

Raytheon Blackbird Technologies

Sinowal Web Form Scraping PoC Report

**For
SIRIUS Task Order PIQUE**

**Submitted to:
U.S. Government**

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1.0 (U) Analysis Summary

(U) Previously, the Sinowal Banking Trojan was of interest due to its Web Form Scraping technique in which sensitive elements of a webpage could be intercepted without the user's knowledge. At that time, the COM APIs that were used had been superseded circa 2005 and we believed that no technique could be applied to Post-XP operating systems.

(U) Recent research into the COM API revealed a number of newer APIs that appear to be functionally similar to the Sinowal Web Form Scraping technique.

(U) Due to the complex / confusing nature of the COM API names, specific excerpts of the original Sinowal article from Virus Bulletin (June 2014) are referenced throughout the analysis.

(U) Ultimately, we were not able to implement the entire functionality of the Web Form Scraping technique while strictly adhering to the description found in the Virus Bulletin report. We believe the technique may still be possible while adhering to the steps laid out in the report. We are able to progress further into the general technique if we deviate from the steps in the report, but we are unable to determine whether or not the end result will be the same.

2.0 (U) Detailed Analysis

(U) All Web Form Scraping functionality that we discuss in the subsections below is contained within the lecl module of the Sinowal malware.

2.1 (U) Enumerating Instances of Explorer / IExplorer

(U) The Virus Bulletin report did not specify the exact technique used to enumerate running instances of Explorer / IExplorer. The IDispatch interface that is used extensively later in the method for each window that is enumerated may only be obtained through methods within the IShellWindows interface.

2.2 (U) IConnectionPoint Interface

(U) After enumerating each window, most of the critical functionality is implemented using a Source / Sink approach that is connected using an IConnectionPoint interface. The source can be anything that user may interact with (e.g., Window, HTML Element).

(U) The Sink is our own implementation of an interface that handles events (e.g. DWebBrowserEvents2). A new Sink class must be created for each type of event interface we are handling (i.e. DWebBrowserEvents2 vs. HTMLDocumentEvents2).

(U) Each IDispatch object has a variety of connections to other various interface. After instantiating our Sink, we get a pointer to its IUnknown interface. Using this pointer, we can then call Advise() to link the Source and Sink together.

(U) When any event occurs, any Sink that has been linked (using Advise()) to receive the category of events is signaled using the Invoke() method. The Invoke method contains a large number of arguments as seen below in **Figure 1**.

```
STDMETHODIMP WebBrowserEventsSink::Invoke( DISPID dispidMember, REFIID riid,
                                         LCID lcid, WORD wFlags,
                                         DISPPARAMS *pDispParams,
                                         VARIANT *pVarResult,
                                         EXCEPINFO *pExcepInfo,
                                         UINT *puArgErr )
```

Figure 1: Invoke Method Declaration

(U) The DISPID parameter contains the type of event that has called the Invoke() method. After determining the type of event we are handling, the DISPPARAMS parameter contains a VARIANT array member that contains the correct number of relevant arguments for the specific type of event that is being handled. For example, consider the case where the BeforeNavigate2 event was thrown below in **Figure 2**.

```
switch(dispidMember)
{
    case DISPID_BEFORENAVIGATE2:
        //DBGPRINT( L"DISPID: BEFORENAVIGATE2\n" );

        /*
         * VOID BeforeNavigate2( IDispatch *pDisp, BSTR url, LONG Flags,
         *                       BSTR TargetFrameName, PUCHAR PostData,
         *                       BSTR Headers, BOOL Cancel );
         *
         * For our purposes, we only care about the IDispatch object and
         * the URL fields.
         */
        VariantChangeType( &v[0], &pDispParams->rgvarg[6], 0, VT_DISPATCH );
        VariantChangeType( &v[1], &pDispParams->rgvarg[5], 0, VT_BSTR );
        //VariantChangeType( &v[2], &pDispParams->rgvarg[4], 0, VT_I4 );
        //VariantChangeType( &v[3], &pDispParams->rgvarg[3], 0, VT_BSTR );
        //VariantChangeType( &v[4], &pDispParams->rgvarg[2], 0, VT_UI1 | VT_ARRAY );
        //VariantChangeType( &v[5], &pDispParams->rgvarg[1], 0, VT_BSTR );
        //VariantChangeType( &v[6], &pDispParams->rgvarg[0], 0, VT_BOOL );

        OnBeforeNavigate2( v[0].pdspVal, v[1].bstrVal );
        break;
```

Figure 2: Filtering Invoke() Events

(U) The definitions for each of the EventHandler functions can be found on the MSDN reference. The VARIANT array type is used in place of a Generic Object type to encapsulate all parameters for every possible type.

(U) Sinowal will, at this point, perform a variety of actions detailed in **Figure 3** below.

If the dispIdMember parameter of the Invoke method is DISPID_BeforeNavigate2 or DISPID_NewWindow3, the Iecl module will check the URL the browser is going to. If the URL is on a blacklist maintained by Sinowal, the visit to this URL will be cancelled by setting DISPPARAMS.Cancel to VARIANT_TRUE.

If the dispIdMember parameter is DISPID_NavigateComplete2, the Iecl module will check the URL the browser has arrived at. If the URL is blacklisted, navigation will be stopped by calling IWebBrowser2::Stop.

If the dispIdMember parameter is DISPID_DownloadBegin, the host name of the current URL will be obtained and saved in the IDispatch object constructed for this browser object.

If the dispIdMember parameter is DISPID_BeforeNavigate2, DISPID_DownloadBegin, DISPID_NavigateComplete2 or DISPID_DownloadComplete, the IHTMLDocument2 interfaces of all the frames opened in the browser will be obtained.

Figure 3: Sinowal's Filtering Actions

(U) The whitelist and blacklist functionality was not implemented (though, it would be trivial to do so) and efforts focused on handling IHTMLDocument2 events within the frames.

Unfortunately, we were unable to find any reference to the IID_IHTMLDocument2 interface of the page by calling the QueryInterface() method of the IDispatch pointer. Because of this, we were unable to link our HTMLDocument2 Sink implementation using the IConnectionPoint interface.

(U) Research suggests that the IWebBrowser2 interface is able to enumerate the fields in a similar manner, but would require refactoring the already-working code detailed above.

Unfortunately, the Web Form Scraping portion of Sinowal appears to hinge on creating a DIID_HTMLDocumentEvents2 Sink which is derived from the IID_IHTMLDocument2 interface that we cannot obtain.

The Invoke method of the IDispatch object for DIID_HTMLDocumentEvents2 and DIID_HTMLTextContainerEvents2 will find all form elements on a web page and monitor the content and submission of each form.

If the dispIdMember parameter of the Invoke method refers to keyboard and mouse events, such as DISPID_HTMLOBJECTEVENTS2_ONCLICK or DISPID_HTMLOBJECTEVENTS2_ONKEYPRESS, the Invoke method will do nothing.

Figure 4: Handling HTMLDocumentEvents

(U) An excerpt from the Virus Bulletin report, shown in **Figure 4**, describes the middle portion of the technique that we are unable to get functioning. Although two further IDispatch interfaces are enumerated (i.e., IHTMLElement2, DIID_HTMLInputElementEvents), the remaining functionality (assuming we encounter no further problems finding a reference) is trivial to implement.

3.0 (U) Recommendations

(U) If the overarching technique remains interesting, we recommend further pursuit. That said, because we are unable to fully implement it and because the true original technique remains deprecated, we cannot be certain that the functionality (regardless of implementation) will be the same as described in the report.