Graz University of Technology

Maschinenbau- und Betriebsinformatik
mbi

Designing Information Systems for Critical Infrastructure and Public Protection

PSCE Conference
Helsinki – 31/5/2012

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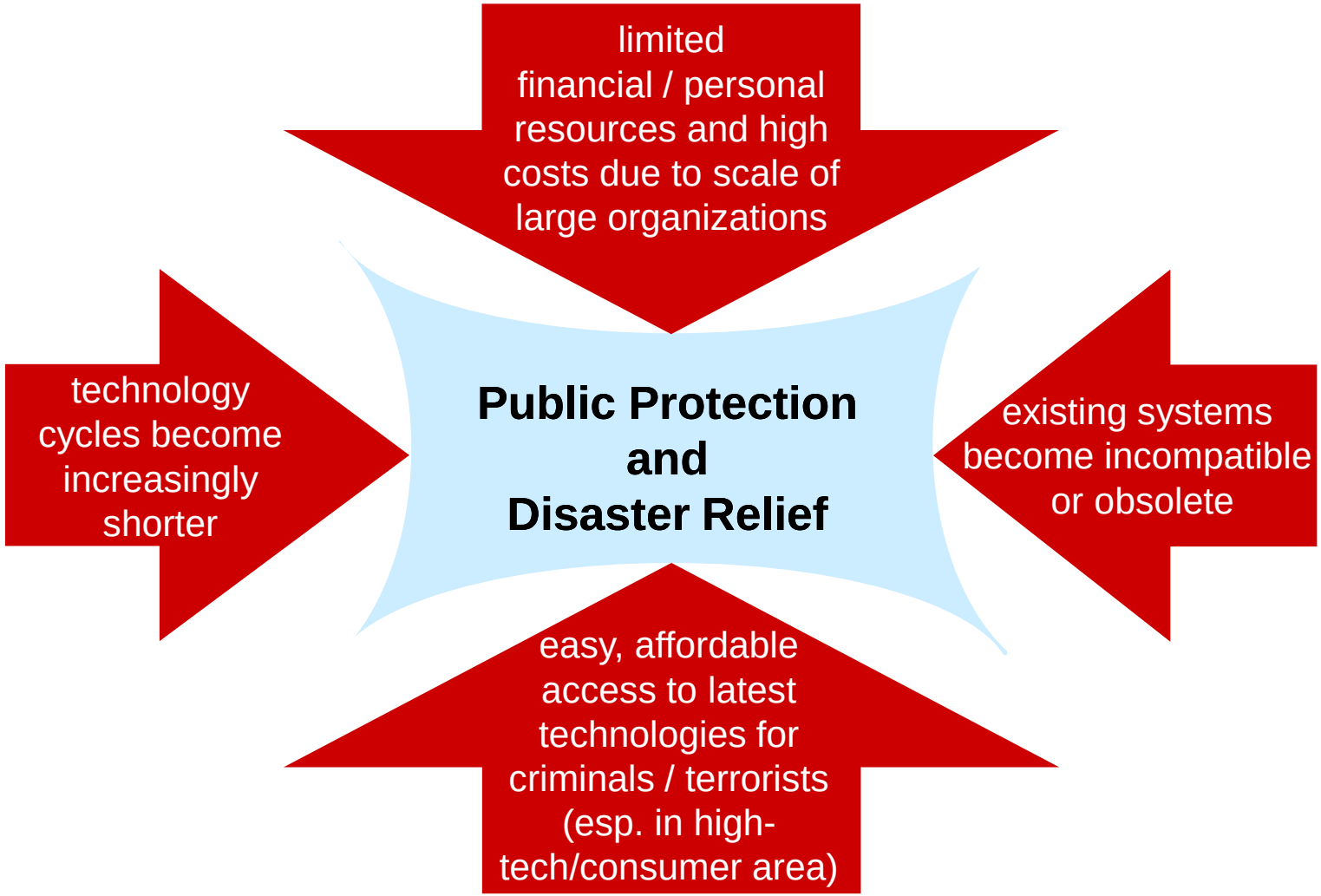
Engineering- and Business Informatics
Graz University of Technology

