Understanding the Utility of Ontology-like Things

Accounting, Reporting, Auditing, Analysis in a Digital Environment

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"I skate to where the puck is going to be, not where it has been."

Wayne Gretzky, legendary Canadian hockey star

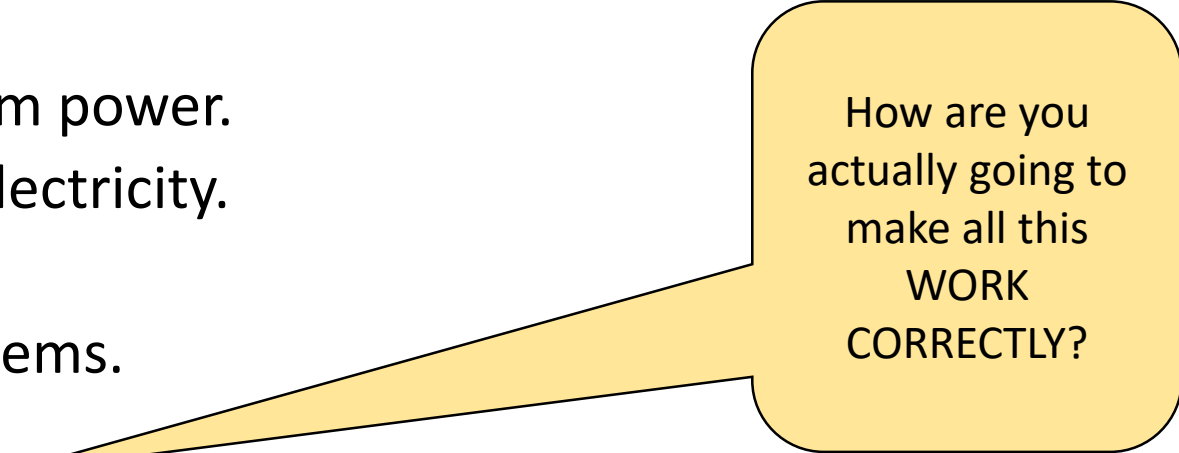# Metacognitive Issue (think about how you are thinking about this)

- **Where** did you get your understanding of XBRL-based financial reporting from?

- **From whom did that person** get their understanding of XBRL-based financial reporting?

- **How do you know they got it right**?

- *I have some views which tend to be different from the "herd"*

Fourth Industrial Revolution

- The four industrial revolutions:

  1. Mechanization, water power, steam power.
  2. Mass production, assembly line, electricity.
  3. Computer and automation.
  4. Interconnected cyber physical systems.
     - *Structured information (such as XBRL)*
     - *Artificial intelligence (rule-based; pattern-based)*
     - *Digital distributed ledgers (blockchain; hypergraph)*

> How are you actually going to make all this WORK CORRECTLY?

- ***Accounting, Reporting, Auditing, Analysis in a Digital Environment***

http://xbrl.squarespace.com/journal/2019/8/4/adapting-to-changes-caused-by-the-fourth-industrial-revoluti.html

# Artificial Intelligence is Supercharged by Curated Metadata

- PWC, KPMG, Deloitte, EY: "The **Fourth Industrial Revolution**"
- Deloitte's vision, "The Finance Factory"
- **Accounting, reporting, auditing, and analysis in a digital environment**.
- "Our entire AI revolution is built on a correlation **house of cards**."
- "Machine learning needs to move beyond **cheap parlor tricks** towards solutions that can truly advance society."
- "AI is **brought to life** by taxonomies and ontologies."
  - "Data is the new oil."
  - "Metadata is the new gold."
  - Crude oil, gasoline, **racing fuel**
- "AI that professional accountants find **useful and will understand**."

Use the Right Artificial Intelligence Approach for the Job

There are two major techniques for implementing artificial intelligence:

- **Logic and rules-based approach** (*expert systems*) : Representing processes or systems using logical rules. Uses deductive reasoning.

- **Pattern-based approach** (*machine learning*) : Algorithms find patterns in data and infer rules on their own. Uses inductive reasoning; probability.

A Plethora of 'Ontology-Like Things'

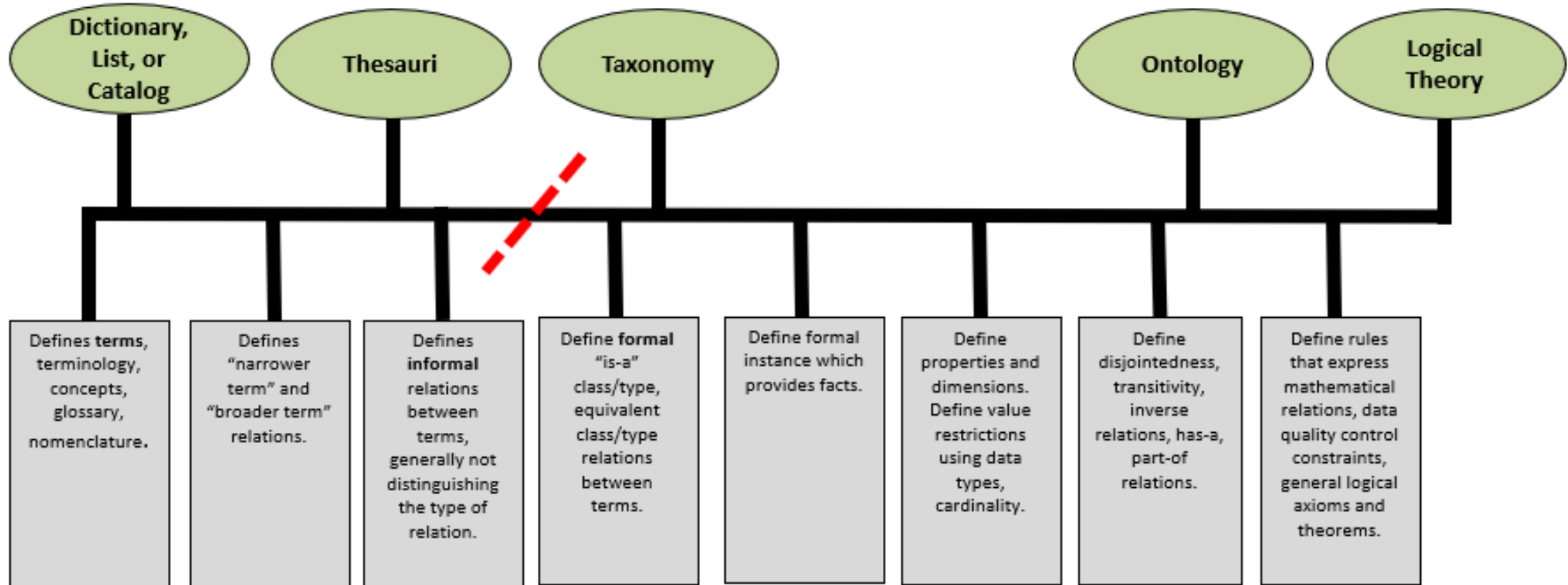https://www.slideshare.net/skhan/ontology-dev, Slide 4
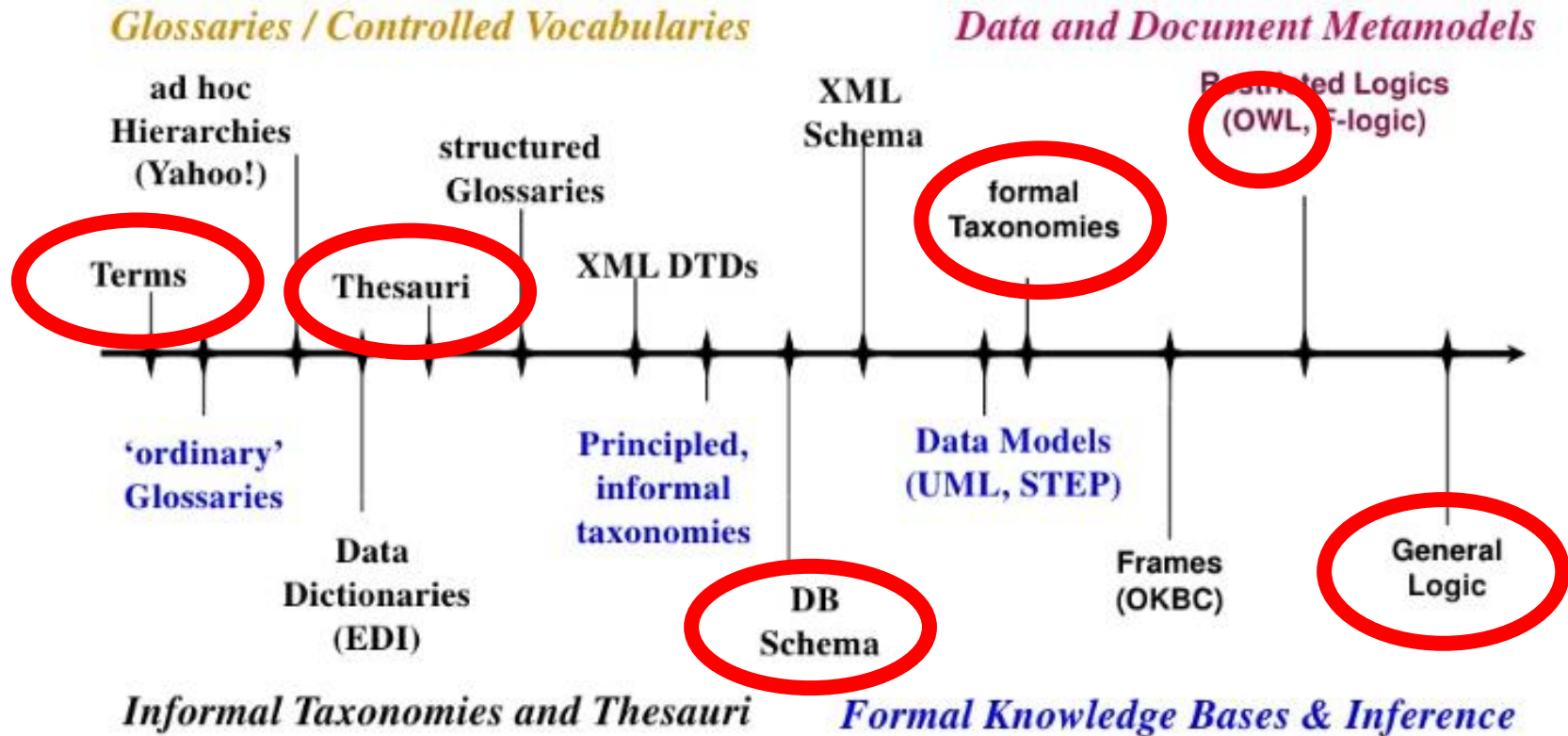
Ontology-like Things (Classification Systems)

- A **dictionary** or list or catalog is a classification system that tends to provide descriptions without much, or any, structure. Dictionaries or lists simply provide a flat inventory of terms with no relations expressed between the terms.

