Quality Information Framework (QIF)

UNIMETRIK
METROLOGY AND CALIBRATION

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Overview

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Overview: Who?

Quality Information Framework

Is an ANSI standard sponsored by the DMSC and/in an A-Liaison to

ANSI
American National Standards Institute

Dimensional Metrology Standards Consortium

ISO TC184/SC4
Industrial Data

Member of the DMSC

innovalia METROLOGY
INNOVATION AND ACCURACY

DATAPIXEL
QUALITY CONTROL ENGINEERING

Contributor of version 3.0, 2018

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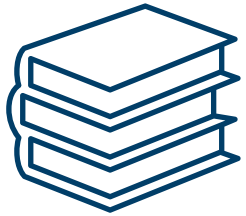
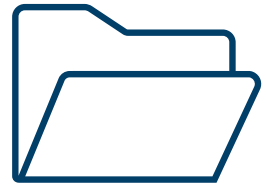
Overview: What is QIF?

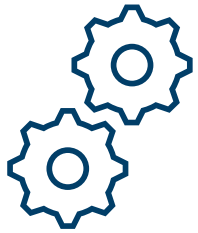
QIF is…



Integrated set of information models for effective exchange of metrology data through the entire manufacturing product-quality lifecycle (product design, inspection, planning, execution, analysis and reporting)

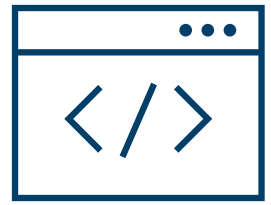
Contained in files written in the XML Schema Definition Language (XSDL)





Ensuring metrology data integrity and interoperability in Model Based Enterprise implementation

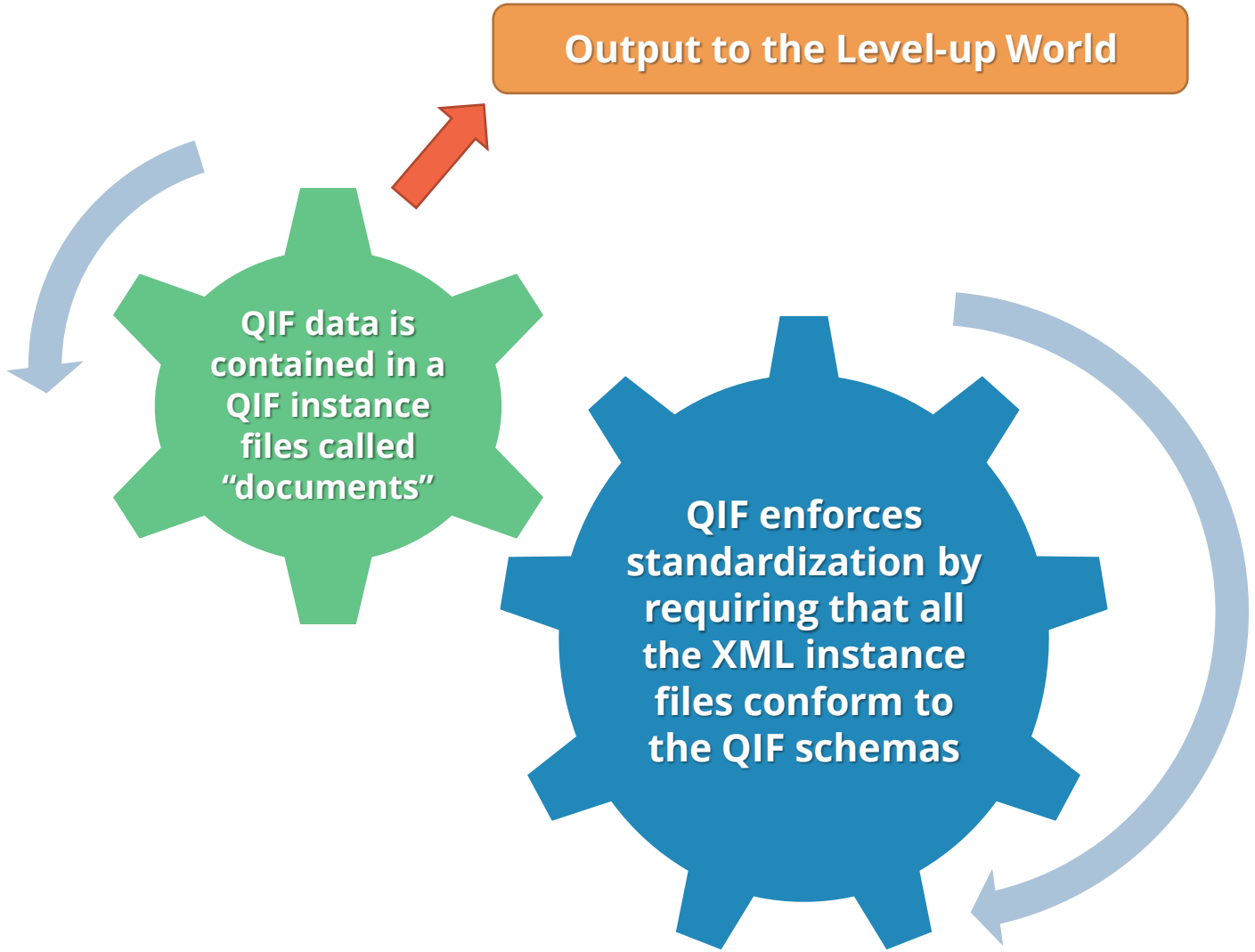
Supporting Digital Thread concepts



Overview: What is QIF?

QIF models include **quality characteristics and measurement features** as defined in:

- ASME Geometric Dimensioning and Tolerancing (GD&T)
- ISO Geometrical Product Specifications (GPS)
- Dimensional Measuring Interface Standard (DMIS).



Overview: Why?