AGENDA

- Introduction
- Introducing Design Patterns for Information Systems
- Examples from research projects
  - ANALYSIS/SYNTHESIS: Search & Rescue in Alpine Regions
  - DESIGN: IT Architecture for Public Protection
  - DESIGN: Multi Actor Value Networks
  - EVALUATION: Localization solutions for large Events
  - Self Experience: Various projects
- Conclusion & Outlook

For „Civil Protection“ Agencies, Operating at a Large Scale, the Use of IT Poses some Additional Problems



INFORMATION (DATA) is a critical factor

Modern IT and Operations Research could provide powerful tools to handle these situations, but they often face big challenges:

Vehicle Routing in Flooded Areas

- Problem: dynamic routing of emergency vehicles when roads are (increasingly) flooded
- Partner: Austrian Civil Protection Agency
- Problem: Real time data availability and incompatible IT Systems

▶ Consequence: Project postponed/cancelled

Lower-Austria 2009, © APA

IT-Support for Mission Critical Supply Chain Operations

- Problem: Evaluation of a new, modern inventory- and distribution system for military
- Partner: Military Chief Logistics Officer
- Problem: Data availability and systems incompatibility

▶ Consequence: Project postponed/cancelled

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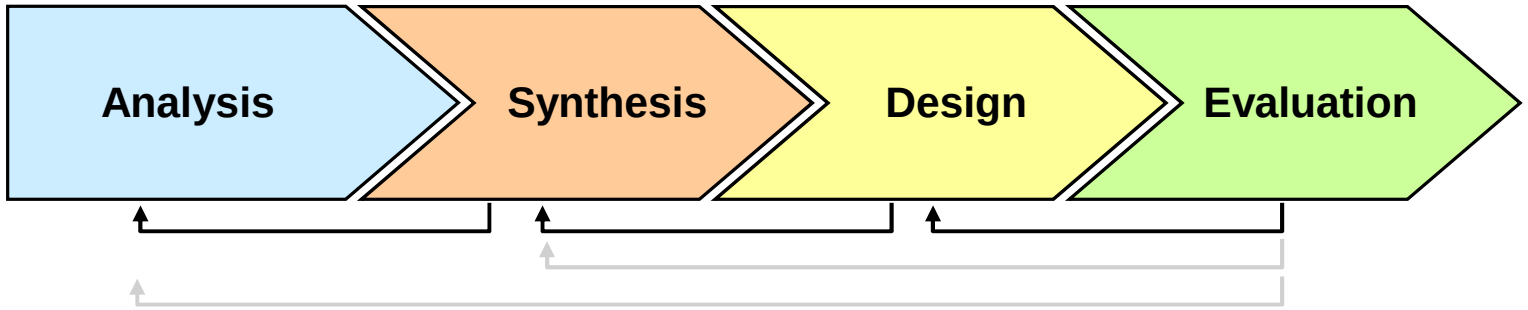
Design Patterns for Information Systems for PPDR



Content

- Analysis and segmentation of use cases and process steps
- Prioritization of use cases with respect to improvement potential and relevance
- Selection of past incidents for in-detail analysis either remotely or if possible with involved people

- Identification of strengths / weaknesses
- Identification of improvement levers
- Prioritization of levers
- Definition of main building blocks for solution

- System design considering:
  - Shortfalls
  - Improvement levers
  - Existing infrastructure
  - Existing information systems
  - Guaranteed future
  - Available technologies

- Concept and improvement potential validation by using:
  - Use cases from Analysis phase
  - Additional use and test cases for
    - extensibility
    - user friendliness
    - technology independence

Tools

- Swim lane-analysis
- Data Mining
- Incident analysis / research
- Participation / self experience

- Systems Engineering
- Simulation
- Proofs of Concept(s)
- Technology evaluations
- Participation / self experience

