XBRL Formula Requirements

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1 Motivation (non-normative)

To effectively exchange business reporting information between a producing and a consuming application often requires the applications to perform validation on data types and values, apply consistency checks, test data quality, augment the data with calculated values and possibly corrections, and to provide feedback to the producing application that indicates the nature and severity of problems encountered. A producing application may also add calculated values and perform tests on its own outputs before sending results to consuming applications. Applications based on the exchange of spreadsheets that contain both data and formulas are common but present maintenance problems; here the intent is explicitly to separate the representation and location of formulas and validation criteria from a given instance.

These different functions are characteristic of many XBRL-enabled applications. That is because it is a goal of XBRL to allow applications to consume XBRL formatted business information no matter what its original source. Data entry validation (e.g., prohibiting dates such as February 31, 2001 from entering the system) is a familiar example of using a formula to flag errors, but the breadth and scope of formulas is much broader than this. Good information management practice generally recognizes that validations should be tested, adhered to, and corrections made as far "upstream" in an information supply chain as possible – recognizing, of course, that the same tests may be applied repeatedly as data makes its way from its many possible origins, to its many ultimate destinations.

Any general programming language could be used to perform computations on business data. However, there is regularity in business reporting information: regularity that is encoded in XBRL in instance constructs such as "facts," "periods," "entities," and in taxonomies as items, definitions, and other relationships. Furthermore, applications that consume XBRL should be able to "publish the formulas" that govern documents containing XBRL data, so that producing applications can test and apply those formulas and thereby reduce delay, rework and retransmissions, and smooth and accelerate the flow of business reporting information.

Rule languages—in which rules are expressed as patterns to be matched and actions to be taken when the data matches the pattern—have a rich tradition and are nearly as old as Computer Science itself ([Newell, 1962]), enjoyed a heyday in the 1980's for the programming of "expert systems", and today rule languages live on in languages such as Prolog, and in commercial products such as the Blaze Rule Engine [HNC] and JRules [ILOG]. Rule languages tend to be fairly compact and concise and resemble a database of logical sentences ("all people are mortal" "if X is a mountain, then the elevation of X must be positive"). They declare the rules to be obeyed, and an interpreter (or compiler) is responsible for efficiently executing the rules (matching patterns and executing actions) correctly when presented with incoming data.

Even if we set aside the goal of synthesizing information and are content merely to detect violation of constraints, XML Schema [XSDL] itself is still not sufficient to this task because it allows the validation of individual data elements ("Revenues are a 12-digit nonnegative number") and structural relationships (e.g., "an invoice must contain a header, a list of items, and an amount") but does not express constraints *between* elements, also known as co-constraints ("if more than 10 dependents are claimed then Schedule K must be completed"). Besides, the nature of rules is that they generally compute a whole series of results, some of which may be considered fatal errors, others as warnings, others as merely informational; an XML Schema validator mainly detects fatal errors. Other general programming languages, including XML Schema Transformation [XSLT], could be pressed into service since they have the requisite pattern-action structure, but these neither take any account nor take any advantage of the constrained nature of XBRL instances, taxonomies, and so on.

XBRL-specific formulas are well motivated. The language would be, like XBRL itself, suitable for publishing and transporting between applications; it would exploit the XBRL language itself, and provide a concise and well constrained way of expressing common rules such as "Net Receivables cannot be negative," "Net revenues are the difference between Gross revenues and Gross expenses," "Unless income for the previous quarter was zero, income growth for

the quarter is the ratio of the change in income between the current and previous quarter, divided by the income of the previous quarter," and so on. The earliest discussions of XBRL acknowledged the need to express not only specific numeric facts ("1988 Revenue for TLA Inc. was $40m"), but also relationships among those facts ("TLA Inc. revenue consists of TBD Inc. revenue plus BFD Ltd. Revenue less eliminations") and general relationships ("The write down allowance for an asset in any year after 1993 is limited to 25% of its original purchase price"). There has now been sufficient experimentation and implementation experience with XBRL for the exchange of business reporting information in live and planned applications to have illustrated both the need for an extension to the language to meet this need, as well as illustrating deficiencies in schemes used to date and the typical patterns of usage and the limitations on what that language actually needs to cover. This information is advantageous to have because it limits the scope and guides the design of the language.

1.1 Terminology and formatting conventions

Terminology used in XBRL frequently overlaps with terminology from other fields. The terminology used in this document is summarised in Table 1.

Table 1. Terminology

abstract element, bind, concept, concrete element, context, Discoverable Taxonomy Set (DTS), duplicate items, duplicate tuples, element, entity, equal, essence concept, fact, instance, item, least common ancestor, linkbase, period, taxonomy, tuple, unit, taxonomy schema, child, parent, sibling, grandparent, uncle, ancestor, XBRL instance, c-equal, p-equal, s-equal, u-equal, v-equal, x-equal, minimally conforming XBRL processor, fully conforming XBRL processor.	As defined in [XBRL].
MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, MAY, OPTIONAL	See [RFC2119] for definitions of these and other terms. These include, in particular: SHOULD — Conforming documents and applications are encouraged to behave as described. MUST — Conforming documents and consuming applications are required to behave as described; otherwise they are in error.
expression	An expression using constants, variables, arithmetic, logical, and functional operators.
formula	An expression along with criteria that indicate the domain of each variable in that expression and how they are to be bound.
rule	The term "rule" is not used in this version of the requirement, although it appeared previously as a synonym for "formula".
variable	A "variable" appears in expressions as a symbol that

	the application of a formula binds to a value, so that the expressions of that formula can be evaluated.
argument	An "argument" of a formula is a formal parameter bound to some portion of an input instance. Some of the arguments will be identified as variables to be used in expressions.

The following highlighting is used for positive examples:

Example 1. Example of an example

Counterexamples indicate incorrect or unsupported examples:

Example 2. Example of a counterexample

Selections from other normative documents is highlighted thus:

Example 3. Example of normative material

Non-normative editorial comments are denoted as follows and removed from final recommendations:

WH**:** This highlighting indicates editorial comments about the current draft, prefixed by the editor's initials.

Italics are used for rhetorical emphasis only and do *not* convey any special normative meaning.

Distinctively bracketed and coloured numbers {1.2.3} refer to that particular numbered section of the XBRL 2.1 Specification Recommendation [XBRL].

1.2 Normative status

This document is normative in the sense that any formula specification recommendations by XBRL International MUST satisfy the requirements as they are stated here.

This document version depends upon XBRL 2.1 Specification Recommendation [XBRL].

XBRL Specification 2.1 does *not* depend in any way upon this document.

1.3 Language independence

The official language of XBRL International's own work products is English and the preferred spelling convention is UK English. Unless otherwise stated, XBRL specifications must not require XBRL users to use English in documentation, item, tuple, entity, scenario or any other elements.

2 Use cases

The general use case for an XBRL formula specification is the externalisation and publication of a set of formulas that will be applied by a consuming application:

- A financial regulator collecting quarterly balance sheets and income statements;
- A statistical agency collecting market valuations of various asset categories;
- A tax authority accepting electronic tax filings;

- A stock exchange accepting registration requests;
- A bank evaluating loan applications or checking loan covenants;

More specifically, there are three general needs these consuming applicaitons may have:

1. Validating an XBRL instance and indicating success or failure. In this case, no XML or XBRL output is really needed.
2. Validating an XBRL instance and providing detailed error messages. In this case, general XML output—for further processing and rendering as appropriate by an application—would seem to be sufficient.
3. Transforming, adjusting, composing or creating XBRL instances based on existing XBRL instances. In this case, it is sensible for a formula processor to produce a valid XBRL instance. If producing applications verify that their own output will be accepted by those consuming applications, significant efficiencies are possible, particularly in a distributed environment such as the Internet.

These needs are not mutually exclusive, but are increasing level of ambition. Underlying all of the use cases below is the presumption that because level 3 above does subsume the other two, it is the level of functionality being sought. Therefore, the specific use cases driving the formula requirements are expressed as "before" and "after" fact sets and instances, along with a structured description of the relevant generalisation of the behaviour illustrated by that case.

The use cases below all depend on a single taxonomy shown in Figure 1 consisting mainly of financial position and performance items.

Figure 1. Items Appearing in Use Cases

@name	@type	@periodType	Label (en, standard)
Assets	monetaryItemType	instant	Assets
CurrentAssets	monetaryItemType	instant	Current Assets
FixedAssets	monetaryItemType	instant	Fixed Assets
Equity	monetaryItemType	instant	Equity
Shares	sharesItemType	instant	Shares
Price	monetaryItemType	instant	Price
Earnings	monetaryItemType	duration	Earnings
AvgShares	sharesItemType	duration	Average Shares
PE	pureItemType	instant	Price-Earnings Ratio
ROE	pureItemType	instant	Return on Equity
EPS	decimalItemType	duration	Earnings per Share
AssetsEquity	pureItemType	instant	Assets-to-Equity Ratio
Rating	integerItemType	instant	Rating
AssetsOkay	booleanItemType	instant	Assets Okay
EquityOkay	booleanItemType	instant	Equity Okay
AssetsMessage	stringItemType	instant	Assets Message
AssetsLB	booleanItemType	instant	Assets in Lower Bound
AssetsUB	booleanItemType	instant	Assets in Upper Bound
AssetsLarge	booleanItemType	instant	Assets not too Large
AssetsSmall	booleanItemType	instant	Assets not too Small
IntangiblesPatents	monetaryItemType	instant	Intangibles (Patents)
IntangiblesClass	stringItemType	instant	Intangibles Class
IntangibleGross	monetaryItemType	instant	Intangible Gross
IntangibleReserve	monetaryItemType	instant	Intangible Reserve
IntangibleNet	monetaryItemType	instant	Intangible Net
IntangibleAsset	tupleType		Intangible Asset
AutoWriteDown	tupleType		Automobile Write-Down
AutoName	tokenItemType	duration	Automobile Name
AcquisitionDate	dateItemType	duration	Acquisition Date
WriteDownAllowance	monetaryItemType	duration	Write-Down Allowance
WDVBroughtForward	monetaryItemType	duration	Write-Down Value Brought Forward
UsefulLife	durationItemType	duration	Useful Life

All facts in the use cases have a `unitRef` and `contextRef` drawn from the units and contexts shown in Figure 2 and Figure 4, respectively. The namespace prefix `si` refers to international standard scientific units.

