United Nations | Department of Economic and Social Affairs
Statistics

SDMX Information Model

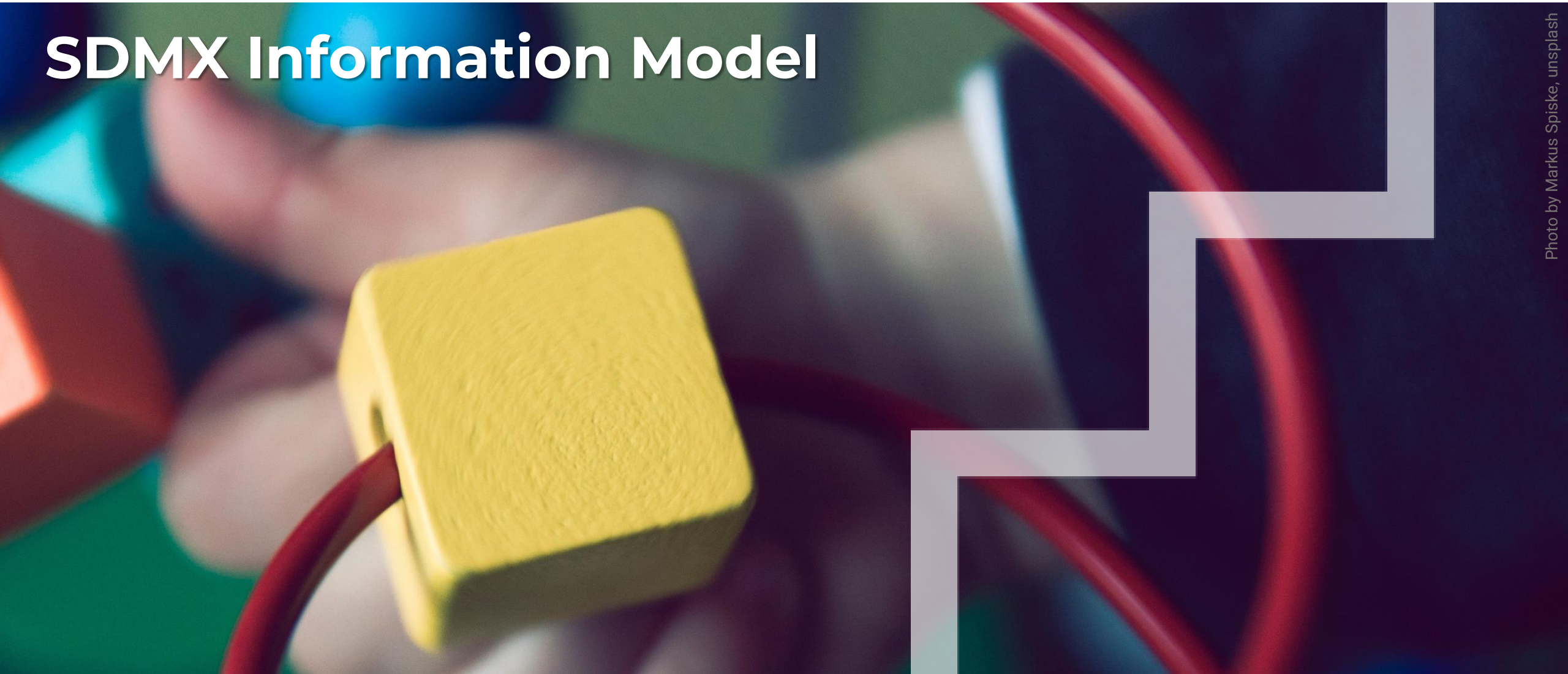
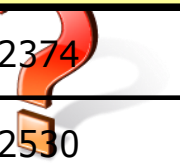


Photo by Markus Spiske, unsplash

Figures vs data

Number of tourist establishments in Italy, annual data			
Indicator / Time	A100 Hotels and similar	B010 Tourist Campsites	B020 Holiday dwellings
2002A00	33411	2374	61479
2003A00	33480	2530	58526
2004A00	33518	2529	56586
2005A00	33527	2411	68385
2006A00	33768	2510	68376
2007A00	34058	2587	61810



- Figures by themselves are meaningless.
- For data to be usable, it must be properly described. The descriptions let users know what the data actually represents.

