XIRAF - Ultimate Forensic Querying

By

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XIRAF
Ultimate Forensic Querying

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Introduction

XIRAF

“An XML Information Retrieval Approach to Digital Forensics”

Collect, manage, and query information extracted from digital evidence

Outline

- Problem statement
- XIRAF approach
- XIRAF architecture
- Forensic application areas
- Initial experiments
- Conclusion

Typical investigation steps

1. Media capture
2. Feature extraction
3. Analysis
4. Reporting

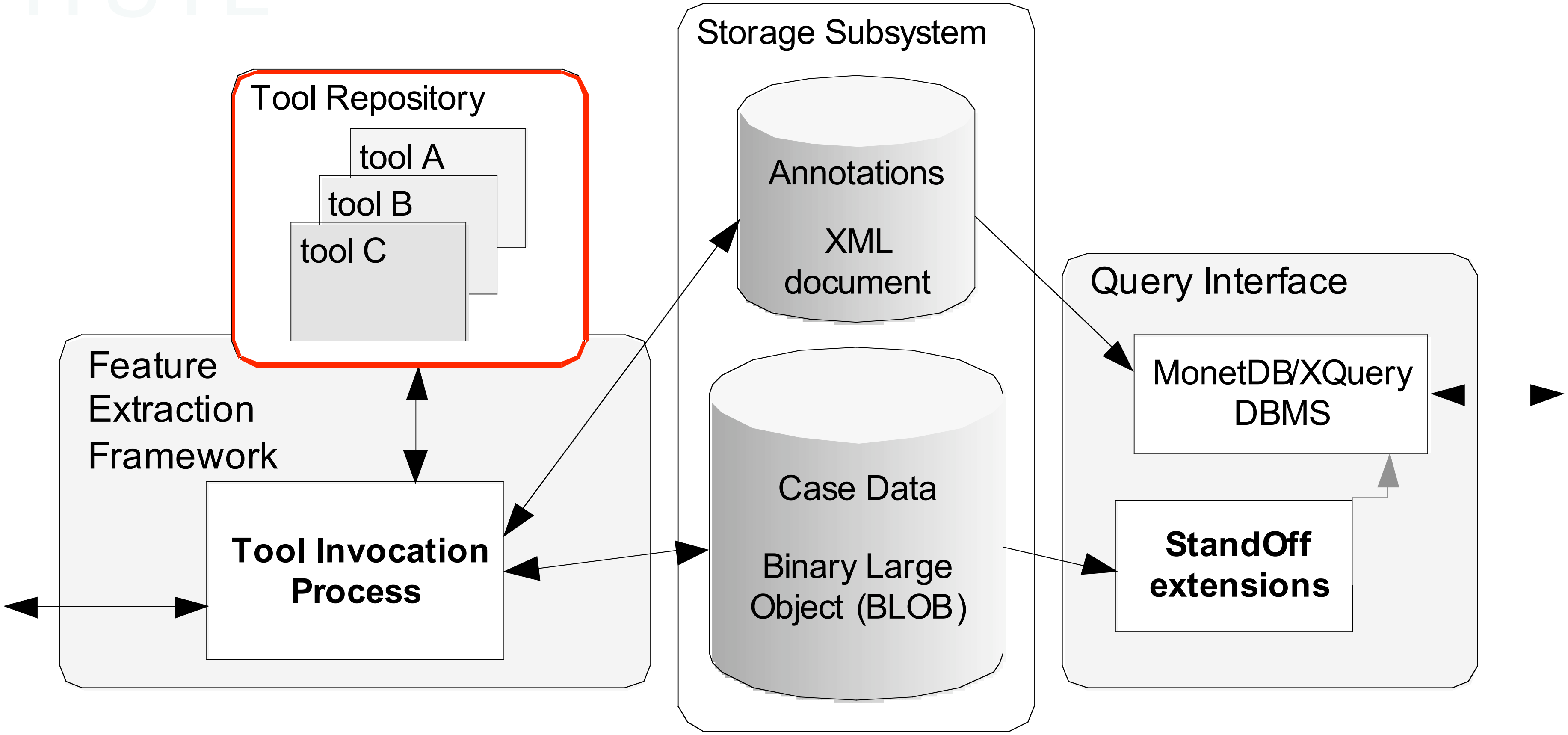
Problem identification

- Large amounts of data
  - Investigation restricted by deadlines
  - Too much information to track manually
- Diversity of data and tools
  - Many different formats
  - Many stand-alone forensic tools

Approach

- Clean separation between feature extraction and analysis
- A single, XML-based output format for tools
- XML database technology to analyze extracted features
- Use of existing forensic analysis tools