- A **thesaurus** is a classification system that tends to document relations between broader terms and narrower terms. Another term for broader and narrower is generalization and specialization.

- A **taxonomy** is a classification system which tends to provide descriptions and a limited amount of structure generally in the form of one hierarchy into which some list of terms is categorized. Categories are basically sets.

- An **ontology** is a classification system which tends to provide descriptions and multiple structures and therefore tends to have more than one hierarchy into which terms are categorized. So, an ontology can be thought of as a set of taxonomies for explicitly differentiate types of relations. An ontology can express many different types of relations which includes traits/qualities of each term.

- A **logical theory** is a classification system where a set of axioms, a set of theorems, and a world view describe some logical theory or logical system.

Ontology Spectrum

| Lightweight ontology-like things: Less formal, weaker expressiveness and therefore reasoning capabilities. | Heavyweight ontology-like things: More formal, stronger expressiveness and therefore reasoning capabilities. |

Dictionary, List, or Catalog — Thesauri — Taxonomy — Ontology — Logical Theory

Defines terms, terminology, concepts, glossary, nomenclature.

Defines "narrower term" and "broader term" relations.

Defines informal relations between terms, generally not distinguishing the type of relation.

Define formal "is-a" class/type, equivalent class/type relations between terms.

Define formal instance which provides facts.

Define properties and dimensions. Define value restrictions using data types, cardinality.

Define disjointedness, transitivity, inverse relations, has-a, part-of relations.

Define rules that express mathematical relations, data quality control constraints, general logical axioms and theorems.

Inspired primarily by 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

Ontology: basic definition used by academics

The following definition of ontology is taken from the textbook *Ontology Engineering* by Elisa Kendall and Deborah McGuinness:

Ontology - a model that specifies a rich description of the

- terminology, concepts, nomenclature;
- relationships among and between concepts and individuals; and
- sentences distinguishing concepts, refining definitions and relationships (constraints, restrictions, regular expressions)

relevant to a particular domain or area of interest.

Ontology: enhanced definition for business

An **ontology or ontology-like thing** is a model (logical conceptualization) that specifies a rich and *flexible* description of the *important relevant*

- **terms** (terminology, concepts, nomenclature; includes simple primitive terms and complex functional terms);

- **relations** (relationships among and between concepts and individuals; is-a relations, has-a relations); and

- **assertions**: (sentences distinguishing concepts, refining definitions and relationships including constraints, restrictions; axioms, theorems, restrictions); and

- **world view**: (reasoning assumptions, identity assumptions)

relevant to a particular domain or area of interest, which generally allows for some certain *specific variability*, and as *consciously unambiguously* and completely as is necessary and practical in order to *achieve a specific goal* or objective or a range of goals/objectives. It enables a community to agree on important common terms for capturing meaning or representing a *shared understanding* of and knowledge in some domain where flexibility/variability is necessary.

Ontological Commitment

- An **ontological commitment** is an agreement by the stakeholders of a community to use some ontology-like thing in a manner that is consistent with the theory of how some domain operates represented by the ontology-like thing. The *shared commitment* is made in order to achieve some specific goal or goals established by the stakeholders in a community sharing the ontology-like thing.

Common Components of an Ontology-like Thing

- **Terms**
  - Simple terms (primitive, atomic)
  - **Functional component terms** (complex functional terms)
  - Properties (qualities, traits)
- **Relations**
  - Type relations (class/type relations, "type-of" or "is-a" or "class-subclass" or "general-special")
  - **Functional relations** (structural relations, "has-a" or "part-of" or "has-part" or "whole-part")
  - Property attribution (has property)
- **Assertions**
  - **Axioms** (Axioms describe self-evident logical principles related to a domain that no one would argue with.)
  - **Theorems** (rules; Theorems are logical deductions which can be proven by constructing a chain of reasoning by applying axioms or other theorems in the form of IF...THEN statements.)
  - **Restrictions** (restrictions, constraints, limitations, ranges)
- **Individuals**
  - Instance (facts)
- **World view**
  - Closed world assumption
  - Unique name assumption
  - Negation as failure

Towards a Theory of Semantic Communication
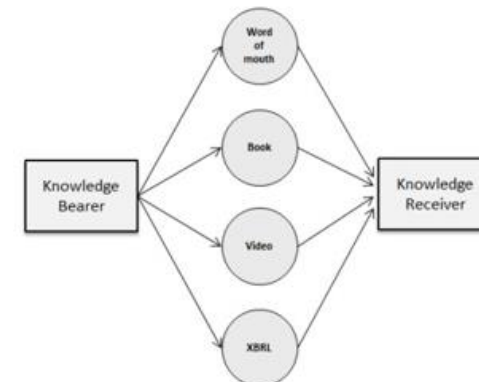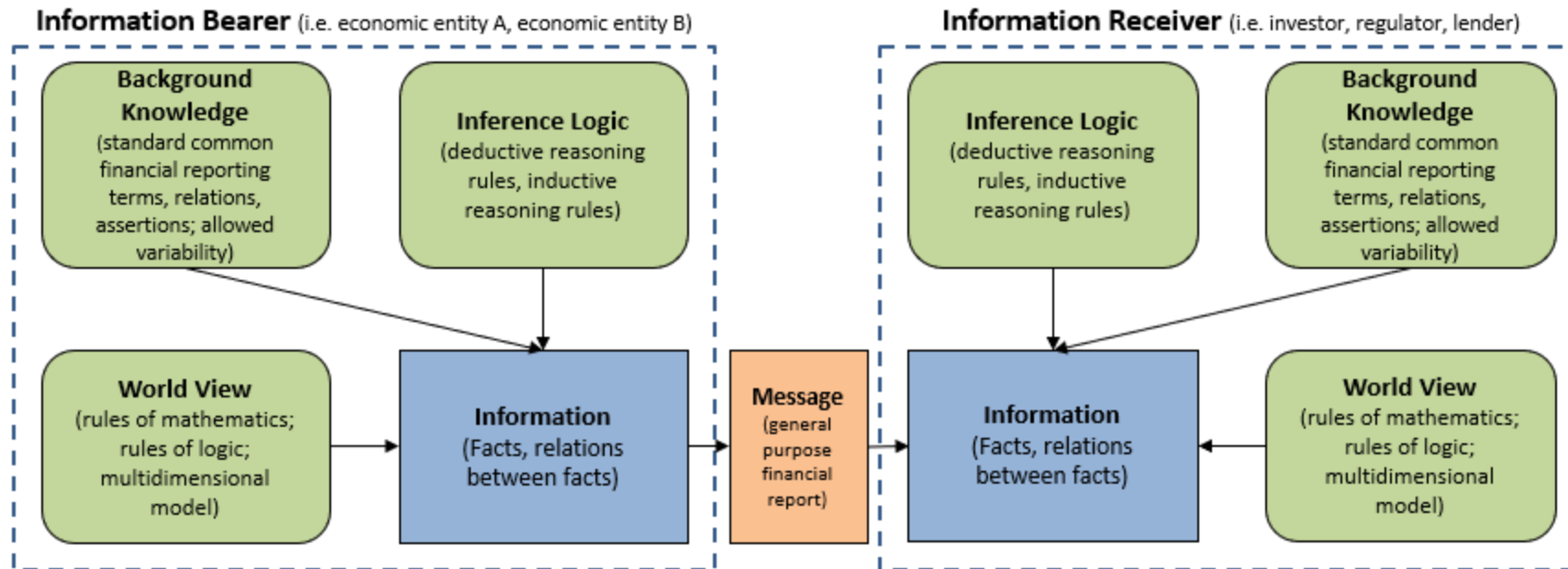
Accounting, Reporting, Auditing and Analysis in a Digital Environment
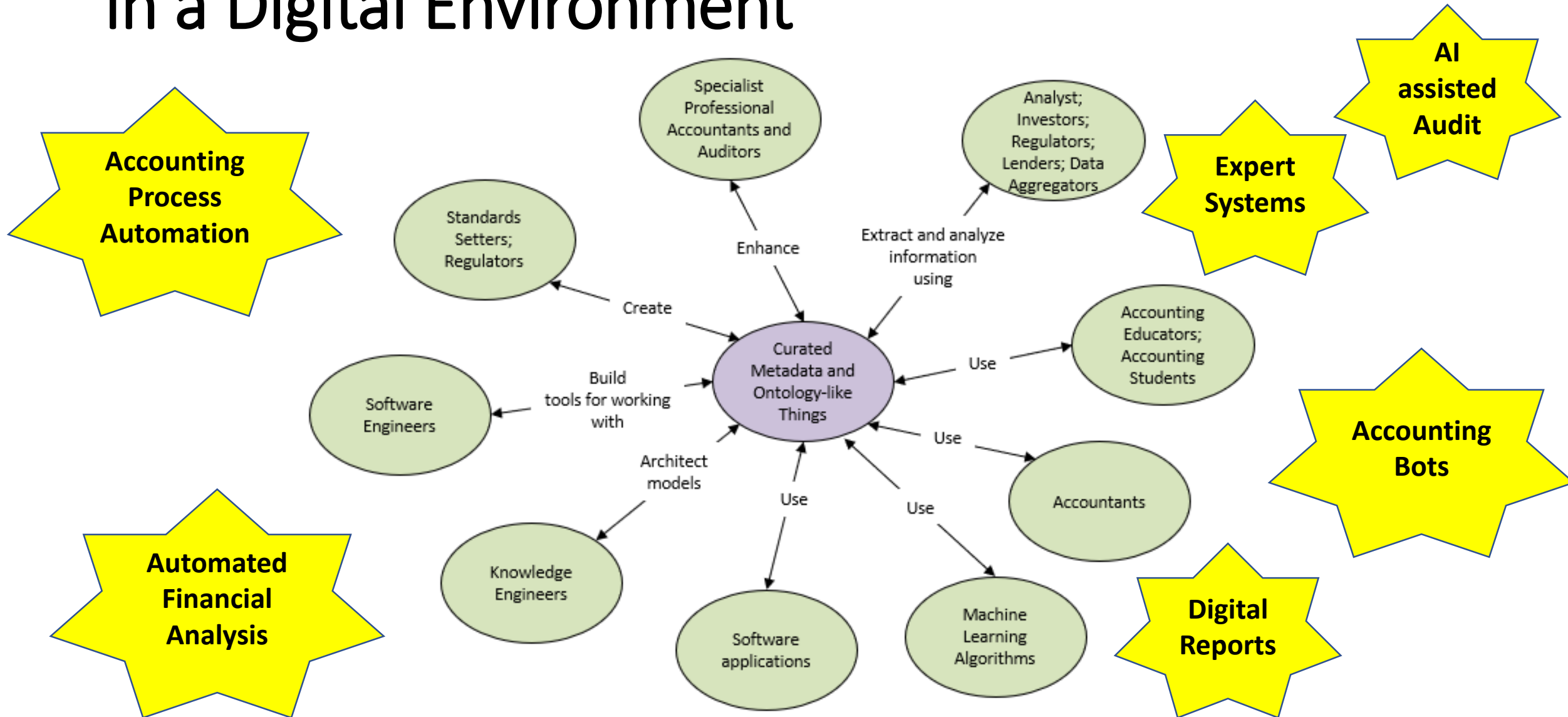
Use Case Example: Financial Report