Developing a Data Model for Data Exchange

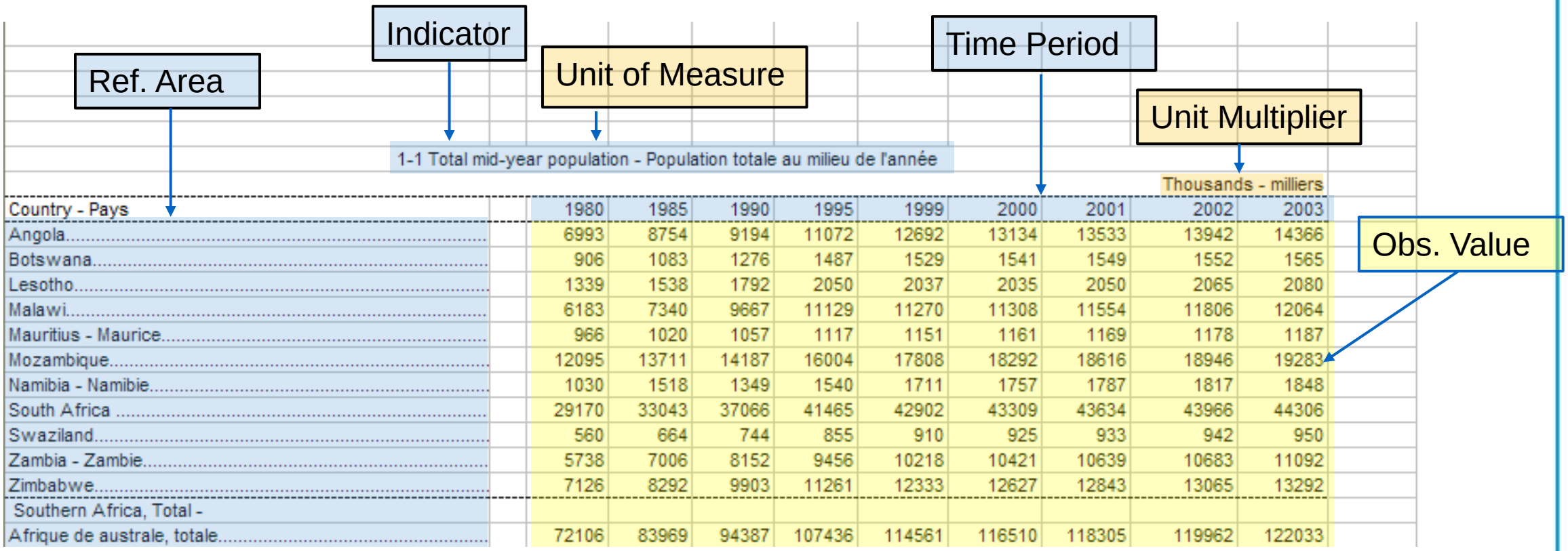
- Data model is developed to provide descriptions for all relevant characteristics of the data to be exchanged
- In some aspects similar to developing a relational database
- In SDMX, data model is represented by a Data Structure Definition (DSD).
- The “shape” of SDMX DSD is roughly similar to star schema.
- To design a DSD, we first need to find *concepts* that identify and describe our data.

Concept

- “Unit of thought created by a unique combination of characteristics”*
- Each concept describes something about the data.
- Concepts should express all relevant data characteristics.

* Source: SDMX Glossary

Identifying Concepts



Country - Pays	1980	1985	1990	1995	1999	2000	2001	2002	2003
Angola	6993	8754	9194	11072	12692	13134	13533	13942	14366
Botswana	906	1083	1276	1487	1529	1541	1549	1552	1565
Lesotho	1339	1538	1792	2050	2037	2035	2050	2065	2080
Malawi	6183	7340	9667	11129	11270	11308	11554	11806	12064
Mauritius - Maurice	966	1020	1057	1117	1151	1161	1169	1178	1187
Mozambique	12095	13711	14187	16004	17808	18292	18616	18946	19283
Namibia - Namibie	1030	1518	1349	1540	1711	1757	1787	1817	1848
South Africa	29170	33043	37066	41465	42902	43309	43634	43966	44306
Swaziland	560	664	744	855	910	925	933	942	950
Zambia - Zambie	5738	7006	8152	9456	10218	10421	10639	10683	11092
Zimbabwe	7126	8292	9903	11261	12333	12627	12843	13065	13292
Southern Africa, Total - Afrique de australe, totale	72106	83969	94387	107436	114561	116510	118305	119962	122033

SDMX Concept Scheme

- “Set of Concepts that are used in a Data Structure Definition or Metadata Structure Definition.”*
- Concept scheme places concepts into a maintainable unit.