XIRAF architecture

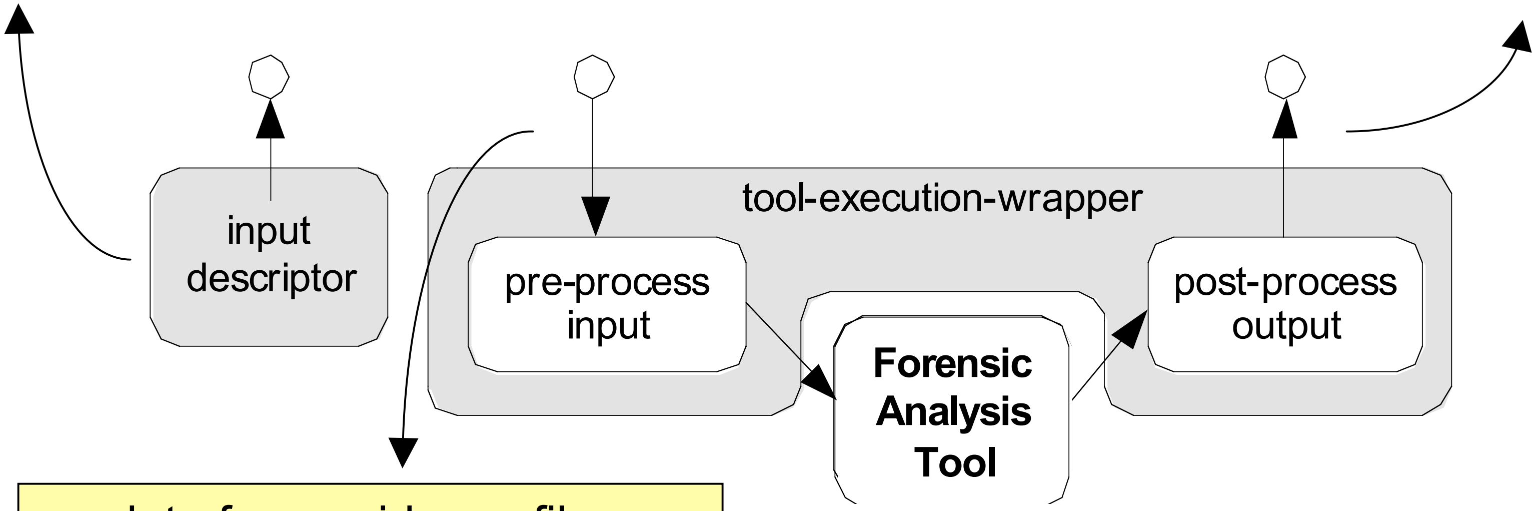


Tool wrapper

```
<photo>
  <camera>Canon<camera>
  <taken-on>
    <date>15-12-2005</date>
  </taken-on>
</photo>
```

- metadata (features/traces)
- new view of the original data

```
//file[mime="image/jpeg"]
```

