Modelling Sustainable Systems and Semantic Web

Introduction

Lecture in the Module 10-202-2309
for Master Computer Science

Prof. Dr. Hans-Gert Gräbe
http://www.informatik.uni-leipzig.de/~graebe

April 2021

Background

Interdisciplinarity

Guiding motto of the University of Leipzig:

A Tradition of Crossing Boundaries

- Boundaries: Humanities – Science – Technology
- Tradition: The Faculty of Philosophy until 1951

But what about technology?

Our mode of production today is closely linked to the use of science and technology. This brings advantages, but also problems.

Background

This was not always so. This bourgeois (or capitalist) mode of production has developed over the last 500 years, first in Western Europe and has since spread around the globe.

Technology and its use have undergone important metamorphoses during the last 200 years, which had also a decisive influence on the organisational forms of that mode of production, for example with the establishment of the factory system and industrial production in the second half of the 19th century.

Background

This is the beginning of what brought Marx to the vision of a society in which the "social metabolism" ("gesellschaftlicher Stoffwechsel", MEW 23) is organised in a way that

"no longer does the worker insert a modified natural thing [Naturgegenstand] as middle link between the object [Objekt] and himself; rather, he inserts the process of nature, transformed into an industrial process, as a means between himself and inorganic nature, mastering it. He steps to the side of the production process instead of being its chief actor." (MEW 42, ch. 14)

Background

Marx goes on to state that the development of the productive forces is *necessarily* heading in such a way towards the organisation of the "social metabolism".

"But, once adopted into the production process of capital, the means of labour passes through different metamorphoses, whose culmination is the *machine*, or rather, an *automatic system of machinery* (system of machinery: the *automatic* one is merely its most complete, most adequate form, and alone transforms machinery into a system), set in motion by an automaton, a moving power that moves itself; this automaton consists of numerous mechanical and intellectual organs, so that the workers themselves are cast merely as its conscious linkages." (MEW 42, ch. 13)

Background

The mastery of that "automaton", that apparently "natural" development of society, is on the agenda today, because its "naturalness" is increasingly undermining the very conditions of human existence on our planet.

Marx's vision that in this process the worker "steps to the side of the production process instead of being its chief actor" is based on a very narrow understanding of "production process".

Background

In the 150 years since then this narrow understanding has been replaced by a common modern understanding of "production process", in which

"it is neither the direct human labour the worker himself performs, nor the time during which he works, but rather the appropriation of his own general productive power, his understanding of nature and his mastery over it by virtue of his presence as a social body – it is, in a word, the development of the social individual which appears as the great foundation-stone of production and of wealth". (MEW 42, ch. 14)

Background

In short, it is a question to overcome the "naturalness" of the "automaton" – the socio-technical-cultural "apparatus" created by human as social being – and put it under the control of the united humanity.

This requires one thing above all – educated and committed personnel who are capable of exercising also their civic responsibility (up to Art. 20 of our constitution). Academic institutions are requested to deliver an important contribution to this. This also requires to cross the old and new boundaries between Humanities – Sciences – Technology.

Background

The academic education system has been on this path for more than 100 years, as the development of technological academic educational institutions in Leipzig shows.

- 1838 Foundation of the Royal Saxonian School of Building Professions (Königlich-sächsische Baugewerkeschule) in Leipzig by Albert Geutebrück
- 1875 Foundation of the Municipal School of Trades (städtische Gewerbeschule) in Leipzig as the historical root for education in mechanical and electrical engineering.

  Realisation that tradesmen need a thorough technical education in addition to a general higher education ("humanistische Bildung").

Background

- 1909 Royal Saxonian Building School
- 1914 Technical school for librarians
- 1920 Saxonian State Building School
- 1949 Technical School for Energy Markkleeberg
- 1954 Leipzig College of Civil Engineering
- 1956 Leipzig School of Engineering for Gas Technology
- 1965 School of Engineering for Automation Technology
- 1970 School of Engineering for Energy Management Leipzig
- 1969 Leipzig College of Engineering
- 1977 Unification into Leipzig Technical University
- since 1992 University of Applied Sciences for Technology, Economics and Culture

Background

In the 20th century, with *engineers* a whole new professional group appeared. Nowadays new professions such as computer scientists, are already crossing the border between science and technology and can graduate from our Faculty to obtain a doctorate in science (Dr. rer. nat.), but also a doctorate in engineering (Dr.-Ing.). The situation with the Humanities has not yet been clarified, but at least you can qualify for a Master in Digital Humanities.

Course Programme

Background and Objectives

The course is an interdisciplinary offer in the Master in Computer Science and Master in DH, but can also be taken as a minor (Nebenfach).

The aim of the course is to illuminate important developments in the outlined field of development.

Course Programme

Four Theses

1) The short digital age is already over, the corona age started.
2) Whereas the digital transformation was still characterised by a rapidly growing "world of digital data", through the analysis and processing of which influence on real-world processes was gained, we are now faced with the challenge of using these tools to meet the challenges of the corona crisis.
3) These challenges are only a small foretaste of the challenges that climate change will pose.
4) These challenges are closely linked to fundamental questions not only about our economy or mode or production, but also of our understanding of technology and science.

Course Programme

It is therefore appropriate to address the three topics

- Social structures of digital change
- Modelling of sustainable systems
- Conceptualisation processes and the Semantic Web

and to develop a set of conceptual and terminological tools that are suitable for a viable analysis of these topics.

The conceptual toolkit to be developed is oriented towards various aspects of the development of socio-technical systems that are addressed in the lecture and in the seminar.

Course Structure

The course includes

- A lecture "Modelling of Sustainable Systems and Semantic Web"
- A seminar "Complex Systems and Co-Operative Action"
- A TRIZ practical course.

Note that the access to the e-learning system used in the TRIZ practical course is subject to a fee. Details can be found in the forum of the OPAL course.

Organisational Matters

These course parts can be taken for credit in various combinations

1) All three parts as In-depth Module 10-202-2309 (10 CP) "Modelling sustainable systems and semantic web".
   - **Prerequisites for examination:** successfully completed seminar and practical course.
   - **Examination:** oral examination (30 min)
2) Lecture and seminar as Seminar Module 10-202-2312(5 CP) "Applied Computer Science".
   - **Prerequisite for examination:** successfully completed seminar.
   - **Examination:** RDF project and home work paper.

Organisational Matters

3) The practical course alone as Module 10-202-2012 (5 CP) "Current Trends in Computer Science".
   - **Prerequisite for examination:** successfully completed practical course.
   - **Examination:** oral examination (30 min)

More about this in OPAL `https://bildungsportal.sachsen.de/opal` in the course S21.BIS.SIM. There, please enrol first in the course and then in the corresponding group.

You can access OPAL with the data of your studserv account.

Organisational Matters

You will find a more detailed lecture concept in the github repo `https://github.com/wumm-project/Leipzig-Seminar` in the folder `Summerterm-2021`.

Data protection

We follow an Open Culture approach not only theoretically but also practically and make course materials publicly available. This also applies to the course materials you have to produce (presentations, seminar papers) as well as to (annotated) chat sessions of the seminar discussions, in which your names are also mentioned. **We assume your consent to this procedure if you do not explicitly object**. The discussions themselves are not recorded.

Organisational Matters

- Lecture: Thursdays 11:15-12:45, synchronous digital
- The Flipped Classroom Concept
- Continuously updated lecture plan and list of references in the `Lecture/README.md` file in the github Repo.
- Further (mainly organisational) information also in the forum of the OPAL course.
- Seminar: Tuesdays 9:15-10:45, synchronous digital
- All events online in the BBB room BIS.SIM, `https://meet.uni-leipzig.de/b/gra-w2c-fhz-qnp`

Questions ?

Modelling Sustainable Systems and Semantic Web Technology

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What is Technology?

Technology in the sense of the **VDI Guideline 3780** comprises:

- the set of use-oriented, artificial, representational structures (artefacts or material systems),
- the set of human actions and facilities in which material systems (Sachsysteme) are created and
- the set of human actions in which material systems are used.

Technology assessment thus refers not only to material real-world systems, but also to the conditions and consequences of their creation and use.

Definition of Technology – Purpose and Objective

The **target group** of the VDI Guideline 3780 is all those responsible and affected in science, society and politics, who are involved in decisions about technical developments and in shaping the corresponding socio-cultural framework conditions, in particular engineers, scientists, planners and managers who design and evaluate new technical developments.

The **purpose** of the guideline is to provide all those involved with a common understanding of terms, methods and value ranges. The guideline is intended to systematically analyse objectives, values and alternatives to make well-founded decisions. ...

Technology excites

Technology as a status symbol

But: You find there also detailed description of the technical parameters and the history.

Source: `http://de.wikipedia.org/wiki/Bugatti_Veyron_16.4`

Technology excites?

"Weapons from the 3D printer"
Source: Netzpolitik.org, 29.3.2013

... In the meantime, statistics show that most of military combats take place at distances of less than 400 m, even less than 200 m in urban areas. In the case of police operations, the distances are usually even shorter. At the same time, the shooter is no longer in the open field, but often fights from vehicles or inside buildings, where only compact weapons offer sufficient room for movement. ...

Source: `http://de.wikipedia.org/wiki/Maschinenpistole`

What else is Technology?

Technology is about techniques (in German oft the same word „Technik“ is used for both notions)

- Painting techniques, writing techniques
- Flower arranging techniques
- Political techniques, power techniques

$\Rightarrow$ It is about Practice, Experience, Skill

Different variants of a machine-centered and an action-centered understanding of technology compete with each other.

More on the Concept of Technology

1) The concept of technology for products of technically supported action, i.e. for individual machines or, more comprehensively, for the entire existing system of material means to transform nature for human purposes.

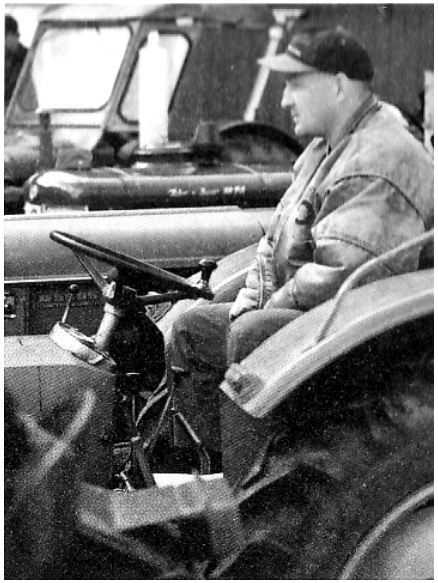
2) An action-oriented concept of technology ... ties in with the Greek concept of *techné* as procedural knowledge that guides people in the production of things ... and thus enables a technical knowledge that controls nature in both a reproductive and a manipulative sense. (Source: H. Petzold, Dictionary of Philosophy)

Technology and Language

Technique is something that obeys to the word.

Example: Sven-Åke Johansson - Concerto for 12 Tractors

Picture source: Höfgen 1996, Photo: Bahr,
`http://www.sven-akejohansson.com`



Technology and Forms of Description

- Technology as "condensed" description
- Essential form in which human agreements manifest theirself
- Technology as a social phenomenon of humanity
- Technology as an intersubjective phenomenon
- Essential intersubjective dimensions: Descriptions and execution of action

What is Technology?

Technology is an interrelation of

- Socially available *procedural knowledge* ("Verfahrenswissen"),
- *Institutionalised procedures* ("Verfahrensweisen", "state of the art") and
- Private *procedural skills* ("Verfahrenskönnen").

Modelling Sustainable Systems and Semantic Web

About the Notion of a Technical System

Lecture in the Module 10-202-2309
for Master Computer Science

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April 2021

Technical Systems in TRIZ

„... a *number of components* combined to a system by establishing *specific interactions* between the components ... assigned to *perform a controllable main useful function* ... within a particular context.“ (Glossary V. Souchkov)

A system is a set of elements ... that form a *unified whole* that has *properties* that only emerge from the *interaction* of the parts (*emergence* of the main useful function). (V. Petrov, 2020)

Significance of the system operator in TRIZ, non-triviality of the anti-system (N. Feygenson, 2020)

Basics

Despite its importance, the definition of the concept remains vague.

How can the concept of a *Technical System* (TS) be sharpened?

1. Which aspects should be considered?
2. Four dimensions of the concept of a TS.
3. Technical Systems as Black Boxes.

Aspects

Differentiation between design time and runtime

- During design time, the basic collaborative work is *planned*.
- During runtime this *plan is executed*.

This requires to distiguish between interpersonal

- forms of description that are communicated as *justified expectations*, and
- embodiments, which *experienced results* stand in a contradictory relation to the justified expectations.

Aspects

Aspect of Reuse

- This does not apply to most large TS – they are *unique specimen*, even if they are assembled from standard components.
- Most computer specialists also create such *unique specimen*, because the IT systems that control the operation of such large TS are also unique.
- The same applies to government agencies, organzations, etc.

Aspects

Clear distinction between the professions

- of Mechanical Engineering and Industrial Plant Engineering as well as
- the Supplier (specialist) and Master Builder (generalist) of such unique specimen.

Thesis 1:

The speciality of a technical system mainly lies in the *interaction of its components* in a world of technical systems.
Purposes embed this relationality in human practices.

First Approximation

The four dimensions of the notion of a *Technial System*

.

1. The real-world unique specimen.
2. The description of this real-world unique specimen.

For components that are manufactured in a larger number, additionally

3. The description of the design of the system template.
4. The description and functioning of delivery, assembly and operation of the real-world unique specimen that were produced according to this template (e.g. production plan, quality assurance plan, delivery plan, plans for operation, maintenance and service).

First Approximation

TS as Black Box

The basis of the concept is the *notion of an Open System* from the more general Theory of Dynamical Systems.

Existing TS are normatively characterized

- at the level of description through the *specification of its interfaces* and
- on the level of embodiment through *guaranteed functioning according to this specification*.

A TS consists of components, which in turn are TS, their specification-compliant functioning is assumed.

Role of the concept of a TS

The concept of a TS has an epistemic function of (functional) "reduction to the essential".

Human practice is inseparably built into the concept of TS because the concepts "essential", "guaranteed" and "functioning" can only be filled with meaning from these practices.

This makes the widespread in TRIZ distinction between technical and socio-technical systems problematic.

TS as White Box

1. Definition of the concept of a TS.
2. TS and the world of technical systems.

The core of a technical system is ...

... the description of concrete processes by reducing them to the essential with the goal of their practical application.

TS as White Box

The reduction to the essential ...

... focuses on the following three dimensions:

(1) Delimitation of the TS from the outside against an *environment*, reduction of this relationships to input/output relations and guaranteed throughput (Purpose and ability to work).

(2) Delimitation of the TS from the inside by grouping parts as *components*, reducing their functioning on a "behavior control" via their interfaces.

(3) Reduction of the relationships in the TS itself to *causally essential* ones.

TS as White Box

The TS in the World of Technical Systems

The description of a TS is only possible based on descriptions of other (explicitly or implicitly given) TS. The description is preceded ...

(1) ... by a vague idea of the (working) input/output characteristics of the environment.

(2) ... by a clear understanding how the components work beyond their pure specification.

(3) ... by a vague idea of cause and effect relationships in the system itself, that precedes the detailed modeling.

TS as White Box

The concept is based on the availability of existing TS, which are present in (2) as components and in (3) as neighboring systems.

Engineering practices thus take place in a *World of Technical Systems*.

Other systems – components or neighboring systems – are present in the description of a TS only by their specifications.

A prerequisite for the smooth operation of a TS is therefore the guaranteed specification-compliant functioning of the corresponding infrastructure.

Components

1. The concept of a component according to Szyperski.
2. Core concern, cross cutting concern.
3. Components as functional connections.
4. Components as function-object relationships between independent third parties.
5. Components and infrastructure.
6. Norms and Standards.

The World of Components

The concept of a component according to Szyperski

What is a component?
Szyperski gives a simple answer: "Components are for composition".

TS are assembled from existing components. Components can be purchased from third parties or developed in-house.

The World of Components

core concern, cross cutting concerns

Szyperski divides the world of component manufacturing (i.e. TS) in two partial worlds – "design for component" and "design from component".

The first world is the world of component developers, that develop special component functions for business applications – "core concern", this corresponds to the MUF – as *core system function*.

The World of Components

In addition to this core function, the operation of the component requires *supporting functions* (logging, data security, access control, printer control, etc. – "cross cutting concerns") that are based on the use of *established concepts* (description dimension) and services from other, already *prefabricated components* (application dimension), that implement *other technical principles* in other systems.

Thesis 2:

In this sense, real-world components are always *bundles of functionality* that bundle procedural knowledge from *several* areas.

The World of Components

The *component developer* must master all such description forms of functions of supporting components, at least on the abstraction level of their specifications to build useful components.

The second world is the world of *component assemblers*. They assemble (following a pre-existing plan) the system from existing components, develop or modify additional support functions ("glue code"), integrate and test the complete system before releasing it to the customer.

Modularization and standardization

This approach of division of labor between component developers and component assemblers in the field of software engineering is also extensively used in other engineering areas.

Modular systems are widely used and allow the standardization of the design of the unique real-world technical systems.

Components and Frameworks

This requires to connect the *application logic* of the component as "core concern" with the *logic of infrastructural networking* as "cross cutting concerns".

Thesis 3:

The infrastructure logic is usually part of the *component framework* that can only be used effectively if it is *jointly owned by the actors of an entire area of technology*.

Standardization and Trends of TS Evolution

Application logic and infrastructure logic are orthogonal to each other, which means that the trends *4.2 of increasing completeness of a system* and *4.4 of migration to the supersystem* practically counteract to each other in the development of a TS.

Thesis 4:

An improvement in the understanding of the *infrastructure requirements* of interacting components (transition to the supersystem) as description form leads to a *reduction of the level of requirements on the completeness* of individual components.

Standardization and Economies of Scale

Standardization opens up the prospect of economies of scale for standard components. Economies of scale lead to lower costs per unit and thus shift the leading role of competition from competition for the *better technical solution* to the competition for its *cheaper economic manufacturing*.

This means that the S-curve switches at the top of mature technical solutions (including standardization) in the phase of general availability *to another mode* in which the reduction of the economic cost of the availability "state of the art" takes over as guiding function of further development.

Standardization and Economies of Scale

Theseis 5:

The technical "trend 4.1 of increasing (technical) value" changes on the third stage of the development on the S-curve to an economic "trend of decreasing (economic) value".

Or, in economic terms: a demand-driven market turns into a supply-driven market. The same (mature) use value has ever lower exchange value.

Conclusions

Thesis 6:

In the TRIZ theory of TS evolution a better distinction between young and mature technologies is required.

In mature technologies ...

- TS are *bundles of technical principles*,
- which in the descriptive form have the goal of *unity in diversity* (think globally),
- from which in the practice form the *diversity in real-world local application contexts* (act locally) has to be restored.

Conclusions

Thesis 7:

The directed graph of *realized purposes* is the core of relationality in the world of technical systems.

This graph is a global socio-technical artifact and is evolving in the contradictionality of description forms and execution forms.

Modelling Sustainable Systems and Semantic Web

Modelling Contradictory Requirements in TRIZ

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Notion of a Technical System

(V. Petrov, 2020)

A **system** is a set of *elements* which are *interconnected* and *interact with each other*, which form a *unified whole* which has *properties* that are not already contained in the constituing elements considered individually.

Such a property is referred to as a **system effect**, **synergy**, or **emergence**.

Synergy is the overall effect of the interaction of two or more factors, characterised by the fact that this overall effect clearly exceeds the effect of each of the components and their simple sum.

TS as Reduction to the Essential

The reduction to the essential ...

... focuses on the following three dimensions:

(1) Delimitation of the TS from the outside against an *environment*, reduction of this relationships to input/output relations and guaranteed throughput (Purpose and ability to work).

(2) Delimitation of the TS from the inside by grouping parts as *components*, reducing their functioning on a "behavior control" via their interfaces.

(3) Reduction of the relationships in the TS itself to *causally essential* ones.

Technical Systems and Antecedence

The TS in the World of Technical Systems

The description of a TS is only possible based on descriptions of other (explicitly or implicitly given) TS. The description is anteceded ...

(1) ... by a vague idea of the (working) input/output characteristics of the environment.

(2) ... by a clear understanding how the components work beyond their pure specification.

(3) ... by a vague idea of cause and effect relationships in the system itself, that precedes the detailed modeling.

Components and Objects

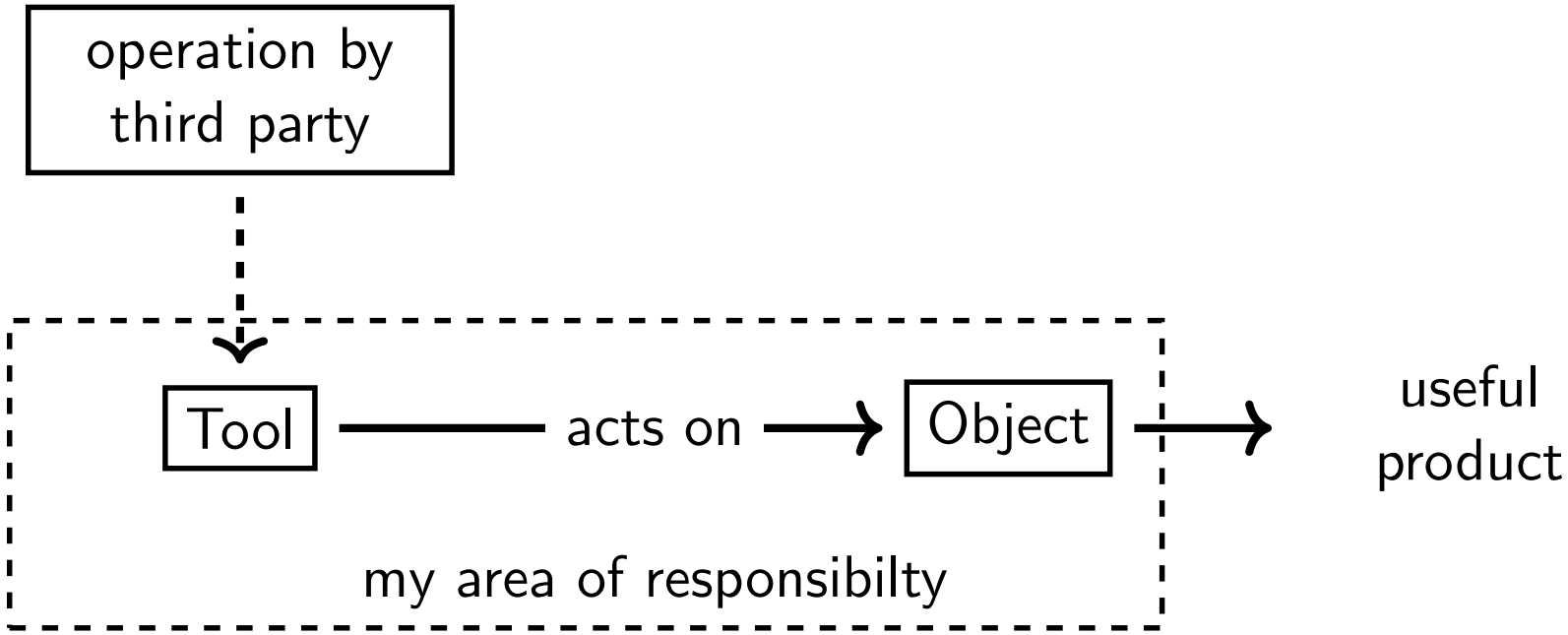
(Szyperski 2002)

- Components are again systems.
- They can be self-developed or purchased from third parties.
- It is not necessary to purchase the whole component, it is sufficient to use the *service*.

This happens in many cases: A component is available in the system with its functional specification as a black box, the operation of the component (provision of the function) is carried out by a third party, out of *their* area of responsibility, the function has an effect on "my" objects in *my area of responsibility*.

- Thus the distinction according to Szyperski: components encapsulate functionality, objects encapsulate system states.

The Minimal Technical System in TRIZ



Dotted frame = the minimum technical system

Dotted arrow = is addressed in Szyperski, but not in TRIZ

Components and Environment

Components (especially those operated by third parties) are thus pointers to other places in the *world of technical systems* and thus represent only another form of the "relationship of a system to the environment".

The question arises whether aspects (1) and (3) in the list of the "reductions to essential" (component and neighboring system) can be unified in such a way.

On the other hand, the question arises how to incorporate the concept of the object into the overall logic.

We will leave both questions open at this point.

