

Advanced  
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Advanced

# PDF TRICKS

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# ANGE ALBERTINI

## reverse engineering

### VISUAL DOCUMENTATIONS

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**PDF-KungFoo with Ghostscript & Co.**  
100 Tips and Tricks for Clever PDF Creation and Handling  
<https://leanpub.com/pdfkungfoo/>

**PDF-Answers:** <https://stackoverflow.com/users/359307/kurt-pfeifle>

A screenshot of Kurt Pfeifle's Stack Overflow profile. It shows his tag info, a list of questions, and a list of answers. His profile picture is a blue square with white text. He has 1.5k answers, 381 questions, and a total score of 31.7k. He is the top pdf Answerer for all time.



how do I convert to |



how do i convert to islam  
how do i convert to judaism  
how do i convert to pdf  
how do i convert to catholicism

[I'm Feeling Lucky »](#)

[Learn more](#)

Press Enter to search.

Recently, PDF officially became a religion...  
... so here we are, Pope and Akuma ;)

# Goal: learn PDF *internals*

(  
"just suck less about the format"  
)

PDF 1.7 spec is 750+ pages, but...  
additional "normative" references to more than other 80 specs (not all public), 10.000+ pages

# Applications:

## watermarks

## censorship

## edits & tricks...

( create PDFs which don't immediately jump out as amateurish because of their syntax errors  
(nothing to do with malicious PDFs analysis or exploitation) )

example: hand-written title

# A real life example

UNCLASSIFIED

## III. TRAFFIC CONTROL POINTS, BLOCKING POSITIONS, AND TRAINING

### A. (U) Introduction

(U) This section examines TCPs, BPs, and training matters. It first discusses the difference between a TCP and a BP. Standing Operating Procedures (SOPs) for the various units involved regarding TCPs and BPs are assessed, and the Rhino Bus TTP is outlined. This is followed by a review of the training on TCPs, BPs, weapons, and Rules of Engagement (ROE) that the Soldiers manning BP 541 had received before 4 March 2005. The ROE that were in effect that night are explained. The section concludes with findings and recommendations.

### B. (U) Traffic Control Points and Blocking Positions

(U) Task Force [REDACTED] had received missions to establish TCPs and blocking positions numerous times in the past. [REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]

### C. (U) Standing Operating Procedures in use on 4 March 2005

(U) SOPs are designed to serve as guidelines for specific operations and are not prescriptive in nature. They provide a baseline for acceptable operations from which commanders can derive principles and techniques and adapt them to their current mission. (Annexes 44C, 65C, 72C, 96C, 98C).

UNCLASSIFIED

But the 'redactor' guy  
really botched that  
job !

Seen in its metadata: “*EmailSubject (Another Redact Job For You)*”  
<http://download.repubblica.it/pdf/rapportousacalipari.pdf>

# Preamble

this presentation is supplemented by many more hands-on examples, that you can find at:

<http://pdf101.corkami.com>

# **PDF 101**

basics of the PDF file format  
Part I / II

# HEADER

```
%PDF-1.1
1 0 obj
<<
/Pages 2 0 R
>>
endobj

2 0 obj
<<
/Type /Pages
/Count 1
/Kids [3 0 R]
>>
endobj

3 0 obj
<<
/Type /Page
/Contents 4 0 R
/Parent 2 0 R
/Resources <<
/Font <<
/F1 <<
/Type /Font
/Subtype /Type1
/BaseFont /Arial
>>
endobj
```

# FILE

```
<< /Length 47 >>
stream
BT
/F1 110
Tf
10 400 Td
(Hello World!)Tj
ET
endstream
endobj
```

```
xref
0 5
000000000 65535 f
0000000010 00000 n
0000000047 00000 n
0000000111 00000 n
0000000313 00000 n
```

```
trailer
<<
/Root 1 0 R
>>

startxref
416
%%EOF
```

# XREF TABLE

CROSS  
REFERENCE

```
416: xref
0 5
000000000 65535 f
0000000010 00000 n
0000000047 00000 n
0000000111 00000 n
0000000313 00000 n
```

CROSS REFERENCES  
5 OBJECTS, STARTING AT INDEX 0  
(STANDARD FIRST EMPTY OBJECT 0  
OFFSET TO OBJECT 1, REV 0  
TO OBJECT 2...  
3...  
4

# TRAILER

```
trailer
<<
/Root 1 0 R
>>

startxref
416
%%EOF
```

My poster on the PDF format (free to print, reuse...) <http://pics.corkami.com>  
to order a print: <http://prints.corkami.com>

# BASICS

PDF IS TEXT BASED, WITH BINARY STREAMS

## TYPES

- 0: STRING  
EX: (Hello World!)
- 1: NAME (IDENTIFIERS)  
EX: /Count 1
- 2: DICTIONARY  
EX: <</key1 value1 /key2 value2>>
- 3: ARRAY  
EX: [8 1 2 3 4]

## OBJECT REFERENCES

CONTENT IS STORED IN OBJECT  
MOST CONTENT CAN BE INLINED OR REFERENCED IN A SEPARATE OBJECT

/Key1 value IS EQUIVALENT TO /Key1 3 0 R  
[...]  
3 0 obj  
value  
endobj

## BINARY STREAMS

BINARY STREAM ARE STORED IN SEPARATE OBJECTS LIKE THIS:

```
<object number> <object revision> obj
<< <STREAM METADATA>>
stream
<STREAM CONTENT>
endstream
endobj
```

STREAM LENGTH, COMPRESSION PARAMETERS...

# FILE STRUCTURE

## HEAD OF THE FILE

THE %PDF-1.1 SIGNATURE IDENTIFIES THE FORMAT AND REQUIRED VERSION

## XREF

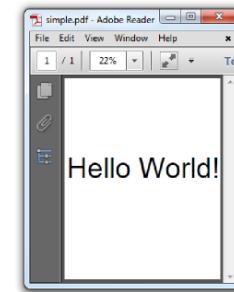
- <STARTING OBJECT> <OBJECT COUNT>  
FOLLOWED BY XREF ENTRIES:  
IF (OBJECT IN USE)  
<OFFSET> <GENERATIONS> n
- ELSE  
<NEXT\_FREE\_OBJECT> <GENERATIONS> f

## END OF THE FILE

startxref  
XREF OFFSET IN DECODED STREAM  
%%EOF

# PARSING

THE HEADER %PDF-1.1 SIGNATURE IS CHECKED TO IDENTIFY THE FILE FORMAT  
THE XREF IS LOCATED VIA THE startxref OFFSET  
THE xref TABLE GIVES OFFSET OF EACH OBJECT  
THE trailer IS Parsed  
EACH OBJECT REFERENCE IS FOLLOWED, BUILDING THE DOCUMENT  
PAGES ARE CREATED, TEXT IS RENDERED

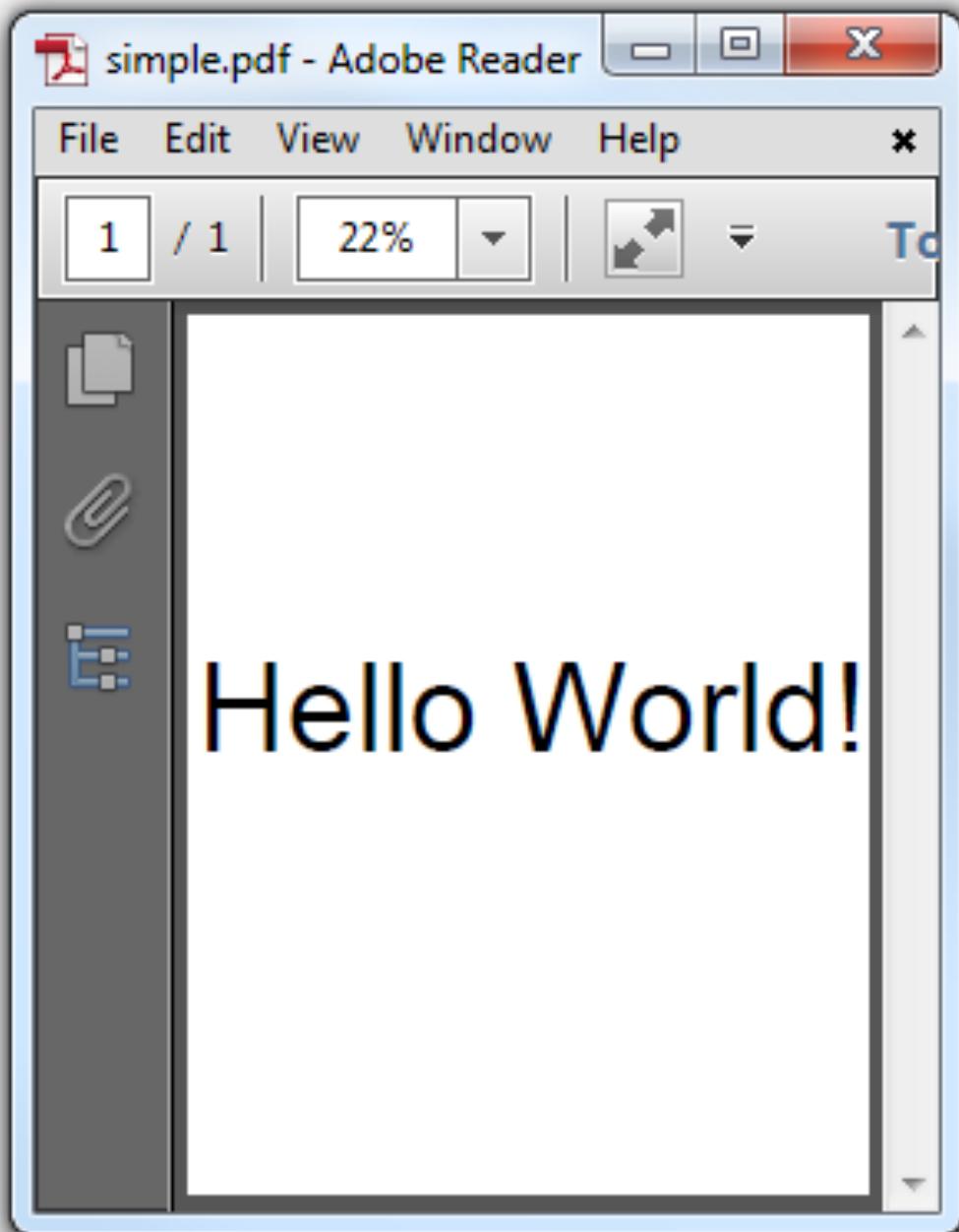


PDF<sup>101</sup> an Adobe document walkthrough

# A simple example

helloworld\_bin.pdf

reminder: this is simplified, PDF is actually much more complex



```
%PDF-1.1
%äãÍÓ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘š“““DLEž_”“¢©DLE’ ÅåSUBÅENQNUL! 0VTx
endstream
endobj

xref
0 5
000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000111 00000 n
0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
414
%%EOF
```

# text

# binary

# text

```
%PDF-1.1
%äääö

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘š“““DLEž_”“¢““DLE’ ÅåSUBÅENQNUL! 0VTx
endstream
endobj

xref
0 5
000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000111 00000 n
0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
414
%%EOF
```

# A PDF file is

- text-based
  - white-space tolerant
- with binary streams

→ it can be edited with any decent text editor  
(that keeps binary and EOLs intact)

# Recommended environment

- Text editor
- Evince/Sumatra/MuPDF/Zathura
  - lightweight
  - updates on the fly
- Tool to decompress streams  
and unbundle object streams
  - (explanations later)
- Check for mistakes with  
`qpdf --check` or `pdfinfo` or `Ghostscript`

# **Exercise: manipulate content**

whitespace doesn't change anything  
(well, at least in most cases...)

Settings Help

Hello World!

```
4 0 obj
<< /Length 50 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj
```

Update content, save...

Settings Help

# Hell of War

```
4 0 obj
<< /Length 50 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hell of War) Tj
ET
endstream
endobj
```

...and you see the result straight away.

