



Stichting NIOC

Stichting NIOC en de NIOC kennisbank

Stichting NIOC (www.nioc.nl) stelt zich conform zijn statuten tot doel: het realiseren van congressen over informatica onderwijs en voorts al hetgeen met een en ander rechtstreeks of zijdelings verband houdt of daartoe bevorderlijk kan zijn, alles in de ruimste zin des woords.

De stichting NIOC neemt de archivering van de resultaten van de congressen voor zijn rekening. De website www.nioc.nl ontsluit onder "Eerdere congressen" de gearchiveerde websites van eerdere congressen. De vele afzonderlijke congresbijdragen zijn opgenomen in een kennisbank die via dezelfde website onder "NIOC kennisbank" ontsloten wordt.

Op dit moment bevat de NIOC kennisbank alle bijdragen, incl. die van het laatste congres (NIOC2025, gehouden op donderdag 27 maart 2025 jl. en georganiseerd door Hogeschool Windesheim). Bij elkaar zo'n 1500 bijdragen!

We roepen je op, na het lezen van het document dat door jou is gedownload, de auteur(s) feedback te geven. Dit kan door je te registreren als gebruiker van de NIOC kennisbank. Na registratie krijg je bericht hoe in te loggen op de NIOC kennisbank.

Het eerstvolgende NIOC vindt plaats op 18 maart 2027 in Arnhem en wordt georganiseerd door HAN University of Applied Sciences.

Reacties over de NIOC kennisbank en de inhoud daarvan kun je richten aan de beheerder:

R. Smedinga kennisbank@nioc.nl.

Vermeld bij reacties jouw naam en telefoonnummer voor nader contact.

Generatieve applicatieontwikkeling: Masteronderzoek in de praktijk



**“A generic transformation approach
to application migration from Windows to Web
of the HAN Individueel Onderwijs system”**

Misja Nabben, 20130404

Contents

- **Personal background**
- **Project background & definition**
- **Materials and methods**
 - Introduction Data – Meta data – Meta meta data
 - Application Generators
- **Project results, conclusions & future research**

Personal Background

- **Lecturer in bachelor of ICT and master MISD program**
- **Member of the HAN research group Model Based Information Systems (M-BIS)**

<https://www.han.nl/onderzoek/kennismaken/technologie-en-samenleving/lectoraat/model-based-information-systems/>

Lector emeritus Guido Bakema.
Lector Dr. Stijn Hoppenbrouwers

Background | M-BIS

- **Fact Oriented Modeling (FOM), Meta modeling**
- **Application & code generation/interpretation**
- **Model to model transformations**
- **Tool development:**
 - Model driven application generating engines
 - Generic graphical drawing engine
 - Fact based modelling tool
 - From code to data using thin clients
- **Application development using these tools**

>> Project HAN Individueel Onderwijs

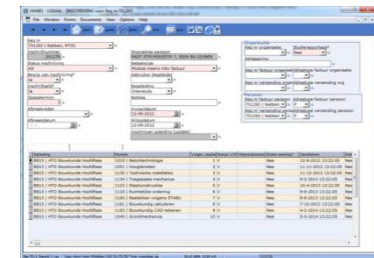
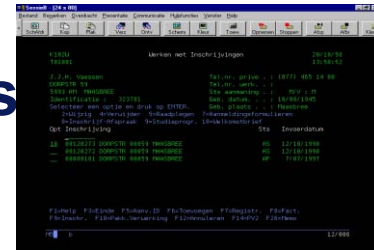
Project | Background information

2002 : the HAN acquires PBNA modules

**2003 : project HAN Individueel Onderwijs
(HAN IO) started**

**research project Application Generator
(UFG) started in parallel**

**2004 : project HAN IO implemented for
'HAN Centrum voor Post-Bachelor- en
Master' (HAN CPM) opleidingen**



Project | Background information

**2008 : HAN IO students should be finished,
HAN IO should be stopped**

2010 : first problems HAN IO on Windows 7

2011 : analysis on upgrading HAN IO

**2012 : Windows 7 rollout planned
project HAN IO II started**

Project | Problem statement

HAN IO is based on Application Generator developed in Delphi:

- **Delphi is no longer supported on Windows 7**
- **Database version MS SQL 2000 outdated**
- **HAN IO should end in 2008, no functionality is added since 2004.**

Project | Objectives

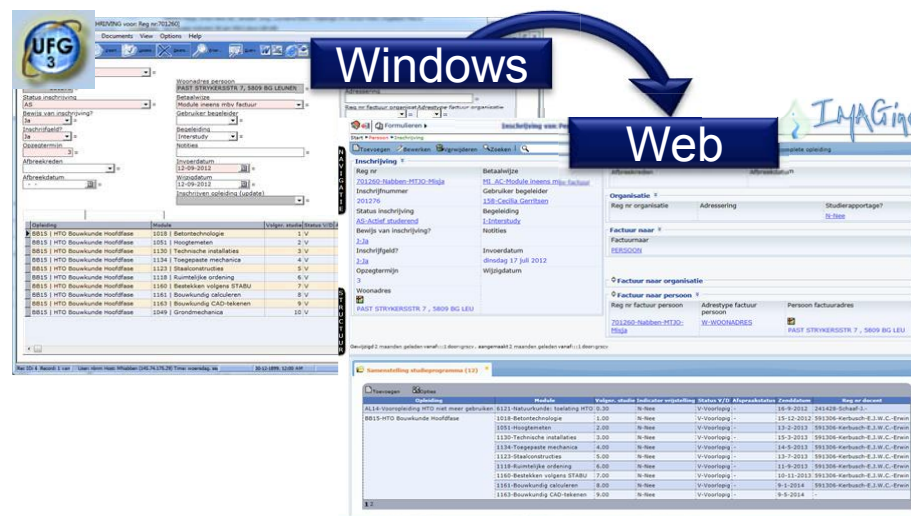
- **A system that**
 - Can support the process of distance education
 - Has at least the same functionality as HAN IO
 - Can easily adapt to new functionality
 - Could be used in the future by students
 - Is easy to use by the current end users
 - Fits in the HAN architecture
 - Is easy to maintain
 - At the lowest cost...