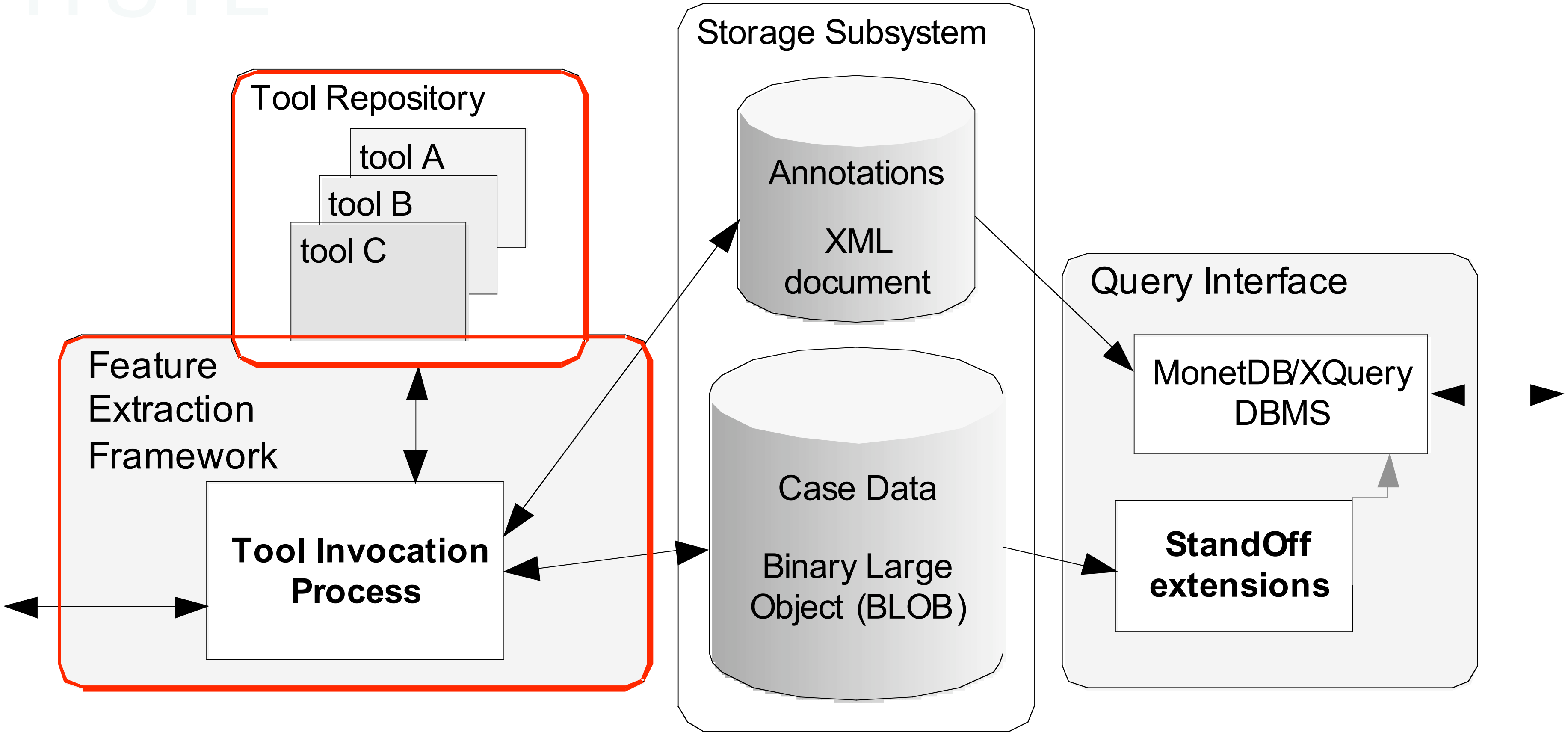


- data from evidence files `Photo03.jpg'
- Optional:
  additional metadata

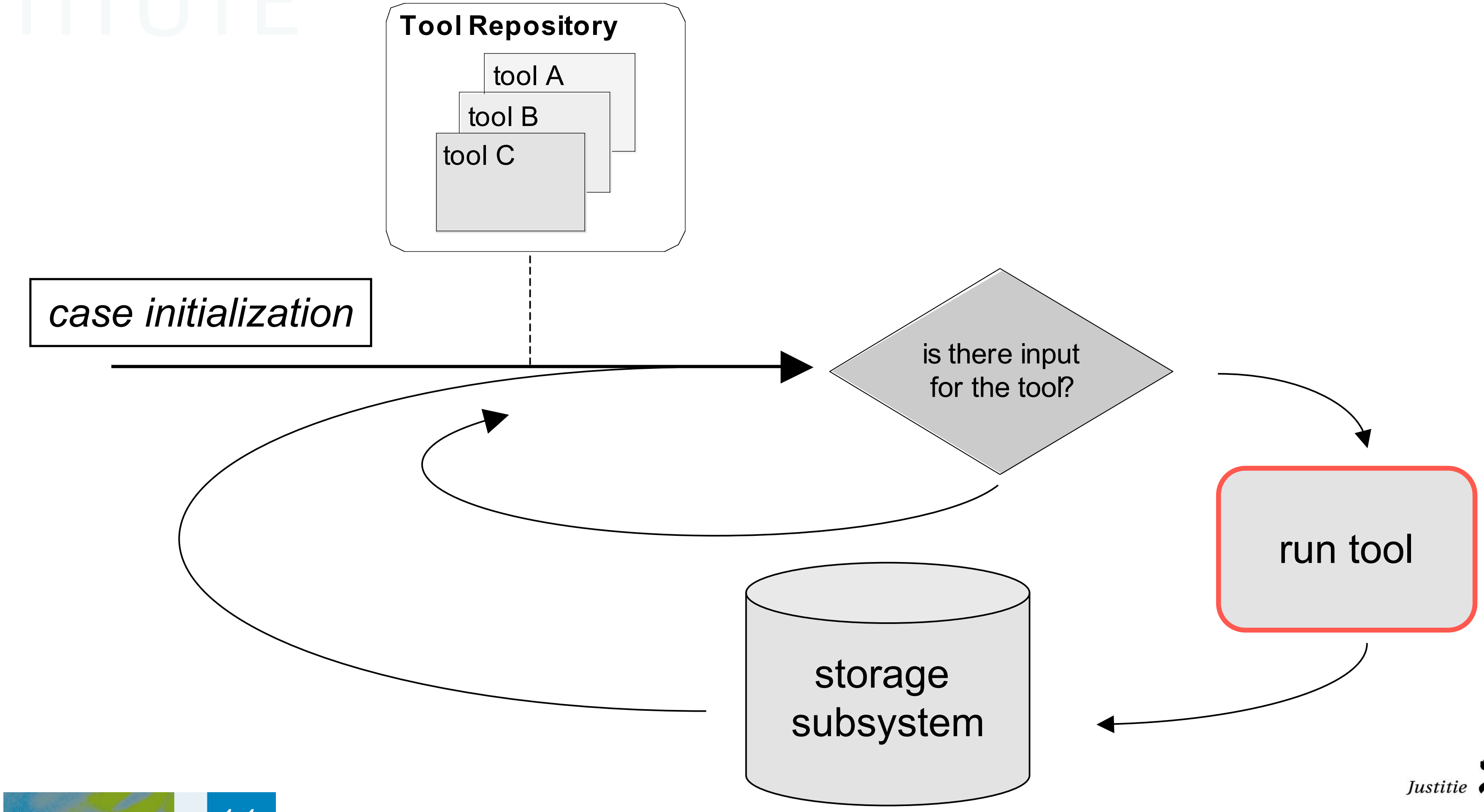
Tool repository

- Feature extraction tools
- Gain knowledge about an ‘object’:
  - volume
  - file-system
  - image
  - email
- Some of the wrapped tools:
  - file-system dissector
  - windows registry analyzer
  - EXIF-data parser
  - carving tool
  - IE-history parser
  - Hashing tool