The need for a **"common communication language"**

- ✓ Enables companies to capture, use, and re-use metrology-related information throughout the PLM/PDM domain
- ✓ Supports seamless exchange and sharing of metrology data across the manufacturing process
- ✓ Promotes production optimization
- ✓ Minimizes quality information loss, lack of features or capabilities and translation errors

- ✓ **Intelligently organizes inspection data generated by inspection technologies to provide output in a standard format**
- ✓ Contributes to feedforward and feedback flow of quality information
- ✓ Satisfies numerous customer use-case requirements and workflows scenarios
- ✓ Manufacturers have a standard platform for setting up a connected digital manufacturing infrastructure

QIF Version 3.0 Information Architecture

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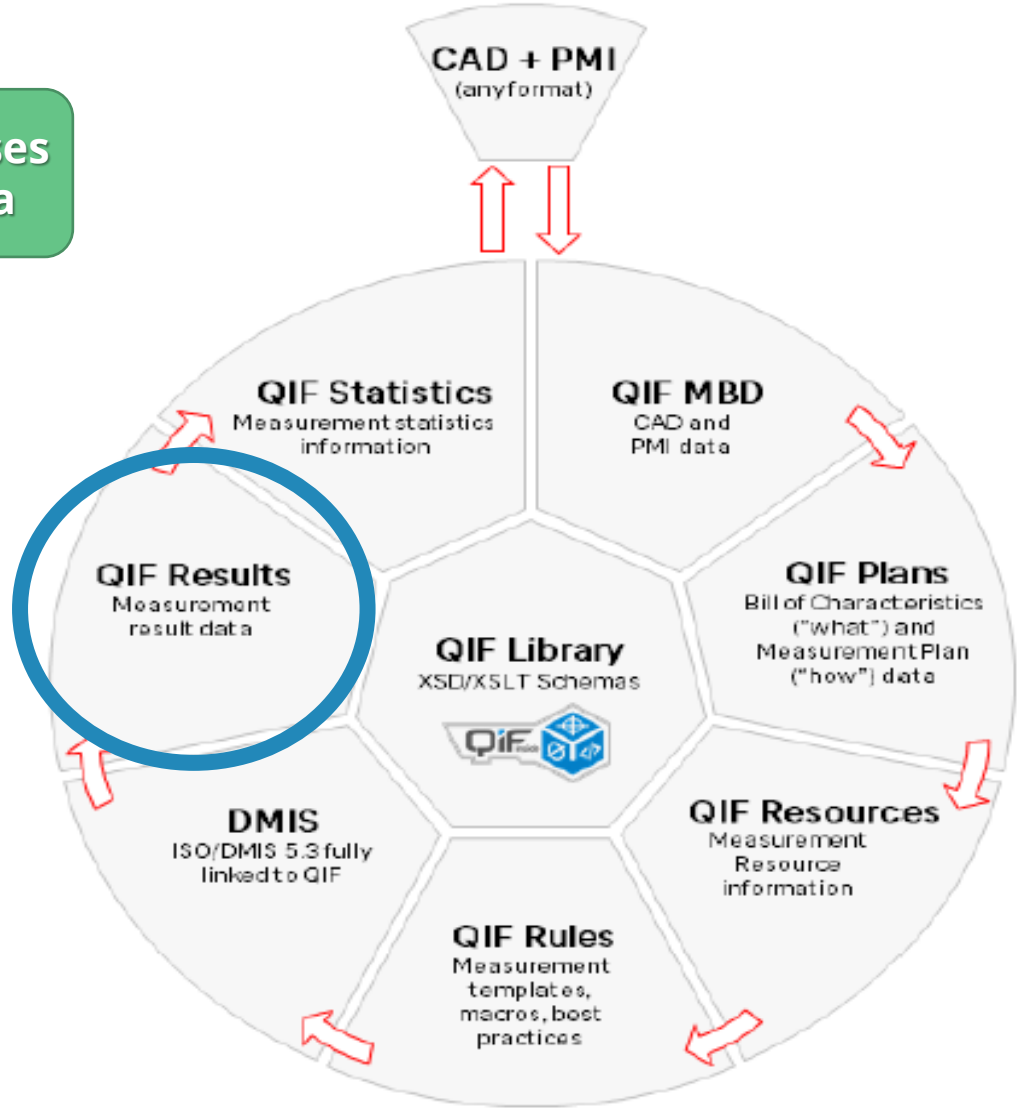
QIF Version 3.0: Information Architecture

Trimek Use Case focuses on this application area



System-wide interoperability is achieved by partitioning the information model between a QIF Library of common, reusable components, and six information models for unique application areas.

Users of the QIF are not required to implement the entire model.

Any of the six application models may be used singly for exchange of quality data.

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Conformance

Software programs that implement this specification to read QIF instance files must:

- Be able to read any valid QIF XML instance file and extract all numerical and semantic data correctly.

Tracking Information: Identifiers

QIF assigns identifiers whenever schema instances are created for any measurement object that is to be referenced (feature, characteristic, rule, resource, etc.) as well as the QIF Document itself:

- When related information is in a single file, it is either nested hierarchically or connected using **identifiers (ids) that are local to the file**.

- When related information is in separate files, it is connected using a combination of local ids and **QIF Persistent Identifiers (QPIds)**, which are universally unique (UUID).

```
<QIFDocument …>
  <QPId>DF837194-1E55-441b-A5D9-9279F56BCBE9</QPId>
  …
  <DiameterCharacteristicItem id="15">
  …
  </DiameterCharacteristicItem>
  …
  <DiameterCharacteristicMeasurement id="47">
  <CharacteristicItemId>15</CharacteristicItemId>
  …
  </DiameterCharacteristicMeasurement>
  …
```

```
10    <QPId>ffb3e503-d9ba-4046-a08e-f6cf5427cd87</QPId>
11
12    <Version>
13      <TimeCreated>2020-04-24T08:36:11</TimeCreated>
14    </Version>
15
16    <Header>
17      <Application>
18        <Name>M32020</Name>
19        <AddonName>M3MH</AddonName>
20        <AddonOrganization>TRIMEK</AddonOrganization>
21      </Application>
22    </Header>
```

About QIF Library

The QIF Library contains fifteen schema files that support the QIF Application schema files.