# Basic PDF structure

1. header
  - signature
2. body
  - made up of "*indirect* objects"
3. cross-reference table
4. trailer
  - cross-reference table
  - trailer dictionary
  - startxref pointer
  - end of file signature

# Signature (2 lines)

## 1. PDF signature

- %PDF-1.0 ... %PDF-1.7

## 2. Charset identifier

- not required
- tells tools file is not ASCII
- 4 non-ASCII chars in a comment

%PDF-1.1  
%ääIÖ

1 0 obj  
<< /Pages 2 0 R >>  
endobj

2 0 obj  
<< /Kids [3 0 R] /Count 1 /Type /Pages >>  
endobj

3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font >>  
>> >> /Contents 4 0 R /Type /Page >>  
endobj

4 0 obj  
<< /Filter /FlateDecode /Length 57 >>  
stream  
xœs  
áRPÐw3T044NUL<sup>2</sup> BÒ€,,i,%BH  
-áš“““DLEž\_”“¢““DLE’ ÅåSUBÅENQNUL!0VTx  
endstream  
endobj

xref  
0 5  
0000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000111 00000 n  
0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref  
414  
%%EOF

# Body

made of objects

<number> <generation> **obj**

<content>

**endobj**

# <generation> in most cases '0'.

<content> frequently composed of:

<<..dictionary..>> # (double angle brackets)

and optionally

stream

# (start keyword)

<streamcontent>

# (can be anything)

endstream

# (end keyword)

%PDF-1.1

%âäÍÓ

1 0 obj

<< /Pages 2 0 R >>

endobj

2 0 obj

<< /Kids [3 0 R] /Count 1 /Type /Pages >>

endobj

3 0 obj

<< /Parent 2 0 R /MediaBox [0 0 612 792]

/Resources << /Font << /F1 <<

/BaseFont /Arial /Subtype /Type1 /Type /Font >>

>> >> /Contents 4 0 R /Type /Page >>

endobj

4 0 obj

<< /Filter /FlateDecode /Length 57 >>

stream

xœs

áPÐw3T044NUL<sup>2</sup> BÒ€,,i,%BH

-á‘š“““DLEž\_”“¢©DLE’ ÅåSUBÅENQNUL!0VTx

endstream

endobj

xref

0 5

0000000000 65535 f

0000000016 00000 n

0000000051 00000 n

0000000111 00000 n

0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref

414

%EOF

# Xref

- table
- byte offsets for each object

xref

0 5	5 objects, starting at 0
0000000000 65535 f	obj #0: always null (dummy obj)
000000016 00000 n	obj #1: offset 16 from filestart
000000051 00000 n	obj #2: offset 51
0000000111 00000 n	...
0000000283 00000 n	

- each line = 20 chars exactly!
  - EOL char = <CR> or <LF> or <CR><LF>
  - if EOL is single byte (<CR> or <LF>), then use extra 1 space before EOL!

```
%PDF-1.1
%ääÍÓ
```

```
1 0 obj
<< /Pages 2 0 R >>
endobj
```

```
2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj
```

```
3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font >>
>> >> /Contents 4 0 R /Type /Page >>
endobj
```

```
4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL²Bò€,,i,%BH
-á‘š“““DLEž_”“¢“CDLE’ ÅåSUBÅENQNUL!0VT×
endstream
endobj
```

```
xref
0 5
0000000000 65535 f
000000016 00000 n
000000051 00000 n
0000000111 00000 n
0000000283 00000 n
```

```
trailer << /Root 1 0 R /Size 5 >>
```

```
startxref
414
%%EOF
```

# Trailer 1/2

- structure
  - a. “*trailer*”
  - b. dictionary (like most objects)
  - c. “*startxref*” info
  - d. “*%%EOF*”
- dict points to “root” object
  - **/Size** = #(xref elements)
  - **/Root** (can be any number)

```
%PDF-1.1
%ääÍÓ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>>> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘š“““DLEž_”“¢“CDLE’ ÅåSUBÅENQNUL!0VT×
endstream
endobj

xref
0 5
000000000 65535 f
000000016 00000 n
000000051 00000 n
000000111 00000 n
000000283 00000 n


```

# Trailer 2/2

## 1. pointer to xref

- a. "startxref"
- b. offset to "xref"
  - (decimal)

## 2. End Of File marker

- a. "%EOF"

**Note:** Some real world files after PDF-1.5 may use a 'cross reference stream' instead of an xref table. Compressed, not directly readable. Not discussed in this talk.

To turn them into a standard cross reference table, use:

```
qpdf --qdf --object-streams=disable \  
in.pdf uncompressed.pdf
```

```
%PDF-1.1  
%>
```

```
1 0 obj  
<< /Pages 2 0 R >>  
endobj
```

```
2 0 obj  
<< /Kids [3 0 R] /Count 1 /Type /Pages >>  
endobj
```

```
3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font >>  
>> >> /Contents 4 0 R /Type /Page >>  
endobj
```

```
4 0 obj  
<< /Filter /FlateDecode /Length 57 >>  
stream  
xœs  
áRPÐw3T044NUL2 Bò€,,i,%BH  
-á‘š“““DLEž_”“¢““CDLE’ ÅåSUBÅENQNUL!0VTx  
endstream  
endobj
```

```
xref  
0 5  
000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000111 00000 n  
0000000283 00000 n
```

```
trailer << /Root 1 0 R /Size 5 >>
```

```
startxref  
414  
%%EOF
```

# Basic types

*boolean, numbers, strings, names,  
arrays, dictionaries, streams, null...*

(Basic types often separated from each other by whitespace. Sometimes no whitespace required because of specific delimiters assigned to the respective basic types...)

# Space, Whitespace & Delimiters

## 4.42

### space character

text string character used to represent orthographic white space in text strings

NOTE 2 space characters include HORIZONTAL TAB (U+0009), LINE FEED (U+000A), VERTICAL TAB (U+000B), FORM FEED (U+000C), CARRIAGE RETURN (U+000D), SPACE (U+0020), NOBREAK SPACE (U+00A0), EN SPACE (U+2002), EM SPACE (U+2003), FIGURE SPACE (U+2007), PUNCTUATION SPACE (U+2008), THIN SPACE (U+2009), HAIR SPACE (U+200A), ZERO WIDTH SPACE (U+200B), and IDEOGRAPHIC SPACE (U+3000)

Table 1 – White-space characters

Decimal	Hexadecimal	Octal	Name
0	00	000	Null (NUL)
9	09	011	HORIZONTAL TAB (HT)
10	0A	012	LINE FEED (LF)
12	0C	014	FORM FEED (FF)
13	0D	015	CARRIAGE RETURN (CR)
32	20	040	SPACE (SP)

Table 2 – Delimiter characters

Glyph	Decimal	Hexadecimal	Octal	Name
(	40	28	50	LEFT PARENTHESIS
)	41	29	51	RIGHT PARENTHESIS
<	60	3C	60	LESS-THAN SIGN
>	62	3E	62	GREATER-THAN SIGN
[	91	5B	133	LEFT SQUARE BRACKET
]	93	5D	135	RIGHT SQUARE BRACKET
{	123	7B	173	LEFT CURLY BRACKET
}	125	7D	175	RIGHT CURLY BRACKET
/	47	2F	57	SOLIDUS
%	37	25	45	PERCENT SIGN

# Strings/Literals

%comment until line return

- (string)  $\Leftarrow$  ASCII
- (\163\164\162\151\156\147)  $\Leftarrow$  octal
- (str\151ng)  $\Leftarrow$  mix of octal & ASCII
- <\686578>  $\Leftarrow$  hex
- <\686\5\7  
  8>  $\Leftarrow$  separated nibbles

(PDF is *quite f\*cked up*)

```

*PDF-1.1
%äö

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Type /Pages /Count 1 >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Length 53 >>
stream
BT
/F1 110
Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000109 00000 n
0000000281 00000 n

*PDF-1.1
%äö

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Type /Pages /Count 1 >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Length 75 >>
stream
BT
/F1 110
Tf
10 400 Td
<48 65 6C 6C 6F 20 57 6F 72 6C 64 21> Tj
ET
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000109 00000 n
0000000281 00000 n

```

example: same content, different encoding

1

0

R

an important fact to know when you read PDF

# Object reference

the declaration

- <object> <generation> R refers to
- the actual contents of the object

some objects CAN'T be inlined

<generation> is *very rarely* non-zero

```
%PDF-1.1
```

```
%ääÍÓ
```

```
1 0 obj  
<< /Pages [2 0 R] >>  
endobj
```

```
2 0 obj  
<< /Kids [3 0 R] /Count 1 /Type /Pages >>  
endobj
```

```
3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font >>  
>> >> /Contents 4 0 R /Type /Page >>  
endobj
```

```
4 0 obj  
<< /Filter /FlateDecode /Length 57 >>  
stream  
xœs  
áRPÐw3T044NUL2 BÒ€,,i,%BH  
-á‘š“““DLEž_”“¢““CDLE’ ÅåSUBÅENQNUL!0VTx  
endstream  
endobj
```

```
xref
```

```
0 5  
0000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000111 00000 n  
0000000283 00000 n
```

```
trailer << /Root 1 0 R /Size 5 >>
```

```
startxref
```

```
414
```

```
%EOF
```

# Object reference - example

/Count 1 ...

/Count 5 0 R ...

5 0 obj

1

endobj

2 equivalent examples via object reference

# Object references: syntax

It's odd, but critical to understand

- `3 0 1` ⇒ 3 elements (3 numbers):
  - a. 3
  - b. 0
  - c. 1
- `3 0 R` ⇒ 1 element:
  - a. reference to “`3 0`”
    - object 3
    - generation 0

Other PDF syntax rules follow common-sense

# Name objects

- “reserved keywords”
    - like symbols in Ruby
  - starts with **/**
    - “/Pages”, “/Kids” ...
  - case sensitive
    - CamelCase by default
    - undefined names are ignored
- ⇒ **/pages != /Pages**  
but **/Pages == /P#61ges ☺**  
(useful to disable or to obfuscate things...)

```
%PDF-1.1
%ääIÖ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL²Bò€,,i,%BH
-áš“““DLEž_”“¢“CDLE’ ÅåSUBÅENQNUL!0VT×
endstream
endobj

xref
0 5
000000000 65535 f
000000016 00000 n
000000051 00000 n
000000111 00000 n
000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
414
%%EOF
```

# Exercise: identify basic types

*boolean, numbers, strings, names,  
arrays, dictionaries, streams, null...*

# **Exercise:**

## **add/edit names**

bogus names ignored, case sensitivity  
the reader may fall back to default values

# Arrays

## Syntax

- [ <values>\* ]

## Examples:

- [ 3 0 R ] = 1 value
  - a. “3 0 R”
- [ 0 0 612 792 ] = 4 values
  - a. “0”
  - b. “0”
  - c. “612”
  - d. “792”

```
%PDF-1.1
%ääÍÓ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>>> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘š“““DLEž_”“¢“CDLE’ ÅåSUBÅENQNUL!0VT×
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000111 00000 n
0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
414
%%EOF
```

# Dictionaries

## Syntax:

- << [ <key> <value> ]\* >>

# <keys> must be "names", must follow the  
rules for "names", which is why...

# ...<keys> always start with forward slashes:  
/Name1, /Something, /Kids, /Type,...

## Object 1 sets:

1. /Pages to “2 0 R” # (to an obj reference)

## Object 2 sets:

1. /Kids to “[3 0 R]” # (to an array)
2. /Count to “1” # (to an integer)
3. /Type to “/Pages” # (to a name)

```
%PDF-1.1
%âãÍÓ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>>> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘ş““““DLEž_”“¢““CDLE’ ÅåSUBÅENQNUL!0VTx
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000111 00000 n
0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
414
%%EOF
```

# Object reference

/Pages 2 0 R

is “equivalent” to

/Pages <<

/Kids [3 0 R]

/Count 1

/Type /Pages

>>

1 0 obj  
<< /Pages 2 0 R >>  
endobj

2 0 obj  
<< /Kids [3 0 R] /Count 1 /Type /Pages >>  
endobj

and then "3 0 R" is a further reference...

# **Binary streams**

parameters, filters...

# Streams

( Streams are only places where in PDF binary chars can appear -- other than in comments... )

## Syntax:

1. usual **obj** declaration
2. stream params in dictionary  
(must include **/Length** !)  
(if encoded, includes **/Filter** !)
3. **stream** (keyword)  
+ EOL character(s)
4. stream data
5. **endstream** (keyword)  
+ EOL character(s)
6. usual **endobj**

stream data is not interpreted (at object level)

```
%PDF-1.1
%ääÍÓ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Count 1 /Type /Pages >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘š“““DLEž_”“¢“CDLE’ ÅåSUBÅENQNUL!0VTx
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000111 00000 n
0000000283 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
414
%%EOF
```

# Example

- stream parameters:
  - /Filter = /FlateDecode
  - /Length = 57
- stream content (binary):

Xœs  
áRPÐw3T044NUL<sup>2</sup> BÒ€,,i,%BH  
-á‘š“““DLEž\_”“¢“©DLE’ ÅåSUBÅENQNUL! 0VT×

```
4 0 obj
<< /Filter /FlateDecode /Length 57 >>
stream
Xœs
áRPÐw3T044NUL2 BÒ€,,i,%BH
-á‘š“““DLEž_”“¢“©DLE’ ÅåSUBÅENQNUL! 0VT
endstream
endobj
```

# Binary streams

- can be stored with different encodings or compression schemes
  - /Filter
  - encodings/compressions can be cascaded
- content is decoded
  - after each filter

only the final (de-coded) data matters

# What's in a stream?

Typical contents of (filtered/encoded/binary) streams are:

- Embedded font files
- Images
- ICC profiles
- Page /Contents

*PDF-1.5 and later: bundle "indirect objects" into streams: “/Type /ObjStm”*

(Some stream contents may be "binary-as-original", without extra /Filter applied.  
Example: font files.)