- Field Tests
- Participation / self experience

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RESEARCH PARTNERS

Federal State Government of Styria

Austrian Ministry of the Interior

Austrian Federal Police

Mountain Rescue Service Austria

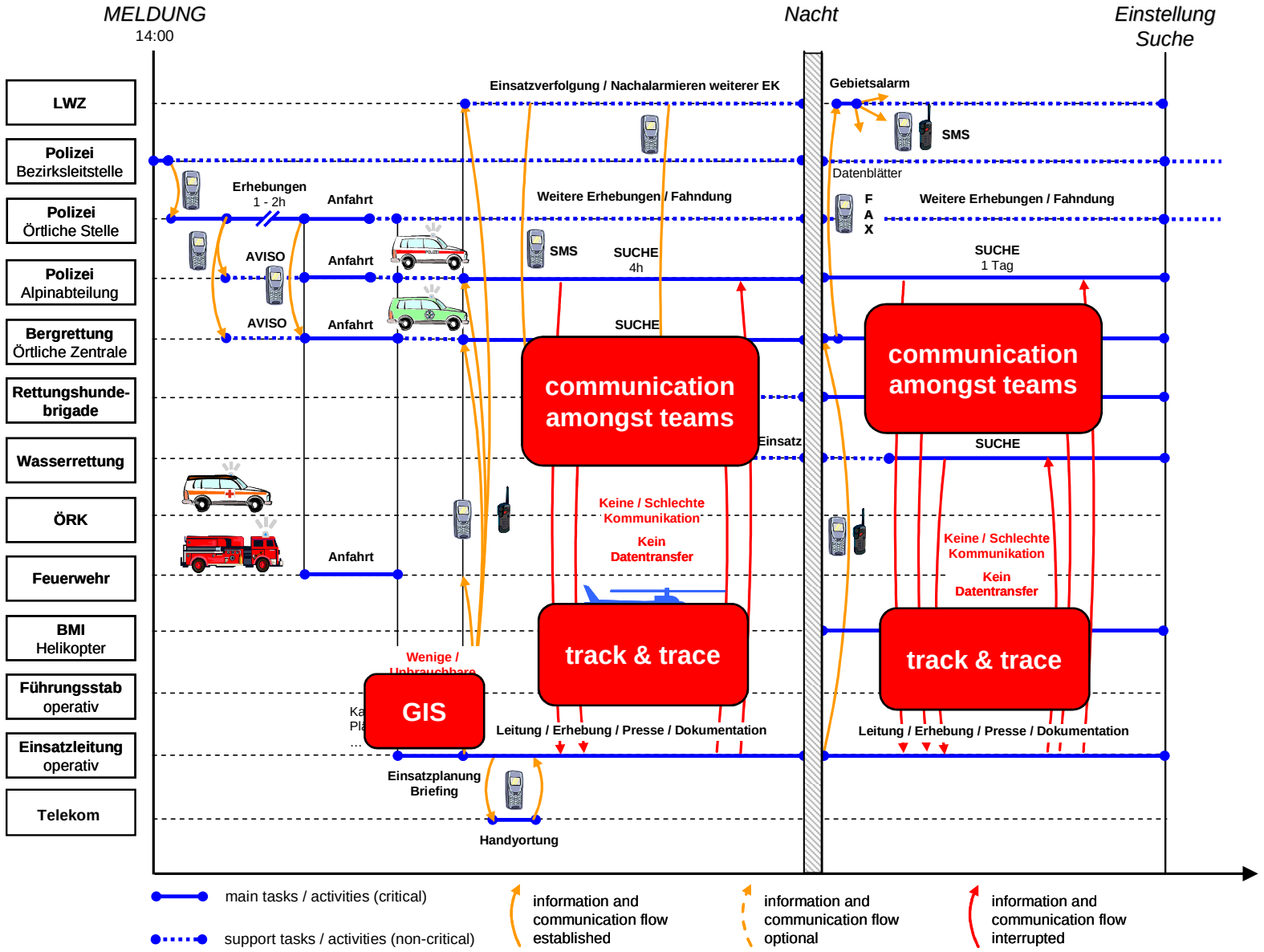
Fire Service Association of Styria

Austrian Red Cross

European Civil Protection

ANALYSIS Processes – Work- and Information Flow

Analysis



Source: MBI, project SARONTAR

SYNTHESIS Levers Along the Process Chain

tasks

levers

	Alerting/Mobilizing	Information Gathering	Locating	Command and control	Detection	Medical treatment	Rescue	Documentation
Self localization				**Strong support**				**Slight support**
Localization of S&R-Teams			**Support** e.g. sectoral search	**Resources: Planning and control**	**Fine adjustment control**		**Coordination of resources** e.g. Replenishment	
Tracing			**Interactive Search**	**Control Capacity planning**				**Controlling Recordings Documents**
GIS		**Simplification** High priority	**Structuring Navigation**	**Control Disposition**				**Support**
Mission updates	**Control**	**Regulation Reorientation**		**Output**		**MED-Info**	**Info-Updates** e.g. Infrastructure Weather…	
Communication amongst teams			**Control Internal adjustment**	**Load removal**	**Intenal adjustemnt**		**Coordination Technical adjustment**	

