Specification (and Implementation) of the EIA/CDIF Meta-Meta-Model for Relational Database Management Systems (ORACLE)

Abteilung für Wirtschaftsinformatik

OOPSLA'98 - CDIF Workshop
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Overview

- Problem statement
- Codd's Relational model of Tasmania (RM/T)
- EIA/CDIF Meta-meta-model
  - determining the structure of EIA/CDIF meta-models
- Mapping of M3 to RDBMS (SQL 3-Specifications)
  - MetaEntities, MetaRelationships
  - Potential Problems
- Checking and analyzing EIA/CDIF compliant meta-models with SQL
- Roundup and outlook

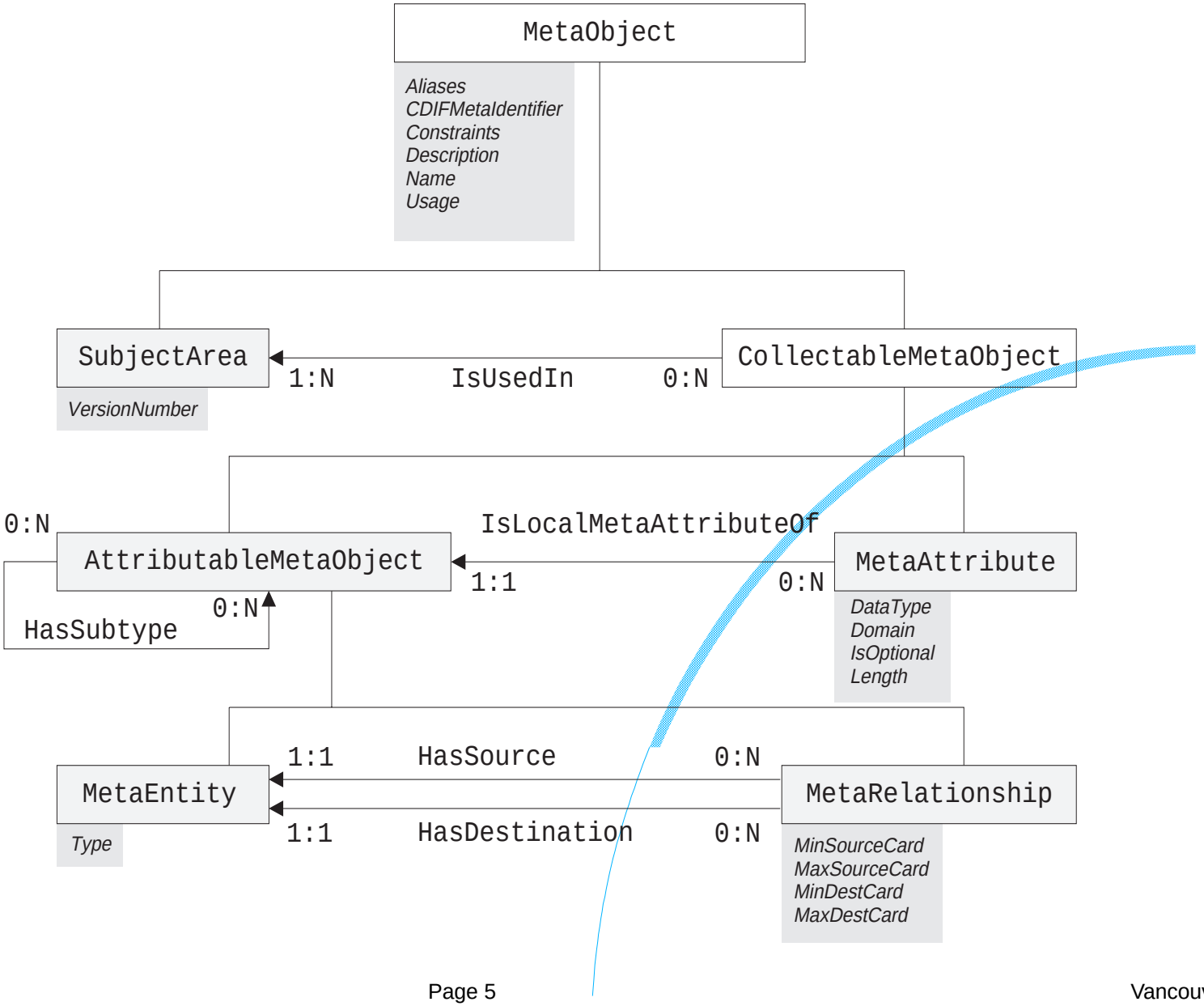
Problem Statement

- EIA/CDIF's reference mechanism
  - assumes full knowledge of all meta-models, otherwise:
    - *used concepts in a transfer cannot be checked*
    - *used, but unknown concepts can lead to errors as inheritance along the generalization tree is unknown*
- Repository for meta-models
  - Storing meta-model-data in commercially available RDBMS'
    - *Maintenance of EIA/CDIF meta-models*
    - *Quality assurance*
    - *Analysis of concepts and structures*
- Problem: M3 is an EERM

