Open Source Framework for Implementing XBRL-based Digital Financial Reporting

A framework for representing metadata using the XBRL technical syntax which enables the creation of a software ecosystem which supports high function and automated quality control

2019-04-21 (DRAFT)

The *Open Source Framework for Implementing XBRL-based Digital Financial Reporting* is a freely available technical framework for implementing a software ecosystem for the creation of financial reports using US GAAP, IFRS, or any other reporting scheme. The framework is well engineered, rigorously tested, proven to be safe and reliable, and based on the global standard XBRL technical syntax. With this framework a software ecosystem can be created which will enable high-level functionality to be exposed to professional accountants using software to creating financial reports using software applications that support this framework. Further, the quality of the reports can be verified using automated processes in specific, known areas therefore manual effort can be focused to areas where automated quality control mechanisms cannot or have not been implemented.

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Introduction

XBRL is a technical syntax. It does not provide a complete environment for implementing XBRL-based digital financial reporting. This framework fills the void, providing additional functionality that enables the implementing of high-level functionality in software applications used by professional accountants. Further, this framework provides a reliable quality control mechanism.

1.1. Intended audience of this document

The intended audience of this document is business professionals and software developers implementing software intended to be used by business professionals.

The average business professional should not need to read or understand this document. Software vendors should embed the information specified within this document within software applications such that the average business professional may only comply with these rules.

1.2. Organization of this document

This document is organized to be read linearly, start to finish.

1.3. Terminology

Throughout this document, several words are used to signify the requirements of this specification. These words are capitalized when they should be interpreted as having a strict meaning. The following definitions are taken from RFC2119[1] and modified so that they are more appropriately worded for use within this standard.

Term	Meaning
MUST	This word means that the definition is an absolute requirement of this specification.
MUST NOT	This phrase, or the phrase "MUST NEVER," means that the definition is an absolute prohibition of this specification.
SHOULD	This word means that valid reasons may exist in particular circumstances to ignore a particular item, but the full implications must be understood and be carefully considered before choosing a different course.

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[1] IETF, *Key words for use in RFCs to Indicate Requirement Levels*, https://www.ietf.org/rfc/rfc2119.txt

Term	Meaning
SHOULD NOT	This phrase means that valid reasons may exist in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully considered before implementing any behavior described with this phrase.
MAY	This word means that an item is truly optional. One business unit may choose to include the item because a particular marketplace requires it or because the business unit feels that it enhances the product while another business may omit the same item.
	An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. Conversely, an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides).

Again, keep in mind that the primary purpose of this document is to create reliable, safe, predictable, interoperable, high-quality, high-function software applications in support of the automation of accounting, reporting, auditing, and analysis workflows and tasks.

1.4. Conceptual model

The conceptual model[2] of this framework is defined by the *Financial Report Semantics and Dynamics Theory*[3] and the *Logical Theory Describing a Business Report*[4].

The following graphic shows the logical model of the entities and the relationships between the entities that make up the conceptual model of a digital financial report[5]. See the glossary of entities[6] which describes the entities in the conceptual model.
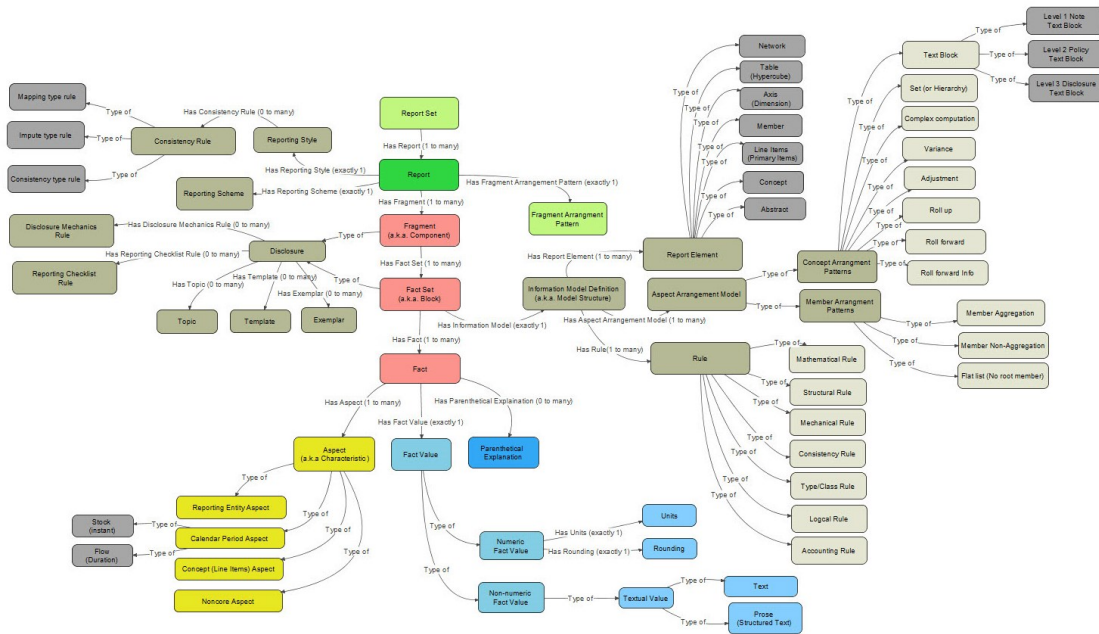
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[2] Conceptual model of a digital financial report, http://xbrl.squarespace.com/conceptual-model/

[3] Charles Hoffman, CPA and Rene van Egmond, *Financial Report Semantics and Dynamics Theory*, http://xbrlsite.azurewebsites.net/2016/Library/Theory-2017-06-26.pdf

[4] Charles Hoffman, CPA and Rene van Egmond, *Logical Theory Describing a Business Report*, http://xbrlsite.azurewebsites.net/2019/Library/LogicalTheoryDescribingBusinessReport.pdf

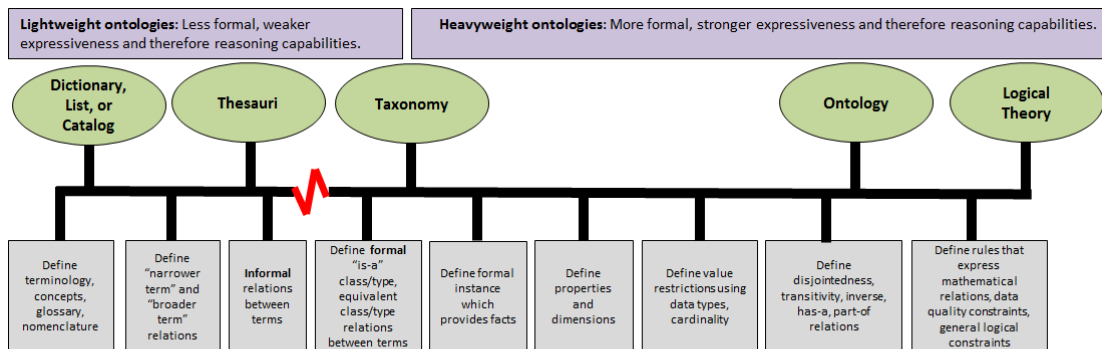[5] Logical Model, http://xbrlsite.azurewebsites.net/2016/conceptual-model/LogicalModel-2019-03-10.jpg

[6] Framework Glossary of Entities, http://xbrlsite.azurewebsites.net/2019/Framework/FrameworkEntitiesSummary.html

1.5. Ontology spectrum

This framework is based on knowledge engineering best practices and conscious knowledge of the ontology spectrum and what it takes to effectively represent knowledge[7].

