

Nabi - A Preventative Solution Against JavaScript and Scriptless Tabnabbing Attacks

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Abstract

Tabnabbing is a phishing technique that attempts to change the look and design of a tab when the user is not currently viewing it so that when the user returns, they will find a seemingly trustworthy form or page requesting their credentials and information. This attack utilizes the user's trust of recently viewed tabs, and the perceived immutability of out-of-focus tabs. Tabnabbing attacks change the appearance of tabs by using JavaScript or the HTML meta tag. Previous attempts of addressing tabnabbing have relied upon detecting tabnabbing after it has occurred. Detecting whether a page has changed with the malicious intent of tabnabbing is a complex problem that is difficult to solve without large amounts of processing or false positives. The authors of this paper investigated and developed a preemptive measure to prevent tabnabbing attacks from occurring. The resulting Chrome browser extension, Nabi, prevents any JavaScript or HTML meta tags from running in inactive tabs outside of a trusted whitelist.

1 Introduction

The use of the Internet has become an almost unavoidable part of life. As the Internet becomes more involved with everyday life, users put more and more of their personal information online. Phishing is the process of stealing, gaining access to, or recording personal accounts or information. Phishing attacks try to convince the target to give up personal information such as passwords, account names, credit card numbers, addresses, and other valuable information or credentials. Phishing has many mediums such as email, phone, websites, and even mail. This information can be used in a variety of destructive ways from the thievery of personal assets to identity theft. However, the large and constantly looming

threat of phishing attacks have caused many users to become perpetually cautious when visiting new and unfamiliar sites.

Phishing attacks are always developing and evolving, and one particular type of attack attempts to trick the user well after they have initially visited the site. Coined by Firefox developer Aza Raskin in 2010, Tabnabbing is a specific phishing technique that relies on the users trust of websites they have already viewed and considered safe [2]. Some users often leave many tabs open to return to interesting websites at a later time, and this behavior makes those users the perfect target for this type of attack. When the user has left a tab, a malicious website can detect that the user is not currently viewing that tab and change the content of that page. This is done using JavaScript or the HTML meta tag with a timer to rearrange the page at a time when the user is most likely not viewing it. The malicious site will typically attempt to change the page content, tab title, and favicon to appear as a login page for a familiar site such as Gmail or Facebook. When the user returns to the tab, the changed page may request the user for their username and password, citing reasons such as an expired login session. Because tabs are not expected to have changed while out-of-focus, and because users do not check URLs often, the site will seem legitimate and trustworthy.

Phishing attacks are becoming more common as web use increases, and as users become more aware of phishing attacks, phishing techniques adapt to continue to be effective. Tabnabbing is one such new technique that is effective even against users that have been trained to only give sensitive information to trusted websites. It also takes advantage of the fact that users are most cautious when they first open a site, not when they return to an existing tab. Because this specific type of attack has only been identified relatively recently, there have been fewer proposed solutions to detect or prevent tabnabbing attacks compared to other phishing techniques.

2 Background

There are some preventative measures one can take to lower the risks of tabnabbing attacks. Aza Raskin recommends using the Firefox Account Manager to prevent unwarranted credential release [2], but this can be cleverly overcome by loading the legitimate site and placing an identical but malicious form over the original form [4]. Many users recommend the browser extension NoScript, which stops JavaScript on every tab unless the site is whitelisted [4], but this extension is only available on Firefox, and the blanket restriction of JavaScript may seem too extensive for some users. There have been some applications that have developed specifically to combat tabnabbing, which will be explained through the following research.

2.1 TabShots

One approach to combating tabnabbing is a Google Chrome browser extension known as TabShots, which was created by Philippe De Ryck, Nick Nikiforakis, Lieven Desmet, and Wouter Joosen [1]. To detect whether a tab has changed or not while not in focus, TabShots uses visual comparison of the tab's appearance before and after the change in the user's focus. The extension records screenshots of the currently focused tab at regular intervals, using a simple Google Chrome API call and storing the screenshot as a data URL. The program also keeps record of the tab's favicon, or the icon displayed in the tab's url and title space. These two sets of images provide the basis for comparison when a tab regains focus.

