Introducing the Microsoft Vista Log File Format

By

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Introducing the Microsoft Vista Event Log File Format.

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Vista Event Log Files.
Agenda.

1. Introduction

2. The Outer Structure

3. The Inner Structure – Binary XML
3.1 Token
3.2 Substitution
3.3 Templates

4. Forensic Practice
4.1 Carving
4.2 Interpretation of a Single Record

5. Conclusion

Vista Event Log Files.
Introduction.

- “Crimson” 2005, now “Windows Event Logging”
- truly new event logging service
- log file format obviously differs from that of NT family
- no parsers available beside the logging service
  - Vista required for analysis
  - doesn’t operate on fragments of files

Vista Event Log Files.
Method.

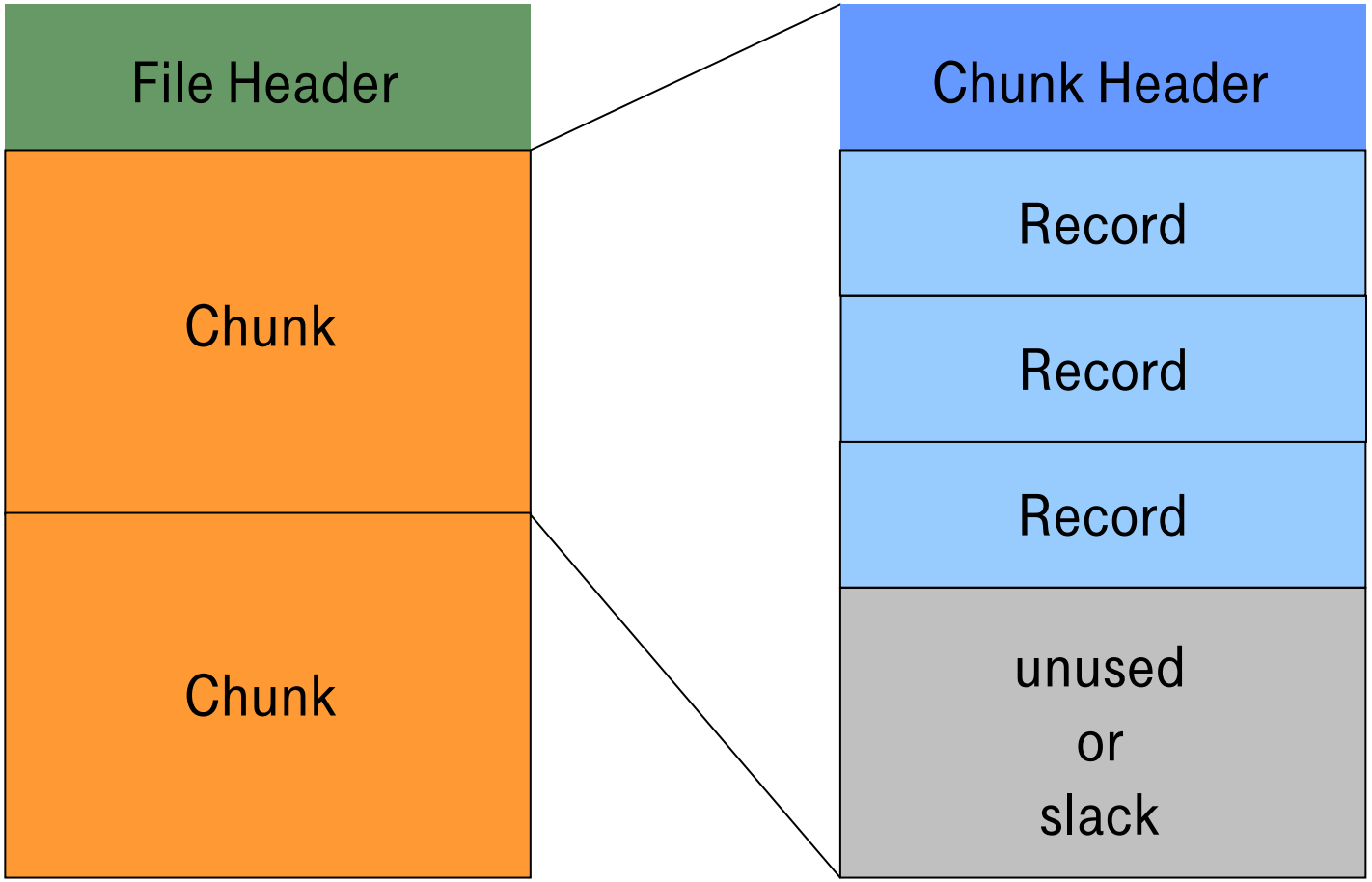
- must not use any material that is under NDA
- no decompilation, restricted by German IP law
- clean-room analysis
  - clean install of Microsoft Vista Ultima RTM
  - normal system activity
    - 17 non-empty files, 2616 records
    - compare binary and textual representation
  - special conditions
    - flooding
    - unclean shutdown

Vista Event Log Files.
Tools.

- Scripts for the 010 Editor
  - outer structure (file to record)
  - SubstitutionArray
  - http://computer.forensikblog.de/files/010_templates/

- Framework (Perl) around a recursive-descent parser
  - outer structure
  - known system tokens, known data types
  - http://computer.forensikblog.de/files/evtx/EvtxParser-1.0.0.zip

The Outer Structure.
Overview.



The Outer Structure.
File.

- file header is permanently mapped into memory
- size 4096 bytes (= 1 physical memory page)
- only 128 Bytes are in use
- magic string “ElfFile”, 0x00
- version 3.1 (NT Event Log uses 1.1, Crimson 2.1)
- count of chunks
  number of current chunk
- flags (DIRTY, FULL)
- integrity protected by CRC32 check sum

The Outer Structure.
Chunk.

- from all chunks only the current one is mapped into memory
- size 64 kiB
- magic string “ElfChnk”, 0x00
- numbers of first/last event record
- integrity protected by CRC32 check sum

The Outer Structure.
Event Record.

- magic string 0x2a 0x2a 0x00 0x00
- length near beginning and at the end
- record number (uint64)
- timestamp (FILETIME, 100ns since Jan 1st, 1601, 00:00:00)
- XML (“inner structure”)

Binary XML.
Schema.

XML schema has been published on the MSDN web site.

```
<Events>
    <Event>
        <System>
            <EventID>1</EventID>
            <TimeCreated SystemTime="2006-10-
              08T09:21:28.415Z"/>
            <EventRecordID>573</EventRecordID>
            …
        </System>
        <EventData>
        …
        </EventData>
    </Event>
</Events>
```

Binary XML.
Problems with Textual XML.

- disk utilization
  - low entropy
- CPU utilization
  - calculating block length
  - check for well-formedness

Solution: binary XML

- commonly found on smartphones

Binary XML.
Tokenization.

XML language elements are replaced by tokens.

- system tokens („operators“)
- application tokens („operands“)
  - element/attribute names
  - XML templates

Binary XML.
Tokenization.

Encoding of a start element tag:

< EventID >

becomes

#OpenStartElementTag#

EventID

#CloseStartElementTag#

Binary XML.
Tokenization.

Encoding of a container element:

```
<EventID>1234</EventID>
```

becomes

```
#OpenStartElementTag#
EventID
#CloseStartElementTag#
1234
#EndElementTag#
```

Binary XML.
Tokenization.