Inspired primarily by this graphic: Deborah L. McGuinness, *Ontologies for the Modern Age*, Slide 4,
https://www.slideshare.net/deborahmcguinness/ontologies-for-the-modern-age-mcguinness-keynote-at-iswc-2017

Dr Leo Obrst, *Ontology Spectrum*, https://slideplayer.com/slide/697642/

It is anticipated that this framework can also use RDF, OWL, and some rules language such as SWRL, SHACL, RIF to implement a digital financial report.

1.6. System narrative[8]

The systems in which this framework will most likely be used are software applications that are used to create internal or external

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[7] Ontology Spectrum, http://xbrl.squarespace.com/journal/2019/4/27/ontology-spectrum.html

[8] This is a more detailed system narrative,
http://xbrlsite.azurewebsites.net/2019/Framework/Narrative.pdf

financial reports. Those reports could be US GAAP based reports; IFRS based reports; or other reports using reporting schemes[9] that might leverage this framework.

Information is stored within many different types of databases, spreadsheets, content information systems which record the transactions, events, circumstances, and other phenomenon which comprise the information that might end up within an internal or external financial report[10].

Information can be put into two broad groups: information which flows through a double-entry accounting system and all other information.

A **financial report** is simply some internal or external financial report which reports financial and nonfinancial which should be consistent with some specified reporting scheme. Reported facts could include sustainability information related to environmental, social, and governance. The financial report must comply with statutory and regulatory reporting requirements and conform to said requirements.

A **financial report fragment** is a set of facts which go together (tend to be cohesive and share a certain common nature) for some specific purpose within a financial report. For example, a "balance sheet" is a fragment of a financial business report. "Maturities of long-term debt" is a fragment of a financial report.

A **fact** describes a single, observable, piece of financial or nonfinancial information contained within a financial report which is contextualized for unambiguous interpretation or analysis by distinguishing characteristics of the fact. Every fact has exactly one value. Every fact must have each of the core characteristics (reporting entity, calendar period, and concept) but may have additional noncore characteristics. Facts can be financial or nonfinancial such as sustainability related such as environmental, social, or governance (ESG[11]) related.

A **characteristic or aspect** provides information necessary to describe a fact or unambiguously distinguish one fact from another fact. A fact has a set of one or many characteristics or aspects, the set being a property of the fact, which describes the fact.

A **document** is an organized set of financial report fragments. Report fragments are sequenced or organized in an appropriate

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9 Comparison of financial reporting schemes, http://xbrlsite.azurewebsites.net/2018/Library/ReportingSchemes-2018-12-30.pdf

10 Process for creating a financial report, http://xbrlsite.azurewebsites.net/2019/Library/Process.jpg

11 Wikipedia, *Environmental, social and corporate governance*, https://en.wikipedia.org/wiki/Environmental,_social_and_corporate_governance

flow. A financial report can be sensibly and logically represented as an electronic document (such as a Word or PDF document), a web document (such as an HTML file or Wiki page), dynamic multidimensional hypercube, a spreadsheet, or any other visual form including something provided by a dynamic viewing application (such as a pivot table, or drill-down information viewer).

The presentation or view of a financial report within a document is created by one or more financial report viewing tools (commonly known as rendering engines), which are specifically capable of reading the structured digital format (in this case XBRL technical syntax) and then creating a structured presentation. It is important to know that different rendering engines may present the same digital financial report in different ways. This does not mean that the underlying representation or meaning being conveyed is different, only that the translation of the logical representation to a visual presentation is different for different software applications.

Rendering engines are expected to understand the semantics of a business report which will help them in creating understandable human readable renderings. Alternatively, pixel-perfect renderings can be created manually using Inline XBRL.

A financial report provides **disclosures**. A disclosure is simply some set of financial or nonfinancial information that is disclosed within a financial report.

Disclosures can be organized into **topics**. Topics simply organize or sequence disclosures primarily for the needs of human readers of a financial report or creators of such a report.

A disclosure may have zero or many **templates**. A template is simply a prototype or a preliminary model of a disclosure.

A disclosure may have zero or many exemplars associated with the disclosure. An exemplar is simply an instance of a similar disclosure within the financial report of some other economic entity or for an economic entity at some other point in time.

Business rules represent some requirement in either machine-readable or human-readable form. The following diagram provides a graphical representation of the relationship between different types of rules.
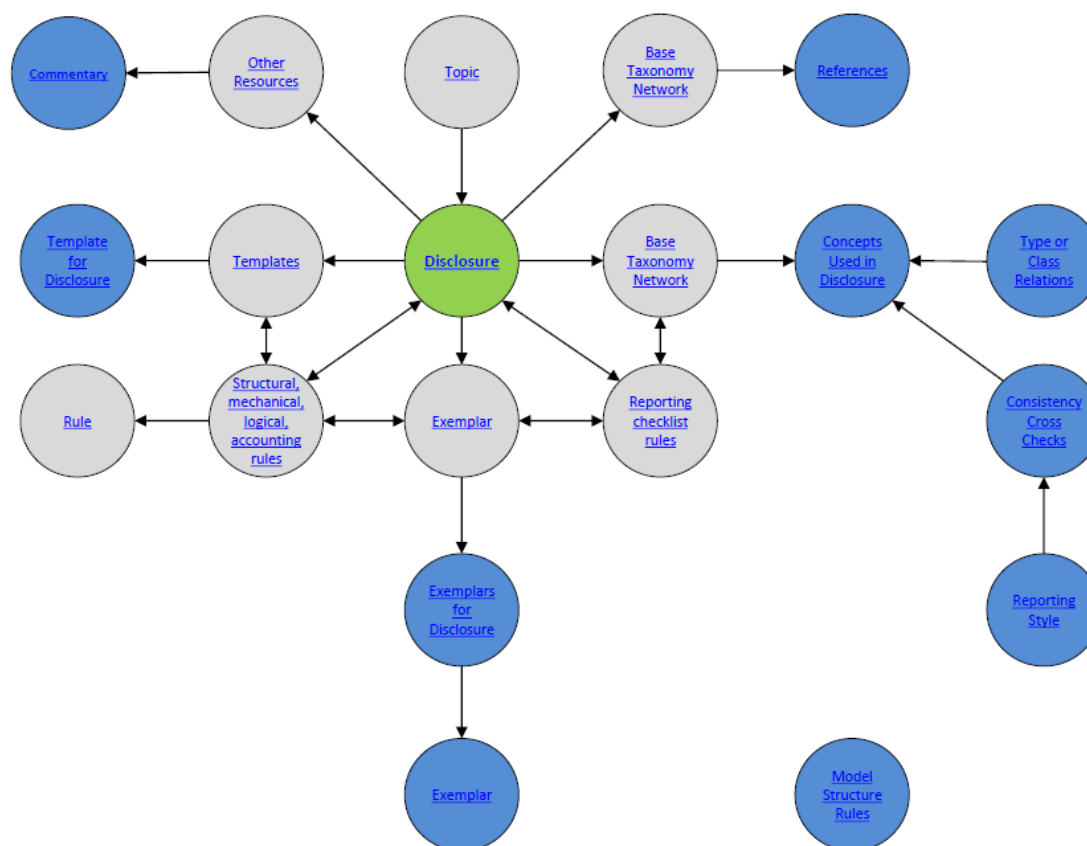
1.7. Methodology