When any tab regains focus, TabShots compares a new screenshot of the tab and its current favicon to the most recent stored screenshot and favicon that was recorded before the tab lost focus. The small favicons are compared by source, and the screenshots are compared in a visually divided manner using the HTML5 canvas element. The screenshots are divided in a raster of fixed-size tiles, and each tile in the new screenshot is compared to the most recently stored screenshot of the tab. The tiles are sized as 10x10 pixels, which are deemed by the authors as a balance between performance and precision. If the tiles do not match

exactly, that area is marked as changed. The HTML5 canvas element provides powerful image manipulation capabilities that allowed the rastering and comparison algorithms to be implemented.

Once the differences in the current tab from its previous version are calculated, an overlay is injected into the page that shows the differences in semi-transparent red. The overlay is both transparent in both visibility and mouse events, so no mouse and keyboard events will be affected by it. The overlay is constantly checked for its presence by the extension whenever an element is removed, ensuring that a malicious page will not be able to remove the overlay without notifying the extension and user. TabShots also places an icon onto the browser's toolbar that changes color in response to the amount of changes on the currently focused tab. The icon serves as an unobtrusive security layer that will remain in view should the overlay be removed.

Finally, there is also an intended component for blacklisting sites that have confirmation of tabnabbing attempts. The developers have created an optional server-side component which can pull reported URLs from individual users, and add the confirmed URLs to a database. If the user decides that the current page is attempting tabnabbing and provides their explicit approval, the application can be signaled to send the accused page's URL, the image before the user switched tabs, and the image of the page after the user switched tabs. The server-side application uses its own automated comparison process and the further verification of a human analyst to decide if the page is indeed a phishing page, and whether the URL should be added to a subscription model blacklist.

According to the testings of the creators, TabShots is said to provide large compatibility with most major sites on the internet at a seemingly acceptable processing speed. The extension was used on the top 1000 websites listed on Alexa.com, and the results showed that 78% of these sites fall within the safe threshold of 5% or less in changed blocks, meaning no compatibility issues exist with that page. About 19% of these sites have moderate changes less than 40%, which is the threshold for high amounts of changes, and 3% report more than

40% differences in changed blocks. While the last two numbers may seem high in terms of false positives, the authors note that TabShots never interferes with the functionality of a page, and does provide a whitelist to providing overlays for these sites. In terms of speed, testing showed that TabShots was able to prepare and calculate the image comparisons on a 1366×768 window within an average time of 284ms, which should provide little impact on browser operating time [1].

There are some problems with this application. First, the performance testing of TabShots was done on a 1366×768 window. Many users today have monitors with much larger resolutions such as 1920×1080 or 2560×1440 , which provide two or four times as many pixels. This means that TabShots will run considerably longer on these types of monitors and provided a much larger performance strain. TabShots is designed to calculate the comparisons every time the user changes tab, which lead to very frequent occurrences of calculations depending on user behavior, and can further exaggerate TabShot's slower performance on higher resolution monitors. Finally, the visual comparison property of TabShots leads to many occurrences of false positives that lead to the high numbers mentioned above. Examples of non-malicious behavior that would trigger overlay occurrences would be videos, GIFs, image slideshows, overlays, and other dynamic advertisements. The authors note that slowly images and files would flag large amounts of tile changes. In addition, if an element was added or removed from the page, every other element on the page would shift, which would flag a major change in the picture comparison algorithm. The uncertain performance of TabShots on large monitors or frequently changing tabs, as well as its high opportunities for false positives make TabShots a potentially unideal solution to tabnabbing.

2.2 TabSol

Another attempt to detect tabnabbing is TabSol, a browser plugin created by Amandeep Singh and Somanath Tripathy [3]. TabSol uses a whitelist and hash computation to determine if a web page has changed while out of focus. TabSol attempts to detect tabnabbing

using less computations and storage than other programs such as TabShots.

The process of TabShots begins with a simple whitelisting check, to check whether the newly opening URL has already been verified as legitimate. If so, the process execution is stopped. Otherwise, TabSol will calculate the hash digest of the web page source to save the current state of the page, using the cryptographic hash function SHA-1 [1]. When the user switches back to the old tab, TabSol will recompute the hash digest of the page, and compare it to the stored digest. If they match, TabSol determines that the site is legitimate and adds the page into the domain whitelist mentioned above. Else, the page is treated as suspicious, and TabSol attempts to find a login form on the changed page, as the authors consider its presence necessary in a phishing attack. The authors chose to use the login form detection method presented in CANTINA+. If a login form is present, then the page is considered a phishing web page attempting tabnabbing, and appropriate actions can be taken.

