

XML Data Exchange Format for HRM

High Resolution Manometry Consensus Group

<http://www.hrmconsensus.org>

- Non-proprietary format
- Data Exchange
- Archiving in clinical databases

High Resolution Manometry Consensus Group

<http://www.hrmconsensus.org>

- Non-proprietary format
- Data Exchange
- Archiving in clinical databases
- Includes
 - Hardware and software manufacturer
 - Sensor position
 - Catheter
 - Calibration
 - Procedures
 - Bolus
 - X-Ray or MRI images
- Can store multiple non-contiguous swallow records

Sample MMS File

Samplerate: 50

First sample: 0

Sample	P1	P2	P3	..	P36	Markers
2637	13	6	6		13	0
2638	13	6	6		13	0
2639	13	7	6		13	0
2640	14	7	6		13	0
2641	15	7	6		13	0
2642	16	7	7		13	0
2643	16	8	7		13	0

Is P1 or P36 distal? It depends on the record!

Sample Sierra File

TIME:	1	2	3	..	35	36
301.13	5.09	45.26	67.58	..	55.03	5.51
301.15	4.71	45.24	67.70		55.21	5.33
301.17	4.71	45.53	67.82		55.21	5.06
301.19	4.59	45.70	67.95		55.44	5.26
301.21	4.45	45.59	68.07		55.24	5.29
301.23	4.31	45.16	68.19		54.46	5.01
301.25	4.58	45.44	68.07		54.72	5.01

XML is Everywhere: XHTML

- XHTML is (or rather should be) XML



XML is Everywhere: XHTML

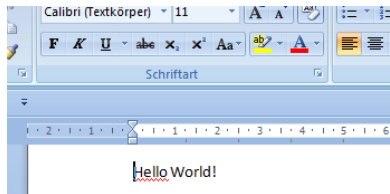
- XHTML is (or rather should be) XML



```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html>
  <head>
    <title>Hello</title>
  </head>
  <body>
    <h1 style="color:red">Hello World</h1>
  </body>
</html>
```

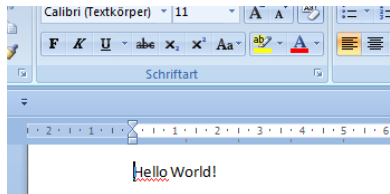
XML is Everywhere: Word 2007

- A minimal word file miniWord.docx



XML is Everywhere: Word 2007

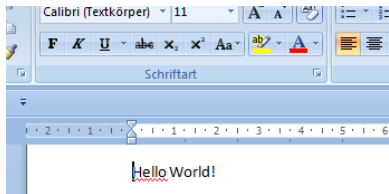
- A minimal word file miniWord.docx



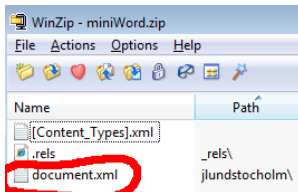
- Rename the file to miniWord.zip

XML is Everywhere: Word 2007

- A minimal word file miniWord.docx



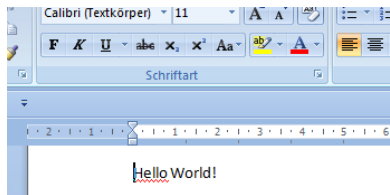
- Rename the file to miniWord.zip



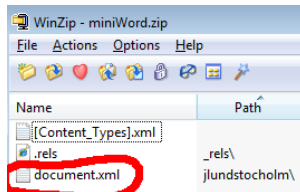
- Word 2007 contains zipped XML files

XML is Everywhere: Word 2007

- A minimal word file miniWord.docx



- Rename the file to miniWord.zip



- Word 2007 contains zipped XML files

Not only Word...

Powerpoint, Excel, OpenOffice, GIML (gastro-intestinal)

Inside Word's document.xml

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<w:document xmlns:r="http://schemas.openxmlformats.org/
officeDocument/2006/relationships" 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>
```

Two ways to store data

```
<body>
  <h1 style="color:red">Hello World</h1>
</body>
```

- As attribute: *style="color:red"*
- As child element: *Hello World*

Why XML?

- Fortune 500 and authorities (FDA): use non-proprietary formats
- XML is text (Unicode, UTF-8)
- “Almost human readable”; can be manually corrected on corruption
- Native support by operating systems
- Native support for storage and retrieval in recent relational databases

- Well-formedness

```
<body>  
  <h1>Hello World</h2>  
</body>
```

- Well-formedness

```
<body>  
  <h1>Hello World</h2>  
</body>
```

- eXtensible

```
<body>  
  <h1>Hello World</h1>  
  <myown>Skip this</myown>  
</body>
```

- XML

```
<xhrm xsi="xhrm.xsd">  
<age>58</age>
```

- Associated Schema *xhrm.xsd*

```
<xs:element name="age" type="ageType"/>  
  
<xs:simpleType name="ageType">  
  <xs:restriction base="xs:integer">  
    <xs:maxInclusive value="110"/>  
    <xs:minInclusive value="1"/>  
  </xs:restriction>  
</xs:simpleType>
```

- XML