They include:

Product and manufacturing information (PMI):

- ✓ Geometric dimensioning and tolerancing information
- ✓ Digital product definition data practices
- ✓ Geometrical product specifications
- ✓ Others

Boundary representation models of the sort found at the core of commercial CAD systems:

- ✓ Geometry
- ✓ Topology
- ✓ Mesh representations
- ✓ Visualization

→ Unimetrik use **STEP** files (*Standard for the Exchange of Product model data)*

QIF Results Information Model

Express the results of dimensional inspection

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QIF

Features & Characteristics

The fundamental constructs behind QIF:

Features

- A tangible portion of a physical part (hole with diameter dimension)
- A derived, constructed, intangible portion of a part

The aspects we measure with metrology HW and SW

- outer edges, triangle, steps
- surfaces
- cylinders, hole
- outer edge, steps
- triangle, steps
- triangle
- cylinders, hole
- cylinders, hole

Characteristics

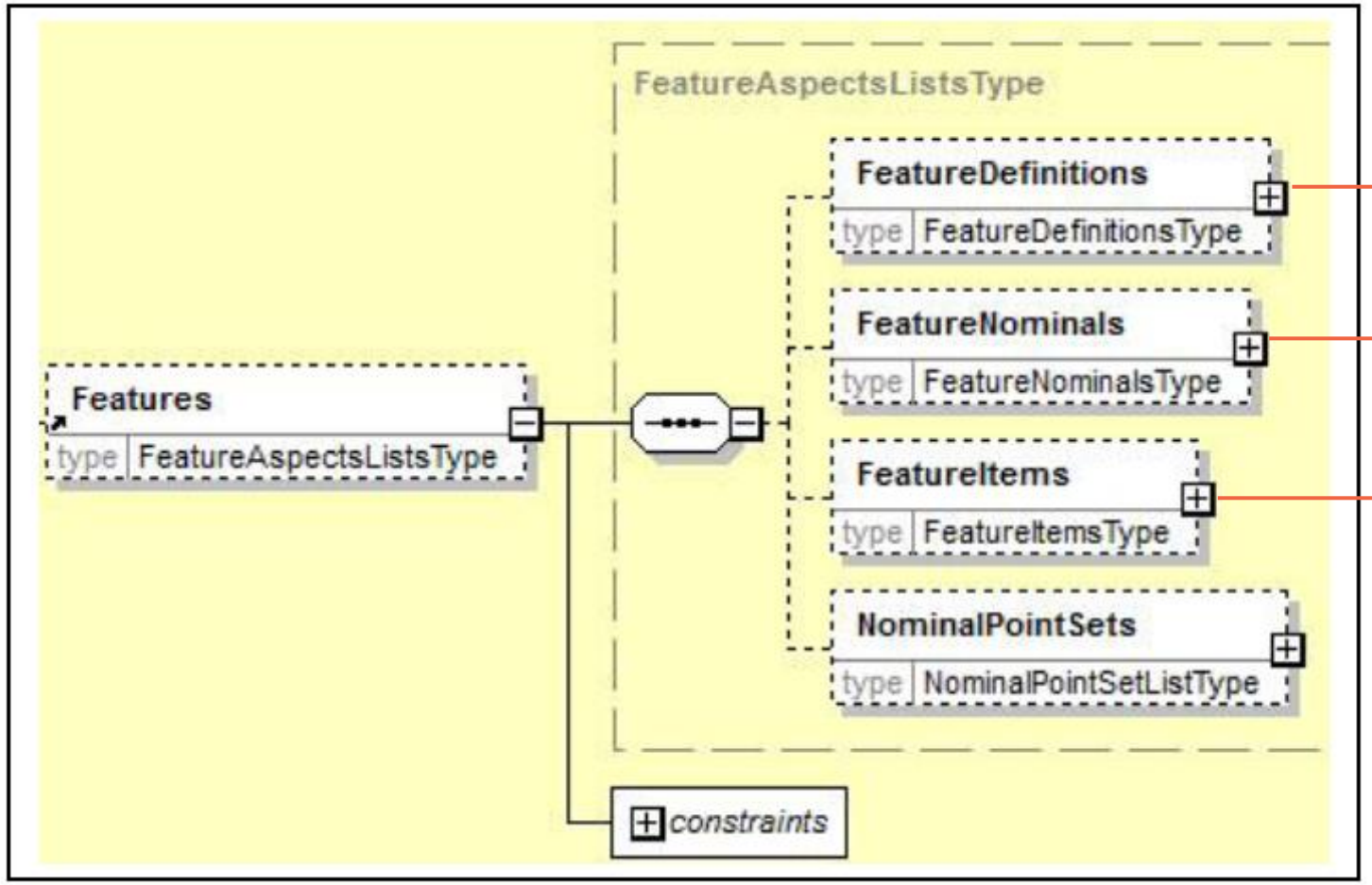
- A control placed on a feature
- A specification limit, a nominal with tolerance, a feature control frame

Determine if the manufactured part meets or fails the specifications

Usually GD&T

- Straightness
- Flatness
- Circularity
- Perpendicularity
- Parallelism
- Angularity
- Concentricity
- Position

Features Element (Measurement Features)



Shareable information to various features of a part (e.g. the diameter of 4 holes in a manufactured part)

Non-shareable information to various features of a part (e.g. nominal location points of each of the 4 holes in a manufactured part)

Name assigned to the feature, optional links to upstream CAD data...

Required *element* ——————

Optional *element* - - - - - - -

QIF XML Document – Features Example

```
223  <Features>
224    <FeatureDefinitions n="6">
225      <EdgePointFeatureDefinition id="8">
228      <PointFeatureDefinition id="19"/>
229      <PointFeatureDefinition id="35"/>
230      <CircleFeatureDefinition id="44">
231        <InternalExternal>INTERNAL</InternalExternal>
232        <Diameter>10</Diameter>
233      </CircleFeatureDefinition>
234      <CircleFeatureDefinition id="61">
238      <CircleFeatureDefinition id="77">
242    </FeatureDefinitions>
243    <FeatureNominals n="6">
244      <EdgePointFeatureNominal id="9">
250      <PointFeatureNominal id="20">
255      <PointFeatureNominal id="36">
260      <CircleFeatureNominal id="45">
261        <FeatureDefinitionId>44</FeatureDefinitionId>
262        <Location>2433.974609375 800.617431640625 890.049621582031</Location>
263        <Normal>0.0558150216639719 -0.907624351305543 -0.41605615038579</Normal>
264      </CircleFeatureNominal>
265      <CircleFeatureNominal id="62">
270      <CircleFeatureNominal id="78">
275    </FeatureNominals>
```

```
322      <CircleFeatureItem id="46">
323        <Attributes n="1">
327        <FeatureNominalId>45</FeatureNominalId>
328        <FeatureName>HOLE1</FeatureName>
329        <DeterminationMode>
330          <Checked>
331            <CheckDetails>
332              <Measured/>
333            </CheckDetails>
334          </Checked>
335        </DeterminationMode>
336      </CircleFeatureItem>
337      <CircleFeatureItem id="63">
352      <CircleFeatureItem id="79">
363    </FeatureItems>
364  </Features>
```

