Malware Analysis (CS6038)

Week 05.1 Document Analysis

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February 12, 2019

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Overview

- Homework
- Walkthrough solutions for the in-class problems
- Document Analysis
  - Adobe PDF
  - Microsoft Office Documents
  - Container Documents

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Homework

- Homework 1:
  - Graded and Submitted to Blackboard
- Homework 2:
  - Due Feb 19, 2019
  - See here for the assignment
  - Hint: The problems from Thursday will solve 95% of the homework
- Homework 3:
  - Assign Feb 14, 2019
  - Due Feb 28, 2019
  - Covers Document Analysis and Windows Artifacts

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In-Class Problem 1

- Demo 1
  - file
  - strings
  - Load in disassembler: IDA, Hopper
    - Find Main Function
      - Use known strings to help
      - Also show where mingw puts.
        - Take the EntryPoint -> jump -> Look for call to exit
  - Load into x32dbg
    - Add break point on Main.
      - Step through

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In-Class Problem 2

- Demo 2
  - file
  - strings
  - Load in disassembler: IDA, Hopper
    - Find Main Function
      - Use known strings to help
      - Also show where mingw puts.
        - Take the EntryPoint -> jump -> Look for call to exit
  - Load into x32dbg
    - Add break point on Main.
      - Step through

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In-Class Problem 3

- Demo 3
  - file
  - Open python file
  - Execute python file
    - Review the similarities and differences of the output

In-Class Problem 4

- Demo 4 -- d4.out
  - file
  - strings
  - Open in editor
    - See the "=" at the end of alphanumeric character string
  - Decode
    - This one is more confusing as I didn't give a hint as to what to do next.
  - Start over with file, strings, etc.
  - Still nothing. Lets try a bruteforce XOR

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In-Class -- Shellcode

- It was discussed on how shellcode can be analyzed by creating a c program that passes execution to the character buffer holding the shellcode.
- Loading this compiled executable into a debugger.
- This saves a lot of time. **USE IT**

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Document Analysis

- Analysis of Word, and PDF documents
  - https://zeltser.com/analyzing-malicious-documents/

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PDF Analysis

- Some interesting features in (most) PDF readers:
  - JavaScript (PDFjs, ECMA) interpreter
  - Forms UI support (XFA, FDF, XFDF)
  - U3D/PRC 3d-model embedded support
  - Inline HTML
  - Numerous embedded image formats
  - PDF-within-PDF
  - Encoded/encrypted stream data

PDF Analysis

- PDF documents more or less follows the below structure:

%PDF-N.N	... header data ...	... unused ...
X Y obj	object data	endobj
W Z obj	object data	endobj
...	more object data	...
xref	... xref table ...	... unused ...
trailer	... trailer data ...	startxref NNNN
%%EOF		

- Each entity inside of the document is located within one of the indirect objects identified above with the "X Y obj", "Z W obj", etc... declarations.
- One of these objects is traditionally the “catalog”, or “root object”.
- The xref table contains an index of the offsets for each of the indirect objects, from beginning of file.
- The trailer contains a pointer to the xref table as well as a dictionary that defines the catalog, the count of objects in the cross-reference table, and other information that may be specific to the viewer.

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PDF Objects

- Object data is defined by beginning with the following text (where X and Y are integers):
  - X Y obj
- The PDF specification defines a number of data types:
  - Boolean values (representing True or False)
  - Numbers • Strings, enclosed with parentheses: (this is a string)
  - Names, character data beginning with a slash: /NameVal1
  - Arrays, ordered data enclosed with square brackets:
    - [(Object) (Data) (in) (a) (list)]
  - Dictionaries, name-indexed data, defined with << and >>:
    - <</Val1 (This is a string) / Val2 [(list) (data)] >>
  - Streams, large blobs of arbitrary data, embedded between stream and endstream keywords
  - Null content

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PDF-Parser

- The pdf-parser.py tool can be helpful in navigating the PDF document structure.
  - Search for data in object: pdf-parser.py -s mytext file.pdf
  - Search for data in stream: pdf-parser.py -searchstream=mytext file.pdf
  - List objects and their hashes: pdf-parser.py -H file.pdf
  - Extract object: pdf-parser.py -o 1 -d stream.dat file.pdf
  - Extract filtered object: pdf-parser.py -f -o 1 -d stream.dat file.pdf
  - Parse, extract malformed: pdf-parser.py -v -x malformed.dat file.pdf
  - Integrate with yara: pdf-parser.py -y, -yarastrings
  - Python code generation: pdf-parser.py -g example.pdf > example.py

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Office Documents

- We will focus our efforts on the Microsoft suite of software, though it is notable that the space is diverse, and any one of these can be its own intrusion vector.