# **Streams don't enforce encodings**

as long as the result is correct  
once decoded by the filters

```
<< /Length 53 >>
```

```
stream
```

```
BT
```

```
 /F1 110 Tf
```

```
 10 400 Td
```

```
 (Hello World!) Tj
```

```
ET
```

```
endstream
```

```
<< /Length 57
```

```
 /Filter /FlateDecode
```

```
>>
```

```
stream
```

```
xœs
```

```
áRPÐw3T044 ²BÒ€,,í,,‰BH
```

```
-á‘š““-ž_”“¢..©’ÅåÂ !0x
```

```
endstream
```

the 2 streams above are equivalent -- they just use a different encoding  
(Flate = ZIP compression)  
(/FlateDecode = Use ZIP uncompression to unpack the stream)

```
<< /Length 170
/Filter [
/ASCIIHexDecode
/FlateDecode] >>
```

stream

```
78 9C 73 0A E1 52 50 D0 77 33 54 30 34
34 00 B2 42 D2 80 84 A1 81 82 89 81 81
42 48 0A 90 AD E1 91 9A 93 93 AF 10 9E
5F 94 93 A2 A8 A9 10 92 C5 E5 1A C2 05
00 21 30 0B D7
```

endstream

```
<< /Length 57
/Filter /FlateDecode
```

>>

stream

xœs

```
áRPÐw3T044 ²BÒ€,,í,,‰BH
- á‘š““-ž_”“¢..@’ÅåÂ !0x
```

endstream

/ASCIIHexDecode will decode ASCII Hex to binary,  
then Deflating will decompress the result

# **Exercise: stream decoding**

via mutool, pdftk, qpdf, podofouncompress,  
peepdf, pdf-parser.py, ...

# Main filters

- <none>: direct raw binary stream in the file
- /FlateDecode : ZIP's deflate (de)compression
  - smaller
- /ASCIIHexDecode: turns hex <=> binary
  - 41 0A ⇒ “A\n”
    - easy text editing (but binary is very common)  
mutool has a specific option for that
- /ASCII85Decode: hex <=> ASCII base 85

# Other filters

## Images

- **/DCTDecode** to store JPEG **files** directly
  - not just the data, even the header!
  - may work for any data, including JavaScript
- **/LZWDecode**, **/CCITTFaxDecode**,  
**/JBIG2Decode**, **/JPXDecode**

## Encryption

- **/Crypt**
  - RC4 or AES

# **Let's put it all together**

how is the file actually parsed?

%PDF-1.1  
%äöÖ

# Parsing 1/7

## 1. Signature is checked

```
1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Type /Pages /Count 1 >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>>> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Length 53 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000109 00000 n
0000000281 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref
384
%%EOF
```

# Parsing 2/7

## 2. %%EOF is located

%PDF-1.1  
%âãïÓ

1 0 obj  
<< /Pages 2 0 R >>  
endobj

2 0 obj  
<< /Kids [3 0 R] /Type /Pages /Count 1 >>  
endobj

3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font>>  
>> >> /Contents 4 0 R /Type /Page >>  
endobj

4 0 obj  
<< /Length 53 >>  
stream  
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!) Tj  
ET  
endstream  
endobj

xref  
0 5  
0000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000109 00000 n  
0000000281 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref  
384  
%%EOF

# Parsing 3/7

## 3. xref is located via startxref

```
%PDF-1.1  
%âãïÓ
```

```
1 0 obj  
<< /Pages 2 0 R >>  
endobj
```

```
2 0 obj  
<< /Kids [3 0 R] /Type /Pages /Count 1 >>  
endobj
```

```
3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font>>  
>> >> /Contents 4 0 R /Type /Page >>  
endobj
```

```
4 0 obj  
<< /Length 53 >>  
stream  
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!) Tj  
ET  
endstream  
endobj
```

→ xref  
0 5  
0000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000109 00000 n  
0000000281 00000 n

```
trailer << /Root 1 0 R /Size 5 >>
```

```
startxref  
384  
%%EOF
```

# Parsing 4/7

4. xref gives the byte offset addresses for each object

%PDF-1.1  
%âãïÓ

→ 1 0 obj  
<< /Pages 2 0 R >>  
endobj

→ 2 0 obj  
<< /Kids [3 0 R] /Type /Pages /Count 1 >>  
endobj

→ 3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font>>  
>> >> /Contents 4 0 R /Type /Page >>  
endobj

→ 4 0 obj  
<< /Length 53 >>  
stream  
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!) Tj  
ET  
endstream  
endobj

xref  
0 5  
0000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000109 00000 n  
0000000281 00000 n

trailer << /Root 1 0 R /Size 5 >>

startxref  
384  
%%EOF

# Parsing 5/7

5. trailer is parsed  
→ gives /Root object

```
%PDF-1.1
%âãïÓ
```

```
1 0 obj
<< /Pages 2 0 R >>
endobj
```

```
2 0 obj
<< /Kids [3 0 R] /Type /Pages /Count 1 >>
endobj
```

```
3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>>> /Contents 4 0 R /Type /Page >>
endobj
```

```
4 0 obj
<< /Length 53 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj
```

```
xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000109 00000 n
0000000281 00000 n
```

```
trailer << /Root 1 0 R /Size 5 >>
```

```
startxref
384
%%EOF
```

# Parsing 6/7

## 6. objects are parsed

- a. /Root object contains /Pages
- b. /Pages contains page array
  - /Kids
- c. each /Page has:
  - size: /MediaBox (\*)
  - /Contents
    - as stream object
  - /Resources
    - defines the /Font dictionary

(\*) If all /MediaBox sizes are identical, can also be set in /Pages obj and "inherited" in individual /Page objects without setting them there.

```
1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Type /Pages /Count 1 >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>>> /Contents 4 0 R /Type /Page >>
endobj
```

```
4 0 obj
<< /Length 53 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj
```

```
xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000051 00000 n
0000000109 00000 n
0000000281 00000 n
```

```
trailer << /Root 1 0 R /Size 5 >>
```

```
startxref
384
%%EOF
```

# Parsing 7/7

## 7. the page is rendered

- a. BT                      BeginText
- b. <name> <size> Tf    select font
- c. <x> <y> Td          move cursor
- d. <string> Tj          display string
- e. ET                      EndText



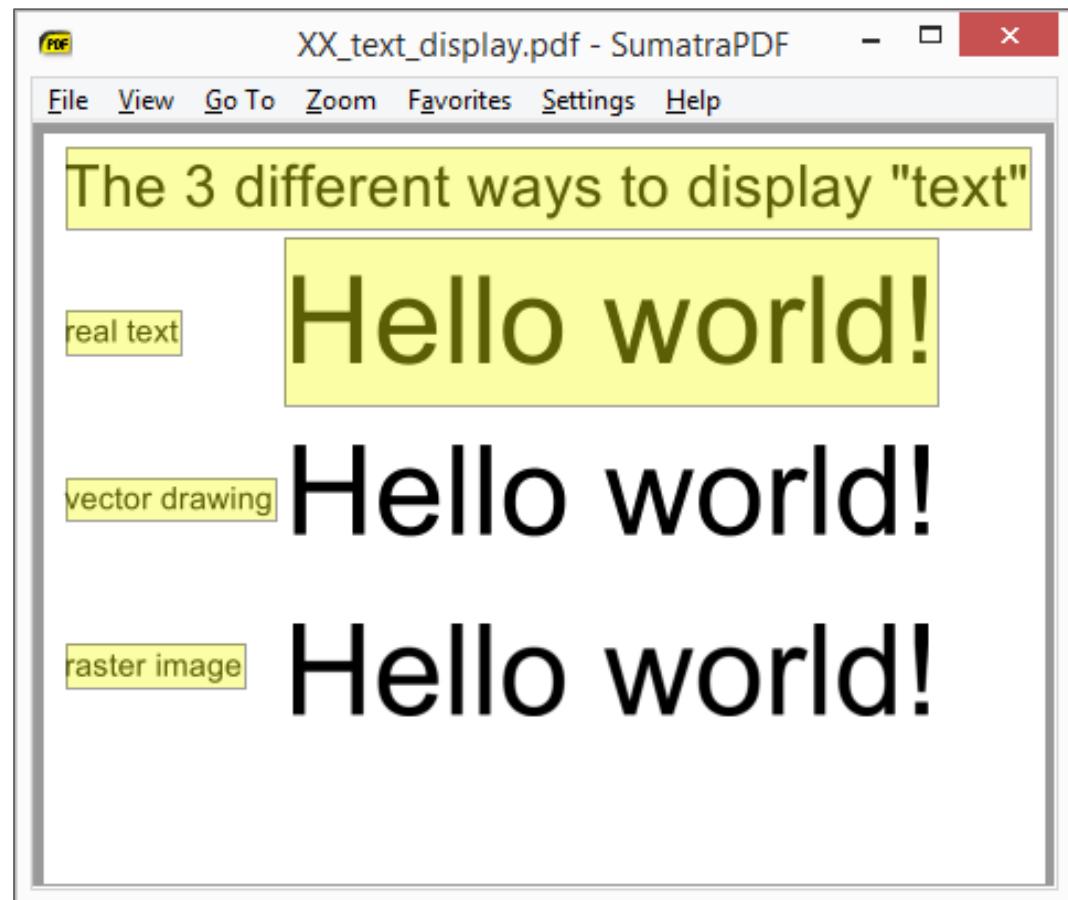
```
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!) Tj  
ET
```

```
%PDF-1.1  
%âãïÓ  
  
1 0 obj  
<< /Pages 2 0 R >>  
endobj  
  
2 0 obj  
<< /Kids [3 0 R] /Type /Pages /Count 1 >>  
endobj  
  
3 0 obj  
<< /Parent 2 0 R /MediaBox [0 0 612 792]  
/Resources << /Font << /F1 <<  
/BaseFont /Arial /Subtype /Type1 /Type /Font>>  
>>> /Contents 4 0 R /Type /Page >>  
endobj  
  
4 0 obj  
<< /Length 53 >>  
stream  
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!) Tj  
ET  
endstream  
endobj  
  
xref  
0 5  
0000000000 65535 f  
0000000016 00000 n  
0000000051 00000 n  
0000000109 00000 n  
0000000281 00000 n  
  
trailer << /Root 1 0 R /Size 5 >>  
  
startxref  
384  
%%EOF
```

# Page contents

## 3 basic types

- Real Text
- Raster Images
- Vector Drawing Elements



# **Exercise:**

# **Text representations**

‘text’ / drawing / image

# In practice

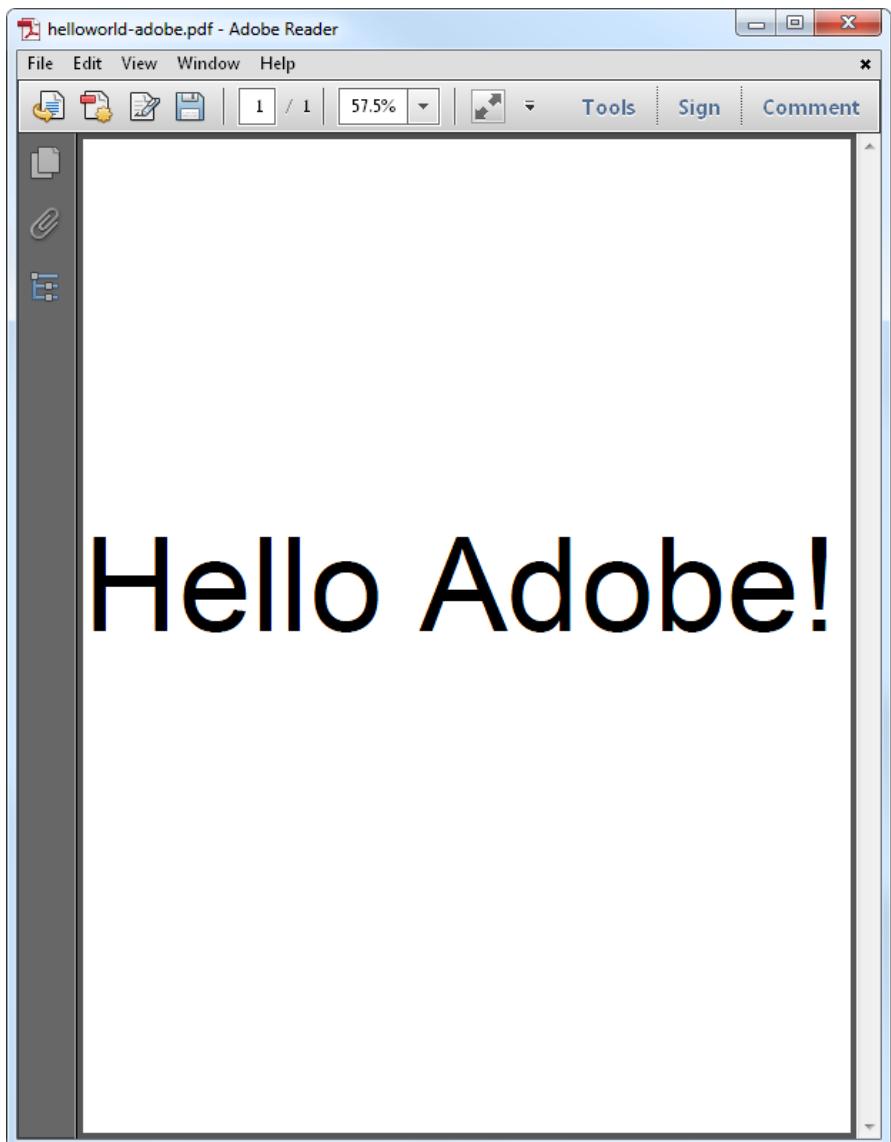
- that was the ‘strict’ minimum
- a typical PDF embeds more information
  - fonts
  - font encodings
  - metadata
  - raster images
  - ICC profiles
  - ...

