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Digitalization - Chances and Challenges of Interconnecting Water Technology and Administrative Systems in Water Management

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IIRM environmental technology
environmental management

Agenda

1. Digitalization in the Water Sector
2. State of Affairs
3. Chances
4. Challenges

UFOPlan-Vorhaben
FKZ [3717 21 327 0]
„Chancen und Herausforderungen der Verknüpfungen der Systeme in der Wasserwirtschaft (Wasser 4.0)“

Umwelt Bundesamt

1 Digitalization in the Water Sector

Digitalization: What for?

- Improve efficiency of processes,
- Improve quality and effectiveness of processes,
- Improve reliability of procedures,
- Achieve separate tasks in an integrated way.

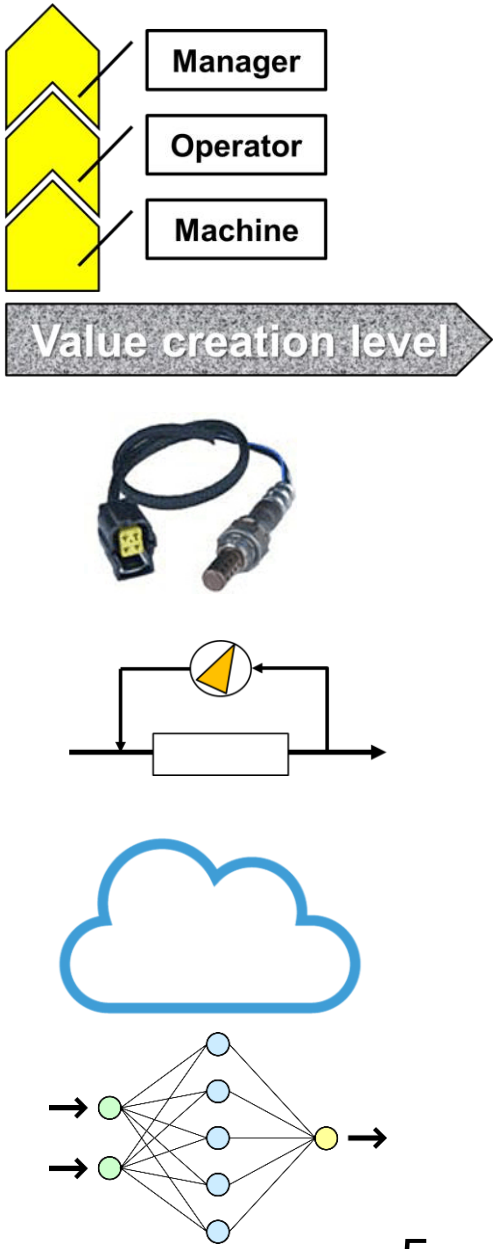
e.g.:

- Better basis for decision making, extended data basis, extended data availability;
- Cost reduction through better management, better product quality, better environmental quality;
- Facilitated communication with customers.