Two economic entities, A and B, each have information about their financial position and financial performance. They must communicate their information to an **investor** who is making investment decisions which will make use of the combined information so as to draw some conclusions. All three parties (economic entity A, economic entity B, investor) are using a **common set of basic logical principles** (facts, statements, axioms, theorems, deductive reasoning, inductive reasoning, etc.), **common financial reporting standard concepts and relations** (i.e. terms, relations, assertions for US GAAP, IFRS, IPSAS, etc.), and a **common world view** so they should be able to communicate this information fully, so that any inferences which, say, the investor draws from economic entity A's information should also be derivable by economic entity A itself using common basic logical principles, common financial reporting standards (terms, relations, assertions), and common world view; and vice versa; and similarly for the investor and economic entity B.

Financial Report is a Logical System

- Follows patterns of logical and mathematical rules
- Basis is the accounting equation: "Assets = Liabilities and Equity"
- Described by matrix algebra
- Forms a knowledge graph

- I have created a **model**, **framework**, **theory**, **principles** that describe that system and a method for implementing in XBRL. OMG's Standard Business Report Model (**SBRM**) is based on my work in financial reporting.

OMG's Standard Business Report Model (SBRM)

- SBRM formally documents a **logical conceptualization of a business report** in both human-readable and computer-readable models. This enables a machine-readable report represented using any technical syntax (XBRL, RDF, JSON, etc.) to be tested to see if it is consistent with that logical conceptualization using reliable automated processes.

(Oracle is a member of OMG, https://www.omg.org/cgi-bin/apps/membersearch.pl)

http://xbrl.squarespace.com/journal/2019/6/26/understanding-the-role-of-sbrm.html
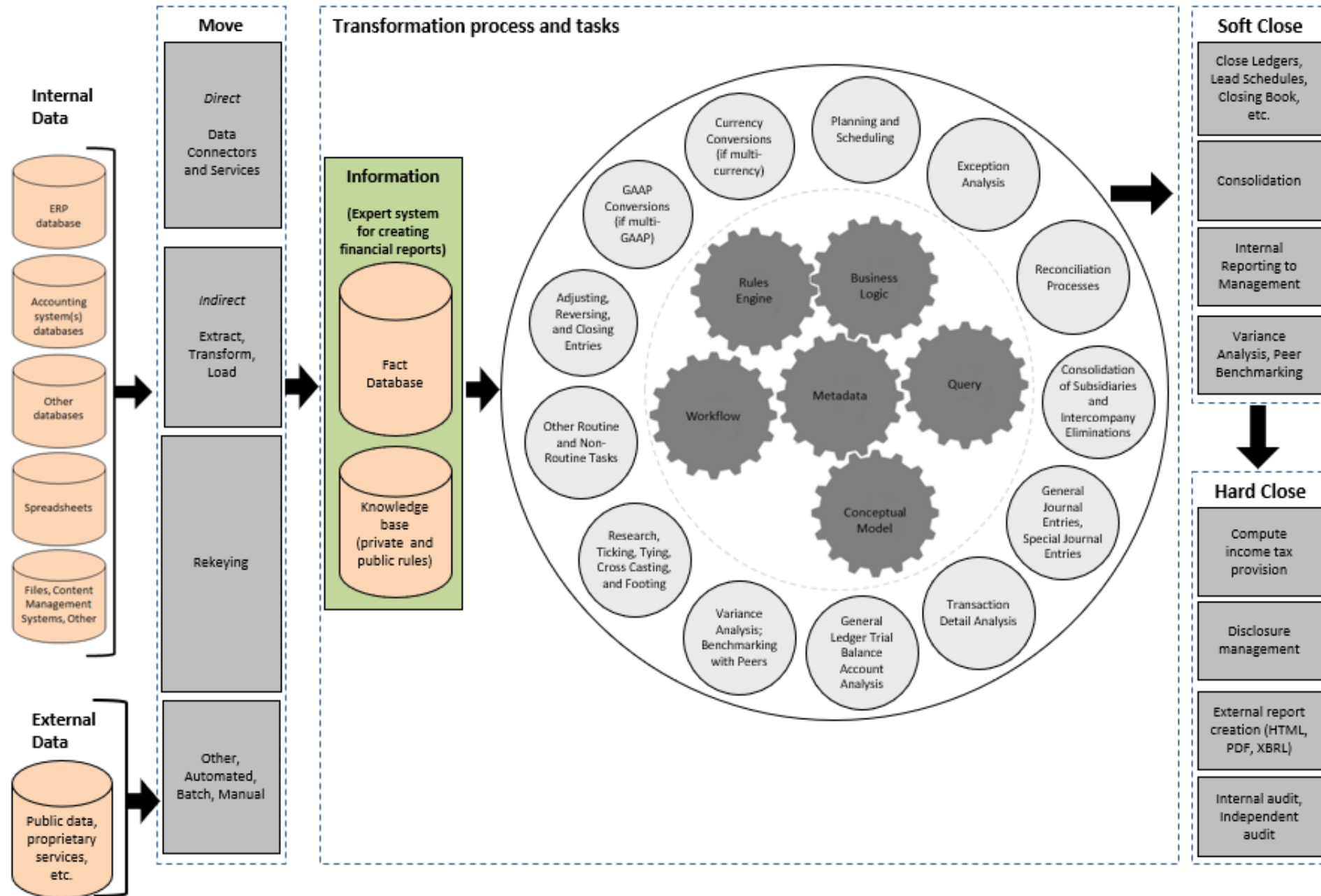
Breaking Down the Pieces of a Financial Report

- **Total reports**: 6,023
- **Total facts reported**: 8,532,275
- **Average facts per report**: 1,416
- **Total networks in all reports**: 462,786
- **Average networks per report**: 77
- **Total fact sets in all reports**: 754,430
- **Average fact sets per report**: 125
- **Average fact sets per network**: 1.6
- **Average facts per network**: 18
- **Average facts per fact set**: 11

Of the 754,430 fact sets there are:

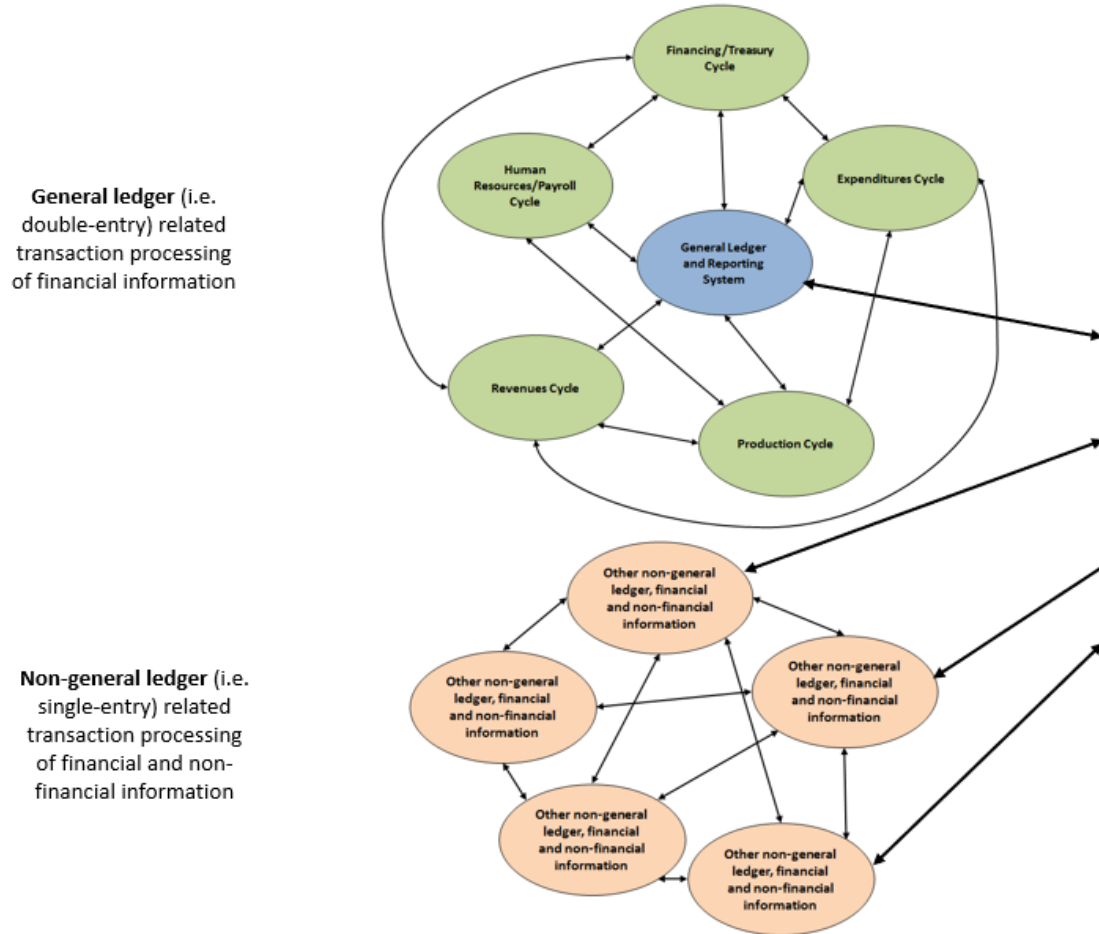- **Text blocks**: 407,392 (54%) are text blocks (Level 1 Notes, Level 2 Policies, Level 3 Disclosures)
- **Sets**: 181,063 (24%) are sets (or hierarchies, no mathematical computations)
- **Roll ups**: 120,708 (16%) are roll ups
- **Roll forwards**: 37,721 (5%) are roll forwards
- **Roll forward info**: 7,546 (1%) are roll forward infos or something else

