The impact of the application of geo-standards on business processes

SDI Seminar SPATIALIST

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Spatial Data Infrastructure and Public Sector Innovation

Outline

- Context
- Geo-standardisation
- SDI-performance
- Impact of geo-standardisation on SDI-performance
- Conclusions

Outline

- Context & problem statement
- Geo-standardisation
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Context & problem statement

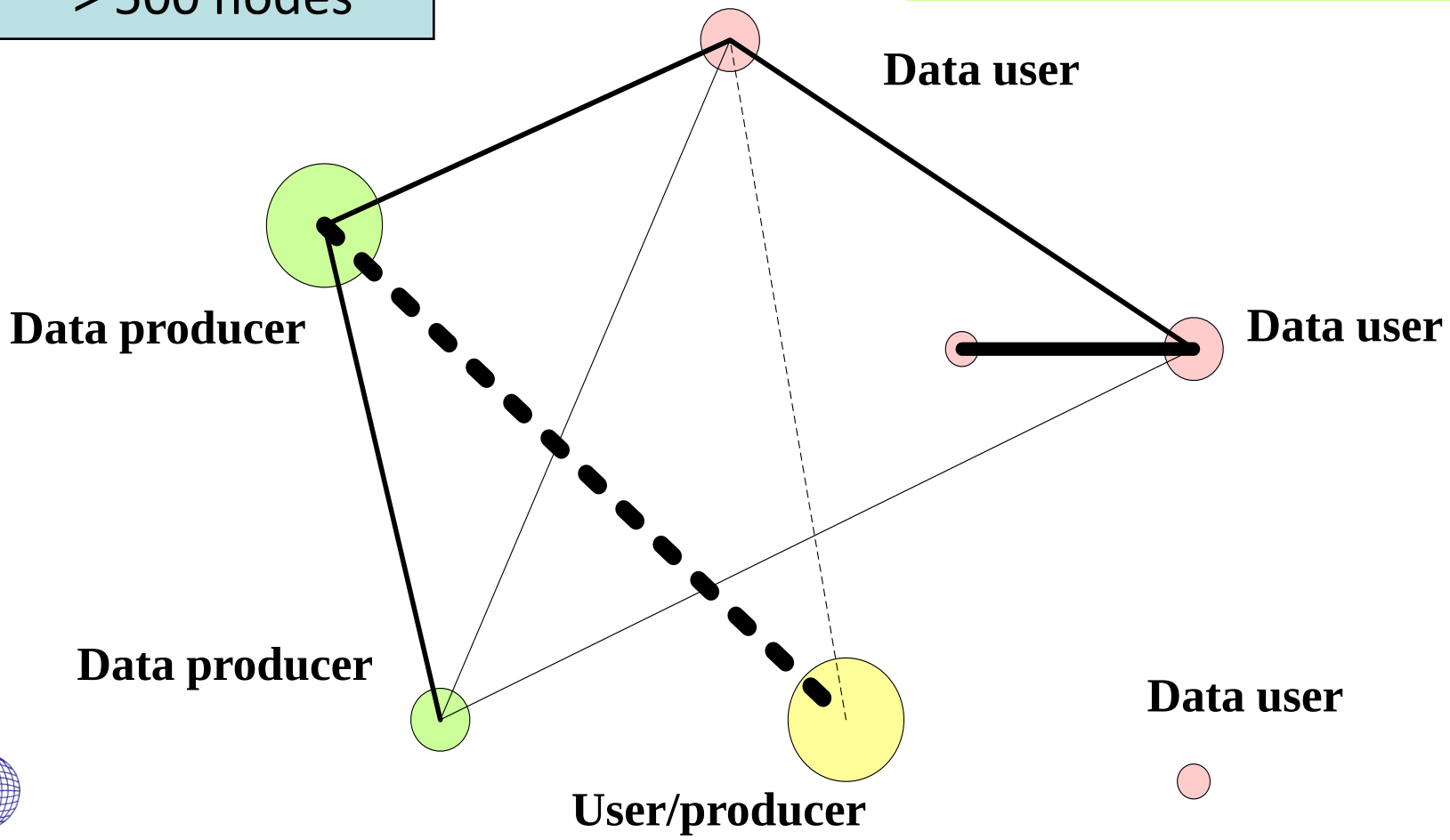
- Many SDI initiatives and definitions
  - (Clinton 1994, ANZLIC 1996, GSDI 1999, Groot and MacLaughlin 2000, Rajabifard et al. 2003, Wytzisk & Sliwinski 2004, van Loenen 2005, INSPIRE 2007, ...)