Figure 2. Units Appearing in Use Cases

@id	measure
usd	iso4217:USD
gbp	iso4217:GBP
pure	xbrli:pure
shs	xbrli:shares
usdsh	iso4217:USD/xbrli:shares
gbpsh	iso4217:GBP/xbrli:shares
year	si:year

The namespace prefix `co` with elements `aaa` and `bbb` are used to distinguish segments of entity `444`. The elements `actual`, `budgeted` and `variance` are used to distinguish scenarios.

Figure 3. Segments and Scenarios Appearing in Use Cases

prefix	element
co:	<aaa/>
co:	<bbb/>
co:	<actual/>
co:	<budgeted/>
co:	<variance/>

Figure 4. Contexts Appearing in Use Cases

@id	entity / @identifier	entity / segment	period / instant	period / startDate	period / endDate	scenario
c01	333			2003-01-01	2003-12-31	
c02	333		2002-12-31			
c03	333		2003-12-31			
c04	444			2003-01-01	2003-12-31	
c05	444		2003-12-31			
c06	333		2003-12-31			
c07	444	<geo>ON</geo>		2003-01-01	2003-12-31	
c08	444	<geo>ON</geo>	2003-12-31			
c09	444	<geo>MI</geo>		2003-01-01	2003-12-31	
c10	444	<geo>MI</geo>	2003-12-31			
c11	444		2003-12-31			<co:actual/>
c12	444		2003-12-31			<co:budgeted/>
c13	444		2003-12-31			<co:variance/>
c14	444			1993-01-01	1993-12-31	
c15	444			1995-01-01	1995-12-31	
c16	333		2001-12-31			
c17	444	<lob>paper</lob>		2003-01-01	2003-12-31	
c18	444	<lob>paper</lob>	2003-12-31			
c19	444	<lob>plastic</lob>		2003-01-01	2003-12-31	
c20	444	<lob>plastic</lob>	2003-12-31			

Note that contexts `c06` and `c03` are s-equal.

The data type of the content in any `UsefulLife` fact is assumed to be `yearMonthDuration`; the XBRL `durationItemType` does not specify whether fact content is `yearMonthDuration` or `dayTimeDuration`.

Each fact in this document also has a unique identifier such as `f42`; the identifiers are not relevant in any way to processing the facts or formulas, but the identifiers allow them to be referred to in the text.

Expressions are written in XML Path Language 2.0 [XPATH2] and are meant to be transparent for the example at hand, not in and of itself prescriptive as to the expression language to be

required. Some cases use the syntax of XML Query Language 1.0 [XQuery] to declare functions; as stated in [XPATH2], "XPath is designed to be embedded in a host language such as XSLT 2.0 or XQuery… XPath per se does not provide a way to declare functions, but a host language may provide such a mechanism." The host language chosen in this example is XQuery because it allows users to declare functions of their own.

2.1 Formula uses items that are p-equal and u-equal in identical contexts

An important type of formula involves a mathematical operator applied to a pair of items when they are p-equal, c-equal and u-equal.

Formulas:

item	test	expression	type[2]	matching
Assets		$CurrentAssets + $FixedAssets	INF	p-equal, c-equal and u-equal

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f34	FixedAssets	c03	usd	INF	35000

Result:

@id	item	@contextRef	@unitRef	Precision	[content]
f13	Assets	c03	usd	INF	43000

2.2 Formula uses items that are p-equal, u-equal and c-equal

A variation of use case 2.1 above is when items are c-equal without the contexts being identical.

Formulas:

item	test	expression	type	matching
Assets		$CurrentAssets + $FixedAssets	INF	p-equal, c-equal and u-equal

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c06	usd	INF	35000

Result:

@id	item	@contextRef	@unitRef	Precision	[content]
f13	Assets	c03	usd	INF	43000

The output context is s-equal to c03 and c06. Formula processors should behave consistently and the specification must define which context to use on output.

2.3 Formula uses items that are p-equal, u-equal and contexts whose periods differ

Formulas must be able to express relations that cross periods. In this example the value of any two values for "Shares" that differ by one year are averaged during the intervening duration.

[2] "type" here means either the result type if non numeric, or else the value of the precision or decimals attribute when the result is numeric.

Formulas:

item	test	expression	type	matching
AvgShares		($SharesNext + $Shares) div 2	INF	p-equal, u-equal; "SharesNext" is in a context offset by one year from "Shares".

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f05	Shares	c02	shs	INF	50000
f17	Shares	c03	shs	INF	60000

Result:

@id	item	@contextRef	@unitRef	Precision	[content]
f11	AvgShares	s-equal to c01	shs	INF	55000

The output context, because it is not present among the input facts, must be synthesised by the formula. In this example it happens to be s-equal to c01. Note that the two inputs are in "instant" contexts while the output is a "duration" context whose start and end dates are equal to those of the input instants (taking into account differences in the way startDate and endDate default the time of day {4.7.2}).

2.4 Formula uses items in contexts that match period endpoints

The matching of input periods may involve matching of endpoints. This example is a simple movement analysis on the value of Equity.

Formulas:

item	test	expression	type	matching
Equity		$EquityPrev + $Earnings	INF	p-equal, u-equal; "EquityPrev" refers to a context in the year previous to that of "Equity". The duration-type period of "Earnings" must begin at the instant represented by "EquityPrev".

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f03	Equity	c02	usd	INF	17000
f09	Earnings	c01	usd	INF	9000

Result:

@id	item	@contextRef	@unitRef	Precision	[content]
f11	Equity	s-equal to c03	usd	INF	26000

More generally, endpoints may match in any relationship expressible by using comparison operators (equal, less than, greater than), arithmetic offsets (plus, minus), and constants (dates, datetimes, durations).

WH: Use cases with richer relative period expressions would be useful.

2.5 Expression yields a new unit of measure

The units of measure of inputs, when multiplied or divided, may yield a different unit of measure. The unit of measure need not have been previously defined in the input instance.

Formulas:

item	test	expression	matching
EPS		($Earnings div $AvgShares)	p-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f36	Earnings	c01	usd	INF	11000
f11	AvgShares	c01	shs	INF	55000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f29	EPS	c01	usdsh	INF	0.2

In this example there are no facts with the unit representing "USD per share"; it is synthesised by the formula for the output. In this example the precision of the output is infinite, just like the inputs.

2.6 Formula determines the result units of an expression from the units of the bound facts

The units of measure of outputs differ depending on the units of the input facts that were bound. If the result item is a numeric type then the formula specifies the result units as a function of the input units.

Formulas:

item	test	expression	type	matching
EPS		($Earnings div $AvgShares)	precision=9 and units(result) = units(Earnings) / units(AvgShares)	p-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f09	Earnings	c01	usd	INF	9000
f10	Earnings	c01	gbp	INF	5000
f11	AvgShares	c01	shs	INF	55000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f37	EPS	c01	usdsh	9	0.16363636
f38	EPS	c01	gbpsh	9	0.09090909

In this example the same formula computes results in the same context having different units depending on which of two input facts (f09 and f10) were used in the computation. The item specified in the result (e.g., EPS) determines the item type (e.g., `pureItemType`) and therefore constrains the possible units (e.g. pure) {4.8.2}.

Rejected requirement 10.6 below, "* Formulas MAY specify one or more alternative items or tuples as the possible result of expression evaluation," would allow a formula to produce either a decimal or a fraction as the result of a division, but without it the result will always be one or the other.

2.7 Formula overrides the natural result units of an expression

In this example the units of the Write-Down Allowance that would be determined from the inputs would be a currency amount "per year", but the formula must type cast the output to a

currency so as to agree with WriteDownAllowance which is a monetaryItemType and therefore must have a unit whose measure is an ISO currency type {4.8.2}.

Formulas:

item	test	expression	type	matching
WriteDownAllowance		$AcquisitionCost div fn:get-years-from-yearMonthDuration ($UsefulLife)	precision=INF and units(result) = units(AcquisitionCost)	p-equal, c-equal;

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f76	UsefulLife	c15			5Y
f78	AcquisitionCost	c15	gbp	INF	12000
f79	AcquisitionCost	c15	usd	INF	20000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f80	WriteDownAllowance	c15	gbp	INF	2400
f81	WriteDownAllowance	c15	usd	INF	4000

The example shows that the currency (or any other part of the unit) cannot be “hard wired” into the formula but MUST be determined from the input facts.

2.8 Expression result has limited precision

When an expression containing the division operator uses a fact with precision="INF" as a divisor, and the result fact of the expression has a denominator with prime factors other than 2 and 5 the result is a repeating decimal without a finite representation.

The precision of a repeating decimal when not otherwise specified will be INF even though its lexical representation is limited to the number of digits of precision available on the executing hardware. This reflects the underlying reality of limited machine precision. Formula authors may choose to limit the precision still further. Moreover, if different processors were allowed to select their own output precision, formulas would yield different results on different machines. Therefore, formulas must be able to specify the desired precision of the output.

Formulas:

item	test	expression	type	matching
EPS		($Earnings div $AvgShares)	precision=8	p-equal, u-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f09	Earnings	c01	usd	INF	9000
f11	AvgShares	c01	shs	INF	55000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f37	EPS	c01	usdsh	8	0.1636363636363636363

The computation 9000/55000 yields a repeating decimal (.1636363…) whose lexical representation is limited to 18 digits by the default data type (double) of the executing processor.

2.9 Expression result has limited number of decimal places

Similarly to use case 2.6 above, the result may also be specified to a number of decimal places rather than by precision.

Formulas:

item	test	expression	type	matching
EPS		($Earnings div $AvgShares)	decimals=7	p-equal, u-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f09	Earnings	c01	usd	INF	9000
f11	AvgShares	c01	shs	INF	55000

Result:

@id	item	@contextRef	@unitRef	@decimals	[content]
f38	EPS	c01	usdsh	7	0.1636364

2.10 Formulas may be prohibited

An extension {3.2} {3.5.3.9.7.5} of a set of formulas may need to change the method by which an item is computed in a base set of formulas. In this example, the simpler calculation of EPS is in the base set of formulas:

Formulas:

item	test	expression	type	matching
EPS		($Earnings div $Shares)	decimals=7	p-equal; Shares context period/instant = Earnings context period/endDate.