Concept name	Concept ID
Indicator	INDICATOR
Reference area	REF_AREA
Time period	TIME_PERIOD
Unit of measure	UNIT_MEASURE
Unit multiplier	UNIT_MULT
Observation value	OBS_VALUE

* Source: SDMX Glossary

Dimension

- Which of the concepts are used to identify an observation?
  - Indicator
  - Reference area
  - Time Period
- When all 3 are known, we can unambiguously locate an observation in the table.
- These are called **dimensions**.
  - A dimension is similar in meaning to a database table's primary key field.

Attribute

- In our example, **Unit Multiplier** and **Unit of Measure** represent additional information about observations.
- This concept is not used to identify a series or observation.
- Such concepts are called **attributes**.
  - Not to be confused with XML attributes!
  - Similar to a database table's non-primary key fields.

Primary Measure

- Observation Value represents a concept that describes the actual values being transmitted.
- In SDMX, such a concept is called **Primary Measure**.
- Primary Measure is usually represented by concept with ID **OBS_VALUE**.

Dimension or Attribute?

- Choosing the role of a concept has profound implications on the structure of data.
- Concepts that identify data, should be made dimensions. Concepts that provide additional information about data, should be made attributes.
- If a concept is a dimension, it is possible to have time series that are different only in the value of this concept.
    - E.g. if Unit of Measure is a dimension, it is possible to have separate time series for “T” and “T/HA” or, more controversially, “KG” and “T”

Dimension or Attribute? (2)

Cambodia		
Fixed and Mobile telephone subscriptions	2013	20.6 million
Fixed and Mobile telephone subscriptions	2012	19.7 million
Fixed and Mobile telephone subscriptions	2013	140.9 per 100 pop.

Unit of measure as a dimension… (dimensions underlined)

Ref.Area	Indicator	Time Period	Unit	Unit Mult.	Obs. Value
Cambodia	Fixed and Mobile telephone subscriptions	2013	Number	Millions	20.6
Cambodia	Fixed and Mobile telephone subscriptions	2012	Number	Millions	19.7
Cambodia	Fixed and Mobile telephone subscriptions	2013	Per 100 pop.	Units	140.9

Dimension or Attribute? (3)

Unit of measure as an attribute…

Violation!

Ref.Area	Indicator	Time Period	Unit	Unit Mult.	Obs. Value
Cambodia	Fixed and Mobile telephone subscriptions	2013	Number	Millions	20.6
Cambodia	Fixed and Mobile telephone subscriptions	2012	Number	Millions	19.7
Cambodia	Fixed and Mobile telephone subscriptions	2013	Per 100 pop.	Units	140.9

- The dataset above is invalid: duplicate observation
- The two values above are only different in their attributes

Dimension or Attribute? (4)

Unit of measure as an attribute…

Ref.Area	Indicator	Time Period	Unit	Unit Mult.	Obs. Value
Cambodia	Fixed and Mobile telephone subscriptions	2013	Number	Millions	20.6
Cambodia	Fixed and Mobile telephone subscriptions	2012	Number	Millions	19.7
Cambodia	Fixed and Mobile telephone subscriptions per 100 population	2013	Per 100 pop.	Units	140.9

- Now there is no violation because every row has a unique key
- The Unit concept is still useful

Attribute attachment

- In SDMX 2.1, attributes can be attached at observation, dimension(s), group, or dataset.
    - When an attribute is attached to all dimensions except time, it is effectively attached to time series
- For practical purposes attributes are often attached at observation or time series.
- In addition, attributes can be designated as **mandatory** or **conditional** (optional). Mandatory attributes must be present at their attachment level for the dataset to be valid, while conditional attributes may be skipped.
    - Dimensions, by contrast, must always be provided.

