/04/19	1 wk	0%
38	Sixth Project Milestone - Complete Conclusion for Final Report	Mon 08/04/19	Mon 08/04/19	0 wks	0%
39	Supervisor Meeting - Discuss Conclusion	Tue 09/04/19	Tue 09/04/19	0.2 wks	0%
40	Start Write up of Future Work and Reflection	Mon 08/04/19	Sun 14/04/19	1 wk	0%
41	Finalise References	Mon 08/04/19	Sun 14/04/19	1 wk	0%
42	◢ Complete Final Report	Mon 15/04/19	Fri 10/05/19	4 wks	0%
43	Seventh Project Milestone - Complete All Write up for Final Report	Mon 15/04/19	Mon 15/04/19	0 wks	0%
44	Final Supervisor Meeting - Discuss Entire Final Report	Tue 07/05/19	Tue 07/05/19	0.2 wks	0%
45	Proof Read Final Report	Mon 15/04/19	Fri 10/05/19	4 wks	0%
46	Hand in Final Report	Fri 10/05/19	Fri 10/05/19	0.2 wks	0%

Task		Inactive Summary		External Tasks	
Split		Manual Task		External Milestone	
Milestone	◆	Duration-only		Deadline	↓
Summary		Manual Summary Rollup		Progress	
Project Summary		Manual Summary		Manual Progress	
Inactive Task		Start-only	[		
Inactive Milestone	◇	Finish-only	]		

Risk Assessment:

Risk	Likelihood	Impact	Minimization Strategy
1) Loss of data/information	Low	High	I will have my work backed up in multiple locations. On my OneDrive cloud storage, laptop, USB stick, and university account. Backups will take place on a regular basis.
2) Failure to complete milestones on time.	Medium	Medium	Stick to the work plan and Gantt chart to ensure key milestones are completed on time.
3) Hardware/software failure	Medium	Medium	Frequently backup data in multiple locations.

Risk Map:

		Likelihood of Happening		
		High	Medium	Low
Potential for Impact	High			(1)
	Medium		(2,3)	
	Low			

References:

[1] T. Berners-Lee, R. Cailliau, A. Luotonen, H. F. Nielsen and A. Secret, The World Wide Web, Communications of the ACM, vol. 37, August 1994, pp. 76-82.

[2] L. Enzer, "Monmouth Web Developers," [Online]. Available: https://www.mwdwebsites.com/nj-web-design-web-browsers.html. [Accessed 2 February 2019].

[3] BBC, "Microsoft's Internet Explorer losing browser share," 4 May 2010. [Online]. Available: https://www.bbc.co.uk/news/10095730. [Accessed 2 February 2019].

[4] apple.com, "Safari 1.0 for Mac OS X: Information and download," 5 March 2012. [Online]. Available: https://support.apple.com/en-gb/HT2964. [Accessed 2 February 2019].

[5] Wikipedia, "Google Chrome," [Online]. Available: https://en.wikipedia.org/wiki/Google_Chrome. [Accessed 2 February 2019].

[6] "StatCounter Global Stats – Browser, OS, Search Engine including Mobile Usage Share," [Online]. Available: http://gs.statcounter.com/#browser-ww-monthly-201204-201205. [Accessed 2 February 2019].

[7] G. Aggarwal, E. Bursztein, C. Jackson and D. Boneh, "An analysis of private browsing modes in modern browsers," *USENIX Security'10 Proceedings of the 19th USENIX conference on Security,* pp. 6-6, 11 August 2010.