An extension set of formulas then prohibits that formula, and asserts a different one:

Formulas:

item	test	expression	type	matching
~~EPS~~		~~($Earnings div $Shares)~~	~~decimals=7~~	~~p-equal;~~ ~~Shares context period/instant =~~ ~~Earnings context period/endDate.~~
EPS		($Earnings div $AvgShares)	decimals=7	p-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f36	Earnings	c01	usd	INF	11000
f11	AvgShares	c01	shs	INF	55000
f17	Shares	c03	shs	INF	60000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f29	EPS	c01	usdsh	INF	0.2

In this example, the calculation based on average shares is used and only one value of EPS is calculated.

2.11 Incompatible formulas are distinguishable

Formulas maintained in the same set may provide alternative, possibly incompatible definitions for the same item. In this example, EPS for some purposes is computed using the

average number of shares during the earnings period, and for other purposes using the number of shares at the end of the period.

Formulas:

item	test	expression	type	matching
EPS	"method 1"	($Earnings div $AvgShares)	decimals=7	p-equal, c-equal.
EPS	"method 2"	($Earnings div $Shares)	decimals=7	p-equal; Shares context period/instant = Earnings context period/endDate.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f36	Earnings	c01	usd	INF	11000
f11	AvgShares	c01	shs	INF	55000
f17	Shares	c03	shs	INF	60000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f29	EPS	c01	usdsh	INF	0.2
f67	EPS	c01	usdsh	9	0.183333333

In this example, *only* one of the two results should be computed, depending on whether the (set of) formulas labelled "method 1" or "method 2" are selected for processing. The `xlink:role` attribute may be an appropriate way to model this, since the evaluation of the condition does not depend in any way on the facts in the instance.

2.12 Formula has a precondition on item values

Setting a precondition on an item value may be needed to ensure the expression is meaningful and will not cause an evaluation error.

Formulas:

item	test	expression	type	matching
PE	($EPS gt 0)	($Price div $EPS)	INF	p-equal, u-equal; Context of "Price" has a period that is the instant which ends that of "Earnings".

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f19	Price	c03	usdsh	INF	11.2
f29	EPS	c01	usdsh	INF	.2
f20	Price	c03	gbpsh	INF	5.2
f30	EPS	c01	gbpsh	INF	-0.8

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f21	PE	c03	pure	INF	56

This is an example in which the condition of one pair of facts (f19 and f29) evaluates to true, the other pair (f20 and f30) to false.

2.13 Formula applies only to certain time periods

Facts may match the formula only if they fall within a named time period. Note that because every item has a fixed `periodType`, it is *not* necessary to be able to specify the kind of period of which the fact is asserted, because that is implicit in the item itself.

Formulas:

item	test	expression	type	matching
AssetEquity	($Equity gt 0)	$Assets div $Equity	precision=10	p-equal, u-equal, c-equal; Context must have a period whose endpoint is strictly before 2003-01-01.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f01	Assets	c02	usd	INF	100000
f03	Equity	c02	usd	INF	17000
f13	Assets	c03	usd	INF	43000
f15	Equity	c03	usd	INF	26000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f31	AssetEquity	c02	pure	10	5.882352941

In this example, one pair of facts (f01 and f03) evaluates the condition to `true` and the other (f13 and f15) evaluates it to `false`.

2.14 Formula applies only to certain units

Facts may match the formula only if the units match.

Formulas:

item	test	expression	type	matching
AssetEquity	($Equity gt 0)	$Assets div $Equity	precision=10	p-equal, u-equal, c-equal; Assets context must have unit/measure = ISO4217:USD

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f01	Assets	c02	usd	INF	100000
f03	Equity	c02	usd	INF	17000
f02	Assets	c02	gbp	INF	43000
f04	Equity	c02	gbp	INF	26000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f31	AssetEquity	c02	pure	10	5.882352941

In this example, one pair of facts (f01 and f03) evaluates the condition to `true` and the other (f02 and f04) evaluates it to `false`.

2.15 Formula applies only to the latest period in an instance

Facts may match the formula only if they fall within a time period that is described as the "latest" period in the instance. This is an extension of use case 2.13 above which allowed matching against a fixed time period.

Formulas:

item	test	expression	type	matching
AssetEquity	($Equity gt 0)	$Assets div $Equity	precision=18	p-equal, u-equal, c-equal; Context must have a period that is the latest occurring in the input instance.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f01	Assets	c02	usd	INF	100000
f03	Equity	c02	usd	INF	17000
f13	Assets	c03	usd	INF	43000
f15	Equity	c03	usd	INF	26000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f31	AssetEquity	c03	pure	18	1.653846153846153846

In this example, one pair of facts (f01 and f03) evaluates the condition to `false` and the other (f13 and f15) evaluates it to `true`. The latest period among the inputs is the instance 2003-12-31.

2.16 Expression contains a conditional

Conditional expressions and nested conditionals can test several conditions in sequence. In this example a continuous P/E ratio is mapped to one of three discrete values of Rating.

Formulas:

item	test	expression	type	matching
Rating		if ($PE gt 5) then 1 else if ($PE gt 10) then 2 else 3	INF	

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f21	PE	c03	pure	INF	56
f22	PE	c02	pure	INF	-6.5

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f39	Rating	c03	pure	INF	3
f40	Rating	c02	pure	INF	1

In principle, any conditional expression could be recast as a series of separate formulas with non-overlapping conditions (this example would require three formulas, with one having the condition "$5 \leq PE$ and $PE < 10$").

2.17 Precondition tests date items in historical period

Setting a precondition on an item value may be part of defining its scope of applicability.

In this example, historical data (Acquisition Cost, Useful Life, and Acquisition Date) of an asset determines its write down allowance for all future periods. Acquisitions made after 11 March 1992 are subject to a GBP 2000 maximum write-down per year; hence the acquisition date of 10 October 1993 means that after two years only GBP 4000 has been written down, not 2*(20000/6) had the acquisition been made (say) 1991.

In this example the context of the Write-Down Allowance is determined from the context of a nonzero Write-Down Value Brought Forward. The item `UsefulLife` is a `durationItemType` but the result of the expression is cast to the same type and unit as `AcquisitionCost`.

Formulas:

item	test	expression	type	matching
WriteDownAllowance	($AcquisitionDate lt 1992-03-11) and ($WDVBroughtForward gt 0)	$AcquisitionCost div fn:get-years-from-yearMonthDuration ($UsefulLife)	INF	p-equal, c-equal; Result context is that of a nonzero WDVBroughtForward whose period is greater than or equal to the input facts' end date.
WriteDownAllowance	($AcquisitionDate ge 1992-03-11) and ($WDVBroughtForward gt 0)	fn:min(2000, $AcquisitionCost div fn:get-years-from-yearMonthDuration ($UsefulLife))	INF	p-equal, c-equal; Result context is that of a nonzero WDVBroughtForward whose period is greater than or equal to the input facts' end date.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f57	AutoWriteDown				(tuple)
f58	AssetName	c14			571XVH
f59	AcquisitionDate	c14			1993-10-10
f60	AcquisitionCost	c14	gbp	INF	20000
f61	UsefulLife	c14			6
f62	WDVBroughtForward	c15	gbp	INF	16000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f63	WriteDownAllowance	c15	gbp	INF	2000

Although the formula requirements in this document do not presume the Financial Reporting Taxonomies Architecture [FRTA], nevertheless Section 2.6 of FRTA does suggest that all facts in a tuple instance will be c-equal. Hence this example encloses facts f58 through f62 within a single tuple (f57) even though they have different contexts, which may not occur often.

2.18 Formula matches facts in different segments

A fixed asset breakdown between an entity (444) and its segments (aaa and bbb) has the formula shown below, and the two figures 50,000 and 80,000 summing to 130,000.

The presumption of this use case is that if there is no segment element, this corresponds to the "universal" segment, i.e., the entire entity.

Formulas:

item	test	expression	type	matching
FixedAssets		$FixedAssetsaaa + $FixedAssetsbbb	INF	p-equal, u-equal; FixedAssets(aaa) and FixedAssets(bbb) contexts are s-equal except for the segment identifier (aaa and bbb, respectively).

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f41	FixedAssets	c08	usd	INF	50000
f42	FixedAssets	c10	usd	INF	80000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f43	FixedAssets	c05	usd	INF	130000

Note that the XML elements aaa and bbb, which are to be used in the input instance, must be present in a namespace accessible to the formulas, just like the item names and other parts of a taxonomy.

2.19 Formula matches facts in different scenarios

The Earnings of an entity are reported as actual and budgeted in different scenarios, and in yet a third scenario the variance figure is to be computed from them.

There is no presumption in this use case is that if there is no scenario element that it means some kind of "universal" scenario; rather, scenario is simply unspecified.

Formulas:

item	test	expression	type	matching
Earnings(variance)		$EarningsActual – $EarningsBudgeted	INF	p-equal, u-equal; Earnings(actual), Earnings(variance) and Earnings(budgeted) contexts are s-equal except for the scenario identifier.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f44	Earnings	c11	usd	INF	12000
f45	Earnings	c12	usd	INF	14000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f46	Earnings	c13	usd	INF	-2000

Note that the XML elements actual, budgeted and variance, which are to be used in the input instance, must be present in a namespace accessible to the formulas, just like the item names and other parts of a taxonomy.

2.20 Formula produces a default fact in the absence of a matching fact

When Current Assets are known in a given context but Fixed Assets are not, a formula author may want to assert a default value (zero) for the item FixedAssets.

Formulas:

item	test	expression	type	matching
FixedAssets	$CurrentAssets and fn:not($FixedAssets)	0	INF	p-equal, u-equal and c-equal;

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f33	CurrentAssets	c03	usd	INF	8000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f43	FixedAssets	c03	usd	INF	0

The conditions expressed in this formula would be evaluated sequentially in the sense that the formula only applies in a context where CurrentAssets is already bound. The function fn:not is

used as the predicate "unbound", in effect assuming that "unbound" variables are initially bound to the empty sequence until bound to something else by the formula processor".

Note also that fact f43 will appear in the output, not the input, so that any formulas that required input facts for CurrentAssets and FixedAssets in c-equal contexts would require additional formula processor iterations, as in use case 2.10 above.

2.21 Formula assumes default values in the absence of matching facts

When values are not known in a given context, a formula author may assume a default value (zero) for items, in this example, default values of zero for CurrentAssets and FixedAssets.

Formulas:

item	test	expression	type	matching
Assets		$CurrentAssets + $FixedAssets	INF	p-equal, c-equal and u-equal; If CurrentAssets unbound then CurrentAssets = 0; If FixedAssets unbound then FixedAssets = 0; If both are unbound the formula produces no result.