Value	Meaning	Example
0x00	EndOfBXmlStream	
0x01	OpenStartElementTag	< name >
0x02	CloseStartElementTag	< name >
0x03	CloseEmptyElementTag	< name />
0x04	End Element Tag	</ name >
0x05	Value	attribute = “value”
0x06	Attribute	attribute = “value”
0x0c	TemplateInstance	
0x0d	NormalSubstitution	
0x0e	OptionalSubstitution	
0x0f	StartOfBXmlStream	

Binary XML.
Substitution.

Separating structure from content:

<EventID> 1234 <EventID/>

becomes

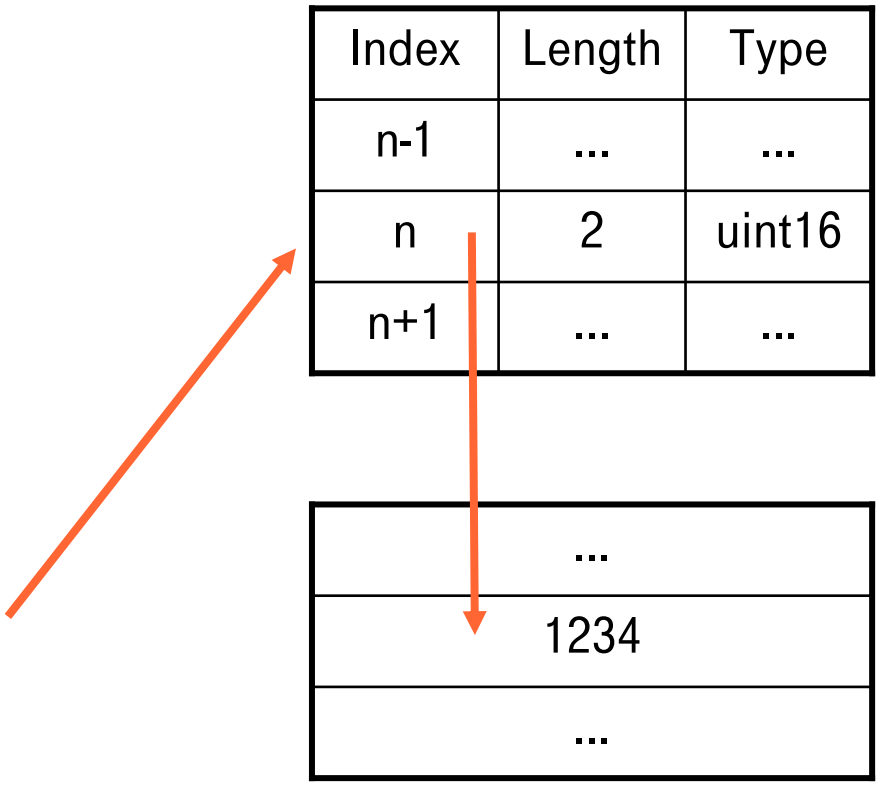
#OpenStartElementTag#

EventID

#CloseStartElementTag#

#NormalSubstitution# *Index n*

#EndElementTag#



Binary XML.
Templates.

After the separation step many records share a common XML structure.

The structure is defined once (“template”) and applied multiple times.

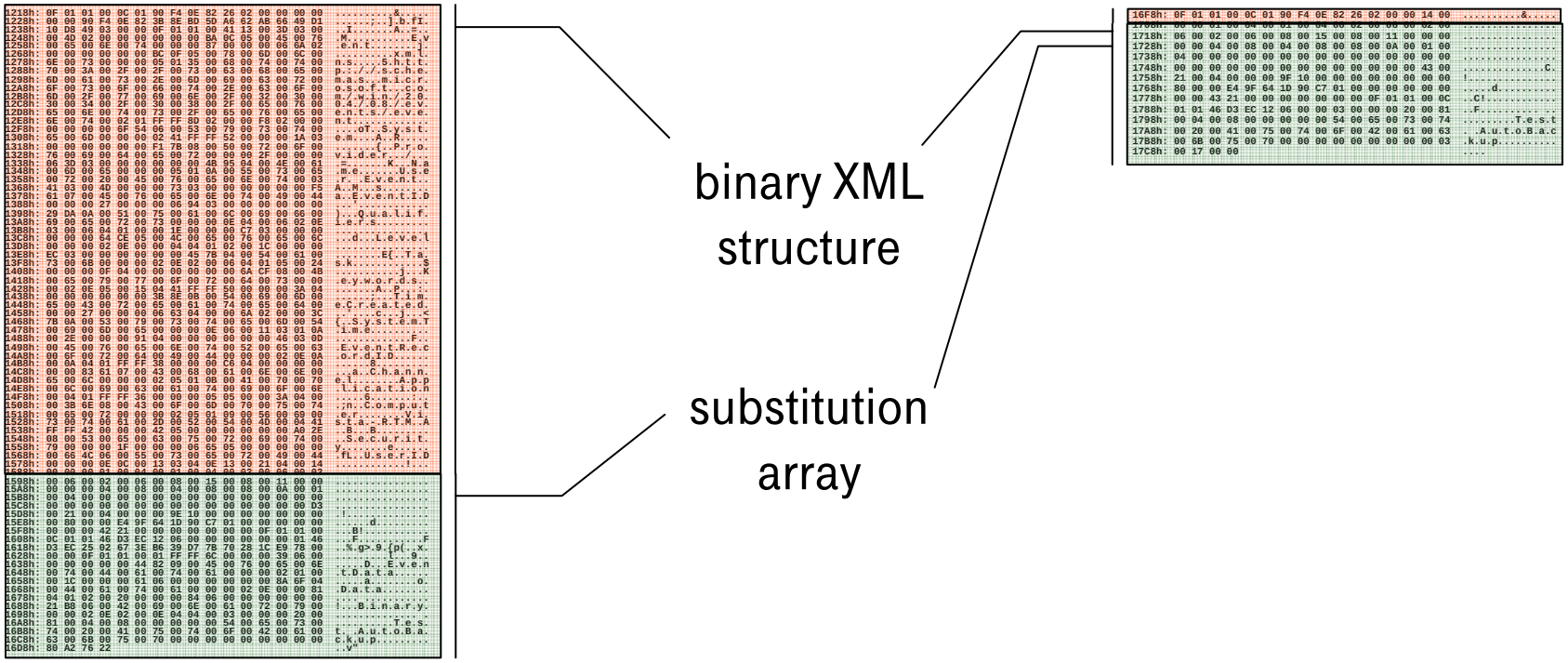
Example:

- the same event message is submitted twice
- only timestamp and record number will differ

Binary XML.
Templates.

First record

Second record



Binary XML.
Summary.

- 3-step process
  - tokenization
  - substitution
  - templates
- results in compact binary XML

Forensic Practice.
Carving – Whole File.