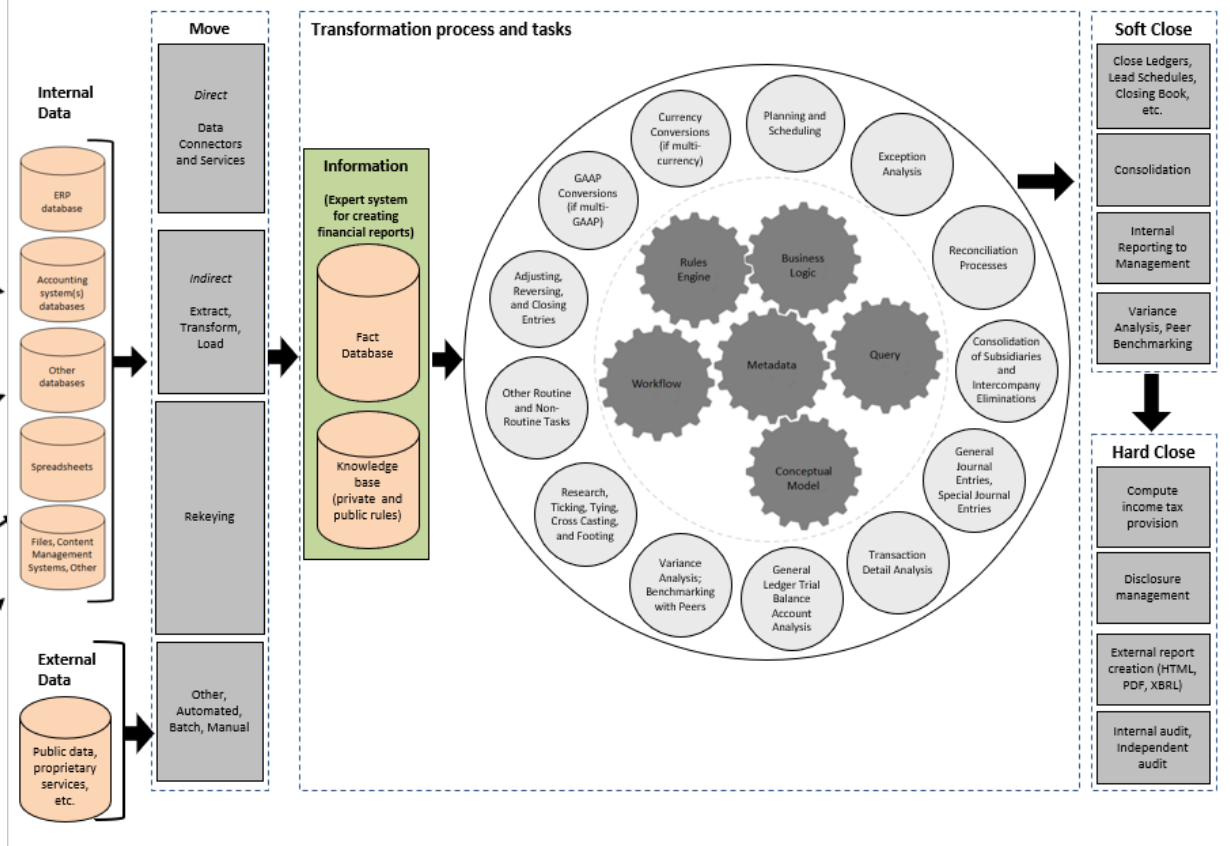If you want to have a look at some fact sets, see **US GAAP** | **IFRS**.

Internal and External Financial Report Creation Process and Tasks (Finance Factory)
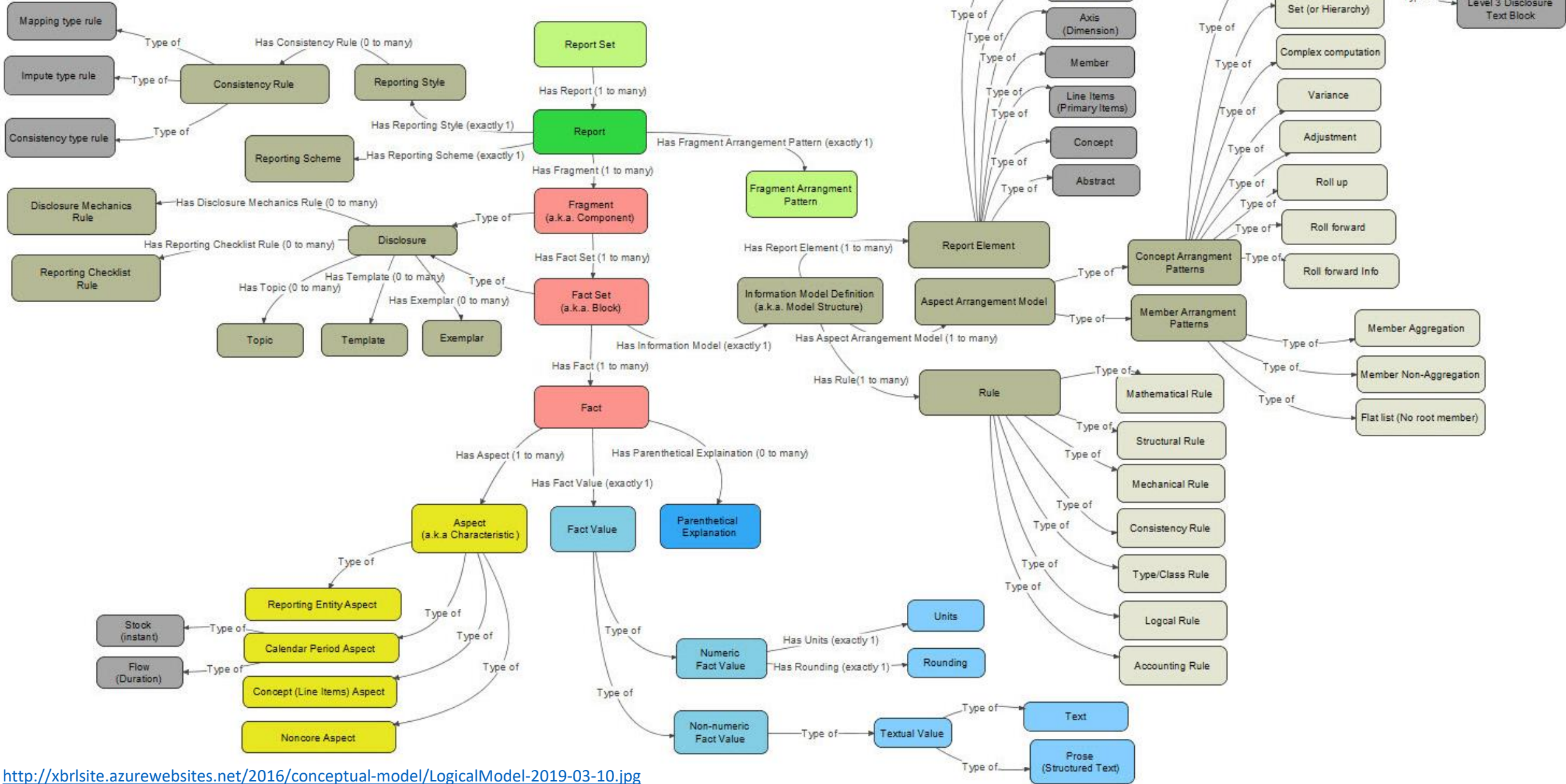
Internal Data

- ERP database
- Accounting system(s) databases
- Other databases
- Spreadsheets
- Files, Content Management Systems, Other

External Data

- Public data, proprietary services, etc.

Move

Direct

Data Connectors and Services

Indirect

Extract, Transform, Load

Rekeying

Other, Automated, Batch, Manual

Transformation process and tasks

Information

(Expert system for creating financial reports)

- Fact Database
- Knowledge base (private and public rules)

Currency Conversions (if multi-currency)

Planning and Scheduling

Exception Analysis

GAAP Conversions (if multi-GAAP)

Adjusting, Reversing, and Closing Entries

Reconciliation Processes

Other Routine and Non-Routine Tasks

Consolidation of Subsidiaries and Intercompany Eliminations

Research, Ticking, Tying, Cross Casting, and Footing

General Journal Entries, Special Journal Entries

Variance Analysis; Benchmarking with Peers

General Ledger Trial Balance Account Analysis

Transaction Detail Analysis

Rules Engine

Business Logic

Workflow

Metadata

Query

Conceptual Model

Soft Close

- Close Ledgers, Lead Schedules, Closing Book, etc.
- Consolidation
- Internal Reporting to Management
- Variance Analysis, Peer Benchmarking

Hard Close

- Compute income tax provision
- Disclosure management
- External report creation (HTML, PDF, XBRL)
- Internal audit, Independent audit

Transaction Cycles Feed Information into Databases and Other Storage Devices

General ledger (i.e. double-entry) related transaction processing of financial information

Non-general ledger (i.e. single-entry) related transaction processing of financial and non-financial information

Internal and External Financial Report Creation Process and Tasks (Finance Factory)

Move

Transformation process and tasks

Soft Close

Close Ledgers, Lead Schedules, Closing Book, etc.