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c03	usd	INF	35000
f77	CurrentAssets	c02	gbp	INF	2000
f65	FixedAssets	c16	gbp	INF	5000

Result:

@id	item	@contextRef	@unitRef	Precision	[content]
f13	Assets	c03	usd	INF	43000
f64	Assets	c02	gbp	INF	2000
f66	Assets	c16	gbp	INF	5000

This set of facts covers each of the three possible binding cases in the formula.

2.22 Formulas ignore Nil facts by default but MAY bind them

Formula authors must have the choice whether or not to bind expressions with nil facts. At least for the purpose of describing formulas in the use cases we assume that the default is that nil facts may not be bound, and so nothing appears in the "test" column.

Formulas:

item	test	expression	type	matching
Assets		$CurrentAssets + $FixedAssets	INF	p-equal, c-equal and u-equal.
Rating	element(my:PE, xbrli:decimalItemType nillable)	if ($PE[@xsi:nil = "true"]) then 0 else if ($PE lt 5) then 1 else if ($PE lt 10) then 2 else 3	INF	

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f68	CurrentAssets	c03	usd	INF	(xsi:nil)
f35	FixedAssets	c03	usd	INF	35000
f70	PE	c02	pure	INF	(xsi:nil)

Result:

@id	item	@contextRef	@unitRef	Precision	[content]
f71	Rating	c02	pure	INF	0

The Assets rule should produce no results. Furthermore, the formula had instead assigned a default value of zero to CurrentAssets then it should behave the same as use case 2.21 above. This suggests that use case 2.21 above represents a somewhat more robust treatment than use case 2.20 above, which would involve creating a new fact that would then be a duplicate {4.10} of the nil item.

The Rating rule should produce one fact as output.

2.23 Expression evaluation exceptions MAY be caught to produce a result

The expression language must support a try/catch or other exception handling mechanism and the formula allowed to produce a result. The following is only an example result and is not meant to be normative for all formulas.

Formulas:

item	test	expression	matching
EPS		Try ($Earnings div $AvgShares) Catch Exception Return <EPS xsi:nil="true"/>	p-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f36	Earnings	c01	usd	INF	11000
f72	AvgShares	c01	shs	INF	0

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f73	EPS	c01	usdsh	INF	(xsi:nil)

Note that the units, context and precision of the result remain the same as if the calculation had not thrown an exception.

2.24 Formula does not bind duplicate facts

In XBRL 2.1 {5.2.5.2} calculations are not performed when there are duplicate facts ("A calculation binds for a summation item if it has no duplicates in the XBRL instance…") or if the facts have nil values ("Items with nil values do not participate in calculation bindings"). The same approach applies consistently in formulas.

Formulas:

item	test	expression	type	matching
Assets		$CurrentAssets + $FixedAssets	INF	p-equal, c-equal and u-equal.

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f69	CurrentAssets	c03	usd	INF	10000
f35	FixedAssets	c03	usd	INF	35000

Result:

@id	item	@contextRef	@unitRef	Precision	[content]

The formula produces no results because f33 and f69 satisfy the XBRL 2.1 "duplicates" predicate. Furthermore, this case is distinct from the *absence* of `CurrentAssets` and therefore a formula specifying a default value (use case 2.21 above) should not apply.

2.25 Formula uses a locally defined symbolic constant

In this formula, `lowerTolerance` and `upperTolerance` are constants bound to "-500" and "500" respectively.

Formulas:

item	test	expression	type	matching
AssetsOkay		($lowerTolerance lt ($Assets – ($CurrentAssets + $FixedAssets)) and (($Assets – ($CurrentAssets + $FixedAssets) lt $upperTolerance)		p-equal, u-equal and c-equal;

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c03	usd	INF	35000
f13	Assets	c03	usd	INF	44000

Result:

@id	item	@contextRef			[content]
f48	AssetsOkay	c03			false

2.26 Formula uses a globally defined symbolic constant.

Here, `tolerance` is bound to "500" globally and so has the identical value in two different formulas, one for testing the upper bound (UB) and one for the lower bound (LB).

Formulas:

item	test	expression	type	matching
AssetsUB		($Assets – ($CurrentAssets + $FixedAssets)) lt $tolerance	Boolean	p-equal, u-equal and c-equal;
AssetsLB		$tolerance lt ($Assets – ($CurrentAssets + $FixedAssets))	Boolean	p-equal, u-equal and c-equal;

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c03	usd	INF	35000
f13	Assets	c03	usd	INF	44000

Result:

@id	item	@contextRef			[content]
f49	AssetsUB	c03			false
f50	AssetsLB	c03			true

2.27 Formula uses a globally defined function

In this formula, there is a reference to an externally defined function:

```
declare function my:withinTolerance( $x as xdt:anyAtomicType, $y as xdt:anyAtomicType )
as xdt:boolean* { fn:abs( $x - $y) lt 500 }
```

Formulas:

item	test	expression	type	matching
AssetsOkay		my:withinTolerance ($Assets,($CurrentAssets + $FixedAssets))	Boolean	p-equal, u-equal and c-equal;

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c03	usd	INF	35000
f13	Assets	c03	usd	INF	44000

Result:

@id	item	@contextRef			[content]
f48	AssetsOkay	c03			false

2.28 Different formulas bind the same name to different functions

In two different formulas, there are references to externally defined functions that apply in different rules within the same set. The rules are not distinguished by an arithmetic test but rather by an indicator such as `xlink:role` as in use cases 2.11 and **Error! Reference source not found.**.

scope	function
Taxation Enforcement	declare function tax:withinTolerance($x as xdt:anyAtomicType, $y as xdt:anyAtomicType) as xdt:boolean* { fn:abs($x - $y) lt 500 }
Securities Enforcement	declare function sec:withinTolerance($x as xdt:anyAtomicType, $y as xdt:anyAtomicType) as xdt:boolean* { fn:abs($x - $y) lt 5000000 }

Formulas:

item	test	expression	type	matching
AssetsOkay	$Enforcement eq "Securities Enforcement"	tax:withinTolerance ($Assets,($CurrentAssets + $FixedAssets))	Boolean	p-equal, u-equal and c-equal;
EarningsOkay	$Enforcement eq "Taxation Enforcement"	sec:withinTolerance ($Equity,$EquityPrev + $Earnings)	Boolean	p-equal, u-equal; "EquityPrev" refers to a context in the year previous to that of "Equity". The duration-type period of "Earnings" must begin at the instant represented by "EquityPrev".

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c03	usd	INF	35000
f13	Assets	c03	usd	INF	44000
f03	Equity	c02	usd	INF	17000
f09	Earnings	c01	usd	INF	9000
f11	Equity	c03	usd	INF	27000

Result:

@id	item	@contextRef			[content]
f48	AssetsOkay	c03			True
f74	EquityOkay	c03			False

Both computations have 1000-dollar errors but only one of them results in a false value.

2.29 Formula produces a fact that is a diagnostic message

Instead of producing only a Boolean value as in 2.25 through 2.29 above, a formula can produce a more detailed warning or explanation of a problem. In this example the formula produces the simplistic warning element

```
<AssetsMessage contextRef='c03'>Assets of 44000 are outside the range (-500,500) compared to 35000 + 44000</AssetsMessage>
```

Formulas:

item	test	expression	type	matching
AssetsMessage	fn:not ($lowerTolerance lt ($Assets - ($CurrentAssets + $FixedAssets)) and (($Assets - ($CurrentAssets + $FixedAssets) lt $upperTolerance)	fn:concat("Assets of ",$Assets," are outside the range (",$lowerTolerance,", ",$upperTolerance,") compared to ",$CurrentAssets," + ",$FixedAssets")		p-equal, u-equal and c-equal;

Facts:

@id	item	@contextRef	@unitRef	Precision	[content]
f33	CurrentAssets	c03	usd	INF	8000
f35	FixedAssets	c03	usd	INF	35000
f13	Assets	c03	usd	INF	44000

Result:

@id	item	@contextRef			[content]
f48	AssetsMessage	c03			"Assets of 44000 are outside the range (-500,500) compared to 35000 + 44000"

2.30 Expression evaluation requires all facts to be bound

Although in principle, expressions such as `or(x,y,z)` could be evaluated left-to-right and with `x="true"`, neither `y` nor `z` would need to be bound, formula processing does not support this.

Formulas:

item	test	expression	type	matching
AssetsOkay		$AssetsUB and $AssetsLB	Boolean	p-equal, c-equal.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f49	AssetsUB	c03			false

Result:

@id	item	@contextRef	@unitRef	@precision	[content]

In this example, even though AssetsLB is not strictly needed to evaluate the expression, the output still should not contain the result that AssetsOkay is false.

2.31 Formula produces a tuple.

One example of the need to produce tuples as the output of formulas is when converting an instance using one taxonomy's representation of some information, into the same information as represented in another taxonomy. In this example we extract information from an instance whose taxonomy includes every asset class explicitly, and produce an instance whose taxonomy treats all asset classes as tuples distinguished by an IntangibleAssetClass child element; for example, for every occurrence of an item (IntangiblesPatents), i.e.,

```
<IntangibleGrossPatents
 contextRef='c03' unitRef='usd' decimals='0'>10742</IntangibleGrossPatents>
```

Create a corresponding tuple:

```
<IntangibleAsset>
  <IntangiblesClass contextRef='c03'>patent</IntangiblesClass>
  <IntangiblesGross
    contextRef='c03' unitRef='usd' decimals='0'>10742</IntangiblesGross>
</IntangibleAsset>
```

Formulas:

tuple	test	expression	type	matching
"<IntangibleAsset> <IntangiblesClass contextRef='{@contextRef}'> patent </IntangiblesClass> <IntangiblesGross contextRef='{@contextRef}' unitRef='{@unitRef}' decimals='{@decimals}'> {.} </IntangiblesGross> </IntangibleAsset>"		$IntangiblesPatents	Tuple	p-equal, u-equal and c-equal; The current node "." Is bound to the fact (not its value).