Modelling of Systems

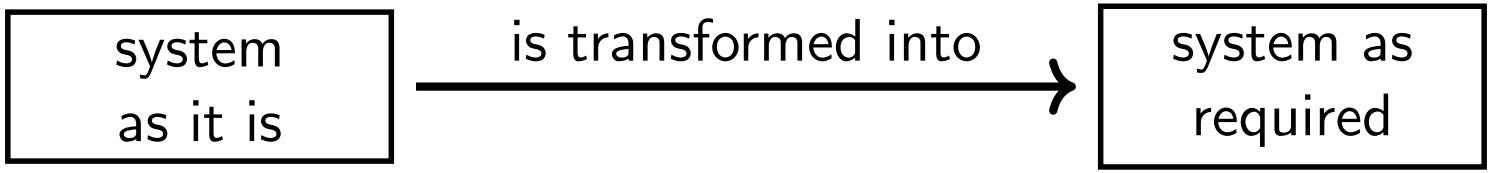
Two problems:

(1) Build a new system

(2) Transform an existing system

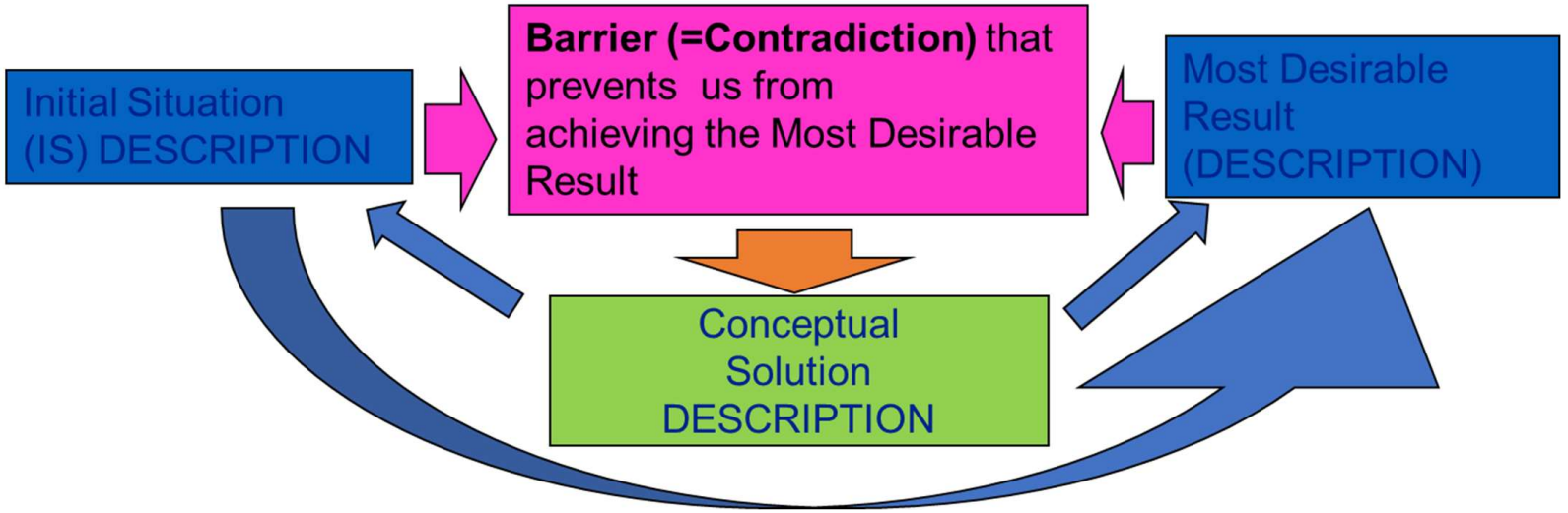
(1) can be considered as a special case of (2), since any need for a new system comes with at least *rough ideas* about that new system, thus also under (1) there is at least a *rough description form* of the system to be created as antecendence.

Modelling of Systems



This basic scheme fits not only technical systems, but also the modelling of social, socio-ecological and cultural systems, hence it is sufficiently universal.

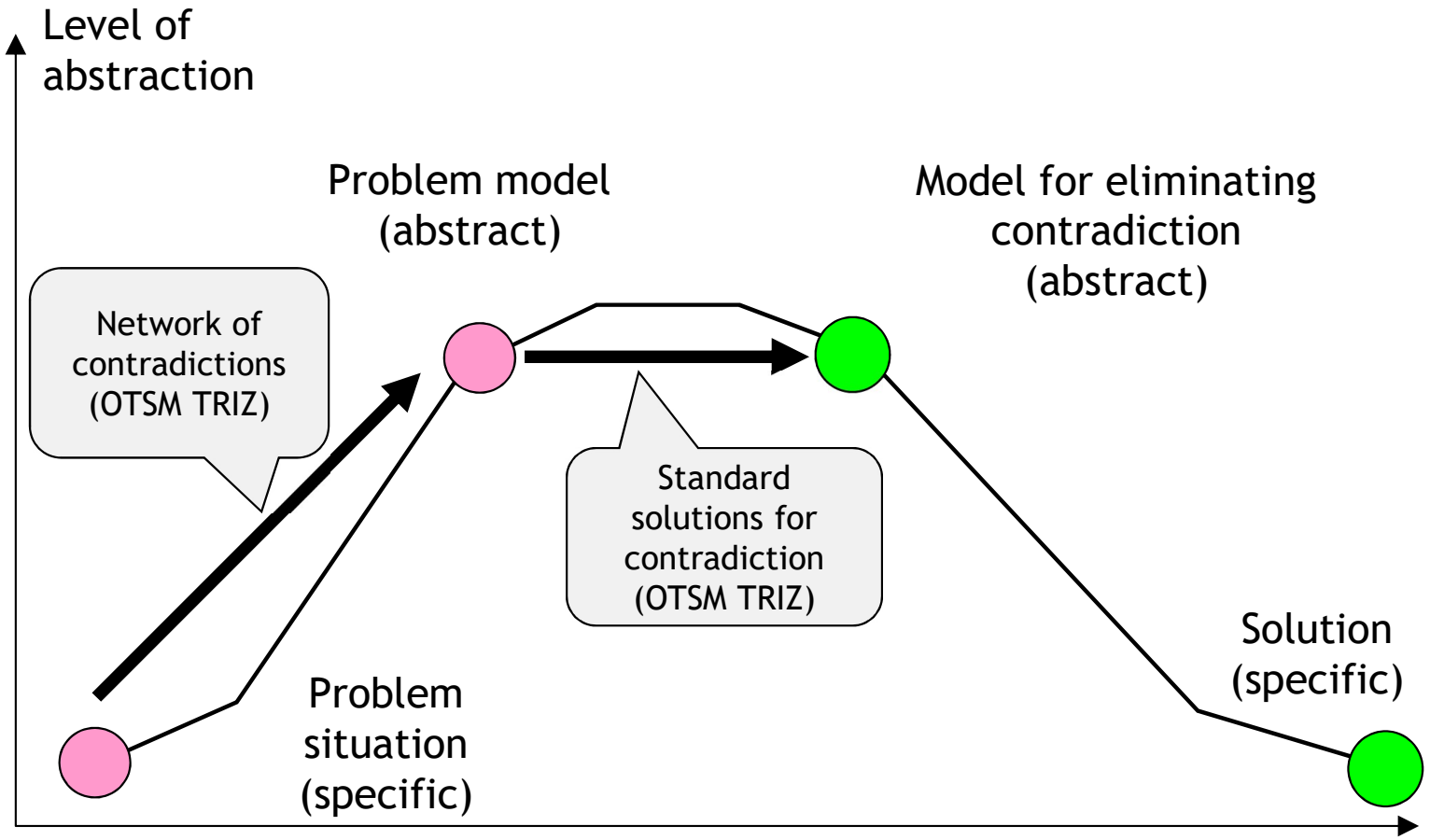
The “Tongs” MODEL



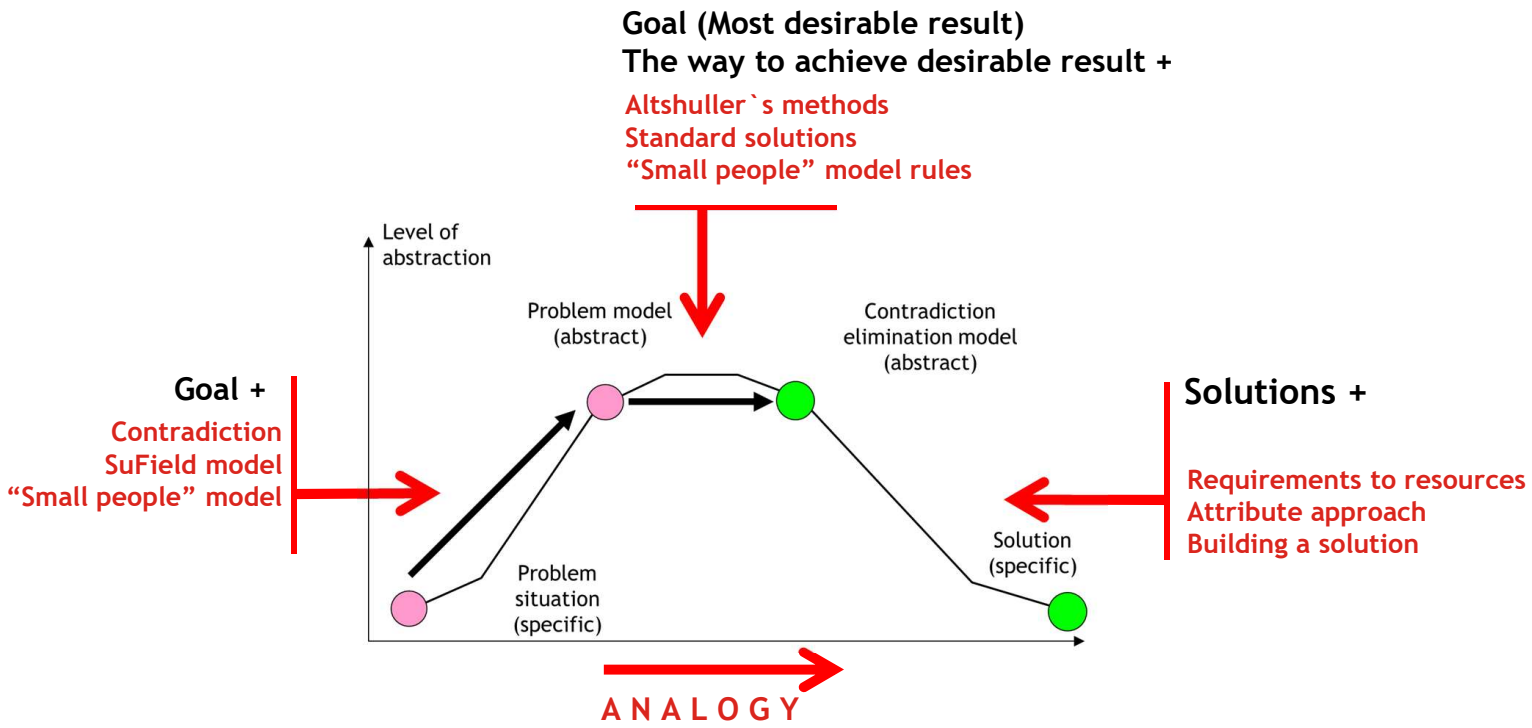
A specific barrier we should overcome is the root of a specific problem.
The root of the barrier is a hidden CONTRADICTION.

What is the root of a contradiction?

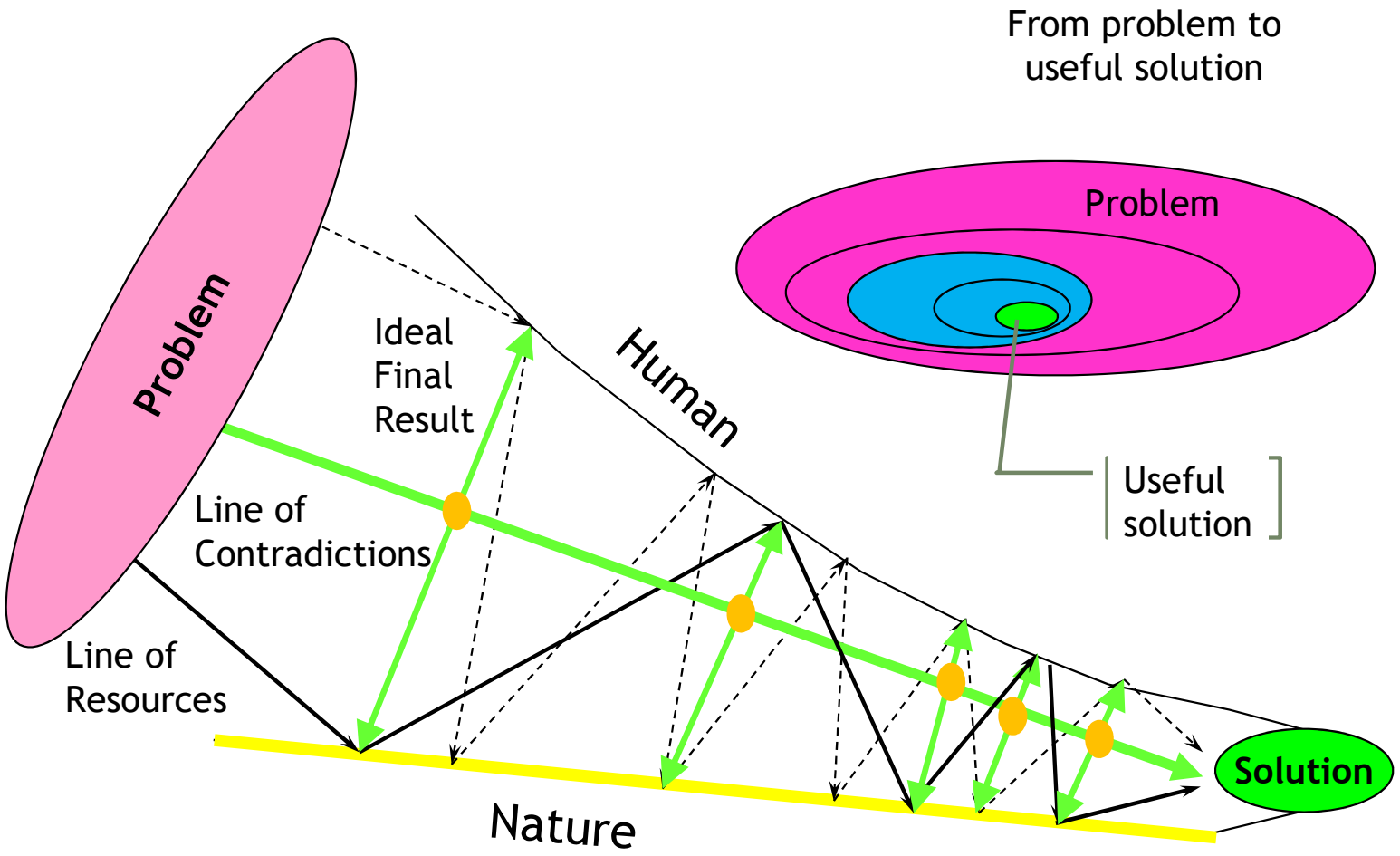
The «Hill» MODEL



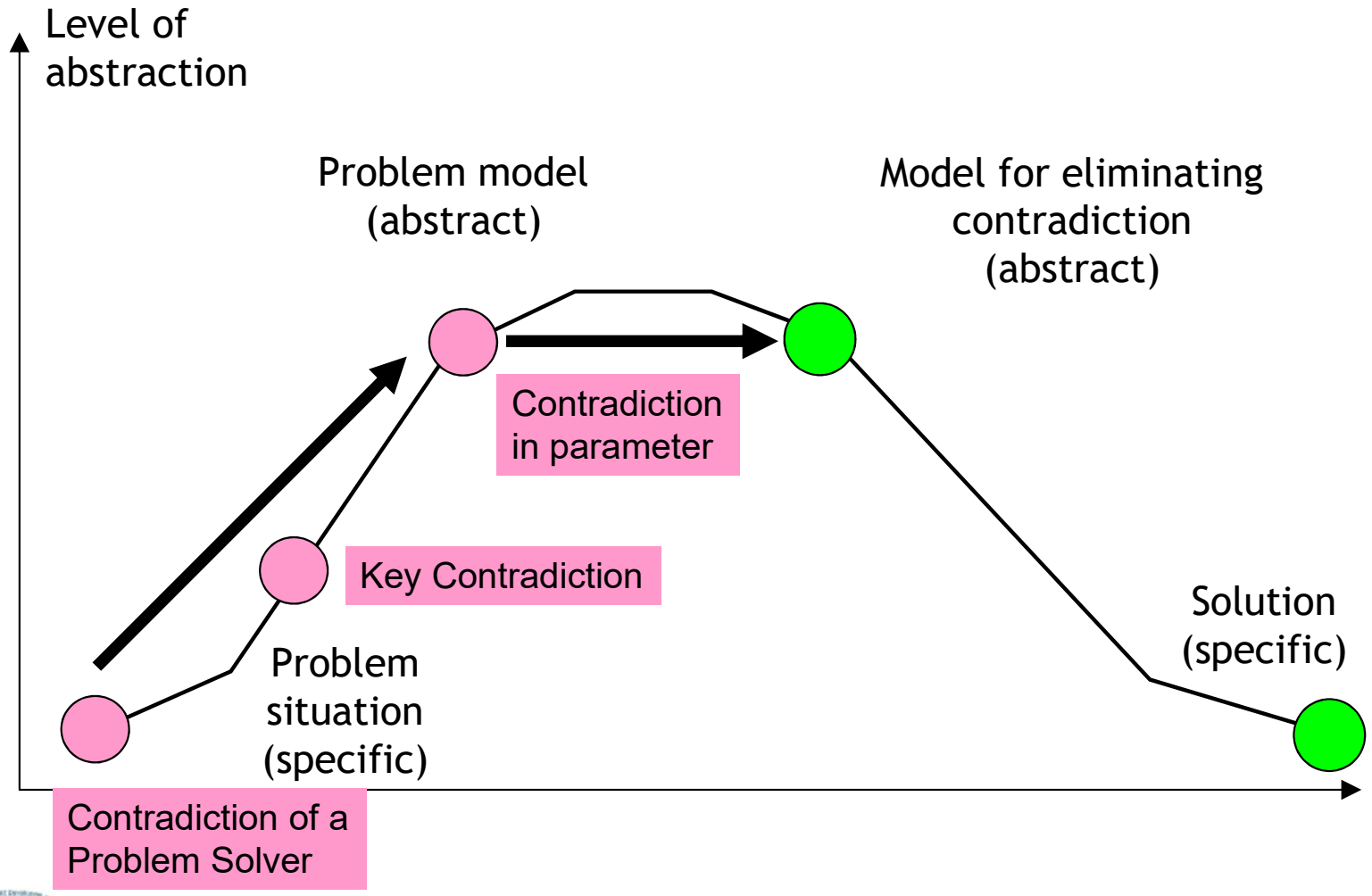
The «Hill» model. Shpakovsky's interpretation



The “Funnel” MODEL



The “Contradiction” technology



THE AXIOMS OF WORLD VISION

Axiom of Unity. *The world is a whole and unique system that evolves in accordance with objective laws of all the sub-systems.*

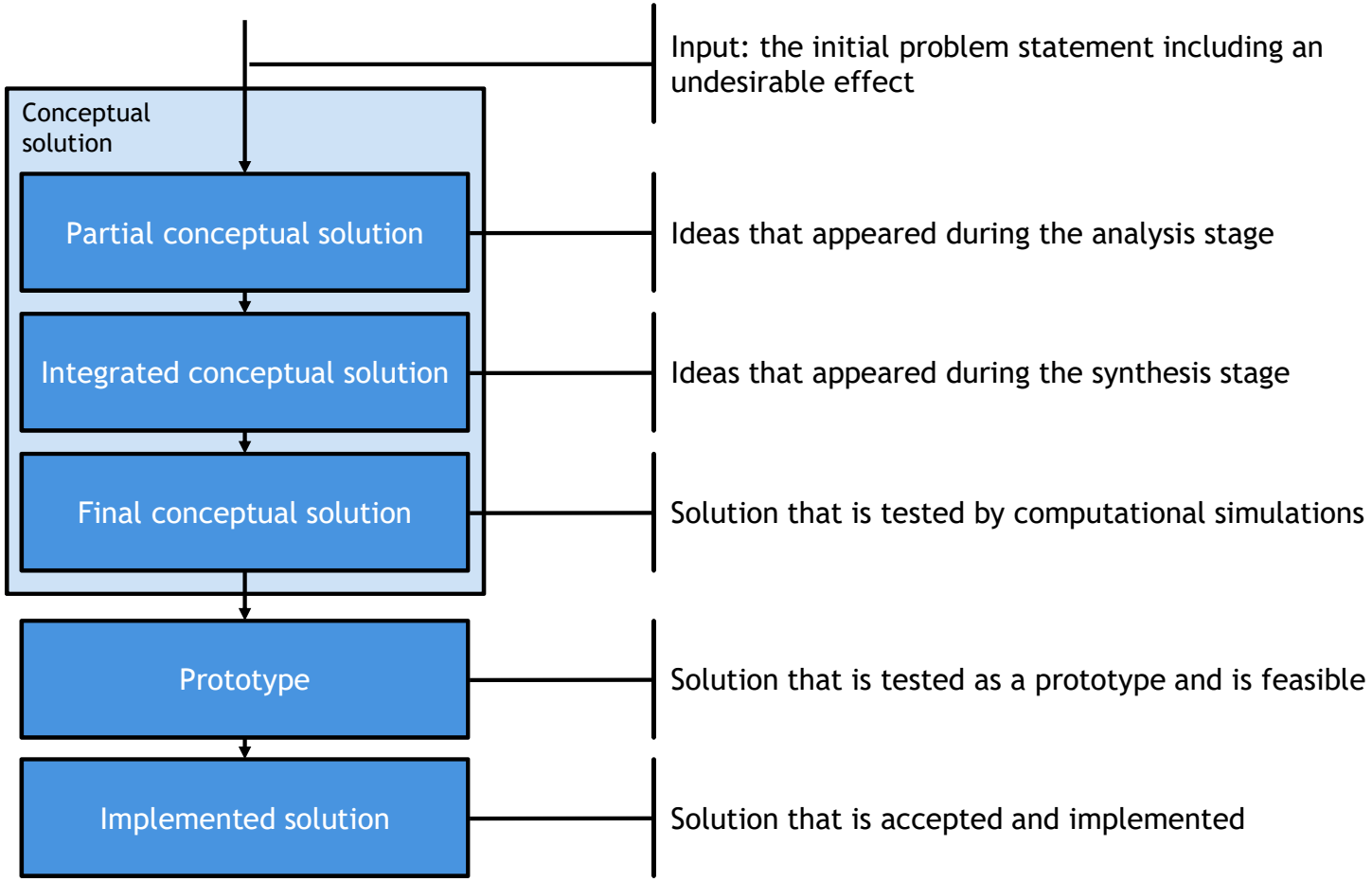
Axiom of Disunity. *The world is a set of different systems, each of them evolving in accordance with its specific laws.*

Axiom of Connectedness Unity and Disunity. *The way the law is manifested in a specific situation is defined by its resources.*

Consequences:
Unity and diversity of the world are governed by the resources used by different systems. Any resource is subject to both general laws and specific laws defined by their specific properties.
General objective laws are manifested differently in specific situations. This difference depends on the nature of the interplay between the law and the specificity of the situation.

N. Khomenko, R. De Guio. *2010. OTSM System of Axioms*

The technology “Line of Solutions”



TRIZ and ARIZ

TRIZ is not just a theory, but proposes a precise algorithmic procedure as a methodology to be applied.

There exist several variants of this algorithm ARIZ (Algorithm for the Solution of Inventive Problems), the "official" one is ARIZ-85C, which is based on a version published by Altschuller in 1985. Others (D. Zobel) see little progress compared to ARIZ-77 (a version published by Altschuller in 1977) and recommend this somewhat simpler approach.

We use AIPS-2015 (Algorithm for the Correction of Problematic Situations), a version in the tradition of OTSM-TRIZ, which is also used in the Minsk TRIZ-Trainer.

TRIZ-Trainer – the First Stage of the Solution Process

The first stage of the solution process provides an accurate model of the "system as it is" that needs to be transformed to solve the problem. This phase consists of three steps

(A) Contextualise the problem. The system as a black box.

(B) Analyse and model the structural and procedural organisation of the "system as it is" – the "machine" in the terminology of the TRIZ-Trainer.

(C) Identify and localise the central contradiction, determine the operational zone and operational time, i.e. where and when the contradiction occurs, and establish possible hypotheses about the causes of the conflict.

From these hypotheses a task is formulated, which in the second stage is analysed in more detail.

TRIZ-Trainer – the First Stage of the Solution Process

First section "Clarification of the circumstances":

1. Identify the system to be examined as a black box and give it a "speaking name", from which the semantics of the system can already be roughly understood – what is the "useful product"?
2. Identify the *main useful function* (MUF) of the system. Investigate, if necessary, what *purpose* the system serves in the supersystem and, if applicable, determine the throughput required to operate the system (input required from the upper system for the functioning of the system).
3. Formulate the existing problem, which prevents the specification compliant behaviour of the system in the supersystem – the "undesired effect".