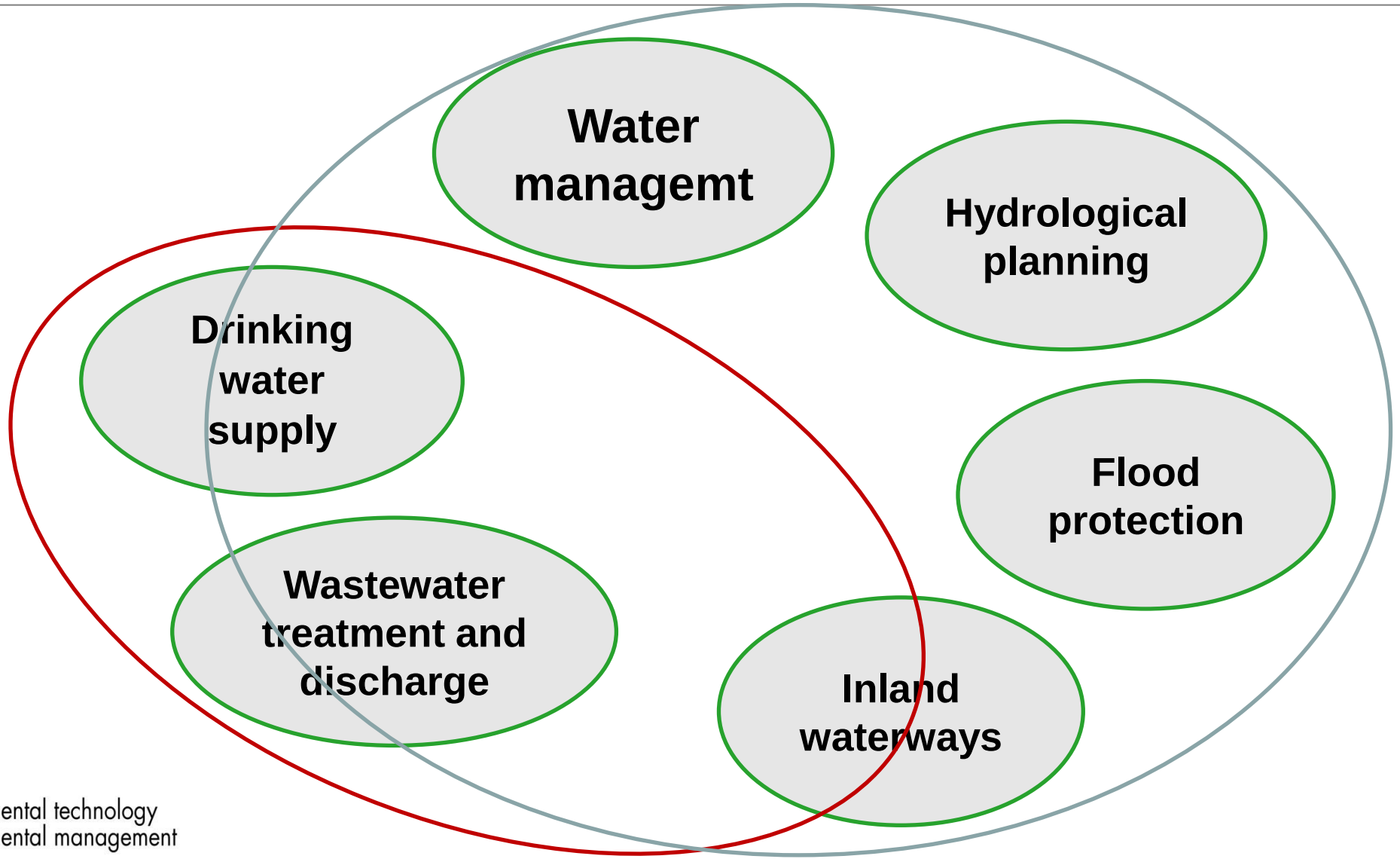
Digitalization: How?