Facts:

@id	item	@contextRef	@unitRef	decimals	[content]
f51	IntangiblesPatents	c03	usd	0	10742

Result:

@id	item	@contextRef	@unitRef	decimals	[content]
f52	IntangiblesClass	c03			Patent
f53	IntangiblesGross	c03	usd	0	10742
f54	IntangibleAssets				(tuple)

2.32 Formula merges items into an existing tuple.

Continuing use case 2.30 above, the input and output taxonomies can differ by having several facts that need to be merged into an output tuple. Without the ability to merge into existing output tuples, a combinatorial number of formulas would be needed to capture each possible combination of facts available. For example, the additional facts appear in the input:

```
<IntangibleReservePatents
 contextRef='c03' unitRef='usd' decimals='0'>3977</IntangiblesReservePatents>
<IntangibleNetPatents
 contextRef='c03' unitRef='usd' decimals='0'>6765</IntangibleNetPatents>
```

This should yield, along with the inputs of use case 2.30 above, a single tuple:

```
<IntangibleAsset>
  <IntangiblesClass contextRef='c03'>patent</IntangiblesClass>
  <IntangiblesGross
    contextRef='c03' unitRef='usd' decimals='0'>10742</IntangiblesGross>
  <IntangiblesReserve
    contextRef='c03' unitRef='usd' decimals='0'>3977</IntangiblesReserve>
  <IntangiblesNet
    contextRef='c03' unitRef='usd' decimals='0'>6765</IntangiblesNet>
</IntangibleAsset>
```

Formulas:

tuple	test	expression	type	matching
"<IntangibleAsset> <IntangiblesClass contextRef='**{@contextRef}**'> patent </IntangiblesClass> <IntangiblesReserve contextRef='**{@contextRef}**' unitRef='**{@unitRef}**' decimals='**{@decimals}**'> **{.}** </IntangiblesReserve> </IntangibleAsset>"		$IntangibleReservePatents Merge the output tuple with any tuple already present having a duplicate IntangiblesClass element.	Tuple	p-equal, u-equal and c-equal; The current node "." Is bound to the fact (not its value).
"<IntangibleAsset> <IntangiblesClass contextRef='**{@contextRef}**'> patent </IntangiblesClass> <IntangiblesNet contextRef='**{@contextRef}**' unitRef='**{@unitRef}**' decimals='**{@decimals}**'> **{.}** </IntangiblesNet> </IntangibleAsset>"		$IntangibleNetPatents Merge the output tuple with any tuple already present having a duplicate IntangiblesClass element.	Tuple	p-equal, u-equal and c-equal; The current node "." Is bound to the fact (not its value).

Facts:

@id	item	@contextRef	@unitRef	decimals	[content]
f51	IntangiblesGrossPatents	c03	usd	0	10742
f52	IntangiblesReservePatents	c03	usd	0	3977
f53	IntangiblesNetPatents	c03	usd	0	6765

Result:

@id	item	@contextRef	@unitRef	decimals	[content]
f54	IntangiblesClass	c03			patent
f55	IntangiblesGross	c03	usd	0	10742
f56	IntangiblesReserve	c03	usd	0	3977
f57	IntangiblesNet	c03	usd	0	6765
f58	IntangibleAssets				(tuple)

Merging a tuple into a null tuple yields the tuple itself. Formula processors may choose to implement tuple merging in a post-processing step. This use case justifies result requirement 7.12; merging into an output tuple does not by itself determine location in the output.

2.33 Formula matches facts across segments of a common entity

Two fixed asset breakdowns between:

- an entity (444);
- its geographic segments (<geo>ON</geo> and <geo>MI</geo>); and
- line of business segments (<lob>paper</lob> and <lob>plastic</lob>)

has the formula shown below, with the two sets of figures 50,000 and 80,000 and 40,000 and 90,000 separately summing to 130,000.

Formulas:

item	condition	expression	type	matching
FixedAssets		sum of FixedAssets*	INF	p-equal, u-equal; FixedAssets* contexts have a common entity, common segment element and distinct segment element contents, FixedAssets* contexts have s-equal scenarios; Result context entity has no segment element.

Facts:

@id	item	@contextRef	@unitRef	@precision	[content]
f41	FixedAssets	c08	usd	INF	50000
f42	FixedAssets	c10	usd	INF	80000
f75	FixedAssets	c18	usd	INF	40000
f76	FixedAssets	c19	usd	INF	90000

Result:

@id	item	@contextRef	@unitRef	@precision	[content]
f43	FixedAssets	c05	usd	INF	130000
f77	FixedAssets	c05	usd	INF	130000

By contrast with use case 2.18 above, "Formula matches facts in different segments in this use case the formula is *not* limited to known segment names. Rather, the formula match criteria MUST be written in conjunction with a design of segment child elements that ensures distinct child elements of segment are treated as orthogonal and distinct element contents are comprehensive and non-overlapping.

3 Linkbase-related requirements

The requirements here specify the linkbase features that formulas must support in order to integrate fully with the rest of XBRL 2.1.

3.1 A discoverable taxonomy set MAY include formulas

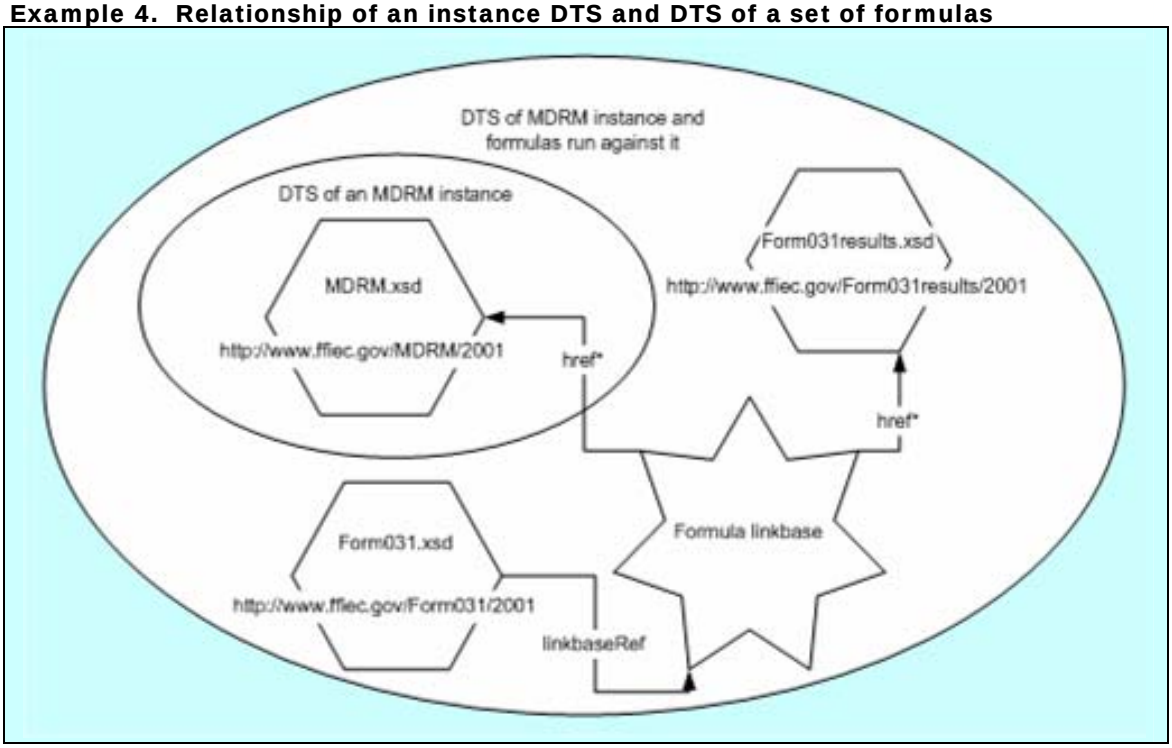
It MUST be possible to define a set of formulas in such a way that it can be part of one or more discoverable taxonomy sets {1.4}.

3.2 Formulas MAY require components of a DTS

Formulas refer to items and tuples defined in taxonomies {3}. Therefore it MUST be possible for a set of formulas to rely upon the presences of specific taxonomy schemas and linkbases in its processing environment.

It is not sufficient to rely on the `schemaRef` and `linkbaseRef` elements of an instance because the formulas may be computing results that are elements from an entirely different taxonomy schema. Example 4 shows a formula linkbase that has inputs from the taxonomy schema `MDRM.xsd` but computes results that are items in `Form031results.xsd`. An instance with a `schemaRef` only to `MDRM.xsd` is not sufficient for execution of the formulas. In effect the execution of formulas requires a DTS that is the union of its own DTS and the DTS of the instance in question.

Example 4. Relationship of an instance DTS and DTS of a set of formulas



3.3 Formulas MAY be partitioned into sets

A formula is a relationship among two or more items and so a set of formulas MUST use the same `xlink:role` attribute as used in XBRL 2.1 to indicate which relationships participate in the same networks of relationships based on the value of the role {5.2}. See use case 2.11 above.

3.4 Formulas MAY be prohibited

An extension taxonomy MAY prohibit a formula in a base taxonomy {3.5.3.9.7.5}. See use case 2.10 above. The requirement does imply that formulas require a base/extension scheme like that used in taxonomies.

In order for one formula to prohibit another they must be identical, not just s-equal. Assuming that a formula set is implemented as a linkbase, a prohibiting arc MUST connect the same XML fragments as the original arc, and both the original and the prohibiting arc MAY connect multiple resources (formulas, variables, constants) by making the ID attribute required.

3.5 Documentation of a formula MAY be included

Human-readable documentation that explains meaning of a formula in multiple languages MAY be included in each formula or set of formulas.

3.6 The representation of formulas SHOULD NOT require redundancy

This is a general principle applicable to most if not all representations. By analogy with the `unit` element in XBRL and the `unitRef` attribute, where a set of formulas is likely to share common information, the specification will use syntax that allows it to be specified just once and referred to in many formulas.

3.7 Formulas may only appear in linkbases associated with a taxonomy, consistent with the treatment of calculations, and not the instance.

Formulas in an instance are believed to irrevocably render XBRL instances useless from an archival standpoint because of differences in the results that different processors would derive results. The treatment of formulas for archiving MUST be the same as for calculation arcs.

4 Processing-related Requirements

The requirements here describe the processing semantics of formulas relative to input and output XBRL elements.

4.1 Application of a set of formulas to an XBRL-valid instance MUST either fail or result in another XBRL-valid instance.

This requirement guarantees that the output of a formula processor is a valid XBRL instance. Non-local properties of XBRL validity that would apply to the output instance—such as the testing of the `requires-element` constraints {5.2.6.2.4}—may be difficult to guarantee on a local, incremental basis, so that in practice a formula processor would almost certainly require an XBRL 2.1 validity checker.

One and only one processing iteration shall be performed in satisfying this requirement.