Codd's RM/T of 1979 (!)

- Aimed at
  - "Extending the database relationship model to Capture more meaning"
- Discusses and adds among other ideas
  - Surrogate
    - *RDBMS-wide unique*
    - *can only be created and deleted*
    - *no reuse, no change in value RDBMS*
  - Generalization tree

EIA/CDIF's Meta-meta-model (1994)



Specifying RDBMS-Table Structures for Mapping EIA/CDIF M3 (1)

- Base tables for representing meta-meta-entities
  - Surrogates
  - Tables represent the M3 meta-meta-objects in a 1:1 correspondence
  - Naming
    - *Acronyms built of capital letters of original M3-names*
    - *Underscore appended, e.g.:*
      *MetaObject --> **MO_***
- Example

```
CREATE TABLE ME_ { surR NUMERIC(6), TYPE VARCHAR(40),
       PRIMARY KEY ( surR ),
       FOREIGN KEY ( surR ) REFERENCES MO_ ( surR )
                            ON DELETE CASCADE };
```

Specifying RDBMS-Table Structures for Mapping EIA/CDIF M3 (2)

- Views for representing meta-meta-entities
  - Naming
    - *Acronmys built of capital letters of original M3-names, e.g.: MetaObject --> **MO***
  - Natural join over surrogates, if necessary
- Example