TRIZ-Trainer – the First Stage of the Solution Process

Second section "Conflict in the system":

4. Determine the components of the machine (the structural organisation of the system) as well as its mode of operation (the procedural organisation of the system). Often it is sufficient to focus on one of the two questions.
   Follow the general structure pattern "energy source, engine, transmission, tool, action, object being processed, useful product plus control".
   Here it is important to describe the main useful function (MUF) of the system, even if the problem is located in one of its components, because the resources used in the system are grouped around the MUF.

TRIZ-Trainer – the First Stage of the Solution Process

5. This MUF is in some relation to the "effect that cannot be completed without problems".
   This effect, as well as its relationship to the MUF, is now to be determined more precisely as the core of the conflict to be resolved.
   In this analysis, in particular the place and time of the conflict must be more precisely determined in order to prepare for possible later separation by time or place as as basic methods of resolution.

TRIZ-Trainer – the First Stage of the Solution Proces

Third section "Formulation of a hypothesis":

- Through a more detailed analysis of the "causes of conflict", one or several hypotheses of general nature are formulated, what measures in the sense of the *Ideal Final Result* would solve the problem.
  One of these approaches is formulated in more detail as a "task" for the second stage of the solution process in order to work on it with suitable TRIZ tools.

The Ideal Final Result

The **ideal final result** (IFR) describes the "system as required" as *target* of the transformation, without initially caring whether the formulated result can be realised in practice. In the further solution process, the obstacles to be overcome on the way to the IFR are identified and, based on the TRIZ methodology, strategies are developed how to overcome these obstacles in practice.

The IFR is one of the basic concepts of TRIZ. The IFR is an orientation in the sense of a "concrete utopia", which essentially determines the target corridor on which the further solution process concentrates in its second stage.

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Modelling Sustainable Systems and Semantic Web

Systems and Development

Lecture in the Modul 10-202-2309 for Master Computer Science

Prof. Dr. Hans-Gert Gräbe

http://informatik.uni-leipzig.de/~graebe

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Modelling Systems

Two problems:
(1) Build new system
(2) Rebuild existing system

(1) can be consideres as a special case of (2), since every need for a new system comes with at least *rough ideas* about that new system, so there is also under (1) an at least *rough description form* of the system to be created.

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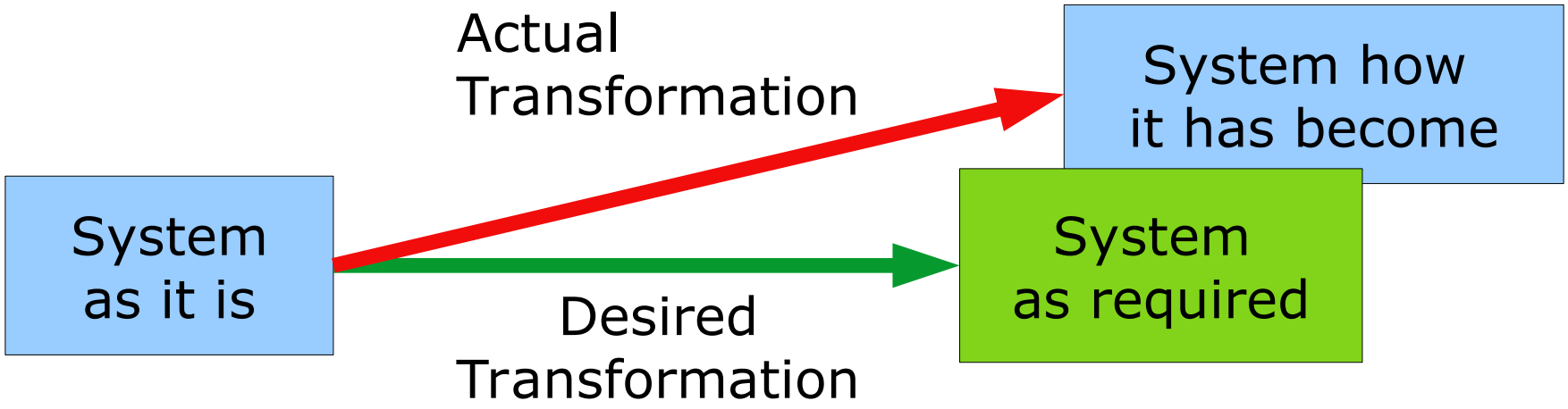
Modelling Systems

This basic scheme fits not only technical systems, but also the modelling of social, socio-ecological and cultural systems, so it is sufficiently universal.

How does such a system evolve over time?



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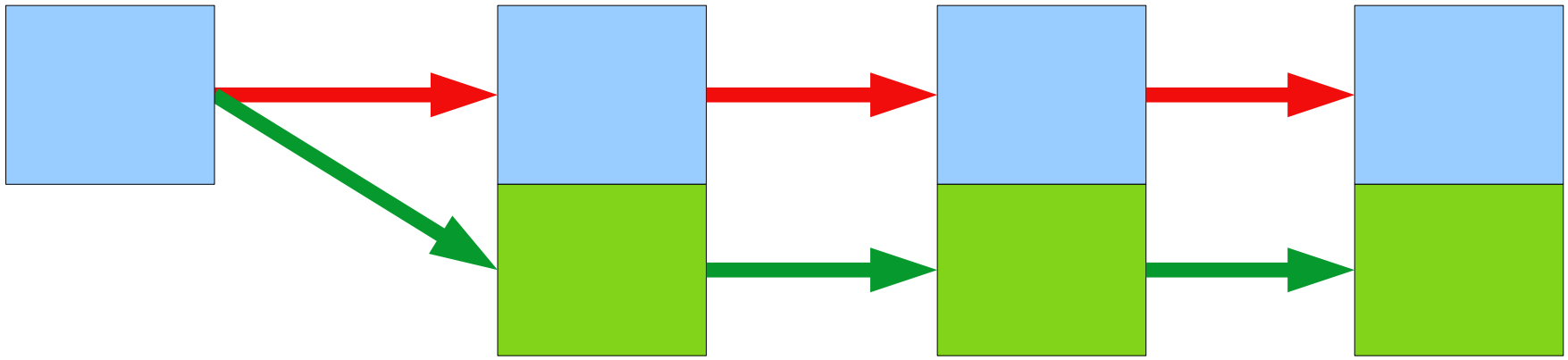

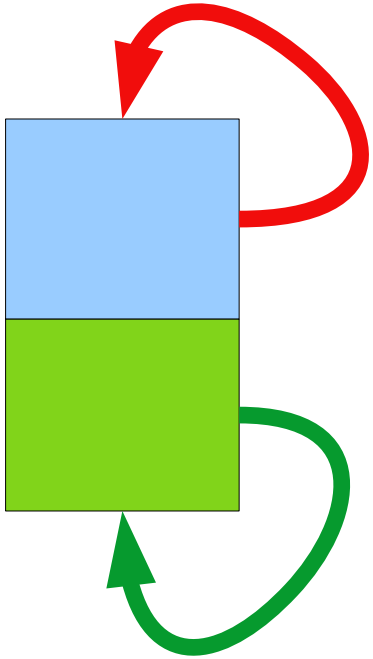

Transitional development as *different versions* of the system over the time.

But can also be understood as development in time of *the same system*.

Transitional management versus adaptive management.

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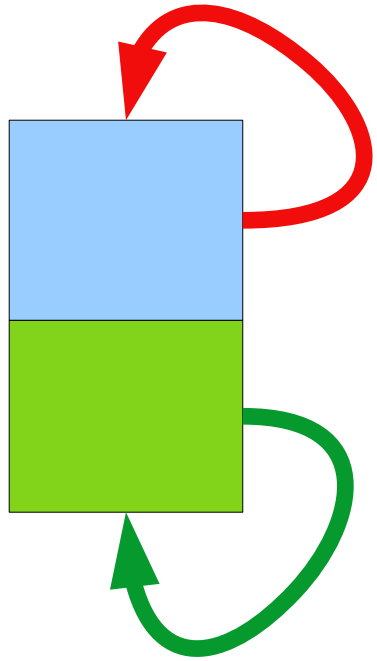
The development of a system can therefore be conceived as a contradiction between an *ideal line of development* and a *real line of development*.



This idea is reflected in the TRIZ concept of the *Ideal Final Result* (IFR).

In the (mathematical) *Theory of Dynamical Systems* (TDS), system development is conceived as a progression of states, which can be described by functions f(t) with values in a phase space.

The *ideal behaviour* is described by mathematical relation-ships, such as differential equations, whose invariant solutions describe a partial structure of stable states (*trajectories*) in phase space.

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These differential equations and trajectories are part of the *description form of the system* and thus have already been created by *reduction to essentials*.

In the modelling it is assumed that everything essential is taken into account, i.e. that the *real temporal development* r(t) of the system differs from the *ideal temporal development* f(t) only by a small difference d(t)=r(t)-f(t), which *is insignificant for the selected essential*.

While f(t) enables a *quantitative prediction* of the development of the system, the statement that d(t) is "small" or "damped" is a *qualitative statement* of the descriptive form.

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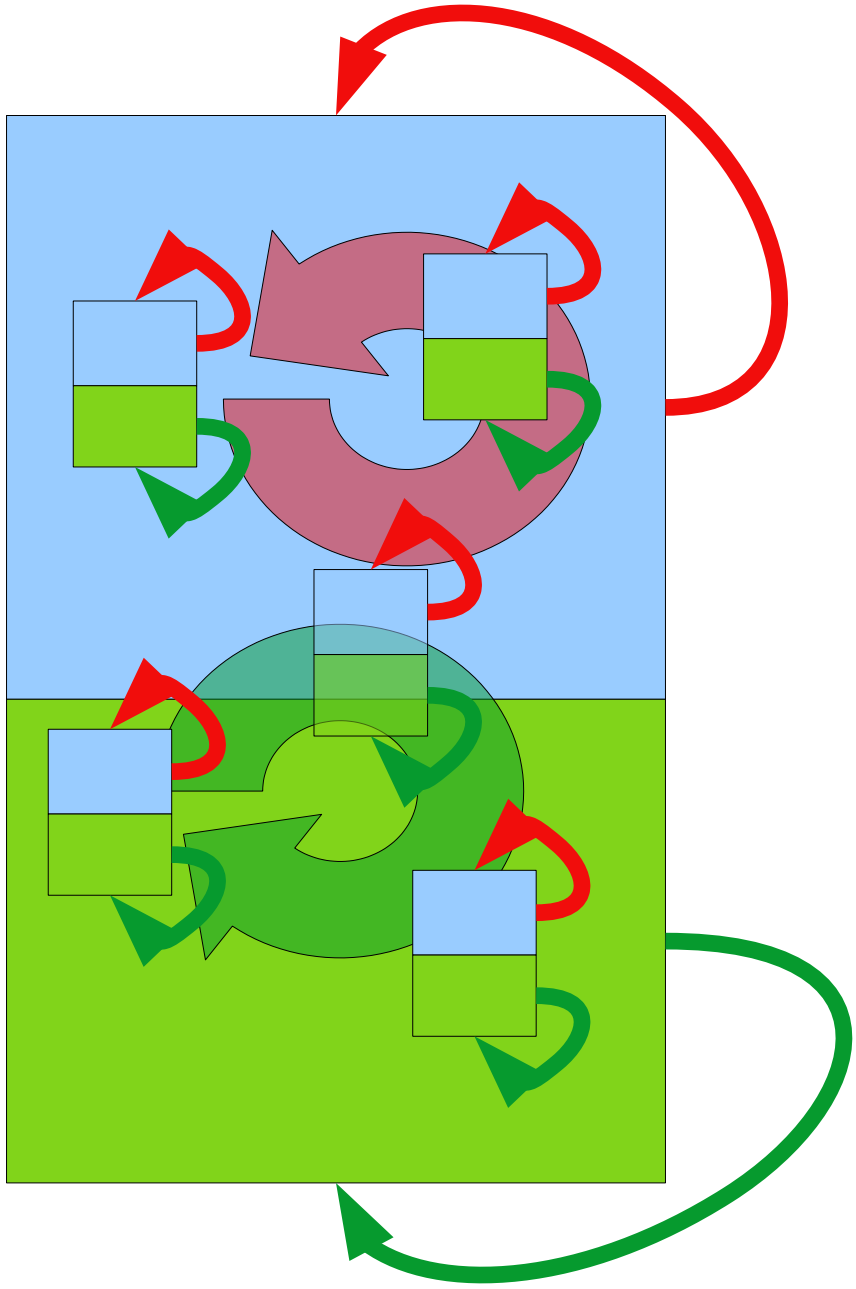
Often one also restricts oneself with f(t) to a *qualitative statement* about the exact position of the trajectories as invariants in the solution space and thus to the statement that r(t) oscillates around these trajectories in a damped manner. These trajectories seem to "magically" attract the real states and are therefore also called *attractors*.

For example, the Earth moves on an elliptical orbit around the Sun in the sense that real deviations from this orbit are always compensated for.



Development

- of the system itself
- the components in the system and
- the relationships in the system

However, let us first take a closer look at how complicated trajectories can be.

See TDS.md

Modelling Sustainable Systems and Semantic Web

Immersive and Submersive System Theories

Lecture in the Module 10-202-2309
for Master Computer Science

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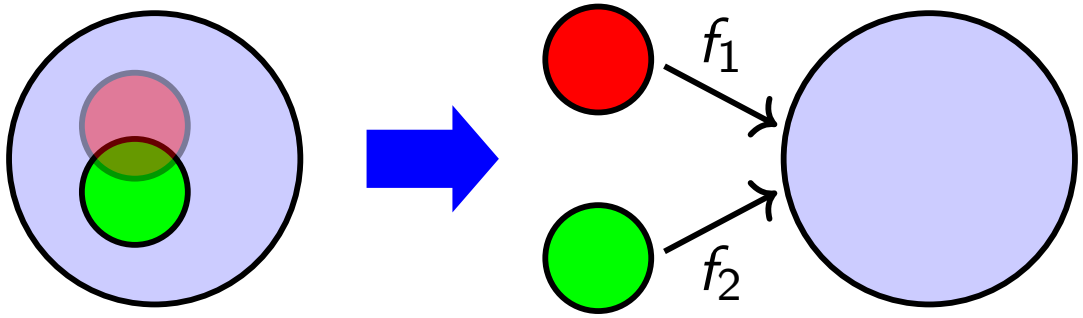
May 2021

Relation Between two Systems in a Supersystem

How can the relationship between two systems be conceptualised in their environment?

According to our systems approach, only if we describe *a larger system* (supersystem) and the relation of the two subsystems to the supersystem as *components*.



Immersive Concept

Mathematical formulation of the question

We look for functions $f_1 : S_1 \to S$, $f_2 : S_2 \to S$ with certain properties.

For a "generic solution" we ask if for such a constellation exists a **Universal Categorial Object**, i.e. a universal U and universal maps

$$p_1 : S_1 \to U, \; p_2 : S_2 \to U,$$

such that for each triple (f_1, f_2, S) the above constellation may be written as

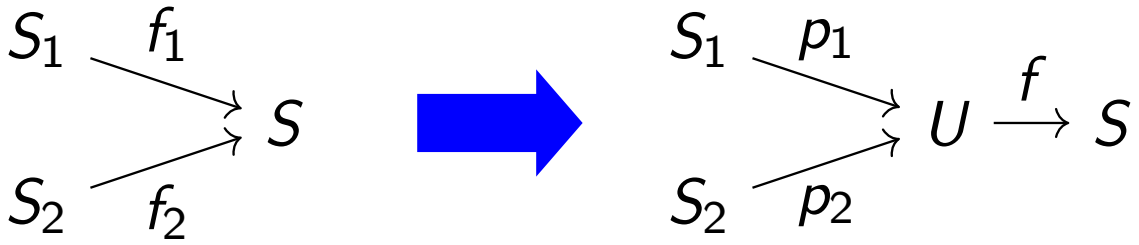
$$f_1 = f \circ p_1 : S_1 \to U \to S, \; f_2 = f \circ p_2 : S_2 \to U \to S$$

for a suitable $f = f_1 \oplus f_2 : U \to S$.

Immersive Concept

U is in some sense the "most general system" that combines the systems S_1 and S_2 without "further effect".

U in such a case is called a **direct sum** and we write $U = S_1 \coprod S_2$.



Mathematical Categories

Most mathematical models live in concrete **categories**, for example, the category of sets, vector spaces, fibre bundles, algebraic varieties, and so on.

Each such category is characterised by the fact that the terms **object** and **morphism** have a clear meaning there.

Morphisms between vector spaces, for example, are operationally faithful mappings, i.e. linear mappings that can be described by matrices for finite-dimensional vector spaces.

Such universal objects do not exist in every category.

Remark: The construction can easily be extended to finitely many S_i and even to infinitely many $S_i, i \in I$, and so it is defined in mathematics.

Category of Sets

In this category direct sums U exist for both finite and infinite index sets I. This is just the **disjunct union** of the sets S_i.

The maps p_i are just the embeddings $p_i : S_i \to U$ of the partial sets in their disjunct union.

The map $f : U \to S$ works as follows: For each $a \in U$ exists exactly one i and one $a' \in S_i$ with $a = p_i(a')$. Put $f(a) = f_i(a')$.

If $|S_1| = a, |S_2| = b$, then $|S_1 \coprod S_2| = a + b$.

The whole is no more than the sum of its parts.

Submersive Concept

Invert all Arrows (TRIZ Prinziple 13)

We look for functions $f_1 : S_1 \leftarrow S$, $f_2 : S_2 \leftarrow S$ with certain properties.

Does for such a constellation exists a **Universal Categorial Object**, i.e. a universal U and universal maps

$$p_1 : S_1 \leftarrow U, \; p_2 : S_2 \leftarrow U,$$

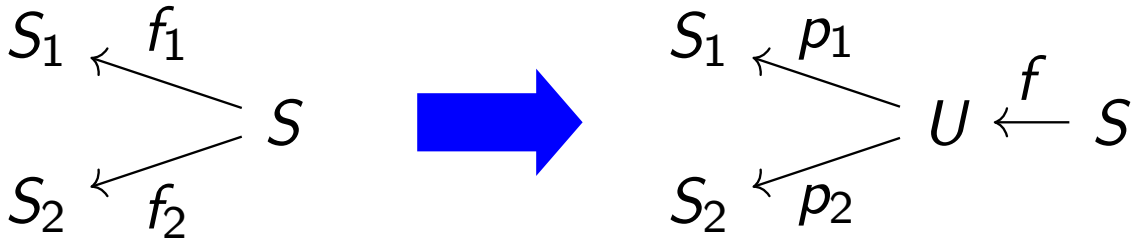
such that for each triple (f_1, f_2, S) the above constellation may be written as

$$f_1 = p_1 \circ f : S_1 \leftarrow U \leftarrow S, \; f_2 = p_2 \circ f : S_2 \leftarrow U \leftarrow S$$

for a suitable $f = f_1 \otimes f_2 : S \rightarrow U$.

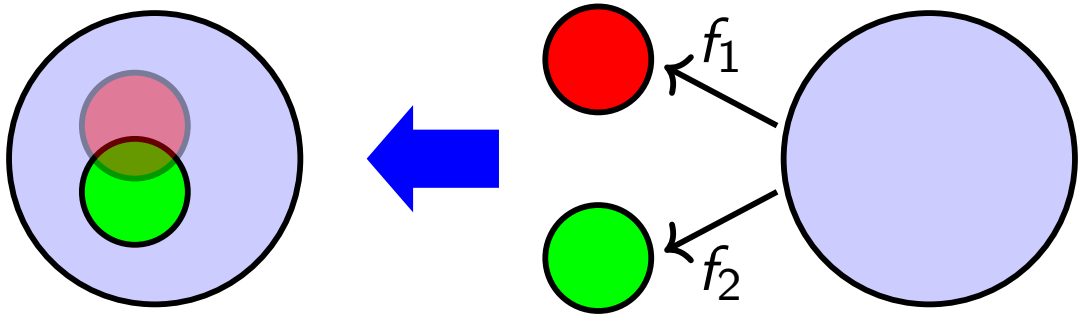
Submersive Concept

U in such a case is called a **direct product** and we write $U = S_1 \prod S_2$.



Submersive Concept

How does this change the perspective on the concept of system?



Category of Sets

In this category direct products U exist for both finite and infinite index sets I. This is just the **cartesian product** of the sets S_i.

The maps p_i are just the projections $p_i : U \to S_i$ of the product to the individual components.

The map $f : S \to U$ works as follows: For each $a \in S$ we set $f(a) = (f_i(a)) \in U$.

If $|S_1| = a, |S_2| = b$, then $|S_1 \coprod S_2| = a \cdot b$.

The whole is clearly more than the sum of its parts, most of the "information" is of relational nature.

Submersive and Immersive System Theories

System theories rarely make a distinction between between these two approaches.

To distinguish between the approaches, system theories in which the first modelling principle dominates, are called **immersive system theories**. They can be recognised their constructions are essentially based on embeddings (immersions).

System theories that are based on the second modelling principle are called **submersive system theories**. They can be recognised by the fact that their constructions are essentially based on projections (submersions) and thus on processes of staggered complexity reduction.

The Theory of Dynamical Systems is a submersive system theory.

Modelling Sustainable Systems and Semantic Web

Development of Systems and Their Components

Lecture in the Module 10-202-2309
for Master Computer Science

Prof. Dr. Hans-Gert Gräbe
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May 2021

Dissipative Systems and Steady States

The Theory of Dynamical Systems in the scope as discussed in this and the last lecture, describes *internal dynamics* of systems.

Our notion of a TS, however, assumes that components of a system in the execution dimension – via their input/output (parametrised in the description form) – are supplied with tasks and material by the system.

Since our concept is recursive, this must be applied to *all* systems, i.e. they are always driven by a *throughput of material and energy*.

This is also stated by the TRIZ law of *"energy conductivity" through all parts of the system*.