The performance of this implementation is a strong feature of this browser extension. On an average machine with a 2.53 GHz processor, 4GB RAM and Windows 7 (64-bit), TabSol takes on average 157ms to detect a Tabnabbing attack, if it exists [1]. The process only uses two hash computations, and the most time-consuming part is the login form detection, which only is used on a subset of tab changes where the hash computations do not match. In addition, the hash values are the only things needing to be stored, which takes up much less memory than screenshots of the user's windows in the case of TabShots. Finally, the authors make the case that the login form detection is a crucial component of TabSol that is lacking in other tabnabbing detection systems, and prevents the large amounts of false positives in TabSol tabnabbing detection.

The authors do leave some issues of TabSol unaddressed in their paper. First, the authors make the fundamental assumption that any tabnabbing page will have a login form. This can be simply avoided by using a tabnabbing page that uses alternative means of communication such as a phone number, email address, or even a link to another login page. The login form detection system will completely fail in detecting these types of phishing attacks. Second,

TabSol immediately and prematurely place any site that has matching hashes onto the whitelist, which could result in malicious sites being placed onto the whitelist. If the user switches away and back to the tab before the malicious tab is scheduled to change, the tab will not change at all, and it will pass TabSol testing and be placed on the blacklist. This login form basis and premature whitelisting can easily lead to the infiltration of tabnabbing sites.

2.3 NoTabNab

NoTabNab is a browser addon designed by Secking Anil Unlu and Kemal Bicakci [4]. Their main objective was to focus on the favicon, page title, and layout changes for each tab, as the authors state that these properties must change in a tabnabbing attack. In particular, the program looks at important offset and margin values that are calculated for the page after the CSS style rules and properties are applied to each HTML element. The authors argue that any tabnabbing site must have some influence on these values, and thus they can be used to detect if the site has changed in an attempt of a tabnabbing attack.

The application begins by recording the page titles and favicons for each tab. NoTabNab then records the important layout values of the topmost page elements on these tabs. By topmost elements, the authors mean the elements which have the highest value on the z-axis above all other elements, as these are the elements that are most likely to change in a tabnabbing attack. When the tab focus returns to a tab, the stored values of the tab are compared to the new ones, and if any change is found, the user is passively alerted through highlighting the address bar. It should also be noted that if the page refreshes itself, redirects to somewhere else, or loads a new URL, the entire recording process is repeated and compared to the older recorded state.

The authors point out the advantages of their minimal information gathering methodology. The primary benefits of only recording data about the topmost elements is the reduced work over gathering the necessary data points for every element, which results in less storage

and processing to initially store the data, and less processing to compare the various data points for each element in the document [4]. In addition, the comparison of values will be resource friendly, as only the simple favicon, title, and important CSS values are compared for each page, as opposed to entire high resolution pictures or entire documents.

The less thorough and structured methodology of NoTabNab does allow some problems in usability and tabnabbing tracking. The elements that are tracked by NoTabNab are chosen at random by finding the topmost elements of the page at random grid points. NoTabNab may be intentionally tricked into tracking nonchanging elements by placing very small, almost invisible elements that are only a handful of pixels large on the page. If these elements are scattered through the page at the highest z-order, then NoTabNab will track their changes, and not the changes of any other elements. In addition, if the document contains many iframes within each other, then the addon must recursively record and check the elements inside them, increasing the storage and processing requirements of the application. Finally, if the user resizes their window, any tab that resizes or changes their layout as a direct result of that action will appear to have radically changed under NoTabNab, and it will provide entirely false and ignorant data about the changes of the user's tabs.

3 Proposal and Methodology

Each of these proposed approaches has particular advantages and disadvantages, but all of them require that the tabnabbing attack be detected first and then dealt with by the software or by alerting the user. Our proposed solution takes a preventative approach to stopping tabnabbing attacks. Aza Raskin suggested the use of the NoScript add-on for the Firefox web browser to eliminate the use of JavaScript across all tabs in the browser. Our proposed system, Nabi, is similar to this approach, but is implemented as an extension in the Google Chrome web browser and differs from Raskin's proposed solution in some key elements. Unlike NoScript, which blocks all JavaScript across every tab within a browser

window, our extension will block JavaScript specifically in all non-active tabs.