"SDI are the technological and non-technological set-ups [combination of components] within and between organisations [network] to facilitate access, use and sharing of spatial data [narrow objectives] thereby contributing to the performance of business processes [broader objectives]."
(SPATIALIST, 2008)

Context & problem statement

Flanders:
> 500 nodes

The network perspective



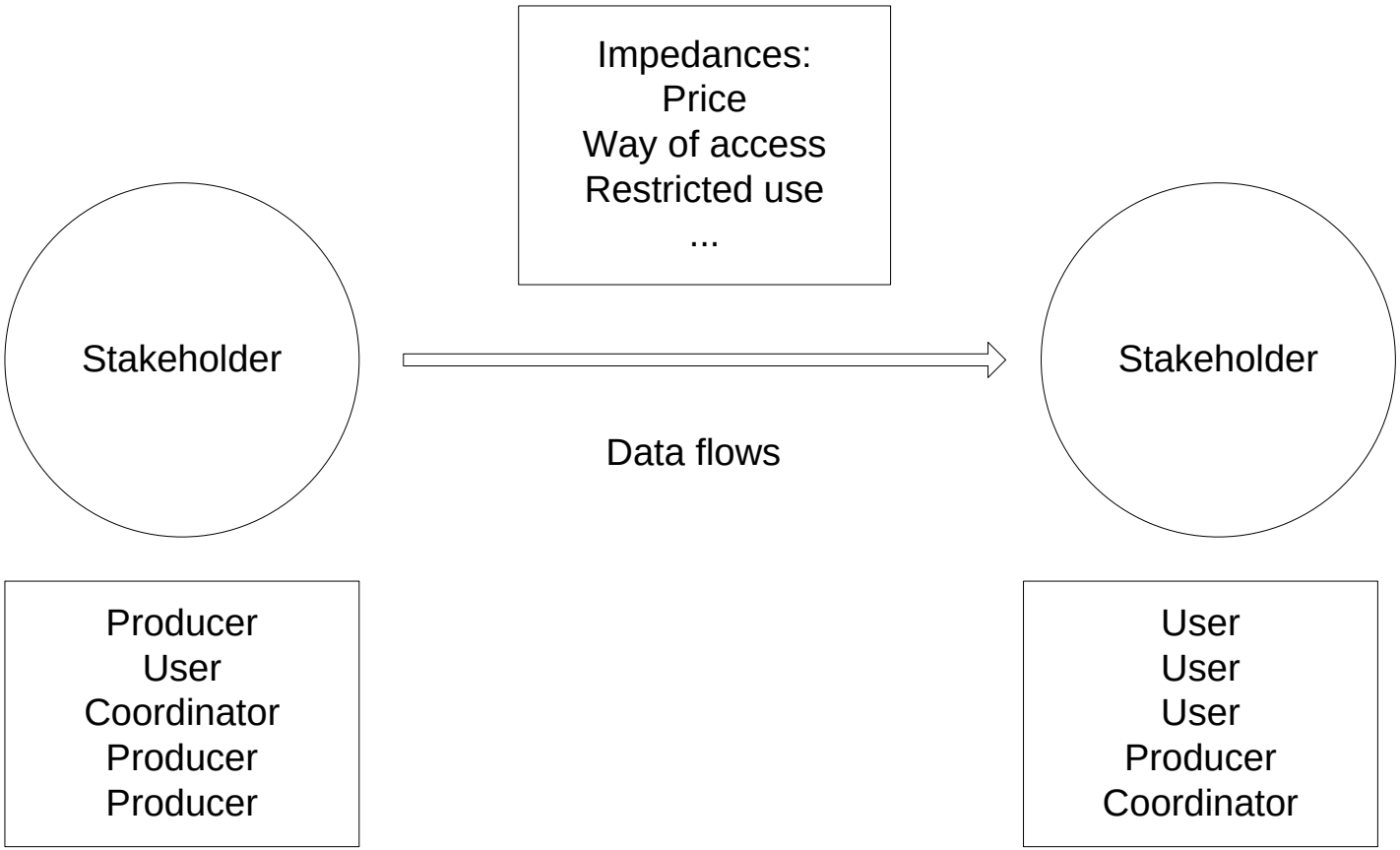
Context & problem statement

- In order to let the data flow and use them in a coherent way:
  - Need for interoperability - (see also ISO, 2004)
  - Semantic (content) and technical (system) – (see also Bishr and Radwan, 2000; Thewessen, 2004)

Interoperability means the possibility for spatial data sets to be combined, and for services to interact, without repetitive manual intervention, in such a way that the result is coherent and the added value of the data sets and services is enhanced (INSPIRE)

"Interoperability is the ability of disparate and diverse organisations to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organizations via the business processes they support, by means of the exchange of data between their respective information and communication technology (ICT) systems." (EIF 2.0)

Context & problem statement



Research Design

Analysing business processes
- Land Use Planning
- Mapping floods
- Registration of traffic accidents
- Management of addresses

>> 24 embedded cases
120 interviews, +200h

Access & Distribution policy, organizational structure, degree of standardization, pricing mechanism, …

Set-up

- **Technology – geo-standards**
- **Legislation**
- **Licensing & Funding**
- **Organization**
- **Coordination & cooperation**