a generated *Hello World* typically weights >10 KB

# In practice - in the malware world

- Most readers accept malformed files
  - many elements may be missing:
    - EOF, startxref, xref, /Length, endobj, endstream
    - /MediaBox /Font
- Each reader has its own weirdness
  - see my “Schizophrenes” talks and PoCs
- ...so much for the so-called “standard”

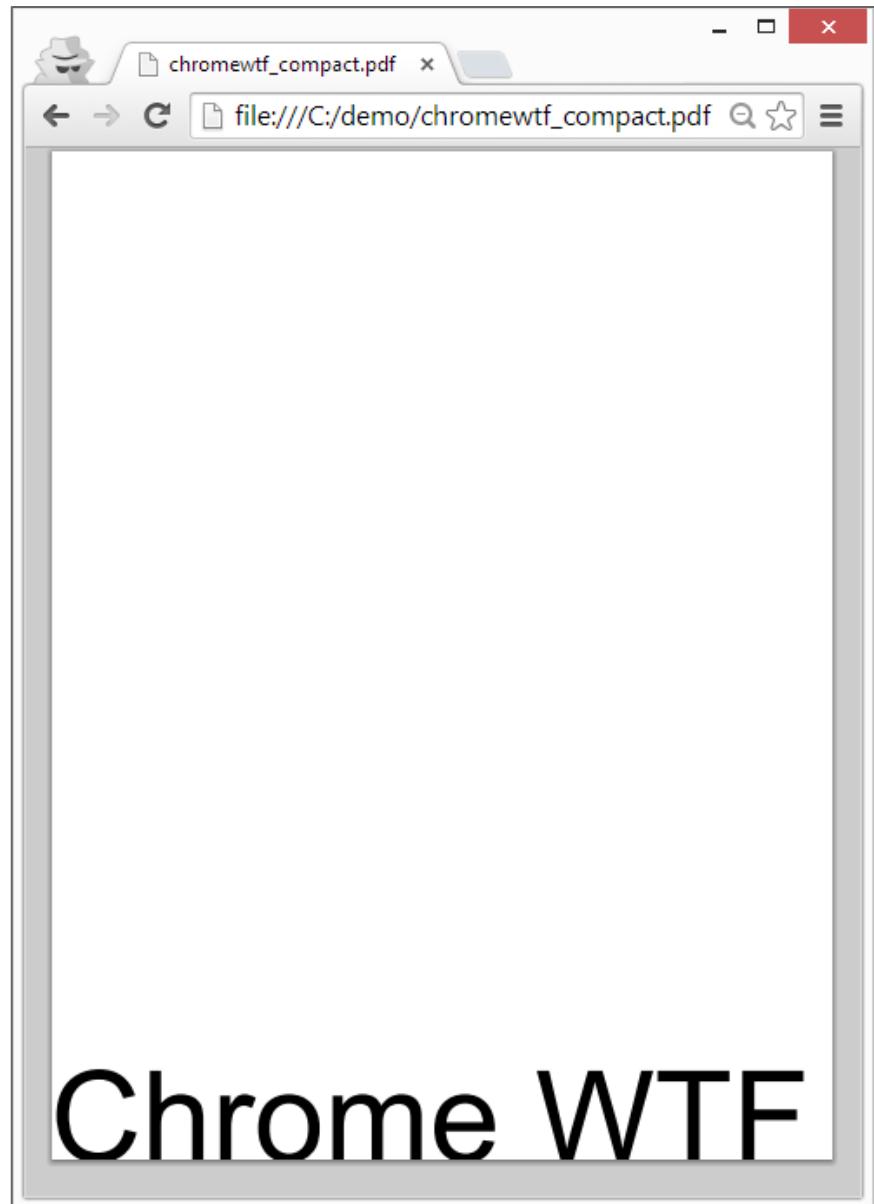
```
%PDF-\0
1 0 obj<</Kids[<</Parent
1 0 R/Contents[2 0 R]>>]
/Resources<<>>
2 0 obj<<>>
stream\n
BT/F1 105 Tf 0 400 Td
(Hello Adobe!)Tj ET
endstream\n
endobj\n
trailer<<
/Root<</Pages 1 0 R>>>>
```



# A “Hello World” for Adobe, in 179 bytes

(demo with Adobe Reader XI [works] and Acrobat Pro [crashes] on Mac)

```
%PDF\n1 0 obj<<\n/W[[]1/]\n/Root 1 0 R\n/Pages\n<</Kids[<</Contents<<>>\nstream\nBT{99 Tf\n(Chrome WTF) '\nendstream\n>>]">>>>\nstream\nendobj\n%startxref%1234567
```



“Chrome WTF”, in a funky tweet

# **Reminders on syntax**

# Basic ones

% comment until line end

<string in hex>  
(standard string)

*Equivalent examples:*

(Hello Loop)

<48 65 6C 6C 6F 20 4C 6F 6F 70>

<4 86 56 C6C6 F20 4 C 6 F6F 7>

(Spec says: if odd no. of characters, 'hex' string should be padded with 0.)

Check your viewers now...

# Dictionaries ( key/value pairs )

```
<< [/name <value>]* >>      # << >> are dictionary delimiters  
                                # [ & ] not part of syntax -- here to denote "pair"  
<< /Size 637 >>            # sets /Size to 637
```

Ex:

```
<</Creator(Ange Albertini)>>    # No whitespace: Why? Optional!  
                                # (other delimiters already present)  
sets /Creator to "Ange Albertini"
```

(/name must comply to syntax rules for "Name tokens")

(<value> can be anything -- even another dictionary, or an array)

(order of key/value pairs is NOT significant!)

# Arrays ( ordered list of elements )

[ <element>\* ] # [ ] are array delimiters!

Ex

[0 0 612 792] # array of 4 elements

(<element> can be anything -- even another array or dictionary!)  
(in arrays the order of elements is significant!)

# Binary streams

absolutely *anything* between

stream

endstream

inside a dedicated object

with stream encoding parameters  
in the object's dictionary

# Backward syntax

- Operators and operands in page contents
- Because PDF inherited some elements from PostScript

# References

**1 0 R** : refers to object 1 generation 0  
refers to what's between

1 0 obj  
endobj

Example:

[ 1 0 R ] is an array of one element  
element is reference to object "1 0"

# Text in page contents

inside a (possibly encoded) stream

- `/F1 110 Tf` : use text font F1 with size 110
- `10 400 Td` : put current point to x=10, y=400
- `(Hello World) Tj` : print Hello World

# Walkthrough

```
%PDF-1.1
%âãïÓ
1 0 obj <<
  /Pages 2 0 R
>>
endobj
2 0 obj <<
  /Type /Pages
  /Count 1
  /Kids [3 0 R]
>>
endobj
3 0 obj <<
  /Type /Page
  /Parent 2 0 R
  /MediaBox [0 0 612 792]
  /Resources <<
    /Font <<
      /F1 <<
        /Type /Font
        /Subtype /Type1
        /BaseFont /Arial
      >>
    >>
  >>
  /Contents 4 0 R
>>
endobj
4 0 obj
<< /Length 51 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj
trailer <<
/Root 1 0 R
/Size 5
>>
startxref
446
%%EOF
```

## /Page's /Resources

```
/Resources
```

```
<<
```

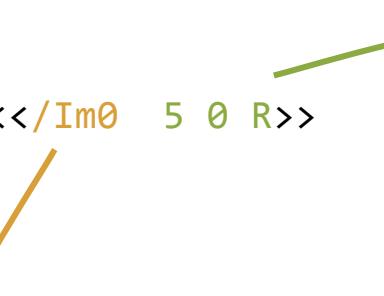
```
 /XObject << /Im0 5 0 R >>
```

```
..
```



## /Page's /Contents object stream:

q



```
<width> 0 0 <height> 0 0 cm
```

**Im0** Do

Q

"<width> 0 0 <height> 0 0" : defines the operand, a matrix.  
 "cm" : is the "concatenate matrix to current transformation matrix"-operator.  
 "Do" : is the operator that calls invokes the rendering of the XObject.  
 "q" and "Q" : are the operators which save and restore the graphics state.

Changing the zeros in the matrix to other numerical values can rotate, skew, scale, translate (and any combination of thereof) the image.

## Image object:

```
5 0 obj
```

```
<<
```

```
/Type /XObject
```

```
/Subtype /Image
```

```
/Width <width>
```

```
/Height <height>
```

```
/BitsPerComponent 8
```

```
/ColorSpace /DeviceRGB
```

```
/Filter [
```

  /ASCIIHexDecode

  /DCTDecode % JPEG compression

```
]
```

```
>>
```

```
stream
```

<IMAGE DATA>

```
endstream
```

```
endobj
```

# **Images = independent objects**

They can be dumped by trivial parsing  
(<4Kb images can be inlined)

# At this point...

We've covered the basics of:

- file structure
- objects relation
- file parsing
- page rendering

→ enough to start playing with PDF internals!

# How to start using the PDF spec

Link to free/gratis version:

- <http://acroeng.adobe.com/PDFReference/ISO32000/PDF32000-Adobe.pdf>  
official specs -- meanwhile belong to ISO ⇒ not free -- costs 198 CHF to buy)

Important starting chapters:

- **Understand `/Contents` stream:**  
Annex A (Operator Summary); also names equivalent PostScript operators
- **Understand other "normative" specs:**  
Chapter 3 (Normative References); lists ~80 more external documents about fonts, encryption, hashes, Unicode, images, compression schemes....
- **Understand text/font encodings:**  
Annex D (Char sets and Encodings)

# Hiding/revealing elements

Part II / II

**text can (most of the times) be copied**

**images can be extracted**

**the “Select All” trick often works,  
but not always**

**even if “Select All” does *not* work,  
secrets *may* still be recovered**

**(incrementally updated PDFs!)**

# **hiding/revealing parts of the PDF document**

from this point on:  
**not hiding data in a PDF file (stego)**  
**nothing reader-specific (schizo)**

# Isn't copy/paste enough?

- why not editing the file itself ?  
and restoring the secrets perfectly?

want to hide something?

- create your own methods!

# Easy PDF editing

1. decompress streams
  - PDFTk , qpdf
  - optional: use ASCIIHex to get an ASCII-only file
2. open in text editor
3. view results via Sumatra

overwrite, or comment (don't delete)

⇒ no offset to adjust

```
D:\> pdftk "GoogleDoc.pdf" output uncompressed.pdf uncompress
```

```
D:\> qpdf --qdf --object-streams=disable "OpenOffice.pdf" uncompressed.pdf
```

```
D:\> mutool clean -d -i -f "GhostScript.pdf" uncompressed.pdf
```

# Remove PDF "protections"

- PDF feature to prevent printing or copy/paste
- If you can view it, it means it **is** decrypted !
  - it just means that the **user** password is empty
- Permission for copy-paste/printing is just a flag
  - the **owner** password “prevents” to change it

⇒ remove it altogether:

```
D:\> qpdf --decrypt protected.pdf unprotected.pdf
```

# Reminder

technically speaking, a PDF page is:

1. a stream object
2. as the /Contents of a /Type /Page object
3. in the /Kids array of a /Type /Pages object
4. as the value of /Pages in root object
5. as the value of /Root in the trailer

and text on the page are simple (*string*)  $Tj$  or  $\langle hexvalues \rangle Tj$  (or  $TJ$ )

# Erasing a page with a tool

- tools such as PDFtk can operate on pages

- D:\>pdftk "Doc.pdf" cat 1-3 5-end output no4.pdf

but:

- they don't erase pages!
    - they extract the other pages and write a new file
- the whole code for page is lost...

...but its image contents (as objects) may still be present + extractable!! (Bug or feature of pdftk ?!)