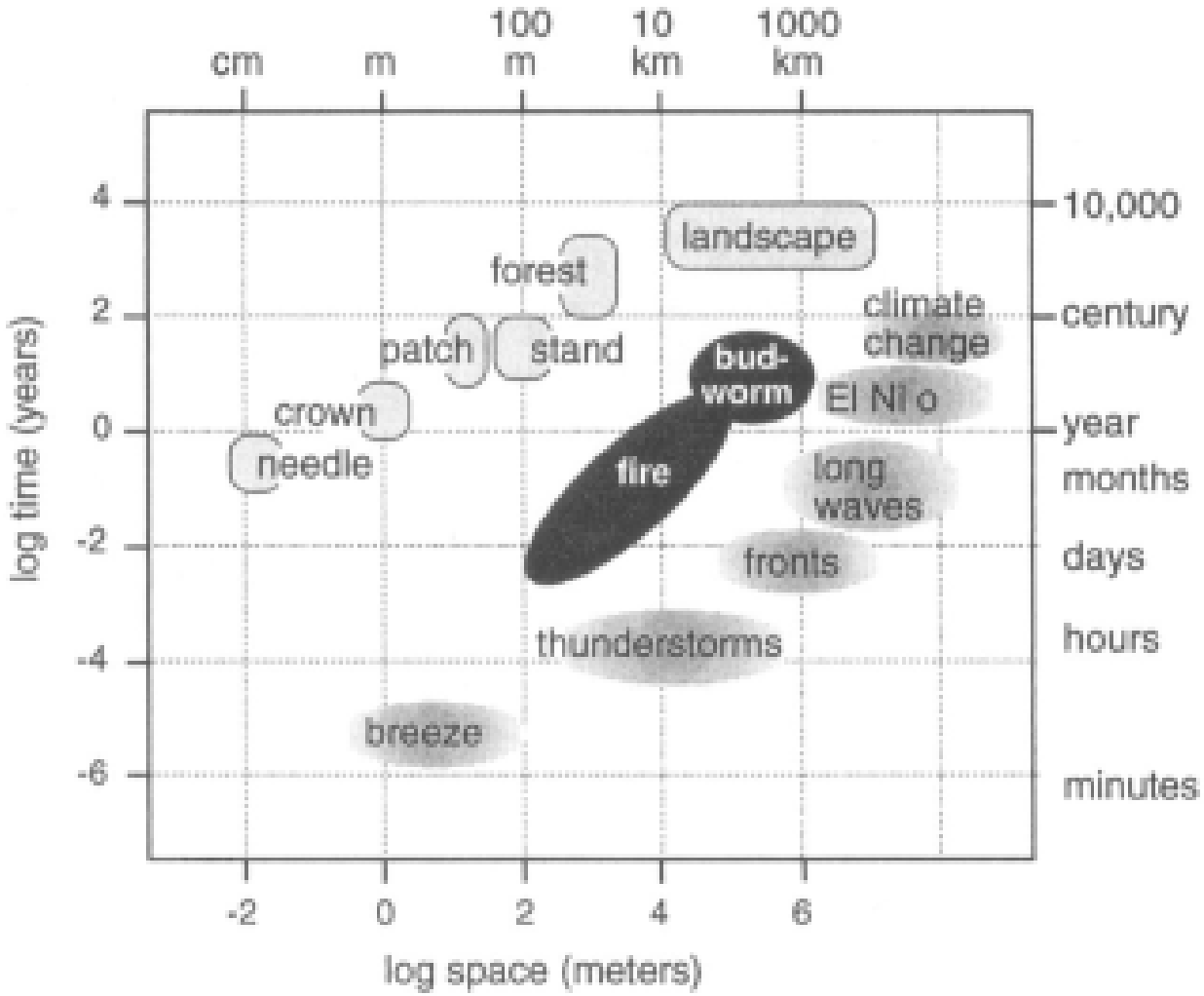
Examples and Notions

Examples: Bénard cell, living beings, Earth's biosphere. See `TDS.md`

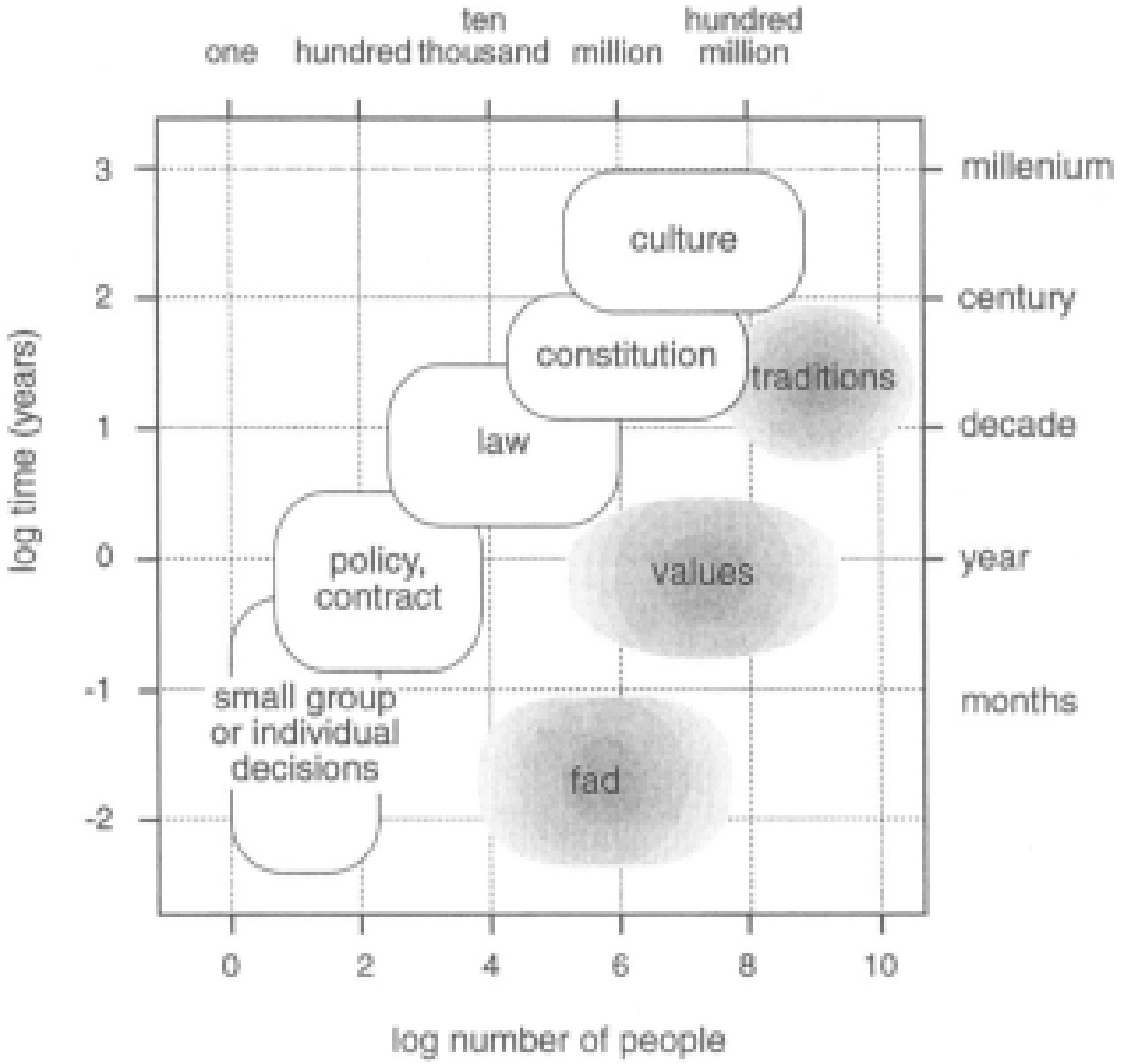
Notions (in the description form!):

- eigentimes and eigenspaces
- limit cycles, attractors
- steady state and dissipative systems

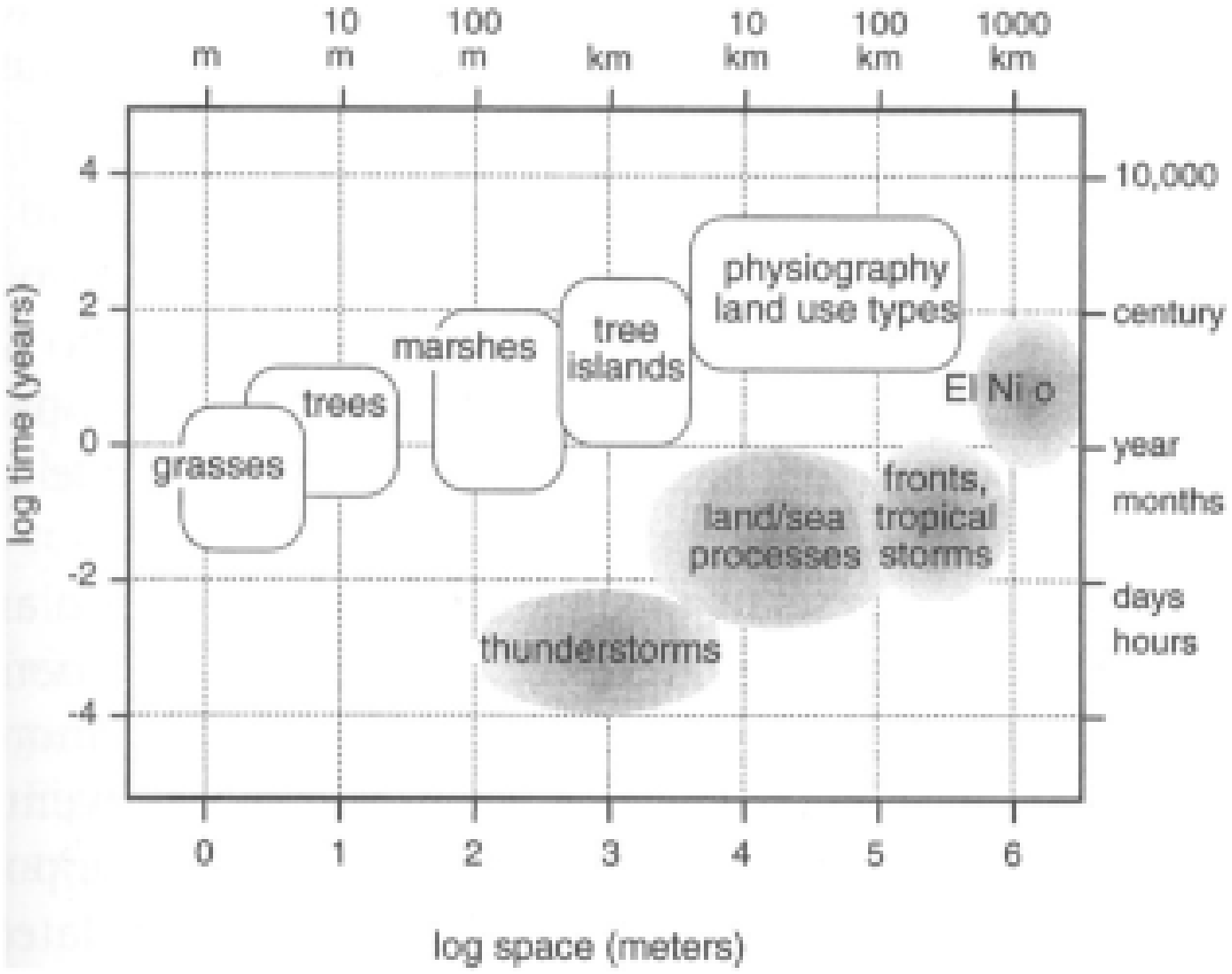
Diagrams from (Holling 2001)



Diagrams from (Holling 2001)

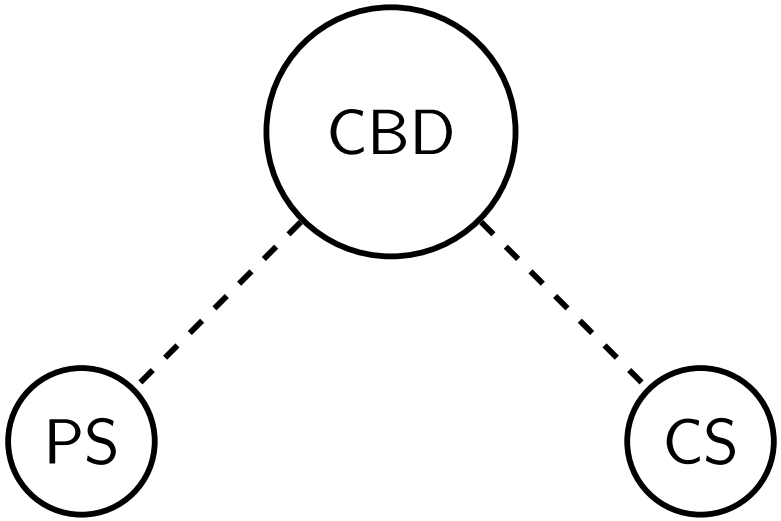


Diagrams from (Holling 2001)

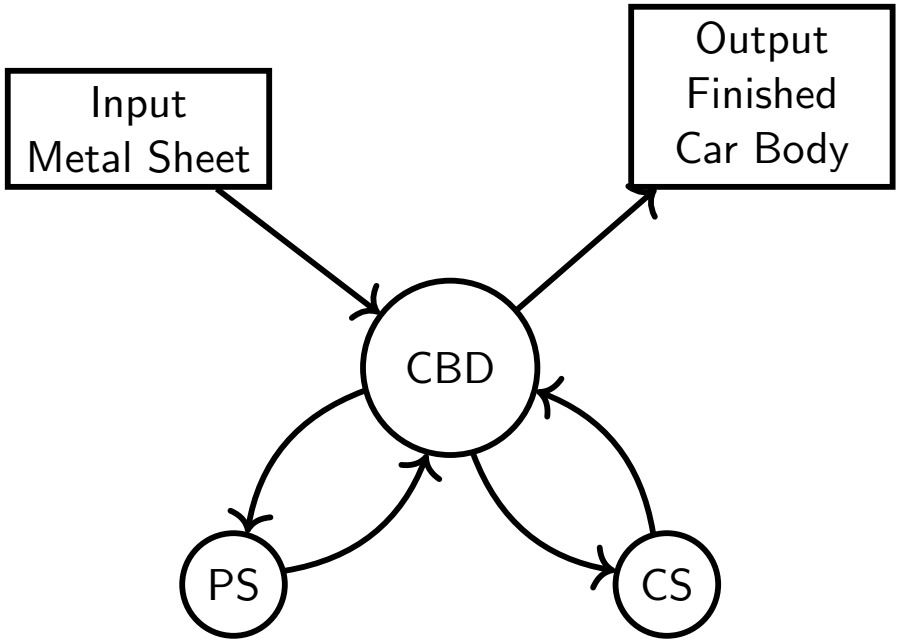


Development of System and Components

Example: A TS with two components – the car body department of a car manufacturer with press subdepartment and coloring subdepartment.



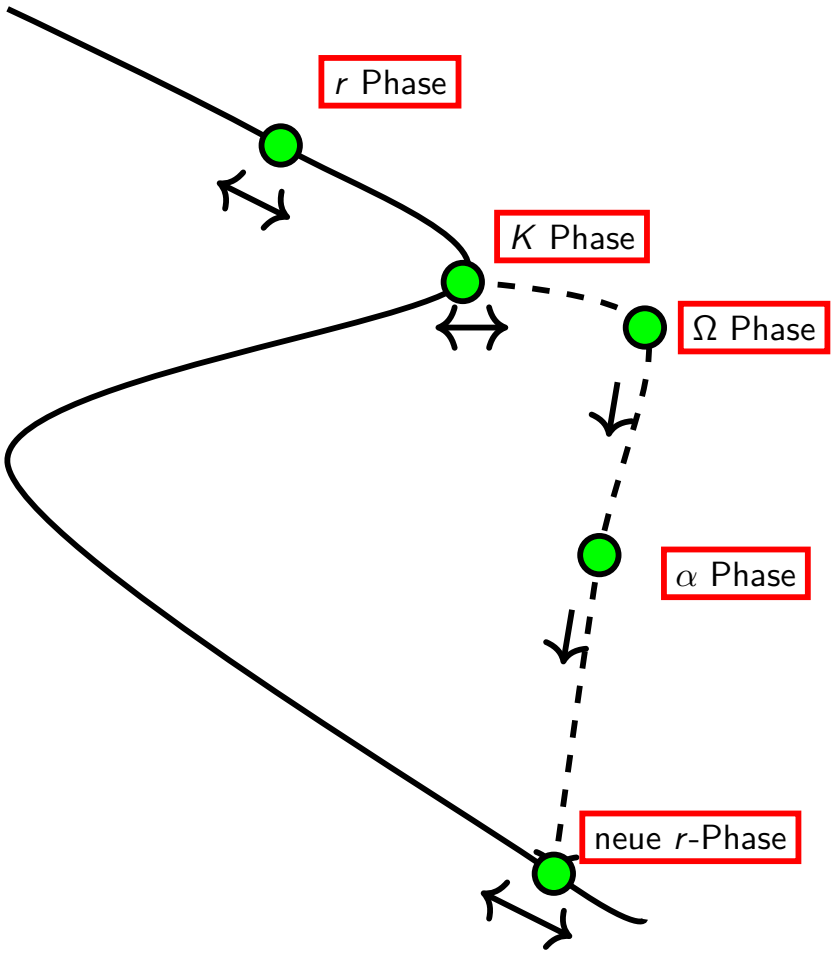
Structural Organisation



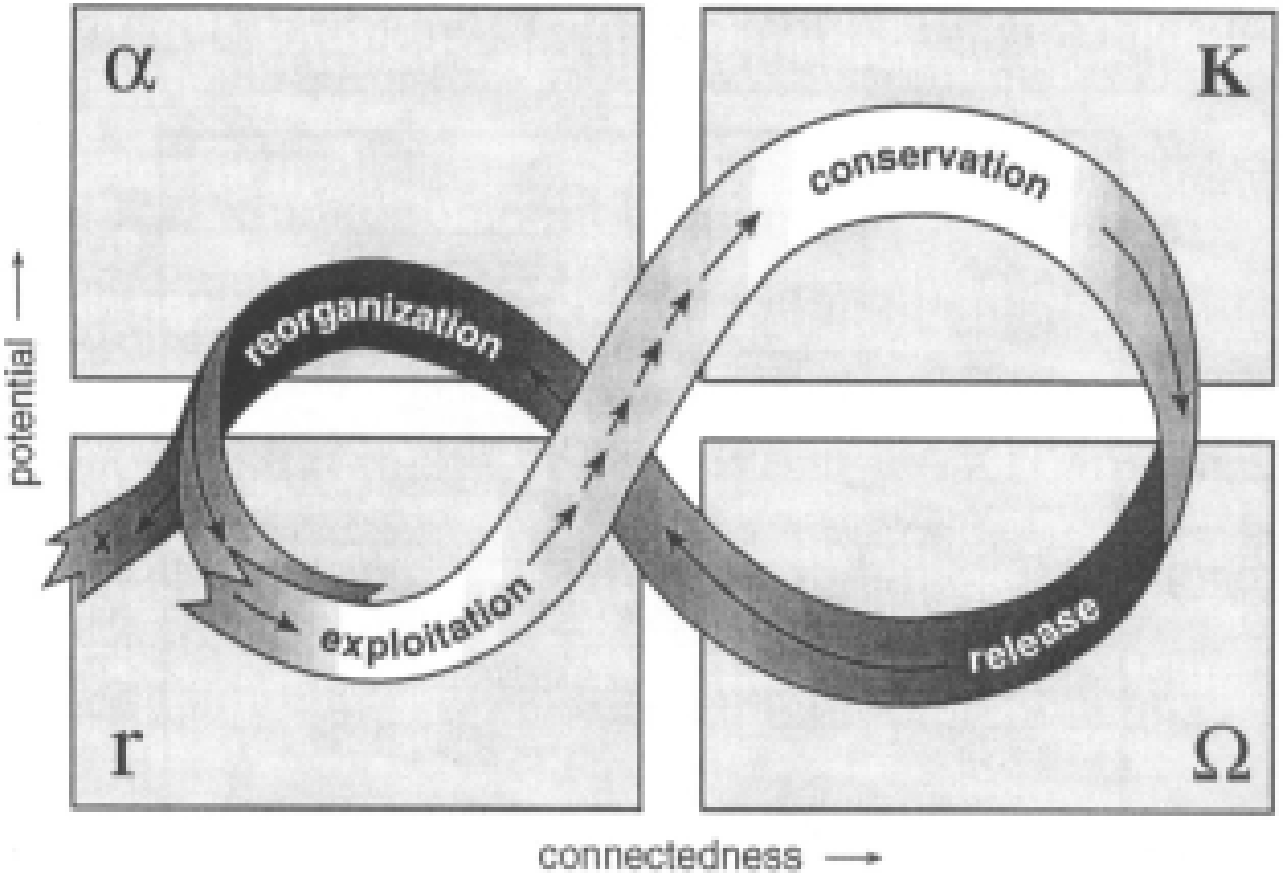
Workflow Organisation

Development of System and Components

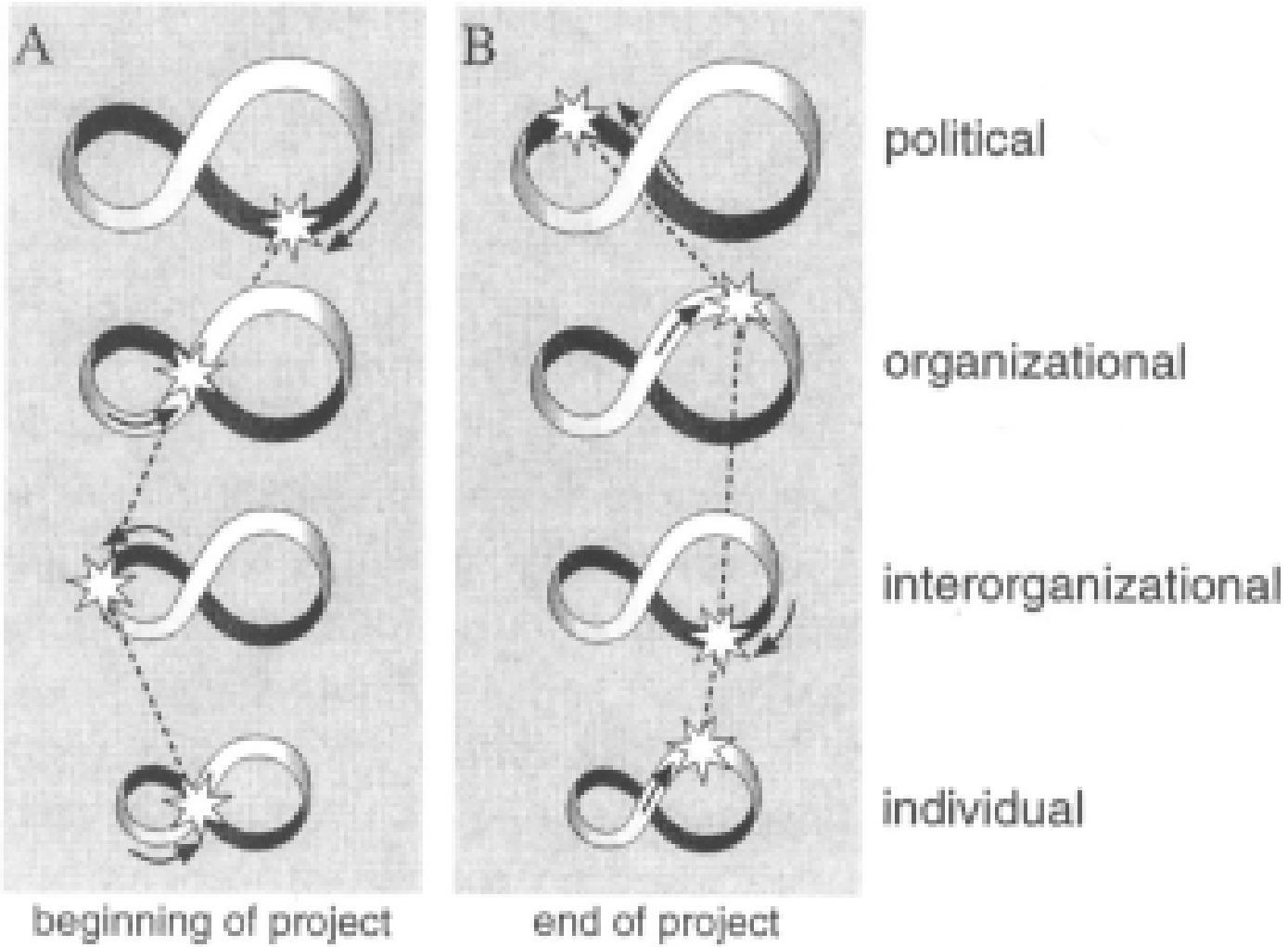
Continuation: The press department is modernised, industrial robots are being used. How does that affect the "neighbouring" systems? What scenarios are conceivable?