Digitalization

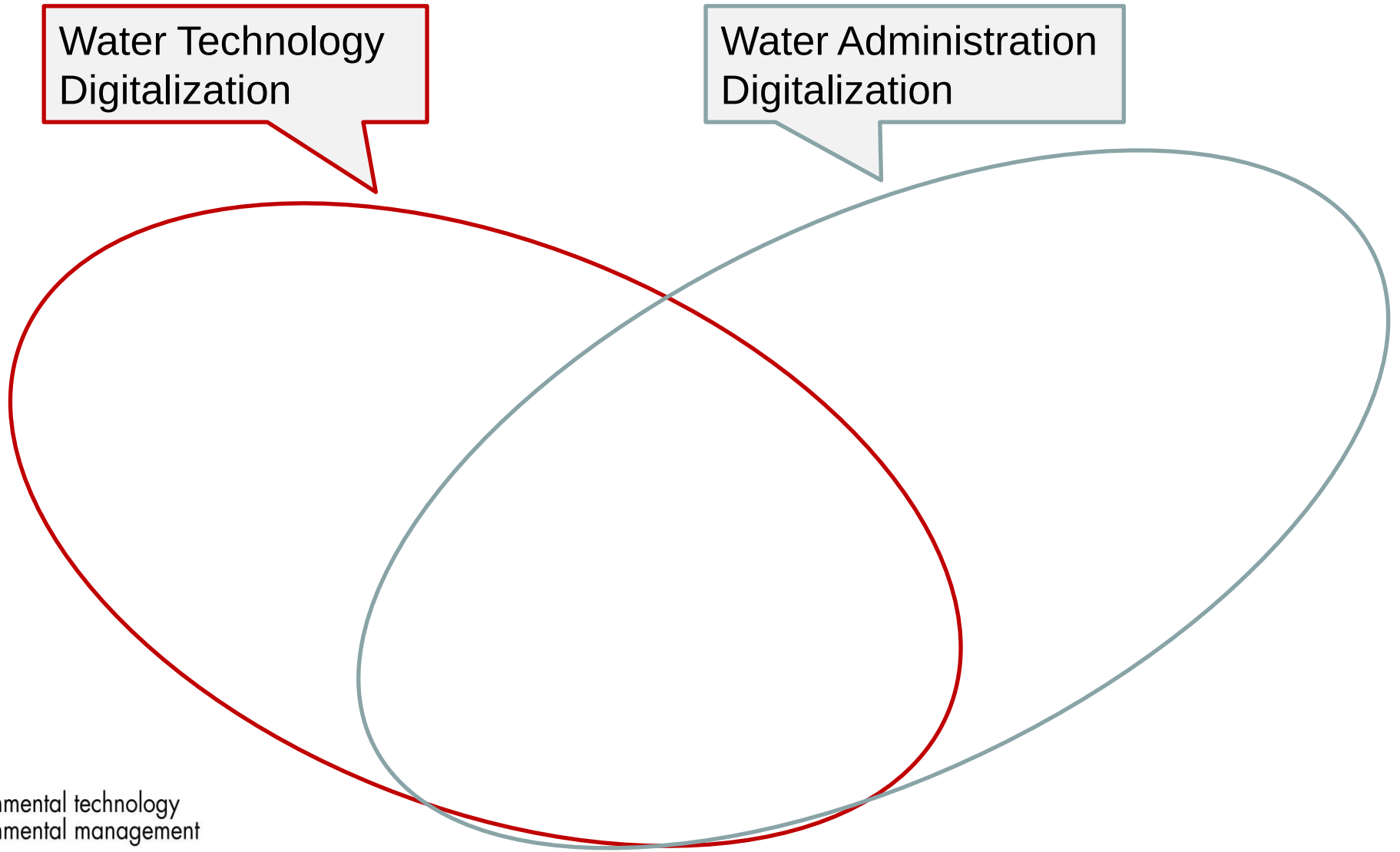
- **Integration of processes**
  - **horizontally** (e.g. customer-client, operational level, including all aspects of value creation**)** and/or
  - **vertically** (e.g. covering different hierarchy levels from physical production process (LCA) up to strategy development);
- Coupling of virtual and physical systems as **Cyber-Physical-Systems** with **sensors** und **actuators** in **local autonomous closed loop controls**;
- Advanced capability of rapid processing of large amounts of data (**Big Data),** central data storage (**Cloud**), high capacity data transmission;
- **Advanced programmes** for decision support or decision making: e.g. „digital twins“, augmented reality, AI (neural networks, machine learning, …..)



Digitalization in the Water Sector



Digitalization in the Water Sector



2 Present State of Affairs

Digitalization in the Water Sector 1

Increasing efficiency by automatization of current processes

- **e.g. control of pumps / installations in drinking water distribution and sewer networks, wastewater treatment, gauging stations, ….**
  (in municipalities as well as large scale water infrastructure)

- **alleviate communication by providing additional electronic communication channels between**
  - service providers and customers
  - water authorities and citizens / companies
    for information requests, application for licences or approvals, declaration of emissions, emergency warnings…..

Digitalization in the Water Sector 2

Increasing efficiency / effectiveness through process integration

- **Integration of upstream and/or downstream process steps**
  - Integration of physical processes by using **intelligent components**
    - intelligent pumps, sensors, valves, autonomous control loops, .. (e.g. actuation of weir control)
  - Restructuring of administrative and **management processes**
    - **Upstream**: e.g. automated coupling integrating information of reliability data, weather data, satellite data….. .
    - **Downstream**: e.g. automated activation procedures as a result of automated assessments (e.g. sending push-mails to alert citizens at certain water levels, …)

Digitalization in the Water Sector 3

Increasing efficiency and/or effectiveness through new processes

- **Additive processes**
  - New data (apps, social media data, telecom data, …)
  - Real time modelling (digital twin….)
  - Coupled models with various scales in time and space