- header with magic string „ElfFile“
- no footer
- file size = 4 kiB + chunks * 64 kiB
- use evtxdump.pl or system service to transform the carved (binary) file into text

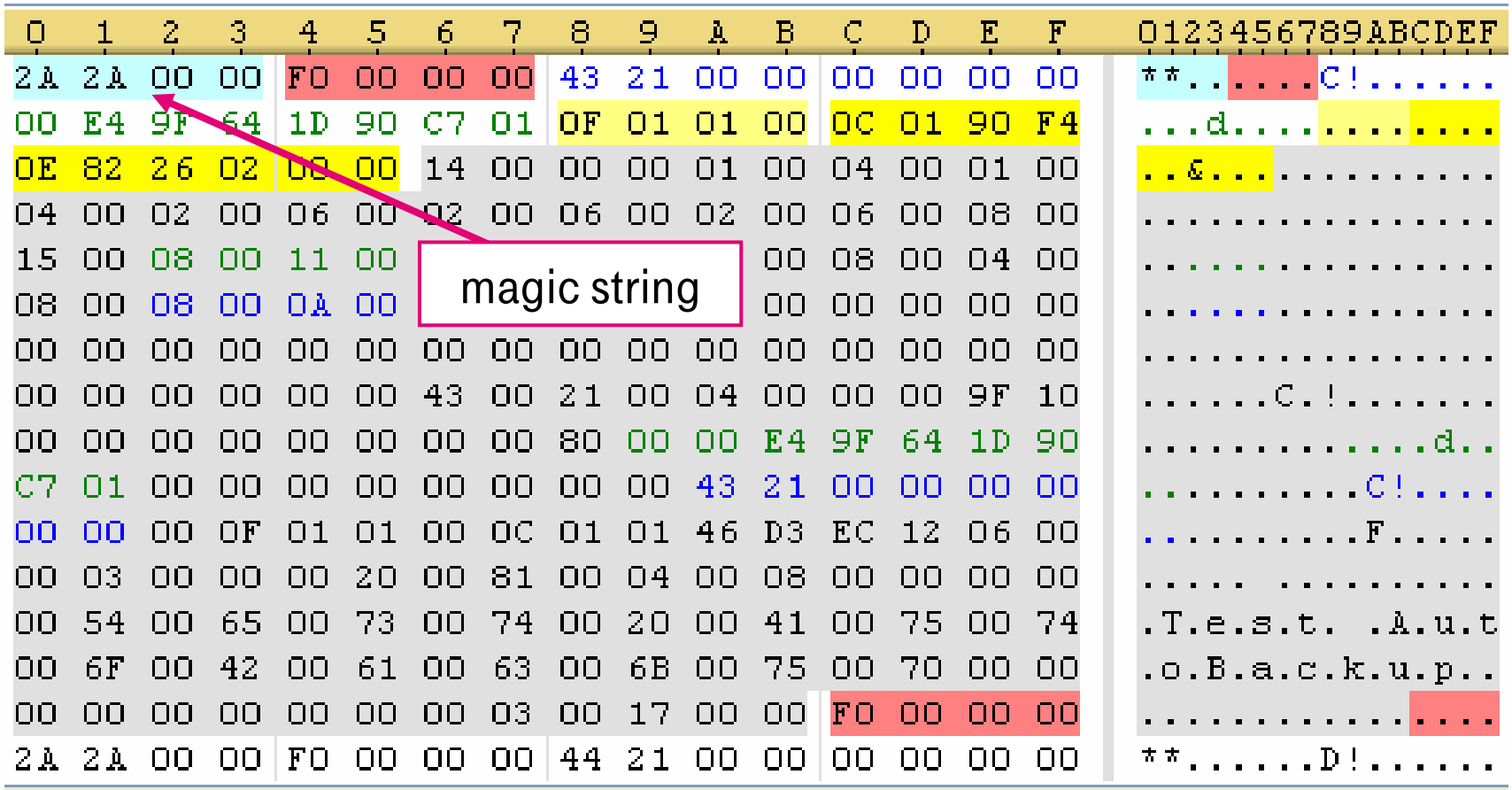
Forensic Practice.
Carving – Single Chunk.

- header with magic string „ElfChunk“
- no footer
- size = 64 kiB
- use evtxdump.pl to transform into text

Forensic Practice.
Carving – Single Record.

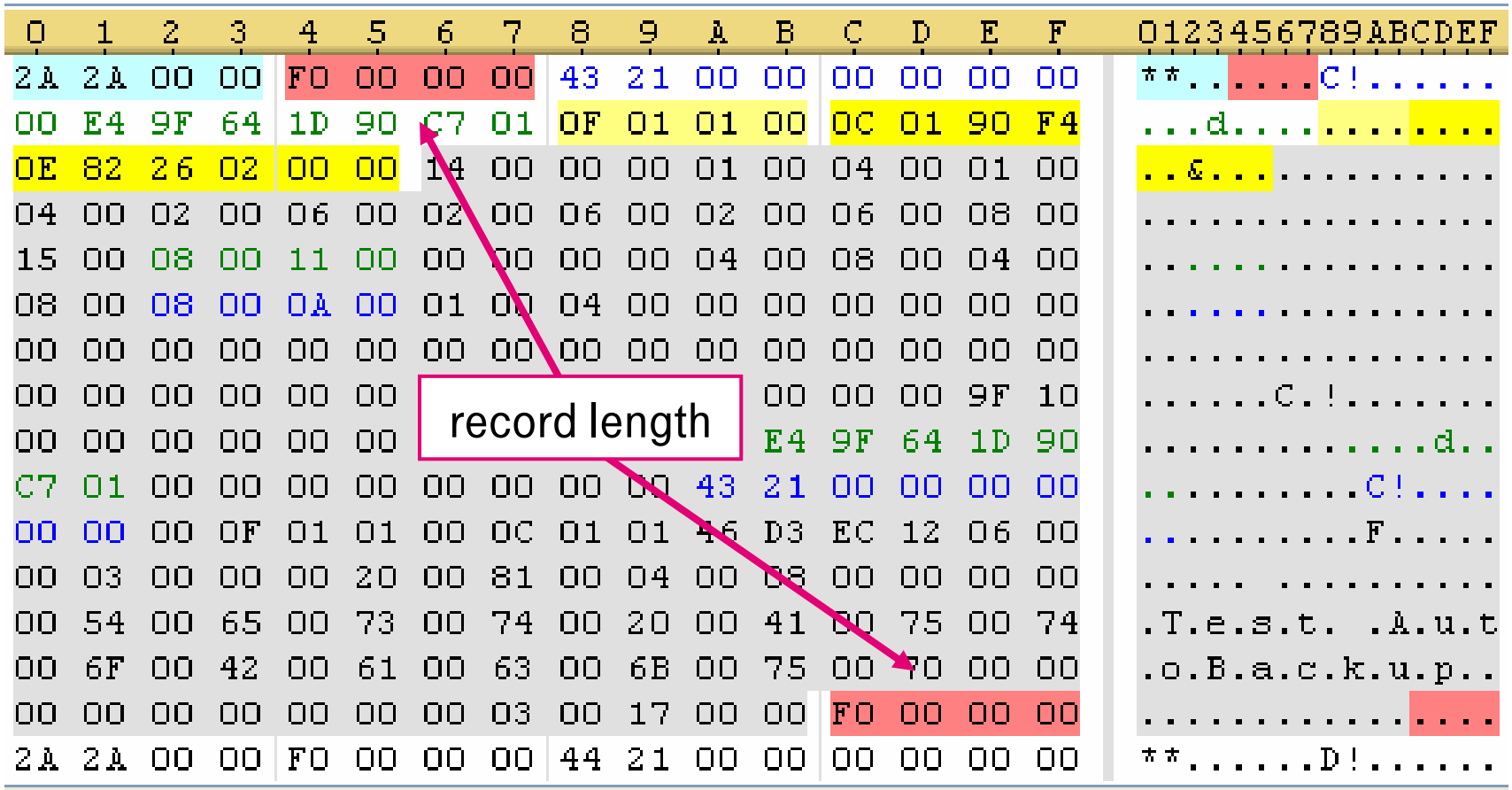
- header with magic string 0x2a 0x2a 0x00 0x00
- no fixed footer
- size is variable, but known

Forensic Practice.
Interpretation of a Single Record.