# Erase overlapping element?

- remove paint/text operators from binary stream

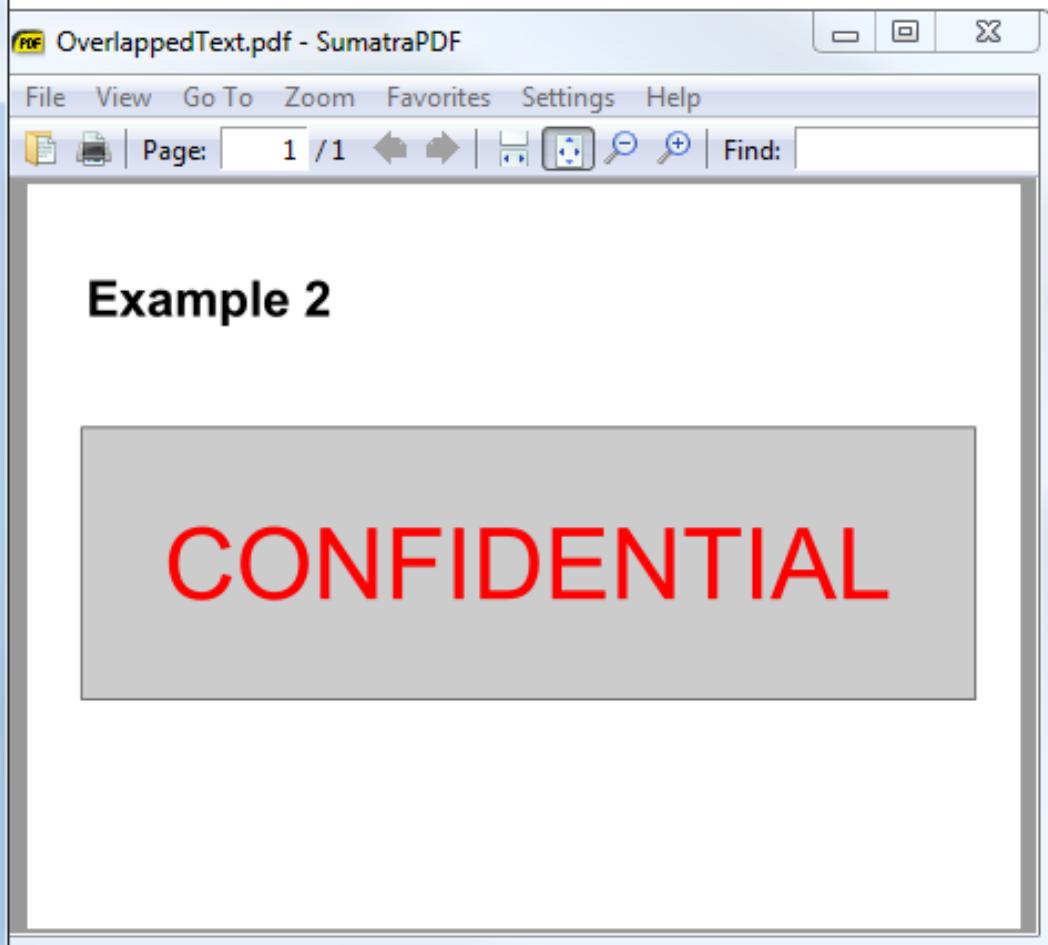
*Hints:*

Content drawing stream operators operate in their order of appearance inside the stream.

Overlapping elements more likely at the end of the stream, as they were likely added last.

**Example:  
manually remove  
overlapping elements**

```
RG  
19931.0  
89692.0  
m  
349115.0  
89692.0  
1  
349115.0  
189868.0  
1  
19931.0  
189868.0  
1  
h  
S  
Q  
q  
381.0  
0  
0  
381.0  
0  
0  
cm  
q  
1.0  
0
```

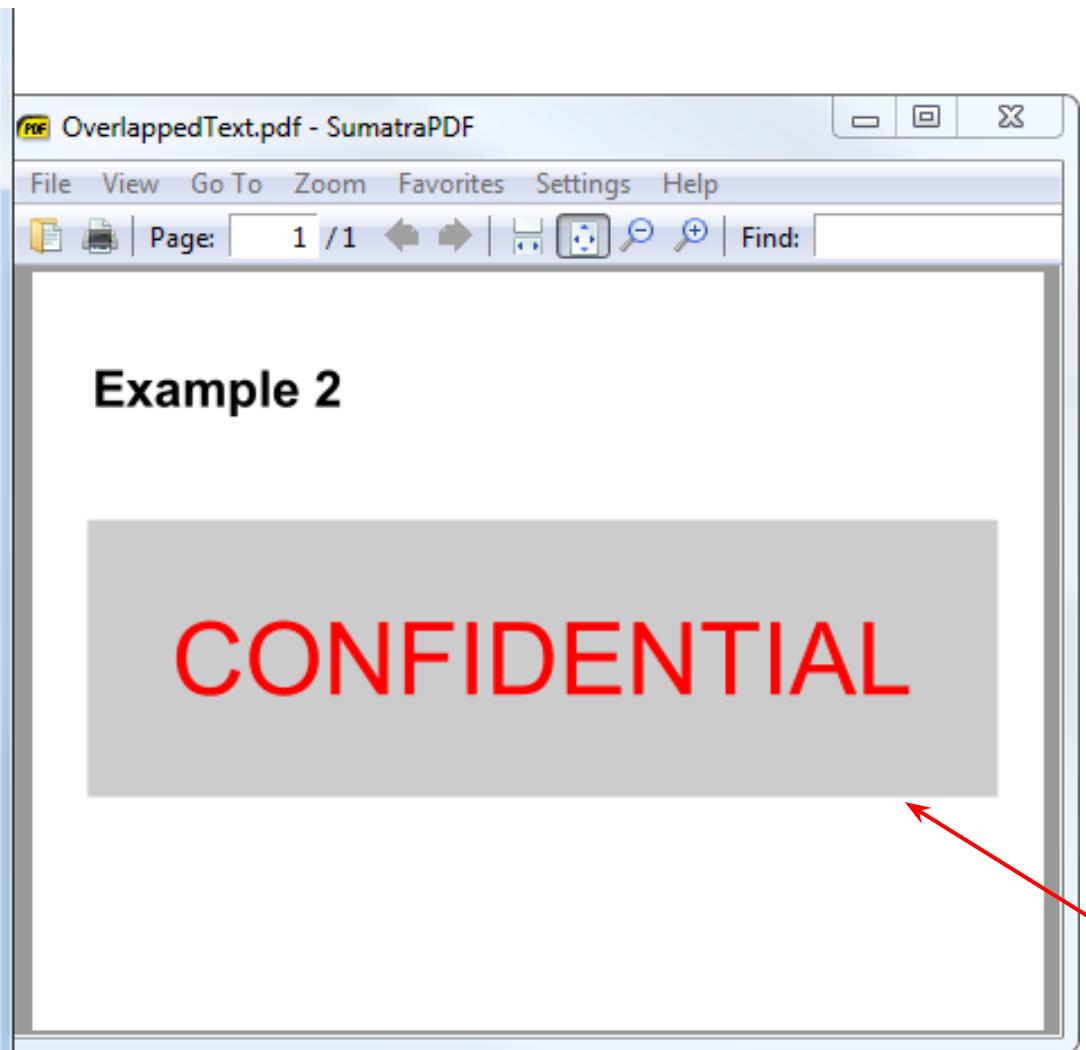


take the uncompressed PDF  
locate the /Contents stream object  
locate the S (Stroke path)  
(you can search for \nS\n)

```
RG  
19931.0  
89692.0  
m  
349115.0  
89692.0  
1  
349115.0  
189868.0  
1  
19931.0  
189868.0  
1  
h  
-  
Q  
q  
381.0  
0  
0  
381.0  
0  
0  
cm  
q  
1.0  
0
```

Ln : 375 | UNIX

ANSI OVR ...



overwrite the S with a space  
⇒ no more black border

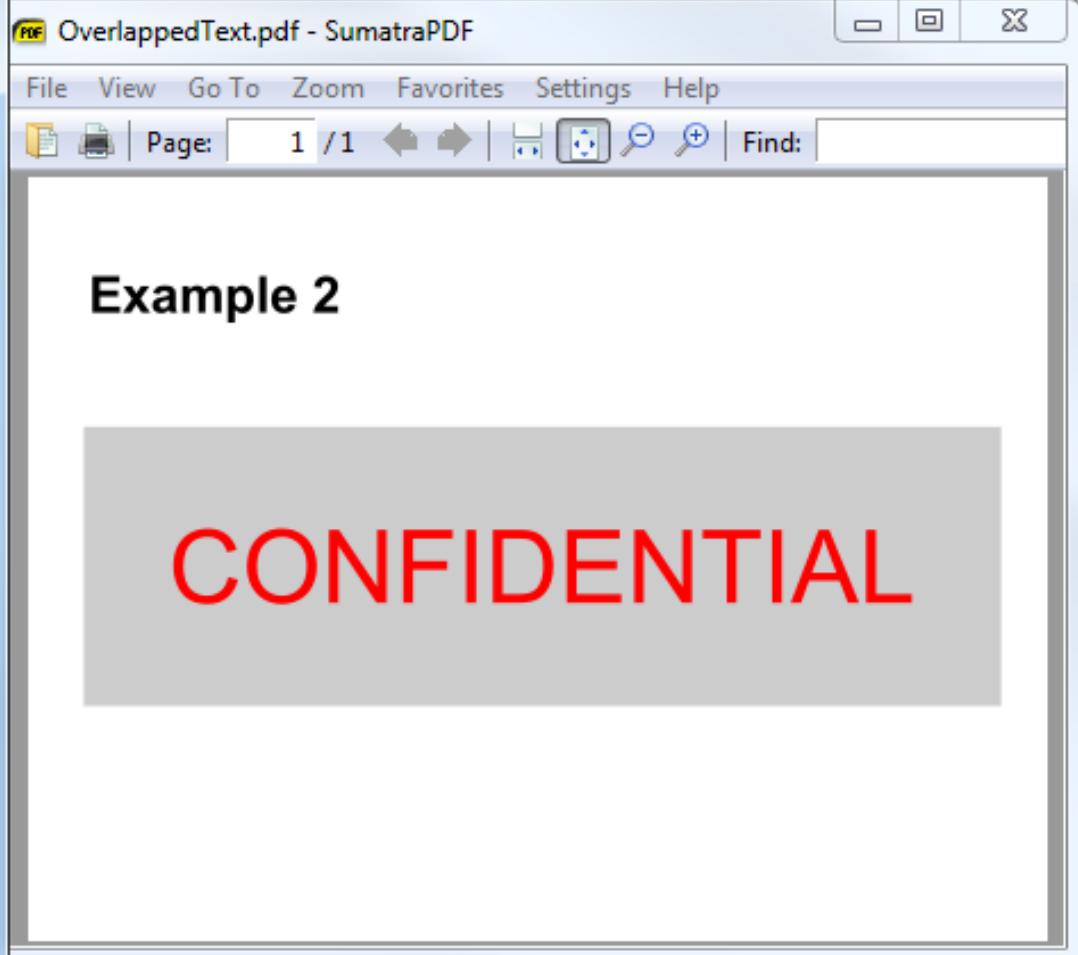
```
19931.0  
89692.0  
m  
349115.0  
89692.0  
1  
349115.0  
189868.0  
1  
19931.0  
189868.0  
1
```

```
h  
f  
Q  
/Alpha0  
gs  
762.0  
w  
0  
J  
1  
j  
14.3355875  
M  
[ ]0  
d
```