Project | Assignment

“A generic transformation approach

to application migration from Windows to Web

of the HAN Individueel Onderwijs system”



Materials and Methods

A web based application interpreter called
'Information Model Application Generating
engine (IMAGine)'



The relational database management system
MS SQL Server

Transforming the business model and
application model to this new platform by
model to model transformation and code
generation

Side step:

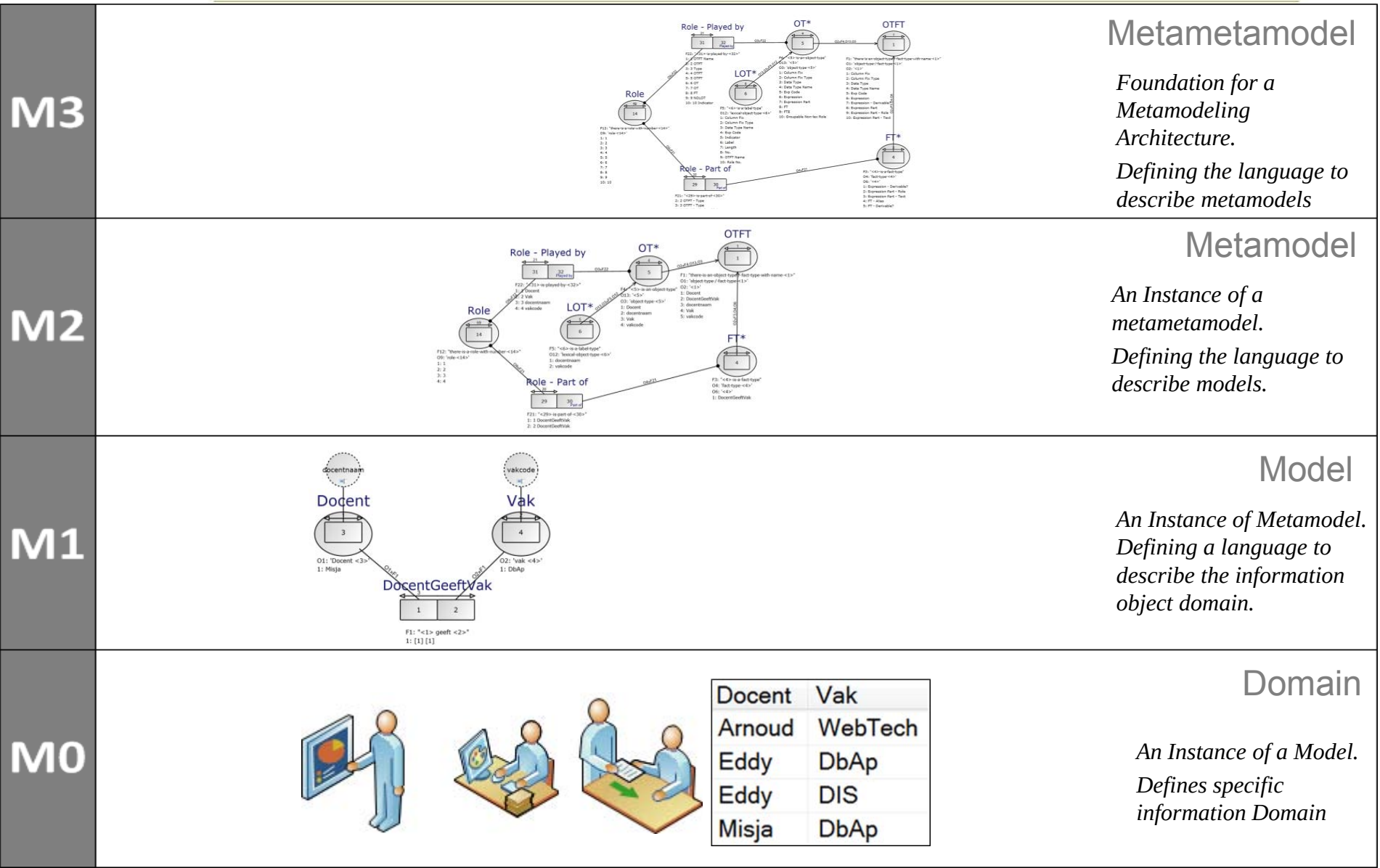
Introduction of

Application generation,

Model to model transformations,

Data - Meta data – Meta meta data,

4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)



4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

Hogeschool



van Arnhem en Nijmegen

HAN University of Applied Sciences

M1 : Information modeling of the domain

Domain M0



Classify/Qualify expression

Enter a new expression:

Enter a new fact expression

Docent Misja geeft vak DbAp

Qualify the expression:

Fact type name:

DocentGeeftVak

☒ Qualify ☒ Cancel

Classify a part of the expression:

<Docent> geeft <Vak>

Docent <docentnaam> vak DbAp

Misja

Clear

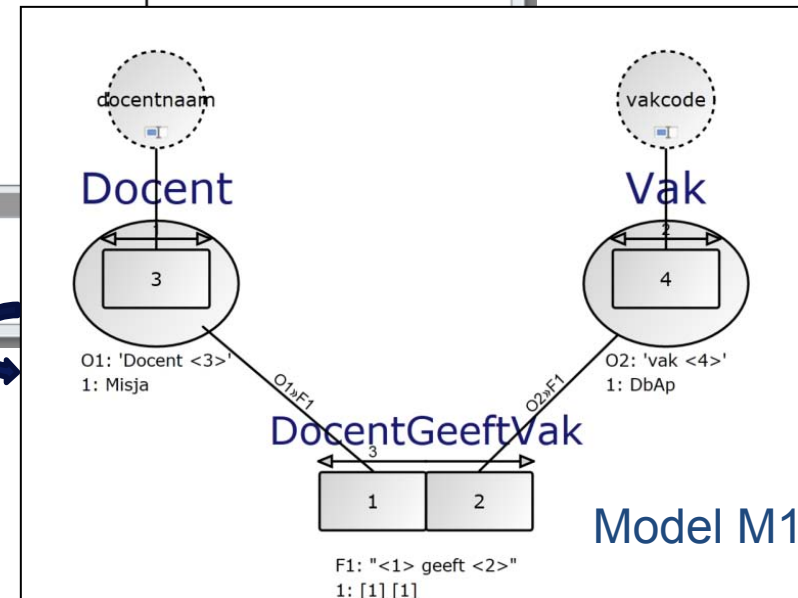
Qualify the classified part of the expression:

Object type name / Fact type name:

vakcode

☒ Qualify ☒ Ready

Graphity



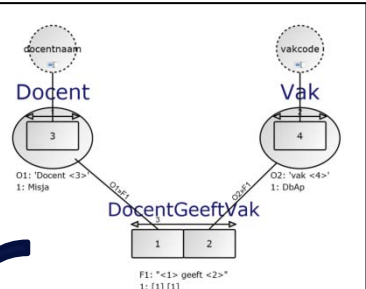
Fact Oriented Modeling using Fully Communicated Oriented – Information Modeling (FCO-IM)

<< back

4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

M2 : Information modeling of the model

Domain M1



Classify/Qualify expression

Enter a new expression:

Enter a new fact expression

Role 1 is played by Docent

Qualify the expression:

Fact type name:

Role - Played By

☒ Qualify ☒ Cancel

Classify/Qualify expression

Classify a part of the expression:

Diagram of new FT

Role - Played By

1 3

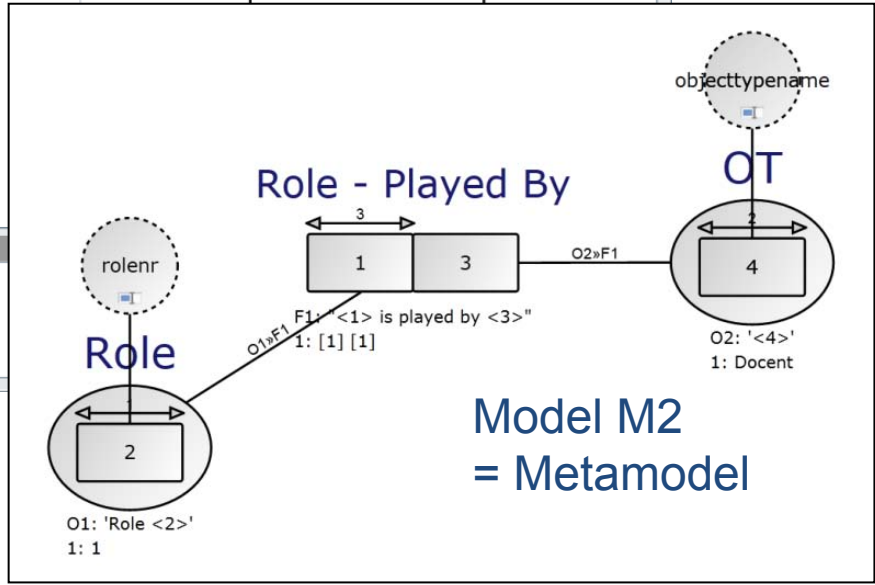
Role OT

2 4

Qualify the classified part of the expression:

Object type name / Fact type name:

☒ Qualify ☒ Ready



4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

Hogeschool

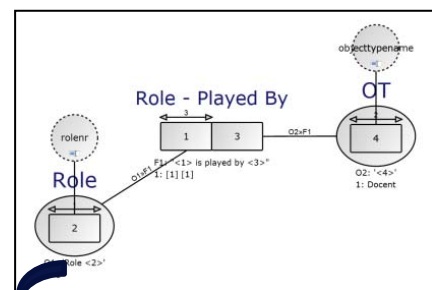


van Arnhem en Nijmegen

HAN University of Applied Sciences

M3 : Information modeling of the metamodel

Domain M2
= Metamodel



Classify/Qualify expression

Classify a part of the expression:

<Role> is played by <OT>

Role <rolenr> <objecttypename>

3 OT

Diagram of new FT

Role - Played By

1 3

Role OT

2 4

Qualify the classified part of the expression:

Object type name / Fact type name:

Qualify Ready

Classify/Qualify expression

Enter a new expression:

Enter a new fact expression

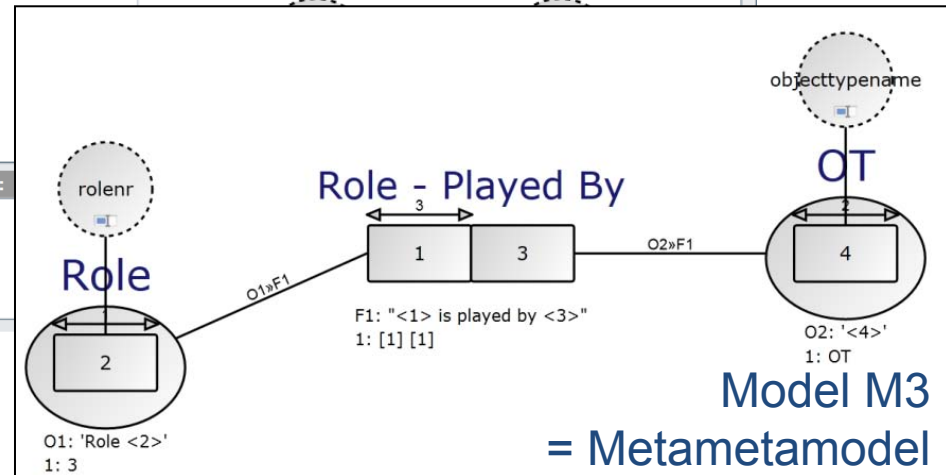
Role 3 is played by OT

Qualify the expression:

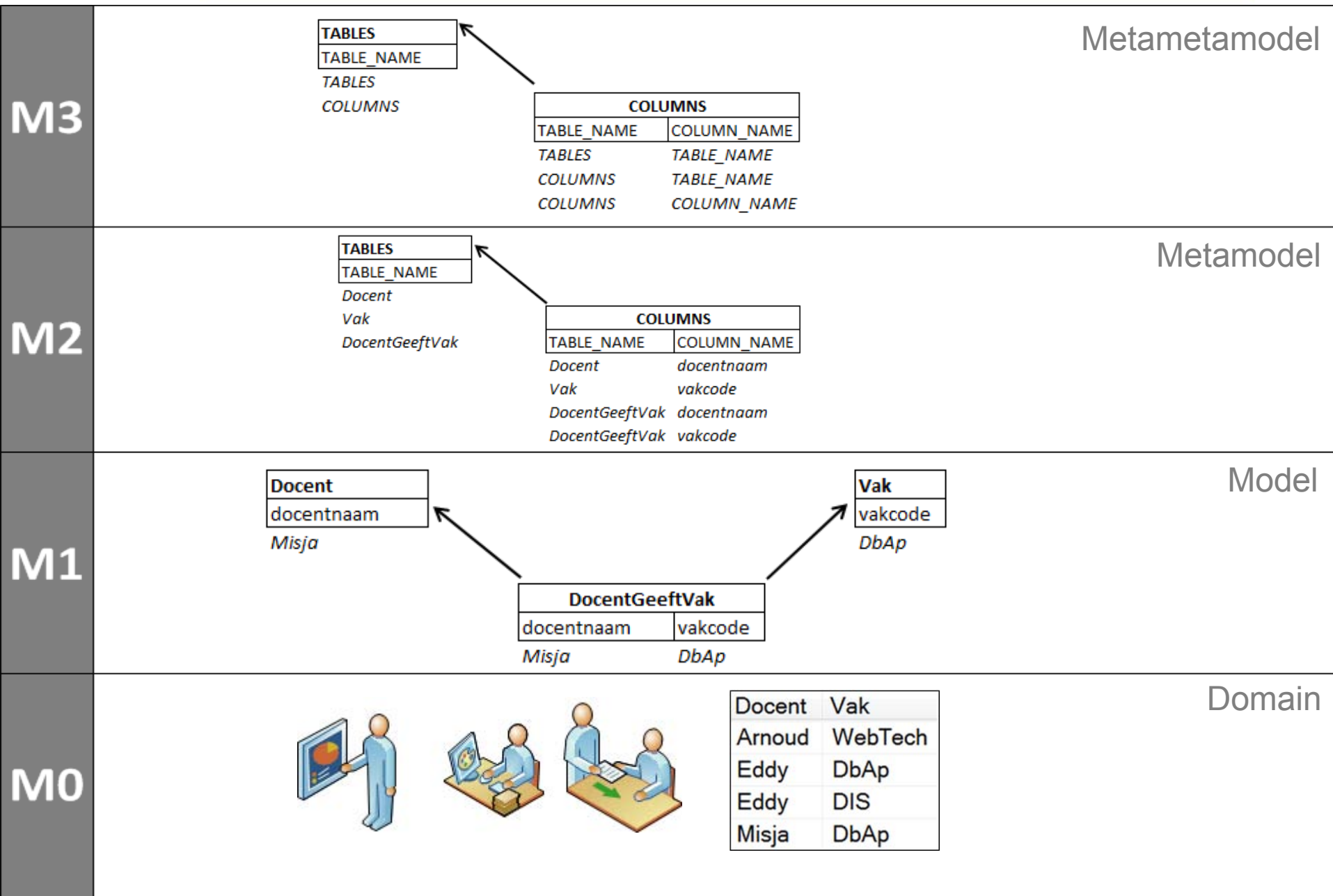
Fact type name:

Role - Played By

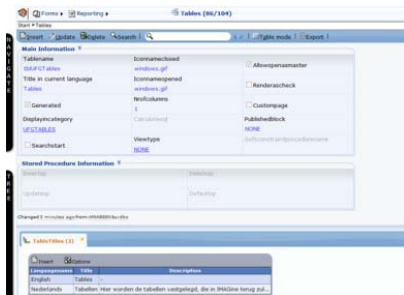
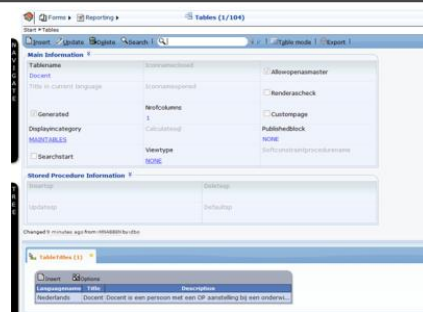
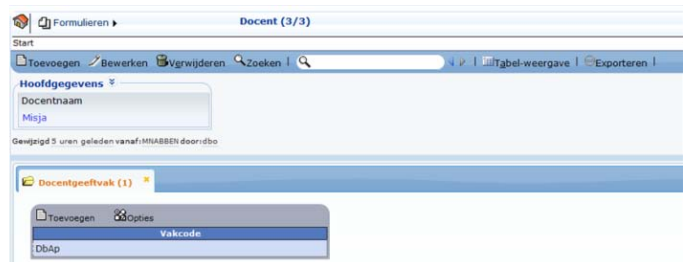
Qualify Cancel



Similar for a Relational Model



Extended with an Application Interface

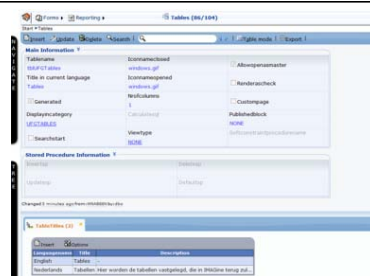
M3	TABLES TABLE_NAME TABLES COLUMNS COLUMNS <table><tr><th>TABLE_NAME</th><th>COLUMN_NAME</th></tr><tr><td>TABLES</td><td>TABLE_NAME</td></tr><tr><td>COLUMNS</td><td>TABLE_NAME</td></tr><tr><td>COLUMNS</td><td>COLUMN_NAME</td></tr></table> 	TABLE_NAME	COLUMN_NAME	TABLES	TABLE_NAME	COLUMNS	TABLE_NAME	COLUMNS	COLUMN_NAME	Metametamodel		
TABLE_NAME	COLUMN_NAME											
TABLES	TABLE_NAME											
COLUMNS	TABLE_NAME											
COLUMNS	COLUMN_NAME											
M2	TABLES TABLE_NAME Docent Vak DocentGeeftVak COLUMNS <table><tr><th>TABLE_NAME</th><th>COLUMN_NAME</th></tr><tr><td>Docent</td><td>docentnaam</td></tr><tr><td>Vak</td><td>vakcode</td></tr><tr><td>DocentGeeftVak</td><td>docentnaam</td></tr><tr><td>DocentGeeftVak</td><td>vakcode</td></tr></table> 	TABLE_NAME	COLUMN_NAME	Docent	docentnaam	Vak	vakcode	DocentGeeftVak	docentnaam	DocentGeeftVak	vakcode	Metamodel
TABLE_NAME	COLUMN_NAME											
Docent	docentnaam											
Vak	vakcode											
DocentGeeftVak	docentnaam											
DocentGeeftVak	vakcode											
M1	Docent docentnaam Misja Vak vakcode DbAp DocentGeeftVak <table><tr><th>docentnaam</th><th>vakcode</th></tr><tr><td>Misja</td><td>DbAp</td></tr></table> 	docentnaam	vakcode	Misja	DbAp	Model						
docentnaam	vakcode											
Misja	DbAp											
M0	<table><tr><th>Docent</th><th>Vak</th></tr><tr><td>Arnoud</td><td>WebTech</td></tr><tr><td>Eddy</td><td>DbAp</td></tr><tr><td>Eddy</td><td>DIS</td></tr><tr><td>Misja</td><td>DbAp</td></tr></table>	Docent	Vak	Arnoud	WebTech	Eddy	DbAp	Eddy	DIS	Misja	DbAp	Domain
Docent	Vak											
Arnoud	WebTech											
Eddy	DbAp											
Eddy	DIS											
Misja	DbAp											

Application interpreters & repositories

M3

TABLES
TABLE_NAME
TABLES
COLUMNS

COLUMNS	
TABLE_NAME	COLUMN_NAME
TABLES	TABLE_NAME
COLUMNS	TABLE_NAME
COLUMNS	COLUMN_NAME



TABLES
TABLE_NAME
TABLES
COLUMNS

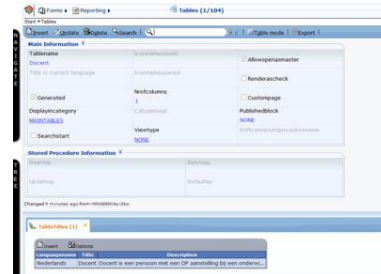
Metametamodel

TABLE TITLES		
TABLE_NAME	LANGUAGE_NAME	TITLE
TABLES	Nederlands	Tabellen
TABLES	English	Tables

M2

TABLES
TABLE_NAME
Docent
Vak
DocentGeeftVak

COLUMNS	
TABLE_NAME	COLUMN_NAME
Docent	docentnaam
Vak	vakcode
DocentGeeftVak	docentnaam
DocentGeeftVak	vakcode



TABLES
TABLE_NAME
Docent
Vak
DocentGeeftVak

Metamodel

TABLE TITLES		
TABLE_NAME	LANGUAGE_NAME	TITLE
Docent	Nederlands	Docent
Docent	English	Lecturer
Vak	Nederlands	Vak
Vak	English	Course

M1

Docent
docentnaam
Misja

DocentGeeftVak	
docentnaam	vakcode
Misja	DbAp

Vak
vakcode
DbAp



Lecturer
lecturer name
Misja

LecturerOfCourse	
lecturer name	course code
Misja	DbAp

Model

M0



Docent	Vak
Arnoud	WebTech
Eddy	DbAp
Eddy	DIS
Misja	DbAp

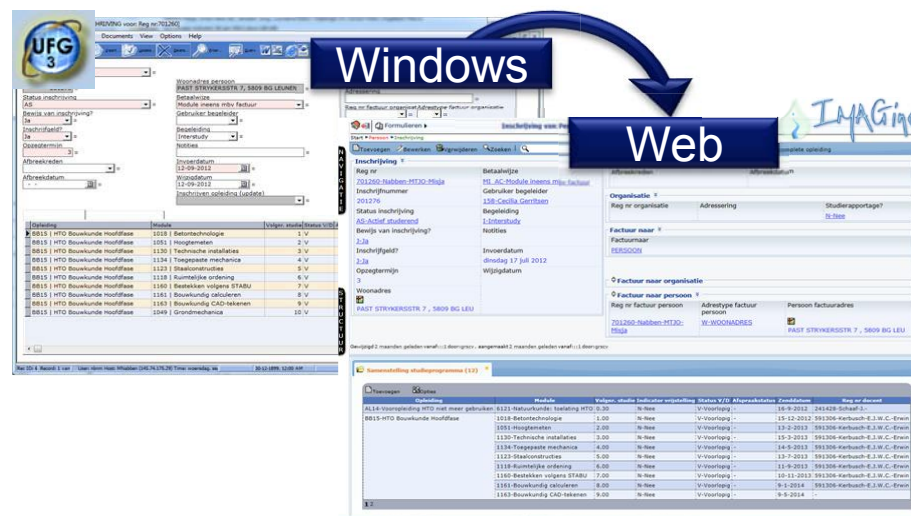
Domain

Back to the Project Assignment

“A generic transformation approach

to application migration from Windows to Web

of the HAN Individueel Onderwijs system”