```
<xhrm xsi="xhrm.xsd">  
<age>58</age>
```

- Associated Schema *xhrm.xsd*

```
<xs:element name="age" type="ageType"/>  
  
<xs:simpleType name="ageType">  
  <xs:restriction base="xs:integer">  
    <xs:maxInclusive value="110"/>  
    <xs:minInclusive value="1"/>  
  </xs:restriction>  
</xs:simpleType>
```

- Complex validation: For a data value in a channel *p1*, the quantity (pressure) and unit (mmHg) must be uniquely defined uniquely in the same file.

XHRM in bird's eye view

Two items are required within <xhrm>

- device
- records/record

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Minimal example of an XHRM file showing only
      channel position of 2 channels, units and measured data
-->
<xhrm xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:noNamespaceSchemaLocation="xhrm0_1.xsd"
      schemaVersion="0.1">
  <device>...
  <records>...
</xhrm>
```

Minimal file: *device*

```
<device>
  <quantities>
    <sensorQuantity>
      <name>p</name>
      <unit>mmHg</unit>
      <symbol>p</symbol>
    </sensorQuantity>
  </quantities>
  <channels>
    <sensorChannel>
      <name>p1</name>
      <quantity>p</quantity>
      <position>1</position>
    </sensorChannel>
    <sensorChannel>
      <name>p2</name>
      <quantity>p</quantity>
      <position>2</position>
    </sensorChannel>
  </channels>
</device>
```

- Time and channels are attributes

```
<records>
  <record>
    <dataValues>
      <v t="0" c="p1">14</v>
      <v t="0" c="p2">12</v>
      <v t="50" c="p1">27</v>
      <v t="50" c="p2">25</v>
      <v t="100" c="p2">29</v>
      <v t="100" c="p1">16</v>
    </dataValues>
  </record>
</records>
```

- Markers and image references are `<dataValues>`
- Images are stored in a zip-subfolder

```
<dataValues>
  <v t="0" c="p1">14</v>
  <v t="0" c="imp1">3</v>
  <s t="1" c="stdmarker1">a standard marker</s>
  <s t="1" c="xray">xray1.tiff</s>
</dataValues>
```

- Traces are time-space <dataValues>
- Lines: UES, LES
- Regions: Swallow, spasm

```
<dataValues>  
  <t t="0" c="spasm" x="10" seq="1" id="1"/>  
  <t t="1" c="spasm" x="10" seq="2" id="1"/>  
  <t t="1" c="spasm" x="11" seq="3" id="1"/>  
  <t t="0" c="spasm" x="11" seq="4" id="1"/>  
</dataValues>
```

Bird's eye view of <procedure>

- <procedure> combines meals, boluses, swallows
- Adds a time sequence of events in standardProcedure>
- Better name it <protocol>?

```
<procedure>
```

```
  <meals> [13 lines]
```

```
  <boluses> [28 lines]
```

```
  <swallows> [60 lines]
```

```
  <standardProcedure> [34 lines]
```

```
</procedure>
```

- `<meals>` holds arbitrary number of `<meal>` elements.
- Each `<meal>` must have at least one `<food>`.
- Optional caloric content

```
<meals>
  <meal>
    <name>ruminaton</name>
    <food>sandwich 50g</food>
    <food>milkshake 50g</food>
    <calories unit="kcal">400</calories>
  </meal>
  <meal>
    <name>reflux</name>
    <food>hamburger</food>
    <food>milkshake 200g</food>
    <calories>800</calories>
  </meal>
</meals>
```

- <boluses> collection holds arbitrary number of <bolus> elements.
- Optional description and viscosity

```
<boluses>
  <bolus>
    <name>dryAir</name>R
    <description lang="en">Dry air</description>
    <description lang="de">Luft</description>
  </bolus>
  <bolus>
    <name>barium300</name>
    <description lang="en">barium 300 cps</description>
    <viscosity unit="cps">300</viscosity>
  </bolus>
</boluses>
```

- `<swallows>` collection holds arbitrary number of `<swallow>` elements.
- Required posture and bolus, optional description

```
<swallows>
  <swallow>
    <name>bread1ccmupright</name>R
    <posture>upright</posture>R
    <bolus>bread</bolus>R
    <description lang="de">1ccm Brot mit Wasser</description>
  </swallow>
  <swallow>
    <name>multiple</name>R
    <posture>special</posture>R
    <specialPosture>Right decubitus</specialPosture>
    <bolus>bread</bolus>R
    <description lang="en">multiple repeated swallows</
      description>
  </swallow>
</swallows>
```

Standard procedure (or protocol?)

- One <standardProcedure> in a file
- Is a sequence of <event>
- An <event> can be meal, swallow, posture or special

```
<standardProcedure>
  <name>Zürich1</name>R
  <duration unit="min">20</duration>
  <event>
    <name>meal1</name>R
    <type>meal</type>R
    <after>0</after>
    <meal>ruminatation</meal>
  </event>
  <event>
    <name>swallow1</name>
    <type>swallow</type>
    <after unit="min" relativeTo="lastEventEnd">5</after>
    <swallow>dryupright</swallow>
  </event>
</standardProcedure>
```