Diagrams from (Holling 2001)



Diagrams from (Holling 2001)



Modelling Sustainable Systems and Semantic Web

Digital Space of Action

Lecture in the Module 10-202-2309
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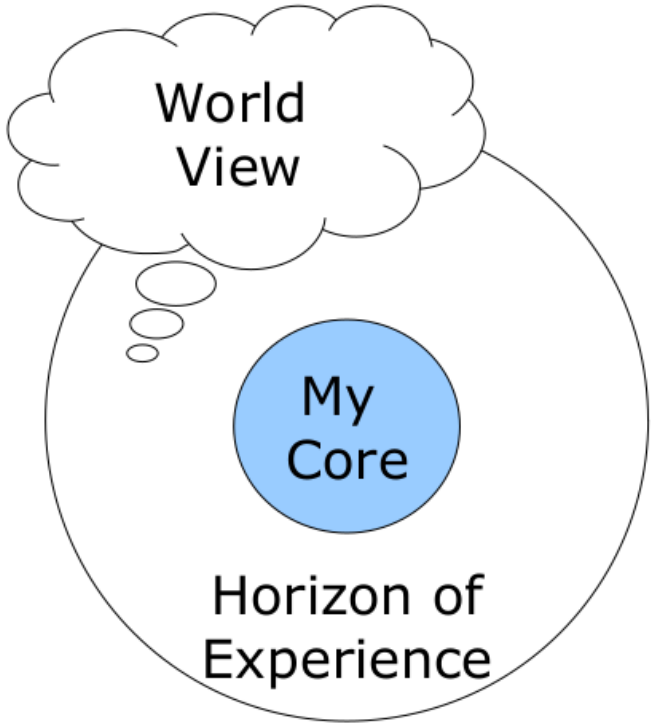
May 2021

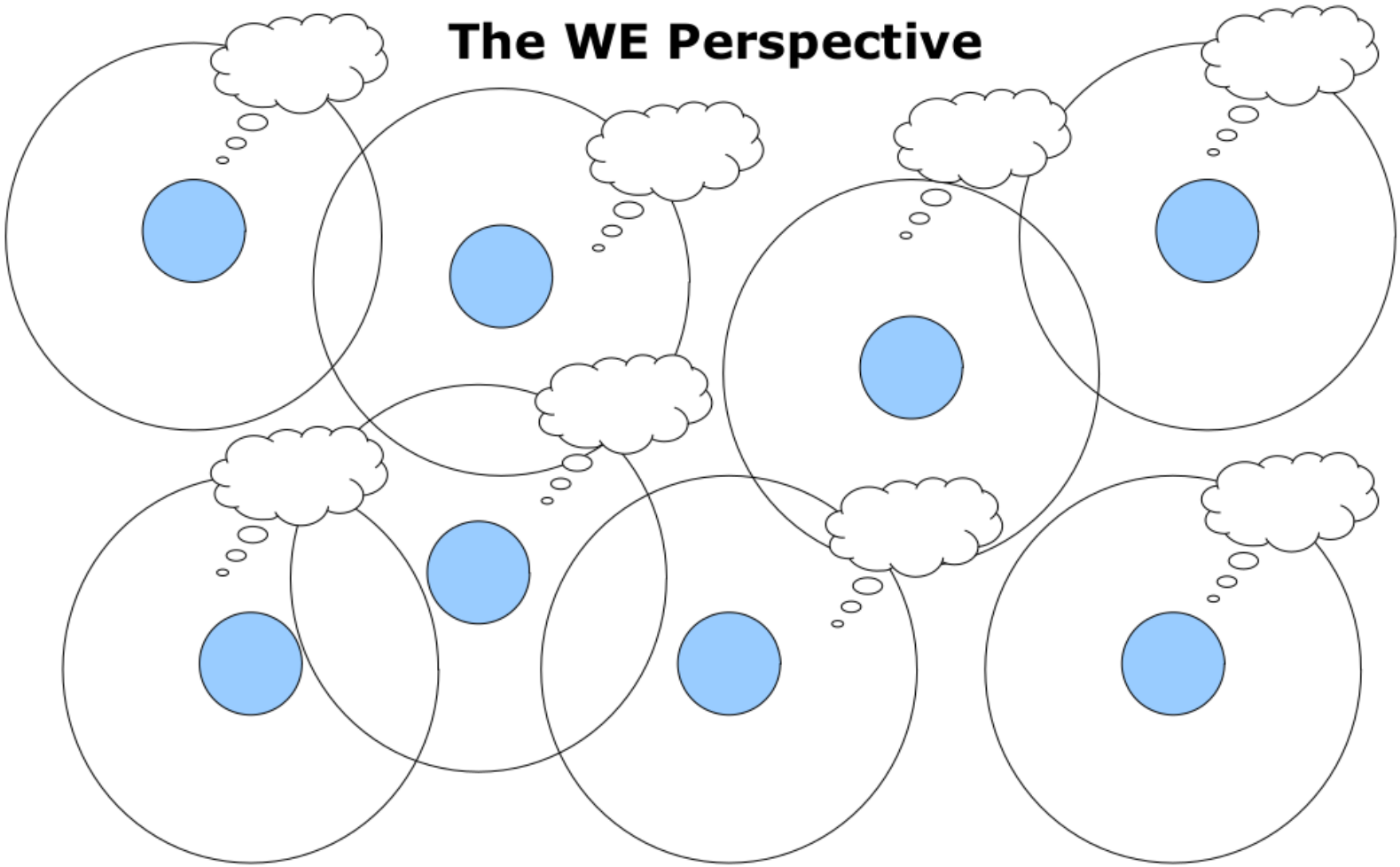
World and Reality



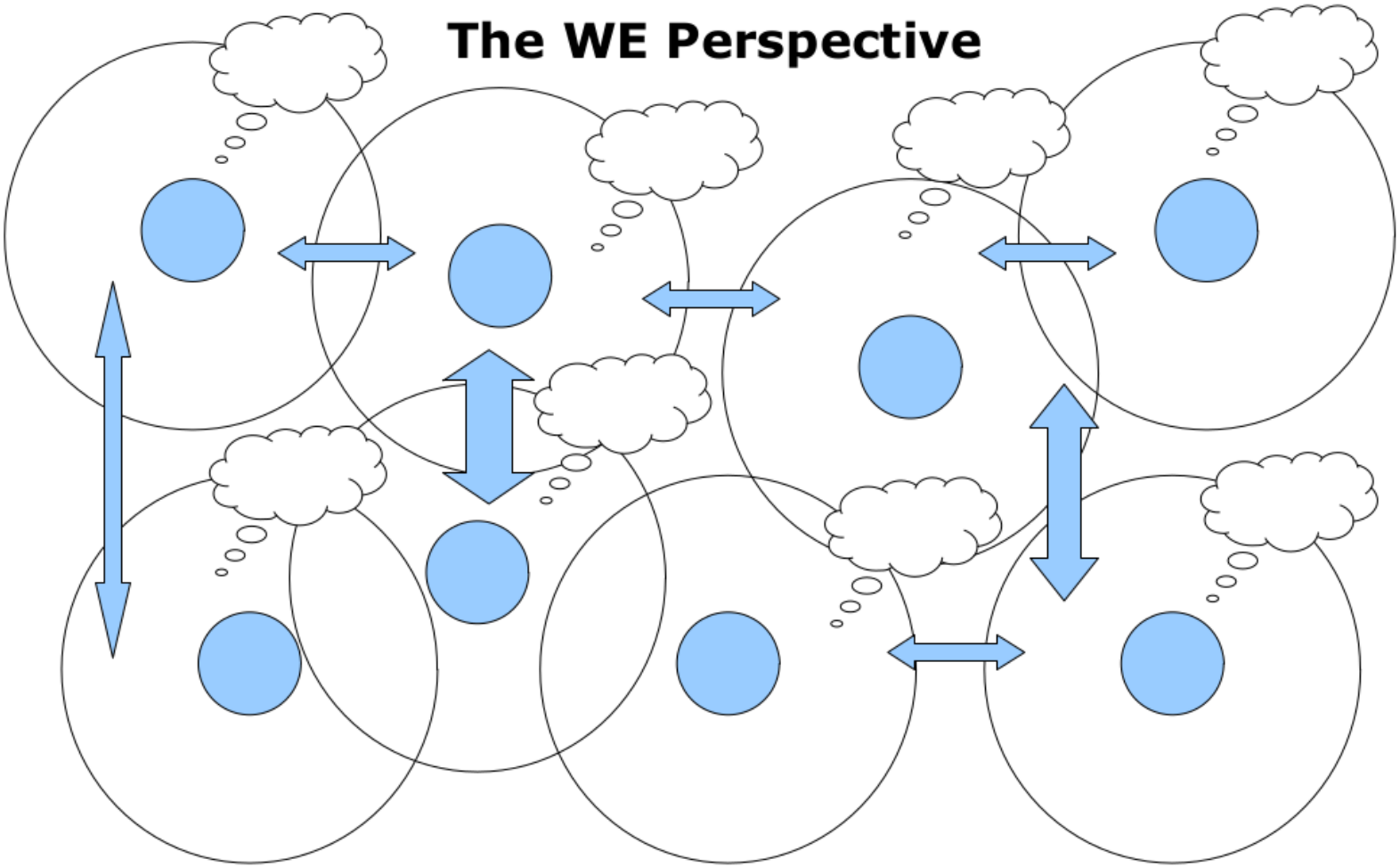
Private and Cooperative Action

- Art of living versus dealing with a structured world in a structured way
- Unpredictability versus predictability
- Constructability of "world"
- Me as a constructor
- (My) imagination and reality

World and Reality



World and Reality



World and Reality. Starting Point

- Forms of description (plural) and reality.
- Contradictoriness of the world (as reality perceived by us)
- Differences in the concept of *contradiction* in forms of description and forms of actions
- Descriptions and contextualisations
  - Creativity and conceptualisation
  - Concepts are a form of cooperative practices of people and thus themselves to be *contextualised in a concrete-historical way*.
- Term *World View* for the complex context of the model-like reference *in the model* to reality.

World and Reality

World is *reality for us* and thus *reality in the process of conceptual comprehension*.

World and Reality. What is Data?

- Data as a specific form of description.
- Capturing data always means choosing what *not* to capture.
- Data as a link between world and reality.
- But what then is *objective* data?
  - Specific reflex of a positivistic understanding of science.
  - Use and misuse: Such an understanding (of science) is an important cultural achievement of humankind, which, however, also has to be *contextualised in concrete-historical terms*.
- Thus data is also a form of cooperative practices of people.

Digital Transformation

Concept of the **Digital Universe** as a rather technically shaped inner-societal space of action through the processing of digital data, with a vague demarcation. Picking up a common buzz word.

- "By 2020, the digital universe will amount to 44 trillion gigabytes" (EMC Digital Universe with Research & Analysis by IDC. The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things. April 2014).
- Reference to the central thesis – a spatial metaphor is used to analyse the digital transformation from a specific dichotomy.

Central Thesis:

The digital transformation is characterised by a rapidly growing "world of digital data", through the analysis and processing of which influence is exerted on real-world processes.

Digital Transformation

On the Critique of this Approach

- In this version, we want to focus on questions of how current structuring processes in the digital universe and real-world processes interact and influence each other.
- The concept of juxtaposing "real-world" and "digital" reality is problematic overall, since actions in the digital universe are both motivated by real-world practices and have an influence on real-world practices.
- However, the concept emphasises that many real-world contexts of action interact with technical processes in this space and therefore such an abstraction seems reasonable.

The Digital Knowledge Revolution

Michael Schetsche: "The digital knowledge revolution" (2006, in German) identifies six social and cultural dimensions:

- a new order of knowledge,
- social control through technical norms,
- the automatic archive function of the net,
- the supplementation of the exchange economy by a gift economy,
- the abolition of the guiding difference between "public" and "private",
- the dialectic of possibility and obligation of permanent communication.

Digital Transformation

All in all, it makes sense and is necessary to speak of a *transformed social order* in which the *structurally decisive changes* emanate from the digital networks.

A more precise understanding of the change in particular in the order of knowledge is an essential part of an analysis of the digital transformation.

Problem: For the new phenomena, we (initially) only have the old terms.

I will not elaborate on that here and refer to (Schetsche 2006).

Digital Spaces of Action

How and where are you acting
in the digital universe?

What opportunities for your own
and collective action in the digital universe
do you frequently use?

Which preconditions
must be fulfilled for this?

Digital Spaces of Action. From earlier Discussions

- The digital universe breaks down into different universes – the Instagram universe, the Facebook universe, the Google Scholar universe, the Wikipedia universe, the Search universe etc.
  - Space in space metapher. Such „subspaces“ are constituted by specific kinds of social relations and specific social practices.
- What to do there?
  - Upload pictures and data.
  - Like and be liked.
  - Communcate with friends in Corona times.
  - Online appointment for offline meeting.
  - Present oneself in digital spaces.
  - Searching for useful information.

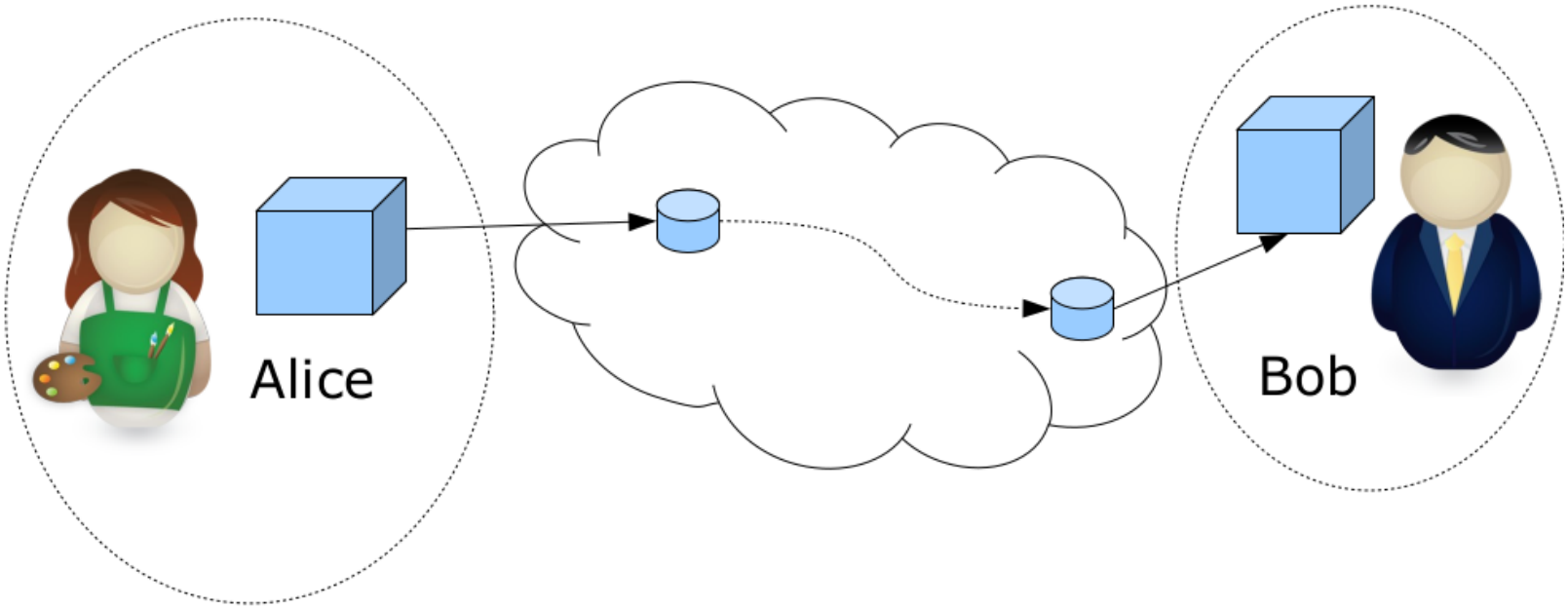
Digital Spaces of Action. Accounts

- Diversity of accounts = diversity of digital identities
  - Identity in the singular or in the plural?
  - My Core – world and reality, meaningful terms?
  - Diversity of identities or of real-world facets
- *Identity* as an important concept in the civil legal system, which is also legally attached in order to be able to assign consequences of actions.
- Questions of private digital spaces of action can only be meaningfully discussed if the user is "logged in" to a computer via an **account**.
  This also applies to other (e.g. mobile) devices, although the technical connection to an account (via SIM card and own security settings) is less visible there.

Using Digital Spaces of Action. Digital Identity

- Such an account is associated with a **digital identity** to which actions on the internet are assigned, via which the usual legal-social constructs of the *legal attributability of actions* are transferred to the digital sphere.
  - The private attribution of consequences of action is a *pillar of the civil legal order*.
  - The technical possibilities in the digital universe can *improve* or *complicate* the attributability of legal responsibility.
  - Possibility of *anonymous action*. But: traces of actions are fundamentally accessible to forensic analysis. This also applies to actions on the internet.

Real-world and Digital Identities



For actions in the digital universe, real-world identities must be tied to digital identities.

Real-world and Digital Identities

- The assignment of a digital identity to a real person takes place via **authentication**, which appears to be a *private* act (albeit technically preconditioned).
  - However, it presupposes an **authenticator** as the technical counterpart and thus a higher-level legal context. This assignment process is nevertheless postulated as private in the public.
- Private digital spaces of action can only be shaped through the binding to a digital identity.
  - The rebinding of a digital identity to a civic legal subject is itself a socio-technically institutionalised process.
  - This rebinding is particularly simple if the signature of a technical artefact from the digital universe can be easily assigned to the civil legal subject.

Acting on the Internet

- Spaces of action are socially determined. Digital spaces of action can be and are constituted and assigned through **authorisation**.
- In shaping spaces of action on the internet, subjects are highly dependent on technical services and thus on external institutions whose *trustworthiness* they must assess appropriately.
- Regulatory provisions for action on the internet exist only in rudimentary form, so that *appropriate practical action* and *cooperative arrangements* on a *contractual basis* are the main forms of shaping a concept of "privacy on the internet".
- An *appropriate* understanding of the technical conditions, possibilities and restrictions of the internet is essential for the qualified shaping of personal actions on the internet.
- Social action constitutes the intersubjective relations of a subject.

On the Concept of Action Space

Thesis:

The concept of action space as it is understood today is a cultural achievement of bourgeois society.

- Spaces of action as a "space within space" contextualise possibilities of cooperative arrangements in an "external space".
- *My* spaces of action are identity-constituting, and the actions in these spaces form the basis for my personality as a civic legal subject.
- Only on this basis can delimitations of other concepts such as *environment*, *acting in an environment*, *cooperative action* and thus ultimately concepts such as *subject*, *privacy* and *identity* be meaningfully grasped.
- Collaborative spaces of action can be condensed into "cooperative subjects" in the sense of the civil legal order.

Private Action and (Digital) Identity

Private action presupposes a *concept of self*, of personal *identity*.

- Digital identity, multiple digital identity and roles

  Is identity divisible?
- Abstract identity, textual representation

  Assignment mechanisms, e.g. website and login
- Authentication

  Password, other forms of authentication
- Authorisation

  Me as subject and as object of authorisation.
- Potential and real assignment. Notion of session.

Digital Identities

- Digital identity, abstract identity, textual representation
- Website, login, mobile devices
- Concept of session (not only on websites)
- Authentication and authorisation

Digital Identity

In the following, we will understand *digital identity* as a **real-world civic subject** *authenticated* under a textual representation `<name@rechnername>` and *authorised* in the context of a session, who performs actions in the digital universe for a limited period of time.

The Concept of Roles in Computer Science

- In computer science, a role is a bundle of necessary *experience, knowledge and skills* that an employee must have in order to perform a certain *activity*.
- Roles are defined by *role descriptions* within a *role model*.
- A role is associated with *activities* and *responsibilities*.
- *Qualification characteristics* are required to perform a role.
- A person can have several roles. Several persons can have the same role.

Modelling Sustainable Systems and Semantic Web

Internet Basics

Lecture in the Module 10-202-2309
for Master Computer Science

Prof. Dr. Hans-Gert Gräbe
http://www.informatik.uni-leipzig.de/~graebe

June 2021

Internet Basics

In the following, we will use the concept of *role* as partial identity as basis when looking at the technical basics of the operation of digital identities (more precisely: *as* digital identities).

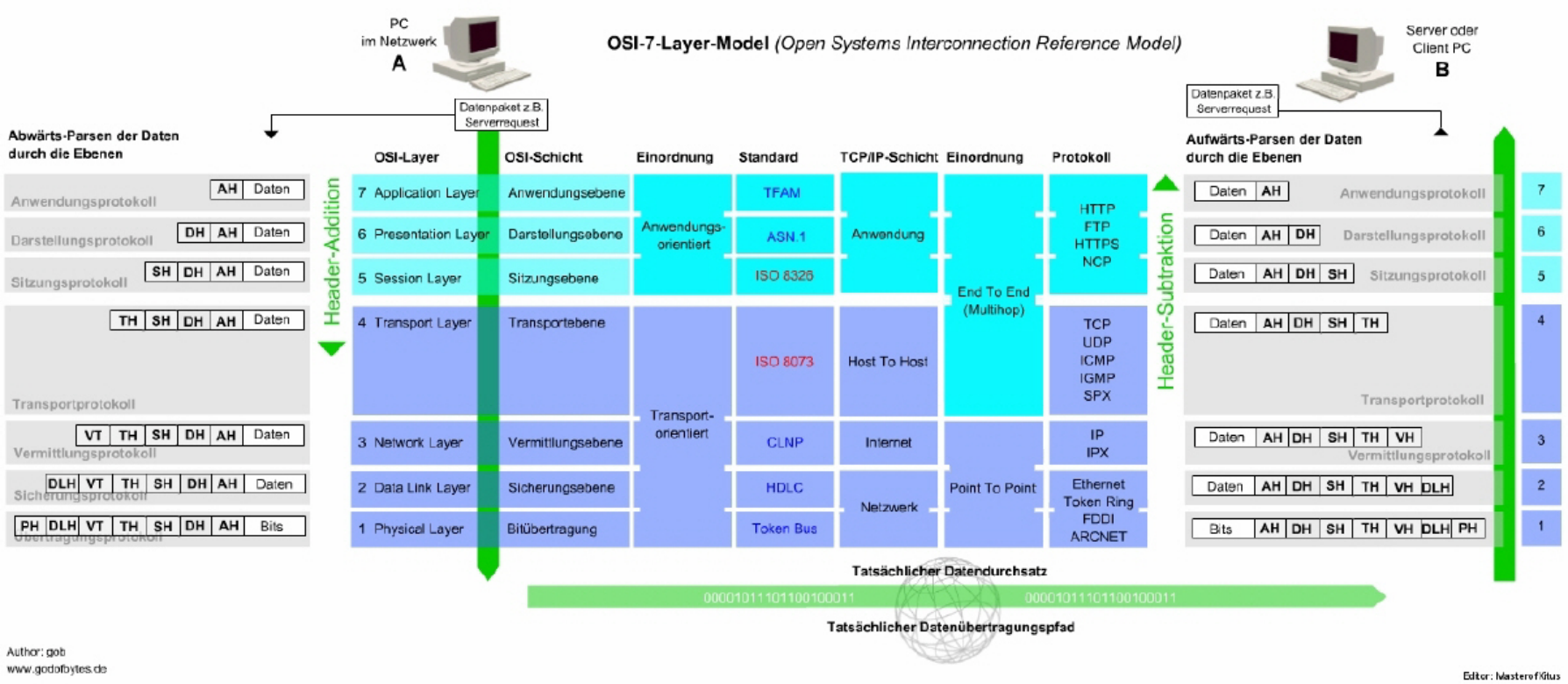
- On the internet descriptions are exchanged.

  Images, for example, are also descriptions that instruct the computer how to render the image.
- Descriptions are exchanged between computers by breaking them down into packets of a given structure and size.

Packet transmission on the internet, the OSI 7-layer model

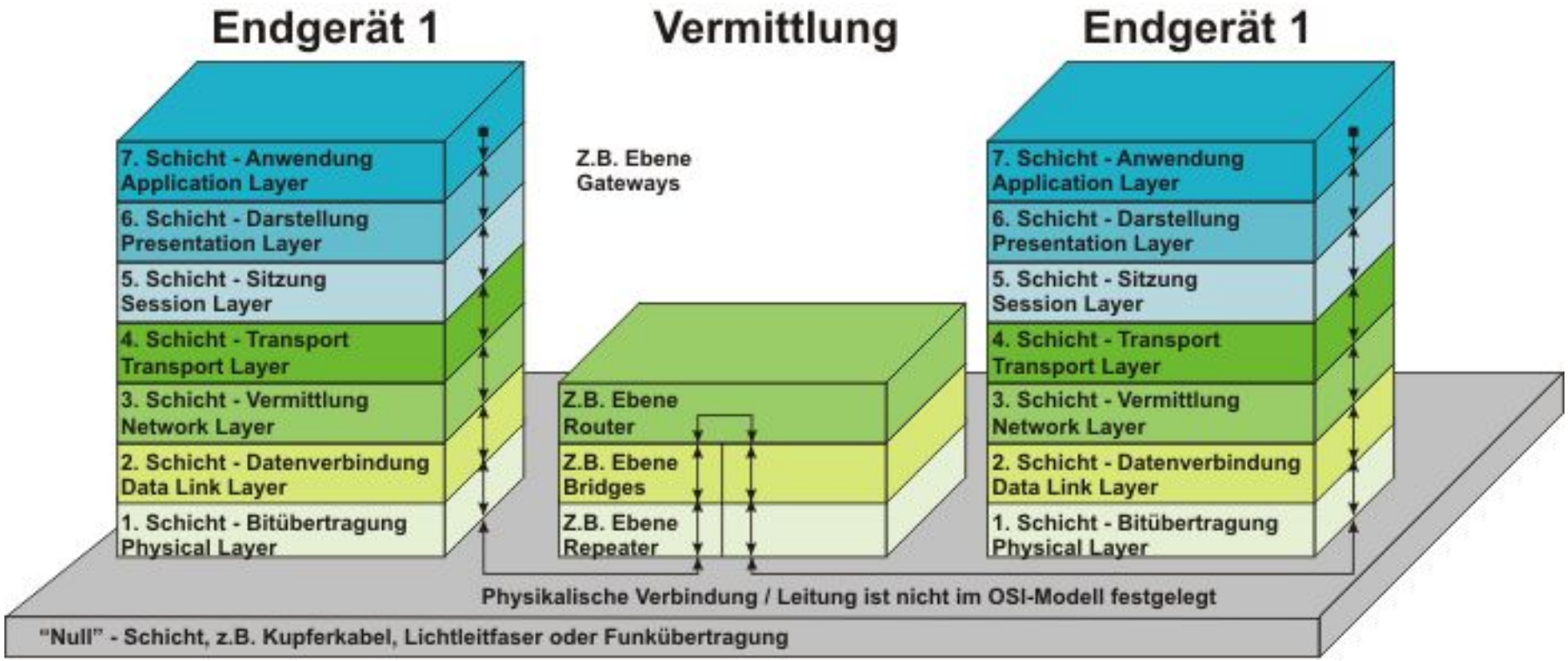
- `http://de.wikipedia.org/wiki/OSI-Modell`
- Layers and protocols
- Protocols and language

Internet Basics. The OSI Layer Model



Source: Wikipedia,
`http://prima-it.de/images/osi7layermodell.jpg`

Internet Basics. The OSI Layer Model



Source: `http://www.hbernstaedt.de/knowhow/ether/osi.jpg`

Internet Basics. How It Works

Texts consist of characters (letters, numbers, etc.)