Hand - LOKAAL - INSCHRIJVING van vog nr [201260]

File Window Forms Documents Views Options Help

Res nr
701260 | Nabben, MTJO

Inscripnummer
201276

Status Inscriptie
AS

Beslis van inschrijving
Ja

Inscripriefact
Ja

Doeltermijn
Ja

Inskredien
Ja

Werkdatum
12-09-2012

Inscriptie selectie (Lofstels)

Organisatie
Res nr organisatie
701260 | Nabben, MTJO

Studieoprichting
Nee

Adresnummer
[]

Res nr factuur organisatie
701260 | Nabben, MTJO

Adresfactuur organisatie
[]

Res nr verzending organisatie
701260 | Nabben, MTJO

Verzendingsorg
[]

Persoon
Res nr factuur, persoon
701260 | Nabben, MTJO

Adresfactuur persoon
[]

Res nr verzending, persoon
701260 | Nabben, MTJO

Verzendingspersoon
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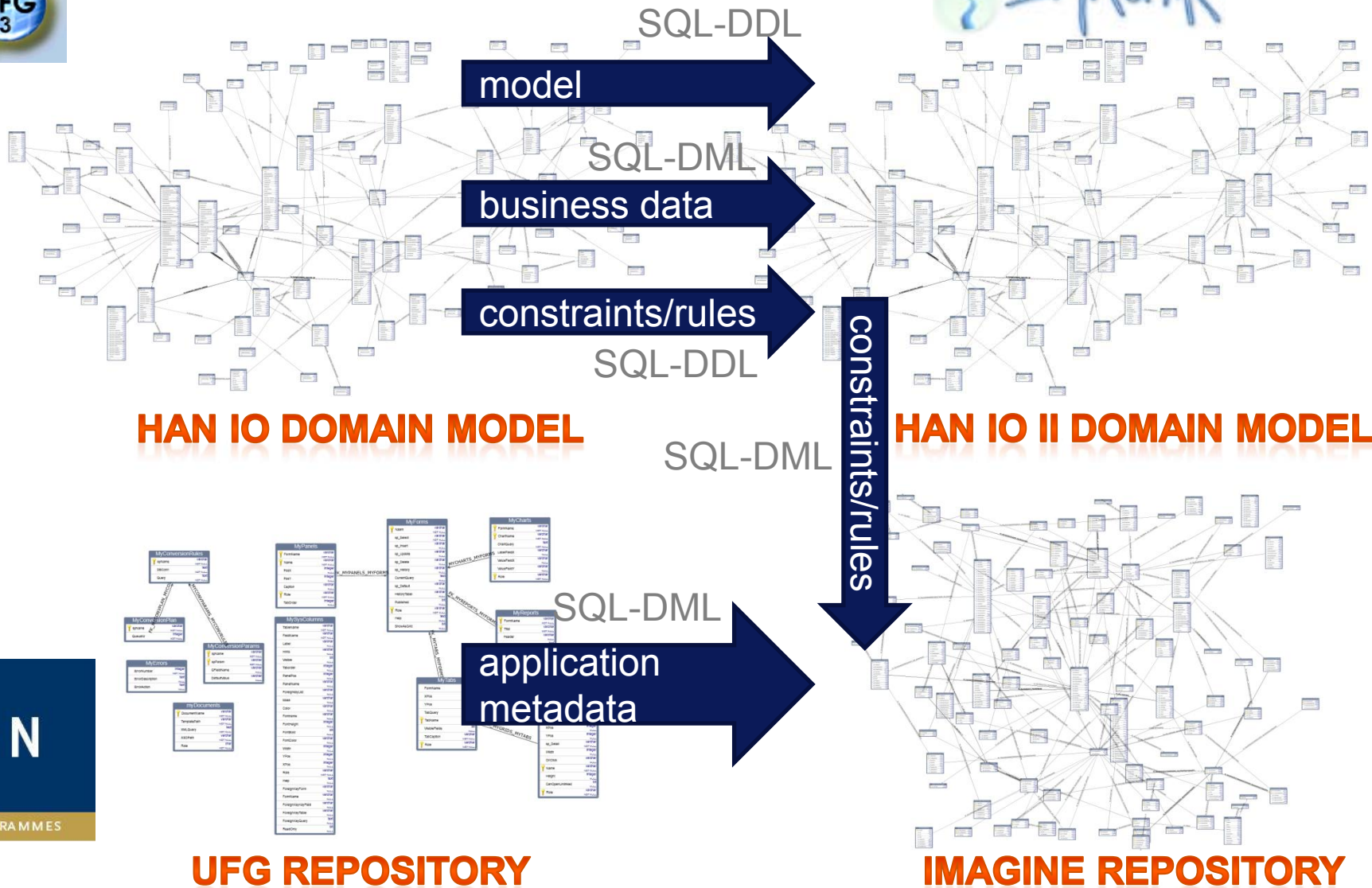
Opleiding	Module	Volgnummer	Status	State	V/D	Afsprekenummer	Gratie sending	Zenddatum	Insk
0815 HTO Bouwkunde hoofdfase	1018 Eetontechnologie	1	V					12-10-2012 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1101 Hoogtematen	2	V					11-11-2012 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1103 Technische installaties	3	V					11-12-2012 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1134 Toegepaste mechanica	4	V				Nee	9-2-2013 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1123 Sjalcoconstructies	5	V				Nee	10-4-2013 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1118 Ruimtelijke ordening	6	V				Nee	9-4-2013 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1160 Betrekken volgens STABU	7	V				Nee	8-8-2013 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1161 Bouwkunde calculeren	8	V				Nee	7-10-2013 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1163 Bouwkunde CAD-tekenen	9	V				Nee	4-2-2014 13:22:05	Nee
0815 HTO Bouwkunde hoofdfase	1249 Grondmechanica	10	V				Nee	5-5-2014 13:22:05	Nee

Net 15 | Record 1 van | Loopt: dien heen: Middelbar (146,74,76) Time: woensdag, 26-11-2014 10:58 AM