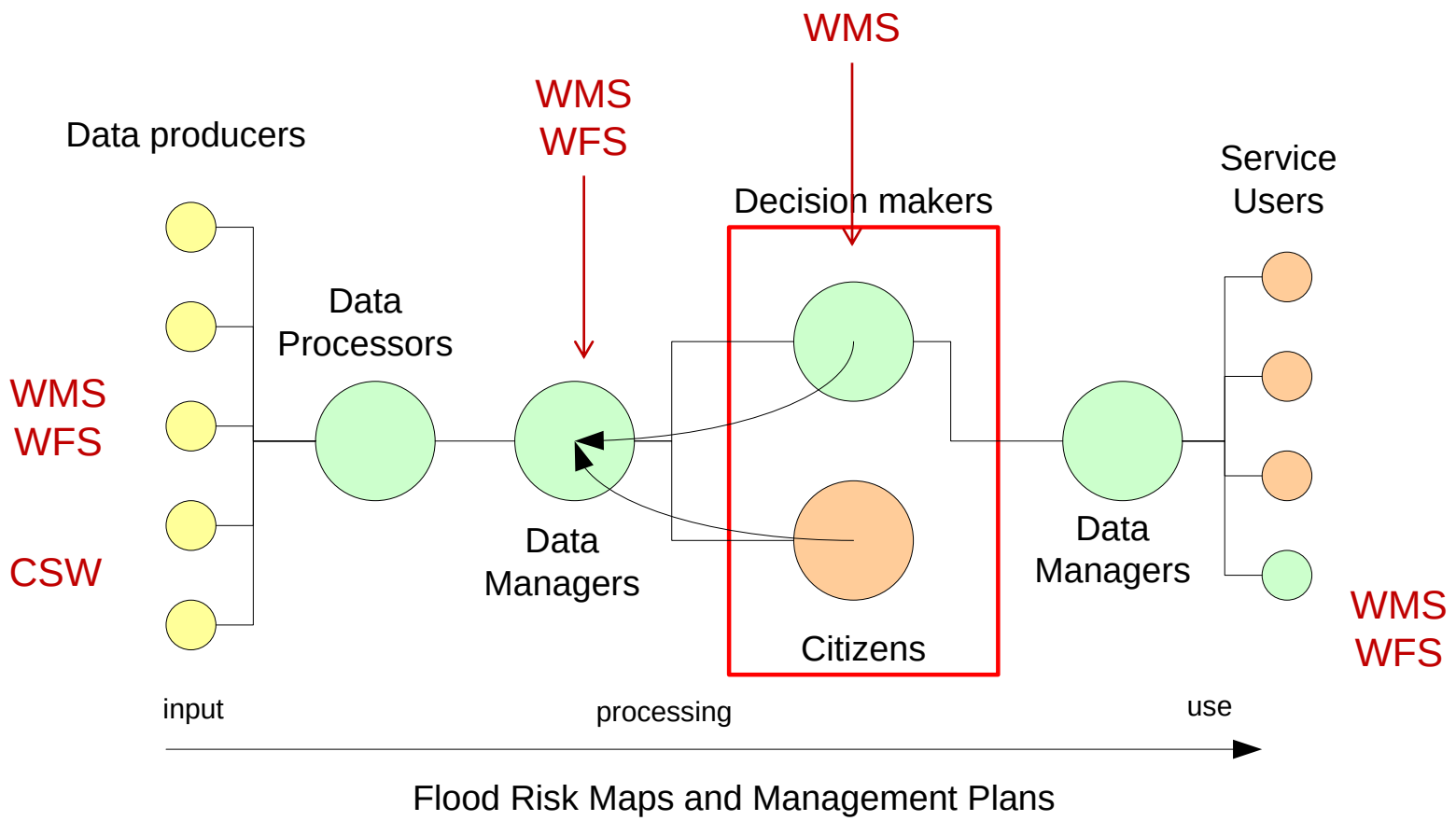
Efficiency of access, intensity of use, degree of sharing

PERFORMANCE
Access, use and sharing
+
Contribution to the Performance of the process