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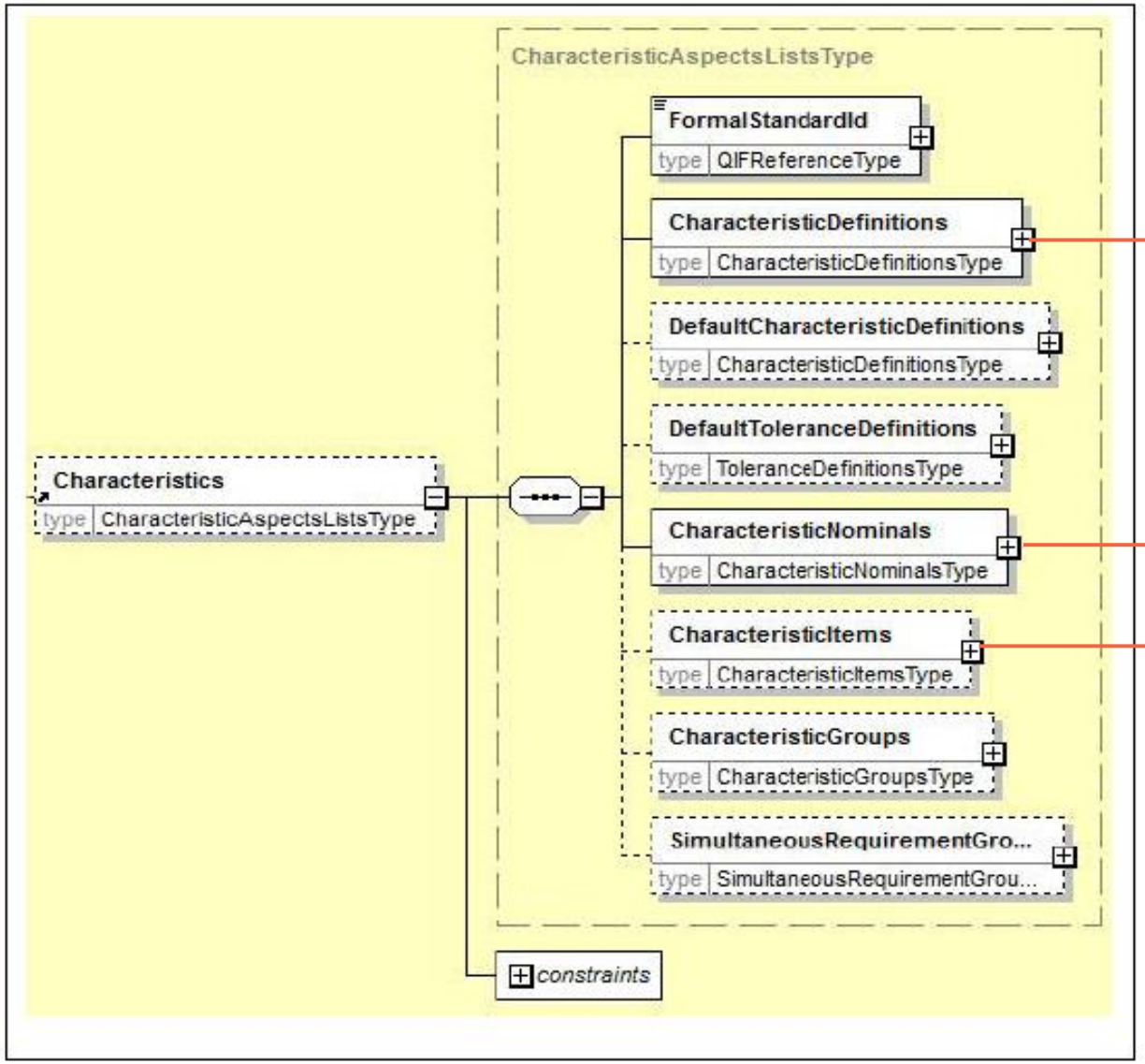
Characteristics Element (Quality Characteristics)



Part of a characteristic that can be shared among different characteristics (e.g. standard diameter tolerance from a manufacturer for a part)

Part of a characteristic that is not shared among different characteristics (e.g. diameter tolerance for a set of holes, all with the same diameter. The shared diameter becomes the target value.)