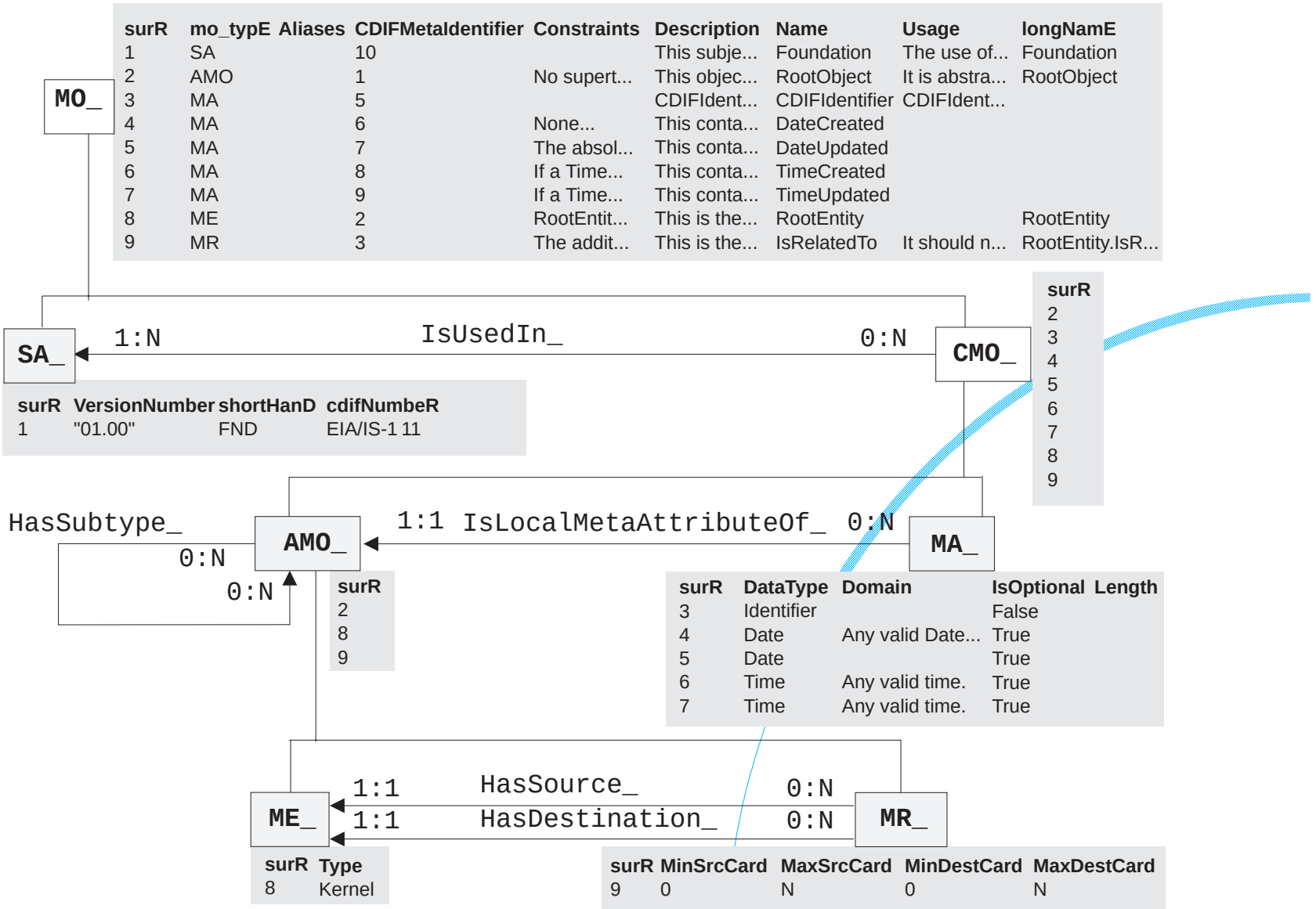
```
CREATE VIEW ME AS
            SELECT AMO.*, ME_.Type
            FROM   AMO, ME_
            WHERE  AMO.surR = ME_.surR;
```

Specifying RDBMS-Table Structures for Mapping EIA/CDIF M3 (3)

- Base tables for representing meta-meta-relationships
  - Surrogates
  - Tables represent in a 1:1 correspondence the M3 meta-meta-relationships
  - Naming
    - *Original M3-names with an underscore appended, e.g.:* *HasSource* --> ***HasSource_***
- Example

```
CREATE TABLE HasSource_ { surR NUMERIC(6),
     Source NUMERIC(6), Destination NUMERIC(6),
     PRIMARY KEY ( surR ),
     FOREIGN KEY ( Source ) REFERENCES ME_ ( surR )
                            ON DELETE CASCADE,
     FOREIGN KEY ( Destination ) REFERENCES ME_ ( surR )
                            ON DELETE CASCADE };
```

EIA/CDIF Meta-meta-model RDBMS (1)



surR	mo_typE	Aliases	CDIFMetaIdentifier	Constraints	Description	Name	Usage	longNamE
1	SA		10		This subje...	Foundation	The use of...	Foundation
2	AMO		1	No supert...	This objec...	RootObject	It is abstra...	RootObject
3	MA		5		CDIFIdent...	CDIFIdentifier	CDIFIdent...	
4	MA		6	None...	This conta...	DateCreated		
5	MA		7	The absol...	This conta...	DateUpdated		
6	MA		8	If a Time...	This conta...	TimeCreated		
7	MA		9	If a Time...	This conta...	TimeUpdated		
8	ME		2	RootEntit...	This is the...	RootEntity		RootEntity
9	MR		3	The addit...	This is the...	IsRelatedTo	It should n...	RootEntity.IsR...