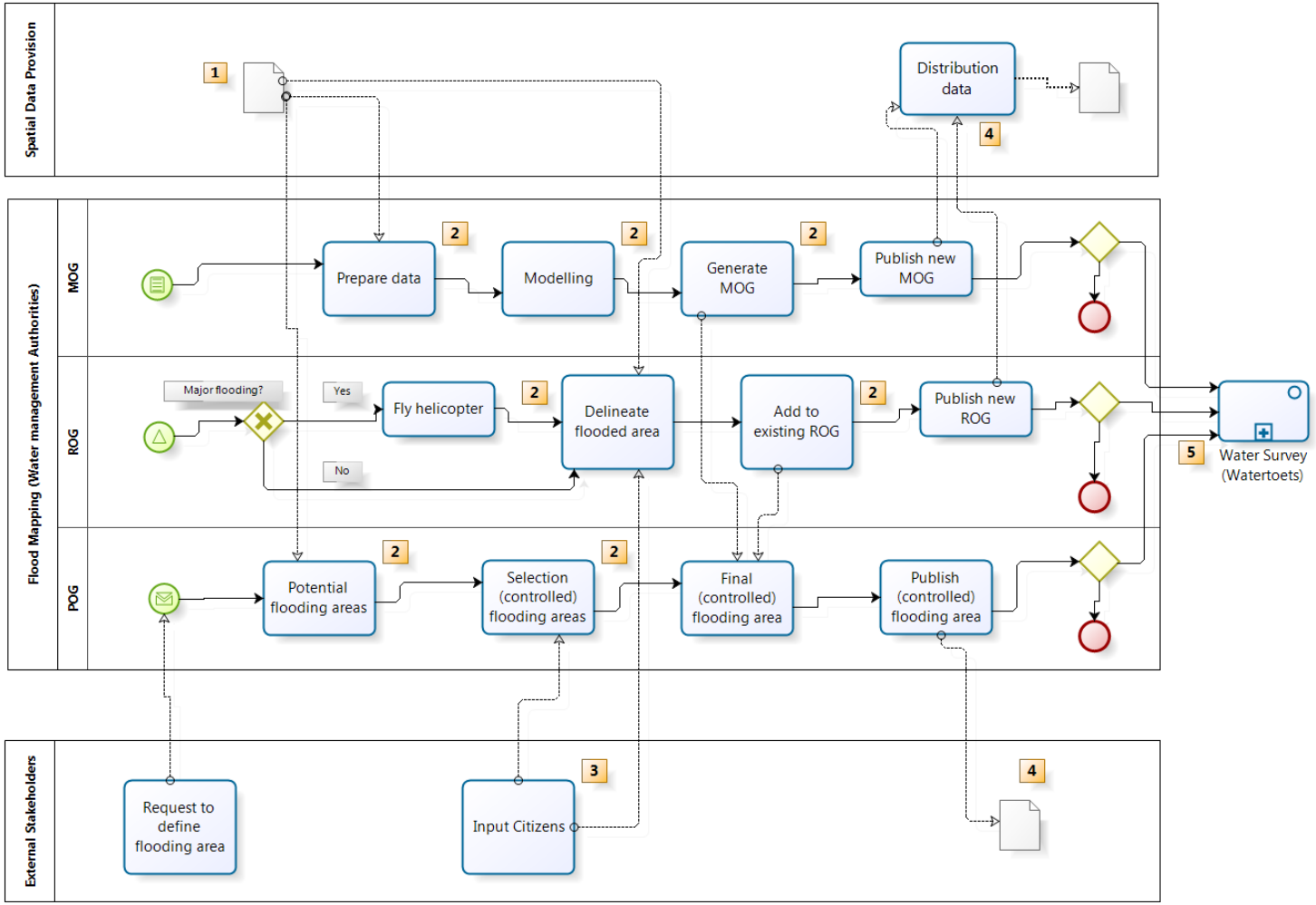
What is the impact of the application of geo-standards on the performance of processes

Efficiency & quality,
Flexibility & innovation
Transparancy & reliability

Analysing business processes



Analysing business processes



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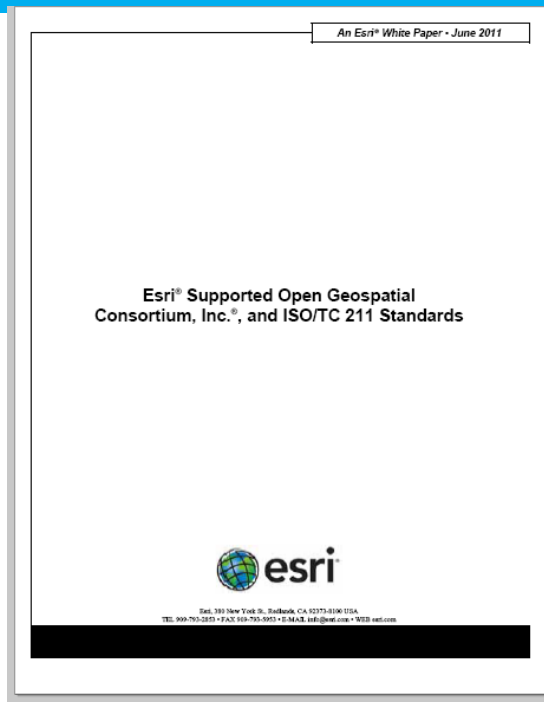
Theories about standardisation

- Diffusion Theory
  - Applied to the development of SDI
    - Diffusion as a process by which an **innovation** is communicated through certain channels over time among the members of a social system (Rogers, 1983)
    - E.g. Masser (2005); Chan et al. (2001); ...
  - Model of technology diffusion applied to standards (Weitzel et al.)
    - Analysed **positive network effects**
    - Distinction is made between **direct** (exchange) and **indirect** network effects
    - **Standardisation process**: discrepancy between private and collective gains – when does it pay of?
    - The **early adopter** paradigm and the **lock-in problem**

Geo-standardisation

- Application in the context of SDIs
  - Geo-standardisation process itself
    - OGC, ISO/TC 211
  - Adoption and implementation process
    - Integration of new specifications in products
    - E.g. INSPIRE metadata profile in ArcGIS products
    - E.g. WMS services supported by Open Source products
  - What with the multi-stakeholders of the SDI
    - Who implements geo-standards?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Esri® Supported Open Geospatial Consortium, Inc.®, and ISO/TC 211 Standards