Consolidation

Internal Reporting to Management

Variance Analysis, Peer Benchmarking

Hard Close

Compute income tax provision

Disclosure management

External report creation (HTML, PDF, XBRL)

Internal audit, Independent audit

Internal Data

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Direct — Data Connectors and Services

Indirect — Extract, Transform, Load

Rekeying

Other, Automated, Batch, Manual

Information (Expert system for creating financial reports)

- Fact Database
- Knowledge base (private and public rules)

Transformation tasks: Currency Conversions (if multi-currency); Planning and Scheduling; Exception Analysis; GAAP Conversions (if multi-GAAP); Reconciliation Processes; Adjusting, Reversing, and Closing Entries; Consolidation of Subsidiaries and Intercompany Eliminations; Other Routine and Non-Routine Tasks; General Journal Entries, Special Journal Entries; Research, Ticking, Tying, Cross Casting, and Footing; Transaction Detail Analysis; Variance Analysis; Benchmarking with Peers; General Ledger Trial Balance Account Analysis

Gears: Rules Engine, Business Logic, Workflow, Metadata, Query, Conceptual Model

Transaction cycles: Financing/Treasury Cycle, Human Resources/Payroll Cycle, Expenditures Cycle, General Ledger and Reporting System, Revenues Cycle, Production Cycle

Non-general ledger: Other non-general ledger, financial and non-financial information (multiple)

Lean Six Sigma Philosophies and Techniques; statistical process control

US GAAP Financial Report Ontology-Like Thing

Knowledge Base of Rules

Consistency Rules (US GAAP)

Retrieve information by consistency rule. (List of all Consistency Rules) | (Machine Readable)

Search...

Consistency Rule	Code
⊞ Assets = LiabilitiesAndEquity	BS02
⊞ Assets = (CurrentAssets + FixedAssets + OtherThanFixedNoncurrentAssets)	BS23
⊞ Assets = (CurrentAssets + NoncurrentAssets)	BS03
⊞ Assets = (CurrentAssets + PublicUtilitiesPropertyPlantAndEquipmentNet + OtherNoncurrentAssetsOfRegulatedEntity)	BS43
⊟ ComprehensiveIncomeLoss = (ComprehensiveIncomeLossAttributableToParent + ComprehensiveIncomeLossAttributableToNoncontrollingInterest)	IS09
⊟ ComprehensiveIncomeLoss = (NetIncomeLoss + OtherComprehensiveIncomeLoss)	IS10
⊞ Equity = (EquityAttributableToParent + EquityAttributableToNoncontrollingInterest)	BS01
⊞ GrossProfit = (Revenues - CostOfRevenue)	IS01
⊞ IncomeLossBeforeEquityMethodInvestments = (OperatingIncomeLoss + NonoperatingIncomeLossPlusInterestAndDebtExpense)	IS03
⊞ IncomeLossBeforeEquityMethodInvestments = (OperatingIncomeLoss + NonoperatingIncomeLossPlusInterestAndDebtExpense)	IS33
⊞ IncomeLossFromContinuingOperationsAfterTax = (IncomeLossFromContinuingOperationsBeforeTax - IncomeTaxExpenseBenefit + IncomeLossFromEquityMethodInvestments)	IS25
⊞ IncomeLossFromContinuingOperationsAfterTax = (IncomeLossFromContinuingOperationsBeforeTax - IncomeTaxExpenseBenefit)	IS05

File | Home | Options and Preferences | Tools | View | Knowledge Base | Analysis | Debugging | Windows | Help

Get Started | New | Open | Print | Save

XBRL-based public company financial reports in US GAAP to the SEC

File | Report Profile

XBRL Syntax | Model Structure | EFM Rules | Type or Class Relations | Fundamental Accounting Concepts | Disclosure Mechanics | Reporting Checklist | To Do List

Report Validation Status

Report Properties | Referenced Taxonomies

Properties

Viewer

Application Mode

Instance (msft-20170630.xml) | Taxonomy (msft-20170630.xsd) | Model Structure Validation Result | FAC Validation Result | FAC Taxonomy | FAC Instance (msft-20170630.xml) | Disclosure Mechanics Taxonomy | Disclosure Mechanics Va...

Rendering | Model Structure | Fact Table | Business Rules Structure | Business Rules Validation Results | Elements

Components (128)

○ Network View   ● Component View   ○ Block View

Filter Type | Filter Level | Filter Status

Enter text to filter ...

- ⊞ 100000 - Document - Document and Entity Information ◆ Statement
- ⊞ **100010 - Statement - INCOME STATEMENTS ◆ Statement [Table]**
- ⊞ 100020 - Statement - COMPREHENSIVE INCOME STATEMENTS ◆ Statement [Table]
- ⊞ 100030 - Statement - COMPREHENSIVE INCOME STATEMENTS (Parenthetical) ◆ Statement [Table]
- ⊞ 100040 - Statement - BALANCE SHEETS ◆ Statement [Table]
- ⊞ 100050 - Statement - BALANCE SHEETS (Parenthetical) ◆ Statement
- ⊞ 100060 - Statement - CASH FLOWS STATEMENTS ◆ Statement [Table]
- ⊞ 100070 - Statement - STOCKHOLDERS' EQUITY STATEMENTS ◆ Statement [Table]
- ⊞ 100080 - Disclosure - ACCOUNTING POLICIES ◆ Statement [Table]
- ⊞ 100090 - Disclosure - EARNINGS PER SHARE ◆ Statement [Table]
- ⊞ 100100 - Disclosure - OTHER INCOME (EXPENSE), NET ◆ Statement
- ⊞ 100110 - Disclosure - INVESTMENTS ◆ Statement [Table]
- ⊞ 100120 - Disclosure - DERIVATIVES ◆ Statement [Table]
- ⊞ 100130 - Disclosure - FAIR VALUE MEASUREMENTS ◆ Statement [Table]
- ⊞ 100140 - Disclosure - INVENTORIES ◆ Statement [Table]
- ⊞ 100150 - Disclosure - PROPERTY AND EQUIPMENT ◆ Statement [Table]
- ⊞ 100160 - Disclosure - BUSINESS COMBINATIONS ◆ Statement [Table]
- ⊞ 100170 - Disclosure - GOODWILL ◆ Statement [Table]
- ⊞ 100180 - Disclosure - INTANGIBLE ASSETS ◆ Statement [Table]
- ⊞ 100190 - Disclosure - DEBT ◆ Statement [Table]
- ⊞ 100200 - Disclosure - INCOME TAXES ◆ Statement [Table]
- ⊞ 100210 - Disclosure - RESTRUCTURING CHARGES ◆ Statement [Table]
- ⊞ 100220 - Disclosure - UNEARNED REVENUE ◆ Statement [Table]

Component Properties

Network	100010 - Statement - INCOME STAT...
Table	Statement [Table]
Disclosure	disclosures:IncomeStatement
Confidence	HIGH
Status	InProgress

Collections

Advanced

Component: (Network and Table)

Network	100010 - Statement - **INCOME STATEMENTS**
Table	Statement [Table]

Reporting Entity [Axis]		0000789019 http://www.sec.gov/CIK
Legal Entity [Axis]		Entity [Domain]

Period [Axis]

Statement [Line Items]	Unit [Axis]	2016-07-01/2017-06-30	2015-07-01/2016-06-30	2014-07-01/2015-06-30
Revenue				
Product	USD	57,190,000,000	61,502,000,000	75,956,000,000
Service and other	USD	32,760,000,000	23,818,000,000	17,624,000,000
Total revenue	USD	89,950,000,000 [1,2]	85,320,000,000 [3]	93,580,000,000
Cost of revenue				
Product	USD	15,175,000,000	17,880,000,000	21,410,000,000
Service and other	USD	19,086,000,000	14,900,000,000	11,628,000,000
Total cost of revenue	USD	34,261,000,000	32,780,000,000	33,038,000,000
Gross margin	USD	55,689,000,000 [1]	52,540,000,000	60,542,000,000
Research and development	USD	13,037,000,000	11,988,000,000	12,046,000,000
Sales and marketing	USD	15,539,000,000	14,697,000,000	15,713,000,000
General and administrative	USD	4,481,000,000	4,563,000,000	4,611,000,000
Impairment, integration, and restructuring	USD	306,000,000	1,110,000,000	10,011,000,000
Operating income	USD	22,326,000,000 [1]	20,182,000,000	18,161,000,000
Other income (expense), net	USD	823,000,000	(431,000,000)	346,000,000
Income before income taxes	USD	23,149,000,000	19,751,000,000	18,507,000,000
Provision for income taxes	USD	1,945,000,000	2,953,000,000	6,314,000,000
Net income	USD	21,204,000,000 [1,4]	16,798,000,000 [5]	12,193,000,000
Earnings per share:				
Basic	USD / shares	2.74 [1]	2.12	1.49
Diluted	USD / shares	2.71 [1,4]	2.10 [5]	1.48
Weighted average shares outstanding:				
Basic	shares	7,746,000,000	7,925,000,000	8,177,000,000
Diluted	shares	7,832,000,000	8,013,000,000	8,254,000,000
Cash dividends declared per common share	USD / shares	2	1	1

http://xbrl.squarespace.com/journal/2019/3/23/summary-of-human-readable-renderings.html

Message List | Console

One *Presentation* is Really Four *Representations* of Information
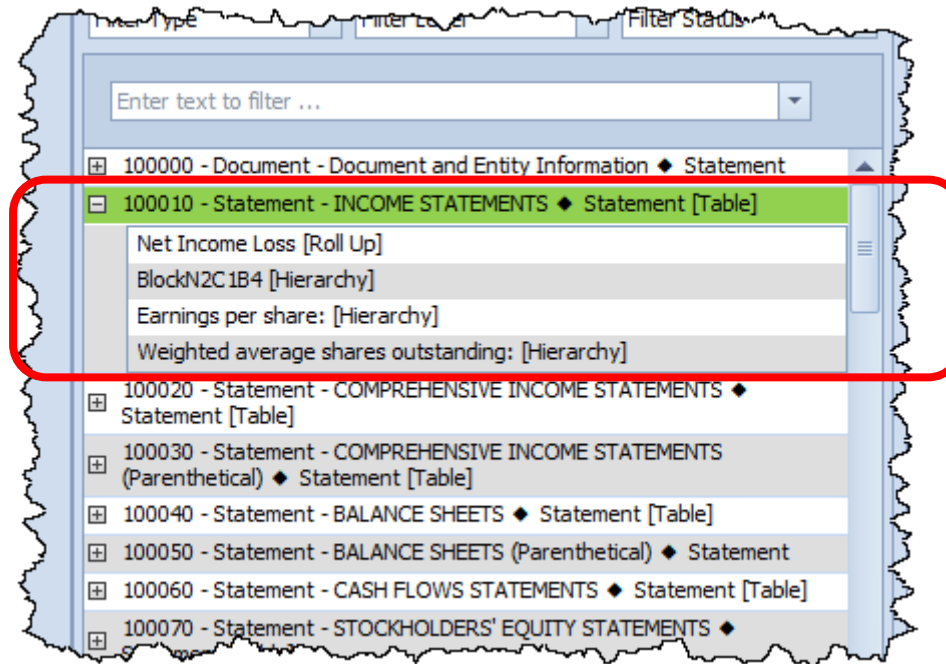
Software Uses and Even Identifies Representations