Our proposal is to prevent all tabnabbing attacks by restricting their ability to execute within the browser. Since tabnabbing attacks inherently run when the user is not looking, our solution is to prevent their execution whenever the user is not viewing that tab. If the attack occurs while the user is looking at the page, they will hopefully notice the change and avoid having their personal data phished by the newly created website. As such, the active tab is allowed to run JavaScript, and thus the user still has the ability to navigate to and utilize pages that incorporate JavaScript functionality, unlike Raskin's NoScript suggestion which blocks all untrusted sources from running JavaScript.

The primary aspects of our tabnabbing prevention solution are as follows: a JavaScript permissions system, a system for whitelisting trusted domains, and a system for the detection and prevention of scriptless redirect attacks. The permissions system will dynamically allow and deny access rights of JavaScript as the user navigates tabs. This system could be implemented a number of ways, such as removing JavaScript tags from the page or changing the access rights of tab, but should inevitably strive to prevent any JavaScript execution. The whitelist provides the user with a way to maintain productivity while staying protected. The user may select trusted websites to be exempt from being blocked by the system, allowing that page to continue running JavaScript after the user has changed tabs. Lastly, the system must provide a method for handling scriptless attacks. The scriptless attack cannot detect when the user selects a different tab, so it must guess the expected time a user will spend looking at their page in order to redirect to the alternative site when they are presumably looking elsewhere. Thus the system must detect when a meta tag is used to issue a redirect request to the browser and either prevent it from doing so or inform the user that the redirect will be occurring.

4 Results

The current build of Nabi restricts JavaScript from running in every tab the user has switched from. The tab is then refreshed to reflect those restrictions and to cancel the actively running JavaScript on that page. The page that is switched to is given access to run JavaScript and is also refreshed to reflect the change in permissions. This prevents JavaScript in the inactive tab from running while the user is not viewing it, but allows it to reactivate once the user returns. Because of this our strategy for defending against tabnabbing attacks allows the user to continue using the browser normally without the risk of running JavaScript in a background tab.

The only two forms of tabnabbing are through JavaScript and via the scriptless HTML meta tag redirect. Our system currently only prevents the former of the two types of attack, but prevents this attack completely. Previous approaches must be able to detect an active attack and take necessary action, and thus can be circumvented if the attacker is aware of the method’s metrics of detection. Nabi can provably prevent all JavaScript tabnabbing attacks before they ever occur by restricting their access to execute only when the user has that tab focused.

Nabi successfully incorporates the first aspect of our proposal by changing the content settings with the Google Chrome browser to allow and disallow JavaScript dynamically whenever the user switches between tabs. However, Nabi does not yet incorporate a whitelist feature, thus all inactive tabs are forbidden from running JavaScript, reducing the capability to multitask within the browser. Thus the current system is more preventative of script-based tabnabbing attacks but less user-friendly. Lastly, Nabi does not yet detect the scriptless redirect attack and is therefore unable to prevent it or inform the user. The scriptless attack is less likely to succeed given that it must guess when the user will be looking away from the page. That makes this feature arguably less important than preventing the more effective script-based tabnabbing attack, but scriptless attack is dangerous nonetheless and its detection will be included in future development.

5 Conclusion

We have proposed a solution for preventing tabnabbing attacks and begun development of a browser extension to implement the different aspects of this solution. Tabnabbing attacks are already inherently clever in their design, so it is very difficult to develop a detection metric capable of identifying tabnabbing attacks without using computationally expensive algorithms or generating an extensive amount of false positives. Our preventative approach provides a solution that stops tabnabbing without resorting to either of these shortcomings. Once it meets all of our proposed system aspects, the Nabi extension will be capable of preventing both script-based and scriptless tabnabbing attacks without unnecessarily burdening the user with a weighty detection-based browser add-on or constantly warning the user about harmless false positives. More so, a detection-based solution that cannot successfully identify all tabnabbing attacks leaves the user with a false sense of security, leaving them vulnerable if they are overly confident in the faulty detection algorithm. This further justifies the use of a preventative method as it can provably prevent all script-based versions of the tabnabbing attack.

References

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