- Bits and Bytes.
- Reduction to standardised bit sequences and thus numbers.
  - First permanent alphabet: ASCII (7 bits) = 0..127
  - 0..31 – control characters.
  - 32..127 – numbers and letters of the English alphabet.
- Several waves of standardisation for further alphabets and character systems (latin-1, Windows character set).
- Need to agree → Unicode.
  - Efforts begin around 1988.
  - First standard in 1991 contained 216 = 65 536 characters.

Internet Basics. Unicode

International standard in which (in the long term) a digital code is defined for every meaningful character or text element of all known writing cultures and character systems in order to standardise the exchange of textual information worldwide.

- Unicode is constantly being supplemented with characters from other. writing systems.
  - Hexadecimal representation, e.g. U+01FA (2 bytes).
- UTF-8 as an evolving de-facto standard.
  - Encoding of characters in up to 4 bytes (variable length).
  - Encoding of ASCII characters in 1 byte.

Internet Basics. Data transmission

- Serial transmission as a bit sequence, for human-readable purposes usually represented in the octal or (more frequently) hexadecimal system (base 16) (x1FA = 0001.1111.1010).
- Bit stream is divided into packets of constant length and sent off with sender/receiver information (routing).
- Packets are forwarded from computer to computer until they reach their recipient.
- Integrity check with a hash function.
- Receiver reassembles the bit stream from the packets.
- Standardised protocols are used so that this is transparent for the user.

Internet Basics

Function	**OSI Layer**	**Protocols**
Anwendung	Anwendungsschicht Darstellungsschicht Sitzungsschicht	HTTP HTTPS SSH
Netzübertragung	Transportschicht Vermittlungsschicht	TCP/IP SSH/SSL
Netzzugang	Sicherungsschicht Übertragungsschicht	WLAN, PPP Ethernet

What Computers Talk About with each Other

Example: `http://www.inspirata.de`

- Web pages are composed of different parts that can come from different sources.
- Parts in different languages (HTML, graphic formats, programme code, ...), the languages determine the form of presentation.
- Rendering web pages therefore (usually) means bringing together heterogeneous information from different sources.

Internet as World of Fictions

Two dimensions of language: description and instruction.

- HTML (HyperText Markup Language) – the language of the internet?
- HTTP – HyperText Transfer Protocol.

The Internet as a **World of Iterated Fictions**:

- Interpretation of modulated electromagnetic waves as sequences of 0-1-bitstreams.
- Intermediate: frames (OSI level 2), packets (OSI level 3)
- Interpretation of bit streams as "digital content".
- Interpretation of digital content as text, pictures, code etc. for rendering.
- Interpretation of rendered content by humans.

On the Assignment of Digital Identities

Digital identity = *authenticated* and *authorised* within a session real-world civic subject, who performs actions in the digital universe for a limited period of time.

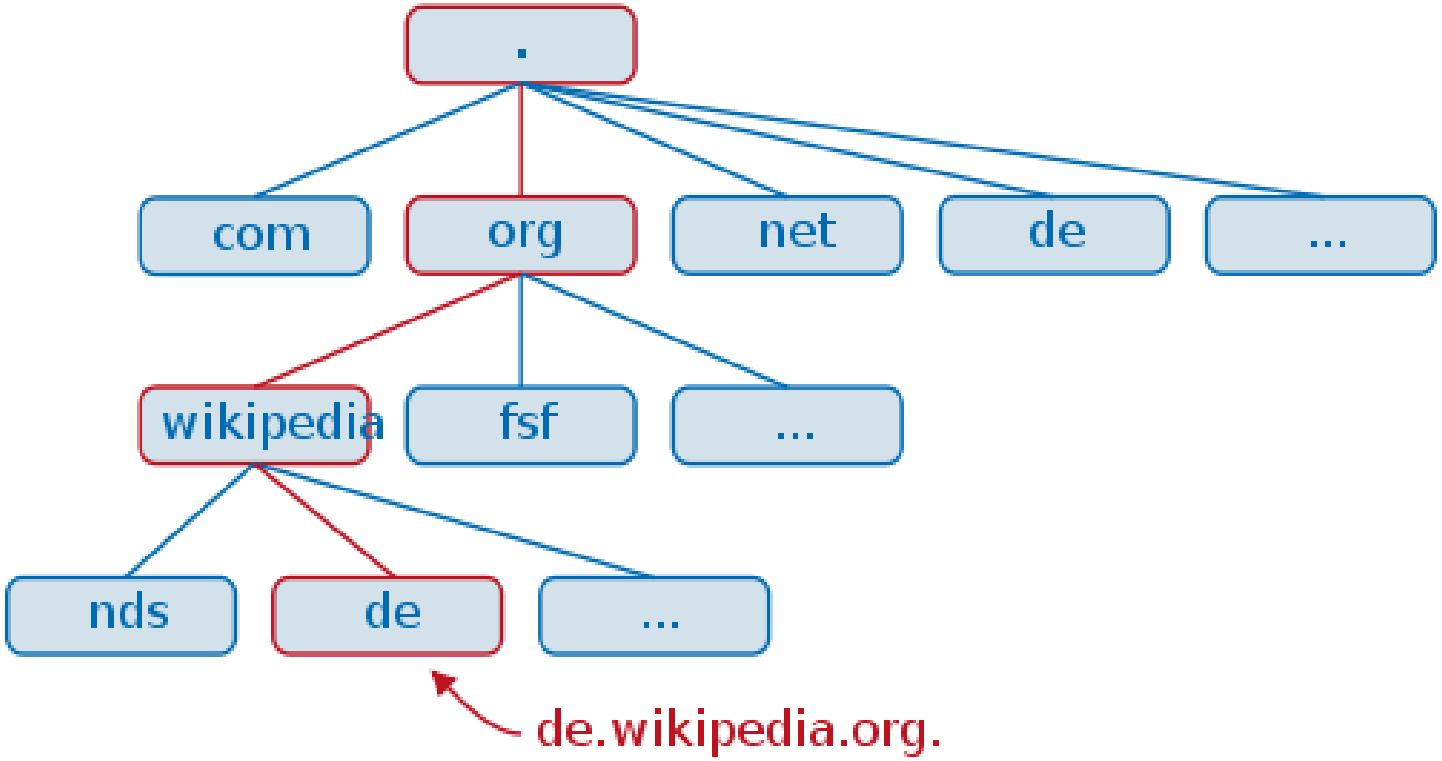
Such digital identities do not fall from the sky, but must be embedded in the civil legal order for the purpose of private assignment of the consequences of actions.

- Market economy: Regulatory framework and contractual arrangements in a hierarchical socio-technical system.

Who authenticates and authorises?

- Computers, computer networks, computer names.
- Registrar, provider, host.

Computer and Computer Names



- IPv4 (32 bit) and IPv6 (128 bit) – `ping` and `ifconfig`
- On the structure of computer names, domain names and top level domains.
- Converting names into addresses – the Domain Name Service System.

Registrar, Provider, Host

- **Registrar:** Administrator of computer names
  - Denic.de – The administrator of the TLD .de is DENIC e.G.
  - Citation Imprint: Registered under No. 770 in the Register of Cooperatives, Frankfurt/Main Local Court.
  - Notes on the legal form
  - URZ administers `uni-leipzig.de` and subdomains
- Which domain names?
  - Ownership of a domain as a legal title
  - Computer names as a commodity:
    `https://sedo.com/de/wissen/markt-trends/`
- **Provider:** Maintains computers with IP addresses (**Hosts**) and takes care of converting domain names into IP addresses as well as forwarding (routing) data packets.

Allocation of IP Addresses

- IP addresses are allocated hierarchically: Users get IP addresses from the ISP (internet service provider), ISPs from a local Internet registry (LIR) or National Internet Registry (NIR) or Regional Internet Registry (RIR – RIPE NCC for Europe, the Middle East, and Central Asia) and these from the Internet Assigned Numbers Authority (IANA).
- IANA is a department of ICANN responsible for coordinating some of the key elements that keep the Internet running smoothly. Whilst the Internet is ... free from central coordination, there is a technical need for some key parts of the Internet to be globally coordinated, and this coordination role is undertaken by IANA. IANA is one of the Internet's oldest institutions, with its activities dating back to the 1970s. → `https://www.iana.org/numbers`
- *Question:* Can I buy IP addresses from the RIPE NCC?

  Answer: No. Internet number resources are a shared public resource and do not have a value. Members are charged fees based on the services that they receive from the RIPE NCC.

Modelling Sustainable Systems and Semantic Web

RDF Basics

Lecture in the Module 10-202-2309
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RDF Basics. Descriptions and Interpretations

Information as interpreted data?

- Measured values as data?

Language is full of implicit assumptions. An example:

- On November 8th at the station Leipzig Airport at 5 p.m. was measured a temperature of 16°C.
- On November 8th at the station Leipzig Airport at 5 p.m. was measured a temperature of 16 °C.
- Things and their names.

RDF Basics. Example

```
@prefix s21:  <http://od.fmi.uni-leipzig.de/s21/> .
@prefix od:  <http://od.fmi.uni-leipzig.de/model/>.
@prefix rdfs:  <http://www.w3.org/2000/01/rdf-schema#>.
@prefix odr:  <http://od.fmi.uni-leipzig.de/rooms/>.
@prefix odp:  <http://od.fmi.uni-leipzig.de/personal/>.

s21:BIS.SemanticWeb.1
    rdf:type od:English , od:LV , od:Vorlesung ;
    rdfs:label "Modelling Substainable Systems ...  " ;
    od:beginsAt "11:15" ;
    od:dayOfWeek "donnerstags" ;
    od:endsAt "12:45" ;
    od:locatedAt odr:online ;
    od:servedBy odp:Graebe_HansGert ;
    od:hasCType "synchron" .
```

- Identifiers and literals. Namespaces.

RDF Basics. Sentences

Resolution in three-word sentences

```
Subject Predicate Object .
```

```
s21:BIS.SemanticWeb.1 rdf:type od:Vorlesung .
s21:BIS.SemanticWeb.1 rdfs:label "Modelling ...  " .
s21:BIS.SemanticWeb.1 od:beginsAt "11:15" .
s21:BIS.SemanticWeb.1 od:dayOfWeek "donnerstags" .
s21:BIS.SemanticWeb.1 od:endsAt "12:45" .
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s21:BIS.SemanticWeb.1 od:servedBy odp:Graebe_HansGert .
s21:BIS.SemanticWeb.1 od:hasCType "synchron" .
```

SPARQL-Schnittstelle für weitere Anfragen
`http://od.fmi.uni-leipzig.de:8892/sparql`

Industry 4.0 and the Internet of Things

- Fiction: There are no things on the Internet, only *representations* of things, just like representations of people (digital identities).
- Descriptions as relational complexes between representations of real things or even just complexes of meaning.
- These things and complexes of meaning must also be assigned "Digital Identities" as textual representations to be able to formulate sentences about them in the Digital Universe.

RDF Basics. Conceptual Ingredients

- UTF-8 as a **uniform character base** for URIs and literals.

  Best practice: URIs only made up of ASCII characters, no diacritics, special characters or similar.
- URI as "digital identities" of resources, *point* to resources.

  Like people's digital identities, these are **textual representations of "things"** in the text fragments circulating in the internet.
- For computers, URIs are just strings, for people it is helpful if the URI already provides a suggestion about its semantics.

  Best practice: "Speaking names" as URIs

RDF Basics. Best Practices

- RDF – Resource Description Framework
- Concept for writing down stories about "the world" as **sets** of three-word sentences

  <subject> <predicate> <object>.
- Subject and predicate must be URIs. The object can be a URI or a literal (type `rdfs:Literal`). Literals can carry type and language markings.
- There are different notations for the same set of RDF sentences (Turtle, rdf/xml, json, ntriples) and tools to convert these notations.

  Redland RDF libraries `http://librdf.org/`
- Pattern search as a powerful concept for analyzing such sets of sentences. SPARQL as query language.

RDF Basics. Example of a SPARQL Query

Example of a request to the SPARQL endpoint
`http://od.fmi.uni-leipzig.de:8892/sparql`

Returns information about all teaching events (`od:LV`) with URI prefix BIS

```
PREFIX od:  <http://od.fmi.uni-leipzig.de/model/>
SELECT distinct ?l ?name?  ?d ?b
from <http://od.fmi.uni-leipzig.de/s21/>
WHERE {
  ?l a od:LV .
  ?l rdfs:label ?name .
  ?l od:beginsAt ?b .
  ?l od:dayOfWeek ?d .
  filter regex(?l, 'BIS') .
}
```

RDF Basics. Different Notations

- **Turtle notation** – collects together all sentences about the same subject. Such a set of predicate-object pairs can be interpreted as a set of key-value pairs that describes this subject.
  - But: Here a key can have *several* values!
  - It is a particularly popular human readable notation.
  - It is a subject-centered point of view, which well serves the specific point of view of "MY World" – as discussed earlier.
  - Computers prefer to work with sets of triples.
- If the subjects and objects are interpreted as nodes and predicates as edges then a set of RDF sentences describes an **RDF graph** (and vice versa).

  A picture is often a better explanation than thousand words.

RDF – Sentences and Pattern

Sentences are arranged following patterns:

1) **Turtle:** Collect all sentences with the same subject. Interpretation of properties of an individual subject as key-value pairs.
   - Key and value = attribute and attribute value
2) Collect **all sentences with the same predicate**

   ```
   A od:beginsAt B
   ```

   - `od:beginsAt` is not only a URI (*syntax*), but also a predicate with two parameters (A and B) and a certain *semantics* that is present in all sentences with this predicate as its *instantiations*.
3) Other patterns are possible, SPARQL as the general standard query language for pattern search in RDF sets of sentences.

See the file **Queries.txt** in the github Repo (with comments in German).

RDF – Descriptions of Descriptions

- **Self-similarity of the concept:** Also descriptions of descriptions can be formulated as RDF phrases. In particular, one can use RDF to describe RDF.
  - A URI that appears as a predicate in a sentence can appear as subject or object in other sentences.
    Example:

```
od:beginsAt rdfs:domain od:LV .
od:beginsAt rdfs:range rdfs:Literal .
```

- This means that also *terms and concepts* can be described using RDF. $\rightarrow$ **Universals**
  - What are universals? Ideas from Plato's *heaven of ideas* or *institutionalized conventions*, i.e. "fictions" in the earlier introduced meaning?

RDF – Basic Limitations

- Set semantics, the order of the sentences does not matter.
  - This is different in other approaches, such as the XML-based TEI (Text Encoding Initiative) which plays a central role in Digital Humanities.
- Problem of contextualization. In which spatio-temporal context the sentence has to be interpreted? There are several approaches here:
  - Extend triples to quadruples with a fourth component containing the URI to the provenance (description).
  - If the sentence contains an instantiation of a predicate, the context often can be inferred from the set of instantiations of that predicate.
  - Often the context results more generally from the *namespace* of the predicate and thus stands as an (explicit or implicit) *model for a whole class of terms*. But this shifts the problem only to the description of the model and thus an abstraction level upwards.

RDF – Summary of the Central Concepts

- *Central idea:* Save textual descriptions in a uniform way as triples and use standard concepts and tools for the management of this data.
- *Resources:* URI, HTTP access
  - URI = Unique Resource Identifier
  - This can be used to access a worldwide distributed database in a uniform manner via a common protocol.
- *Resource Descriptions:* Return on a HTTP request a useful piece of information in RDF format that can be combined with others such information units.
- Operate an *RDF Triple Stores* and *SPARQL endpoints* as part of a worldwide distributed Data storage infrastructure, e.g. `http://od.fmi.uni-leipzig.de/` (note that only the SPARQL endpoint is publicly accessible).
- SPARQL as language for (distributed) queries.

Modelling Sustainable Systems and Semantic Web

Modelling of Conceptual Worlds

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RDF – Language Forms and Practices

Procedural knowledge $\rightarrow$ Practical procedures

- Correspondence between the coherence of the language form and the coherence of practices.
- Establishing coherent practices as procedures allows to substantiate predicates. "At the beginning of the school lesson the sandwiches have to be packes away". Normative sentences are possible only after such a transposition of the predicate to the subject position.
- Parallels to the concert example in the first lecture.
- *Processual knowledge* is the description form, *practical procedures* are the embodiment.

The Linked Open Data Cloud

Back to the basic idea.

- This creates a globally networked **decentralized open database**, the Linked Open Data Cloud, in which all **public** information is freely and machine-readable available.
  - The collection of data is reversed. Data is nothing private but part of a world built around a core stock of **publicly available information** in a **public domain** as an essential cultural constituent.
  - See `http://lod-cloud.net/`
  - Growing the LOD Cloud: `http://lod-cloud.net/versions/`
- The context of Industry 4.0 and all major data projects including Google is inconceivable without these efforts.
- Basis for internal and inter-company information systems such as ERP and CRM.

Namespaces and Conceptual Worlds

Communication is made possible through the introduction of **namespaces** supported as a URI prefix.

Namespaces allow to generate URIs without overlapping.

- This can be used to generate descriptions that contain the fictions of MY world, MY concepts, I-core, worlds and reality, construction of reality, without having to transcend MY context mentally.
- But we want more: cooperation with specific others.
- Semantics = pragmatically contextualized **formation of models** as a basis for *common practical procedures*.
- Language is required to *speak about the models themselves*, and thus ways of formalizing semantics are required, too.

Conceptualizations and Conceptual Worlds

But: **The Tower of Babel phenomenon**

- What does it mean that every communicative context along with his own practical procedures develops also his own models and speaks his own language?
- Which concepts can support translation services?
- **Ontologies** (or vocabularies): WE agree on the usage of common namespaces (foaf, skos, org, sioc etc.) for *special* purposes and thus on common *partial models* of the world.
  - Phenomenon of coherence between private and cooperative language practices.
- How does that work exactly?
  - **Content:** Pragmatically contextualized formation of *models* as basis for common *practical procedures*.
  - **Form:** *Ontologization* as pragmatically contextualized semantification of syntax.
  - Examples on the next slide.

Conceptualizations and Conceptual Worlds

Example foaf: Friend of a Friend

- foaf: `<http://xmlns.com/foaf/0.1/>`
- Redirect to `http://xmlns.com/foaf/spec/`
- We study the model developed there and the descriptions of semantics and syntax.

Example skos: Simple Knowledge Organization System

- skos: `<http://www.w3.org/2004/02/skos/core#>`
- Forwards to a tabular overview `https://www.w3.org/2009/08/skos-reference/skos.html`.
- At the very bottom of the page three references with more detailed explanations about semantics.

Conceptualizations and Conceptual Worlds

Example org: The Organization Ontology

- org: <http://www.w3.org/ns/org#>
- Forwards to a turtle file. Download and inspect it.
- rdfs:seeAlso <https://www.w3.org/TR/vocab-org/>

A socially extremely difficult process, but that is **the core of semantic technologies**: The *institutionalization* of machine-readable common conceptual worlds as *social process*.

Conceptualizations and Conceptual Worlds

Associated with this are *formation of models*, conditionalities (contextuality of different realities) and the process of transcending contexts if ontologies are not applied as originally intended.

- Talk to each other – agree on ontologies.
- Further development of ontologies.
- Large databases of ontologies: `http://prefix.cc` or `http://lov.okfn.org` (Linked Open Vocabularies)
- Creativity in a cooperative context. Requirement of formalization to exchange information as data. Again the concert example.

Conceptualizations and Conceptual Worlds

Example: DBPedia – extract structured information from Wikipedia

- DBpedia is a crowd-sourced community effort to extract structured information from Wikipedia and make this information available on the Web. ... We hope that this work will make it easier for the huge amount of information in Wikipedia to be used in some new interesting ways. ...
- Example: `http://dbpedia.org/page/Leipzig`

Conceptualizations and Conceptual Worlds

Example: Linked data service of the German National Library

- The German National Library offers a linked data service for long-term use of the entire national bibliographic data including all norm data by the Semantic Web Community. Offering this data service it endeavors to make a contribution to the worldwide information infrastructure as a prerequisite for modern commercial and non-commercial web services.
- `http://www.dnb.de/lds`

Other Approaches

Schema.org

- Other approach: `http://schema.org` – Google's ontologization of the world and incorporation into websites instead of building a distributed database as the Linked Open Data Cloud.
- Schema.org and Microdata: `https://schema.org/docs/gs.html`.
  - itemscope, itemtype and itemprop and the link to RDF.
- Labeling websites with this markup increases their visibility on Google.

Other Approaches

Google's Knowledge Graph

Google's Knowledge Vault: Extracted facts by supervised learning from the examined websites as Google's knowledge base.

- Per 2014 it contained over 1.6 billion facts. Facts were assessed with a probabilistic confidence value.

Google Knowledge Graph: Consolidation and enrichment with structured facts from Freebase (founded in 2007, 2010 bought by Google), Wikipedia and Wikidata.

- Contained over 70 billion facts per 2016.
- At the end of 2015, the Google Knowledge Graph API was published. Web developer can use it to access the stock of data.

Other Approaches

But that is only a part of the **Giant Global Graph** (Tim Berners-Lee, 2007).

Wolfram Alpha

Also a *search engine* that is based on facts from own collection of data. Uses Mathematica as additional *compute engine* to create more complex presentations and visualizations.

The goal is to network mathematical knowledge and general knowledge.

- `https://www.wolframalpha.com`
- Example "Leipzig".

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The Internet as a World of Fictions

Data and information – a first approximation

Bit streams and **data packets**.

- There are no bit streams on the "Internet", but rather data packets that are sent and received at the devices. Data packets are generated and transformed back again from bit streams at the 4 lower levels of the OSI stack.
- Fiction of the universally networked end devices and reality of the net failures.

The mouse phenomenon

- Tools and their use. The spoon.
- Fictions in everyday life. Discussion.

The Internet as a World of Fictions

The Notion of Fiction

Fiction as socially supported, guaranteed and sustained *consensus* on a *shortened way of speaking* about a *social normality*.

- Fictions are a specific way of dealing with a increasing complexity of the world.
- Fictions in this sense are not a new phenomenon.
- Fictions and Myths
  - A *myth* in its original meaning is a story. The religious myth links human existence with the world of gods or ghosts. Myths demand to be valid for the truth they claim. ... The ensemble of all myths of a nation, a culture, a religion is called *mythology*. (Wikipedia)

The Internet as a World of Fictions

Complexity and Clock Frequencies in a Society

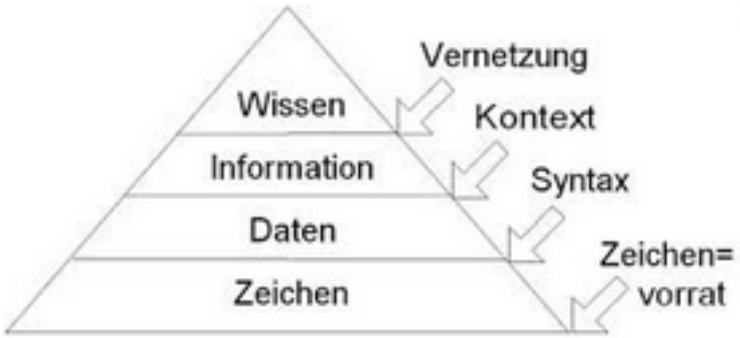
- A clock (or timing) is used to impress a periodicity to a sequence or to synchronise processes. The system clock in a computer determines the working speed of many components. (Wikipedia)
- Timing is also essential for the coordination and synchronization of social activities.
- Development of complexity and clock rates of computer chips see `https://arxiv.org/pdf/1803.00254.pdf`
- Moore's Law (1965) states that complexity of integrated circuits with minimal component costs doubles on a regular basis. Depending on the source, the period is 12 to 24 months.
- But the „human clock rate“ does not change ...

The Internet as a World of Fictions

Fiction of the universal end-to-end connection and its realization as a scale-free network

- $v(k) = c \cdot k^{-a}$ – proportion of nodes with k neighbors (v as valence).
- Example with $a = 3$: $v(1) = 0.832$, $v(2) = 0.104$, $v(3) = 0.031$, $v(4) = 0.013$, $v(5) = 0.007$, $v(6) = 0.004$, ...
- Compared to a random network (another model!) the proportion of nodes with many connections (hubs) decreases slower.
- How quickly does the graph break down into several subgraphs if nodes are removed?
- Scale-free networks are robust against the failure of a larger number of randomly selected nodes, but not against failure of a small number of hubs.
- Robustness: Each node is embedded in a local socio-technical infrastructure, which takes care of its operation, maintains the "social normality" and thus reproduces the "fiction".