surR
2
3
4
5
6
7
8
9

surR	VersionNumber	shortHanD	cdifNumbeR
1	"01.00"	FND	EIA/IS-1 11

surR
2
8
9

surR	DataType	Domain	IsOptional	Length
3	Identifier		False	
4	Date	Any valid Date...	True	
5	Date		True	
6	Time	Any valid time.	True	
7	Time	Any valid time.	True	

surR	Type
8	Kernel

surR	MinSrcCard	MaxSrcCard	MinDestCard	MaxDestCard
9	0	N	0	N

EIA/CDIF Meta-meta-model RDBMS (2)

CMO_.IsUsedIn_.SA_

surR	sourcE	destinatioN
10	2	1
11	8	1
12	9	1
13	3	1
14	4	1
15	5	1
16	6	1
17	7	1

AMO_.HasSubtype_.AMO_

surR	sourcE	destinatioN
18	2	8
19	2	9

MR_.HasSource_.ME_

surR	sourcE	destinatioN
20	9	8

MR_.HasDestination_.ME_

surR	sourcE	destinatioN
21	9	8

MA_.IsLocalMetaAttributeOf_.AMO_

surR	sourcE	destinatioN
22	3	2
23	5	2
24	6	2
25	4	2
26	7	2

Mapping to RDBMS Potential Problems (1 - Insertions)

- Complex insertions
  - INSERT-statements need to be conceptually built for instantiable nodes of the hierarchy
  - INSERT-statements need to be split up into multiple INSERT-statements along the generalization hierarchy up to and including table ***MO***_
    - *All persons inserting data into these tables need to be aware of these restrictions*
    - *Tedious task, if done by hand and error-prone*
    - *Solution: doing inserts under program control (an exemplified implementation exists for Object Rexx in the book "Meta-Modellierung in EIA/CDIF", ISBN 3-901198-09-0)*

Mapping to RDBMS Potential Problems (2 - Deletions)

- Deleting from a meta-object other than MetaObject (MO_)
  - If deleting directly from basetable MO_
    - *all dependent tuples in all MME subtables are deleted due to the delete cascade constraint*
    - *all dependent tuples in all relevant tables representing meta-meta-relationships are deleted due to the delete cascade constraint*
  - If deleting directly from any other MME basetable, then
    - *make sure via a TRIGGER that the appropriate MO_ tuple is deleted, so that all other dependent tuples in all other tables get deleted as well*
    - *take care of the "Mutating Table" problem in such a case*

SQL Examples (1)

Count # of MOs per type

```
Create or replace VIEW
   view_Nr_of_instances_raw (MO, SA, CMO, MA, AMO, ME, MR)
AS
   select count(*), 0, 0, 0, 0, 0, 0 from mo
   UNION
   select 0, count(*), 0, 0, 0, 0, 0 from sa
   UNION
   select 0, 0, count(*), 0, 0, 0, 0 from cmo
   UNION
   select 0, 0, 0, count(*), 0, 0, 0 from ma
   UNION
   select 0, 0, 0, 0, count(*), 0, 0 from amo
   UNION
   select 0, 0, 0, 0, 0, count(*), 0 from me
   UNION
   select 0, 0, 0, 0, 0, 0, count(*) from mr ;

SELECT max( mo ) mo, max( sa ) sa,
       max(cmo ) cmo, max( ma ) ma,
       max( amo ) amo, max( me ) me, max( mr ) mr
FROM   view_nr_of_instances_raw ;
```

MO	SA	CMO	MA	AMO	ME	MR
297	5	292	169	123	62	60

SQL Examples (2)

MOs per SA with mandatory MA

```
SELECT SA_.SURR, SA_.Shorthand, MO_.mo_type, SUBSTR( MO_.longname, 1, 50) "Longname",
       MO_.surr, ma_.isoptional, count( * ) "# mand MA"
FROM   SA_, MO_, MA_, IsUsedIn_, IsLocalMetaAttributeOf_
WHERE  MA_.IsOptional = 'False'
     AND
       MO_.SURR = IsUsedIn_.Source
     AND
       SA_.SURR = IsUsedIn_.Destination
     AND
       MO_.SURR = IsLocalMetaAttributeOf_.Destination
     AND
       MA_.SURR = IsLocalMetaAttributeOf_.Source
GROUP BY SA_.SURR, SA_.Shorthand, MO_.mo_type, MO_.longname, MO_.surr, ma_.isoptional;
```