4.2 The result of applying formulas to an instance that is not XBRL-valid is not defined.

Authors may write formulas in such a way as to presume an XBRL-valid instance with respect to a known taxonomy schema.

4.3 Any number of formulas may compute the value of any item.

Authors may write formulas in such a way as to provide multiple ways to derive a given fact. In practice authors should avoid writing formulas that bind the same set of facts to produce the same result facts, since the result facts may be duplicates or even contradictory.

4.4 All formulas in a DTS are to be processed concurrently and without exception in a non-deterministic order without regard to priority.

The firing order of formulas is implementation dependent. This cannot affect the semantics of the outcome, given requirement 6.7 below, “Formulas MUST only bind facts that are explicitly present in the input.” Formulas are to be processed one instance at a time. Processing the instances is implementation dependent and cannot affect the semantics of the outcome. There is no dependency between any formula and any other formula.

If formulas had priorities then they could be used to order formula application in cases where more than one formula applies, but since all must be evaluated, and the order of output elements is not relevant in XBRL, the XBRL semantics would not be impacted.

5 Expression-related Requirements

The requirements here refer to the common features needed in all three of:

- expressions that may be used to bind arguments to facts;
- expressions that may form a Boolean precondition of the formula after arguments are bound; and
- expressions that yield the result of processing a formula.

Where it is not clear from context elsewhere in the document, these are called *binding* expressions, *precondition* expressions, and *result* expressions.

5.1 Expressions MAY include constants and mathematical operations.

Formulas must be able to express any constant from the value space of XML Schema primitive data types [SCHEMA-2].

Formulas must be able to express the following operations:

- Addition and subtraction of values;
- Division and modulus of values, both integer and real;
- Multiplication of items;
- Determine maxima and minima of a sequence of values;
- The range of string matching and modification operations made possible by regular expressions;
- All of the following relational operations, =, <, >, <=, >=, != on numeric items and =, != on non-numeric items.

See use cases 2.1 through 2.27 above.

5.2 Expressions MAY include conditional expressions.

Formulas must be able to express the following operations:

- If, Then, Else
- Elseif
- Switch / Case

See use case 2.16 above.

5.3 Expressions MAY determine the minimum and maximum period that appear among the contexts in an instance.

Expressions may determine the latest and earliest `startDate`, `endDate` and `instant` appearing in the instance. This could also include the use of date expressions that include a function such as `now()` which would return the current instant as an ISO 8601 string.

See use case 2.15 above.

5.4 Expressions MAY test for the presence of a fact for any item in any context.

The presence or absence of a fact may be tested.

See use case 2.20 for an example in a conditional expression, use case 2.21 for a case in binding expressions; use case 2.22 also indicates that Nil items may be tested for.

WH: Need a use case for result expressions.

5.5 The behaviour of a formula processor MUST be defined in case of an expression evaluation exception.

A formula will bind arguments to facts, and substitution of the arguments as variables in the expression allows the expression to be evaluated. The formula specification MUST indicate, in particular, what result if any is produced when the expression throws an exception when evaluated. Use case 2.23 above presupposes a try/catch mechanism that allows the formula author to control the behaviour on a case-by-case basis. This presumably though not always will include the generation of a human-readable error message.

See use case 2.23 above which covers result expressions.

WH: Use cases for exceptions occurring in binding and condition expressions are needed.

5.6 Constants MAY be named and defined outside a formula and referenced in its expressions.

Sets of formulas often refer to constants which may either appear locally or may appear in several related formulas; there MUST be a way to define a constant whose scope is an entire set of formulas. There MUST be a means to limit the scope of such a constant, such as by using the `xlink:role` attribute.

See use cases 2.25 through 2.26 above.

WH: Use cases covering binding and condition expressions are needed.

5.7 Functions MAY be named and expressions defined outside a formula and referenced in its expressions

Any function that is not "built in" to the expression language – for example, trigonometric functions – would either have to be defined repeatedly in every formula that needed it, or an intermediate item defined in the taxonomy whose only role would be to hold the result of the formula and then append that result to an instance so that its value could be bound in all formulas that may need it. Examination of UK Inland Revenue Tax Computation use cases, similar items on the FFIEC 031 and 041 forms, and consideration of many financial analysis routines, reveals that the same formulas are used again and again.

See use case 2.27 above.

5.8 Functions MAY have their scope defined to apply to only a subset of formulas in a set

There must be a way to limit the scope of such a function definition to be usable only within a certain set of formulas, such as by using the `xlink:role` attribute.

See use case 2.28 above.

5.9 There MUST be only one expression language

From an initial adoption standpoint, it is not desirable to allow multiple expression languages since that would unnecessarily increase the implementation burden on a compliant formula processor.

Other standards (e.g., XSL and XPointer) have frameworks in which different expressions or scripting languages may be used; new recommendations incrementally extend the set of expressions that must be supported.

Therefore, the requirement that there must be only one expression language MAY be relaxed in a future version of the formula specification.

5.10 The expression language MUST be recognisable to a programmer of average skill.

A "programmer of average skill" means a person familiar with infix and functional notations able to write spreadsheet formulas, SQL queries, or expressions in a 3GL or 4GL programming language.

This requirement will be satisfied if the expression language is a subset of a widely used language such as ECMAScript or XPATH 1.0. Expression syntaxes ruled out by this requirement include those used by APL, FORTH, LISP, PROLOG, etc.

5.11 The expression language MUST include operators that can select any node in the instance accessible from bound facts.

Fact-binding expressions, conditional expressions and result expressions to operate (for example) on the units of measure, the contexts, and other parts of the input instance.

It is believed to be more difficult for the specification and therefore for an implementation to *prevent* this accessibility than it is to *allow* it.

6 Fact-binding Requirements

The requirements here refer to the features needed to bind facts to the arguments for the formula as they appear in the condition and result expressions.

6.1 Formulas MAY filter the input facts to which they apply according to relationships between facts in one or more contexts.

The input facts of a formula may have different contexts. Contexts are related to one another using the following orderings:

- The relationship "after" that partially orders periods;
- The subset relationship "during" between periods;
- The subset relationship implied between an entity and its segments {4.7.3};
- The subset relationship implied between an empty (universal) scenario and a scenario with additional discriminators {4.7.4}.

See use cases 2.1 through 2.4, 2.13, and 2.14 through 2.18, and 2.22 through 2.30. Note that contexts need not be c-equal: See use case 2.1 above.

6.2 Formulas MAY restrict the facts that they bind based on their context.

See use cases 2.1 through 2.4. This requirement also implies that the expression language SHOULD provide a native library of date manipulation functions such as those specified for XQuery and XPath [XQPFO].

6.3 Formulas MAY restrict the facts that they bind based on their unit.

See use case 2.14.

6.4 Formulas MAY restrict the facts that they bind based on their precision or decimals attribute.

The condition on the facts may allow precision, decimals, or both, and comparative operators on their values.

WH: Need use cases for this.

6.5 Formulas MAY filter input facts depending on their surrounding tuple structure.

Formulas MUST be able to use predicates that use paths with the parent-child and other XPATH axes in order to filter input facts. These paths MAY refer to facts already bound.

WH: Need a use case for this.

6.6 Formulas MAY filter input facts based on the filters applied in that formula to other facts.

For example, an input may be filtered according to a criterion such as "the same context as that other argument, except one quarter earlier."

See use cases 2.4 and 2.17.

6.7 Formulas MUST only bind facts that are explicitly present in the input.

There is no requirement that formulas automatically match to facts derived from previous formulas matched and evaluated.

Consequences of this are shown in use case 2.20.

6.8 Formulas MAY bind facts that are present in more than one XBRL instance within a single root XML element.

The motivation for this is that some formulas will require multiple XBRL instances; for example, in use case 2.20 the implication is that a given instance may require more than one formula processing iteration. Because all identifiers—particularly the id attributes of unit and context elements—cannot be duplicated in an XML element, simple concatenation within a parent element may not be significantly easier than actually merging the two instances properly to create a single XBRL-valid instance. Nevertheless the requirement remains.

See use case 2.20.

6.9 Multiple applications of a formula to a set of facts, with multiple combinations of bindings of arguments to facts, may produce multiple results.

A formula MAY match the same facts to different arguments and apply multiple times.

See use cases 2.13 and 2.14.

WH: A better use case would be to have facts for both quarterly and annual periods along with a single value for an instant.

6.10 The outcome of a formula match MUST be defined in situations in which duplicates appear in the input instance.

When duplicate facts appear in an instance, a single formula could:

(a) repeatedly bind different duplicate facts and re-evaluate its expression repeatedly,

(b) follow the approach used in the calculation linkbase and derive *no* facts, or

(c) take some other approach.

The specification MUST indicate what facts if any are derived in this situation. The specification MUST use whichever approach is consistent with interpretation of XBRL 2.1 {5.2.5.2}.

See use case 2.24, "Formula does not bind duplicate facts".

6.11 Formulas MAY specify preconditions on expressions based on context and fact value

For example, an expression may apply only when the value of a certain item is nonzero in the bound context. The requirement is that there be a way to "abort" the application of a formula after all inputs are bound to facts, but before its expression is evaluated.

This does *not* require that the matching and binding criteria of any argument be able to reference the value of any other bound argument. For example, a formula that binds argument "S" to the "SignatureDate" of a financial statement does not need to be able to use the date "S" to find the Revenue value as of date "S". In general, computed offsets (e.g., the binding of one argument determines which of many different time periods the other arguments are bound in) do not have to be supported.

See use case 2.12.

6.12 Formula arguments MUST bind to facts, not to their contents

This requirement is a logical consequence of other requirements such as 6.5 above, "Formulas MAY filter input facts depending on their surrounding tuple structure."

6.13 Constants MAY be facts

This requirement is a logical consequence of 6.12 above. Use cases 2.25 and 2.26 above presume that constants consist only of numbers, strings and other primitive data types, however, if formula arguments are bound to facts then constants must also be able to represent facts having a precision, context, and units.

6.14 A variable number of facts may be bound

Arguments bound in a formula may be bound to a sequence of facts for execution. Formulas such as "the sum of all revenues for years before 2001" and "the sum of values of the children of the item" are allowed. This will require operations on vectors and matrices spanning any number of contexts, which in turn requires a definition of the "best" or "maximal" match in order to avoid a combinatorial explosion. For example, if argument X is defined in six periods, then the "moving average of X" must be defined with respect to a fixed number of periods anyway (2 periods? 3 periods?), and this can adequately be expressed using formulas with a fixed number of input arguments. By contrast, if X is "the sum of X for *all* child entities," *all* could mean "all child entities for which X is known in each known period" or "all child entities for which X is known in all periods."