Source: MBI, project SARONTAR

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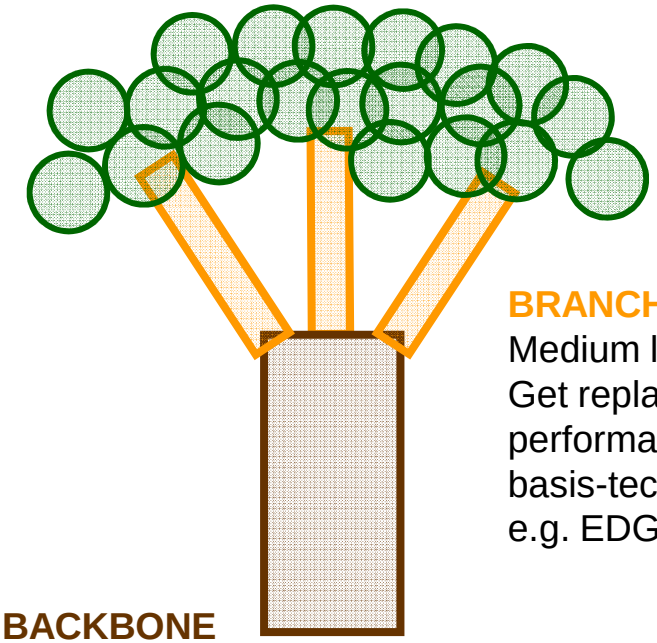
DESIGN ARCHITECTURE – COMPONENT CATEGORIES

BASIC COMPONENT STRUCTURE

LEAVES / END NODES

Short lifecycle (2-4 years): Get replaced due to fundamental performance upgrades within an application technology
e.g. GSM cell phone – Smartphone with GPS



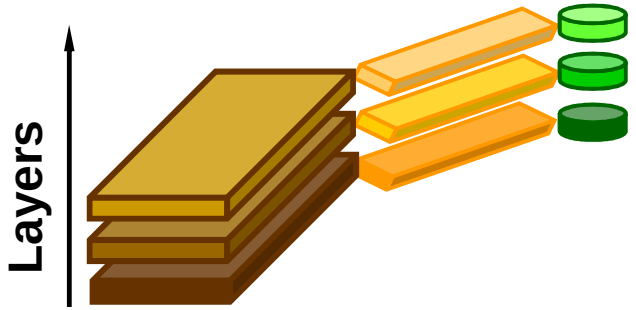
BRANCHES

Medium lifecycle (~5 years):
Get replaced due to fundamental performance upgrades within a basis-technology
e.g. EDGE – HSPA/LTE

BACKBONE

Long lifecycle (>10 years):
Get replaced due to fundamental performance upgrades of basic-technologies
e.g. ANALOG/DIGITAL

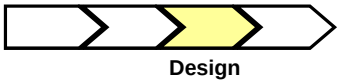
SUBSTRUCTURE



SUBSTRUCTURE
Each component category consists of different layers that interact based on standardized open interfaces.

Source: MBI, project ISKOS

DESIGN: Architecture – Concepts “Predetermined Breaking Points”



Technology Lifecycles

Lifespan of high-tech devices declines tremendously

Technology lifecycles get shorter

Technology Upgrade / Replacement

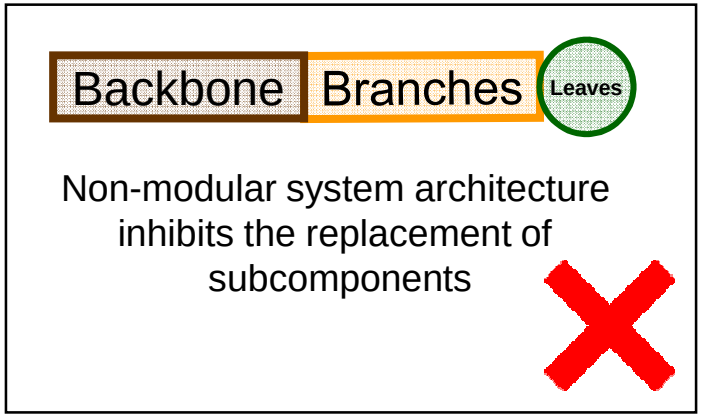
Technology replacements are required more frequently