Ln : 344 UNIX

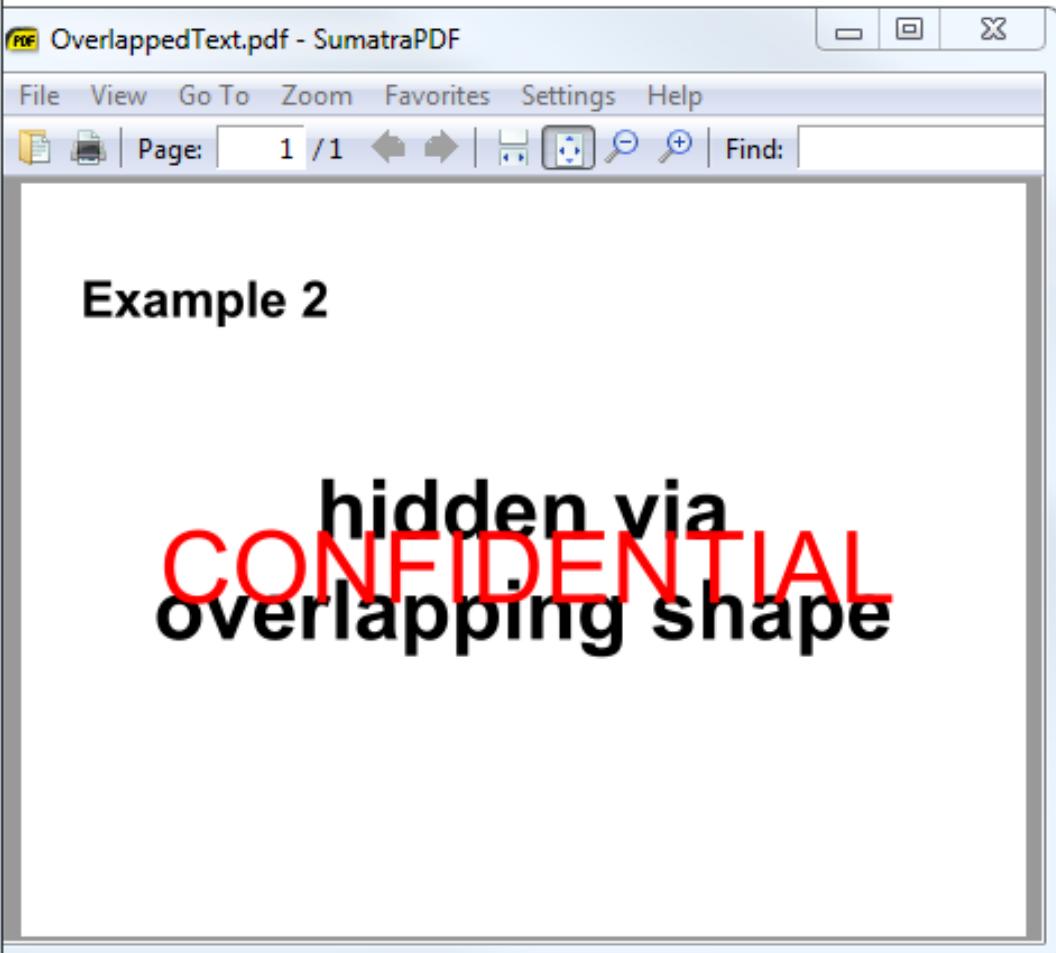
ANSI

OVR



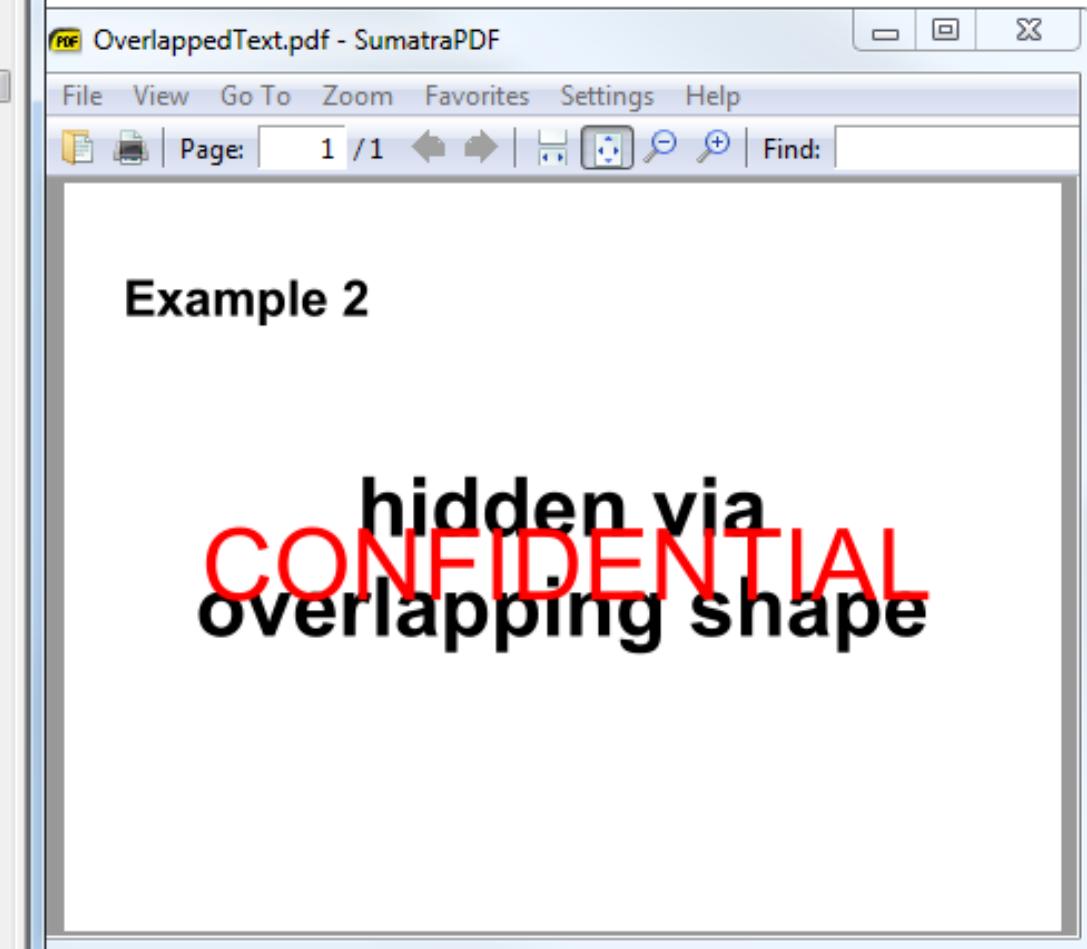
locate the f (path Filling)  
overwrite with space too...

```
19931.0
89692.0
m
349115.0
89692.0
1
349115.0
189868.0
1
19931.0
189868.0
1
h
Q
/Alpha0
gs
762.0
w
0
J
1
j
14.3355875
M
[]0
d
```



⇒ no more gray surface

```
96.0
Tf
1.0
0
0
-1.0
79.96875
166.12457
Tm
0
0
Td
( \u0000&\u0002\u0001\u0001\u0004 ) \u0000, \u0001' \u0004\ ( \u0001\u0004
Tj
ET
1.0
0
0
rg
BT
0
Tr
/Font3
96.0
Tf
1.0
0
```

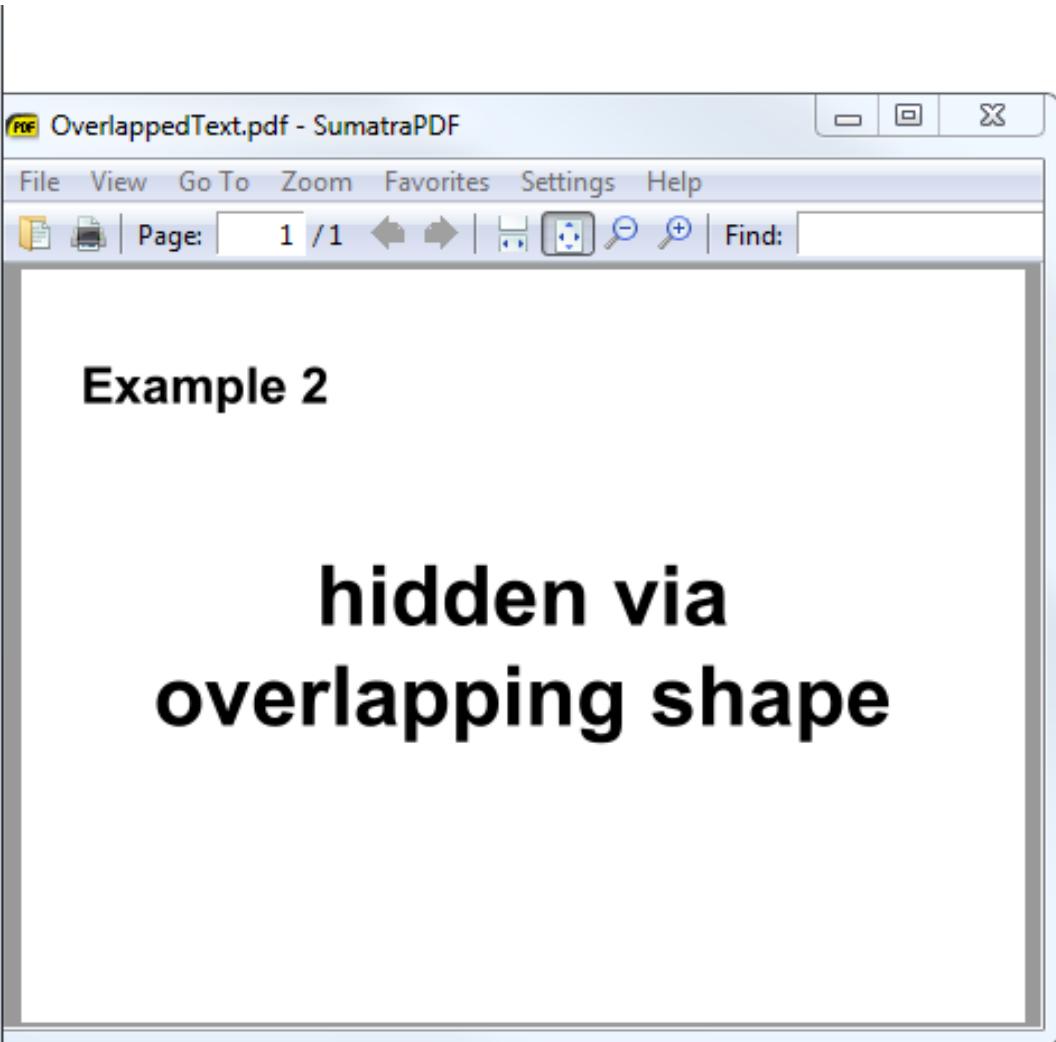


and the “obvious” Tj after the string ( . . . )

Note: the chars in this PDF are different to letters in rendered text, due to the font mapping:

&→C, 2→O, 1→N...

```
96.0
Tf
1.0
0
0
-1.0
79.96875
166.12457
Tm
0
0
Td
(NUL&NUL2NUL1NUL\)\NUL, NUL' NUL\(\NUL1N
-
ET
1.0
0
0
rg
BT
0
Tr
/Font3
96.0
Tf
1.0
0
```



→ no more hidden elements!

bonus: the operation can be easily automated!  
(on all pages, etc...)

# Page size (`MediaBox/CropBox`) effects

- a page isn't just a `/MediaBox` :(
    - PDF is not so simple!
      - `CropBox/BleedBox/TrimBox/ArtBox/...`
  - What you see is `/CropBox`
    - Copy/Paste and (some) `pdftotext` respect that
- ⇒ what is in `MediaBox` (but not `CropBox`) is not extracted by tools or copy/paste (most times -- some tools/versions do it)

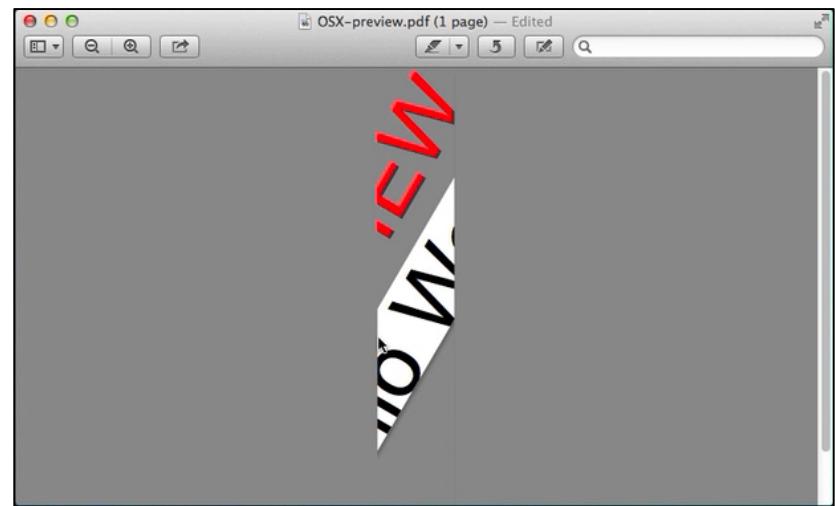
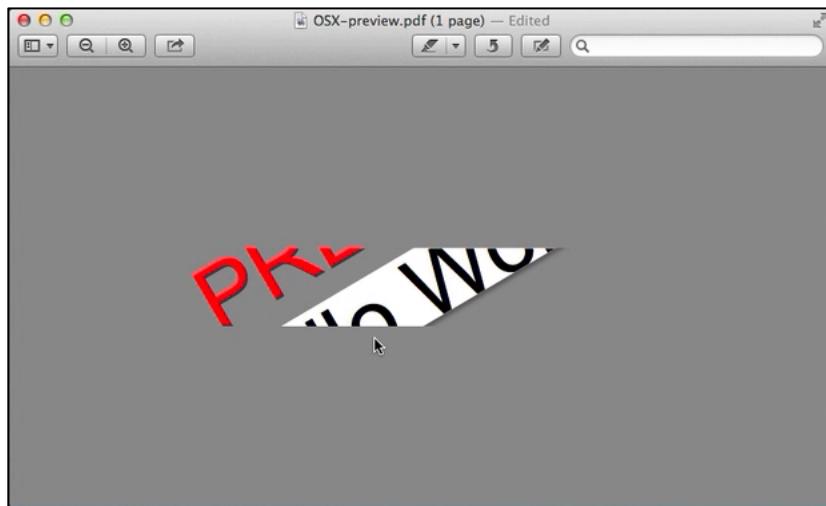
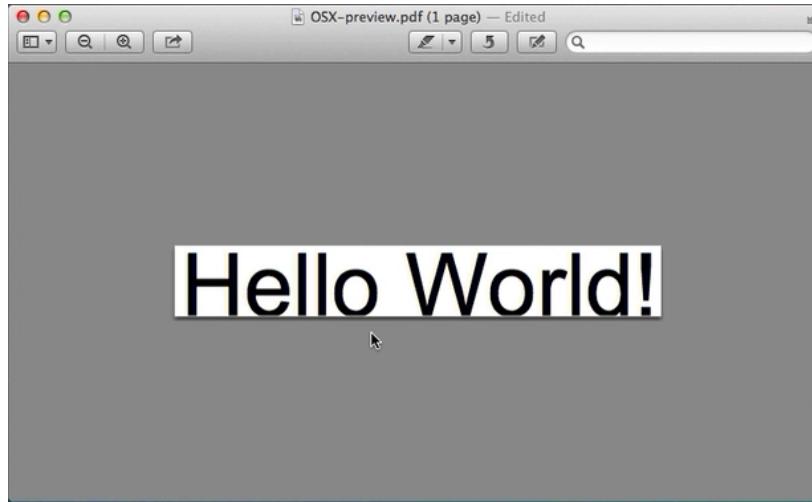
```
<< /Kids [3 0 R] /Type /  
endobj  
  
3 0 obj  
<< /Parent 2 0 R  
/MediaBox [0 0 612 950]  
/CropBox [0 0 612 792]  
/Resources << /Font << /  
/BaseFont /Arial /Subtyp  
>> >> /Contents 4 0 R /T  
endobj  
  
4 0 obj  
<< /Length 75 >>  
stream  
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!)Tj  
70 450 Td  
(SECRET!)Tj  
ET  
endstream  
endobj
```

Hello World!

```
<< /Kids [3 0 R] /Type /  
endobj  
  
3 0 obj  
<< /Parent 2 0 R  
/MediaBox [0 0 612 950]  
/cropBox [0 0 612 792]  
/Resources << /Font << /  
/BaseFont /Arial /Subtyp  
>> >> /Contents 4 0 R /T  
endobj  
  
4 0 obj  
<< /Length 75 >>  
stream  
BT  
/F1 110 Tf  
10 400 Td  
(Hello World!)Tj  
70 450 Td  
(SECRET!)Tj  
ET  
endstream  
endobj
```



"mis"-spell and disable /CropBox to see the full contents



OS-X actually does use a /CropBox when you copy/paste out of a PDF, but full page content is still there. You can see full original content by rotating the page. Or just mis-spell "/cropBox" once more to expose the secret again...