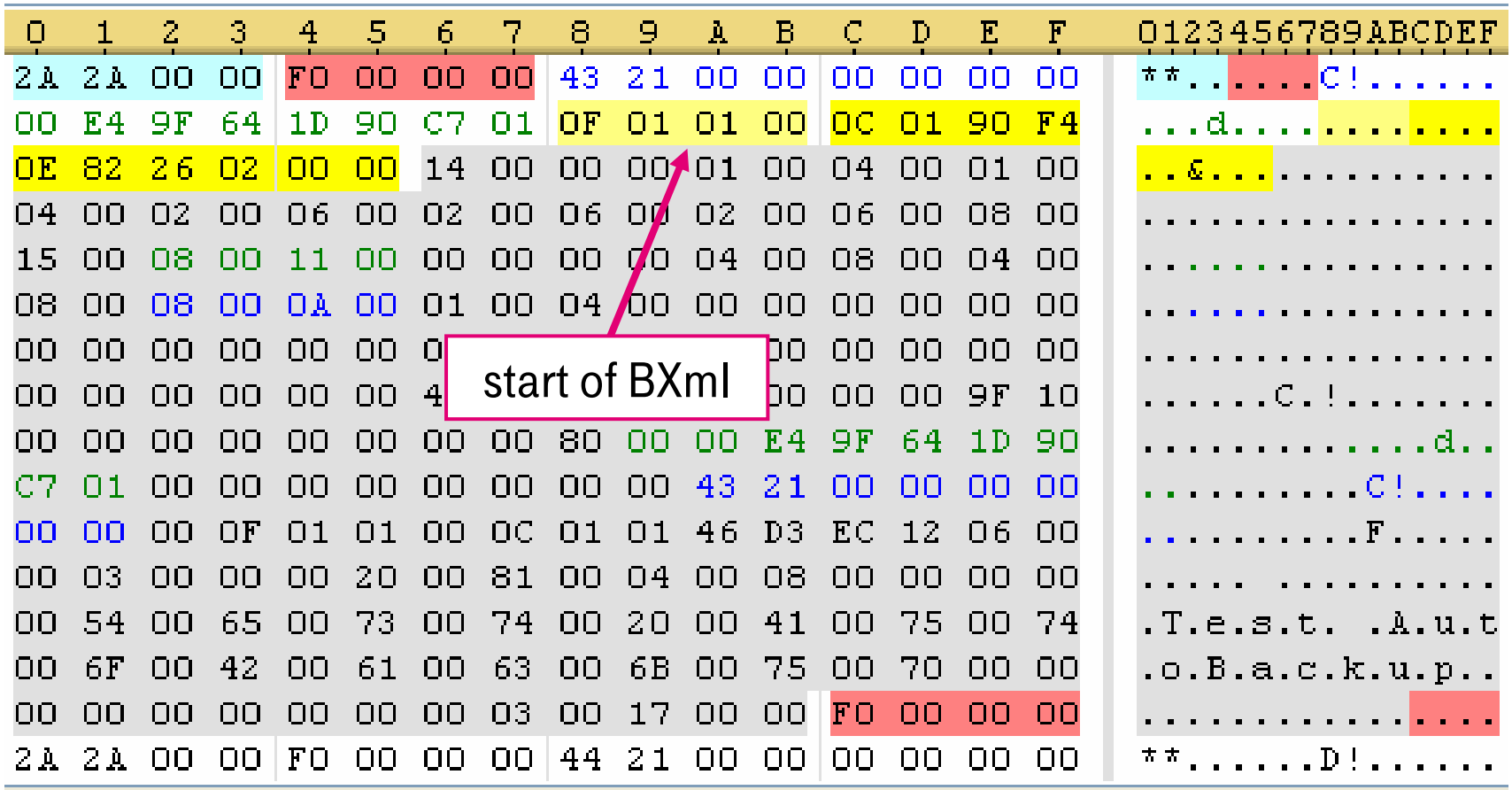
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d..........ô
0E	82	26	02	08	00	14	00	00	00	01	00	04	00	01	00	..&..............
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	....
15	00	08	00	11	00	02	00	00	00	00	00	00	08	00	04	....
08	00	08	00	0A	00	02	00	00	00	00	00	00	00	00	00	....
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	....
00	00	00	00	00	00	43	00	21	00	04	00	00	00	9F	10	......C.!.......
00	00	00	00	00	00	00	00	80	00	00	E4	9F	64	1D	90	..............ä.d.
C7	01	00	00	00	00	00	00	00	00	43	21	00	00	00	00	..........C!....
00	00	00	0F	01	01	00	0C	01	01	46	D3	EC	12	06	00	..........FÓì...
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	....
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	..............ð...
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**....ð...D!.....

Forensic Practice.
Interpretation of a Single Record.



0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d.....d.....ô
0E	82	26	02	00	00	14	00	00	00	01	00	04	00	01	00	..&.....Ç.....
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	.....
15	00	08	00	11	00	00	00	00	00	04	00	08	00	04	00	.....
08	00	08	00	0A	00	01	00	04	00	00	00	00	00	00	00	.....
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
00	00	00	00	00	00	[record length]					00	00	00	9F	10	.....C.!.....
00	00	00	00	00	00						E4	9F	64	1D	90	.....d..
C7	01	00	00	00	00	00	00	00	00	43	21	00	00	00	00	.....C!....
00	00	00	0F	01	01	00	0C	01	01	A6	D3	EC	12	06	00	.....F.....
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	....
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	.....ð...
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**....D!.....

Forensic Practice.
Interpretation of a Single Record.