Cross-domain Concepts

- SDMX Statistical Working Group (SWG) develops and publishes Cross-Domain Concepts
- These are recommended concept IDs that are shared among statistical subject-matter domains and can be reused in many DSDs. The full list of cross-domain concepts is available at the SDMX web site under Guidelines: https://sdmx.org/?page_id=3215
- The cross-domain concept scheme is also published at the SDMX Global Registry: https://registry.sdmx.org

Cross-domain Concepts: examples

- Some of the widely used cross-domain concepts include:
  - Statistical indicator: **INDICATOR**
  - Reference area: **REF_AREA**
  - Sex: **SEX**
  - Age: **AGE**
  - Unit of measure: **UNIT_MEASURE**
  - Unit multiplier: **UNIT_MULT**
  - Time period: **TIME_PERIOD**
  - Observation value: **OBS_VALUE**

Data model so far…

Concept	ID	Role	Attachment
Indicator	INDICATOR	Dimension	
Reference area	REF_AREA	Dimension	
Time period	TIME_PERIOD	Dimension	
Unit of measure	UNIT_MEASURE	Attribute	Time series
Unit multiplier	UNIT_MULT	Attribute	Time series
Observation value	OBS_VALUE	P.Measure	

Exercise 1

- Identify concepts in a table
- Mark each concept as:
  - Dimension
  - Attribute
  - Primary Measure (observation value)
- For each attribute, specify its attachment level.

Representation

- DSD defines a range of valid values for each concept.
- When data are transferred, each of its descriptor concepts must have valid values.
- A concept can be
  - Coded
  - Un-coded with format
  - Un-coded free text

Code

- “A language-independent set of letters, numbers or symbols that represent a concept whose meaning is described in a natural language.”
- A sequence of characters that can be associated with descriptions in any number of languages.
    - Descriptions can be updated without disrupting mappings or other components of data exchange.

Code List

- “A predefined list from which some statistical coded concepts take their values.”
- A code list is a collection of codes maintained as a unit.
- A code list enumerates all possible values for a concept or set of concepts
  - Sex code list
  - Country code list
  - Indicator code list, etc

Code List: Some Examples

CL_SERIES

Code	Description
SI_POV_DAY1	Population below international poverty line (1.1.1)
SI_POV_EMP1	Employed population below international poverty line (1.1.1)
SI_POV_NAHC	Population below national poverty line (1.2.1)
SI_COV_BENFTS	Population covered by at least one social protection floor/system (1.3.1)
SI_COV_CHLD	Children covered by social protection (1.3.1)
SI_COV_DISAB	Population with severe disabilities collecting disability social protection benefits (1.3.1)
SI_COV_LMKT	Population covered by labour market programs (1.3.1)
SI_COV_MATNL	Mothers receiving maternity benefits and benefits for newborns (1.3.1)
SI_COV_PENSN	Population above retirement age receiving a pension (1.3.1)

CL_EDUCATION_LEV

Code	Description (EN)	Description (FR)
_T	Total or no breakdown by education level	Total ou aucune ventilation par niveau de s
ISCED11_0	Early childhood education	Education de la petite enfance
ISCED11_01	Early childhood educational development	Développement éducatif de la petite enfan
ISCED11_02	Pre-primary education	Enseignement préprimaire
ISCED11_1	Primary education	Enseignement primaire
ISCED11_10	Primary education	Enseignement primaire

CL_AREA

Code	Description
1	World
2	Africa (M49)
4	Afghanistan
5	South America (M49)
8	Albania
9	Oceania (M49)
10	Antarctica
11	Western Africa (M49)
12	Algeria

SDMX Concepts and Code lists

- Code lists provide a representation for concepts, in terms of Codes.
- Codes are language-independent and may include descriptions in multiple languages.
- Code lists must be harmonized among all data providers that will be involved in exchange.

Un-coded Concepts

- Can be free-text: Any valid text can be used as a value for the concept.
  - Footnote
- Can have their format specified
  - Postal code: 5 digits
  - Last update: date/time

Representation of concepts in SDMX

- **Dimensions** must be either coded or have their format specified.
  - Free text is not allowed.
- **Attributes** can be coded or un-coded; format may optionally be specified.

Data model so far…

Concept	ID	Role	Attachment	Representation
Indicator	INDICATOR	Dimension		CL_INDICATOR
Reference area	REF_AREA	Dimension		CL_AREA
Time period	TIME_PERIOD	Dimension		Date/time (YYYY)
Unit of measure	UNIT_MEASURE	Attribute	Time series	CL_UNIT_MEASURE
Unit multiplier	UNIT_MULT	Attribute	Time series	CL_UNIT_MULT
Observation value	OBS_VALUE	Pr. Measure		Floating point number

Cross-domain Code Lists

- Similar to cross-domain concepts, SDMX Statistical Working Group (SWG) develops and publishes Cross-Domain Code Lists.
- When available, these are based on existing statistical classifications and contain codes from those classifications. Otherwise, codes are developed by the SWG.
- These codes should be used whenever possible in SDMX exchange or dissemination. The code lists are often extended with country or organization-specific codes. For example, the global Reference Area code list is often extended with subnational reference area codes for national data dissemination.

