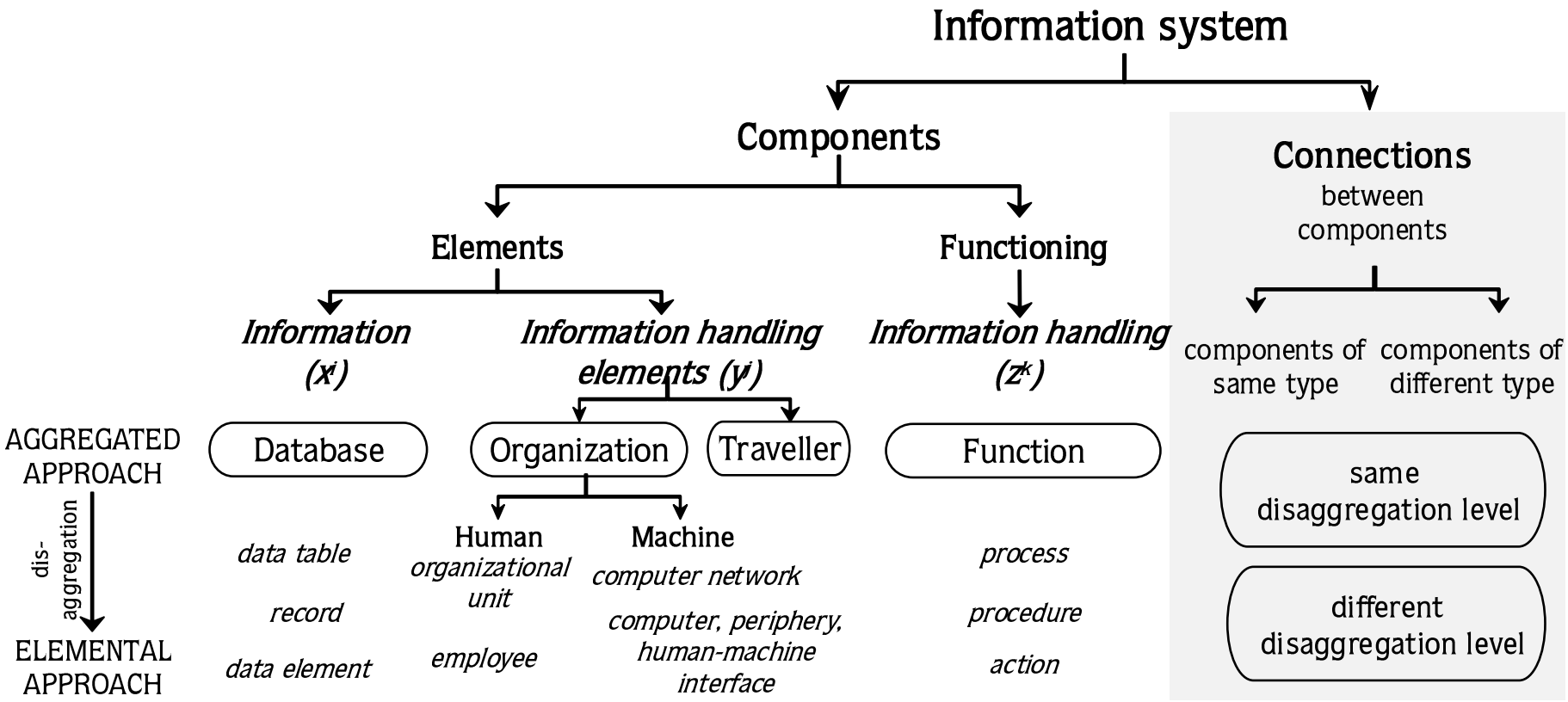
Analysis and modelling methods of transportation information systems

Framework



the connections are realized through the data transfer

Components

Types of components:

1. information handling functions (processes),
2. information handling elements (human and machine components),
3. data groups (data system).