The methodology which will be used to create and maintain this framework and related artifacts is the build, test, deploy, and maintain methodology[12]. Quality matters and testing and proof of concepts contribute to achieving the high quality that is necessary.

1.8. General high-level requirements

The following is a summary of general high-level requirements of this framework:

- **Straightforwardly usable over the Internet**: The financial reports are intended to be used over the Internet.

- **Shall support a wide variety of common business use cases**: A wide variety of business use cases should be handled, considering the 80/20 rule is appropriate. It is not a requirement to meet all business use cases.

- **Minimal options**: The number of optional features is to be kept to the absolute minimum, ideally zero.

- **Formal and concise**: The design shall be formal and concise.

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[12] EDM Council, *FIBO™ Build, Test, Deploy and Maintain Methodology*, https://spec.edmcouncil.org/fibo/doc/20170930_FIBO_BTDM.pdf

- **Readable by both humans and machines**: A report should be readable by both humans and machines. Information provide within a report should be more a representation of information than presentation oriented.

- **Global standard format with high level of semantics:** The format of the report should be a global standard which can provide a high level of semantic clarity.

- **The "model" and the "view" should not be intermingled**: The information and the model should be separate.

- **Business rules separate**: Business rules should be separated from the information. Business rules which are external to the report should be allowed for.

- **Managed global standard or de facto standard**: The report should ultimately be a global standard under the control of someone like OMG, XBRL International, ISO, Apache OpenOffice, or some other such organization.

1.9. *System high-level requirements*

The following is a summary of the high-level system requirements for reports:

- Minimize the probability of ambiguity between what a reporting entity may say and what a user of the report may interpret.

- Maximize safe reuse of information contained within a report.

- Minimize the possibility of errors within the report.

- Maximize the probability of detecting errors using automated processes assisted by software applications.

- Maximize the probability that any software which supports XBRL will be able to make use of a report with no need for adjusting the software.

1.10. *Principles*

The following is a set of principles which those stakeholders creating this framework agree to use to understand their perceptions, positions, and risks when it comes to creating this framework.

1. Prudence dictates that using information from an XBRL-based report should not be a guessing game.

2. A near zero defect report is useful; a defective financial report is not useful.

3. Rules prevent anarchy.

4. The only way to achieve a meaningful exchange of information without disputes is with the prior existence of and agreement as to a standard set of technical syntax rules, business logic rules, and workflow rules.

5. Explicitly stated information or reliably derived information is preferable to implicit information. Derived and implied are not the same things.

6. Reports can be guaranteed to be defect free using automated processes to the extent that machine-readable rules exist.

7. When possible to effectively create, machine-based automated processes tend to be more desirable than human-based manual processes because machine processes are more reliable and cost less.

8. Complexity cannot be removed from a system, but complexity can be moved.

2. Syntax and Restrictions

XBRL technical specification[13] rules are used to validate the technical syntax or format used to represent information within this framework.

The following section summarizes parts which exist within the XBRL 2.1 Specification, XBRL Dimensions 1.0 specification, and XBRL Formula 1.0 specification which MUST NOT exist within XBRL taxonomy schemas, XBRL linkbases, and XBRL instances which comply with this framework.

All other aspects of XBRL 2.1, XBRL Dimensions 1.0, XBRL Formula 1.0, and Generic Linkbase 1.0 are allowed other than those items specifically prohibited within this section.

2.1. Tuples MUST NOT exist.

Tuples can always be detected because elements which define tuples have a substitutionGroup attribute value of "xbrli:tuple". No such elements are allowed under this profile.

Reasoning: Tuples are not allowed by the US GAAP Taxonomy Architecture or the IFRS XBRL Taxonomy architecture and are therefore not allowed within SEC XBRL financial filings. Tuples and XBRL Dimensions tend to provide the same functionality so both are not necessary. XBRL Dimensions provides better functionality than tuples.

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[13] XBRL International, *XBRL Technical Specifications*, https://specifications.xbrl.org/specifications.html

2.2. Complex typed members MUST NOT exist.

Typed members can always be detected as they contain the xbrldt:typedDomainRef attribute which defines the typed member. No such attribute should ever be detected within a discoverable taxonomy set (DTS) which makes use of this profile.

Reasoning: Typed members are not allowed by the US GAAP XBRL Taxonomy or IFRS XBRL Taxonomy Architecture and are therefore not allowed within SEC XBRL financial filings. Explicit members can be created which serve the same general purpose as typed members.

2.3. Precision attribute MUST NOT exist on facts.

The precision attribute MUST NOT exist on facts. Instead, the decimals attribute MUST be used.

Reasoning: The decimals attribute and the precision attribute provide very similar functionality. Allowing use of both the decimals attribute and the precision attribute would require conversion between the two attributes[14].

3. Defined Objects (Entities)

The following are is a summary of key high-level classes of objects or entities that have specific utility and meaning in this framework. See the framework glossary for a complete list of entities[15].

3.1. Topic

A Topic is a name under which a set of Disclosures that are grouped together for some specific reason can be organized. A topic is defined using an XBRL taxonomy schema and is defined by having a type attribute with the value set to "topics:topicItemType".

Reasoning: Topics are used to organize or sequence disclosures which could be numerous in volume, sometimes in the hundreds or even thousands.