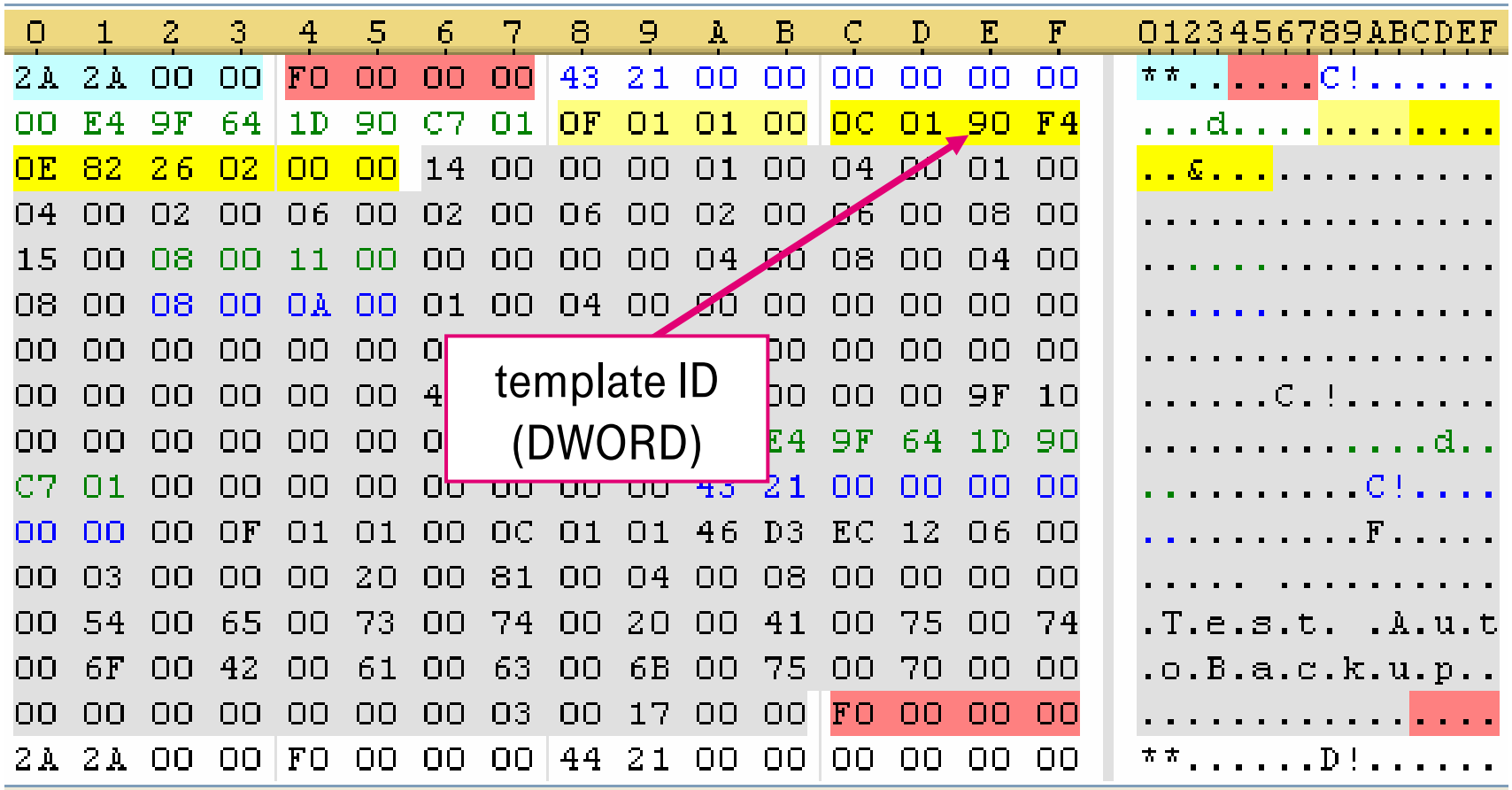


0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d..........ô
0E	82	26	02	00	00	14	00	00	00	01	00	04	00	01	00	..&.....¶......
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	..¶.¶.¶.¶.¶.¶.
15	00	08	00	11	00	00	00	00	00	04	00	08	00	04	00	..¶.¶.¶.¶.¶.¶.
08	00	08	00	0A	00	01	00	04	00	00	00	00	00	00	00	..¶.¶.¶.¶.¶.¶.
00	00	00	00	00	00	0					00	00	00	00	00	..¶.¶.¶.¶.¶.¶.
00	00	00	00	00	00	4					00	00	00	9F	10	..¶.¶.C.!..¶.¶.
00	00	00	00	00	00	00	00	80	00	00	E4	9F	64	1D	90	..¶.¶.¶.¶.¶.d..
C7	01	00	00	00	00	00	00	00	00	43	21	00	00	00	00	..¶.¶.¶.¶.C!.¶.¶.
00	00	00	0F	01	01	00	0C	01	01	46	D3	EC	12	06	00	..¶.¶.¶.F..¶.¶.
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	..¶.¶ .¶.¶.¶.¶.
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	..¶.¶.¶.¶.¶.¶.ð...
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**....ð...D!..¶.¶.

Forensic Practice.
Interpretation of a Single Record.

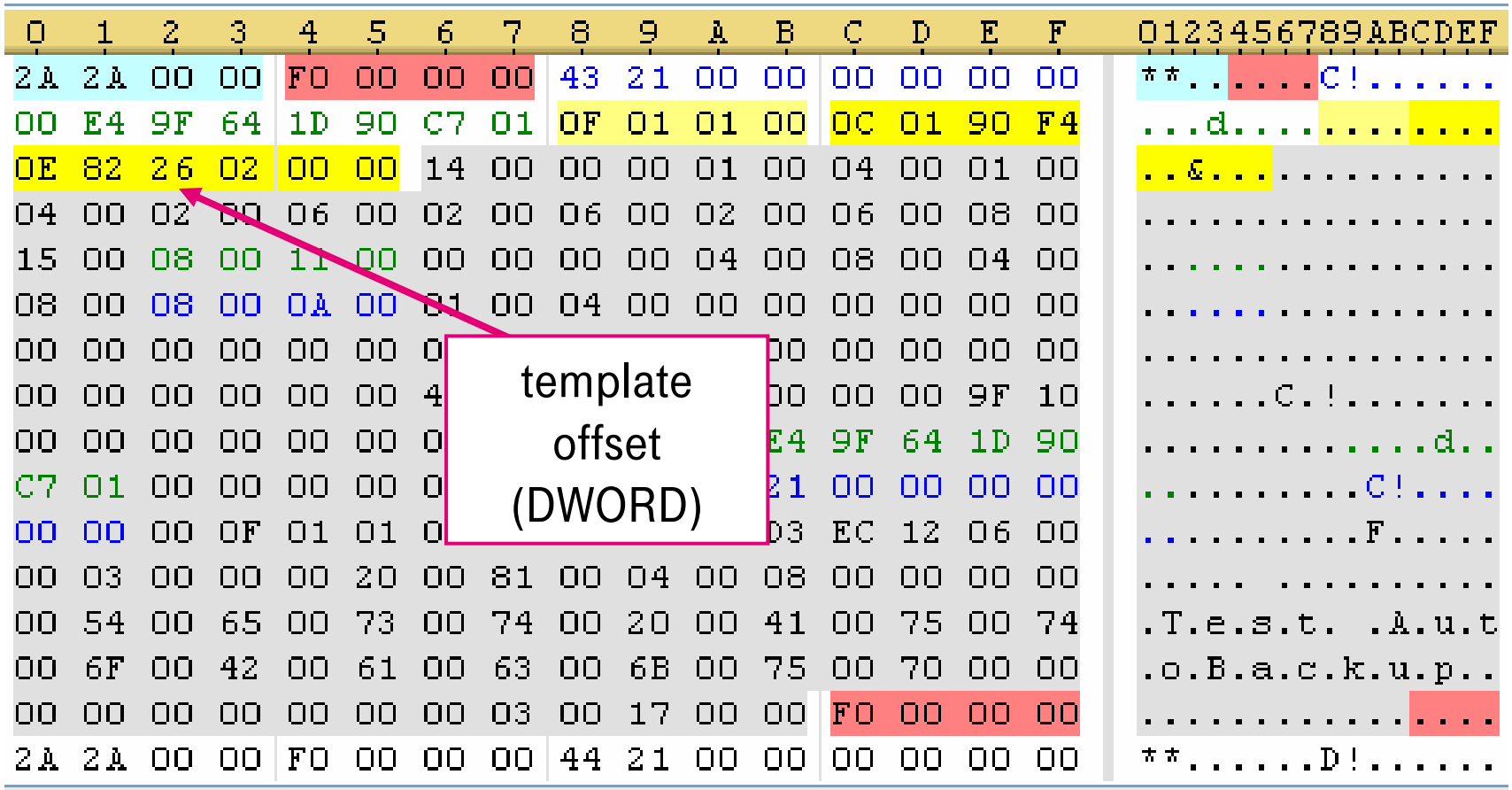
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d.....F....
0E	82	26	02	00	00	14	00	00	00	01	00	04	00	01	00	..&.....F.....
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	.....
15	00	08	00	11	00	00	00	00	00	04	00	08	00	04	00	.....
08	00	08	00	0A	00	01	00	04	00	00	00	00	00	00	00	.....
00	00	00	00	00	00	0					00	00	00	00	00	.....
00	00	00	00	00	00	4					00	00	00	9F	10	.....C.!.....
00	00	00	00	00	00	0					E4	9F	64	1D	90	.....d..
C7	01	00	00	00	00	0					21	00	00	00	00	.....C!....
00	00	00	0F	01	01	0					D3	EC	12	06	00	.....F.....
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	.....
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	.....F....
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**....D!.....