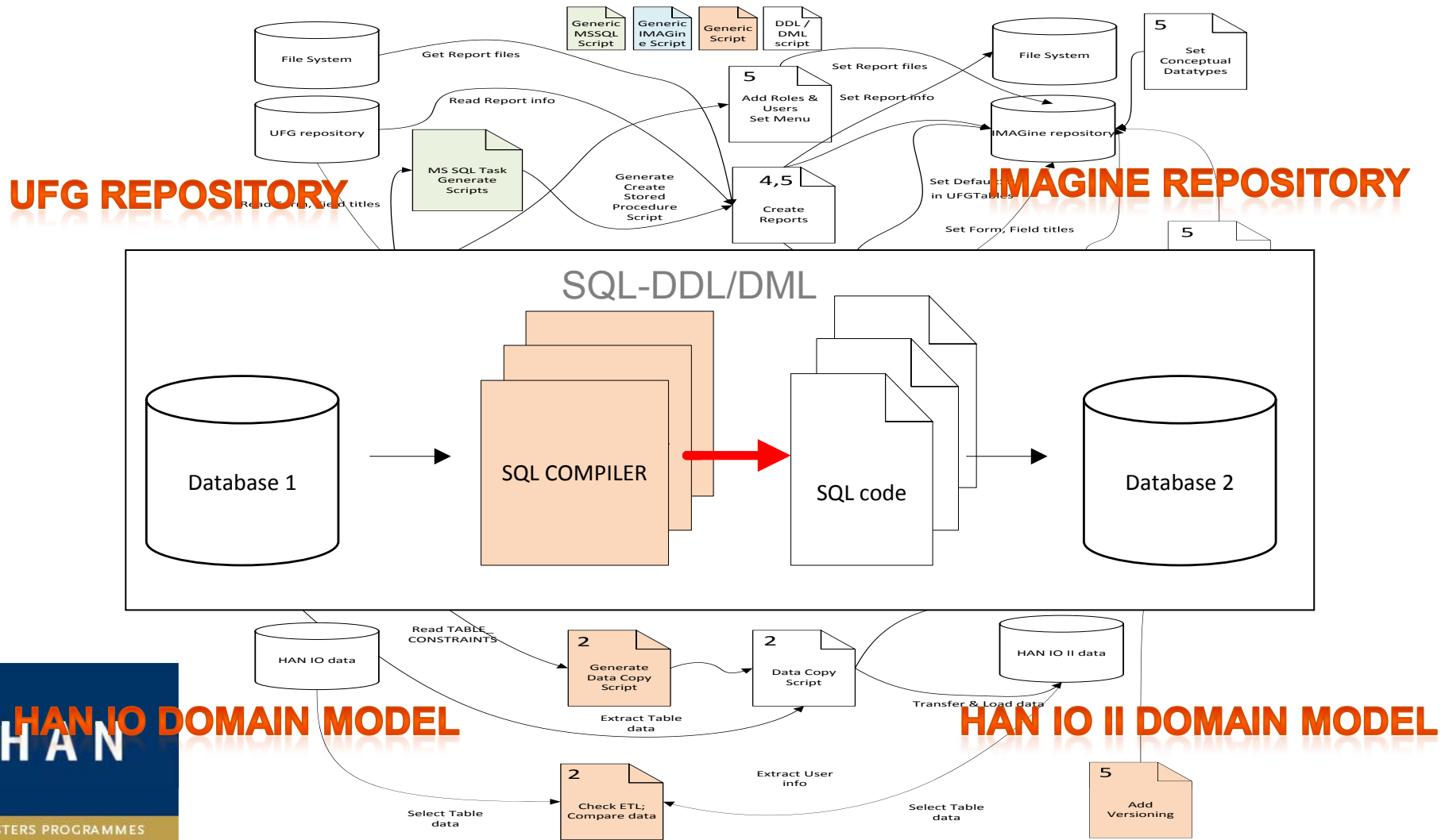
Design of the transformations

Global overview



Design of the transformations

Detail overview

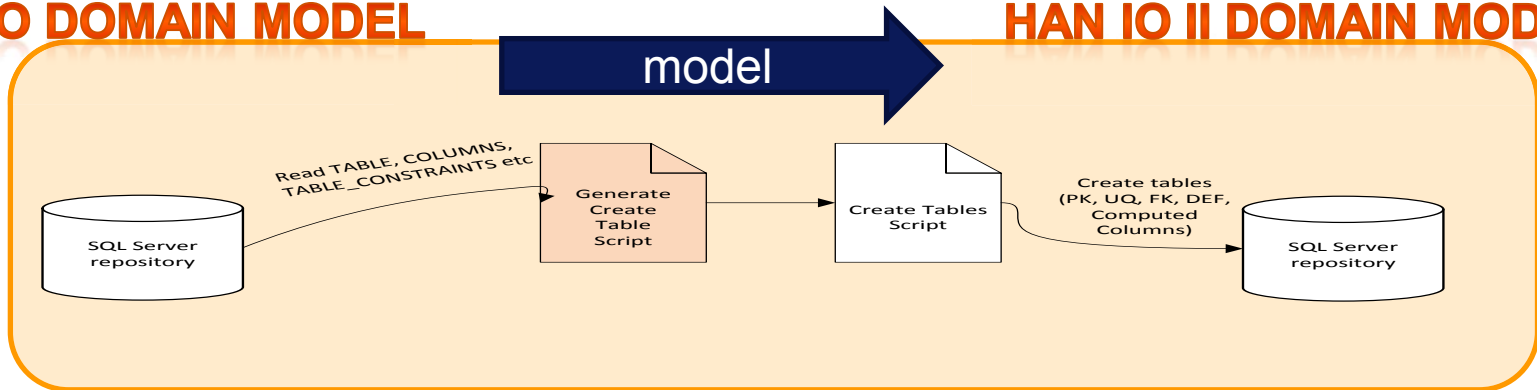




Development of the transformations

HAN IO DOMAIN MODEL

HAN IO II DOMAIN MODEL



- **CREATE TABLEs**

- Column; data type, length, mandatory, identity, calculation
- Primary key definition

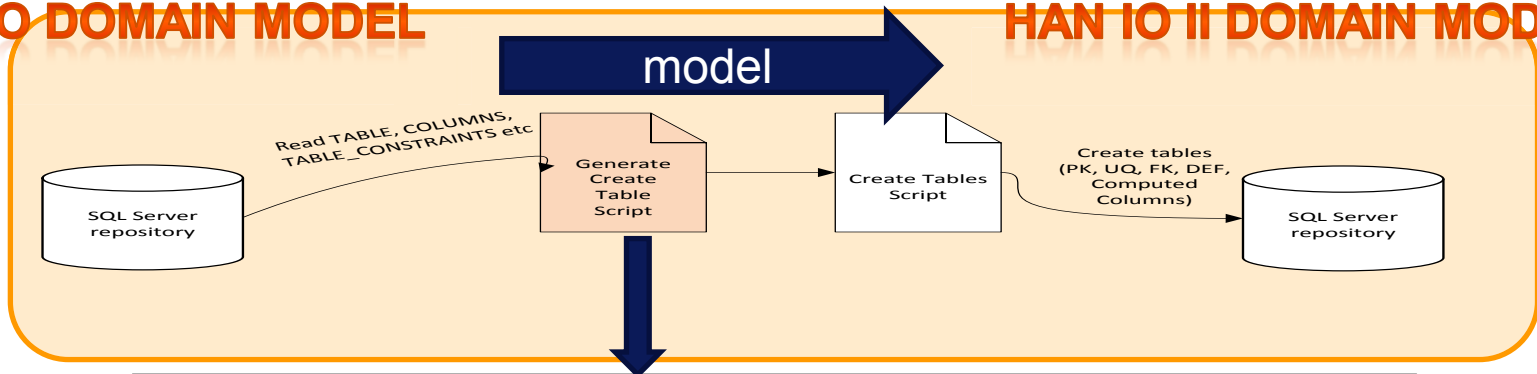
- **ALTER TABLEs**

- Foreign key definition
- Unique key definition
- Check constraints
- Default constraints (+ default SP's)