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ESRI			Top
Product Name	Type	Contact	Date
* ArcGIS Server for DB2 9.3	Server	Danko, David	2008-10-01
ArcIMS 4.0, 4.0.1	Server and Client	Danko, David	2005-02-07
* ArcGIS Server Enterprise (ArcSDE) for DB2 10.0	Server	Sankaran, Satish	2010-06-01
ArcGIS Server 9.0	Server	Danko, David	2005-01-12
* ArcGIS Server Enterprise (ArcSDE) for DB2 - Spatial Types and Functions 9.3.1	Server	Sankaran, Satish	2009-07-01
ArcGIS Explorer	Client	Danko, David	2008-03-11
* ArcSDE for Oracle 9.1	Server	Danko, David	2005-08-22
* ArcIMS 9.2	Server	Danko, David	2006-10-24
* Spatial Database Engine for Oracle 3.0.2	Client	Danko, David	1999-12-23
* ArcSDE for Oracle 9.0	Server	Danko, David	2005-08-22
* ArcIMS 9.1 SP1	Server	Danko, David	2005-11-01
* ArcGIS Server Enterprise: Oracle - Spatial Types and Functions 9.2	Server	Danko, David	2006-10-24

Geo-standardisation

- ***The nice thing about standards is that there are so many to choose from***. - Andrew S. Tannenbaum

- There are mainly two classes of geo-standards
  - Semantic standards – abstract specifications often used to describe how to model and implement spatial data
    - E.g. ISO 19131 – Data Product Specification
  - Technical standards – implementation standards describing interfaces
    - E.g. WMS
  - Referring back to the presentation(s) of Diederik Tirry

Geo-standardisation

ISO/TC 211 PUBLICATIONS (1)

- ISO 6709:2008 – Standard representation of geographic point location by coordinates *
- ISO 19101:2002 – Reference model (under revision) *
- ISO 19101-2:2008 – Reference model – Part 2: Imagery
- ISO/TS 19103:2005 – Conceptual schema language (under revision)
- ISO/TS 19104:2008 – Terminology
- ISO 19105:2000 – Conformance and testing *
- ISO 19106:2004 – Profiles *
- ISO 19107:2003 – Spatial schema *
- ISO 19108:2002 – Temporal schema *
- ISO 19109:2005 – Rules for application schema *
- ISO 19110:2005 – Feature cataloguing methodology (under revision) *
- ISO 19111:2007 – Spatial referencing by coordinates *
- ISO 19111-2:2009 – Spatial referencing by coordinates – Part 2: Extensions for parametric values

* This standard is adopted as an EN

ISO/TC 211

Geo-standardisation

ISO/TC 211 PUBLICATIONS (2)

- ISO 19112:2003 – Spatial referencing by geographic identifiers *
- ISO 19113:2003 – Quality principles (under revision) *
- ISO 19114:2003 – Quality evaluation procedures (under revision) *
- ISO 19115:2003 – Metadata (under revision) *
- ISO 19115-2:2008 – Metadata – Part 2: Extensions for imagery and gridded data *
- ISO 19116:2004 – Positioning services *
- ISO 19117:2005 – Portrayal (under revision) *
- ISO 19118:2005 – Encoding (under revision) *
- ISO 19119:2005 – Services *
- ISO/TR 19120:2001 – Functional standards
- ISO/TR 19121:2000 – Imagery and gridded data
- ISO/TR 19122:2004 – Qualification and certification of personnel
- ISO 19123:2005 – Schema for coverage geometry and functions *

* This standard is adopted as an EN

ISO/TC 211

Geo-standardisation

ISO/TC 211 PUBLICATIONS (3)

- ISO 19125-1:2004 – Simple feature access – Part 1: Common architecture (under revision) *
- ISO 19125-2:2004 – Simple feature access – Part 2: SQL Option (under revision) *
- ISO/TS 19126:2009 – Feature concept dictionaries and registers *
- ISO/TS 19127:2005 – Geodetic codes and parameters
- ISO 19128:2005 – Web Map Server Interface *
- ISO/TS 19129:2009 – Imagery, gridded and coverage data framework
- ISO/TS 19130:2010 – Imagery sensor models for geopositioning
- ISO 19131:2007 – Data product specification *
- ISO 19132:2007 – Location-based services – Reference model *
- ISO 19133:2005 – Location-based services – Tracking and navigation *
- ISO 19134:2007 – Location-based services – Multimodal routing and navigation *

* This standard is adopted as an EN

ISO/TC 211

Geo-standardisation

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ISO/TC 211 PUBLICATIONS (4)

- ISO 19135:2005 – Procedures for item registration *
- ISO 19136:2007 – Geography Markup Language (GML) *
- ISO 19137:2007 – Core profile of the spatial schema *
- ISO/TS 19138:2006 – Data quality measures (under revision)
- ISO/TS 19139:2007 – Metadata – Implementation specification *
- ISO 19141:2008 – Schema for moving features *
- ISO 19144-1:2009 – Classification systems – Part 1: Classification system structure
- ISO 19142:2010 – Web Feature Service *
- ISO 19143:2010 – Filter encoding
- ISO 19146:2010 – Cross-domain vocabularies *