Forensic Practice.
Interpretation of a Single Record.



0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d..........ô
0E	82	26	02	00	00	14	00	00	00	01	00	04	00	01	00	..&..............
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	....
15	00	08	00	11	00	00	00	00	00	04	00	08	00	04	00	....
08	00	08	00	0A	00	01	00	04	00	00	00	00	00	00	00	....
00	00	00	00	00	00	0					00	00	00	00	00	....
00	00	00	00	00	00	4					00	00	00	9F	10	......C.!.......
00	00	00	00	00	00	0					E4	9F	64	1D	90	..............d..
C7	01	00	00	00	00	00	00	00	00	43	21	00	00	00	00	..........C!....
00	00	00	0F	01	01	00	0C	01	01	46	D3	EC	12	06	00	..........F.....
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	....
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	..............ð...
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**....ð...D!.....

Forensic Practice.
Interpretation of a Single Record.

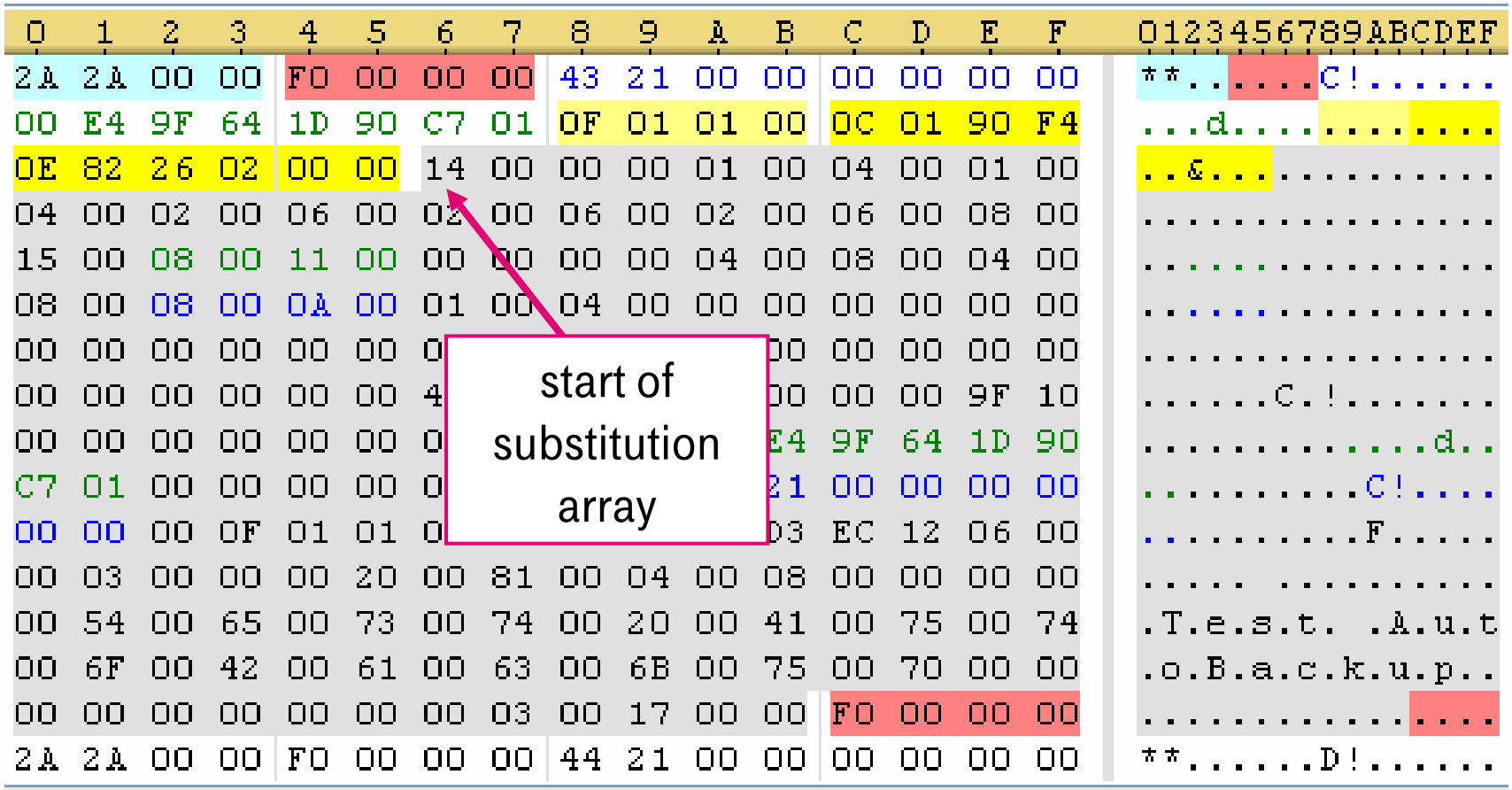


Forensic Practice.
Interpretation of a Single Record.

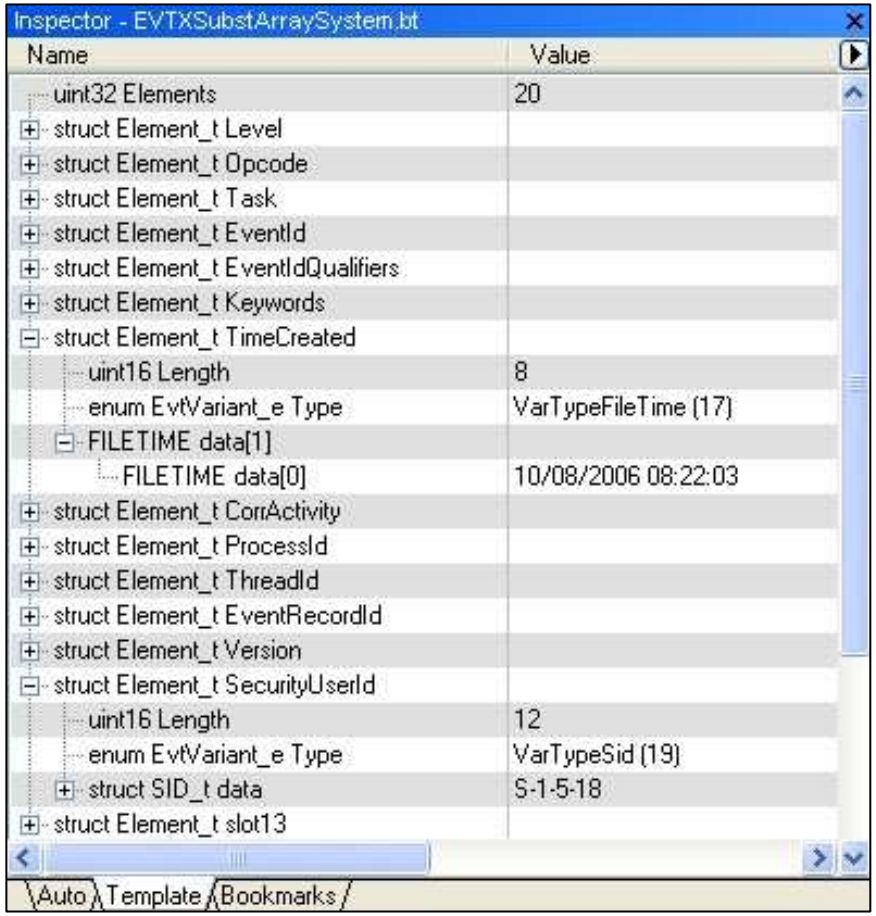
- Problem: XML template requested, but not available
- XML schema: „System“ is a mandatory element
- observation: static mapping between element/attribute and index into substitution array
- use evtxtemplates.pl to view:

```
<Event xmlns="...">
  <System>
    <EventID Qualifiers="#4 (type 6, optional)#">
      #3 (type 6, optional)#
    </EventID>
```