Cross-domain Concepts and Code Lists: examples

- Reference area: **REF_AREA** → **CL_AREA**
- Sex: **SEX** → **CL_SEX**
- Unit multiplier: **UNIT_MULT** → **CL_UNIT_MULT**

Generic cross-domain codes

Recommended Code Value	Recommended Code Description
_L	Local extension (can be used as a prefix)
_N	Non response
_O	Other
_S	Subtotal
_T	Total
_U	No data/unknown
_X	Not allocated/unspecified
_Z	Not applicable

- These codes are recommended to be used in all code lists as appropriate.

* Source: Guidelines for the creation and Management of SDMX Code Lists

Data model so far: Code Lists

CL_INDICATOR	
Code	**Name**
POP	Total Mid-Year Population

CL_UNIT_MULT	
Code	**Name**
0	Units
1	Tens
2	Hundreds
3	Thousands
6	Millions
9	Billions

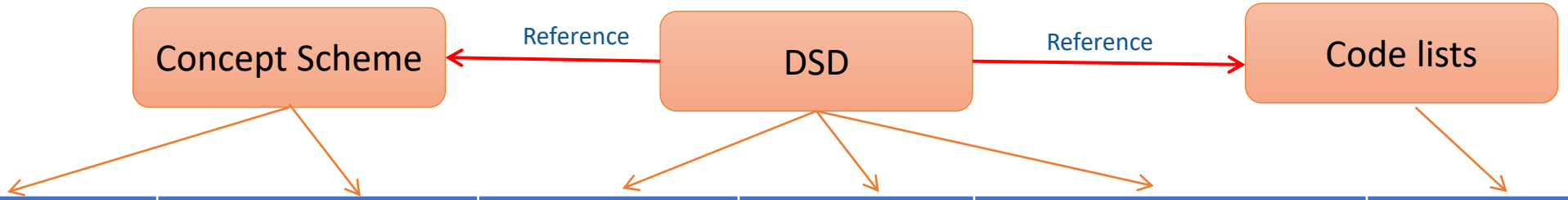
CL_AREA (partial)	
Code	**Name**
AF	Afghanistan
AL	Albania
AQ	Antarctica
DZ	Algeria
AS	American Samoa
AD	Andorra

CL_UNIT_MEASURE	
Code	**Name**
PER	Person

Exercise 2

- Determine the representation of each concept in your data model: coded, formatted, or free-text.
  - For each coded concept, develop a code list
  - Select any approach for codes: numeric, alphabetical, alphanumeric, etc.
  - Use the approach consistently
- For each formatted concept, if any, specify its format (e.g. date, 5-digit number, 10-character string, etc)

Data Structure Definition: summary



Concept	Concept ID	Role	Attachment	Representation	Code list ID
Indicator	INDICATOR	Dimension		Code List	CL_INDICATOR
Reference area	REF_AREA	Dimension		Code List	CL_AREA
Time period	TIME_PERIOD	Dimension		YYYY	
Unit of measure	UNIT_MEASURE	Attribute	Time series	Code List	CL_UNIT_MEASURE
Unit multiplier	UNIT_MULT	Attribute	Time series	Code List	CL_UNIT_MULT
Obs. value	OBS_VALUE	Pr. Measure		Floating point number	

Importance of Data Model

- Data model, represented by DSD, defines what data can be encoded and transmitted.
- Flaws in a DSD may have significant adverse impact on data exchange
  - Missing concepts
  - Incorrect role of concepts
  - Un-optimized model

Dataset

- Organised collection of data defined by a Data Structure Definition (DSD)*
- A dataset is structured in accordance with *one* DSD
- Serves as a container for time-series or cross-sectional series in SDMX data messages.

*Source: **SDMX Glossary**

Time Series

- A set of observations of a particular variable, taken at different points in time.
- Observations that belong to the same time series, differ in their time dimension.
  - All other dimension values are identical.
  - Observation-level attributes may differ across observations of the same time series.