# Hidden text

- White color
  - 1 1 1 rg (filling's color)
- Text rendering mode ('Tr')
  - 3 Tr = invisible
    - OCRs use it to store text, overlaid over scanned image...

```

endobj
4 0 obj
<< /Length 68 >>
stream
BT
/F1 110 Tf
10 400 Td
1 1 1 rg
3 Tr
(Hello World!) Tj
ET
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n

```

```

endobj
4 0 obj
<< /Length 68 >>
stream
BT
/F1 110 Tf
10 400 Td
0 0 0 rg
0 Tr
(Hello World!) Tj
ET
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n

```

(Both of the above work independently from each other. Both allow to still copy'n'paste text...)

# A more ‘deniable’ hiding?

Altering /Kids or the page’s /Contents works.

But there is another elegant solution:  
*"incremental updates"*

# PDF incremental updates

- Not commonly used *on purpose*
  - ...but required for signing
- Supported by readers
- Acrobat incrementally updates after (<sup>most</sup>) changes when clicking "**Save**" (to avoid this, use "**Save As...**" !)

The concept:

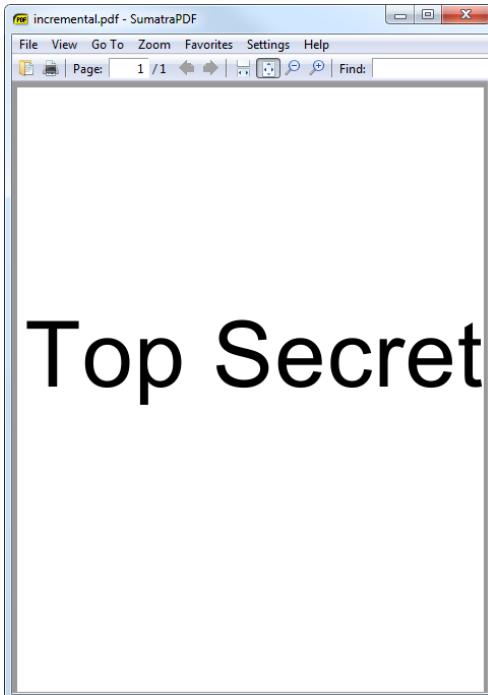
...add another set of objects, xref, trailer, ...

...to update the objects' hierarchy

...while leaving all previous objects in place.

# Example

a confidential object  
with a secret stream object 4  
to be hidden



```
%PDF-1.1
%âãÖ

1 0 obj
<< /Pages 2 0 R >>
endobj

2 0 obj
<< /Kids [3 0 R] /Type /Pages /Count 1 >>
endobj

3 0 obj
<< /Parent 2 0 R /MediaBox [0 0 612 792]
/Resources << /Font << /F1 <<
/BaseFont /Arial /Subtype /Type1 /Type /Font>>
>> >> /Contents 4 0 R /Type /Page >>
endobj

4 0 obj
<< /Length 50 >>
stream
BT
/F1 120 Tf
10 400 Td
(Top Secret) Tj
ET
endstream
endobj

xref
0 5
0000000000 65535 f
0000000016 00000 n
0000000052 00000 n
0000000110 00000 n
0000000282 00000 n

trailer << /Size 5 /Root 1 0 R >>

startxref
385
%%EOF
```

# New /Contents

**append** a new object 4

```
4 0 obj
<< /Length 52 >>
stream
BT
/F1 110 Tf
10 400 Td
(Hello World!) Tj
ET
endstream
endobj
```

# Extra xref

**append** a new xref  
that references it

```
xref
0 1
0000000000 65535 f
4 1
000000551 00000 n
```

# Extra trailer 1/2

- same /Size & /Root
- gives byte offset to previous **xref** via /Prev  
(not to previous trailer)

```
trailer <<
  /Size 5
  /Root 1 0 R
  /Prev 385
>>
```

# Extra trailer 2/2

points to the new **xref**

```
startxref  
654  
%%EOF
```

# Result

⇒ different content !

restore content by deleting everything after the first %%EOF:



# Incremental update to hide page

use the same trick  
to override /Type /Pages

```
...
%%EOF

1 0 obj
<<
/Type /Pages
/Kids [ 6 0 R 21 0 R]
/Count 2
>>
endobj

xref
0 1
0000000000 65535 f
1 1
0000118783 00000 n

trailer << /Size 41 /Root 4
0 R /Prev 117882 >>

startxref
118849
%%EOF
```

# **Actual accidental leaks in the wild ?**

***Of course!***

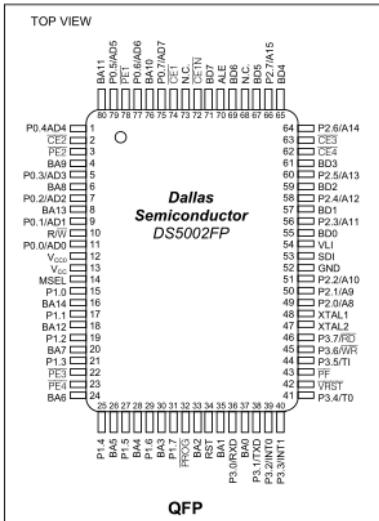
In any PDF with /Prev in the trailer:

- restore each intermediate version...
- ...by truncating after each %%EOF, one by one

## GENERAL DESCRIPTION

The DS5002FP secure microprocessor chip is a secure version of the DS5001FP 128k soft microprocessor chip. In addition to the memory and I/O enhancements of the DS5001FP, the secure microprocessor chip incorporates the most sophisticated security features available in any processor. The security features of the DS5002FP include an array of mechanisms that are designed to resist all levels of threat, including observation, analysis, and physical attack. As a result, a massive effort is required to obtain any information about memory contents. Furthermore, the "soft" nature of the DS5002FP allows frequent modification of the secure information, thereby minimizing the value of any secure information obtained by such a massive effort.

## PIN CONFIGURATION



# DS5002FP

## Secure Microprocessor Chip

### FEATURES

- **8051-Compatible Microprocessor for Secure/Sensitive Applications**  
Access 32kB, 64kB, or 128kB of NV SRAM for Program and/or Data Storage  
In-System Programming Through On-Chip Serial Port  
Can Modify Its Own Program or Data Memory in the End System
- **Firmware Security Features**  
Memory Stored in Encrypted Form  
Encryption Using On-Chip 64-Bit Key  
Automatic True Random Key Generator  
Self Destruct Input (SDI)  
Optional Top Coating Prevents Microprobe (DS5002FPM)
- **Improved Security Over Previous Generations**  
Protects Memory Contents from Piracy
- **Crash-Proof Operation**  
Maintains All Nonvolatile Resources for Over 10 Years in the Absence of Power  
Power-Fail Reset  
Early Warning Power-Fail Interrupt  
Watchdog Timer

### ORDERING INFORMATION

PART	TEMP RANGE	INTERNAL MICRO PROBE	PIN-SHIELD PACKAGE
DS5002FPM-16	0°C to +70°C	Yes	80 QFP
DS5002FPM+16	0°C to +70°C	Yes	80 QFP
DS5002FMN-16	-40°C to +85°C	Yes	80 QFP
DS5002FMN+16	-40°C to +85°C	Yes	80 QFP

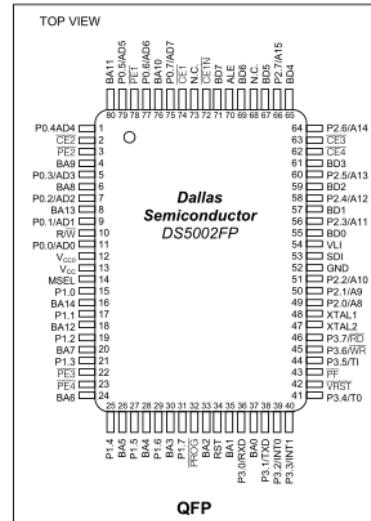
+ Denotes a Pb-free/RoHS-compliant device.

*Selector Guide appears at end of data sheet.*

## GENERAL DESCRIPTION

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Maintains All Nonvolatile Resources for Over 10 Years in the Absence of Power  
Power-Fail Reset  
Early Warning Power-Fail Interrupt  
Watchdog Timer

### ORDERING INFORMATION

PART	TEMP RANGE	INTERNAL MICRO PROBE	PIN-PACKAGE
DS5002FP-16	0°C to +70°C	No	80 QFP
DS5002FP+16	0°C to +70°C	No	80 QFP
DS5002FPM-16	0°C to +70°C	Yes	80 QFP
DS5002FPM+16	0°C to +70°C	Yes	80 QFP
DS5002FMN-16	-40°C to +85°C	No	80 QFP
DS5002FMN+16	-40°C to +85°C	Yes	80 QFP
DS5002FP-16N	-40°C to +85°C	No	80 QFP
DS5002FP+16N	-40°C to +85°C	No	80 QFP
DS5002FMN-16N	-40°C to +85°C	Yes	80 QFP
DS5002FMN+16N	-40°C to +85°C	Yes	80 QFP

+ Denotes a Pb-free/RoHS-compliant device.

*Selector Guide appears at end of data sheet.*

Note: Some revisions of this device may incorporate deviations from published specifications known as errata. Multiple revisions of any device may be simultaneously available through various sales channels. For information about device errata, click here: [www.maxim-ic.com/errata](http://www.maxim-ic.com/errata).

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incrementally updated PDF found in the wild  
(removed parts, incorrect page number)

**REVISION HISTORY**

REVISION	DESCRIPTION
112795	Original release.
073096	Change $V_{CC02}$ specification from $V_{LI} - 0.5$ to $V_{LI} - 0.65$ (PCN F62501). Update mechanical specifications.
111996	Change $V_{CC01}$ from $V_{CC} - 0.3$ to $V_{CC} - 0.35$ .
061297	$\overline{PF}$ signal moved from $V_{OL2}$ test specification to $V_{OL1}$ . PCN No. (D72502). AC characteristics for battery-backed SDI pulse specification added.
051499	Reduced absolute maximum voltage to $V_{CC} + 0.5V$ . Added note clarifying storage temperature specification is for nonbattery-backed state. Deleted $I_{BAT}$ specification (Duplicate of $I_L$ specification). Changed RRE min (industrial temp range) from $40k\Omega$ to $30k\Omega$ . Changed $V_{PFW}$ max (industrial temp range) from 4.5V to 4.6V. Added industrial specification for $I_{LJ}$ . Reduced $t_{CEH0V}$ and $t_{CEHDV}$ from 10ns to 0ns.
052599	Minor revisions and approval.
062102	Update $V_{CC0}$ and $I_{CC01}$ specifications to reflect 0.45V internal voltage drop instead of 0.35V.
100102	Ordering information updated.
030403	Reset Trip Point in Stop Mode (DC Characteristics) with BAT = 3.0V was changed to 3.3V (original issue was 3.3V).
070605	Added Pb-free part numbers to Ordering Information and Selector Guide. Added Operating Voltage specification. (This is not a new specification because operating voltage is implied in the testing limits, but rather a clarification.) Updated Absolute Maximum soldering temperature to reference JEDEC standard.
090805	In the AC Characteristics—SDI Pin table, changed $t_{SPR}$ MAX (in active mode) from $2\mu s$ to $1.3\mu s$ . This change is only to correct a documentation error, and does not reflect a change in device operation or any change in testing.
072806	Removed products from Ordering Information table that do not contain internal micro probe shields.

25 of 25

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No circuit patent licenses are implied. Maxim/Dallas Semiconductor reserves the right to change the circuitry and specifications without notice at any time.

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062102	Update $V_{CC0}$ and $I_{CC01}$ specifications to reflect 0.45V internal voltage drop instead of 0.35V.
100102	Ordering information updated.
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090805	In the AC Characteristics—SDI Pin table, changed $t_{SPR}$ MAX (in active mode) from $2\mu s$ to $1.3\mu s$ . This change is only to correct a documentation error, and does not reflect a change in device operation or any change in testing.

25 of 25

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“Printed USA”

**real examples**  
**(of info leaks because of f\*ck-up)**

# US Military in Iraq

1. decompress streams
2. locate page
3. locate content
4. locate **re** operators
5. disable **re** operators

UNCLASSIFIED

## III. TRAFFIC CONTROL POINTS, BLOCKING POSITIONS, AND TRAINING

### A. (U) Introduction

(U) This section examines TCPs, BPs, and training matters. It first discusses the difference between a TCP and a BP. Standing Operating Procedures (SOPs) for the various units involved regarding TCPs and BPs are assessed, and the Rhino Bus TTP is outlined. This is followed by a review of the training on TCPs, BPs, weapons, and Rules of Engagement (ROE) that the Soldiers manning BP 541 had received before 4 March 2005. The ROE that were in effect that night are explained. The section concludes with findings and recommendations.