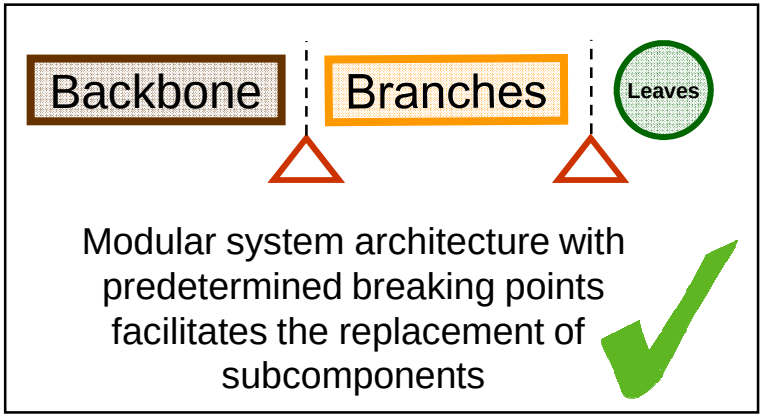
Design Consequences

IT System Architecture has to provide concepts that support the replacement of system components

→ Modularization

→ Predetermined breaking points





Source: MBI, project ISKOS

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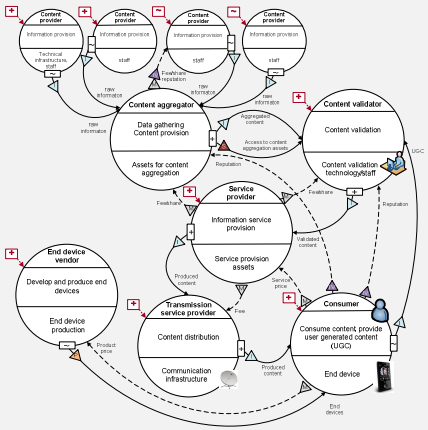
Motivation

- Value Networks
  - Represent value exchanges between actors in a value chain
  - Value chain (Porter[1]) is not linear any more[2], thus Value Networks are created → Complexity rises