Used to apply a tolerance to an individual feature

Required *element* ——————

Optional *element* - - - - - - -

QIF Results XML Document - Characteristics Example

```
366  <Characteristics>
367    <FormalStandardId>90</FormalStandardId>
368    <CharacteristicDefinitions n="11">
369      <PointProfileCharacteristicDefinition id="12">
373      <LinearCoordinateCharacteristicDefinition id="23">
376      <LinearCoordinateCharacteristicDefinition id="27">
383      <LinearCoordinateCharacteristicDefinition id="31">
390      <PointProfileCharacteristicDefinition id="39">
395      <DiameterCharacteristicDefinition id="48">
396        <Tolerance>
397          <MaxValue>0.4</MaxValue>
398          <MinValue>-0.4</MinValue>
399          <DefinedAsLimit>false</DefinedAsLimit>
400        </Tolerance>
401      </DiameterCharacteristicDefinition>
402      <PositionCharacteristicDefinition id="52">
403        <ToleranceValue>1</ToleranceValue>
404        <DatumReferenceFrameId>53</DatumReferenceFrameId>
405        <MaterialCondition>MAXIMUM</MaterialCondition>
406        <ZoneShape>
407          <DiametricalZone/>
408        </ZoneShape>
409      </PositionCharacteristicDefinition>
410      <DiameterCharacteristicDefinition id="65">
417      <PositionCharacteristicDefinition id="70">
425      <DiameterCharacteristicDefinition id="81">
428      <DistanceBetweenCharacteristicDefinition id="85">
435    </CharacteristicDefinitions>
```

```
436    <CharacteristicNominals n="11">
437      <PointProfileCharacteristicNominal id="14">
440      <LinearCoordinateCharacteristicNominal id="24">
445      <LinearCoordinateCharacteristicNominal id="28">
450      <LinearCoordinateCharacteristicNominal id="32">
454      <PointProfileCharacteristicNominal id="40">
457      <DiameterCharacteristicNominal id="49">
458        <CharacteristicDefinitionId>48</CharacteristicDefinitionId>
459        <TargetValue>10</TargetValue>
460      </DiameterCharacteristicNominal>
461      <PositionCharacteristicNominal id="57">
462        <CharacteristicDefinitionId>52</CharacteristicDefinitionId>
463      </PositionCharacteristicNominal>
464      <DiameterCharacteristicNominal id="66">
467      <PositionCharacteristicNominal id="74">
470      <DiameterCharacteristicNominal id="82">
474      <DistanceBetweenCharacteristicNominal id="86">
479    </CharacteristicNominals>
```

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QIF Results XML Document - Characteristics Example

```
480    <CharacteristicItems n="11">
481      <PointProfileCharacteristicItem id="15">
506      <LinearCoordinateCharacteristicItem id="25">
530      <LinearCoordinateCharacteristicItem id="29">
555      <LinearCoordinateCharacteristicItem id="33">
579      <PointProfileCharacteristicItem id="41">
604      <DiameterCharacteristicItem id="50">
605        <Attributes n="1">
606          <AttributeStr name="Comment"
607            value="A bi-directional diameter tolerance"/>
608        </Attributes>
609        <Name>6</Name>
610        <CharacteristicDesignator>
611          <Designator>6</Designator>
612          <Criticality>
613            <OtherLevel>MINOR</OtherLevel>
614          </Criticality>
615        </CharacteristicDesignator>
616        <FeatureItemIds n="1">
617          <Id>46</Id>
618        </FeatureItemIds>
619        <MeasurementDeviceIds n="1">
620          <Id>16</Id>
621        </MeasurementDeviceIds>
622        <CharacteristicNominalId>49</CharacteristicNominalId>
623        <LocationOnDrawing>
624          <DrawingId>5</DrawingId>
625          <SheetNumber>SHEET1</SheetNumber>
626          <DrawingZone>C1</DrawingZone>
627        </LocationOnDrawing>
628      </DiameterCharacteristicItem>
629      <PositionCharacteristicItem id="58">
654      <DiameterCharacteristicItem id="67">
676      <PositionCharacteristicItem id="75">
701      <DiameterCharacteristicItem id="83">
712      <DistanceBetweenCharacteristicItem id="87">
735    </CharacteristicItems>
736  </Characteristics>
```

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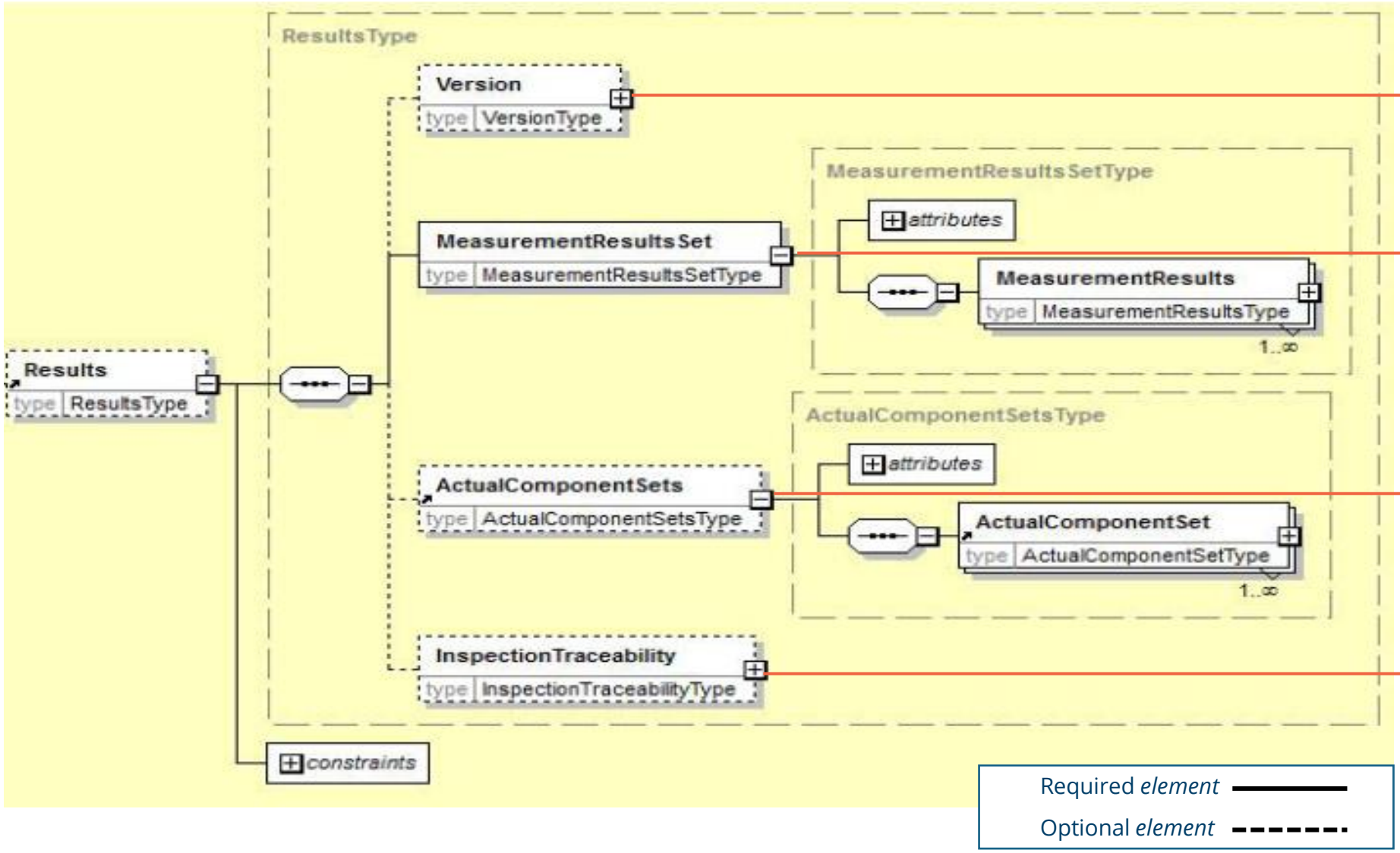
The results *element*