* This standard is adopted as an EN

ISO/TC 211

Geo-standardisation

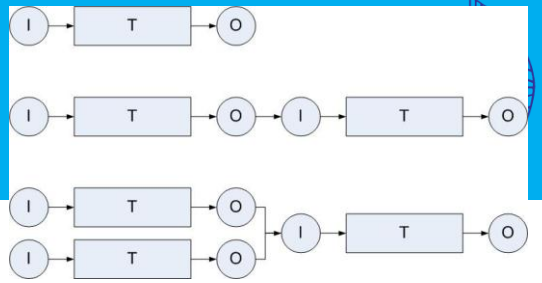
ISO/TC 211 PROJECTS (2)

Colour legend: DIS, FDIS

- ISO 19147 – Transfer Nodes
- ISO 19148 – Linear Referencing
- ISO 19149 – Rights expression language for geographic information – GeoREL
- ISO 19150-1 – Ontology – Part 1: Framework
- ISO 19150-1 – Ontology – Part 2: Rules for developing ontologies in the Web Ontology Language (OWL)
- ISO 19151 – Dynamic Position Identification Scheme for Ubiquitous Space (u-Position)
- ISO 19152 – Land Administration Domain Model (LADM)
- ISO 19153 – Geospatial Digital Rights Management Reference Model (GeoDRM RM)
- ISO 19154 – Standardization Requirements for Ubiquitous Public Access (Stage 0 – NWIP initiated
- ISO 19155 – Place Identifier (PI) Architecture
- ISO 19156 – Observations and measurements
- ISO 19157 – Data quality (revision of ISO 19113:2003, ISO 19114:2003 and ISO/TC 19138:2006)
- ISO/TS 19158 – Quality assurance of data supply
- ISO/TS 19159 – Calibration and validation of remote sensing imagery sensors and data
- ISO 19160 – Addressing (Stage 0)

ISO/TC 211

Research Design



- Set-up – technological aspects – geo-standards
  - It is about the application of geo-standards and the standardisation behavior
  - Looking to the (sub-)process from different perspectives
    - Input
    - Throughput (the process itself)
    - Output
    - + Context
  - 4 variables and 10 sub-variables are defined to classify the information from the interviews
    - Access and distribution mechanisms for spatial data
    - Access and distribution formats
    - Application of data specifications
    - The creation, use and delivery of metadata
  - Allows to classify the organisations (embedded cases) regarding their geo-standardisation behavior

Research design

- Examples of variables
  - Access mechanisms
    - 4 levels according to the interoperability levels defined by US DoD
    - CD/DVD, FTP/e-mail, online webmapping, service oriented access
  - Distribution format
    - 3 levels according to the type of exchange formats used
    - De facto standards (e.g. SHP files), GML (or XML) international standard
  - Metadata creation
    - 4 levels according to the degree to which they are created in a standardised way
    - None, descriptive files, established own norm, standard (ISO, INSPIRE, …)
  - Application of data model / data specification
    - 4 levels of application
    - From fully applied (very strict) to not applied

Research design

Spatial Zoning Plans

	RWO	Limburg	West-Vlaanderen	Genk	Kortrijk	Leuven
Access format	Low	Low	Medium	Low	Medium	Low
Access mechanism	Low	Low	High	Low	High	Low
Use of metadata	Low	Medium	Low	Low	Medium	Low
Degree of Standardisation	**Low**	**Low**	**Medium**	**Low**	**Medium / High**	**Low**

	RWO	Limburg	West-Vlaanderen	Genk	Kortrijk	Leuven
Application Data Model	Medium/ High	Medium/ High	High	Medium	Medium	Medium
Metadata Creation	High	High	High	Low	Medium	Medium/ High
Degree of Standardisation	**High**	**High**	**High**	**Low**	**Medium**	**Medium**

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SDI assessment, SDI impact, SDI performance

- List previous SDI assessment activities
  - Research
    - Ian Masser (1999), Rajabifard et. al. (2003): generational
    - Steudler et al. (2003): Evaluation and Performance indicators
    - Van Orshoven & Vandenbroucke (2003/4/5): INSPIRE State of Play
    - Kok & Van Loenen (2004): Organisational/Institutional
    - Delgado et al. (2005): SDI-Readiness
    - Rodriguez Pabon (2005): Theoretical framework to assess SDIs
    - Crompvoets (2006): Clearinghouse Suitability Index
    - Lance et al. (2006): SDI control evaluation
    - Giff (2006): Performance based management
    - Grus et al. (2007, 2008): CAS, Multi-view framework
    - …

Different assessment orientations, different approaches, different sampling methods, different levels, different definitions

SDI assessment, SDI impact, SDI performance

- List previous SDI assessment activities
  - Projects & activities
    - GSDI survey (Onsrud): assessment of SDI at global level
    - Impact assessment at NSDI level (e.g. CH)
    - SDI Observatory (IDEE)
    - Monitoring implementation of regional SDI (e.g. AGIV, including use of indicators)
    - C/B at local levels (e.g. City of Leuven)
    - MetroGIS (US)
    - ...