analysis can be performed by several criteria at different resolution levels (breakdowns) in an aggregated or elemental approach (top-down approach)

Vertical extension of the analysis on the base of components

1. functions
   - process,
   - procedure,
   - action,
2. human subsystems (organizations)
   - organizational unit,
   - employee,

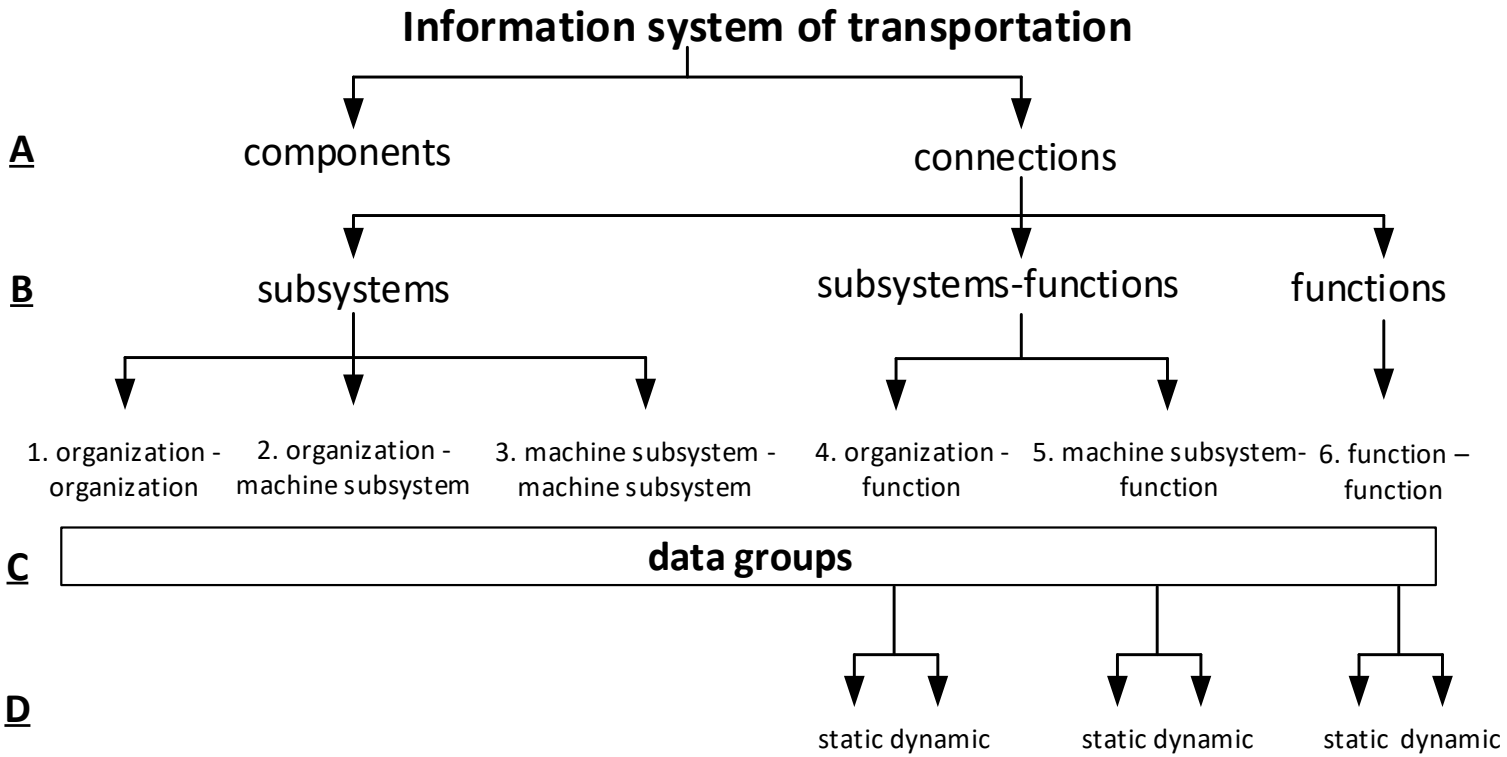
   machine subsystems
   - data collection element,
   - data transmission element,
   - data storing/processing element,
   - human-machine interface,
3. data groups
   - databases,
   - data table,
   - record,
   - data element.