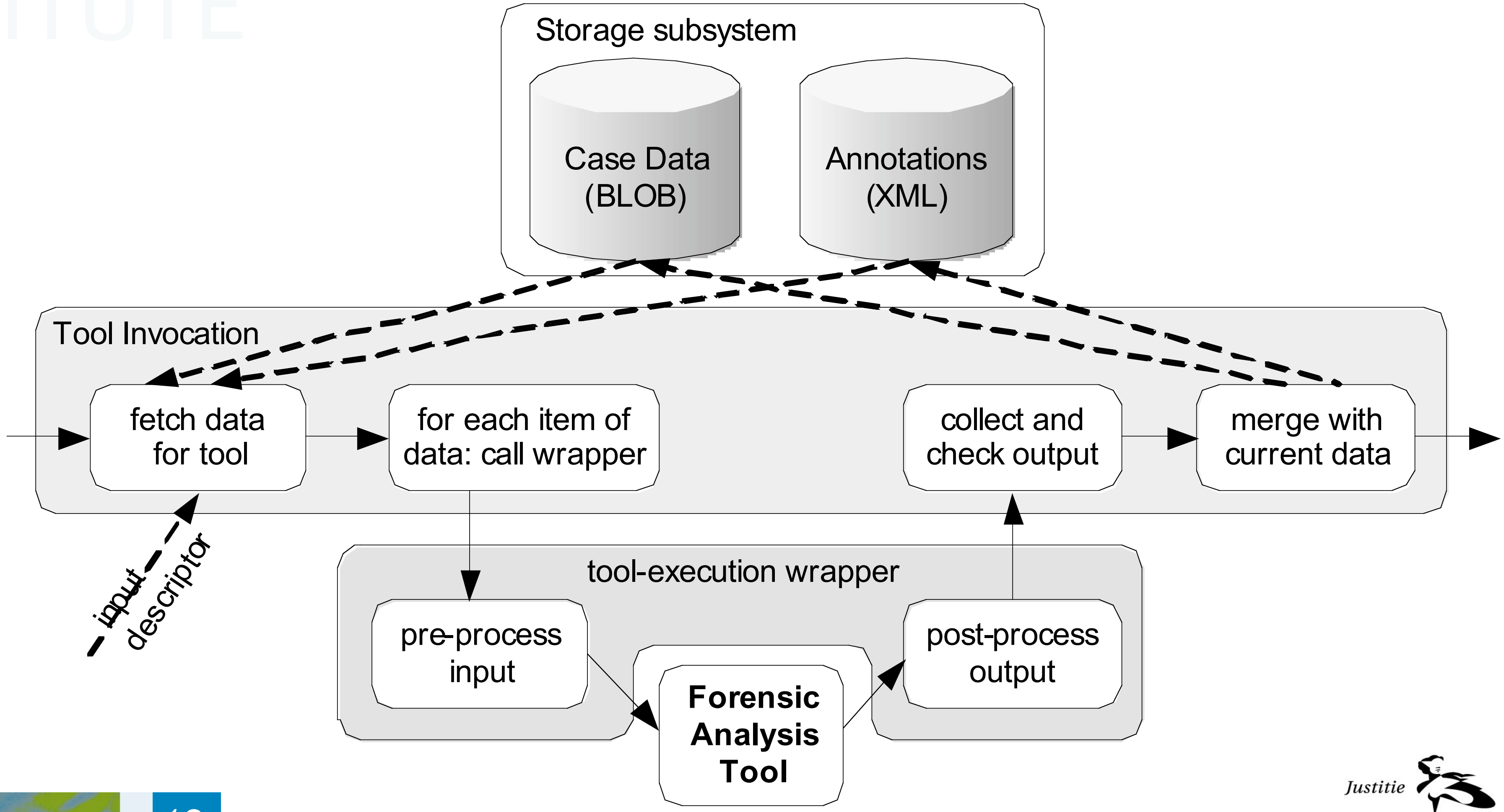
XIRAF architecture



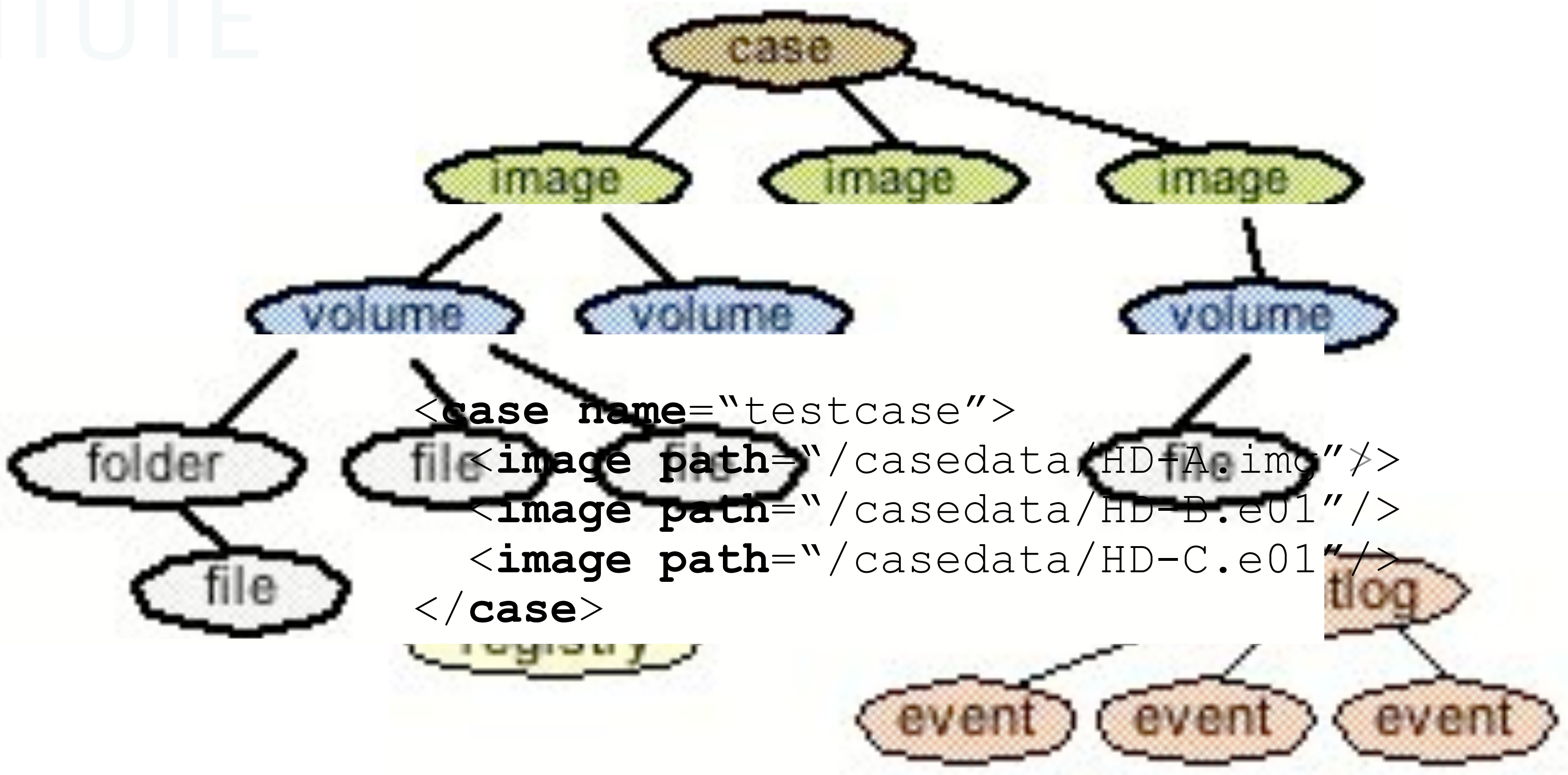
Feature extraction framework



Feature extraction framework



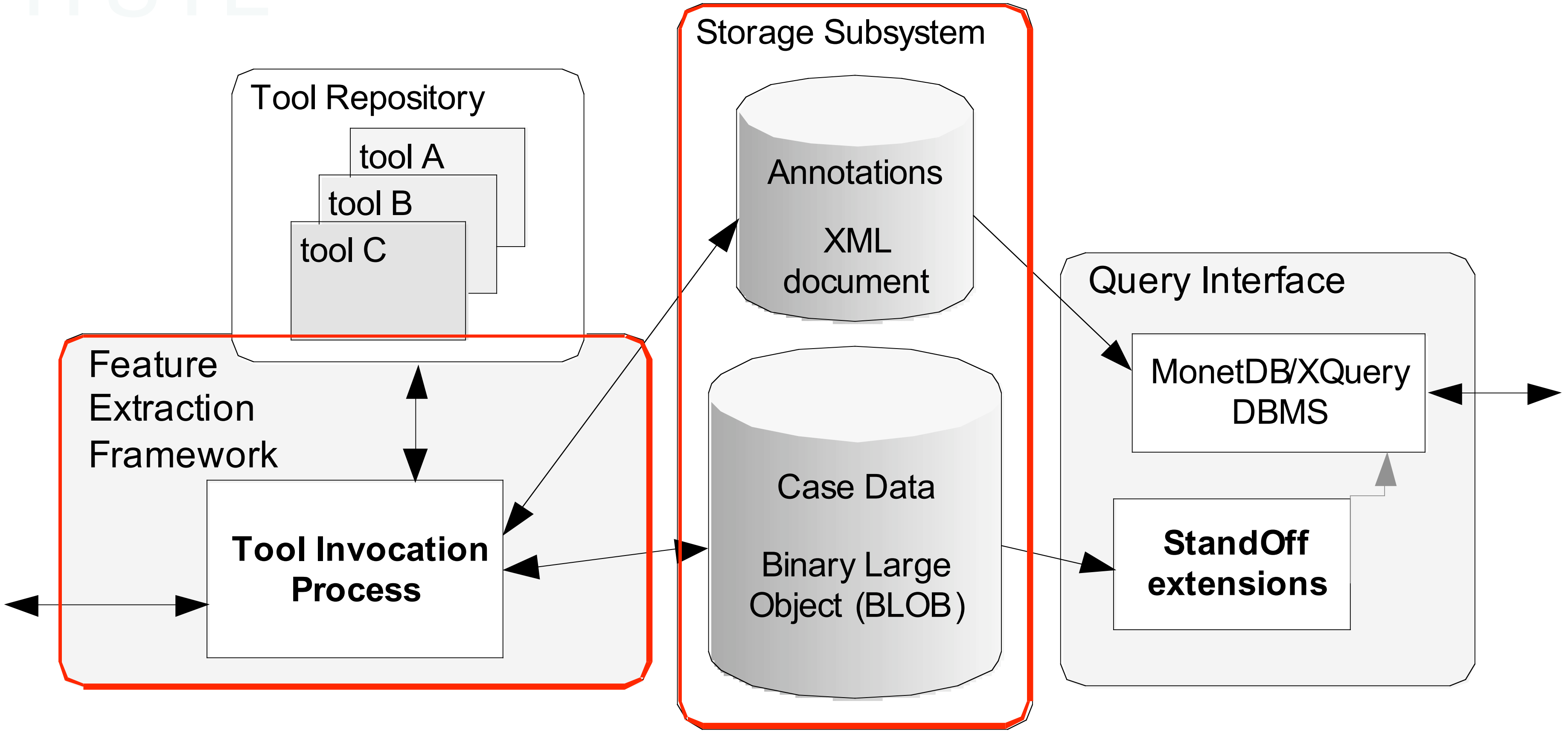
Feature extraction



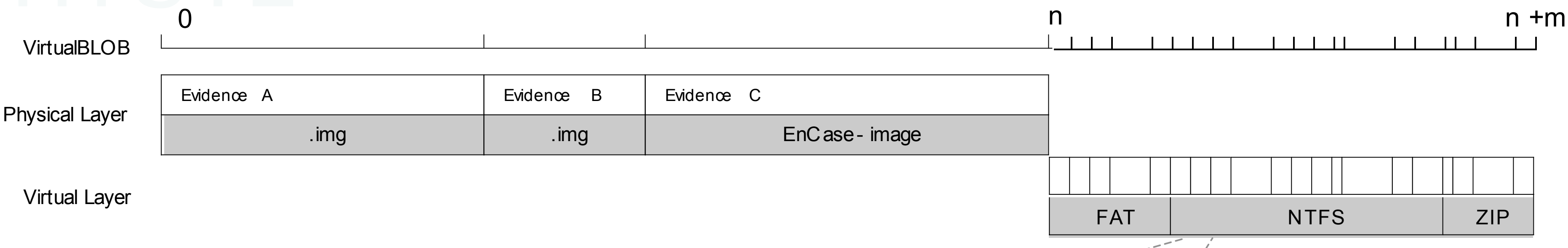
```
<case name=“testcase”>
  <image path=“/casedata/HD-A.img”/>
  <image path=“/casedata/HD-B.e01”/>