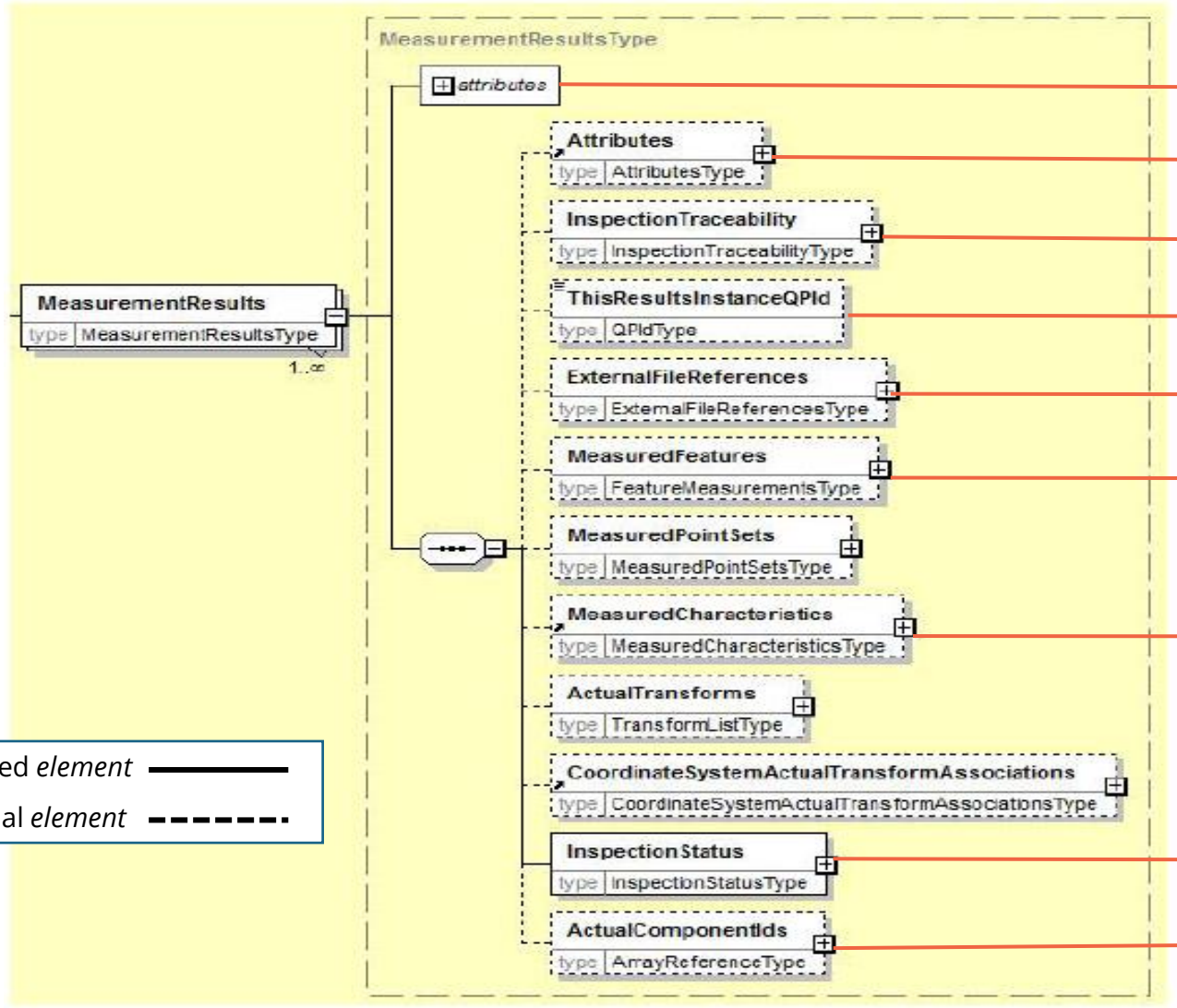
Information about the file, e.g. TimeCreated

Information about a set of related measurements of the part

Describes physical object: manufactured part that was inspected

Information common to all product measurements in the file, workflow details, inspection resources used

High level view of the Measurement Results *element*



QIF id of the measurements results

User defined attributes

Traceability information that applies to this set of measurements results (e.g. name and ID of report preparer, date of preparation…)

Globally unique identifier to this set of measurements results

URI, references to additional files created in the measurement process, a photo, reports…