Time Series: Demonstration

1.1 Proportion of population below $1 (PPP) per day

Series	1990	1992	1994	1996	1998	1999	2000	2002	2006	2007	2008	2009	2011
Rwanda													
MDG Population below $1 (PPP) per day, percentage Last updated: 02 Jul 2012							74.6[1,3]		72.1[1,3]				63.2[1,3]
State of Palestine													
MDG Population below $1 (PPP) per day, percentage Last updated: 02 Jul 2012										0.4[1,2,3]		0.0[1,2,3]	
Thailand													
MDG Population below $1 (PPP) per day, percentage Last updated: 02 Jul 2012	11.6[1,3]	8.6[1,3]	4.1[1,3]	2.5[1,3]	2.1[1,3]	3.2[1,3]	3.0[1,3]	1.6[1,3]	1.0[1,3]		0.4[1,3]	0.4[1,3]	

1.2 Poverty gap ratio

Series	1990	1992	1994	1996	1998	1999	2000	2002	2006	2007	2008	2009	2011
Rwanda													
MDG Poverty gap ratio at $1 a day (PPP), percentage Last updated: 02 Jul 2012							36.9[1,3]		34.8[1,3]				26.6[1,3]
State of Palestine													
MDG Poverty gap ratio at $1 a day (PPP), percentage Last updated: 02 Jul 2012										0.1[1,2,3]		0.0[1,2,3]	
Thailand													
MDG Poverty gap ratio at $1 a day (PPP), percentage Last updated: 02 Jul 2012	2.4[1,3]	1.6[1,3]	0.7[1,3]	0.4[1,3]	0.3[1,3]	0.5[1,3]	0.5[1,3]	0.3[1,3]	0.2[1,3]		0.0[1,3]	0.1[1,3]	

Footnotes	
1	Based on nominal per capita consumption averages and distributions estimated from household survey data.
2	Based on Purchasing Power Parity (PPP) dollars imputed using regression.
3	Source: http://research.worldbank.org/PovcalNet/index.htm

Non-Time Series Data (a.k.a. Cross-Sectional Data[1])

- A non-time dimension(s) is chosen along which a set of observations is constructed.
  - E.g. for a survey or census the time is usually fixed and another dimension may be chosen to be reported at the observation level
- Used less frequently than time series representation

[1] The term "Cross-sectional" was discontinued in SDMX 2.1

Time Series View vs Cross-Sectional View

2.1 Net enrolment ratio in primary education

	2009	2010	2011
Morocco			
Total net enrolment ratio in primary education, both sexes		94.1	96.2
Total net enrolment ratio in primary education, boys		95	96.8
Total net enrolment ratio in primary education, girls		93.3	95.6
State of Palestine			
Total net enrolment ratio in primary education, both sexes	88.2	89.2	
Total net enrolment ratio in primary education, boys	88.2	89.8	
Total net enrolment ratio in primary education, girls	88.2	88.5	
Uganda			
Total net enrolment ratio in primary education, both sexes	94.2	91	
Total net enrolment ratio in primary education, boys	93.1	89.7	
Total net enrolment ratio in primary education, girls	95.3	92.3	

- The Sex dimension was chosen as the cross-sectional measure.

- Note that Time is still applicable.

2.1 Net enrolment ratio in primary education
2010

	Total	Boys	Girls
Morocco	94.1	95	93.3
State of Palestine	89.2	89.8	88.5
Uganda	91	89.7	92.3

Keys in SDMX

- **Series key** uniquely identifies a series
  - In the case of time series, consists of all dimensions except **time**
- **Group key** uniquely identifies a group of time series
  - Consists of a subset of the series key

Exercise 3

- Working with your table, determine the total number of time series.
- For the first 5 time series in your table, provide a value for each concept in its series key, in accordance with the concepts and their representations you identified above.
  - Add a column for each dimension, which you will fill with a value for the dimension.
  - For coded concepts, provide a valid code from the corresponding code list.
  - For un-coded concepts, provide a formatted value in accordance with the concept's format.