  <image path=“/casedata/HD-C.e01”/>
</case>
```

```
  <image path=“/casedata/HD-C.e01”>
    <volume label=“MP3”/>
  </image>
</case>
```

XIRAF architecture



Virtual BLOB and XML



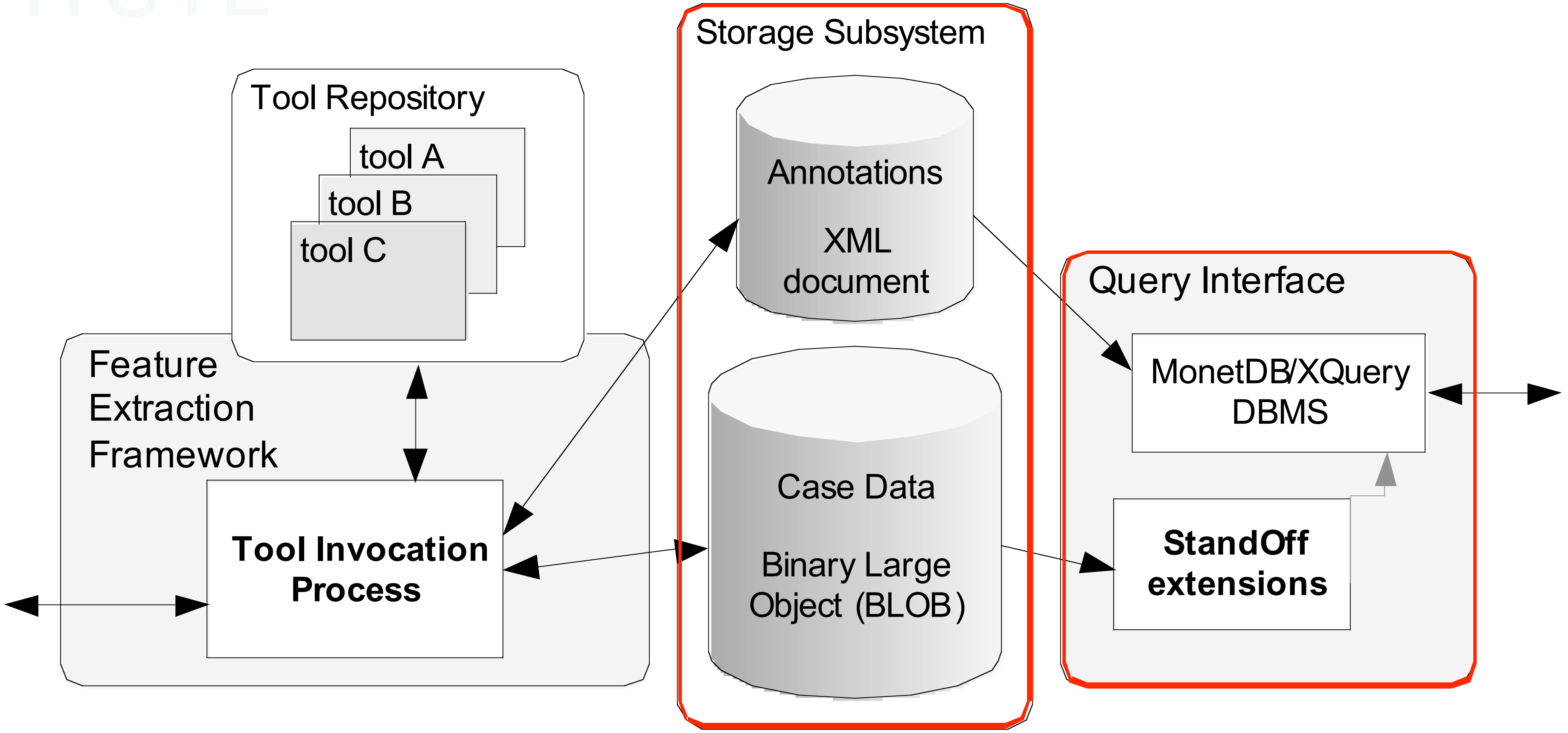
```
<case name="testcase">
  <image path="/casedata/HD-A.img" start="0" end="19999"/>
  <image path="/casedata/HD-B.img" start="20000" end="29999"/>
  <image path="/casedata/HD-C.e01" start="30000" end="59999"/>
</case>
...
<volume type="FAT" start="1000" end="19999"/>
<volume type="NTFS" start="35000" end="39999"/>
```

```
...
  <file name="Photo03.jpg" start="70000" end="74999">
    <size>5000</size>
    <mime>image/jpeg</mime>
    <modified><date>2006-08-15T09:10:00</date></modified>
  </file>
```