Example: modification of the time of a parking place booking

1. functions
   - traffic management,
   - booking parking place,
   - modification of the time of booking,
2. human subsystems (organizations)
   - parking operator company,
   - dispatcher,

   machine subsystems
   - sensors,
   - wired data transfer channels,
   - server,
   - desktop computerised workstation,
3. data groups
   - database of parking,
   - booking table,
   - parking place booking record,
   - start time of booking data element.

Types of models



Modelling aspects:

A. architecture
B. subsystem structure – functional structure
C. data structure
D. temporal features of operation

modelling the connections within and among the component groups

A - architecture

Only the components and the hierarchy or even their connections are mapped.

B - subsystem structure/functional structure

In order to represent structures connections can be revealed and analysed between subsystems, between subsystems and functions or between functions. As subsystems may include humans and/or machines various pairing of organizations and machine subsystems are to be investigated. Machine subsystems are connected in most cases to human elements (e.g. intelligent driver).

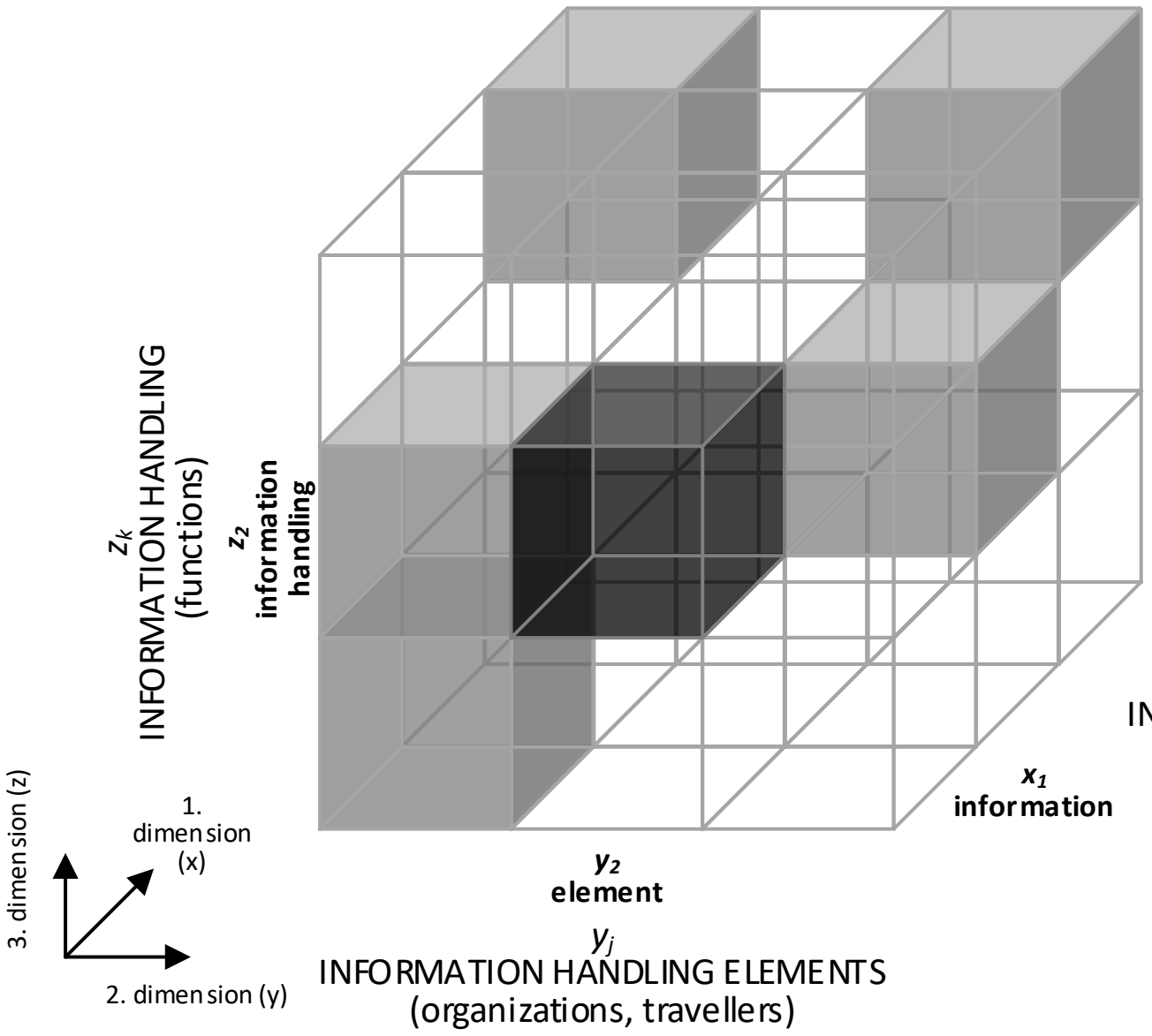
C - data structure

As cooperations are realized by flowing data the data groups, their properties and interrelations are to be explored. Data transmission can be characterized by: direction, volume of data-flow, soundness, rate, duration, reliability, communication technology, etc.

D - temporal features of operation (static/dynamic)

In the case of the connections, where either of the components is a function, its temporal features are also to be studied. Two basic cases can be distinguished: the operation is unaltered in time (static) or the operation is adapting itself due to changing situations (dynamic). Temporal features of the operation significantly influence the input and output data.

Spatial representation



analysis
assessment
planning

slicing

projection
(aggregation)

Analysis aspects

I. Communication technology (communication-intensive systems)

II. What kind of devices are involved and what is the direction of the communication?

III. What is the aim? (impacts are to be derived from aims)

1. improve safety and security
2. improve utilization of the road network capacity
3. reduce travel time (reliable travel time)
4. support driver activities (driver interventions remain)
5. support driver activities (automatic intervention)
6. improve travel comfort (infotainment)