Data and Information



Data and Information

Syntax, Semantics, Pragmatics

Data and Information. A first definition

Information = interpreted data

Data = formalized information

Both (formalization and interpretation) are only "valid" in a special natural, technical or social *embedding* – a *context* (or pragmatics) – and thus assume a "working fiction".

Compare this also with the concert example in the first lecture.

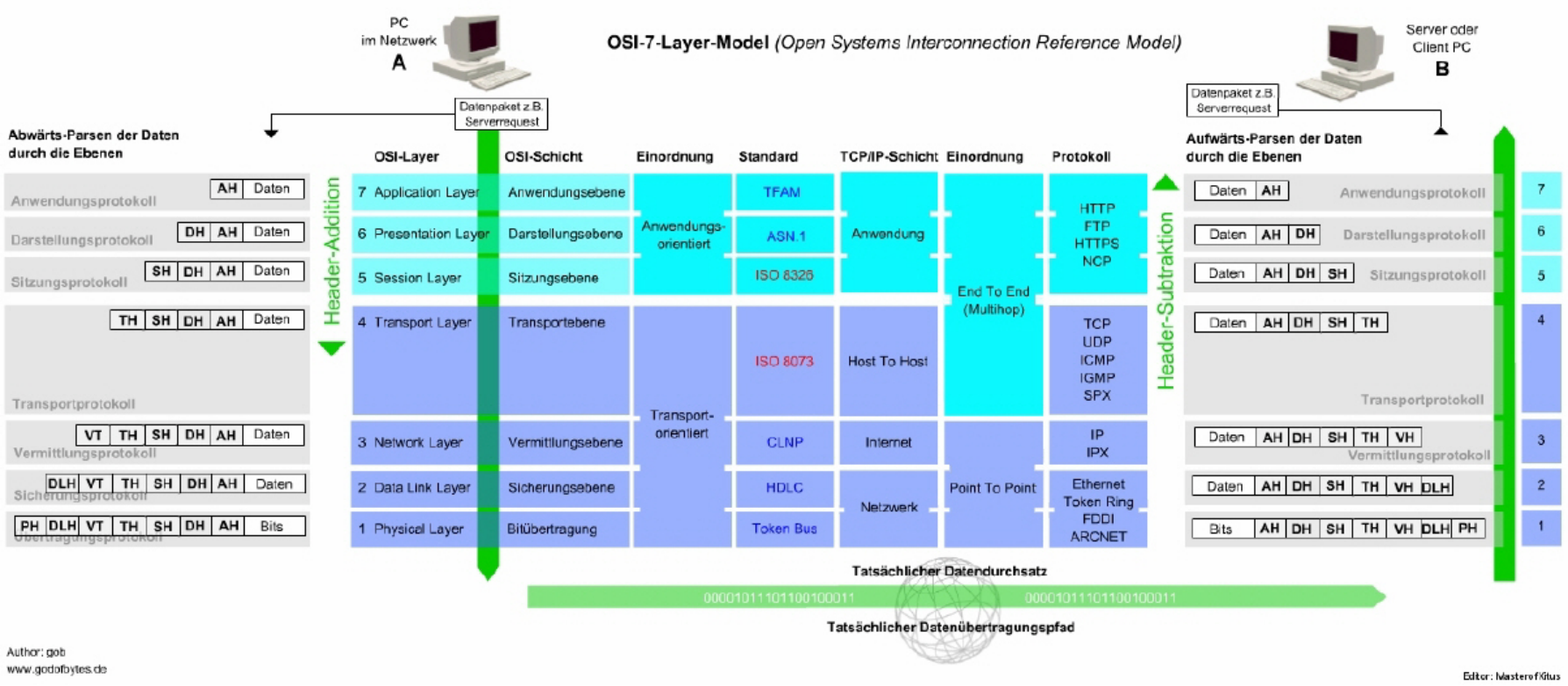
Data and Information

Syntax, Semantics, Pragmatics in the OSI layer model

We consider such a *pragmatically* contextualized interplay of (formalized) *syntax* and (formalized) *semantics* on different levels at the example of the OSI stack.

- Each layer is based on a fiction (i.e., social normality) and its language representation given as formalized syntax.
- This formalized syntax was practically produced on the previous layer.
- On this basis a further pragmatics is realised through language constructions as special way of speaking (semantics).
- This special way of speaking in turn is formalized for use on the next layer.

Data and Information



Source: Wikipedia,
`http://prima-it.de/images/osi7layermodell.jpg`

Data and Information

Syntax, Semantics, Pragmatics in the OSI layer model

Explanation of this idea:

Layer 1:

- Syntax = modulated waves,
- Semantics = bit sequences (first fiction),
- Pragmatics = diversity of transmission media

Layer 2:

- Syntax = bit sequences,
- Semantics = frames (second fiction),
- Pragmatics = control of the transmission speed of the bit sequences, addition of checksums for error detection

Data and Information

Syntax, Semantics, Pragmatics in the OSI layer model

Layer 3:

- Syntax = frames,
- Semantics = data packets (third fiction),
- Pragmatics = routing and organization of forwarding of packets across multiple nodes

Etc.

Modelling Sustainable Systems and Semantic Web

Information and Language

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July 2021

Storytelling and Action

Our actions are closely related to the stories which we are permanently telling in parallel to each other.

- With these stories we transcend *our own world of experience* that is only a small part of THE WORLD. And we can grasp it only selectively.
- Storytelling is the form in which we make other people's worlds of experience accessible for us.
- This requires the *coordination of our conceptual worlds*.
- The *purpose* of the exchange of ideas is to *agree on cooperative action*.

Storytelling and Action

The (cooperative) changes of the world are preceded by speaking about these changes (the imagination of the change).

- Thinking and Doing: Justified expectations $\rightarrow$ World-changing action $\rightarrow$ Experienced results
- In the tension between justified expectations and experienced results the ceasefire lines of the WORLD become visible.

Storytelling and Action

But how change a world that is also constantly changing by itself?

- Culture: Change the changes of the world (nature).
- Technology (tool perspective) and storytelling (perspective of expectations and experiences) are two essential moments of culture.
- Technology comes in here as *general processual knowledge*.
- Separation of goals and means in modern society is a specific form of storytelling.
- The widespread separation of these two moments causes essential problems to understand the wholeness of the reality.

Storytelling and Digital Change

- Within the digital change new forms of storytelling are developing, which break up the previously institutionalized procedures of storytelling.
- Web 1.0 – Linked websites as a new form of storytelling.
- Semantic Web – RDF as a new basic technology to operate a certain kind of storytelling with computer support.
- Digitization of important language artifacts. Examples from the German Digital Universum:
  - German Digital Library (Deutsche Digitale Bibliothek – Kultur und Wissen online) `https://www.deutsche-digitale-bibliothek.de/`
  - Europeana – `https://www.europeana.eu/de`
  - Digital Library at TextGrid – `https://textgrid.de/digitale-bibliothek`
  - Zeno.org, a full text library – `http://www.zeno.org/`

Storytelling and Digital Change

What social conditions are required in order to develop this potential?

- *Free* (as in free speech) access to the knowledge resources of the mankind, to communicate prospects of expectation and experience in an appropriate way.
- Acting in a civil society as responsible *private* action, in which the consequences of action are privately assigned is a cultural achievement.
  - Ability to close contracts, liability, ownership, and institutionalised checks and balances in their historical evolution.
- The digital change requires a new balance between these two perspectives. In the legal context of a civil society that means above all readjustment of the legal constitution and framework.

What is Language?

It is obviously about processes mediated by language (computer language). How does language work? What does linguistics say about this?

> *Language, a system of conventional spoken, manual (signed), or written symbols by means of which human beings, as members of a social group and participants in its culture, express themselves. The functions of language include communication, the expression of identity, play, imaginative expression, and emotional release.*
> *(https://www.britannica.com/topic/language)*

Information and Language. Linguistics

`http://de.wikipedia.org/wiki/Sprachsystem`

The idea of how the **language system** is built depends on which language or grammar theory as base. The different theories support mostly the following assumptions about the components of the language system:

- There are **linguistic units that are organized hierarchically** and reach from the smallest units, the sounds, to the phonemes, morphemes, words, parts of sentences, sentences up to texts and possibly to discourses.
- In this hierarchy, from the morphemes on the units have **additional to their form** a grammatical or lexical **meaning**.
- At each level of the hierarchy there are **rules** that determine which positions and combinations of units are allowed and which are not. This applies to both the linguistic forms and their meanings.

Information and Language. Linguistics

http://www.christianlehmann.eu/ling/lg_system/index.html

Formative and Significative Subsystems

The language system relates thoughts to sounds. This association is indirect in several ways: A language system cannot associate thoughts ... and also not sounds ... but only linguistic units with each other. These are on the one hand **Significata** (the thought as content of the sign) and on the other hand **Significantia** (the sound as expression of the sign).

Hence the language system contains **two formative subsystems**:

- In **Semantics**, the thought is formed into a significatum.
- In **Phonology**, the sound is formed into a significant.

Information and Language. Linguistics

(cont.)

In addition to these formative subsystems, there is the **Significant Subsystem**, which combines Significantia and Significata and thus creates **Language Signs**. ... It is divided into two subsystems:

- Finalised language signs are stored in the **lexicon**.
- New language signs are formed in the **grammar**.

Information – a new Phlogiston?

What is Information?

- Inflationary use of the term information.
  - Günter Ropohl remembers the times when there was a counter "Auskunft" at a German railway station. (Source: Klemm 2003)
- The computer scientists stick to an ontologizing (and ultimately a tangible) concept of information.
- The linguists talk about language practices.

Information – a new Phlogiston?

Another critical debate occured in the late 1990s

- Capurro's Trilemma
- Trialog (Capurro, Fleissner, Hofkirchner): Is a unified theory of information feasible?
- Heinz Klemm (2003): "A great misery"
  (German: "Ein großes Elend")
- Peter Janich: The concept of information has necessarily to refer to successful human communication.

  However, for successful prompting practices it is fundamental that through them a successful connection is established for the involved people between the (language) act of prompting and (non-language) act of obeying. (Janich 1998)

Information – a new Phlogiston?

Raphael Capurro:

> *What I am criticizing is the idea to have by the reductionistic concept of information* a kind of phlogiston*: To mean that one comes through the different levels – Aristotle called this logical error metabis eis allo genos – and thus to believe e.g. better to explain how life arises from matter. So we are not far from the use of the concept of form – informatio originally goes back to forma and eidos – in relation to matter, life, soul, etc. We would be faced with a new or old form of metaphysics.*

The problem is once again: Where is the human being as an *acting* subject?

Klaus Fuchs-Kittowski stated already in the 1980s:

> *The concept of unity of self-organization and generation of information – the information processing approach neglects the formation of meaning in the process of real life.*

Modelling Sustainable Systems and Semantic Web

Knowledge and Action

Lecture in the Module 10-202-2309
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Storytelling and Digital Change. Summary

Starting point: RDF – what is happening there and in general in the internet?

- It is a digital form of storytelling.
- Storytelling accompanies our *cooperative actions*. Cooperative actions are possible only in such an interpersonal language based context.
- Question (1): *What* is here conveyed by language?
- But: Storytelling is not reduced to its *communicative* function. It has also a *reflective* component.
- Question (2): How does *theory building* work on such an empirical background?
- There is an arc of tension *Justified expectations* $\rightarrow$ *World changing actions* $\rightarrow$ *Experienced results*
  - Interpersonally this arc of tension is to be explored only in language form and *only in specific contexts*.

Storytelling and Digital Change. Summary

Why act cooperatively? "Change the world".

- But how change a world that is also constantly changing itself? How to deal with the diversity and contradictions of the requests for change?
- Approach "influence the changes of the world".
  - "Doing" is embedded here, prior to it is the reality of life. Justified expectations can only be derived from this reality of life.
  - Experience: *Practical* influence is (today) only possible through application of adequate processual knowledge and processual skills.
- But why cooperate?
  - Cooperative action is more powerful than individual action due to emergent synergistic effects.
  - The whole is more than the sum of its parts.

Storytelling and Digital Change. Summary

Cooperative action is only possible in a *common context of meaning*.

- Experience: *Understanding* language presupposes a common context of meaning on the one hand, and continues it on the other.
- This context of meaning expresses itself above all in the *social use of common terminology in common activities*.
- Question (3): How can that itself be expressed in language form?

Storytelling and Digital Change. Summary

Experience: Such contexts of meaning are stabilised through *institutionalisation*. Meanings are tied to social practices as a specific interaction between logos and telos.

- The *practically approved* is socially secured and institutionalised as *processual knowledge* (technology) and *approved practices*.
- Question (4): How to set up the notion of *knowledge* in this context?

Storytelling and Digital Change. Summary

Observation: Such institutionalised contexts of meaning are nested and interlaced in many ways.

- Experience: Cooperation between cooperative structures requires translation between contexts of meaning.
  This is yet hardly understood in the field of semantic technologies.
- People are involved in cooperative contexts with partial identities only $\rightarrow$ concept of roles.

The core of all four questions: How does such an institutionalisation of contexts of meaning work?

Storytelling and Digital Change. Summary

- We also identified this question as a core problem of semantic technologies.
- Historically in the last 150 years there have been various attempts to this problem.

Attempts to develop a general language theory as Universal Theory.

- Logical positivism of the Vienna Circle (1920s).
- Syntax, semantics, pragmatics (Charles W. Morris, 1940)
- Continuation as semiotics and linguistics in the 1970s.
- Noam Chomsky and his approach to a universal grammar.

Storytelling and Digital Change. Summary

At the same time, since 1920, the importance of evolutionary approaches increases: Institutionalisations of contexts of meaning are hierarchically complex and can be unterstood only in their historical-cultural development.

- Biosemantics: focus on coevolution of neural patterns and evolutionary patterns of contexts of meaning.

Pragmatics: Notions develop with their interactive use. (Jacob L. Mey: Pragmatics, 1993)

- The development of concepts cannot be detached from their practical use, in particular forms and practices of evaluation and judgment.

What is Knowledge?

Stabilisation of contexts of meaning through institutionalisation: what has been *practically approved* is transferred to *processual knowledge* (technology) and thus socially fixed in *approved practices*.

How is a notion of knowledge to be understood in this context?

What is knowledge?

- A cumulative notion as in a knowledge pyramid approach (Aamodt, Nygard 1995) was already criticised.
- The debate is heavily influenced by the accumulation theory of knowledge developed within linguistics in the 1970s.
- An understanding of knowledge as tangible resource was prominently present once more in the discussions about an approriate concept of information around 2000.

Storytelling, Conceptual Systems, Knowledge

Storytelling is tied to *interpersonal contexts of meaning*.

What is meaning?

- Meaning *is* the use of terms.
- Terms are a form of *cooperative human practices* and thus to be contextualised in a concrete-historical manner.
- Context of a civil society as legal system in which the actors are made individually responsible for the consequences of their actions.
- Action is thus embedded in the updating of interpersonal *relations of reasoning* (Begründungszusammenhänge) and *judgment practices* (Urteilspraxen).

Knowledge According to Berger/Luckmann

We have rejected a concept of knowledge, which considers knowledge as external epistemic entity which precedes human action (approach "knowledge pyramid", cumulative concept of knowledge of linguistics and semiotics).

Another approach is rooted in the sociology of knowledge. (Berger/Luckmann 1966) develop a concept of knowledge starting from its social use.

- Knowledge as socially objectified and therefore legitimate *interpretation of sense*.
- Also to be viewed critically. How far reaches a sociological approach of knowledge as objectification and institutionalisation if interpretations are subjectively pre-formed?
- How stabilisation and institutionalisation of contexts of meaning develop in such a concept?

Forms of Knowledge Practices

What has been practically approved becomes processual knowledge and is institutionalised as approved practices.

Which types of practices are relevant at all?

- Wide range of forms: general knowledge – special knowledge – calculus – skills – technology.
  - Experience: Massive devaluation of knowledge (even of entire professions) during technological progress argues against a cumulative picture of knowledge.
- "Big data" and "digitization of the world" produces the opposite picture – quantity instead of quality is required?
  - But: Successful semantic projects work on a digital reconstruction of well established contexts of meaning in order to make them accessible for the use of digital tools.

Forms of Institutionalisation of Knowledge

Phenomenon of institutionalisation of approved structures through "pattern formation" (Musterbildung), "best practices", "meaning formation" (Bedeutungsbildung).

But that are only forms of complexity-reduction of descriptions (a *production of fiction*), because

- The investigation of the dynamics of the *relations* on the macro level assumes a relatively constant structure at the micro level.
  - This is valid at least in "normal times" (cf. T. Kuhn's notion of "normal science").
- "Enslavement effect": macro structures (as context) have a stabilizing impact on the dynamics and thus the stability of structures at the micro level. Throughput defines the inner structure of a system.
- Approach of a co-evolution model.

Knowledge and Cooperative Action

The considerations concentrate on a systemic model, i.e. the interweaving of the dynamics as well as structure and pattern formation processes on the micro and macro levels and thus on the dynamics of the *internal relations* of a cooperative context, which is separated from the *outside world* by a *system boundary*.

Such an approach is a *methodical approach to complexity reduction* by dividing all possible relationships into three groups,

- the relations within the system boundaries – internal relations,
- the cross-border relations and
- the relations outside the system – external relations.

The relations in the groups differ in the mode of shapeability related to a concrete cooperative action.

Focus of consideration: Contexts of meaning unfold in the field of tension between *justified expectations* and *experienced results within the cooperative context* which develops in time.

Yesterday – Today – Tomorrow

- The (processed) *experienced results* are anchored in the World View and thus are a conditionality of future action. They are a reflex of the Yesterday in the Today.
- The *justified expectations* are based in the World View as a reflex of the Tomorrow in the Today.
- Yesterday: justifications, action planning, development of *competence to act*.
- Today: execution of action
  - It is time critical! Acting under "incomplete information".
  - *Private* decision-making, action, responsibility.
  - To enable this condition of possibility are to be *socially* produced: Manageability, trust, reliability
- Tomorrow: The justified expectations are compared with the experienced results.

Yesterday – Today – Tomorrow

Reasonable expectations

- The diversity of private expectations appears socially as multi-optionality of expected future development.

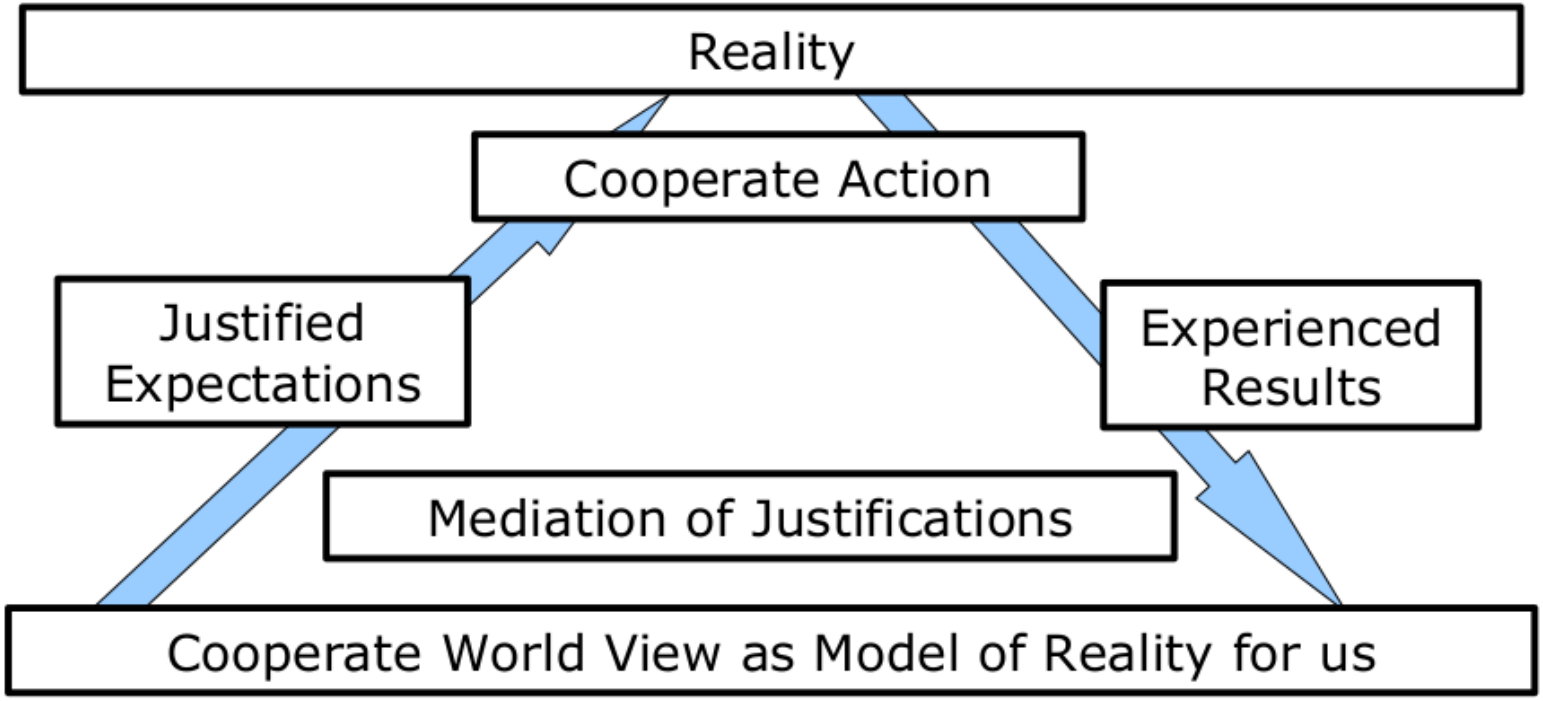
Lessons learned: comparison of the results of action with the expectations. Further development of *experienced results*.

- Common experiences are the basis of the further development of the *cooperative world view*.

Two central mediation contexts for *synchronicity* of cooperative action:

- Mediation on the level of description forms as further social development of a common World View (and thus of *competence* to act).
- Mediation on the level of action forms as socially based further development of *shaping reality*.

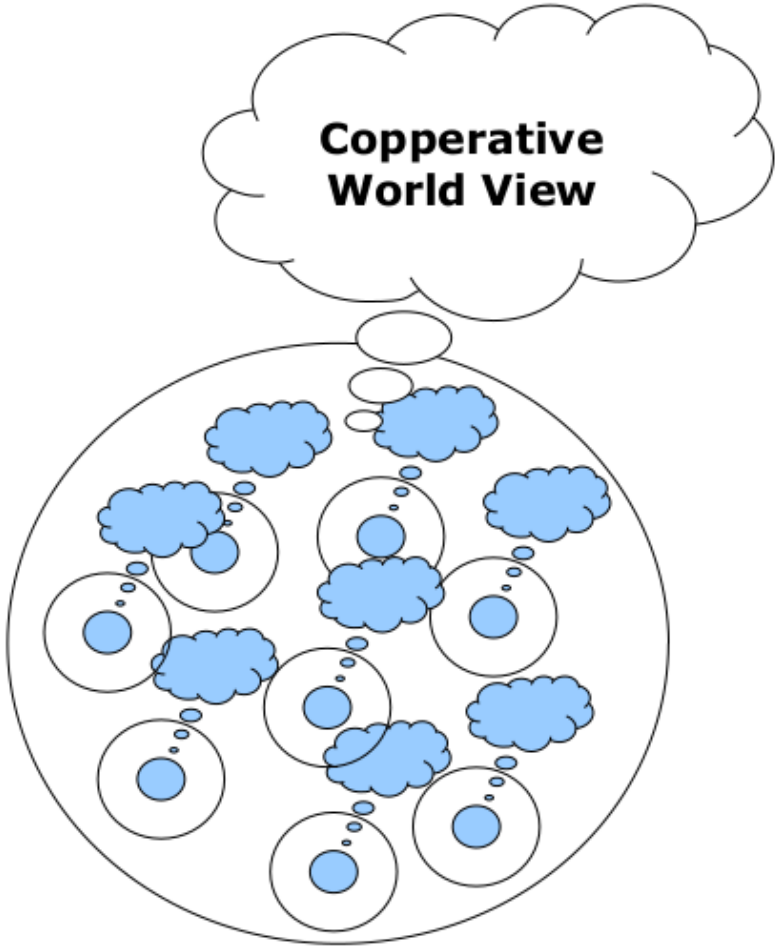
Yesterday – Today – Tomorrow



This picture describes the position of the two mediation contexts of the dynamics of cooperative action both at the micro level and the macro level.

Cooperative Action

How do justified expectations develop in the context of cooperative action?
Forms? Common interests, predefined norms.
Dynamic moments? Generalise and spread the approved as commonly accepted processual knowledge, marginalize or criticize the non approved.
Structural Moments? *Operationalisation* of processural knowledge in institutions, tools or technology. Corporate identity.