Results about features that were measured

Results about characteristics that were used and evaluated

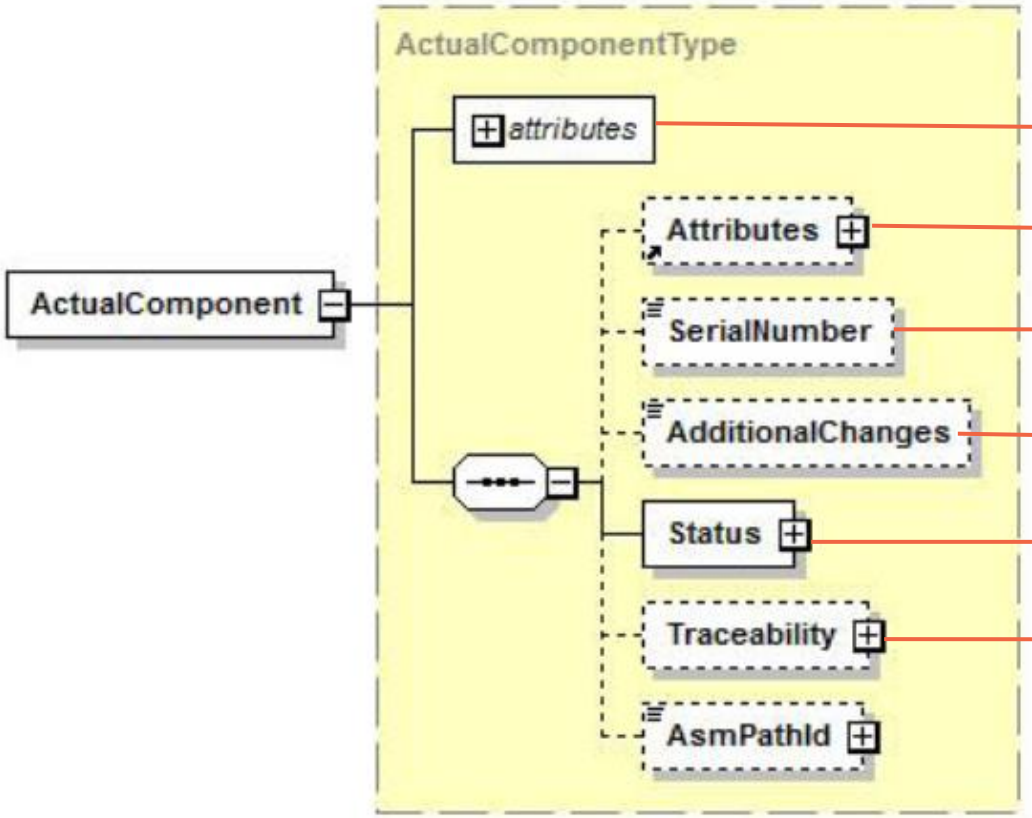
Status of the measurement results (e.g. fail, pass…)

QIFIds of actual component involved in the measurement results

Required *element* ——————

Optional *element* - - - - - - -

The *Actual Component Type* Data Type



QIF id of actual component, for referencing

User defined attributes

Serial number of the actual component

Record of any changes to the product beyond what is recorded in the product model

Inspection status of the actual component

Traceability information for the actual component

Required *element* ——————

Optional *element* - - - - - -

QIF Results XML Document Example

```
<Version>
  <TimeCreated>2020-04-24T08:36:11</TimeCreated>
</Version>

<Header>
  <Application>
    <Name>M32020</Name>
    <AddonName>M3MH</AddonName>
    <AddonOrganization>TRIMEK</AddonOrganization>
  </Application>
</Header>
```

```
<Results>
  <MeasurementResultsSet n="1">
    <MeasurementResults id="89">
      <ThisResultsInstanceQPId>
        8521ff0f-4c05-4f13-a2be-1386190f75a6
      </ThisResultsInstanceQPId>
      <ExternalFileReferences n="1">
        <ExternalFileReference>
          <URI>C:\M3_parts\5802804.res</URI>
          <FileSpec>
            <OtherFileSpec>res</OtherFileSpec>
          </FileSpec>
          <Description>M3 Results</Description>
        </ExternalFileReference>
      </ExternalFileReferences>
      <MeasuredFeatures n="6">
        <EdgePointFeatureMeasurement id="11">
        <PointFeatureMeasurement id="22">
        <PointFeatureMeasurement id="38">
        <CircleFeatureMeasurement id="47">
          <FeatureItemId>46</FeatureItemId>
          <Location>2434.01 801.52505599193 889.98</Location>
          <Normal>0.0558150216639719 -0.907624351305543 -0.41605615038579</Normal>
          <Diameter>9.499476</Diameter>
        </CircleFeatureMeasurement>
        <CircleFeatureMeasurement id="64">
        <CircleFeatureMeasurement id="80">
      </MeasuredFeatures>
```

QIF Results XML Document Example

```
<MeasuredCharacteristics>
  <CharacteristicMeasurements n="13">
    <PointProfileCharacteristicMeasurement id="17">
    <PointProfileCharacteristicMeasurement id="18">
    <LinearCoordinateCharacteristicMeasurement id="26">
    <LinearCoordinateCharacteristicMeasurement id="30">
    <LinearCoordinateCharacteristicMeasurement id="34">
    <PointProfileCharacteristicMeasurement id="42">
    <PointProfileCharacteristicMeasurement id="43">
    <DiameterCharacteristicMeasurement id="51">
      <Status>
        <CharacteristicStatusEnum>FAIL</CharacteristicStatusEnum>
      </Status>
      <CharacteristicItemId>50</CharacteristicItemId>
      <FeatureMeasurementIds n="1">
        <Id>47</Id>
      </FeatureMeasurementIds>
      <NonConformanceDesignator>1234</NonConformanceDesignator>
      <Value>9.499476</Value>
    </DiameterCharacteristicMeasurement>
    <PositionCharacteristicMeasurement id="60">
      <Status>
        <CharacteristicStatusEnum>PASS</CharacteristicStatusEnum>
      </Status>
      <CharacteristicItemId>58</CharacteristicItemId>
      <FeatureMeasurementIds n="1">
        <Id>47</Id>
      </FeatureMeasurementIds>
      <NonConformanceDesignator>NA</NonConformanceDesignator>
      <Value>0.897298445619006</Value>
    </PositionCharacteristicMeasurement>
    <DiameterCharacteristicMeasurement id="69">
    <PositionCharacteristicMeasurement id="76">
    <DiameterCharacteristicMeasurement id="84">
    <DistanceBetweenCharacteristicMeasurement id="88">
  </CharacteristicMeasurements>
</MeasuredCharacteristics>
```

```
      <InspectionStatus>
        <InspectionStatusEnum>FAIL</InspectionStatusEnum>
      </InspectionStatus>
      <ActualComponentIds n="1">
        <Id>4</Id>
      </ActualComponentIds>
    </MeasurementResults>
  </MeasurementResultsSet>
  <ActualComponentSets n="1">
    <ActualComponentSet n="1">
      <ActualComponent id="4">
        <Status>
          <InspectionStatusEnum>FAIL</InspectionStatusEnum>
        </Status>
        <AsmPathId>3</AsmPathId>
      </ActualComponent>
    </ActualComponentSet>
  </ActualComponentSets>
  <InspectionTraceability>
    <ReportPreparer>
      <Name>Andrea Gomez</Name>
      <EmployeeId>123-456</EmployeeId>
    </ReportPreparer>
    <ReportPreparationDate>2020-04-24T08:36:11</ReportPreparationDate>
  </InspectionTraceability>
</Results>

</QIFDocument>
```