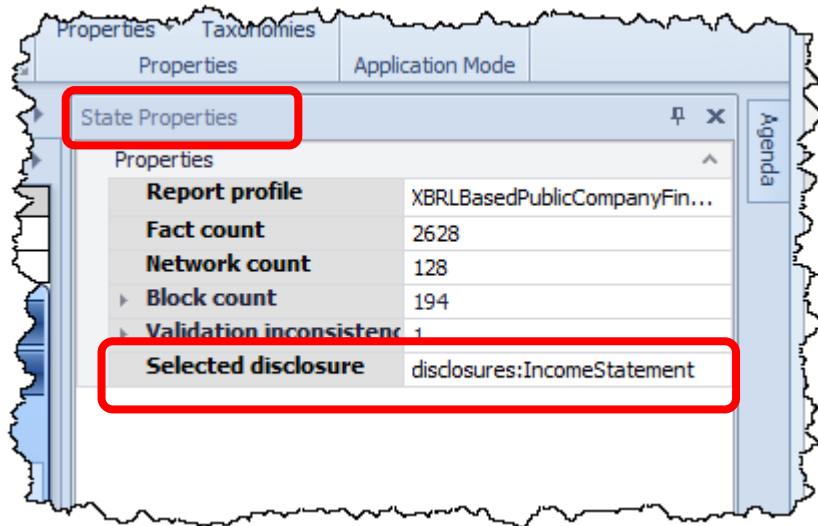| Label	Report Element Class	Period	Balance	Preferred L...	Name
Statement [Table]	[Table]			Terse Label	us-gaap:StatementTable
Legal Entity [Axis]	[Axis]			Terse Label	dei:LegalEntityAxis
Entity [Domain]	[Member]			Terse Label	dei:EntityDomain
Statement [Line Items]	[LineItems]			Terse Label	us-gaap:StatementLineItems
Revenue	[Abstract]			Terse Label	us-gaap:SalesRevenueNetAbstract
Cost of revenue	[Abstract]			Terse Label	us-gaap:CostOfRevenueAbstract
Gross margin	[Concept] Monetary	For Period	Credit	Total Label	us-gaap:GrossProfit
Research and development	[Concept] Monetary	For Period	Debit	Terse Label	us-gaap:ResearchAndDevelopmentExpense
Sales and marketing	[Concept] Monetary	For Period	Debit	Terse Label	us-gaap:SellingAndMarketingExpense
General and administrative	[Concept] Monetary	For Period	Debit	Terse Label	us-gaap:GeneralAndAdministrativeExpense
Impairment, integration, and restructuring	[Concept] Monetary	For Period	Debit	Terse Label	msft:ImpairmentIntegrationAndRestructuringExpenses
Operating income	[Concept] Monetary	For Period	Credit	Total Label	us-gaap:OperatingIncomeLoss
Other income (expense), net	[Concept] Monetary	For Period	Credit	Terse Label	us-gaap:NonoperatingIncomeExpense
Income before income taxes	[Concept] Monetary	For Period	Credit	Total Label	us-gaap:IncomeLossFromContinuingOperationsBeforeIncomeTaxesMino
Provision for income taxes	[Concept] Monetary	For Period	Debit	Terse Label	us-gaap:IncomeTaxExpenseBenefit
Net income	[Concept] Monetary	For Period	Credit	Total Label	us-gaap:NetIncomeLoss
Earnings per share:	[Abstract]			Terse Label	us-gaap:EarningsPerShareAbstract
Basic	[Concept] Share	For Period		Terse Label	us-gaap:EarningsPerShareBasic
Diluted	[Concept] Share	For Period		Terse Label	us-gaap:EarningsPerShareDiluted
Weighted average shares outstanding:	[Abstract]			Terse Label	us-gaap:WeightedAverageNumberOfSharesOutstandingAbstract
Basic	[Concept] Shares	For Period		Terse Label	us-gaap:WeightedAverageNumberOfSharesOutstandingBasic
Diluted	[Concept] Shares	For Period		Terse Label	us-gaap:WeightedAverageNumberOfDilutedSharesOutstanding
Cash dividends declared per common share	[Concept] Share	For Period		Terse Label	us-gaap:CommonStockDividendsPerShareDeclared

Net Income roll Up

Earnings Per Share

Weighted Average Shares

Other

State Machine

Properties	
Report profile	XBRLBasedPublicCompanyFinancialReportsInUSGAAPToSEC
Fact count	2628
Network count	128
Block count	194
Level 1 Note Text Blocks	22
Level 2 Policy Text Blocks	23
Level 3 Disclosure Text Blocks	47
Level 4 Disclosure Details	102
Roll Ups	32
Roll Forwards	9
Hierarchy	60
Roll Forward Info	1
Adjustments	0
Variances	0
Unknown	0
Unknown	0
Validation inconsistencies	1
XBRL Syntax	0
Model Structure	0
EFM Rules	0
Type or Class Relations	0
Fundamental Accounting Conc	0
Disclosure Mechanics	0
Reporting Checklist	1
To Do List	0
Selected disclosure	disclosures:IncomeStatement

Agenda

Reporting Checklist

#		Disclosure	Checklist Category	Reason Disclosure Must Exist	Discovered	Expectation Met	Link to Disclosure Mechanics
0		Reporting Checklist					
	1	Document Information [Hierarchy]	Required disclosure	Disclosure always required	True	CONSISTENT	Document Information [Hierarchy]
	2	Document and Entity Information [Hierarchy]	Alternative representation	Not necessary, satisfied by Document Information [Hierarchy] disclosure	True	N/A	Document and Entity Information [Hierarchy]
	3	Entity Information, by Legal Entity [Hierarchy]	Required disclosure	Disclosure always required	True	CONSISTENT	Entity Information, by Legal Entity [Hierarchy]
	4	Document and Entity Information [Hierarchy]	Alternative representation	Not necessary, satisfied by Entity Information, by Legal Entity [Hierarchy] discl...	True	N/A	Document and Entity Information [Hierarchy]
	5	Balance Sheet	Required disclosure	Disclosure always required, satisfied by Assets [Roll Up] and Liabilities and Equi...	True	CONSISTENT	Balance Sheet
	6	Assets [Roll Up]	Part of disclosure	Satisfies Balance Sheet disclosure	True	CONSISTENT	Assets [Roll Up]
	7	Liabilities and Equity [Roll Up]	Part of disclosure	Satisfies Balance Sheet disclosure	True	CONSISTENT	Liabilities and Equity [Roll Up]
	8	Income Statement, by Legal Entity [Roll Up]	Required disclosure	Disclosure always required	True	CONSISTENT	Income Statement, by Legal Entity [Roll Up]
	9	Statement of Income and Comprehensive Income [Roll Up]	Alternative representation	Not necessary, satisfied by Income Statement, by Legal Entity [Roll Up] disclos...	True	N/A	Statement of Income and Comprehensive Income [Roll Up]
	10	Statement of Comprehensive Income [Roll Up]	Required disclosure	Disclosure always required	True	CONSISTENT	Statement of Comprehensive Income [Roll Up]
	11	Statement of Income and Comprehensive Income [Roll Up]	Alternative representation	Not necessary, satisfied by Statement of Comprehensive Income [Roll Up] discl...	True	N/A	Statement of Income and Comprehensive Income [Roll Up]
	12	Cash Flow Statement [Roll Forward]	Required disclosure	Disclosure always required	True	CONSISTENT	Cash Flow Statement [Roll Forward]
	13	Statement of Changes in Equity [Roll Forward]	Required disclosure	Disclosure always required	True	CONSISTENT	Statement of Changes in Equity [Roll Forward]
	14	Nature of Operations Note [Note Level]	Required disclosure	Disclosure always required	False	INCONSISTENT	Nature of Operations Note [Note Level]
	15	Basis of Reporting Note [Note Level]	Required disclosure	Disclosure always required	True	CONSISTENT	Basis of Reporting Note [Note Level]
	16	Significant Accounting Policies Note [Note Level]	Required disclosure	Disclosure always required	True	CONSISTENT	Significant Accounting Policies Note [Note Level]
	17	Revenue Recognition Policy [Policy Text Block]	Required disclosure	Disclosure always required	True	CONSISTENT	Revenue Recognition Policy [Policy Text Block]
	18	Inventory, Net (Current) [Roll Up]	Line item exists, then disclosure requi...	Required because line item us-gaap:InventoryNet was reported	True	CONSISTENT	Inventory, Net (Current) [Roll Up]
	19	Property, Plant and Equipment, Net, by Type [Roll Up]	Line item exists, then disclosure requi...	Required because line item us-gaap:PropertyPlantAndEquipmentNet was repor...	True	CONSISTENT	Property, Plant and Equipment, Net, by Type [Roll Up]
	20	Property, Plant and Equipment, Net, by Type [Roll Up] (A...	Alternative representation	Not necessary, satisfied by Property, Plant and Equipment, Net, by Type [Roll ...	True	N/A	Property, Plant and Equipment, Net, by Type [Roll Up] (A...
	21	Property, Plant and Equipment Useful Lives, by Type [Hier...	Line item exists, then disclosure requi...	Required because line item us-gaap:PropertyPlantAndEquipmentNet was repor...	True	CONSISTENT	Property, Plant and Equipment Useful Lives, by Type [Hier...
	22	Finite-lived Intangible Assets, Net, by Major Class [Roll Up]	Line item exists, then disclosure requi...	Required because line item us-gaap:FiniteLivedIntangibleAssetsNet was reported	True	CONSISTENT	Finite-lived Intangible Assets, Net, by Major Class [Roll Up]
	23	Finite-lived Intangible Assets, by Major Class [Hierarchy]	Alternative representation	Not necessary, satisfied by Finite-lived Intangible Assets, Net, by Major Class [...	True	N/A	Finite-lived Intangible Assets, by Major Class [Hierarchy]
	24	Finite-lived Intangible Assets, Estimated Useful Lives, by ...	Line item exists, then disclosure requi...	Required because line item us-gaap:FiniteLivedIntangibleAssetsNet was reported	True	CONSISTENT	Finite-lived Intangible Assets, Estimated Useful Lives, by ...
	25	Finite-lived Intangible Assets, Future Amortization Expens...	Possible disclosure	Disclosure is present	True	CONSISTENT	Finite-lived Intangible Assets, Future Amortization Expens...
	26	Finite-lived Intangible Assets, Future Amortization Expens...	Alternative representation	Not necessary, satisfied by Finite-lived Intangible Assets, Future Amortization ...	True	N/A	Finite-lived Intangible Assets, Future Amortization Expens...
	27	Indefinite-lived Intangible Assets, by Major Class [Roll Up]	Line item exists, then disclosure requi...	NOT required, because line item us-gaap:IndefiniteLivedIntangibleAssetsExclu...	False	N/A	Indefinite-lived Intangible Assets, by Major Class [Roll Up]
	28	Goodwill [Roll Forward]	Line item exists, then disclosure requi...	Required because line item us-gaap:Goodwill was reported	True	CONSISTENT	Goodwill [Roll Forward]
	29	Goodwill, by Business Segment [Hierarchy]	Alternative representation	Not necessary, satisfied by Goodwill [Roll Forward] disclosure	True	N/A	Goodwill, by Business Segment [Hierarchy]
	30	Product Warranty Liability [Roll Forward]	Line item exists, then disclosure requi...	NOT required, because line item us-gaap:ProductWarrantyAccrual WAS NOT F...	False	N/A	Product Warranty Liability [Roll Forward]
	31	Long-term Debt Maturities [Roll Up]	Line item exists, then disclosure requi...	Required because line item us-gaap:LongTermDebt was reported	True	CONSISTENT	Long-term Debt Maturities [Roll Up]
	32	Long-term Debt Maturities [Hierarchy]	Alternative representation	Not necessary, satisfied by Long-term Debt Maturities [Roll Up] disclosure	True	N/A	Long-term Debt Maturities [Hierarchy]
	33	Long-term Debt Instruments, by Instrument [Hierarchy]	Line item exists, then disclosure requi...	Required because line item us-gaap:LongTermDebt was reported	True	CONSISTENT	Long-term Debt Instruments, by Instrument [Hierarchy]
	34	Long-term Debt Instruments, by Instrument [Roll Up]	Alternative representation	Not necessary, satisfied by Long-term Debt Instruments, by Instrument [Hiera...	True	N/A	Long-term Debt Instruments, by Instrument [Roll Up]
	35	Deferred Tax Assets and Liabilities [Roll Up]	Line item exists, then disclosure requi...	Required because line item us-gaap:DeferredTaxAssetsLiabilitiesNet was repor...	True	CONSISTENT	Deferred Tax Assets and Liabilities [Roll Up]
	36	Reconciliation of Statutory to Effective Income Tax Rate, ...	Line item exists, then disclosure requi...	Required because line item us-gaap:IncomeTaxExpenseBenefit was reported	True	CONSISTENT	Reconciliation of Statutory to Effective Income Tax Rate, ...
	37	Income Tax Expense (Benefit), Current and Deferred Det...	Line item exists, then disclosure requi...	Required because line item us-gaap:IncomeTaxExpenseBenefit was reported	True	CONSISTENT	Income Tax Expense (Benefit), Current and Deferred Det...
	38	Income before Income Tax, Domestic and Foreign [Roll Up]	Line item exists, then disclosure requi...	Required because line item us-gaap:IncomeLossFromContinuingOperationsBef...	True	CONSISTENT	Income before Income Tax, Domestic and Foreign [Roll Up]
	39	Unrecognized Tax Benefits, Excluding Amounts Pertaining ...	Possible disclosure	Disclosure is present	True	CONSISTENT	Unrecognized Tax Benefits, Excluding Amounts Pertaining ...
	40	Restructuring Reserve, by Type of Cost [Roll Forward]	Line item exists, then disclosure requi...	Required because line item us-gaap:RestructuringReserve was reported	True	CONSISTENT	Restructuring Reserve, by Type of Cost [Roll Forward]