Examples

- **Automated pump management in wastewater treatment plants**
- **Horizontal integration in drinking water distribution**
- **Horizontal integration in sewer network operation**
- **Interactive information websites**
- **Water level regulation at waterways**

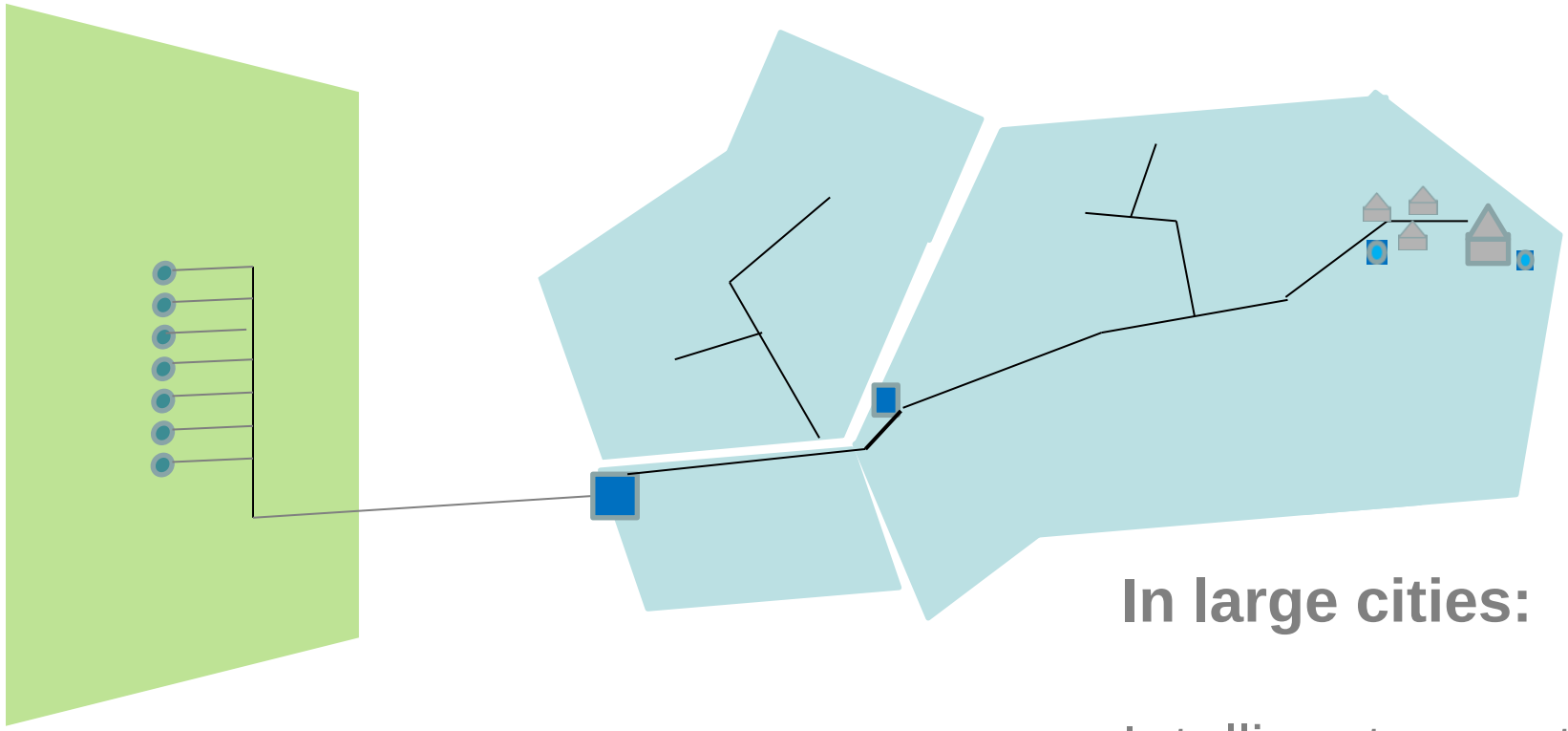
Automated Pump Management in Wastewater Treatment Plants