7. fee/fare/toll collection
8. reduce energy consumption
9. protect the environment
10. traffic management (collecting information about traffic)
11. parking management
12. control and enforcement

IV. Where do data come from?

1. from the vehicle
2. from the infrastructure along the road
3. from travellers' devices (e.g. smartphone)

V. What is the technology of data collection?

VI. What does the data collection refer to?

VII. What „induce” the data transmission?

1. event (e.g. reaching a position)
2. time (cycle time)
3. continuous

VIII. Where are the data being stored and processed (where is the intelligence)?

1. in the vehicle
2. in the infrastructure along the road
3. in travellers’ devices (pl. smartphone)

IX. Can so-called information nodes be identified?

information nodes: (organizations) organize and merge information from different sources, and create value-added information

X. What kind of data processing method is used?

1. there is no data processing: handling and transmission of real-time (raw) data
2. processing real-time data (summation, grouping, calculation, etc.)
3. forecast on the basis of historical and real-time data
4. analysis of historical data

XI. What kind and complexity of back-end telematics systems are required?

1. fleet management system (communication among vehicles and remote elements)
2. traffic management (monitor and control) system (communication among infrastructure elements and remote elements)

XII. Where are the data being used?

1. in the vehicle
2. in the infrastructure along the road
3. in travellers' devices (pl. smartphone)

XIII. What are the requirements towards the design and operation of the terminal/device?

(e.g. human-machine interface, RFID)

XIV. What kind of process is induced by the output of the data handling?

1. mandatory (without discretionary margin)
2. non mandatory (with discretionary margin)

XV. What is the availability of information service?

1. commercial
2. public

aims – situation analysis, assessment and comparison of the systems

logical (functional) and physical integration of transportation information systems and services

demands for information can be derived from the **functions**

the functions are timeless, the organizations are not

Analyses of data management

Matrix used for the analyses shows that what kind of data groups (column header) are required for a function (row headers on two levels) of a data handling element. In a simple case an „x” represents the presence of the relationship; further specification can be given in a more detailed analysis.