Machine readable example[16]:

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14 Eurofiling, *Precision, rounding and margin of error in reporting processes*, http://www.eurofiling.info/documents/CX-108_Precision_in_reporting_processes.pdf

15 Framework Glossary of Entities, http://xbrlsite.azurewebsites.net/2019/Framework/FrameworkEntitiesSummary.html

16 Topics, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/topics.xsd

```
<element id="topics_AccountingPolicies" type="topics:topicItemType"
    name="AccountingPolicies" abstract="true" xbrli:periodType="duration"
    substitutionGroup="xbrli:item"/>
<element id="topics_BalanceSheet" type="topics:topicItemType" name="B...
```

Human readable example[17]:

			Period		
Line	**Label**	**Object Class**	**Type**	**Balance**	**Report ElementName**
1	Topics	Network			http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-schemes/xasb/topics/role/Topics
2	Financial Report	Abstract			topics:FinancialReport
3	Primary Financial Statements	Abstract			topics:PrimaryFinancialStatements
4	Balance Sheet	Abstract			topics:BalanceSheet
5	Income Statement	Abstract			topics:IncomeStatement

3.2. Disclosure

A Disclosure is a set of financial or nonfinancial facts that is disclosed.

Reasoning: The notion of a disclosure is used to provide a name for specific disclosures such that templates, exemplars, topics, and other information can be linked to a disclosure.

Machine readable example[18]:

```
<comp...
<element id="disclosures_AdditionalPaidInCapitalChanges"
    type="disclosures:disclosureItemType" name="AdditionalPaidInCapitalChanges"
    abstract="true" xbrli:periodType="duration" substitutionGroup="xbrli:item"/>
<element id="disclosures_AssetsRollUp" type="disclosures:disclosureItemType"
    name="AssetsRollUp" abstract="true" ...periodType="duration"...
```

Human readable example[19]:

	Balance Sht	Abstract	topics:BalanceSheet
5	Assets [Roll Up]	Abstract	disclosures:AssetsRollUp
6	Balance Sheet	Abstract	disclosures:BalanceSheet
7	Liabilities and Equity [Roll Up]	Abstract	disclosures:LiabilitiesAndEquityRollUp
8	Income Statement	Abstract	topics:IncomeStatement

3.3. Template

A Template is a starting point or sample used to create a complete Disclosure.

Reasoning: The notion of a template is use to enable professional accountants using software applications to interact with higher level

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[17] Topics, human readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/topics_modelstructure.html

[18] Disclosures, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/disclosures.xsd

[19] Disclosures, human readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/disclosures_ModelStructure.html

objects rather than be burdened with lower level primitive objects when possible.
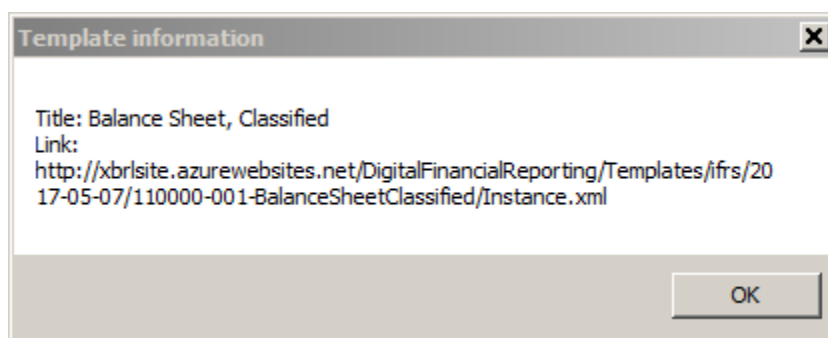
Machine readable example[20]:

Human readable example:

3.4. Exemplar

An Exemplar is an example of a Disclosure from some other existing financial report.

Reasoning: The notion of an exemplar is very similar to that of a template; the only difference is that the source of the template is some other existing financial report which contains the disclosure which the professional accountant is representing.

Machine readable example[21]:

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[20] Template, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/ifrs/disclosures/disclosures-templates-ref.xml

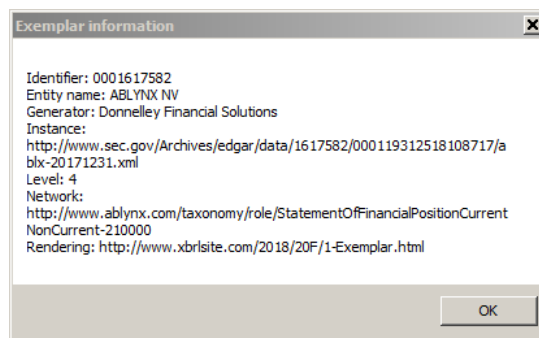[21] Exemplar, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/ifrs/disclosures/exemplars-forDisclosure-1361-ref.xml

```
</reference...
- <referenceLink xlink:role="http://www.xbrl.org/2003/role/link" xlink:type="extended">
    <loc xlink:href="disclosures.xsd#disclosures_BalanceSheetClassified" xlink:type="locator"
        xlink:label="disclosures_BalanceSheetClassified"/>
    <referenceArc xlink:type="arc" xlink:to="disclosures_BalanceSheetClassified_lbl"
        xlink:from="disclosures_BalanceSheetClassified"
        xlink:arcrole="http://www.xbrl.org/2003/arcrole/concept-reference"/>
  - <reference xlink:role="http://xbrlsite.azurewebsites.net/2016/conceptual-model/cm-
    roles/roles/exemplar" xlink:type="resource" xlink:label="disclosures_BalanceSheetClassified_lbl">
        <rpart:LEI>0001172494</rpart:LEI>
        <rpart:EntityRegistrantName>AU OPTRONICS CORP</rpart:EntityRegistrantName>
        <rpart:AccessionNumber>0000950103-18-003972</rpart:AccessionNumber>
        <rpart:Generator>DataTracks</rpart:Generator>
        <rpart:Instance>http://www.sec.gov/Archives/edgar/data/1172494/000095010318003972/auo-
            20171231.xml</rpart:Instance>
        <rpart:Level>4</rpart:Level>
        <rpart:Network>http://auo.com/role/ConsolidatedStatementsOfFinancialPosition</rpart:Network>
        <rpart:Table/>
        <rpart:Rendering>http://www.xbrlsite.com/2018/20F/10-Exemplar.html</rpart:Rendering>
        <rpart:Confidence>80%</rpart:Confidence>
        <rpart:Likes>1</rpart:Likes>
        <rpart:Dislikes>0</rpart:Dislikes>
        <rpart:Rating>5</rpart:Rating>
    </reference>
  </referenceLink>
- <referenceLink xlink:role="http://www.xbrl.org/2003/role/link" xlink:type="extended">
```

Human readable example:

```
Exemplar information                                    [x]

Identifier: 0001617582
Entity name: ABLYNX NV
Generator: Donnelley Financial Solutions
Instance:
http://www.sec.gov/Archives/edgar/data/1617582/000119312518108717/a
blx-20171231.xml
Level: 4
Network:
http://www.ablynx.com/taxonomy/role/StatementOfFinancialPositionCurrent
NonCurrent-210000
Rendering: http://www.xbrlsite.com/2018/20F/1-Exemplar.html

                                              [ OK ]
```

3.5. Template List

A Template List is some listing of templates which are available and is used to load templates into software applications. Zero, one, or many template lists can exist.