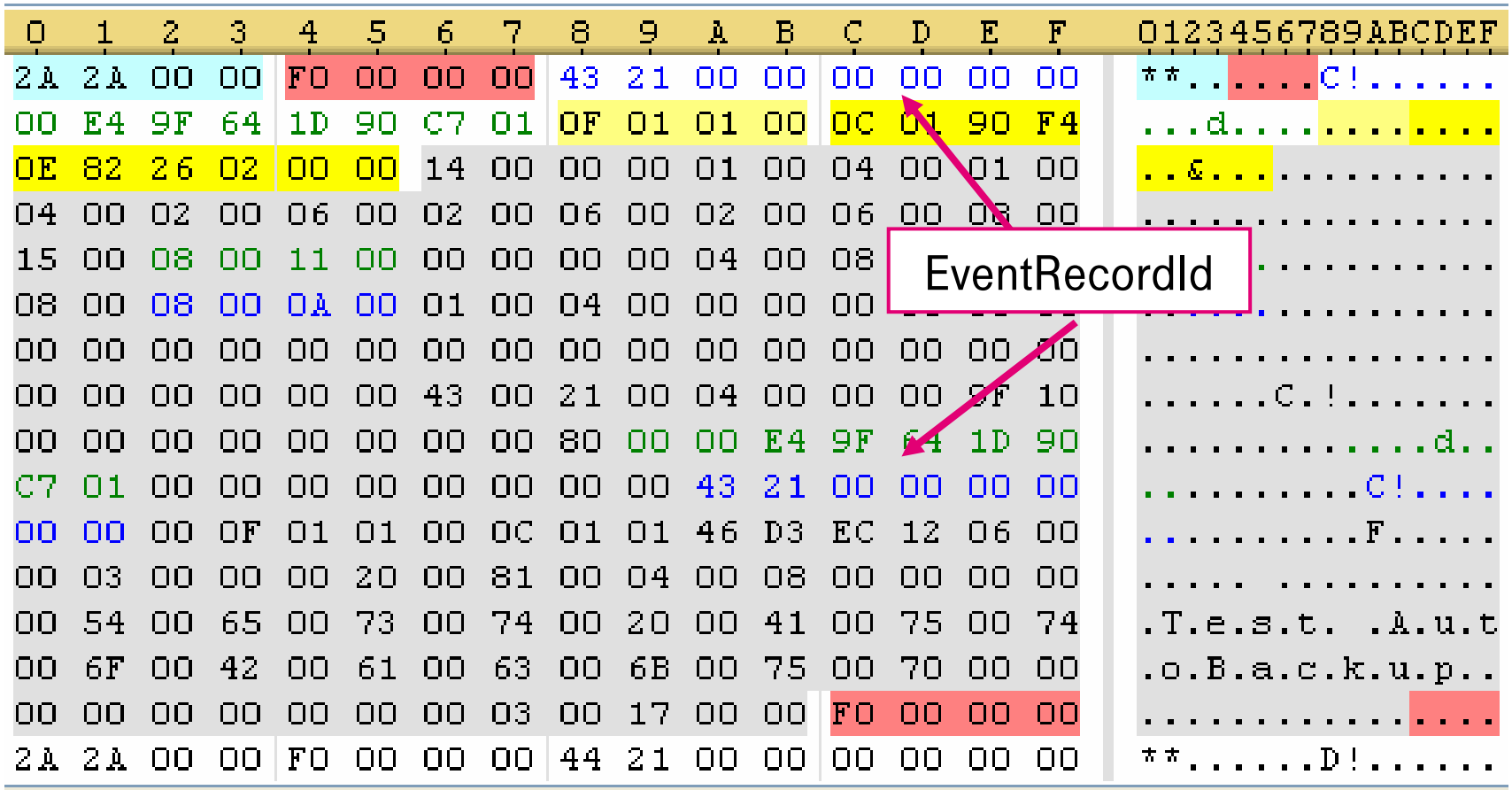
Forensic Practice.
Interpretation of a Single Record – Locate SubstitutionArray.



Forensic Practice.
Interpretation of a Single Record.