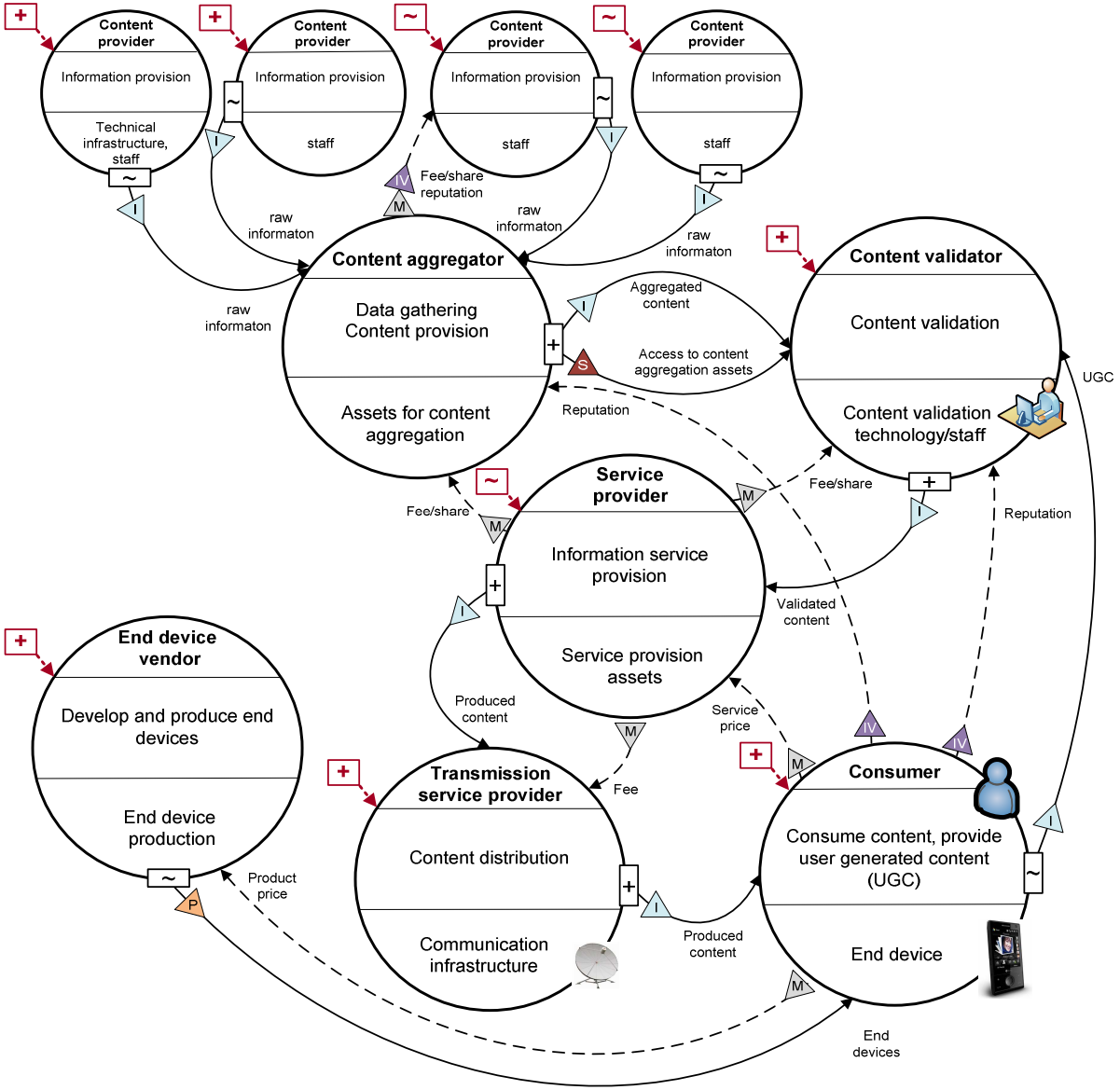
- Existing Value Network Notations[3] are limited
  - No analysis of dynamics in relations between participants
  - No consideration of motivation levels of participants

  → Unexplainable effects occur

Enhancements to existing Value Network Notations are required

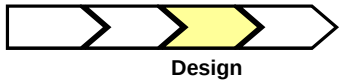
Source: MBI, [1] Porter, 1985; [2] Biem & Caswell, 2008; [3] Gjordin et al., 2000; Yu, 1994; Allee, 2009; [3] Weigand et al. 2007; Biem & Caswell, 2008

Example: Value Network

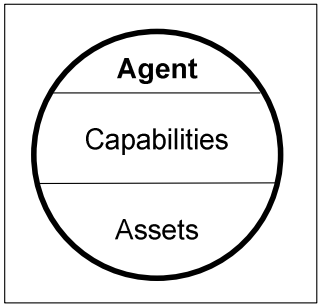


Source: MBI

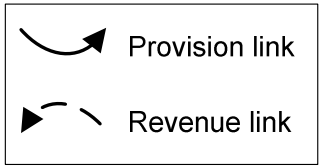
Basic elements of Extended Value Network Notation



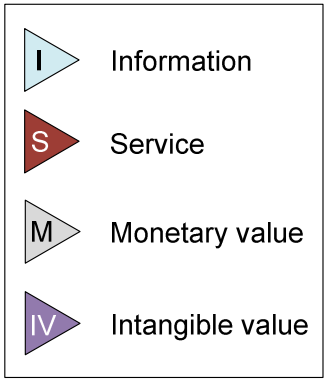
- Economic Entity*
  - Agent*: Designation of the participant
  - Capabilities*: Dynamic aspects – processes, skills
  - Assets*: Static aspects – tangible (e.g. IT-systems) and intangible things (e.g. knowledge) tied to economic entity



- Value Exchanges
  - Provision link*: Value provision in direction of end customer
  - Revenue link: Value provision against direction of end customer