Disclosure Mechanics

Fundamental Accounting Concept Relations

Entity	Period	ID	Test	Result	Amount Of Inconsistency	Evaluation
0000789019	2017-FY	FAC_CONSISTENCY_1	fac:Equity = (fac:EquityAttributableToParent + fac:EquityAttributableToNoncontrollingInterest)	True	0	fac:Equity[72,394,000,000] = (fac:EquityAttributableToParent[us-gaap:StockholdersEquity[72,394,000,000]] + fac:EquityAttributableToNoncontrollingInterest[0])
0000789019	2017-FY	FAC_CONSISTENCY_10	fac:NetCashFlowFromInvestingActivities = (fac:NetCashFlowFromInvestingActivitiesContinuing + fac:NetCashFlowFromInvestingActivitiesDiscontinued)	True	0	fac:NetCashFlowFromInvestingActivities[(46,781,000,000)] = (fac:NetCashFlowFromInvestingActivitiesContinuing[us-gaap:NetCashProvidedByUsedInInvestingActivitiesContinuingOperations[(46,781,000,000)]] + fac:NetCashFlowFromInvestingActivitiesDiscontinued[0])
0000789019	2017-FY	FAC_CONSISTENCY_11	fac:NetCashFlowFromFinancingActivities = (fac:NetCashFlowFromFinancingActivitiesContinuing + fac:NetCashFlowFromFinancingActivitiesDiscontinued)	True	0	fac:NetCashFlowFromFinancingActivities[8,408,000,000] = (fac:NetCashFlowFromFinancingActivitiesContinuing[us-gaap:NetCashProvidedByUsedInFinancingActivitiesContinuingOperations[8,408,000,000]] + fac:NetCashFlowFromFinancingActivitiesDiscontinued[0])
0000789019	2017-FY	FAC_CONSISTENCY_12	fac:GrossProfit = (fac:Revenues - fac:CostOfRevenue)	True	0	fac:GrossProfit[us-gaap:GrossProfit[55,689,000,000]] = (fac:Revenues[us-gaap:SalesRevenueNet[89,950,000,000]] - fac:CostOfRevenue[us-gaap:CostOfRevenue[34,261,000,000]])
0000789019	2017-FY	FAC_CONSISTENCY_13	fac:OperatingIncomeLoss = (fac:GrossProfit - fac:OperatingExpenses)	True	0	fac:OperatingIncomeLoss[us-gaap:OperatingIncomeLoss[22,326,000,000]] = (fac:GrossProfit[us-gaap:GrossProfit[55,689,000,000]] - fac:OperatingExpenses[33,363,000,000]])
0000789019	2017-FY	FAC_CONSISTENCY_15	fac:IncomeLossFromContinuingOperationsBeforeTax = (fac:OperatingIncomeLoss + fac:NonoperatingIncomePlusInterestAndDebtExpensePlusIncomeFromEquityMethodInvestments)	True	0	fac:IncomeLossFromContinuingOperationsBeforeTax[us-gaap:IncomeLossFromContinuingOperationsBeforeIncomeTaxesMinorityInterestAndIncomeLossFromEquityMethodInvestments[23,149,000,000]] = (fac:OperatingIncomeLoss[us-gaap:OperatingIncomeLoss[22,326,000,000]] + fac:NonoperatingIncomePlusInterestAndDebtExpensePlusIncomeFromEquityMethodInvestments[823,000,000])
0000789019	2017-FY	FAC_CONSISTENCY_16	fac:IncomeLossFromContinuingOperationsAfterTax = (fac:IncomeLossFromContinuingOperationsBeforeTax - fac:IncomeTaxExpenseBenefit)	True	0	fac:IncomeLossFromContinuingOperationsAfterTax[21,204,000,000] = (fac:IncomeLossFromContinuingOperationsBeforeTax[us-gaap:IncomeLossFromContinuingOperationsBeforeIncomeTaxesMinorityInterestAndIncomeLossFromEquityMethodInvestments[23,149,000,000]] - fac:IncomeTaxExpenseBenefit[us-gaap:IncomeTaxExpenseBenefit[1,945,000,000]])
0000789019	2017-FY	FAC_CONSISTENCY_17	fac:NetIncomeLoss = (fac:IncomeLossFromContinuingOperationsAfterTax + fac:IncomeLossFromDiscontinuedOperationsNetOfTax + fac:ExtraordinaryItemsOfIncomeExpenseNetOfTax)	True	0	fac:NetIncomeLoss[21,204,000,000] = (fac:IncomeLossFromContinuingOperationsAfterTax[21,204,000,000] + fac:IncomeLossFromDiscontinuedOperationsNetOfTax[0] + fac:ExtraordinaryItemsOfIncomeExpenseNetOfTax[0])
0000789019	2017-FY	FAC_CONSISTENCY_18	fac:NetIncomeLoss = (fac:NetIncomeLossAttributableToParent + fac:NetIncomeLossAttributableToNoncontrollingInterest)	True	0	fac:NetIncomeLoss[21,204,000,000] = (fac:NetIncomeLossAttributableToParent[us-gaap:NetIncomeLoss[21,204,000,000]] + fac:NetIncomeLossAttributableToNoncontrollingInterest[0])
0000789019	2017-FY	FAC_CONSISTENCY_19	fac:NetIncomeLossAvailableToCommonStockholdersBasic = (fac:NetIncomeLossAttributableToParent - fac:PreferredStockDividendsAndOtherAdjustments)	True	0	fac:NetIncomeLossAvailableToCommonStockholdersBasic[21,204,000,000] = (fac:NetIncomeLossAttributableToParent[us-gaap:NetIncomeLoss[21,204,000,000]] - fac:PreferredStockDividendsAndOtherAdjustments[0])
0000789019	2017-FY	FAC_CONSISTENCY_2	fac:Assets = fac:LiabilitiesAndEquity	True	0	fac:Assets[us-gaap:Assets[241,086,000,000]] = fac:LiabilitiesAndEquity[us-gaap:LiabilitiesAndStockholdersEquity[241,086,000,000]]
0000789019	2017-FY	FAC_CONSISTENCY_20	fac:ComprehensiveIncomeLoss = (fac:ComprehensiveIncomeLossAttributableToParent + fac:ComprehensiveIncomeLossAttributableToNoncontrollingInterest)	True	0	fac:ComprehensiveIncomeLoss[20,098,000,000] = (fac:ComprehensiveIncomeLossAttributableToParent[us-gaap:ComprehensiveIncomeNetOfTax[20,098,000,000]] + fac:ComprehensiveIncomeLossAttributableToNoncontrollingInterest[0])