Reasoning: The notion of a template list is simply to provide a mechanism for loading templates into software when necessary.

Machine readable example[22]:

```
        xlink:arcrole="http://www.xbrl.org/2003/arcrole/concept-reference"/>
  - <reference xlink:role="http://xbrlsite.azurewebsites.net/2016/conceptual-model/cm-
    roles/roles/template" xlink:type="resource" xlink:label="disclosures_DocumentInformation_lbl">
        <rpart:Title>Document Information</rpart:Title>
        <rpart:Description>Information about the document.</rpart:Description>
        <rpart:Level>4</rpart:Level>
        <rpart:TemplateForDisclosure>http://xbrlsite.azurewebsites.net/2016/conceptual-
            model/reporting-scheme/xasb/templates/1000-001-
            DocumentInformation/Instance.xml</rpart:TemplateForDisclosure>
    </reference>
  </referenceLink>
```

Human readable example:

---

[22] Template list, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/disclosures-templates-ref.xml

3.6. Exemplar List

An Exemplar List is some listing of exemplars which is available and is used to load exemplars into software applications. Zero, one, or many exemplar lists can exist.

Reasoning: The notion of an exemplar list is simply to provide a mechanism for loading exemplars into software when necessary.

Machine readable example[23]:

Human readable example:

Identifier	Entity Name	Generator	Instance
000161...	ABLYNX NV	Donnelley Financial Solutions	http://www.se
000112...	ADVANCED SEMICONDUCTOR E...	Donnelley Financial Solutions	http://www.se
000111...	AETERNA ZENTARIS INC.	Workiva	http://www.se
000156...	AMBEV S.A.	Thunderdome	http://www.se
000100...	ARAUCO & CONSTITUTION PUL...	DataTracks	http://www.se
000117...	AU OPTRONICS CORP	DataTracks	http://www.se
000140...	B COMMUNICATIONS LTD	Ez-XBRL	http://www.se
000101...	BUENAVENTURA MINING CO INC	DataTracks	http://www.se
000103...	CELESTICA INC	Workiva	http://www.se

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[23] Exemplar list, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/disclosures-exemplarsList-ref.xml

4. Defined Relations

The following is a summary of relations that have been defined in the general arcroles[24] and disclosure rules arcroles[25] XBRL taxonomy schemas. These relations are used to define relations within XBRL definition linkbases in support of describing and verifying specific relations.

4.1. Topic and disclosure organization related relations

The following relations are associated with the representation of relations between topics and disclosures only for visual presentation of such topics and disclosures in an organized sequence or ordering.

ArcRole	Definition
heading-topic	Represents a relation between a heading (topics:headingItemType) and a topic (topics:topicItemType).
topic-disclosure	Represents a relationship between a topic (topics:topicItemType) and a disclosure (disclosures:disclosureItemType).

4.2. Model structure related relations

The following relations are associated with the representation of allowed and disallowed relations between parent report elements categories and child report element categories associated with model structure rules.

ArcRole	Definition
parentCategory-allowedChildCategory	Specifies that a type of model structure relationship is **ALLOWED** between a parent report element category and a child report element category.
parentCategory-disallowedChildCategory	Specifies that a type of model structure relationship is **NOT ALLOWED** between a parent report element category and a child report element category.
parentCategory-discouragedChildCategory	Specifies that a type of model structure relationship is **DISCOURAGED** between a parent report element category and a child report element category.

4.3. Reporting checklist related relations

The following are relations which can be represented in XBRL definition relations in support of reporting checklist rules.

ArcRole ID	Definition

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[24] General relations arcroles, http://xbrlsite.azurewebsites.net/2016/conceptual-model/cm-arcroles.xsd

[25] Disclosure relations arcroles, http://xbrlsite.azurewebsites.net/2016/conceptual-model/drules-arcroles.xsd

ArcRole ID	Definition
financialReport-requiresDisclosure	Type of full-hasPart relation. Indicates that a financial report (full) is required to have a specific disclosure (hasPart). This disclosure MUST always be present.
financialReport-possibleDisclosure	Indicates that a financial report might possibly provide a specific disclosure.
financialReport-reportsConcept	Indicates that a financial report contains a specific reported fact which has a characteristic of a specific concept.
disclosure-allowedAlternativeDisclosure	Type of class-subClass relation. Allow for an alternative disclosure to be used in place of another disclosure.
reportingLineItem-requiresDisclosure	Indicates that if a specific line item is reported, then a financial report is required to have a specific disclosure. If the line item is present, the disclosure is required.
reportedDisclosure-requiresDisclosure	Indicates that if a specified disclosure exists, then another disclosure is also required to exist.
reportedFact-requiresReportedFact	Indicates that if a specified reported fact exist, then another reported fact is also required.
reportedFact-prohibitsReportedFact	Indicates that if a specified reported fact exist, then another reported fact is MUST NOT exist.

4.4. Disclosure mechanics related relations

The following are relations which can be represented in XBRL definition relations in support of disclosure mechanics rules.

ArcRole ID	Definition
disclosure-requiresConcept	Type of full-hasPart relation. Indicates that a disclosure (full) is required to have a specific concept (hasPart). This concept MUST always be present for the specified disclosure.
disclosure-requiresHypercube	Type of full-hasPart relation. Indicates that a disclosure (full) is required to have a specific concept (hasPart). This concept MUST always be present for the specified disclosure.
disclosure-requiresAxis	Indicates that the disclosure requires the specified Axis to exist.
disclosure-requiresMember	Indicates that the disclosure requires the specified Member to exist.
disclosure-requiresConceptInContext	Type of full-hasPart relation. Indicates that a disclosure (full) is required to have a specific concept (hasPart). This concept MUST always be present for the specified disclosure AND in the same context.
disclosure-hasConceptArrangementPattern	Indicates that a disclosure is organized using the indicated concept arrangement pattern.
disclosure-hasMemberArrangementPattern	Indicates that a disclosure has an axis whose members are arranged using a particular member arrangement pattern.
disclosure-relatedPolicy	Indicates that a disclosure has a related policy.
disclosure-relatedLevel1NoteTextBlock	Indicates that a disclosure has related Level 1 Note [Text Block].
disclosure-equivalentTextblock	Indicates that the disclosure has the text block which can also be used to report the same information
disclosure-isSECType	Indicates that a disclosure is a specific SEC type (Document, Statement, Disclosure, Schedule) per the EFM.
disclosure-oftenContainsConcept	Evoking strength. A disclosure often contains this specific concept.

ArcRole ID	Definition
disclosure-mostlyContainsConcept	Evoking strength. A disclosure mostly contains this specific concept.
disclosure-rarelyContainsConcept	Evoking strength. A disclosure rarely contains this specific concept.
disclosure-practicallyAlwaysContainsConcept	Evoking strength. A disclosure practically always contains this specific concept.
disclosure-neverContainsConcept	Evoking strength. A disclosure never contains this specific concept.
concept-allowedAlternativeConcept	Type of class-subClass relation. Allow for an alternative concept to be used in place of another concept.
conceptArrangementPattern-requiresConcept	Indicates that a concept arrangment pattern requires a concept that will be the total of a roll up or balance or instant of a roll forward or total of an adjustment
axis-allowedAlternativeAxis	Type of class-subClass relation. Allow for an alternative axis to be used in place of another axis.