### B. (U) Traffic Control Points and Blocking Positions

(U) Task Force [REDACTED] had received missions to establish TCPs and blocking positions numerous times in the past. [REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]

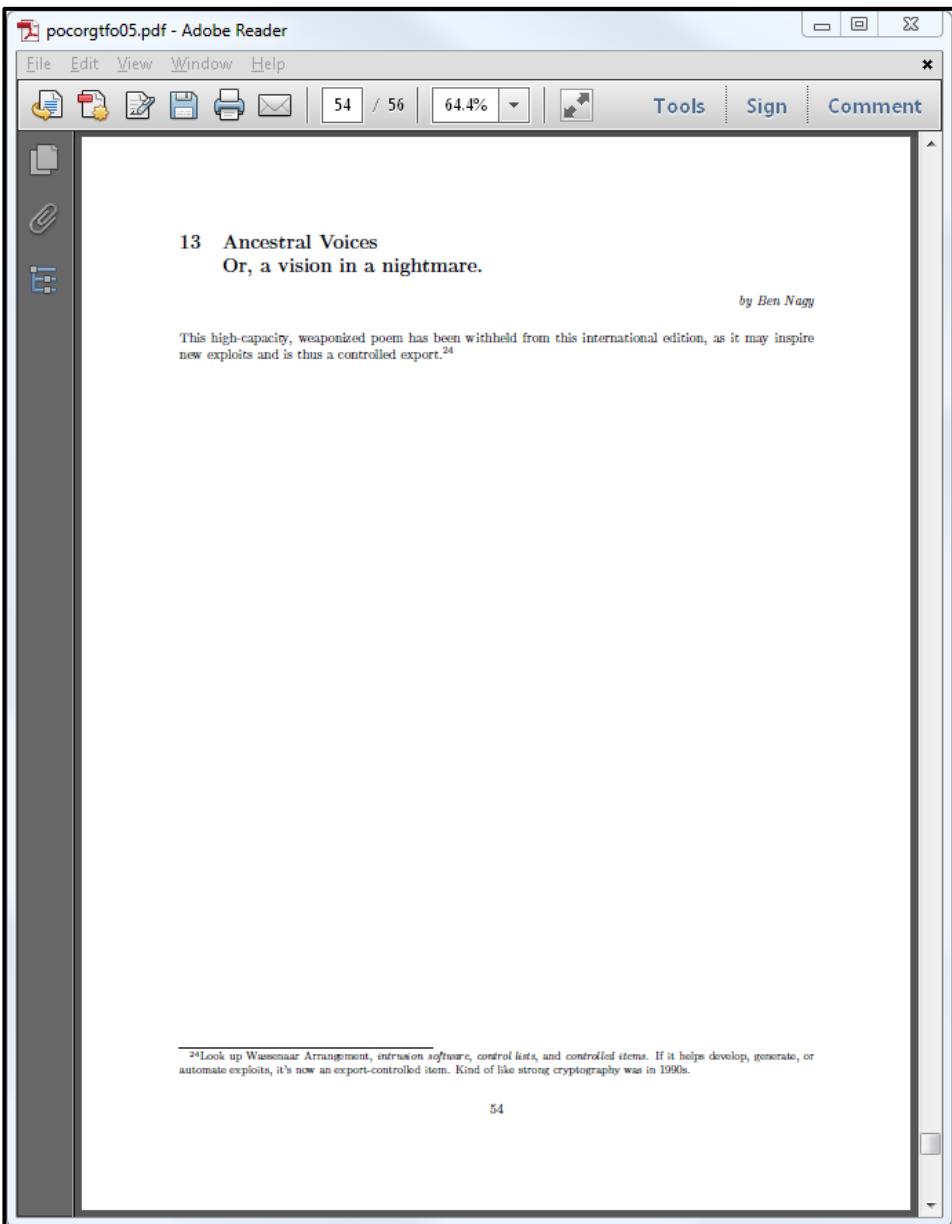
### C. (U) Standing Operating Procedures in use on 4 March 2005

(U) SOPs are designed to serve as guidelines for specific operations and are not prescriptive in nature. They provide a baseline for acceptable operations from which commanders can derive principles and techniques and adapt them to their current mission. (Annexes 44C, 65C, 72C, 96C, 98C).

UNCLASSIFIED

# PoC||GTFO 0x05

1. restore structure
2. decompress
3. locate \*
4. modify operator



# Conclusion

# Conclusion

- the PDF file format is awkward & complex
  - different logics together
  - a format still evolving
    - 2.0 is in final draft at ISO, due in 2016
- accidental leaks of information can be easy
- text can still be modified
  - adding/removing watermarks and other contents

This was just an overview - have fun!

# ACK

@Daeinar @veorq @\_Quack1 @MunrekFR  
@dominicgs @mwgamera @kevinallix @munin  
@kristamonster @ClaudioAlbertin @push\_pnx  
@JHeguia @doegox @gynvael @nst021  
@iamreddave @chrisklein

# Bonus

# Prepare a PDF for the text editor

(check out these tools + make your pick)

```
qpdf --qdf --object-streams=disable in.pdf out.pdf  
pdftk in.pdf cat output out.pdf uncompress  
mutool clean -d in.pdf out.pdf  
podofouncompress in.pdf out.pdf
```

## Check for errors after editing

```
qpdf --check edited.pdf  
qpdf --show-xref edited.pdf  
gs -o /dev/null -sDEVICE=pdfwrite edited.pdf  
pdfinfo -box -f 1 -l 1000 edited.pdf  
pdfimages -list -f 1 -l 1000 edited.pdf  
pdffonts -f 1 -l 1000 edited.pdf
```

# Prepare a PDF for the text editor

- Be sure to check with *different* PDF viewers: Ghostscript/gv, MuPDF, SumatraPDF, FoxitReader, Adobe Reader, Adobe Acrobat, Chrome's builtin PDF viewer, PDF.js in Firefox, Evince, Preview.app (on OSX), Zathura...
- Scroll through all PDF pages (some errors only materialize when page must be rendered)
- If Acrobat/Adobe Reader open PDF with no warning or error, but upon closing ask if you want to "save *the changes*"... it's not *your* changes it wants to save, but some errors it found!

## Fixing errors after editing

```
qpdf edited.pdf fixed.pdf  
gs -o fixed.pdf -sDEVICE=pdfwrite edited.pdf  
mutool clean edited.pdf fixed.pdf
```

# Remove a page ?

easy hiding

1. remove reference from /Kids (commenting out is sufficient)
2. write it back later

```
obj  
15776  
endobj  
1  
0  
obj  
<<  
/Type  
/Pages  
/Kids  
[  
6  
0  
R  
14  
0  
R  
21  
0  
R  
]  
/Count  
3  
>>  
endobj  
xref  
0 41  
0000000002 65535 f  
0000117809 00000 n  
0000000003 00000 f  
0000000000 00000 f  
0000000016 00000 n  
0000000160 00000 n  
0000000207 00000 n  
0000000373 00000 n  
0000083202 00000 n  
0000000730 00000 n  
0000000719 00000 n
```

# my public prezo

**this slide should deniably removed**

private text



and private image:

**public slide**

public text

locate the /Kids array

```
obj
15776
endobj
1
0
obj
<<
/Type
/Pages
/Kids
[
6
0
R
R
21
0
R
]
/Count
3
>>
endobj
xref
0 41
000000002 65535 f
0000117809 00000 n
0000000003 00000 f
0000000000 00000 f
0000000016 00000 n
0000000160 00000 n
0000000207 00000 n
0000000373 00000 n
0000083202 00000 n
0000000730 00000 n
0000000719 00000 n
```

# my public prezo

## public slide

public text

Edit out your page's reference

```
obj
15776
endobj
1
0
obj
<<
/Type
/Pages
/Kids
[
6
0
R

21
0
R
]
/Count
2_
>>
endobj
xref
0 41
000000002 65535 f
0000117809 00000 n
000000003 00000 f
0000000000 00000 f
0000000016 00000 n
0000000160 00000 n
0000000207 00000 n
0000000373 00000 n
0000083202 00000 n
0000000730 00000 n
0000000749 00000 n
```

## my public prezo

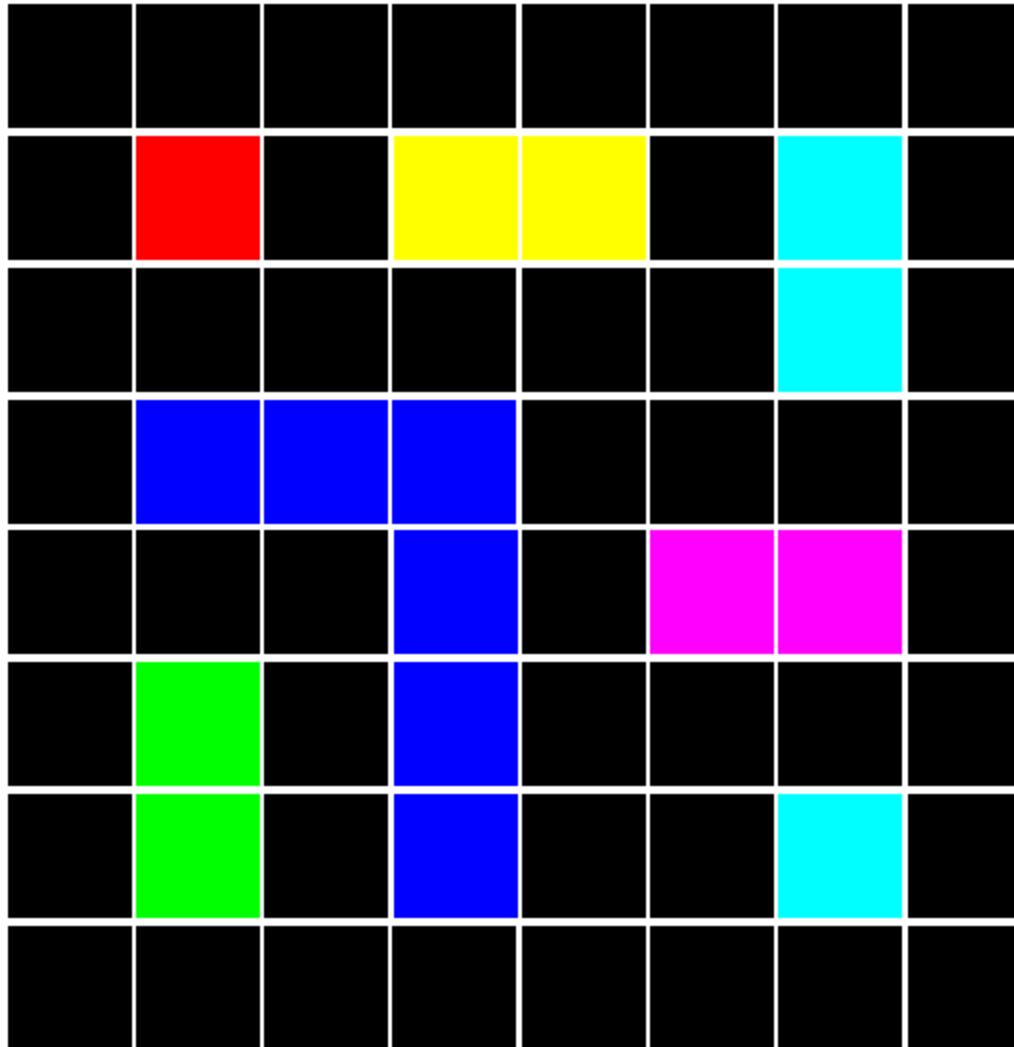
### public slide

public text

and don't forget to update the pages' /Count ☺  
(may lead to funny results)

# A little riddle to solve...

Which hidden message is in this PDF?



this slide intentionally left blank

# PDF + PostScript: Myths and Facts

- PDF is *not* an "extension of PostScript" (PS is a Turing-complete programming language -- PDF is not!)
- Yes, PDF inherited its basic *graphics model* from PS (and extended it with many new features)
- But PDF got everything removed what made PS a programming language: conditions, loops, arithmetics,... *precisely because it did more bad than good for PS as: (1) a universal "electronic document format"; (2) a "reliable print job format"*  
(however, its retrofitted JavaScript support since PDF-1.3 makes up for this ;-)

# PDF + PostScript: Guesses and Facts

- Which format does typically requires smaller file sizes for identical screen or page content? ***PDF or PS?*** (Make an un-educated guess, if you dare. Then look at the *fractals-sierpinski-\*.ps* files. Open them in a text editor. Convert them to PDF with Ghostscript -- a working command is in the PS comments. Check their respective file sizes.)
- Which graphics type does typically produce smaller files for the same screen or page content? ***Raster images or vector drawings?*** (Again, make an un-educated guess, if you dare. Then look at the same files as above. Open them in a text editor. Convert them to PDF with Ghostscript -- a working command is in the PS comments. Open them, one after another in your favorite PDF viewer and watch them render... Would the PS version render faster?)

(*Warning! Beware of the files with depth 8 or higher!*)



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