- Transfer Objects
  - Information*: Exchange of information
  - Service*: Provision of a service
  - Monetary Value: Exchange of a monetary value
  - Intangible Value: Exchange of an intangible value

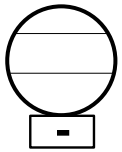


Source: MBI, * Biem & Caswell, 2008

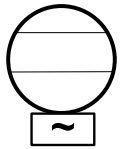
Endogenous Motivation

- Description
  - Motivation level of employees of an economic entity
  - Based on „Expectancy Theory“ of Vroom[1]
  - Employees prioritize their personal tasks

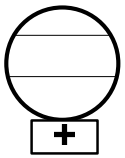
- Categorization
  - **Defensive (-):** The agent performs the value activity only if it is not conflicting with his own goals. Employees give least attention to value network task → „Passive Aggression[2]“



  - **Neutral (~):** Agents performs the value activity collaboratively in a timely manner.

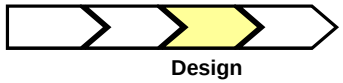


  - **Active (+):** The agent performs and pursues the value activity actively.



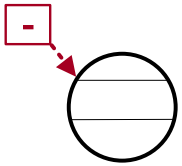
Source: MBI, [1] Vroom, 1964; Vroom, 1995; [2] Buss, 1961; Giacalone & Greenberg 1997

Exogenous Influences

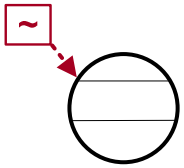


- Description
  - External influence on employees (e.g. Management)
  - Based on:
    - Porter & Lawler[1] - „Extrinsic rewards“
    - Kelman[2] – Exogenous influence on a persons compliance

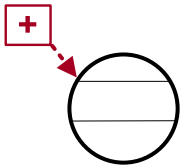
- Categorization
  - **Defensive (-):** The external force disencourages the value activity.



  - **Neutral (~):** The external force neither endorses, facilitates nor discourages the activity.