Relatively ‘new’ field, very few operational set-ups, few from business process / user perspective

Example of impact study

- Return on Investment study NASA
  - Booz-Hamilton
  - Focus on interoperability issues and set-ups
  - GeoVMM process (Value Measurement Method)

Table 5: Weights Assigned by Experts to GeoVMM Value Factors

Direct User Value	**26.5%**	
Data Availability	38%	10.1%
Ease of Use	37%	9.9%
Broad Data Sharing Capabilities	25%	6.5%
Social Value	**28.7%**	
Better Decision Making Ability	27%	7.8%
Extra-Governmental Coordination	20%	5.8%
Minimal Barriers	20%	5.7%
Institutional Effectiveness	20%	5.6%
Efficient Use of Taxpayer Resources	13%	3.7%
Government Foundation/Operational	**24.4%**	
Ease of Integration	23%	5.6%
Intragovernmental Collaboration	17%	4.1%
Public Participation and Accountability	15%	3.7%
Interagency Collaboration	14%	3.4%
Reuse, Adaptation, and Consolidation	14%	3.3%
Mainstreaming of GIS	11%	2.7%
IT Performance	6%	1.5%
Government Financial Value	**11.6%**	
Total Cost Savings	62%	7.2%
Total Cost Avoidance	38%	4.4%
Strategic/Political Value	**8.8%**	
Close Working Relationship	30%	2.7%
Supports Improved Decision Making	30%	2.7%
Supports NSDI	28%	2.4%
E-Gov Support	12%	1.0%
Total		**100%**

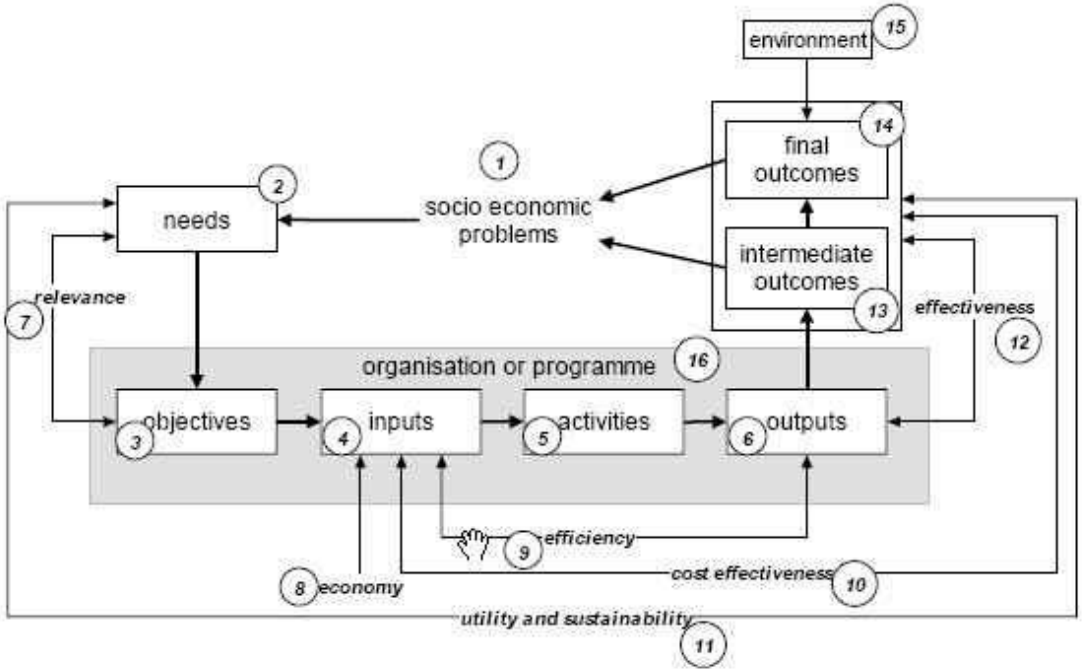
Source: Booz Allen Hamilton 2005, pg. 16

Approach SPATIALIST

- Review scientific literature and practices
  - Of existing SDI assessment approaches
  - Of practices and aproaches in eGovernment
- What do we want to assess?
  - Does the SDI reach its objectives?
  - Does it contribute to the process performance?
  - Level of granularity – overall SDI, business processes, organisations and their relations
    - SDI seen from a network perspective
    - Seen from the business processes and the users of the SDI within those processes

Approach SPATIALIST

- Performance and impact assessment
  - Framework used in eGovernment & Public Management
  - Applied to SDIs as well (e.g. Lance, Giff)



(Van Dooren et al., 2010)

Approach SPATIALIST

- Looking at
  - Input, Output, Outcome (short term), Impact (long term outcome)
    - Input-throughput-output model (Thompson, 1967)

Input	Output	Outcomes	Impact
Technical and non-technical set-ups	Effect on the access, use and sharing of data	Effect on the process	Broader effect on policy making, citizen

  - Look into efficiency and effectiveness by comparing input, output and outcome

Research Design

- SDI performance - double approach
  - Performance in the narrow sense – 3 variable and 7 sub-variables
    - Efficiëncy of geospatial data access
    - The intensity of geospatial data use
    - The degree of geospatial data sharing
    - ☞ **Degree to which the data / information flows i.e. an indication of interoperability**
  - Contribution to the performance of the process – 1 variable and 3 sub-variable
    - Based on several criteria (efficiency & quality; flexibility & innovation; transparency & reliability)
  - This allows to classify the organisations regarding their SDI-performance