See use case 2.33 above, "Formula matches facts across segments of a common entity".

7 Result Expression Requirements

Unless otherwise noted, the "expressions" referred to here refer to all three of:

- expressions that are used to bind arguments;
- expressions that form the Boolean precondition of the formula; and

- the expression that yields the result of the formula.

7.1 If the application of a formula results in an XBRL fact then the formula MUST fully determine the context of that fact

The context is determined on the basis of the formula itself, the information in the contexts of the facts being drawn upon by the formula, and the facts bound to variables in the expression when the formula matches.

See all use cases.

7.2 If the application of a formula results in a numeric XBRL fact, then the formula processor MUST also result in a unit reference and a precision or decimals attribute

The unit reference and the `precision` and `decimals` attributes are determined on the basis of the formula itself and the information in the facts bound to variables in the expression when it applies {4.6}. Furthermore, the formula author MUST be able to specify the unit, precision, and decimals attributes in addition to the requirement is that the formula processor be able to determine them on its own. If the result item is a numeric type then the formula MUST specify the result units; there is no default.

See use cases 2.5 through 2.9.

7.3 Formulas MAY include expressions to construct a derived fact or tuple

Each formula MAY specify how new elements are to be constructed as a consequence of the presence and content of other facts in an instance. All parts of the result fact MUST be specifiable by the formula, including element names, content of each element, context, and in the case of numeric facts, the unit and either `decimals` or `precision` attributes.

7.4 Formulas MAY include expressions to construct a derived context

See use case 2.2 above.

7.5 Formulas MAY include expressions to construct a derived unit

See use case 2.5 above.

7.6 Formulas MAY create the content of a new fact or tuple from facts in different contexts

For example, a formula that derives the “cash” at end of period as “cash” (at the beginning of period) + collections – disbursements” may calculate the value as of the end of 2003 from the value at the beginning of 2003 and values during the period 2003-01-01 to 2003-12-31, which are two distinct contexts also distinct from the context of the ending value.

The result of a single application of a formula to a set of facts may be a single fact or a tuple populated by several facts.

7.7 A formula MUST be able to create contexts, units, and facts that were not present in the input document

Output facts may contain elements from any taxonomy namespace present in the input document, and may produce new `context` and `unit` elements.

Formulas do *not* have to provide a way to synthesize namespaces, elements or attributes that are not already present in the instance being processed, the DTS of the instance, or the DTS of the formula set being processed.

Formulas do *not* need to be able to produce XBRL `footnoteLink`, `footnoteArc`, `footnote`, `loc`, `schemaRef`, `roleRef`, or `arcRoleRef` elements.

When the result of a formula contains a numeric item type, the unit element to which its `unitRef` attribute refers does not have to have an identifier unique among all `unit` elements in the output; the identifier of the `unit` element is unconstrained so long as the result output is XBRL-valid.

When the result of a formula contains a fact, the context element to which its `contextRef` element refers does not have to have an identifier unique among all `context` elements in the output; the identifier of the `context` element is unconstrained so long as the result output is XBRL-valid.

7.8 Formulas MAY include expressions to limit the precision of result facts

The default `precision` attribute of a numeric result is the maximum allowed by the input facts and the expression, but is truncated to 18 if a repeating decimal representation would result.

See use case 2.6.

All numeric facts are asserted with a `precision` attribute unless `decimals` is specified.

7.9 Formulas MAY include expressions to limit the decimals of result facts

The default `decimals` attribute of the result is that which would result after conversion of all inputs to their equivalent `precision` attribute and requirement 7.8 adhered to and then converted back to a `decimals` attribute.

See use case 2.9.

7.10 Result expressions may return Nil facts

That is, the result element would have `xsi:nil="true"`.

WH: Need a use case.

7.11 Result expressions MAY return tuples

Requirements 7.3 and 7.5 above, in which a tuple is a possible expression result, imply that this requirement. See use cases 2.31 and 2.32 above.

7.12 Result expressions MAY indicate that a result element is to be inserted into last inserted tuple

Requirement 7.11 above implies that additional formulas may create items or other tuples that are meant to be children of a previously output tuple. The default behaviour is to append the result to the `xbrl` root element.

8 Approval requirements

The requirements here apply generally to the formula specification and the process for its approval.

8.1 The formula specification MUST depend only on finalised specifications with broad implementation experience

A working definition of "broad" implementation experience is "at least as many commercial implementations as XBRL 2.1 itself." The expression syntax used within the formula specification is covered by this requirement.

Figure 5. Expression requirements *vs.* W3C specifications.

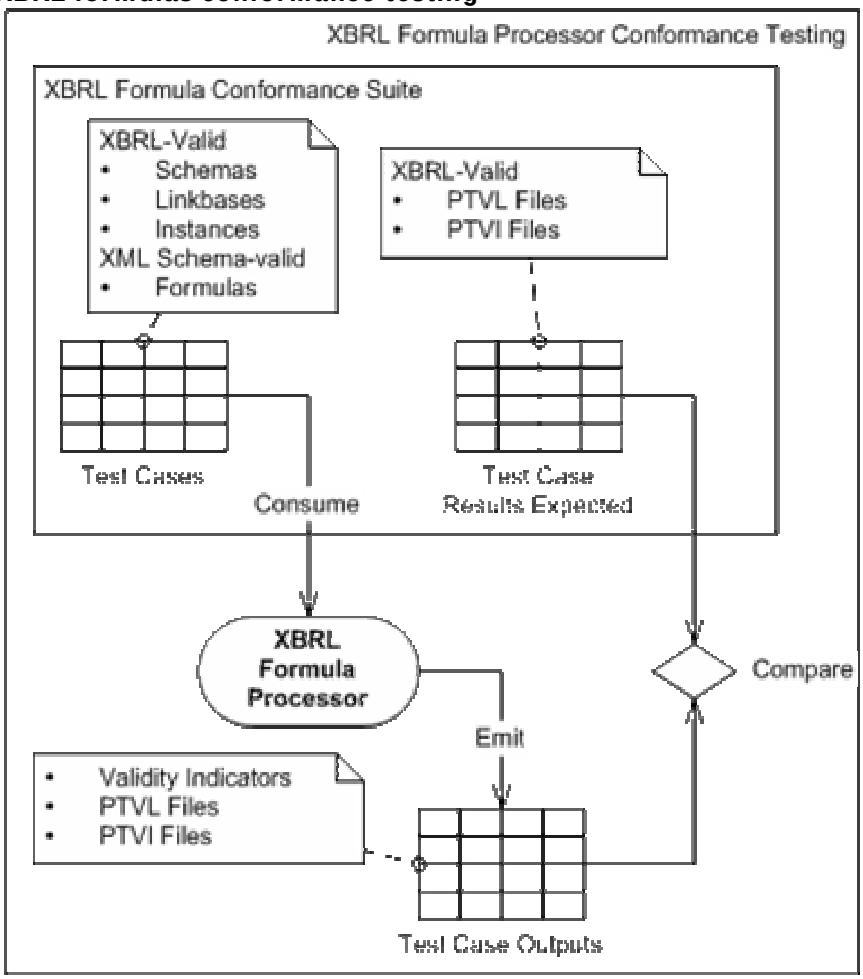
Requirement	[XPATH]	[XPATH2]	[XQuery]
5.2, Expressions MAY include conditional expressions.	No	Yes	Yes
5.7. Functions MAY be named and expressions defined outside a formula and referenced in its expressions	No	No	Yes
Use case 2.23 "Expression evaluation exceptions MAY be caught to produce a result" Requirement 5.5 says only "The behaviour of a formula processor MUST be defined in case of an expression evaluation exception."	No	No	No
6.2. Formulas MAY restrict the facts that they bind based on their context.	No	Yes	Yes

WH: It remains issue 34 whether XPATH 2.0 will be a finalised specification in an appropriate time frame.

8.2 Two formula processing implementations MUST produce semantically equivalent results on a conformance suite

A conformance suite will consist of sets of inputs and their expected outputs according to the formula specification. The conformance suite will exercise each feature of the formula specification. The ability to process these inputs and produce semantically equivalent outputs will be taken as evidence of a compliant formula processing implementation. Evidence of two separate and compliant formula processing implementations both having non-discriminatory licensing terms MUST be provided before the specification can be issued as a recommendation.

Figure 6. XBRL formulas conformance testing



8.3 A Formula specification MUST NOT redefine any term defined in any specification upon which it depends

In particular, the term "duplicate" MUST retain its XBRL 2.1 meaning {4.1}.

9 Proposed requirements

Proposed requirements and corresponding use cases that are not part of the official set of requirements and that have not been conclusively rejected are documented here. The "?" indicates that the use case or requirement has been proposed.

9.1 ? A formula binds to the PTVI of an instance, not to the instance

Beneficial consequences of processing the PTVI rather than the instance itself include:

- Formula expressions are NOT required to draw inferences from the existence of calculation or essence-alias arcs discoverable from the instance.
- Fact-binding criteria are NOT required to infer precision or decimals attributes.
- A formula processor would have to be a superset of an XBRL processor as defined in the XBRL 2.1 Conformance Suite [CONF].

Issues include:

- The PTVI is NOT formally defined in the XBRL 2.1 Recommendation.
- The PTVI of an instance tends to be much larger in byte count than the instance itself.
- This requirement would require modification of requirement 6.7 above, "Formulas MUST only bind facts that are explicitly present in the input."
- The PTVI must be defined so as to be compatible with proposed requirement 6.8 above, "Formulas MAY bind facts that are present in more than one XBRL instance within a single root XML element."

  WH: This remains a proposed requirement because the PTVI specification is still a work in progress.

10 Rejected requirements and use cases.

Some previously proposed use cases and corresponding requirements are documented here. The "*" prefix indicates that the requirement is rejected.

*10.1 * Formulas may bind facts in multiple XML instances*

This would add generalised addressing of absolute and relative URLs to the fact binding expressions. Cases include

- http://data.example.com/2003/10K.xbrl -- refers to a specific document
- http://data.example.com/2003/ -- refers to a set of documents?
- http://data.example.com CurrentAssets – refers to an element somewhere on the web site?

There is no use case included for this.