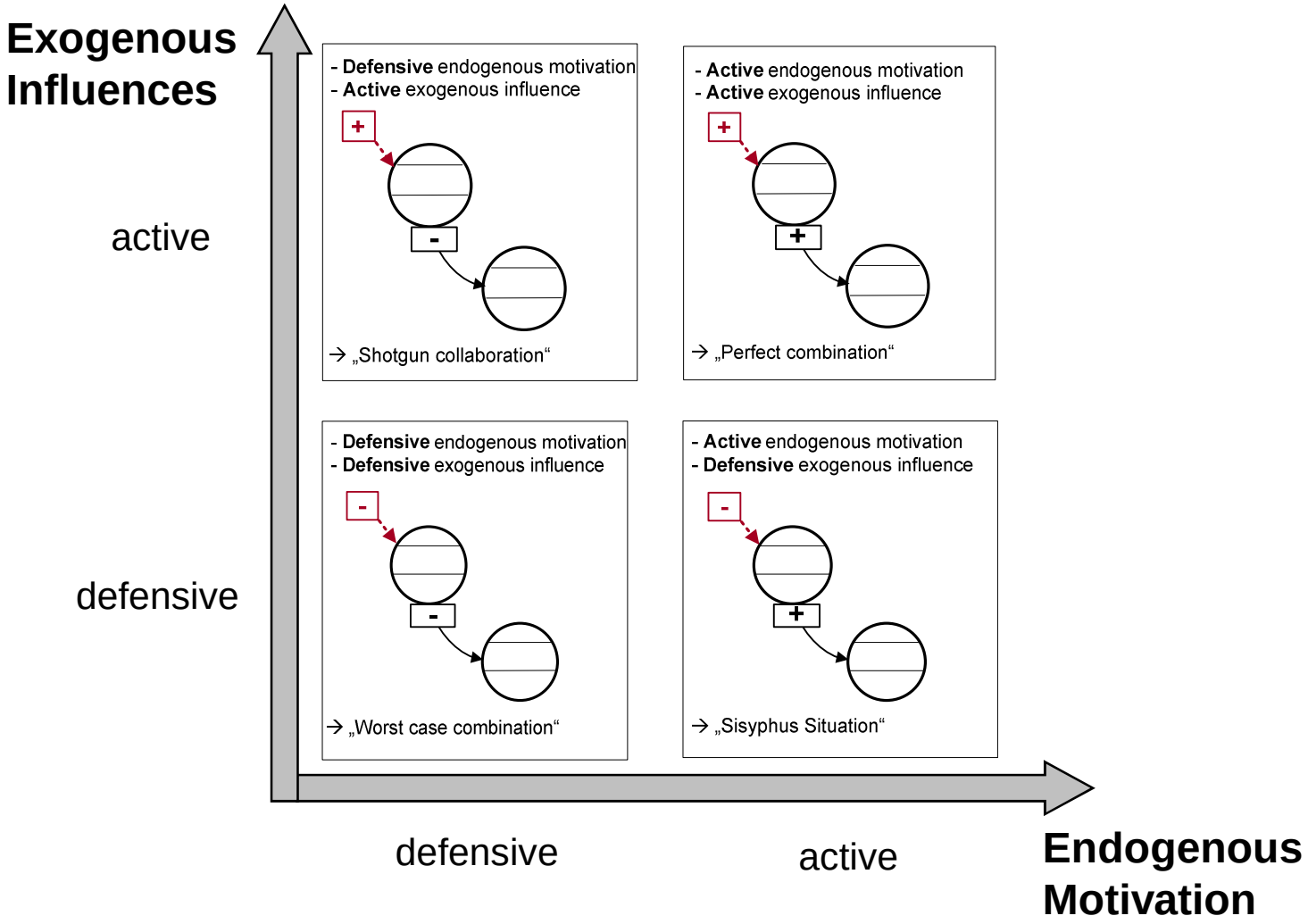


  - **Active (+):** The external force actively encourages and facilitates the activity (e.g. special reward programs, management inquiries about project progress or performance).



Source: MBI, [1] Porter & Lawler, 1968; [2] Kelman, 1961

Typical Combinations:
Endogenous Motivation - Exogenous Influences



Source: MBI

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TECHNOLOGY STUDY FIS Night Race

Mission Support:

Localization of Alpine Police and Task Force via GPS equipped smart phones

Wireless data transfer of pictures taken by the observation unit to the command centre

Secure, web-based access to localization data and pictures to authorized external users

Benefit:

► Localization without using radio communication

► Improved assessment based on latest on-scene pictures

► Complete mission documentation based on time stamped path records

Involved parties:

- Observation unit with mobile camera equipment
- Alpine Police (three units)
- Task Force (five units)
- Police helicopter (mobile FLIR unit)
- Command center, remote online observers

Source: MBI, project ISKOS

EVALUATION IT support for Illegal Immigration & Organized Crime Operations

Command Center
Notebook connected to web-based command center software via GSM modem

Source: MBI, project ISKOS

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Self Experience is a Main Source of Insight for Systems Design

Source: MBI, project SARONTAR

... and Stress

Source: MBI, project ISKOS

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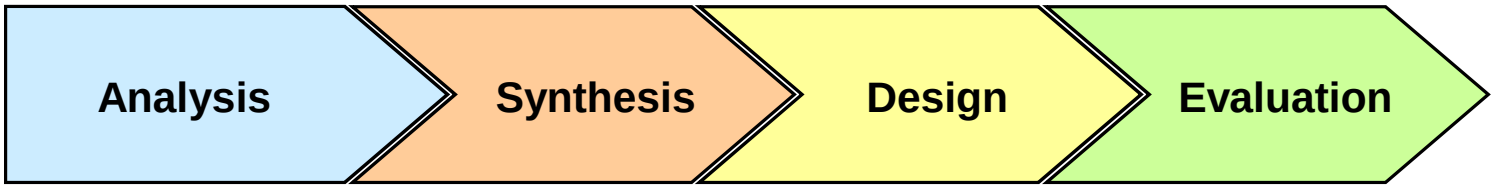
Conclusion and Outlook

- We have developed and applied this framework in the course of several research projects in the area of information systems support for PPDR
- Compared to conventional system design approaches, we heavily rely on user input and interaction and use
  - bottom-up design for IT support (user-centered)
  - top-down design for systems architecture
- Advantages over conventional approaches have been demonstrated on smaller solutions and have yet to be proven for the entire framework
- We are seeking for more real world problems to apply our approach. They will serve as case studies for the evaluation and further improvement of our design patterns



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Thank You

for your attention