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Approaching a QIF XML Document

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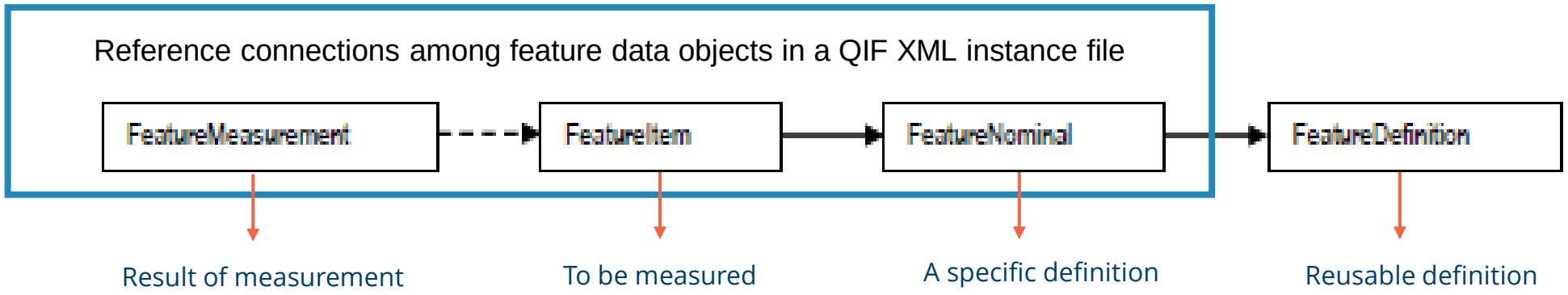
How to Approach a QIF XML Document

PMI in QIF

Feature



1

```
767        <CircleFeatureMeasurement id="47">
768          <FeatureItemId>46</FeatureItemId>
769          <Location>2434.01 801.52505599193 889.98</Location>
770          <Normal>0.0558150216639719 -0.907624351305543 -0.41605615038579</Normal>
771          <Diameter>9.499476</Diameter>
772        </CircleFeatureMeasurement>
```

2

```
322      <CircleFeatureItem id="46">
323        <Attributes n="1">
327        <FeatureNominalId>45</FeatureNominalId>
328        <FeatureName>HOLE1</FeatureName>
329        <DeterminationMode>
336      </CircleFeatureItem>
```

3

```
260      <CircleFeatureNominal id="45">
261        <FeatureDefinitionId>44</FeatureDefinitionId>
262        <Location>2433.974609375 800.617431640625 890.049621582031</Location>
263        <Normal>0.0558150216639719 -0.907624351305543 -0.41605615038579</Normal>
264      </CircleFeatureNominal>
```

4

```
230      <CircleFeatureDefinition id="44">
231        <InternalExternal>INTERNAL</InternalExternal>
232        <Diameter>10</Diameter>
233      </CircleFeatureDefinition>
```

Through the identifiers (IDs) we search and connect

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How to Approach a QIF XML Document

PMI in QIF

Characteristics

References connections among characteristic data objects in a QIF XML instance file

CharacteristicMeasurement → CharacteristicItem → CharacteristicNominal → CharacteristicDefinition

- CharacteristicMeasurement: Result of measurement of the characteristic; Deviation - Pass/fail
- CharacteristicItem: Individual to be measured
- CharacteristicNominal: A specific definition or group
- CharacteristicDefinition: Reusable definition; Global tolerances

1

```
874          <DiameterCharacteristicMeasurement id="51">
875            <Status>
876              <CharacteristicStatusEnum>FAIL</CharacteristicStatusEnum>
877            </Status>
878            <CharacteristicItemId>50</CharacteristicItemId>
879            <FeatureMeasurementIds n="1">
882            <NonConformanceDesignator>1234</NonConformanceDesignator>
883            <Value>9.499476</Value>
884          </DiameterCharacteristicMeasurement>
```

2

```
604        <DiameterCharacteristicItem id="50">
605          <Attributes n="1">
609          <Name>6</Name>
610          <CharacteristicDesignator>
616          <FeatureItemIds n="1">
619          <MeasurementDeviceIds n="1">
622          <CharacteristicNominalId>49</CharacteristicNominalId>
623          <LocationOnDrawing>
628        </DiameterCharacteristicItem>
```

3

```
457      <DiameterCharacteristicNominal id="49">
458        <CharacteristicDefinitionId>48</CharacteristicDefinitionId>
459        <TargetValue>10</TargetValue>
460      </DiameterCharacteristicNominal>
```

4

```
395      <DiameterCharacteristicDefinition id="48">
396        <Tolerance>
397          <MaxValue>0.4</MaxValue>
398          <MinValue>-0.4</MinValue>
399          <DefinedAsLimit>false</DefinedAsLimit>
400        </Tolerance>
401      </DiameterCharacteristicDefinition>
```

Through the identifiers (IDs) we search and connect

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Additional QIF Information

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Additional QIF Information

- https://qualityinformationframework.github.io/

The online hub for the QIF community

QIF3 Schema Browser
Are you busy writing support for the QIF format? Here is an online location where you can browse the contents of the QIF schemas. It's easy to use!

QIF3 Sample Instance Files
Here are a set of sample QIF3 files. These should help to give you an idea of all the different ways that QIF can help support your enterprise!

Source Code Bindings
Here, you will find bindings to help you automatically generate source code to start reading and writing QIF files in C++, C# and Python. You'll be surprised how easy it is to start pushing some QIF code.

QIF3 "Issues" List
This is for more than just flagging issues with the QIF standard. Here is where you can interact with the rest of the community: ask questions about your implementation, submit enhancements requests, and ask general questions about QIF.

QIF Standard Website
The main QIF website. This is where you can download the standard, including the schemas and the documentation. It's free, go and get it!

Getting Started with QIF Hacking

Here is a presentation which can show just how easy it is to get started with QIF!

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Thank you

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