4.5.   Definition of properties related relations

The following are relations which can be represented in XBRL definition relations in support of defining properties[26] of report elements.

ArcRole ID	Definition
property-hasProperty	Creates a relation between a property and a report element that has that property.
property-disjointedProperty	Creates a relation between a property and another property to indicate that the two properties are disjointed.

4.6.   Definition of class/subclass related relations

The following are relations which can be represented in XBRL definition relations in support of defining properties[27] of report elements.

ArcRole ID	Definition
class-subClass	The class extension of a class description is a subset of the class extension of another class description. Same as OWL definition of subClassOf.
class-equivalentClass	Both class extensions contain exactly the same set of individuals. Same as OWL definition of equivalentClass.
full-hasPart	A has part B. Note that from A hasPart B we cannot infer that B is partOf A.

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[26] Example of defining properties, http://xbrlsite.azurewebsites.net/2016/conceptual-model/properties.xsd; http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/properties/Properties-us-gaap-rules-def.xml

[27] Example of defining properties, http://xbrlsite.azurewebsites.net/2016/conceptual-model/properties.xsd; http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/properties/Properties-us-gaap-rules-def.xml

5. Rules

The following is a summary of structural, mechanical, mathematical, logical, and some accounting rules related to the correct representation of financial and nonfinancial information within an XBRL-based financial report.

5.1. Model structure rules

Model structure rule relate to the relations between the report elements within a set of XBRL presentation relations.

Model structure rules are identifiable via the extended link role URI fragment "/ModelStructureRules/" or by the arcroles which are used to represent the rules.

Reasoning: While the XBRL specification enforces relations within XBRL calculation relations and XBRL definition relations; it does not enforce relationships within XBRL presentation relations. As such, these relations are enforced via model structure rules.

Machine readable example[28]:

```
-R:definitionLi
- <link:definitionLink xlink:title="" xlink:role="http://www.xbrl.org/2003/role/link" xlink:type="extended">
    <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/cm.xsd#cm_Member"
        xlink:type="locator" xlink:label="cm_Member"/>
    <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-
        model/cm.xsd#cm_Network" xlink:type="locator" xlink:label="cm_Network"/>
    <link:definitionArc xlink:type="arc" use="optional" order="31" xlink:from="cm_Member"
        xlink:to="cm_Network" xlink:arcrole="http://xbrlsite.azurewebsites.net/2016/conceptual-
        model/arcrole/parentCategory-disallowedChildCategory"/>
  </link:definitionLink>
- <link:definitionLink xlink:title="" xlink:role="http://www.xbrl.org/2003/role/link" xlink:type="extended">
    <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/cm.xsd#cm_Member"
```

Human readable example:

		Restrictive model (Meets EFM filing rules, but less ambigous)						
					Parent			
		Network	Table	Axis	Member	LineItems	Abstract	Concept
Child	Network	Illegal XBRL	Illegal XBRL	Illegal XBRL	Illegal XBRL	Illegal XBRL	Illegal XBRL	Illegal XBRL
	Table	OK	Disallowed	Disallowed	Disallowed	Disallowed	OK	Disallowed
	Axis	Disallowed	OK	Disallowed	Disallowed	Disallowed	Disallowed	Disallowed
	Member	Disallowed	Disallowed	OK	OK	Disallowed	Disallowed	Disallowed
	LineItems	Disallowed	OK	Disallowed	Disallowed	Disallowed	Disallowed	Disallowed
	Abstract	OK	Disallowed	Disallowed	Disallowed	OK	Disallowed	Disallowed
	Concept	Disallowed	Disallowed	Disallowed	Disallowed	OK	OK	Disallowed

5.2. Mathematical relations rules

Mathematical relations rules relate to the correct computations of roll ups, roll forwards, adjustments, variances, member

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[28] Model structure rules, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/model-structure/ModelStructure-rules-us-gaap-def.xml

aggregations (a type of roll up), and other such mathematical computations.

Reasoning: Many regulators do not allow the submission of XBRL Formula relations within their allowed formats and not all regulators enforce the existence of XBRL calculation relations when roll ups are present. As such, this framework requires that all mathematical relations to be supported by a set of machine-readable rules that describe and which can be used to verify such mathematical relations.

Machine readable example[29]:

```
<generic:link xlink:role="http://xasb.org/gaap/role/schedule/level4/IncomeStatementSchedule"
    xlink:type="extended">
        <!-- Value ASSERTION -->
        <va:valueAssertion xlink:label="ASSERTION_IncomeStatementSchedule" xlink:type="resource"
            test="$VARIABLE_Total = ($VARIABLE_A - $VARIABLE_B - $VARIABLE_C - $VARIABLE_D +
            $VARIABLE_E - $VARIABLE_F - $VARIABLE_G - $VARIABLE_H + $VARIABLE_I)"
            implicitFiltering="true" aspectModel="dimensional" id="ASSERTION_GAAP_Complex_BB-
            Part-1_IncomeStatementSchedule"/>
        <!-- Arc from Assertion to Label -->
        <generic:arc xlink:type="arc" order="1.0" xlink:to="ASSERTION_Label"
            xlink:from="ASSERTION_IncomeStatementSchedule"
```

Human readable example[30]:

Income Tax Contingency [Line Items]	Period [Axis]		
	2016-07-01 - 2017-06-30	2015-07-01 - 2016-06-30	2014-07-01 - 2015-06-30
Balance, beginning of year	10,164,000,000	9,599,000,000	8,714,000,000
Decreases related to settlements	(4,000,000)	(201,000,000)	(50,000,000)
Increases for tax positions related to the current year	1,277,000,000	1,086,000,000	1,091,000,000
Increases for tax positions related to prior years	397,000,000	115,000,000	94,000,000
Decreases for tax positions related to prior years	(49,000,000)	(317,000,000)	(144,000,000)
Decreases due to lapsed statutes of limitations	(48,000,000)	(118,000,000)	(106,000,000)
Balance, end of year	11,737,000,000	10,164,000,000	9,599,000,000

5.3. *Type/class relation rules*

Type/class relations rules enforce explicitly allowed and explicitly disallowed relations between reported concepts.

A type/class rule is identifiable via the extended link role URI fragment "/TypeOrClassRelations/" or by the arcroles which are used to represent the rules.