Development of the transformations

HAN IO DOMAIN MODEL

HAN IO II DOMAIN MODEL



```

USE HANKC_PROD
GO
--Tables to be excluded by the script
DECLARE @IgnoreTables AS XML
= (SELECT Item FROM (
VALUES
    ('sysdiagrams')           --exclude system table for storing diagram definition
    , ('%_HISTORY')           --exclude History tables
    , ('My%')                  --exclude UFG Repository tables
    , ('dtproperties')         --exclude system table for storing diagram definition
) AS List(Item)
FOR XML PATH(''), ROOT('List'))

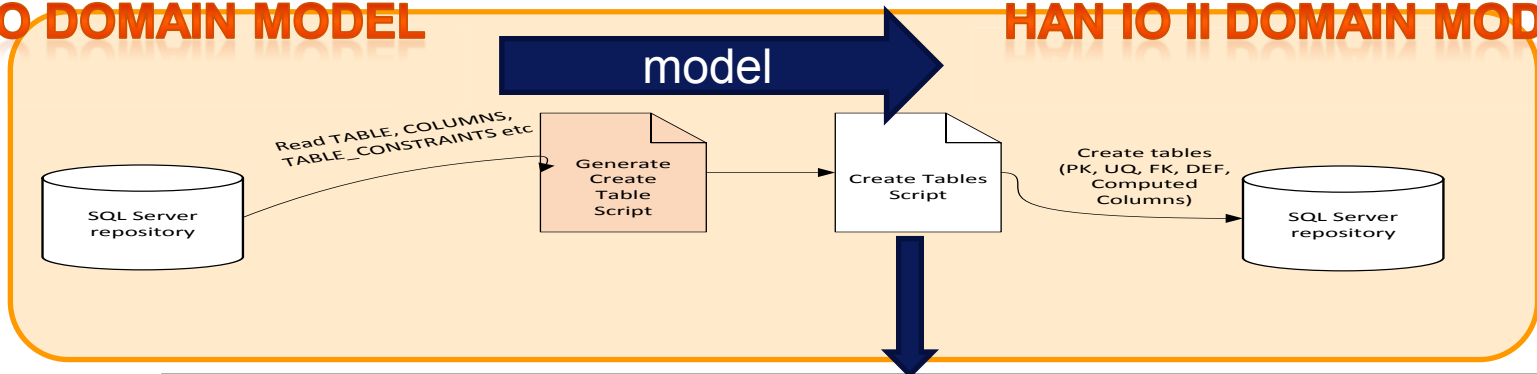
--Columns to be excluded by the script
DECLARE @IgnoreColumns AS XML
= (SELECT Item FROM (
VALUES
    ('chg_User')              --exclude UFG change user column
    , ('chg_Host')             --exclude UFG change host column
    , ('chg_Time')             --exclude UFG change time column
) AS List(Item)
FOR XML PATH(''), ROOT('List'))

EXEC SP_CREATETABLESCRIPT '%', @IgnoreTables, @IgnoreColumns
  
```

Development of the transformations

HAN IO DOMAIN MODEL

HAN IO II DOMAIN MODEL



```

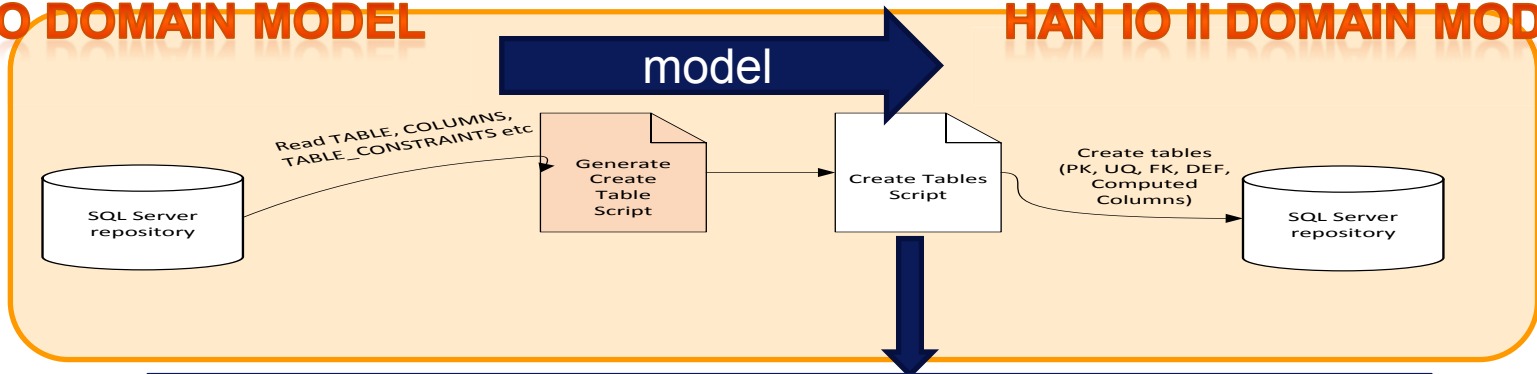
/*****
Table :      ADRESCODE
ColumnPrefix : adc
*****/
CREATE TABLE [dbo].[ADRESCODE]
(
    [LAND] VARCHAR(10) NOT NULL
,   [ADRESCODE] VARCHAR(8) NOT NULL
,   [HUISNRVANAF] VARCHAR(8) NOT NULL
,   [HUISNRTOT] VARCHAR(8) NOT NULL
,   [POSTCODE] VARCHAR(8) NOT NULL
,   [STRAATNAAM] VARCHAR(60) NOT NULL
,   [PLAATS] VARCHAR(50) NOT NULL
,   [CODEPROVINCIE] VARCHAR(10) NULL
,   [CODECEBUCO] VARCHAR(10) NULL
,   [INDEVENONEVEN] INT NULL
,   [ID] INT IDENTITY NOT NULL
,   [ADRES] AS ([POSTCODE] + '
' + [STRAATNAAM] + '
' + [PLAATS]) -- calculated column
,   [HUISNRRANGE] AS ([HUISNRVANAF] + '-' + [HUISNRTOT]) -- calculated column
,   CONSTRAINT [PK_ADRESCODE] PRIMARY KEY ([LAND] , [ADRESCODE] , [HUISNRVANAF] )
)
GO

```

Development of the transformations

HAN IO DOMAIN MODEL

HAN IO II DOMAIN MODEL



```

/*****
REFERENCES
*****/
ALTER TABLE [ADRESCODE] ADD CONSTRAINT [FK_ADRESCODE_LAND] FOREIGN KEY ([LAND])
REFERENCES [LAND]( [CODELAND]) ON UPDATE NO ACTION ON DELETE NO ACTION
  