SURR	SHORTH	MO_TY	Longname	SURR	ISOPTIONAL	# mand MA
1	FND	AMO	RootObject	2	False	1
27	CMMN	ME	AbstractionLevel	28	False	1
27	CMMN	ME	ToolUser	55	False	1
656	DFM	ME	Port	702	False	1
656	DFM	MR	ReferencedElement.DefinesPath.ComponentObject	728	False	1
887	PLAC	ME	AbsolutePoint	888	False	1
887	PLAC	ME	RelativePoint	913	False	2
887	PLAC	ME	SemanticObjectReference	926	False	1

8 rows selected.

SQL Examples (3)

of mandatory MRs per SA

```
SELECT SA_.SURR, Shorthand, COUNT( * )
FROM   MR , SA_, IsUsedIn_
WHERE  ( MinSourceCard <> '0'
           OR
         MinDestCard   <> '0' )
     AND
       MR.Surr = IsUsedIn_.Source
     AND
       SA_.Surr = IsUsedIn_.Destination
GROUP BY SA_.SURR, Shorthand ;
```

SURR	SHORTH	COUNT(*)
27	CMMN	4
164	DMOD	14
656	DFM	2
887	PLAC	7

SQL Examples (4)

MEs participating in mandatory MRs

```
SELECT ME.MO_Type, ME.Surr, SUBSTR( ME.CDIFMetaIdentifier, 1, 5  ) "C-M-I",
       SUBSTR( ME.LongName, 1, 64 ) "LongName"
FROM   ME
WHERE  ME.SURR IN ( SELECT Destination
                    FROM   HasSource_
                    WHERE  Source IN ( SELECT Surr
                                       FROM   MR
                                       WHERE  MinSourceCard <> '0' ) )
      OR ME.SURR IN ( SELECT Destination
                      FROM   HasDestination_
                      WHERE  Source IN ( SELECT Surr
                                         FROM   MR
                                         WHERE  MinDestCard   <> '0' ) )
ORDER BY ME.LongName ;
```

MO_TY	SURR	C-M-I	LongName
ME	890	10010	Annotation
ME	169	17	Attribute
ME	173	1003	CandidateKey
ME	176	8000	ComponentObject
ME	177	1008	DataModel
ME	180	1012	DataModelObject
ME	183	8002	DefinitionObject
ME	897	10002	Diagram
ME	903	10006	Edge
ME	188	1016	Entity
ME	204	1033	InheritableDataModelObject
ME	907	10003	Point
ME	217	1040	Relationship
ME	219	1042	Role
ME	225	1048	RolePlayer
ME	8	2	RootEntity
ME	47	4	SemanticInformationObject
ME	250	1070	SubtypeSet

18 rows selected.

Roundup and Outlook

- Mapping of M3 to RDBMS (SQL 3-Specifications)
  - Implemented in Oracle 7.3
    - *defining triggers for deletion*
    - *defining stored procedures to take care of mutating table problem*
- Great for analyzing the definitions and structures of meta-models via SQL
- ISO/CDIF
  - almost no adaptions necessary, e.g.
    - *adding a table for MMR "CMO.IsDefinedIn.SA"*
    - *adding MMA "IsAbstract" for AMO*

CDIF-related URLs (as of: 1998-10-14)

- OOPSLA'98: CDIF-workshop
  http://www.metamodel.com/oopsla98-cdif-workshop/
- EIA/CDIF
  http://www.cdif.org
  - Cf. book on EIA/CDIF (e.g. overview, cross-references, IMM, specifications, implementation details for Oracle/Object Rexx, ...)
  http://www.wu-wien.ac.at/wi/rgf/adv/
- ISO/CDIF ("ISO/IEC JTC1/SC7 WG11")
  - ISO/IEC JTC1/SC7
  http://saturne.info.uqam.ca/Labo_Recherche/Lrgl/sc7/
- OMG
  - Stream-based Model Interchange Format ("SMIF")
  http://www.omg.org/library/schedule/Stream-based_Model_Interchange.htm