Reasoning: Type/class relations rules are not provided by most, if any, financial reporting taxonomies. Because extension is allowed, these rules are used to detect the incorrect use of a concept relative

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[29] Mathematical relations, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/taxonomy/gaap-formula.xml

[30] Mathematical relations, human readable, http://www.xbrlsite.com/2017/Prototypes/Microsoft/evidence-package/#Rendering-DisclosureChangesInUnrecognizedTaxBenefitsDetail-us_gaap_IncomeTaxContingencyTable.html

to other concepts within a report. For example, a common error is the reporting of an indirect operating expense within a set of direct operating expenses. Type/class relations rules prevent and detect these common errors. Further, if financial reporting taxonomies do provide type/class relations; this framework requires the enforcement of these relations.

Machine readable example[31]:

```
  <link:linkbase>
  - <link:definitionLink xlink:title="Total Operating expenses DOES NOT INCLUDE Cost of Revenues"
    xlink:role="http://www.xbrlsite.com/2016/Prototype/elr/TypeOrClassRelations/role/DisallowedRollUpRelations"
    xlink:type="extended">
        <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/fac/fac-
            xasb.xsd#fac-xasb_OperatingExpenses" xlink:type="locator" xlink:label="fac-xasb_OperatingExpenses"/>
        <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/fac/fac-
            xasb.xsd#fac-xasb_CostOfRevenue" xlink:type="locator" xlink:label="fac-xasb_CostOfRevenue"/>
        <link:definitionArc xlink:arcrole="http://www.xbrlsite.com/2015/fro/us-
            gaap/xbrl/Ontology/rules/arcrole/summationConcept-disallowedItemConcept" xlink:type="arc" use="optional"
            order="1" xlink:from="fac-xasb_OperatingExpenses" xlink:to="fac-xasb_CostOfRevenue"/>
    </link:definitionLink>
  </link:linkbase>
```

Human readable example:

[CSH: To do.]

5.4. Consistency cross check rules

Consistency cross check rules are used to make sure there are no logical conflicts or contradictions within high-level reported facts in a financial report[32].

Common errors[33] include reversing the concepts equity attributable to parent and total equity; contradictory net income (loss), net income (loss) attributable to parent, and net income (loss) attributable to noncontrolling interest; reversing the polarity of a fact entering a positive as a negative or a negative as a positive fact.

Reasoning: If a reported fact in one area of a report contradicts, conflicts with, or is otherwise inconsistent with other reported fact then the financial report is illogical. For example, "Assets = Current assets + Noncurrent assets" is a universally applicable rule for a classified balance sheet.

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[31] Type/class relations rules, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/type-class/TypeOrClassRelations-DisallowedRollUpRelations-xasb-rules-def.xml

[32] Quarterly XBRL-based Public Company Financial Report Quality Measurement (September 2018), http://xbrl.squarespace.com/journal/2018/9/29/quarterly-xbrl-based-public-company-financial-report-quality.html

[33] High Quality Examples of Errors in XBRL-based Financial Reports, http://xbrl.squarespace.com/journal/2017/4/29/high-quality-examples-of-errors-in-xbrl-based-financial-repo.html

Machine readable example[34]:

Human readable example[35]:

5.5. *Disclosure mechanics rules*

Disclosure mechanics rules enforce structural, mechanical, mathematical, logical, and some accounting type relations within a specific reported disclosure[36].

For example, the disclosure "Inventory components" is always required to be a roll up, the total concept of the roll up is always to be "us-gaap:InventoryNet" or some alternative concept; if the inventory components is provided then an inventory policy is also expected to be found, etc.

Disclosure mechanics rules are identifiable via the extended link role URI fragment "/DisclosureMechanics/" or by the arcroles which are used to represent the rules.

Reasoning: An analysis of XBRL-based reports submitted to the SEC show that 20% of disclosures have errors in the structural, mechanical, mathematical, logical, and accounting relations between the primitive objects used to create that disclosure.

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34 Consistency cross check rules, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/fac/ReportingStyles/COMID-BSC-CF1-ISM-IEMIB-OILY-SPEC6_schema.xsd

35 In this example the fact value for the line item "Other Comprehensive Income (Loss)" was entered as a positive but should have been entered as a negative as can be seen by the fact that the amount of the error is exactly twice the amount of the reported fact value.

36 Understanding Disclosure Mechanics, http://xbrlsite.azurewebsites.net/2016/Analysis/UnderstandingDisclosureMechanics.pdf

The following are the currently supported arcrole[37] used to represent the relations which are used to represent the disclosure mechanics rules.

ArcRole
disclosure-hasConceptArrangementPattern
disclosure-equivalentTextblock
disclosure-requiresConcept
concept-allowedAlternativeConcept
disclosure-oftenContainsConcept
disclosure-requiresAxis
conceptArrangementPattern-requiresConcept
disclosure-relatedLevel1NoteTextBlock
concept-allowedAlternativeConcept
disclosure-relatedPolicy
disclosure-requiresMember
reportedDisclosure-requiresDisclosure
disclosure-oftenContainsConcept
disclosure-hasMemberArrangementPattern

[CSH: The details of how the arcroles should be processed needs to be documented.]

Machine readable example[38]:

```
- <link:definitionLink xlink:title="" xlink:role="http://xbrlsite.azurewebsites.net/2016/us-gaap/dm/role/DisclosureMechanics/BalanceSheet"
    xlink:type="extended">
    <link:loc xlink:type="locator" xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-
      gaap/Disclosures/disclosures.xsd#disclosures_BalanceSheet" xlink:label="disclosures_BalanceSheet"/>
    <link:loc xlink:type="locator" xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/cm.xsd#cm_Component"
      xlink:label="cm_Component"/>
    <link:definitionArc xlink:type="arc" use="optional" order="1" xlink:from="disclosures_BalanceSheet" xlink:to="cm_Component"
      xlink:arcrole="http://xbrlsite.azurewebsites.net/2016/conceptual-model/drules-arcroles/arcrole/disclosure-
      hasConceptArrangementPattern"/>
  </link:definitionLink>
```
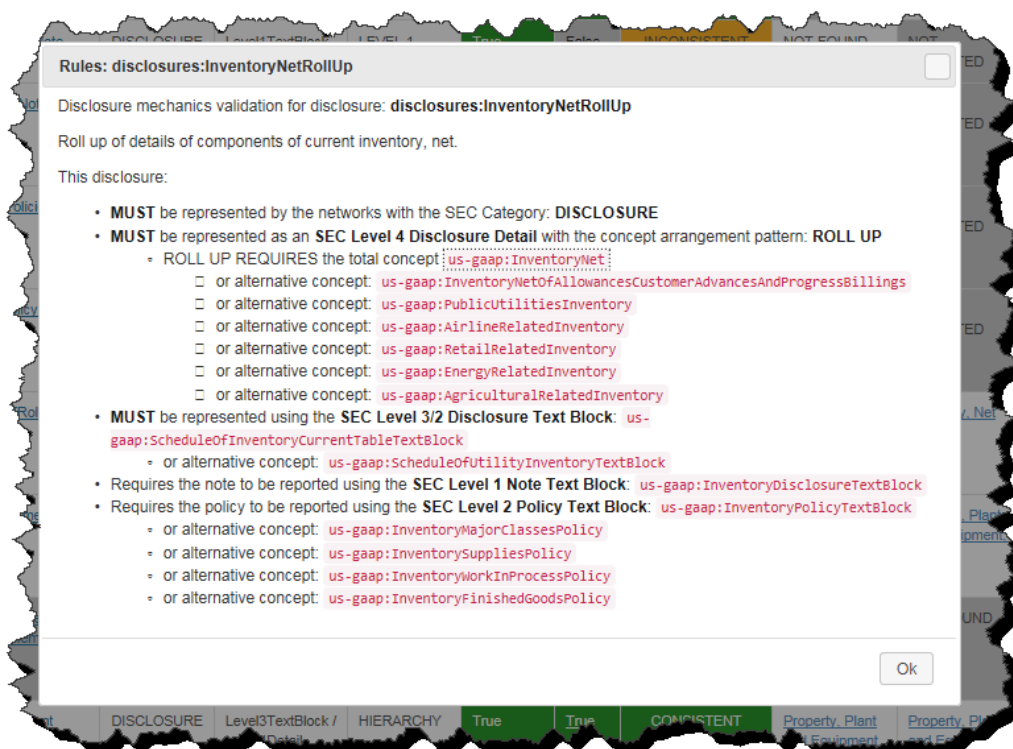
Human readable example[39]:

5.6. *Reporting checklist rules*

Reporting checklist rules enforce statutory and regulatory reporting requirements to the extent that these reporting requirements can be automated.

Reporting checklist rules are identifiable via the extended link role URI fragment "/ReportingChecklist/" or by the arcroles which are used to represent the rules.

Reasoning: Today, financial reports are manually checked using human-readable disclosure checklists in a labor intensive process. The machine-readable reporting checklist rules can automate a portion of these checks.

The following are the currently supported arcrole[40] used to represent the relations which are used to represent the disclosure mechanics rules.

ArcRole
report-requiresDisclosure
report-reportsConcept
reportingLineItem-requiresDisclosure
disclosure-allowedAlternativeDisclosure
concept-allowedAlternativeConcept

---

[40] Disclosure mechanics arcroles, http://xbrlsite.azurewebsites.net/2016/conceptual-model/drules-arcroles.xsd

ArcRole
report-possibleDisclosure

[CSH: The details of how the arcroles should be processed needs to be documented.]

Machine readable example[41]:

```
    </link:definitionLink>
  - <link:definitionLink xlink:title="Document information ALLOWS an alternative representation, document and
    entity information." xlink:role="http://xbrlsite.azurewebsites.net/2016/us-gaap/rc/role/ReportingChecklist"
    xlink:type="extended">
      <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-
        gaap/Disclosures/disclosures.xsd#disclosures_DocumentInformation" xlink:type="locator"
        xlink:label="disclosures_DocumentInformation"/>
      <link:loc xlink:href="http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-
        gaap/Disclosures/disclosures.xsd#disclosures_DocumentAndEntityInformation" xlink:type="locator"
        xlink:label="disclosures_DocumentAndEntityInformation"/>
      <link:definitionArc xlink:type="arc" use="optional" order="3" xlink:from="disclosures_DocumentInformation"
        xlink:to="disclosures_DocumentAndEntityInformation"
        xlink:arcrole="http://xbrlsite.azurewebsites.net/2016/conceptual-model/drules-
        arcroles/arcrole/disclosure-allowedAlternativeDisclosure"/>
    </link:definitionLink>
```

Human readable example[42]:

#	Disclosure	Category	Level	Pattern	Applicable	Found	Disclosure Consistent	Representation Concept [TEXT BLOCK]	Representation Concept [DETAIL]	Checklist Category	Reason
1	Document Information [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	True	True	CONSISTENT	NOT-EXPECTED	Document Fiscal Period Focus	Required disclosure	Disclosure always required
2	Document and Entity Information [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	False	True	CONSISTENT	NOT-EXPECTED	Entity Registrant Name	Alternative representation	Not necessary, satisfied by Document Information [Hierarchy] disclosure
3	Entity Information, by Legal Entity [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	True	True	CONSISTENT	NOT-EXPECTED	Entity Registrant Name	Required disclosure	Disclosure always required
4	Document and Entity Information [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	False	True	CONSISTENT	NOT-EXPECTED	Entity Registrant Name	Alternative representation	Not necessary, satisfied by Entity Information, by Legal Entity [Hierarchy] disclosure
5	Balance Sheet	STATEMENT	Level4Detail	COMPONENT	True	True	CONSISTENT	NOT-EXPECTED	NOT-EXPECTED	Required disclosure	Disclosure always required, satisfied by Assets [Roll Up] and Liabilities and Equity [Roll Up]

5.7. Compliance and governance checklist

Automatable compliance and governance rules[43].

[CSH: This needs work.]

---

41 Reporting checklist, machine readable, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/reporting-checklist/ReportingChecklist-us-gaap-strict-rules-def.xml

42 Reporting checklist, human readable example, http://xbrlsite.azurewebsites.net/2017/Prototypes/Microsoft2017/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

43 Deloitte, Corporate Governance Disclosure Checklist, https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/Audit/2014_corporate_governance_disclosure_checklist_deloitte_ireland.pdf

6.   References

This section contains references to information that is useful in understanding this framework.

Framework for Implementing XBRL-based Digital Financial Reporting is Complete and Tested:

http://xbrl.squarespace.com/journal/2019/4/20/framework-for-implementing-xbrl-based-digital-financial-repo.html

Method of Implementing a Standard Digital Financial Report Using the XBRL Syntax:

http://xbrlsite.azurewebsites.net/2019/Library/MethodForImplementingStandardFinancialReportUsingXBRL.pdf

Putting the Expertise into an XBRL-based Knowledge Based System for Creating Financial Reports:

http://pesseract.azurewebsites.net/PuttingTheExpertiseIntoKnowledgeBasedSystem.pdf

Guide to Building an Expert System for Creating Financial Reports:

http://xbrlsite.azurewebsites.net/2018/Library/GuideToBuildingAnExpertSystemForCreatingFinancialReports.pdf

Understanding Block Semantics:

http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/UnderstandingBlockSemantics.pdf

Leveraging the Theoretical and Mathematical Underpinnings of a Financial Report:

http://xbrlsite.azurewebsites.net/2018/Library/TheoreticalAndMathematicalUnderpinningsOfFinancialReport.pdf

Leveraging XBRL's Extensibility Effectively:

http://xbrlsite.azurewebsites.net/2018/Library/LeveragingXBRLExtensibilityEffectively.pdf

Blueprint for Creating Zero-Defect XBRL-based Digital Financial Reports:

http://xbrlsite.azurewebsites.net/2017/Library/BlueprintForZeroDefectDigitalFinancialReports.pdf