```

```

ALTER TABLE [ADRESTYPE] ADD CONSTRAINT [U1_ADRESTYPE] UNIQUE ([OMSTYPEADRES])
  
```

```

ALTER TABLE [INSCHRIJVING] ADD CONSTRAINT [CHK_PersoonOrganisatieFactuur] CHECK
((([persoonFactuur] is not null and [persoonAdresTypeFactuur] is not null and
([organisatieFactuur] is null and [organisatieAdresTypeFactuur] is null) or
[persoonFactuur] is null and [persoonAdresTypeFactuur] is null and
([organisatieFactuur] is not null and [organisatieAdresTypeFactuur] is not
null))))
  
```

```

ALTER TABLE [dbo].[ARTIKEL] ADD CONSTRAINT [DEF_ARTIKEL_INVOERDATUM] DEFAULT
((getdate())) FOR INVOERDATUM
  
```

Project results

A web based HAN Individueel Onderwijs system implemented for CPM department in March 2013

Formulieren ▾ **Inschrijving (2/23)**

Start ▸ **Inschrijving**

[Toevoegen](#)
[Bewerken](#)
[Vervrijden](#)
[Zoeken](#)

[Tabel-weergave](#)
[Exporteren](#)
[Inschrijven voor complete opleiding](#)

Inschrijving ▾

Reg nr 701284-Nabben-MTJO-Misja	Status inschrijving AS-Actief studerend	Opzegtermijn 3	Begeleiding S-Schriftelijk	Wijzigdatum
Inschrijfnnummer 201296	Bewijs van inschrijving? J-Ja	Betaalwijze MI-AC-Module incens mbv factuur	Notities	
Woonadres PAST STRYKERSSTR 7, 5809 BG LEU	Inschrijfgeld? J-Ja	Gebruiker begeleider 158-Cecilia Gerritsen	Invoerdatum woensdag 6 februari 2013	

Onderbreking, Beëindiging ▾

Afbreken	Afbreke datum
----------	---------------

Organisatie ▾

Reg nr organisatie	Adressering	Studierapportage? N-Nee
--------------------	-------------	--

Factuur naar, Verzenden naar ▾

Factuur naar PERSOON	Verzendennaar PERSOON
---	--

Factuur naar persoon ▾

Reg nr factuur persoon 701284-Nabben-MTJO-Misja	Adrestype factuur persoon P-POSTADRES	Persoon factuuradres PAST STRYKERSSTR 7, 5809 BG LEU
--	--	---

Verzending naar persoon ▾

Reg nr verzending persoon 701284-Nabben-MTJO-Misja	Adrestype verzending persoon P-POSTADRES	Persoon verzendadres PAST STRYKERSSTR 7, 5809 BG LEU
---	---	---

Gewijzigd 56 dagen geleden vanaf:::1 door:grscv, aangemaakt 56 dagen geleden vanaf:::1 door:grscv

Samenstelling studieprogramma (4)

Opties	Module	Volgnr.	studie Indicator	toelating	Status: V/D	Afspraakstatus	Zenddatum	Reg nr docent
AL15-Voorbereidend Jaar Technische HBO	7004-Voorbereidende Wiskunde HBO	1.00	N-Nee	D-definitief	EC-Cursist die de cursus regulier beëindigd	6-2-2013	241428-Schaaf-J.-	
	6121-Natuurkunde: toelating HTO	2.00	N-Nee	D-definitief	EC-Cursist die de cursus regulier beëindigd	6-2-2013	241428-Schaaf-J.-	
	6122-Scheikunde: toelating HTO	3.00	N-Nee	D-definitief	EC-Cursist die de cursus regulier beëindigd	6-2-2013	-	
	6081-Rapporteren	4.00	N-Nee	V-Voorlopig	-	7-5-2013	248178-Lockefeer-E.L.R.M.-	

Conclusions

- ❑ Development is based on (meta-)data transformations instead of programming.
- ❑ More declarative rules instead of procedural code
- ❑ Testing is primarily based on testing the existence of (meta-)data in the new environment.



Errors arise in procedural code not in declarative rules

- ❑ **Project cost of HAN IO II was < 10% of the original costs of HAN IO I.**

Input for future research and improvements regarding application generation for us and bachelor / master students

- ❑ Improving default heuristics.
- ❑ Improving subtype support
- ❑ Improving foreign key titles
- ❑ Improving the visualization of child records
- ❑ Improving the user interface controls to support high volume domain tables
- ❑ Adding the verbalized fact type expression to the user interface

Future research and improvements regarding application generation

- Adding the verbalized fact type expression to the user interface

Classify/Qualify expression

Enter a new expression:

Enter a new fact expression

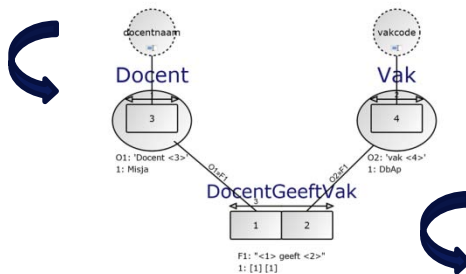
Docent Misja geeft vak DbAp

Qualify the expression:

Fact type name:

DocentGeeftVak

☒ Qualify ☒ Cancel



```

INSERT INTO dbo.tblUFGHelpText
(uhe_TableName,uhe_Rolenname,uhe_Language,uhe_HelpText)
SELECT
utb_TableName,'UFGAdministrator','Nederlands',
ISNULL(CAST((SELECT Expressions.Expression AS span
FROM tblUFGColumns
OUTER APPLY
(SELECT CHAR(10) + CHAR(13) + Expressions.Expression AS Expression
FROM FCOIMDemo.dbo.tblFCO_OTFT
INNER JOIN FCOIMDemo.dbo.tblFCO_Roles
ON otf_Modelname = rol_PlayedModelname
AND otf_ModelType = rol_PlayedModeltype
AND otf_OTFTName = rol_PlayedBy_OTFT
CROSS APPLY FCOIMDemo.dbo.fn_AllRegExpression(
otf_Modelname,otf_ModelType,rol_PartOf_OTFT) AS Expressions
WHERE otf_Modelname = 'OIS'
AND otf_ModelType = 'EL-IGD'
AND otf_OTFTName = ucl_TableName
) AS Expressions
WHERE ucl_TableName = utb_TableName
AND Expressions.Expression LIKE '%<' + ucl_ColumnName + '>%'
FOR XML PATH('br'),ROOT('ROOT'),TYPE) AS VARCHAR(MAX)),'-')
FROM tblUFGTables
  
```

Formulieren ▶ Docent (1/1)

Start

Toevoegen Bewerken Verwijderen Zoeken

Hoofdgegevens

Docentnaam

Misja

Gewijzigd 9 minuten geleden vanaf:MNABBEN door:NT AUTHORITY\NETWORK SERVICE

Docentgeeftvak (1)

Toevoegen Opties Sluiten

Vakcode

DbAp

Hulp voor: Docent

Hulp voor UFGAdministrator:

Docent <docentnaam> geeft vak <vakcode>

concept

Thank you for your attention

More info at:

Lectoraat Model-based Information Systems - HAN.nl

<<Google>> M-BIS

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