Structural and Reference Metadata

- Structural Metadata: Identifiers and Descriptors, e.g.
  - Data Structure Definition
  - Concept Scheme
  - Code

} What we have covered so far

- Reference Metadata: Describes contents and quality of data, e.g.
  - Indicator definition
  - Comments and limitations

Reference Metadata in SDMX

- Can be stored or exchanged separately from the object it describes, but be linked to it
  - Some reference metadata, like footnotes and flags, is transmitted as part of the dataset.
    - Observation status, Observation comment
  - Higher level reference metadata can be transmitted separately from the data.
    - Indicator definition, Methodological notes
- Can be indexed and searched
- Reported according to a defined structure

Metadata Structure Definition (MSD)

- MSD Defines:
  - The object type to which reference metadata can be associated
    - E.g. DSD, Dataflow.
  - The components comprising the identifier of the target object
    - E.g. the draft SDG MSD allows metadata to be attached a partial key.
  - Concepts used to express metadata (“metadata attributes”).
    - E.g. Indicator Definition, Quality Management

Reference metadata in SDMX 3.0

- Reference metadata support has been redesigned in SDMX 3.0.
  - To simplify implementation, discovery, and use
- It is possible to declare reference metadata concepts directly in the DSD, and transmit reference metadata as part of a dataset or in a separate message.
- Metadata Structure Definitions, metadata sets, and metadata flows are still supported for higher-level metadata that is not attached to specific datasets.
- It is expected that simplification of reference metadata will lead to its implementation in common tools as well as much broader usage.

Dataflow and Metadataflow

- Dataflow defines a “view” on a Data Structure Definition, or a transmission channel
  - Can be constrained to a subset of codes in any dimension
  - Can be categorized, i.e. can have *categories* attached
  - Defines a slice of a DSD and gives it an ID. In its simplest form defines any data valid according to a DSD
  - The same dataset can be exposed through many different dataflows
- Similarly, Metadataflow defines a view on a Metadata Structure Definition.

Content Constraints

- Constraints can be used to define which codes or combinations of codes are allowed (or disallowed)
- Constraints can define more granular validation rules than a simple validation of concepts and codes
- Are often attached to the Dataflow but can also be attached to DSD, Provision Agreement, etc

Content Constraint Types

- **Cube Region Constraints** define valid (or invalid) codes as a subset of those defined in a DSD's code lists.
  - E.g. for the Country Global SDG Dataflow, the only valid value for dimension REPORTING_TYPE is N ("National").
- **Series Constraints** define valid (or invalid) combinations of codes defined in a DSD's code lists.
  - SERIES=**SH_STA_STNT** (Proportion of children moderately or severely stunted)
  - AGE=**Y0T4** (Under five years old)
  - COMPOSITE_BREAKDOWN=**_T**,**MS_MIGRANT**,**MS_NOMIGRANT**,**MS_EUMIGRANT**, or **MS_NONEUMIGRANT**
  - PRODUCT=**_T**
  - ACTIVITY=**_T**

Category, Category Scheme, and Categorisation

- Category is a way of classifying data for reporting or dissemination
    - Subject matter-domains are commonly implemented as Categories, such as “Demographic Statistics”, “Economic Statistics”
- Category Scheme groups Categories into a maintainable unit.
- Categorisation links a Category to the object to which it applies.

SDMX Messages

- Any SDMX-related information is exchanged in the form of documents called *messages*. An SDMX message can be sent in a number of standard formats including XML, JSON, CSV.
- There are several types of SDMX messages, each serving a particular purpose, e.g.
  - **Structure** message is used to transmit structural information such as DSD, MSD, Concept Scheme, etc.
  - **GenericData**, **StructureSpecificData,** and other messages are used to send data.
- SDMX messages in the XML format are referred to as SDMX-ML messages.

SDMX Artefacts

- While there are many types of artefacts, in almost all situations “SDMX Artefact” refers to an identifiable, maintainable and versionable component of structural metadata.
  - Concept Scheme
  - DSD
  - Code List
- Note that e.g. an individual Code is not a maintainable artefact, since it can only exist and be transmitted as part of a Code List.

SDMX Artefact Identification and Versioning

- Identification of SDMX Artefact consists of 3 fields: ID; Maintenance Agency; Version

Type	Name	ID	Maintenance Agency	Version
DSD	NA Main Aggregates	NA_MAIN	ESTAT	1.11
DSD	NA Main Aggregates	NA_MAIN	ESTAT	1.10
Concept Scheme	SDG Concept Scheme	SDG_CONCEPTS	IAEG-SDGs	1.0
Code List	Reference area code list	CL_AREA	SDMX	2.0

- Each artefact can also be marked final or non-final. When an artefact is final, it can no longer be updated – a new version needs to be created for an update.

THANK YOU