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Microsoft Office File Formats

- Generally, there are two data file formats that are of interest to MS Office document malware analysis:
  - Office Open XML (OOXML) Files
    - Basically PKZIP archives with a specially-defined layout. Most office documents since about 2007 are dsitributed using this format (XLSX, DOCX, PPTX, etc.)
  - Compound File Binary (CFB)
    - A binary file specification defined by Microsoft. Older Microsoft Office documents were built up from this format (DOC, XLS, PPT).
    - Since 2007, it is still frequently used to embed Microsoft-specific binary data structures within documents and applications.
- Latest CFB file specification
- Latest Office Open XML specifications (ISO/IEC 29500-1:2016, 29500-2:2012, 29500-3:2015, 29500-4:2008)

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CFB File Format

- The CFB file format is a chunked data format,
  - The file is divided into sectors,
  - There exist file allocation tables that each define an array of pointers to other file locations that map blocks in the file to their ordering within a data stream.
- This organizational model creates a file structure where whole data streams (such as images, sub-documents, videos, content, embedded fonts, macros, etc...) are not guaranteed to exist contiguous within the file.
- There exist a number of utilities that are useful for navigating this structure:
  - https://www.decalage.info/python/oletools
  - https://github.com/unixfreak0037/officeparser
  - https://poi.apache.org/ - Java API for Office Documents

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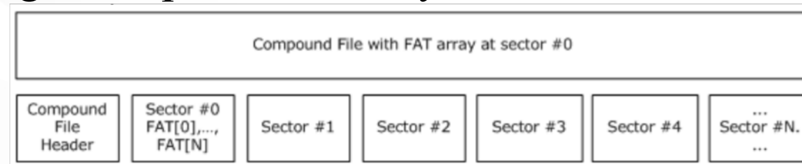
CFB Sectors

- The first sector of the file contains the CFB header, which is where all of the information defining the top-level file layout



- Almost exclusively, sector sizes are defined to be 512 bytes (0x200 hex), which is consistent with most common OS filesystems as well.

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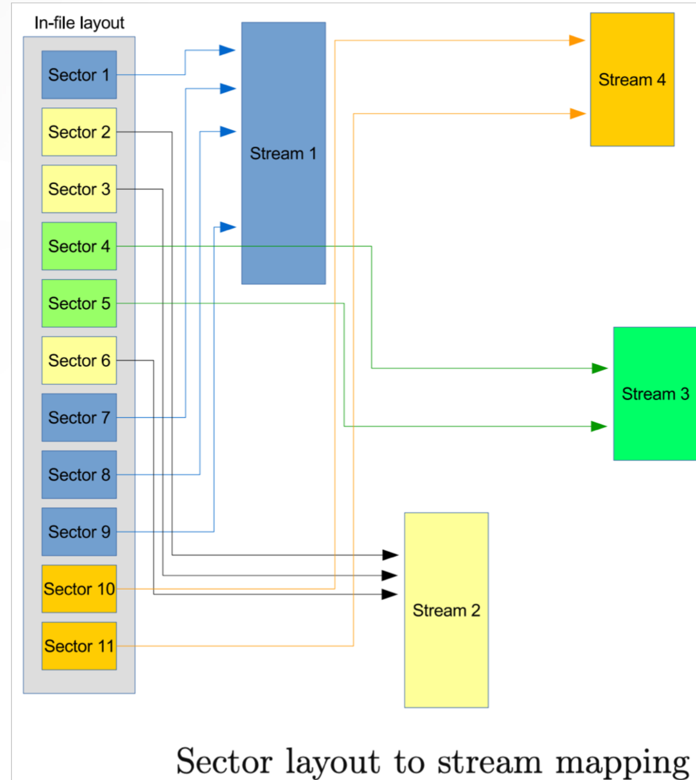
CFB Streams



Sector layout to stream mapping

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OLE Tools

- Documentation on the following site:
  - olebrowse: A GUI browser enabling you to navigate, view and extract streams. Very basic.
  - oledir: Dump the stream directory of the document
  - olemap: Dump the sector mappings (allocation) of a file
  - olemeta: Dump metadata about the document
  - olevba: Dump VBA macros from files

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OOXML Layout

Can be extracted through the unzip utilities.

```
Archive:  test-doc.docx
    testing: _rels/.rels                   OK
    testing: word/document.xml             OK
    testing: word/styles.xml               OK
    testing: word/_rels/document.xml.rels    OK
    testing: word/settings.xml             OK
    testing: word/media/image1.jpeg        OK
    testing: word/fontTable.xml            OK
    testing: docProps/app.xml              OK
    testing: docProps/core.xml             OK
    testing: [Content_Types].xml           OK
```

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Macros

- Microsoft Office supports executable scripts embedded within documents.
  - A common language used for this is Visual Basic for Applications (VBA).
  - Similar to PDFjs that we discussed earlier, this language is a derivative of Visual Basic
  - Has special hooks into the Office environment and the current (and linked) documents.
- An example macro is available here
- Macros can be used to execute arbitrary code, without relying upon exploits that intend to break parsing of the document. Some examples:
  - http://blog.fortinet.com/2017/03/08/microsoft-excel-files-increasingly-used-to-spread-malware
  - https://blogs.sophos.com/2015/09/28/why-word-malware-is-basic/
  - http://www.kahusecurity.com/2015/malicious-word-macro-caught-using-sneaky-trick/

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Container Documents

- A file that contains other files
  - Zip
  - GunZip
  - Microsoft OOXML format (docx)
  - Androids Apk
  - Java Jar

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