*10.2 * Formulas form arcs from their input items to outputs and directed cycles in these arcs are prohibited.*

Formulas already do have a certain kind of directed cycle, as in use case 2.4 "Formula uses items in contexts that match period endpoints" where there is a directed cycle from the Equity item to itself except for the fact that the period of the input and output do not overlap. The static analysis to detect cycles is sufficiently complex that it does not seem worthwhile to mandate. Moreover, it is believed that formulas such as z = f(z) + c is a legitimate use case even though solving them may require iteration or other techniques.

*10.3 * The maximum number of facts bound in a formula is fixed*

The number of facts to be bound in a given formula is always fixed. Arguments bound in a formula may *not* be bound to a sequence of facts for execution. Formulas such as "the sum of all revenues for years before 2001" and "the sum of values of the children of the item" are *not* required. This would essentially require operations on vectors and matrices spanning any number of contexts, which in turn requires a definition of the "best" or "maximal" match in order to avoid a combinatorial explosion. For example, if argument X is defined in six periods, then the "moving average of X" must be defined with respect to a fixed number of periods anyway (2 periods? 3 periods?), and this can adequately be expressed using formulas with a fixed number of input arguments. By contrast, if X is "the sum of X for *all* child entities," *all* could mean "all child entities for which X is known in each known period" or "all child entities for which X is known in all periods."

See the contradictory use case 2.33 above, "Formula matches facts across segments of a common entity".

*10.4 * Application of a set of formulas to an XBRL-valid instance MUST either fail or result in an XML instance*

This would have replaced and relaxed requirement 4.1 above, so that the output could be either XBRL, XML or any combination thereof.

*10.5 * Conforming processors MUST allow a user agent to copy the input instance to the output, and the processing model MUST state that it is the default*

This would have required that the output of a formula processor to be either an empty instance or a copy of the input instance, and force the processing model to allow the choice to be overridden. This was removed from the requirements since it has no impact on the syntax of formulas.

*10.6 * Formulas MAY specify one or more alternative items or tuples as the possible result of expression evaluation*

The results from a formula may select a subset of a finite set of possible element names (items) that depend on the input facts. This is requirement is supported by general requirement 3.6, "The representation of formulas SHOULD NOT require redundancy". An example use case would be the formula "If revenue is less than expense then `loss` is expense minus revenue, otherwise `profit` is revenue minus expense". Another use case would be to combine use cases 2.25 and 2.29, with the formula computing either or both of a Boolean flag and a diagnostic error message. In both use cases, to achieve the same effect using two separate formulas having the same variable bindings and tests would be redundant. This requirement is *not* meant to imply that the element name(s) in the output might be synthesised via an expression; the formula would still need to explicitly list the possible alternative items, with the expression selecting among them. (Note that the fact that FRTA 1.0 and rule 2.1.1 – supported by FRTA 1.0 example 1 – would forbid the use of both profit and loss items suggests that a better use case is needed than the first example used here – a moot point since the requirement is rejected).

*10.7 * Conforming processors MUST default the units of a result by analysis of the input facts and expression*

The units of the fact resulting from a result expression have a default which is determined by analysis of the expression; e.g., a/b yields units(a)/units(b); a+b yields unit(a) and throws an exception if units(a)<>units(b), etc.

A use case would be identical to 2.6 above in terms of facts and results except that the formula itself would not specify that the output results are a currency amount per year.

10.8 Formulas MAY specify the location of their result in the output instance

The output result is by default appended to the root `xbrl` element of the output, but a path may be specified where it is to be inserted. This is a stronger version of result requirement 7.12 above.

10.9 ? Expressions may test for duplicate output facts and tuples before asserting a result

The most general form of this requirement would mean evaluating expressions that reference the output instance—realistically this would have to be restricted to specific circumstances such as testing whether the fact about to be inserted is already present.

11 Document history (non-normative)

Date	Editor	Remarks
2002-01-10	vun Kannon	Note posted on XBRL-SpecV2 group describes the design of the "Computational Linkbases" prototype by David vun Kannon and Yufei Wang of KPMG.
2002-01-25	Hamscher	First draft of "Augmented Computational Linkbases" which included both requirements and an alternate design proposal.
2002-02-18	Hamscher	Edits after draft reviewed by David vun Kannon.
2002-02-20	Hamscher	Draft distributed to the XBRL-SpecV2 group.
2002-02-27	Hamscher	Draft with inline edits by Geoff Shuetrim published to XBRL-SpecV2 group.
2002-07-01	Hamscher	Reissued as internal working draft of a Requirements document, with examples from Rene van Egmond added. The notion of a "rule base" is the functional requirement which might be satisfied by a computational linkbase with modifications.
2002-07-03	Hamscher	Issued as internal working draft to XBRL-SpecV2 group after comments by contributors.
2002-08-31	Hamscher	Incorporated comments on initial working draft. In recognition of issues illustrated in the draft specification of 2002-08-19, some requirements were reworded, dropped, or changed category.
2002-09-10	Hamscher	Incorporated further minor comments and requested issuance as a public working draft.
2002-09-25	Hamscher	Relaxed the requirement for an open source implementation, and relaxed the requirement with respect to XPATH 2.0. Changed intellectual property notices to conform to IPR policy currently pending ISC approval. Revised target approval dates. Requested again issuance as a public draft.
2002-09-26	Hamscher	Corrections in use cases and various typos caught by Watanabe-san. Added line numbering to facilitate commentary.
2002-10-01	Hamscher	Finalisation for public release. Removed redundant use case 5 and renumbered the remainder.
2002-10-16	Hamscher	Various errata from Hugh Wallis. Returned to previous numbering and stabilised on UC01, UC02, etc. Reinstated a simplified UC05.
2002-10-22	Hamscher	Various marginal notes included from New York face-to-face meeting 22 October 2002 which changed the status of some requirements from basic to complex and vice versa.
2003-11-14	Hamscher	Updated entire document contents to conform to XBRL 2.1 syntax and style. Defined the relationship between this new specification and XBRL 2.1. Removed the distinction between basic and complex requirements. Restated each requirement as a normative statement and defined conformance with stringency similar to that of XBRL 2.1. Included consideration of the impact of duplicates and other XBRL 2.1 issues. Eliminated the Open Issues and Design notes sections, folding any relevant remarks into the explanation for each requirement. Revised use cases to remove cases now irrelevant and added general scenarios of use.

Date	Editor	Remarks
2003-12-07	Hamscher	Incorporated feedback from Yuji Furusho, Geoff Shuetrim and others.
2004-01-08	Hamscher	Reworked the use cases to use a common set of concepts, contexts, and units. Reorganised document to emphasise concrete use cases. Broke requirements up into several separate sections by theme. Distributed a truncated draft for comments to the Formula subgroup.
2004-01-12	Hamscher	Brought draft into alignment with issues list. Referenced each individual requirement to a use case. Added additional use cases but left others open for others to add. Added sections of proposed and rejected requirements (and use cases). Indicated in the draft where outstanding decisions need to be made and provided notes on the issues.
2004-01-18	Hamscher	Promoted the proposed requirements for multiple formulas per item, and globally defined functions; added several new proposed requirements that emerged in online discussions. Added an approval requirement that terms must not be redefined. Added explicit requirement that expressions may produce tuples. Made editorial change to distinguish arguments and variables. Added use cases to clarify the treatment of units in output expressions. Updated target completion dates.
2004-02-02	Hamscher	Added explanation of general use cases and added proposed requirement relaxing the need for XBRL output.
2004-02-11	Hamscher	Rejected the requirement that each formula binds a fixed number of facts, replacing it with a use case involving summation across segments and the accompanying requirement that expressions must be able to access the DTS of the instance that it is processing. Merged David vun Kannon's edits to expression syntax so as to use XPATH 2.0 W3C Working Draft 12 November 2003 syntax, and incorporated his observations into a table in the "broadly implemented expression language" requirement. Promoted the rejected requirement to have computed item results to a proposed requirement.
2004-02-16	Hamscher	Merged comments from Hugh Wallis to use s-equal instead of "equivalent" or "same" contexts, and typographical errors in some use cases. Reworded the use case for formula prohibition to refer to sets of formulas rather than taxonomies. Moved "arbitrary XML output" from proposed to rejected. Added result requirement that formula must indicate whether result is a child of the `xbrl` element or the last tuple.
2004-03-17	Hamscher	Incorporated changes to rules so as to align the treatment of formulas from the standpoint of duplicates and archiving with the treatment of calculation arcs under XBRL 2.1. Edited the rule regarding prohibition. Corrected typos found by Mark Goodhand.
2004-04-06	Hamscher	Modified the segment summation use case to clarify that the formula fact matching over segments must take into account the meaning of the segment child elements, and conversely that the segment child elements should be designed so as to distinguish orthogonal segmentations. Clarified the rule regarding input copying so as to remove it from the realm of linkbase syntax. Promoted the

Date	Editor	Remarks
		requirement for accessibility of all parts of the input instance to a full requirement. Removed use case involving formula sequencing using roles. Rejected requirements concerning processing iterations, multiple alternative item outputs, computation of output units, and testing for duplicate outputs. Clarified that the output instance may have duplicate contexts and units, so long as the result is XBRL-valid.
2004-04-20	Hamscher	Edit to turn Internal WD into Public WD, no other changes.

12 Intellectual Property Status (non-normative)

13 References (non-normative)

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http://www.iso.ch/

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Appendix: Approval process (non-normative)

This section will be removed from the final recommendation.

The approval process follows XBRL International process for specifications [Processes]. This internal working draft is a substantial revision of the public working draft of 2002-10-15 and has restarted stage 1 after having previously reached stage 3.

	Stage (* - Current)	Party responsible for decision	Next step	Revisions needed	Target date for stage completion
1	* Internal WD	Domain WG Chair	Recommend for Stage 2	Stay in Stage 1	2004-01-27
2	Internal WD pending publication	ISC	Approve for Stage 3	Return to Stage 1	2004-02-25
3	Public WD under 45 day review	WD Editor(s)	Minor revisions – to Stage 4	Major revisions, Restart Stage 1	2002-04-20
4	Public WD pending publication	Domain WG Chair	Recommend for Stage 5	Restart Stage 3	2002-06-15
5	Candidate Recommendation	ISC	Approve for Stage 6	Restart Stage 4	2002-06-30
6	Recommendation	Done			

The process for approving specifications satisfying this requirements document can proceed concurrently, although no specification can be recommended without conforming to a requirements document that has already been recommended.