Research design

- Examples of variables
  - Efficiency of access – lead time and HR needed
    - Easiness to find
    - Efforts to obtain
  - Intensity of use
    - Time intensity – from occasional to daily
    - Extent user group – from none to majority of people in the process
    - Scope of use – from basic to advanced
  - Degree of sharing
    - Extent of sharing – with whom
    - Content of sharing - what
  - Contribution to process performance – scored by process owners
    - Efficiency & quality
    - Flexibility & innovation
    - Transparancy & reliability

Research design

Performance	RWO	Limburg	West-Vlaanderen	Genk	Kortrijk	Leuven
Intensity of use	High	Low	High	High	High	High
Extent user group	Medium	Low	High	Medium	Medium	High
Scope of use	Medium	Low	Medium	Medium	Medium	Medium
Intensity of Use	**Medium / High**	**Low**	**High**	**Medium / High**	**Medium / High**	**High**

Spatial Zoning Plans

	RWO	Limburg	West-Vlaanderen	Genk	Kortrijk	Leuven
Efficiency and Quality	High	Medium	Medium / High	Medium / High	Medium	Medium / High
Flexibility and Innovation	High	Low	Medium	Low	Low	Low
Transparency and Reliability	High	Low	Medium	Medium	Medium / Low	Medium
Contribution to sub-process performance	**High**	**Low**	**Medium / High**	**Medium**	**Medium / Low**	**Medium**

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Qualitative analysis

Spatial Zoning Plans

		Key Variable	Criterion	RWO	West-Vlaanderen	Genk	Leuven	Kortrijk	Limburg
SDI CONFIGURATION	INPUT	Access policy	Coordinated policy	yes	yes	yes	Yes	no	no
		Degree of standardisation	Marked standardisation	no	yes	no	No	yes	no
		Legal arrangements	Simplicity of legal arrangements	no	no	no	no	no	no
		Transaction costs	Low costs	yes	no	yes	yes	no	yes
	THROUGHPUT	Sub-process structure	Integrated sub-process	yes	yes	no	no	no	no
		Spatial data function in sub-process structure	Embedded spatial data function	yes	yes	no	no	no	no
		Degree of standardisation	Marked standardisation	yes	yes	no	no	no	yes
	OUTPUT	Distribution policy	Coordinated policy	yes	yes	no	yes	no	no
		Degree of standardisation	Marked standardisation	yes	yes	no	no	no	no
		Financial arrangement	No costs	yes	no	no	no	no	no
	CONTEXT	Organisational structure	Matrix structure	no	yes	no	no	yes	no
		Spatial data function in organisational structure	De-concentrated spatial data function	yes	no	no	no	yes	yes
		Internal demands	Strong internal demands	yes	yes	no	no	no	no
		Degree of standardisation	Marked standardisation	yes	yes	yes	no	no	no
		Privacy policy	Fairly open privacy policy	-	yes	yes	yes	no	no
		Funding model	Cost recovery	no	no	no	yes	no	no
OVERALL PERFORMANCE				**High**	**High**	**Medium**	**Medium**	**Low**	**Low**

Results & observations

- Overall, the degree of standardization is weak
  - Limited use and deployment of the OGC type of services
  - Use of GML limited to test environments
  - Development of spatial data is not done according to ISO19100 series of standards
  - Metadata according to standards (ISO, FGDC, …), or own norm
- Standardisation <> performance – general observations
  - The organizations that standardize more, also have a higher performance - trend
    - Not necessarily to the same extent for every process studied
    - Not always very explicit at all levels (input-throughput-output)
  - Other factors seem to play a (sometimes more) important role

Results & observations

- Particular relationships were found as well
  - The application (or not) of data specifications seems to have an important impact on the performance
    - At the level of the usage of spatial data in the process
    - As well as on the degree of sharing
  - The weak standardization of the data models upstreams seems to have an important negative impact on performance
    - More specifically, the efficiency of access tends to decrease
    - In general, a lot of re-engineering is done in order to allow usage of the data in the process (Unique IDs, classification schemes, definitions, ...)
  - The publication of spatial data through OGC type of services seems to have a positive impact on performance
    - It improves the degree of sharing
  - Metadata are only used and produced to a certain extent, mostly de facto exchange formats, few web services for access are used
    - There is no clear relationship with performance

Conclusions & further work

- The objective of the research was to find the discriminating factors that contribute to improved SDI performance Impact of geo-standardization?
- The more geo-standardization, the better performance; the application of (standard) data specifications is key
- The analysis of SDI from a network perspective allows to better understand the dynamics and integrate the user perspective
- The current approach was qualitative: further improvements of the method are possible and needed

Conclusions

- Zooming in to business processes allows to find bottle necks of flows and to detect reasons for decreased or increased interoperability (measured through efficiency of access, intensity of use and degree of sharing)
  - Real measurements of lead time, resources used, …, would allow to improve the insights
  - A systematic modelling of the studied processes (e.g. with BPMN) would also allow to link more detailed information on the impedances detected and to have a clear view on the bottlenecks in the process chain

Thank you!

Questions?

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