Cooperative Action. Observations

Relational moments as relationships between actors shape the cooperative context more than individual moments of individual actors.

- This requires to postulate also *specific, cooperative processual knowledge* that cannot be assigned to individual actors. Such phenomena cannot be described within an accumulative concept of knowledge.

Actors are involved in cooperative contexts only with partial identities. Or, interpreted submersively: only in a reduced form of their overall personality.

- Such a *reductionistic approach* to the individual personality hides intercooperative phenomena of the intentionality of personalities and leads to the assumption of a *relational intentionality*.

Micro Level: Private Actions of the Actors

The great importance of private action results from the legal basic constellation and various institutionalisations of the civil society in which the consequences of actions can be attributed.

In the field of tension of private action between expectations and results evolve

- The private *capability* to act (Handlungsfähigkeit) as socio-technical *capacity* to act (Handlungsvermögen) in a socially determined *field of action* (Handlungsfeld).
- The *private World View* (as "Unity of Consciousness") as a reflex on the *conditionalities* of this capability to act.

In a theory of the *inner perspective of cooperative action* (within the systemic limit) these processes are visible only so far as they *relate to the cooperative context* (reductionistic assumption of relational intentionality).

Modelling Sustainable Systems and Semantic Web

Cooperative Action in Digital Change

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Cooperative Action. Practical Examples

Examples of cooperative structures

- OEIS – The online encyclopedia of number sequences
- The Debian Project – `http://www.debian.org/index.de.html`
- The Apache Project – `http://www.apache.org/`
- Java Community Process – `https://www.jcp.org`
- Wolfram Alpha – `http://www.wolframalpha.com/`

Theoretical considerations: The GNU Manifesto

`https://www.gnu.org/gnu/manifesto.en.html`

Cooperative Action. Practical Examples

- What similarities can be seen?
- Which priorities characterise internal and external relationship?
- Which hints for a *theory of forms of cooperation* can be derived?
- How does this relate to the considerations of the *1985 GNU Manifesto*?

Example: OEIS – The Online Encyclopedia of Integer Sequences

`https://oeis.org/?language=german`

OEIS – The Online Encyclopedia of Integer Sequences

Observations:

- In the internal relationship, power structures have emerged that are based on well-known academic reputation structures.
- Central moments of an internal personal structuring are Bylaws, Board of Trustees, Advisory Board, Editorial Board.
- There is a "History of the OEIS". Today's structures can only be understood on the background of this historical development.
- Four "goals" are defined
  - To own the intellectual property known as "The Online Encyclopedia of Integer Sequences®" (or "OEIS®").
  - To maintain the OEIS as a service that is freely accessible by the general public.
  - To act so as to maintain its own existence indefinitely.
  - To collect and distribute funds in order to carry out the first three goals.

The 5-Level Model

1. User: Uses the given options without having to take part in its extension. Interested in the *existence* of the platform.
2. Contributor: Posts own content. Contribution to the *development* of the platform content.
3. Editorial Board: Review of submissions. Contribution to the *quality assurance of the content* of the platform.
4. Platform operator: Reproduction of conditions for the platform to be running smoothly (in a comprehensive socio-technical sense) as management of the internal relationship.
5. The core of the OIES Foundation: Reproduction of conditions that ensure that running the platform is even possible. (Management of the external relationship).

What is the relationship between the individual levels and the 5-level model?

The 5-Level Model

Users
Editors
Office
Platform Operator
Financing

Users
Content Provider
Organisation and quality assurance of the platform
Socio-technical organisation of the infrastructure
Financing

This relates to five system levels – the coupling between the system elements is organised in the system of the next level.

The 5-Level Model

Observation:

- The model is typical for today's platform structures and can be found in different forms.
- E.g. Amazon:
  - Level 2: Different shop owners.
  - Level 3: Organisation of the shop operator by Amazon, establishing an institutionalised code of conduct and its monitoring as a social level of the infrastructure.
  - Level 4: Technical level of the infrastructure. Research and further development of the algorithmic basis as requirement for level 3.
  - Level 5: Amazon as a private capitalist company.

Forms of Cooperative Action

Observations:

- The (legal as well as economic) functional logic of civic capitalist relationships shapes the internal relationship.
- Level i creates the infrastructural prerequisites for the level $i-1$.
- From level 1 to level 5, the scope of personal involvement in the cooperative project increases.
- It is not a relation between equals: From level 1 to level 5 the possibility to influence the development of the cooperative project increases.
- There are fluctuations of staff between these levels: Intensive users become contributors, hard-working contributors participate in the editorial board, etc.
  - In the example, reputation and power structures are formed that are heavily oriented at academic reputation patterns or, conversely, are influenced by them.

Forms of Cooperative Action

Observation: Prosumer approaches can be observed at all levels; there is no typical division into producers and consumers.

- The transition from level i to level $i+1$ means to move from a *user* of the service of the infrastructure to a *producer* of this service within the framework of the cooperative context.
- Every contributor remains a user, every editor remains a contributor etc., and brings in the knowledge about the "what?"
- Hence the question of the identification of "Customer needs" (what?) move in the background in favour of questions of the implementation (how?) of cooperative goals on the respective level.

Forms of Cooperative Action

The internal structure of capitalist companies follows a similar "top-bottom logic". From such a perspective the following forms can be distinguished.

1. The classical owner-managed company.
   - With the notions "ingenious inventor" and "wage labourer". "Intellectual Property" is a right of a person and basis for the expropriation of the wage labourer.
2. Stakeholder-driven company forms such as Stock Corporation.
   - With the notion "legal person". Copyright as economically useful legal title in the *external relationship* and basis for expropriation of the "ingenious inventor". Copyright, Closed Culture.
3. Network cooperation.
   - Copyright law as a functional basis of the *internal relationship* required to reproduce the infrastructure. Copyleft, Open Culture.
4. (Hypothetical?) Free cooperation.

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Microsoft on the Way to Modes of Network Cooperation – the .NET Project

What is .NET

"... completely redefining the way Microsoft will do business in the future ... and how software should be developed." (Westphal, 2002)

- The platform should replace the previous art of Windows programming, flexibly access operating system and basic functions and support exchanges between programs.
- Designed for use on different hardware platforms down to cell phones and PDAs. The Java idea without restriction to Java as programming language.

The History of the .NET Project

Prehistory:

Legal dispute between Sun and Microsoft over Java

- Microsoft is expanding Java according to its own ideas and needs and thus endangers Java compatibility
- Microsoft implementations J++ and J#

Further problems:

- Also those languages as Visual Basic, C++, and J++ mostly used for Windows programming languages were not binary compatible.
- Even string data types weren't binary compatible – .NET is consistently Unicode based.
- No uniform model of memory management.

The History of the .NET Project

- 1996: first work on .NET
- 2000: .NET Framework 1.0 Beta
- October 2000 – C# and the CLI are submitted by MS, HP and Intel for standardisation to the ECMA
  - ECMA – European Computer Manufacturers Association
  - December 2001 – First standard passed to ISO
  - April 2003 – Adoption of the ISO standards ISO/IEC 23270 (C#) and ISO/IEC 23271 (CLI).
- April 2003 – Delivery of .NET Framework 1.1 together with Windows Server 2003, which provides an integrated .NET runtime environment.
  - Thus transition to the new platform at the conceptual level of Corporate Servers. However, integration into the whole product family is not advancing as quickly as expected.
- End of 2006: .NET 3.0, later an integral part of Windows Vista and Windows Server 2008, with profound, also conceptual extensions of the architecture.

The History of the .NET Project

- End of 2007: Visual Studio 2008 and .NET Framework 3.5
  - Framework Class Library (FCL) – comparable to the Java Base Classes that are shipped with any Java distribution – includes almost 12 000 classes in 300 namespaces.
  - Partial release of the source code of the Base Class Library under the restrictive Microsoft Reference Source License.
- April 2014: Microsoft announces the creation of an independent .NET Foundation at – `http://www.dotnetfoundation.org`
  - January 2015: Announcement of the .NET Open Source Initiative.
  - Stronger separation between .NET Framework and .NET Core. .NET Core contains the base classes and the runtime environment. Their further development will be transferred to the .NET Foundation.

.NET Project and Open Source

ECMA standardization also allows implementation of the standard on other platforms.
Versions beyond Windows:

- Microsoft itself with the Shared Source CLI released in 2002 versions for Mac OS and FreeBSD. These activities were later abandoned.
- Various activities of the Linux community to implement the concepts and create a free .NET version.
  - In 2009 the dotGNU project starts to implement a runtime environment for Portable.NET. Developed upto a release version 0.1 and discontinued at the end of 2012: "As of December 2012, the DotGNU project has been decommissioned, until and unless a substantial new volunteer effort arises."
- Much behind the capabilities of the Windows versions.
- The only powerful "free" project is the Mono Project `http://www.mono-project.com/`

The History of the Mono Project

- In 1999, Miguel de Icaza and Nat Friedman founded the company *Helix Code*. The company was renamed to *Ximian* in 2001.
- Business model: Solutions and services, based on a mix of free and commercial software.
- Involved in the creation of the Linux Gnome project.
- 2002 start of the Mono project.
- Company was acquired by *Novell* in 2003, which continues to strenghten its Linux portfolio.
- In 2011, Novell was acquired by the *Attachmate Group* who has no interest in the continuation of the Mono project.
  - After several months of discussions, the US Department of Justice (DOJ) and the German Federal Competition Office (FCO) have allowed a consortium of Microsoft, Oracle, Apple and EMC to acquire 882 patents from Novell only subject to conditions clearly intended to prevent their use against free software players. (FSFE Newsletter, April 2011)

The History of the Mono Project

- In 2011, Icaza and Friedman founded *Xamarin* `http://xamarin.com` and there bundle the further development on the Mono Project.
  - The company's focus is on mobile applications.
- The mono core, the runtime environment, is freely available under the LGPL v.2, but Xamarin also offers commercial licenses for the Mono platform.
  - If you are planning to use Mono as a bundled part of your commercial product, on embedded hardware, or in any other situation where using the LGPL-licensed Mono is impossible or problematic, Xamarin can sell you a commercially-friendly license that will suit your needs.
  - Many commercial users of Mono acquire a commercial license when they want the flexibility and peace of mind to use Mono without worrying about the terms of the LGPL.
- New stage of cooperation: at the end of 2013, Microsoft, Xamarin and others create the *.NET Foundation*.

.NET Open Sourcing

- In 2008 Microsoft published the source code of the framework under the restrictive Microsoft Reference License.
- At the end of 2013, Microsoft, Xamarin and others founded the *.NET Foundation* as the new rights holder and licensor of .NET Frameworks. `http://www.dotnetfoundation.org/`
  - In 2007 Microsoft still claimed that the Mono project violated Microsoft's IP rights.
- At the end of 2014, a subset of the Reference Source source code is made available on GitHub and published under the MIT license.
  - `https://github.com/dotnet`
  - This was done to fill gaps between Mono and .NET using the same code.

.NET Open Sourcing

- At the same time, Microsoft has started also to publish the revised components of the framework under the name *.NET Core* on GitHub under the MIT license.
- Basis for the upcoming, modular *.NET Framework 5*.
  - .NET Core has been transferred from Microsoft to the .NET Foundation been.
- Using the MIT license, there are in fact no more restrictions how to use the source code of .NET Core.
  - With the establishment of the .NET Foundation and the transfer of rights and source codes to the Foundation, Microsoft works actively with Xamarin, to provide .NET on different platforms. By disclosing the source code under the MIT license or Apache 2.0 license the source code of the .NET Framework can be used almost arbitrarily – even in closed source projects. Licensing and patent law disputes are therefore hardly possible any more and no longer to be feared. (Wikipedia)

Conditions of Cooperative Action

Which *legal requirements* for the civil society are constitutive for cooperative contexts?

- *Freedom of contract* as the right to establish contexts of cooperative agreements.
- The *right to free speech* (as an internal right) precedes the freedom of contract.
  - This right has nothing directly to do with the concept of democracy.
- Both presuppose the (mental and social) *ability to close contracts* and thus a society of owners. (Legal capacity – Geschäftsfähigkeit)
- *Prohibited direct intervention from outside* on the inside of cooperative contexts as *social normative*.
  - Such a right on the *private level* is part of the personality rights (Persönlichkeitsrecht – right to privacy as a personality right in the Constitution) and a cultural achievement of the civil society.

Conditions of Cooperative Action

Results of dynamics in the internal relationship are as topoi visible from the outside.

- Example of corporate identity.
- Consequence of the prohibition of intervention.

Inside is outside in relation to almost everyone else.

- Foreign topoi appear as conditions of action, whose *dynamics* are only accessible to the extent that this process can be internalized via a translation (justified expectations).

Cooperation and Competition

Cooperation and competition (Kooperation und Konkurrenz) are available as forms of structuring of society on the same logical level.

- Only *parts* of bundle of interests are used in cooperative ties, other interests remain *competitive* (concurrent).
- *Concurrent* means more concurrency than opposition, clash.
- System theory: positive and negative feedback.
- Debate about (German) Kooperenz, `http://www.frei-gesellschaft.de/wiki/Kooperenz`

„The area of tension between cooperation and competition is the tension between the possibility of cooperation and the possibility of demarcation and thus the field of tension between two pillars of the civil legal system – Freedom and Property“. (E. Moglen)

Cooperation and Competition

Cooperation and competition thus appear as two poles a continuum of possible forms.

- **Cooperation:** narrow interests, high depth of justification, coupling already in the *planning phase* of the action.
- **Competition:** broad range of interests, low depth of justification, coupling only occurs in the course of *action execution*.

The balance of the weights between the two poles are constantly changing. Regional regulatory and legal areas (e.g. states) are competing social practices where these weights are differently balanced.

- (inner) bourgeois "cultures".

In this understanding, **Open Culture** is a *specific bourgeois cultural practice* in which cooperative moments are valued higher than in currently common (e.g. neoliberal) practices.

Modelling Sustainable Systems and Semantic Web

Open Culture

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Open Culture as Phenomenon

In the lectures and seminars we were faced in many places with "Open Culture" (Open Source, Open Design, Open Access etc.) as a phenomenon of digital change. In the last lecture we developed an interpretation framework for this phenomenon in the context of cooperate action.

- Digital change is a change *within* the bourgeois civil society.
  - Essential constituent elements of a civil society – privacy, prohibition of penetration, right to free speech, personal rights, property, monetary system – are not questioned.
- These constituent elements stand in tension to one another and need to be rebalanced socially under the new conditions.

Open Culture as Phenomenon

- Concept of the *author's work* as individually attributable intellectual output that is publicly available.
  - At the legal level, this means to weigh up between the legitimate particular interests of owners and the public interest in free accessibility.
- With the technological simplification of access to digital works the field of tension between the consequences of individual attributability of intellectual output ("intellectual property") and their public accessibility of this output shifts at the center of the controversy about the further development of the civil society.
- With a broader concept of *Open Culture* a new "cease-fire line" started *practically* to establish itself since around 2005.

Open Culture as Phenomenon

- These *practical* changes started with the transition from the "Free Software" concept to the "Open Source" concept initiated around 2000.
- The visionary beginnings of Free Software in the 1980s and its forms of institutionalisation prepared the ground for these developments, even if not everyone of the activists from the first hour is satisfied with that further development.
- The practical activities and social experiences in the GNU project and the GPL as a first *legal technical instrument* played a particularly important role.

In the following, some aspects of the historical genesis of the term *intellectual property* and the practical struggle for a related balancing facts between the aforementioned poles are shown.

On the Way to "Intellectual Property"

Invention of printing.

- The book as *opus* leads to a stronger alignment of content and form.
- The haptic perception of books as artifacts enhances the perception of knowledge as a *thing*.
- The new medium also creates new craftsmanship and professions closely related to the formation of the relationships of a civil society.
- It emerges a new symbioses of technology and power.
  - 15th century: Copyright as a monopoly right of the book printers' guild – copying rights, secured by the crown
  - In mutual interest – economic interests of the book printers and control of "public opinion" by the power.

On the Way to "Intellectual Property"

Two "cultures of knowledge" form the poles of a field of tension.

- Perception of ideas as individual performance, as a result of creativity and ingenuity.
  - Basis for the formation of the term "work" and its embedding in the (civil) right of personality.
- Panta rhei – knowledge as a procedural element of a changing world.
  - Newton: "Standing on the shoulders of giants"
  - Ideas as permanent recombination. Flow of ideas as inherently societal achievement.
  - The safeguarding of the conditions of creative productivity is in the foreground.

On the Way to "Intellectual Property"

The tension between these two cultures manifests itself as a field of tension between two pillars of the civil law:

- Level of action execution $\rightarrow$ *property* as the basis of responsibility.
- Level of action planning $\rightarrow$ *freedom* (free as in free speech; liberty, freedom of contract) of combinability

Development of the legal constitution of a civil society in the 19th century.

- United States declare their Constitution (Bill of Rights. September 17, 1787) as an important result of the American Independence War.
- Civil Code (BGB. January 1, 1900) as the first codification of private law in the German Empire.

On the Way to "Intellectual Property"

The beginnings cannot be presented here in a comprehensive way.

- 1790: Copyright becomes part of the American Constitution (regular 14-year period of protection).
- Major differences between Anglo-American and continental European legal systems.
- Berne Convention for the Protection of Literary and Artistic Works.
- 1886 first version, 1908 revised Berne Convention.
- Protection period of at least 50 years after the death of the author.
- Harmonization of property rights, equality between nationals and foreigners.

On the Way to "Intellectual Property"

The spiritual fathers.

- Significant increase of the economic importance of science and knowledge in the 20th century.
- 1950s: Fourastié claims that in the tertiary sector will be the most important sphere of future value creation.
- 1960s and 1970s: Milton Friedman and the Chicago School – Theoretical foundation for neoliberalism.
- Late 1970s: Daniel Bell and the post-industrial society.

On the Way to "Intellectual Property"

The roadmap: Revised Berne Convention

- Other versions Rome 1928, Brussels 1948, Stockholm 1967
- 1952 UNESCO Universal Copyright Convention (UCC), in order to involve also the USA.
- In 1967 these topics are united under the roof of the World Intellectual Property Organization (WIPO).
- RBC, Paris version of July 24, 1971 with amendment of September 29, 1979 – the version which is valid today.
- 1973 – The Soviet Union joins the RBC.
- 1989 – The USA joins the RBC.
- Today (2020) 179 states joined the RBC.
  `https://www.wipo.int/treaties/en/ip/berne/`

On the Way to "Intellectual Property"

The roadmap: the supporters are joining forces.

- 1967 founding of WIPO as an umbrella organization for worldwide administration of intellectual property rights.
- 1974 upgrading of WIPO to a sub-organization of the UN
  - Manages today RBC, trademark protection agreement, harmonization of the patent system and the handling of rights on industrial designs.
- 1984 the International Intellectual Property Alliance (IIPA) was founded for the worldwide implementation of the concept of *Intellectual Property* as legal term.
- 1986 the Intellectual Property Committee (IPC) was founded as industry lobby organization complementary to the IIPA to fix "Intellectual Property" in the course of the Uruguay Round in GATT.

On the Way to "Intellectual Property"

- 1980s – US policy develops various penal mechanisms against countries with insufficient IPR legalisation.
- 1995 TRIPS-1 – Trade Related Aspects of Intellectual Property Rights – as partial result of the GATT negotiations which resulted in the establishment of the WTO.
- 1996 WIPO Copyright Treaty – member states must implement legal measures against circumvention of IPR protection measures.
- 1998 DMCA – legal protection of technical IPR protection measures in the USA (Digital Millenium Copyright Act).
- 2001 – EU guideline on the implementation of the WIPO specifications in national copyright law.
- 2003 – German UrhG amendment, basket 1 – "German DMCA".

On the Way to "Intellectual Property"

- Further German debate:
  `https://dini.de/ag/ehemalige-arbeitsgruppen/urhg/`
- Subjects:
  - § 31a – contracts for unknown types of use.
  - § 52a, 52b – availability to the public for teaching and research (later moved to a new § 60 and new sections 4, 5 and 5a).
  - § 53 – Reproductions for private use and other purposes.
- ACTA 2006–2012:
  - With a vote on July 4, 2012, the EU Parliament decided not to ratify ACTA, which means that ACTA does not come into effect for the EU.
- TTIP since 2012 ... the next attempt.

Counteractions from within Science

October 2003 – Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities
`https://openaccess.mpg.de/Berlin-Declaration`

- Signed by well-known European and American Research organizations and universities.
  - As of March 2011, more than 297 institutions from around the world were supporting the Berlin Declaration on Open Access.
- The signees commit themselves to further develop the idea of open access by e.g. encouraging researchers to share their findings in Open Access publications.
- Inclusion of the cultural heritage, i.e. of the cultural assets kept in archives, libraries and museums, in the demand for Open Access.

Counteractions from within Science

2004 – Göttingen Declaration on Copyright for Education and Research
`http://www.urheberrechtsbuendnis.de/ge.html.en`

- Foundation of the *Coalition for Action "Copyright for Education and Research"* as a lobbying organization for science in the struggle around the amendment of the German UrhG. `http://www.urheberrechtsbuendnis.de`
- At the end of 2004 on the basis of the Göttingen Declaration the six major German science organizations Science Council, University Rectors' Conference, Max Planck Society, Helmholtz Association, Leibniz Association, Fraunhofer Society and almost 200 other institutions and 3 000 individuals join forces in this alliance.
- The Open Access principle is thus becoming increasingly important in the scientific field, conducive to the principle structures are established and institutionalised.

A Slightly Wider Perspective

Perspective yet around 2005: The (re)production conditions of the creatives have changed dramatically in the last 20 years. In a world that is more restrictive and more immaterial, with ownership and and IPR the creatives have bad cards and are largely defenseless and at the mercy of the owners and their lawyers.

> *As, in the new digital society, creators establish genuinely free forms of economic activity, the dogma of bourgeois property comes into active conflict with the dogma of bourgeois freedom. (Eben Moglen, The dot Communist Manifesto, 2003)*

Visionaries like *Richard Stallman* already envisaged such problems in the early 1980s: the sustainable reproduction of the conditions of creativity cannot and must not be left to the owners.

A Slightly Wider Perspective

When the freedom of access to the *works* of others is an essential part of the conditions of creative, then there *must* be enforced an appropriate legal weighing of the facts even against the will of the property owners – even if the monetary incentives are immense: "Be creative once and then collect money forever".

> *"Free as in free speech not as in free beer" is a basic requirement of creative work, Richard Stallman never tires to repeat.*

It is in the hands of the creative people themselves – because they are producing that "property" – to organize their own conditions of production in such a way that knowledge is freely available and everyone has access to it.

> *Our time offers like no other a vast collection of knowledge in text form. The entire intellectual history of mankind is availably on CD-Roms, on internet sites, in second-hand bookshops and in book trade, everything is well networked and easily accessible, that it would be a shame not to use this material awake and with open senses. Because, to cite the smart Bacon once more: Knowledge is power. (Matthias Käther, Utopie kreativ, 2005)*

A Slightly Wider Perspective

With the *GNU Project and Free Software*, that thought first emerged in an area central to the digital society – the area in which the tools of the new society are built.

With the *GNU Public License* (GPL) the meaning of an adequate legal-technical regulation was early recognized and successfully "implemented".

Creative Commons extends this approach to other areas of culture and creativity, *Free Culture* (based on the book of the same name by Lawrence Lessig) captures the cultural significance of such principles.

In this way, processual knowledge is developed to shape the own conditions of creativity within the framework of the civil legal system.

A Slightly Wider Perspective

On December 13-14, 2010, the **International Expert conference "Open Access – Open Data"** took place. Six years after the first open access conference in Cologne, it is time to sum up the state of development and discuss the challenges for the next ten years. In addition, new ways for the increasingly important open data movement are to be discussed.

The conference is organized by **Goportis** (now part of TIB Hannover). Goportis is the name of the *Leibniz library network of research information*, consisting of the three German central specialised libraries TIB (Technical Information Library, Hanover), ZB MED (German Central Library for medicine, Cologne/Bonn) and ZBW (German Central Library for Economics – Leibniz Information Center for Economics, Kiel/Hamburg).

A Slightly Wider Perspective

After all, with *Open Access* the scientific community as a whole raised the principle of free access to its own productions as one of their central future projects. This is shown by the Conference *Open Access and Open Data* once again.

- On December 9, 2014, the Senate of Leipzig University passed a resolution "Open Access Policy"
- With Qucosa `http://www.qucosa.de`, Saxony creates with ERDF funds (European Regional Development Fund) a Saxonian Open Access infrastructure for its academic institutions.

The major scientific publishers as the previous advocates of restrictive IPR can hardly withstand this pressure – some of them, such as Springer, already started with *Springer Open Access* to develop appropriate business models that take account of the new framework conditions.