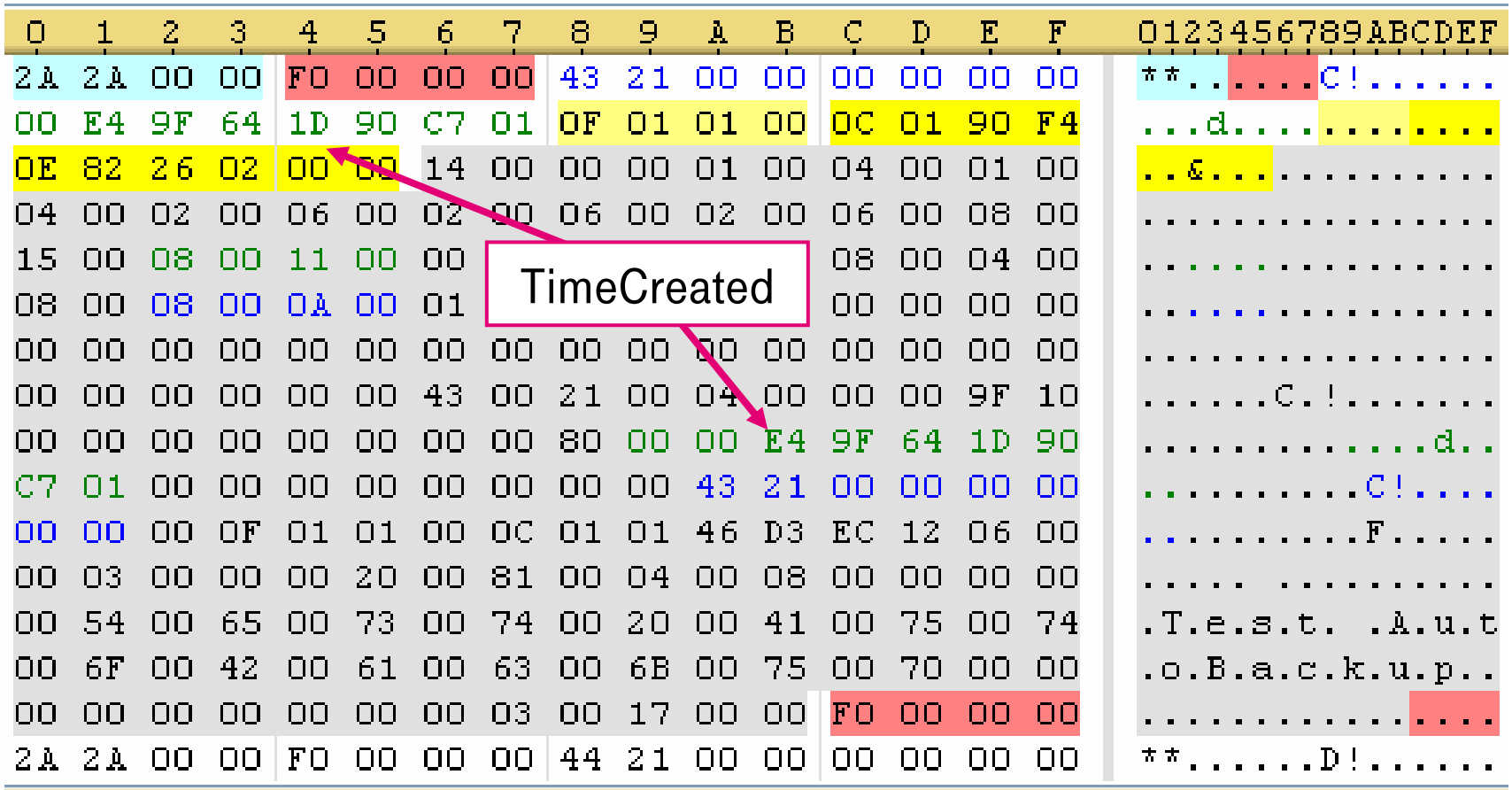


Forensic Practice.
Interpretation of a Single Record - Validation.



0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d.....F....
0E	82	26	02	00	00	14	00	00	00	01	00	04	00	01	00	..&.....F.....
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	.....
15	00	08	00	11	00	00	00	00	00	04	00	08				.....
08	00	08	00	0A	00	01	00	04	00	00	00	00				.....
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
00	00	00	00	00	00	43	00	21	00	04	00	00	00	0F	10	.....C.!.....
00	00	00	00	00	00	00	00	80	00	00	E4	9F	64	1D	90	.....d..
C7	01	00	00	00	00	00	00	00	00	43	21	00	00	00	00	.....C!....
00	00	00	0F	01	01	00	0C	01	01	46	D3	EC	12	06	00	.....F.....
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	....
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	.....F....
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**.....D!.....

Forensic Practice.
Interpretation of a Single Record - Validation.



0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
2A	2A	00	00	F0	00	00	00	43	21	00	00	00	00	00	00	**....C!......
00	E4	9F	64	1D	90	C7	01	0F	01	01	00	0C	01	90	F4	...d.....d.....ô
0E	82	26	02	00	69	14	00	00	00	01	00	04	00	01	00	..&...i.....i...
04	00	02	00	06	00	02	00	06	00	02	00	06	00	08	00	.....
15	00	08	00	11	00	00	00	00	00	00	00	08	00	04	00	.....
08	00	08	00	0A	00	01	00	00	00	00	00	00	00	00	00	.....
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
00	00	00	00	00	00	43	00	21	00	04	00	00	00	9F	10	.....C.!.....
00	00	00	00	00	00	00	00	80	00	00	E4	9F	64	1D	90	.....ä.d..
C7	01	00	00	00	00	00	00	00	00	43	21	00	00	00	00	.....C!....
00	00	00	0F	01	01	00	0C	01	01	46	D3	EC	12	06	00	.....FÓì.....
00	03	00	00	00	20	00	81	00	04	00	08	00	00	00	00	....
00	54	00	65	00	73	00	74	00	20	00	41	00	75	00	74	.T.e.s.t. .A.u.t
00	6F	00	42	00	61	00	63	00	6B	00	75	00	70	00	00	.o.B.a.c.k.u.p..
00	00	00	00	00	00	00	03	00	17	00	00	F0	00	00	00	.....ð...
2A	2A	00	00	F0	00	00	00	44	21	00	00	00	00	00	00	**....ð...D!.....

Forensic Practice.
Interpretation of a Single Record.

Recovered data:

- EventID
- Keywords
- TimeCreated
- ProcessID
- ThreadID
- User SID
- Level, Task, Opcode
- Version

Lost data:

- XML namespace
- provider (data source)
- channel
- computer name

Conclusion.
Improvements.

- low memory load, only 68 kiB per log
  - the old service keeps the whole file in memory
- rich set of data types (strings, numbers, special types)
  - the old service only supports strings and binary
- XPath queries

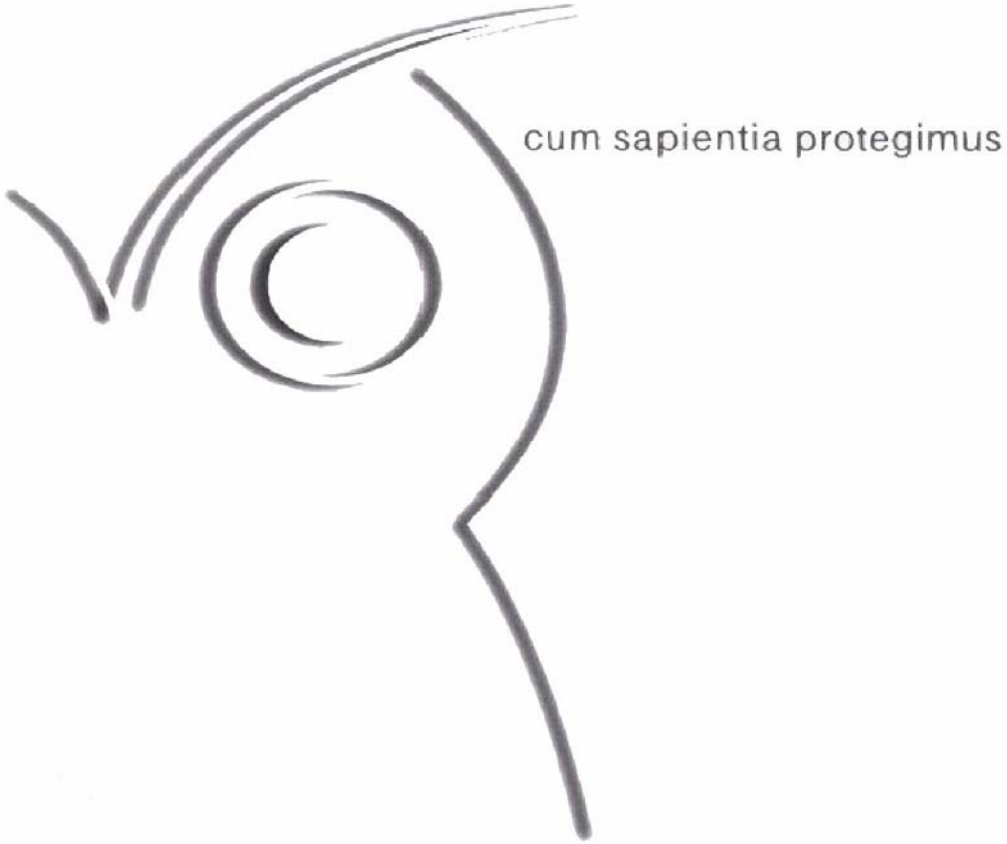
- It's less likely that administrators turn logging off.
- It's more likely that programmers instrument their code for logging.

Conclusion.
Parsers.

- Vista Event Viewer Applet by Microsoft for uncorrupted files.

- EvtxParser
  - platform-independent (Perl)
  - works on corrupted files
  - some data types are missing
  - some system tokens are missing
    CDATA, PI, EntityRef?

Questions?



Thank You for Your Attention.

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Forensic Practice.
Interpretation of a Single Record – Locate SubstitutionArray.