Storage subsystem

- Virtual BLOB mapping
  - evidence files
  - alternative representations
- Single XML document
  - extracted features
  - references to layout

XIRAF architecture



XQuery language

- Database language:
  - large XML documents
  - sorting/grouping/selecting/(updating)
- Example: timeline
  - different tools produce date-elements

```
for $i in doc(“case.xml”)//date
order by $i
where $i > $lowerbound
    and $i < $upperbound
return $i
```

Forensic application areas

- search for keywords, MD5s, URLs

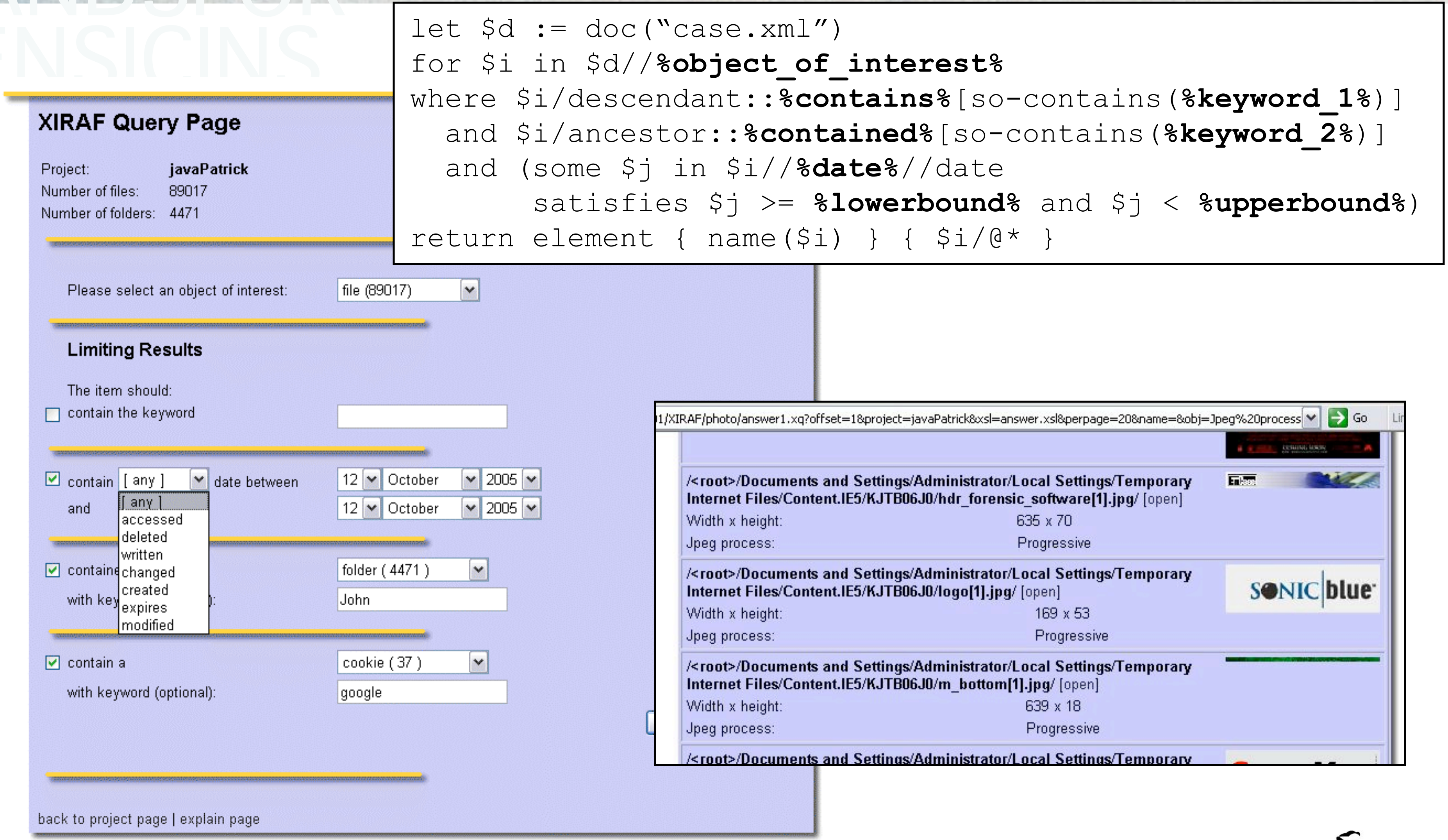
```
for $i in doc(“case.xml”)//file
for $j in doc(“CP-hashes.xml”)//md5
where $i/md5 = $j
return <file> { $i/@name } </file>
```

```
let $word_list :=
      doc(“terrorism-words.xml”)//word
for $i in doc(“case.xml”)//*
where some $i in $word_list
      satisfies blob-contains($i,$j)
return element { name($i) } { $i/@* }
```

Benefits

- Exploit exhaustive runs of tools
- Use knowledge from previous investigations
- Integrated data schema

- Added functionality:
  - XQuery extensions to relate XML to Virtual BLOB content



```
let $d := doc("case.xml")
for $i in $d//%object_of_interest%
where $i/descendant::%contains%[so-contains(%keyword_1%)]
  and $i/ancestor::%contained%[so-contains(%keyword_2%)]
  and (some $j in $i//%date%//date
       satisfies $j >= %lowerbound% and $j < %upperbound%)
return element { name($i) } { $i/@* }
```

XIRAF Query Page

Project: **javaPatrick**
Number of files: 89017
Number of folders: 4471

Please select an object of interest: file (89017)

Limiting Results

The item should:

☐ contain the keyword

☑ contain [any] date between 12 October 2005
and 12 October 2005

☑ containe folder (4471)
with key : John

☑ contain a cookie (37)
with keyword (optional): google

back to project page | explain page

1/XIRAF/photo/answer1.xq?offset=1&project=javaPatrick&xsl=answer.xsl&perpage=20&name=&obj=Jpeg%20process

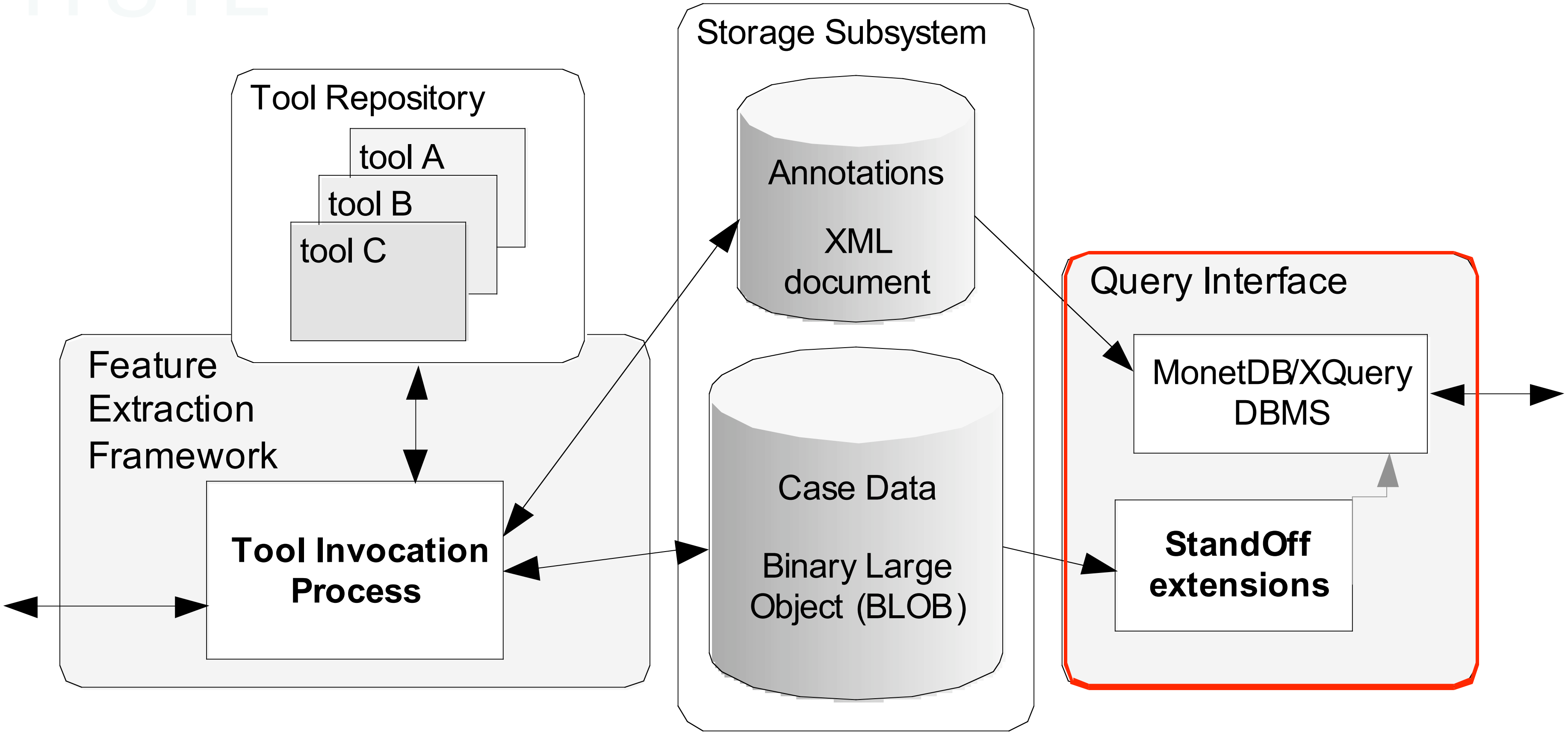
/<root>/Documents and Settings/Administrator/Local Settings/Temporary Internet Files/Content.IE5/KJTB06J0/hdr_forensic_software[1].jpg/ [open]
Width x height: 635 x 70
Jpeg process: Progressive

/<root>/Documents and Settings/Administrator/Local Settings/Temporary Internet Files/Content.IE5/KJTB06J0/logo[1].jpg/ [open]
Width x height: 169 x 53
Jpeg process: Progressive

/<root>/Documents and Settings/Administrator/Local Settings/Temporary Internet Files/Content.IE5/KJTB06J0/m_bottom[1].jpg/ [open]
Width x height: 639 x 18
Jpeg process: Progressive

/<root>/Documents and Settings/Administrator/Local Settings/Temporary

XIRAF architecture



Initial Experiments

- Evidence: 2 hard disks
  - (2 x 120GB)
- ~200MB XML
  - ~2.5M elements
- Recognized ~90000 files
  - file-systems / unallocated space
- ~500000 timestamps
  - file-system, registry, EXIF, .LNK, log-entry, cookie, etc

Conclusion

- Separation of feature extraction and analysis seems a viable approach
- Integrated querying of multiple tools becomes possible

Status & Future Work

- Prototype implementation (Java/Python)

- Make system production-ready
- More tools, query patterns
- Connect XIRAF to existing knowledge-bases

More information

- xiraf-info@holmes.nl
- http://www.forensischinstituut.nl/
- http://monetdb.cwi.nl/