0000789019	2017-FY	FAC_CONSISTENCY_21	fac:ComprehensiveIncomeLoss = (fac:NetIncomeLoss + fac:OtherComprehensiveIncomeLoss)	True	0	fac:ComprehensiveIncomeLoss[20,098,000,000] = (fac:NetIncomeLoss[21,204,000,000] + fac:OtherComprehensiveIncomeLoss[(1,106,000,000)])
0000789019	2017-FY	FAC_CONSISTENCY_3	fac:Assets = (fac:CurrentAssets + fac:NoncurrentAssets)	True	0	fac:Assets[us-gaap:Assets[241,086,000,000]] = (fac:CurrentAssets[us-gaap:AssetsCurrent[159,851,000,000]] + fac:NoncurrentAssets[81,235,000,000])
0000789019	2017-FY	FAC_CONSISTENCY_4	fac:Liabilities = (fac:CurrentLiabilities + fac:NoncurrentLiabilities)	True	0	fac:Liabilities[us-gaap:Liabilities[168,692,000,000]] = (fac:CurrentLiabilities[us-gaap:LiabilitiesCurrent[64,527,000,000]] + fac:NoncurrentLiabilities[104,165,000,000])
0000789019	2017-FY	FAC_CONSISTENCY_5	fac:LiabilitiesAndEquity = (fac:Liabilities + fac:CommitmentsAndContingencies + fac:TemporaryEquity + fac:Equity)	True	0	fac:LiabilitiesAndEquity[us-gaap:LiabilitiesAndStockholdersEquity[241,086,000,000]] = (fac:Liabilities[us-gaap:Liabilities[168,692,000,000]] + fac:CommitmentsAndContingencies[us-gaap:CommitmentsAndContingencies[0]] + fac:TemporaryEquity[0] + fac:Equity[72,394,000,000])
0000789019	2017-FY	FAC_CONSISTENCY_50	fac:NetCashFlow = (fac:NetCashFlowContinuing + fac:NetCashFlowDiscontinued + fac:ExchangeGainsLosses)	True	0	fac:NetCashFlow[us-gaap:CashAndCashEquivalentsPeriodIncreaseDecrease[1,153,000,000]] = (fac:NetCashFlowContinuing[1,134,000,000] + fac:NetCashFlowDiscontinued[0] + fac:ExchangeGainsLosses[us-gaap:EffectOfExchangeRateOnCashAndCashEquivalents[19,000,000]])
0000789019	2017-FY	FAC_CONSISTENCY_6	fac:NetCashFlow = (fac:NetCashFlowFromOperatingActivities + fac:NetCashFlowFromInvestingActivities + fac:NetCashFlowFromFinancingActivities + fac:ExchangeGainsLosses)	True	0	fac:NetCashFlow[us-gaap:CashAndCashEquivalentsPeriodIncreaseDecrease[1,153,000,000]] = (fac:NetCashFlowFromOperatingActivities[39,507,000,000] + fac:NetCashFlowFromInvestingActivities[(46,781,000,000)] + fac:NetCashFlowFromFinancingActivities[8,408,000,000] + fac:ExchangeGainsLosses[us-gaap:EffectOfExchangeRateOnCashAndCashEquivalents[19,000,000]])
0000789019	2017-FY	FAC_CONSISTENCY_7	fac:NetCashFlowContinuing = (fac:NetCashFlowFromOperatingActivitiesContinuing + fac:NetCashFlowFromInvestingActivitiesContinuing + fac:NetCashFlowFromFinancingActivitiesContinuing)	True	0	fac:NetCashFlowContinuing[1,134,000,000] = (fac:NetCashFlowFromOperatingActivitiesContinuing[us-gaap:NetCashProvidedByUsedInOperatingActivitiesContinuingOperations[39,507,000,000]] + fac:NetCashFlowFromInvestingActivitiesContinuing[us-gaap:NetCashProvidedByUsedInInvestingActivitiesContinuingOperations[(46,781,000,000)]] + fac:NetCashFlowFromFinancingActivitiesContinuing[us-gaap:NetCashProvidedByUsedInFinancingActivitiesContinuingOperations[8,408,000,000]])
0000789019	2017-FY	FAC_CONSISTENCY_8	fac:NetCashFlowDiscontinued = (fac:NetCashFlowFromOperatingActivitiesDiscontinued + fac:NetCashFlowFromInvestingActivitiesDiscontinued + fac:NetCashFlowFromFinancingActivitiesDiscontinued)	True	0	fac:NetCashFlowDiscontinued[0] = (fac:NetCashFlowFromOperatingActivitiesDiscontinued[0] + fac:NetCashFlowFromInvestingActivitiesDiscontinued[0] + fac:NetCashFlowFromFinancingActivitiesDiscontinued[0])
0000789019	2017-FY	FAC_CONSISTENCY_9	fac:NetCashFlowFromOperatingActivities = (fac:NetCashFlowFromOperatingActivitiesContinuing + fac:NetCashFlowFromOperatingActivitiesDiscontinued)	True	0	fac:NetCashFlowFromOperatingActivities[39,507,000,000] = (fac:NetCashFlowFromOperatingActivitiesContinuing[us-gaap:NetCashProvidedByUsedInOperatingActivitiesContinuingOperations[39,507,000,000]] + fac:NetCashFlowFromOperatingActivitiesDiscontinued[0])

Good Old-Fashioned Expert System
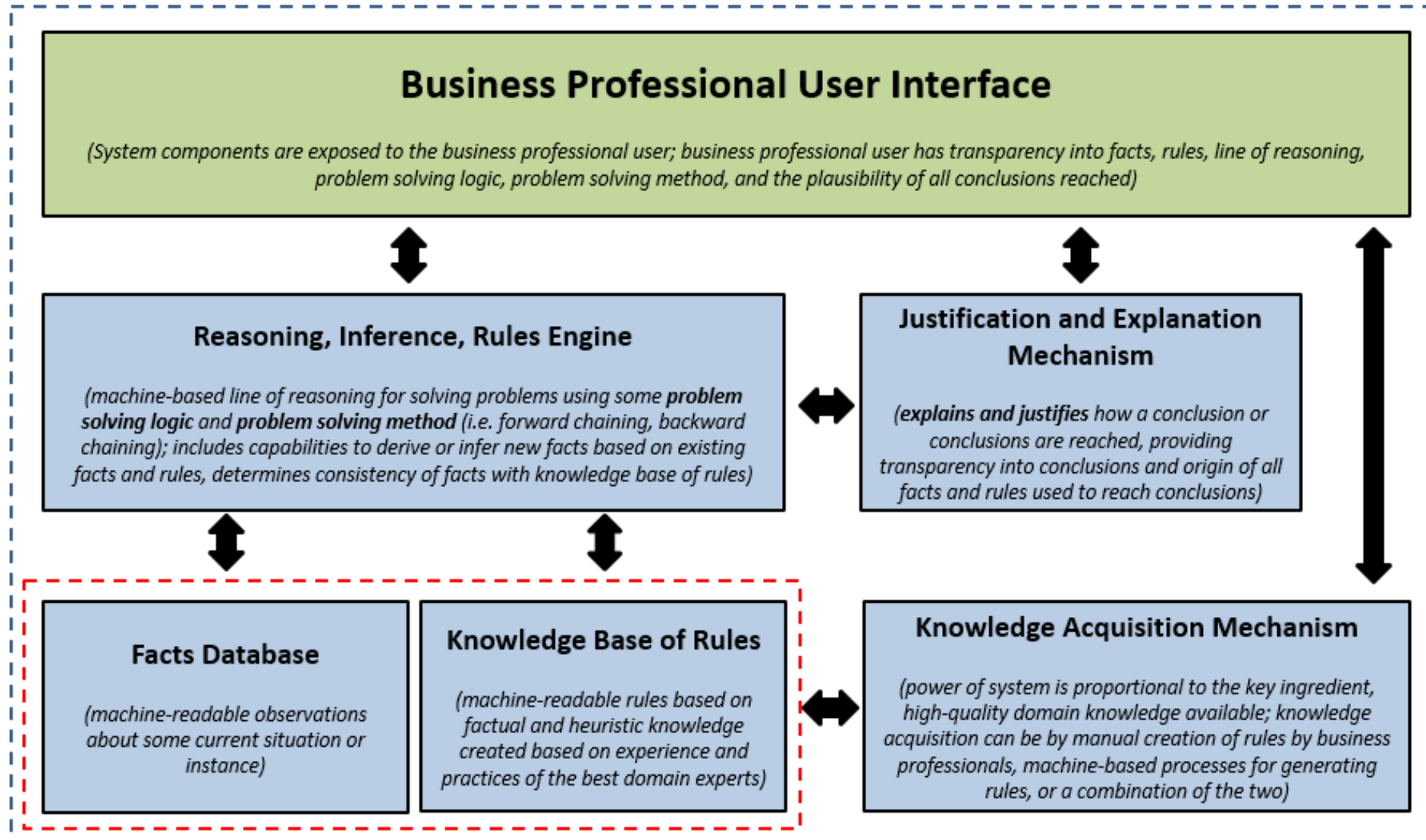
Artificial Intelligence is Supercharged by Curated Metadata

- PWC, KPMG, Deloitte, EY: "The **Fourth Industrial Revolution**"
- Deloitte, "The Finance Factory"
- **Accounting, reporting, auditing, and analysis in a digital environment**.
- "Our entire AI revolution is built on a correlation **house of cards**."
- "Machine learning needs to move beyond **cheap parlor tricks** towards solutions that can truly advance society."
- "AI is brought to life by taxonomies and ontologies."
  - "Data is the new oil."
  - "Metadata is the new gold."
  - Crude oil, gasoline, **racing fuel**
- "AI that professional accountants find useful and will understand."