		Static data			**Semi-dynamic data**			**Dynamic data**		
O_i	F_i	D^s_1	…	D^s_5	D^{sd}_1	…	D^{sd}_5	D^d_1	…	D^d_5
O_1	F_1									
	…									
	F_8									
…	F_1									
	…									
	F_8									
O_6	F_1									
	…									
	F_8									

Analyses of data flows/transmission

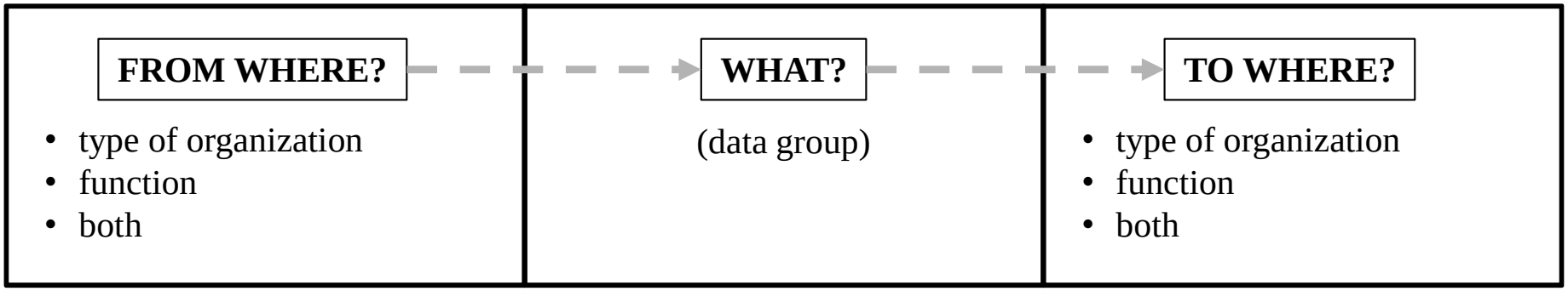
Matrix used for the analyses shows that an output data group of a function of a data handling element (row headers on two levels) transferred to which function of a data handling element (column headers on two levels) as an input. In a simple case an „x" represents the presence of the relationship; further specification can be given in a more detailed analysis (considering the model of data structure).

This representations is a mapping of the three-dimensional relationships in two dimensions.

		O_3																							
		F_1			**F_2**			**F_3**			**F_4**			**F_5**			**F_6**			**F_7**			**F_8**		
O_1	…	…			…			…			…			…			…			…			…		
	F_2					**X**	X					X	X						X			X		X	X
						X						X												X	
							X						X						X						X
					X	X	X				X	X	X	X	X	X							X	X	X
							X						X												X
	…	…			…			…			…			…			…			…			…		

Example (blue cell): The organization O_1 (road operator) provides data group D_1^{sd} (semi-dynamic data on road network, infrastructure and traffic) as output data of function $F_{2,}$ to organization O_3 (fleet operators) as input data of function F_2 (management of traffic).

Simplified analyses of data transmission



Fields of application

- complex analysis of the operation (both basic and information management processes) of organizations, situation analysis, sizing of activities, analyses of information demand, revealing of the information connections that are necessary and/or intended to be developed
- support of decision-making, preparation of modifications in structure of organization
- determination of the structure and the operational characteristics of the machine subsystem; sizing of the operational characteristics of each element
- transportation research
- logical preparation of integration by information of transportation