Examples

- Pump operation controlled by sensors for wastewater quality (nitrogen, oxygen..)
- Pump maintenance controlled by pressure sensors in pumps

Source: commons.wikimedia.org/wiki/File:Dry-installed_chopper_pump.jpg Bogelund

Horizontal Integration: Drinking Water Distribution (→ efficiency)

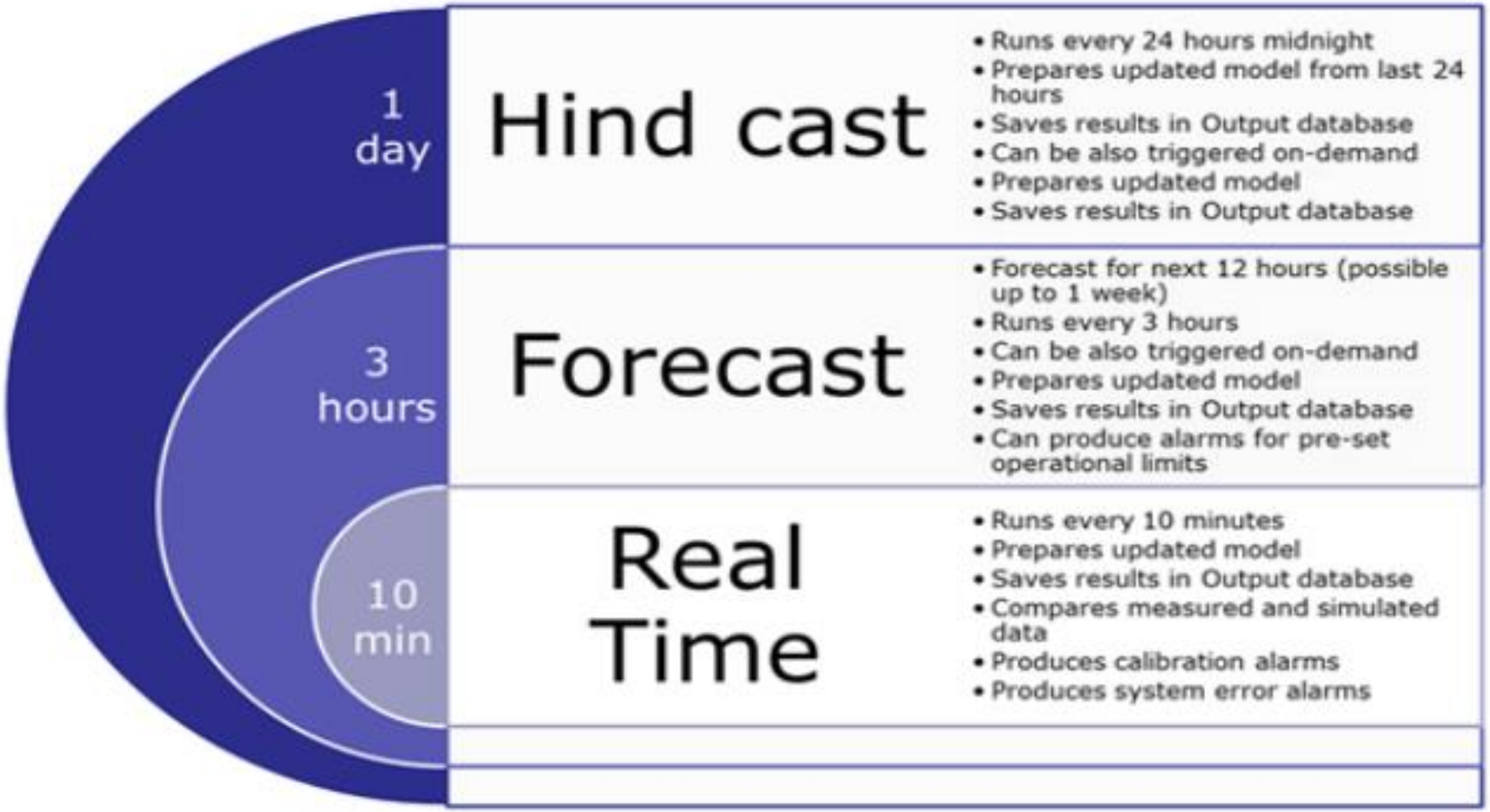


In large cities:

Intelligent operation of pumps

- makes better use of the storage capacity of the supply net
- reduces the need of reservoirs and water towers

Horizontal Integration: Drinking Water Distribution ("digital twin" → quality)

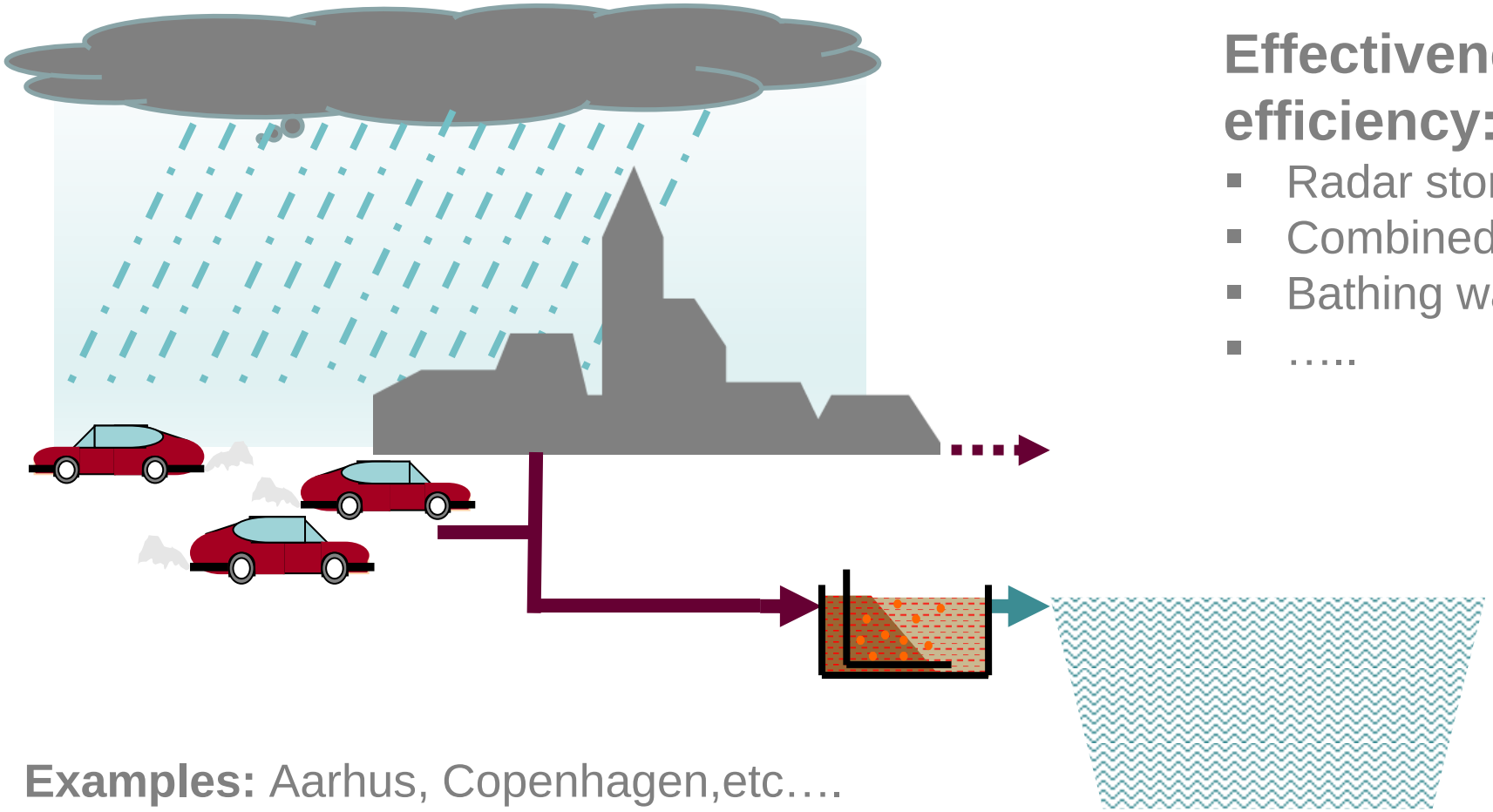


Source DHI with permission:
www.dhigroup.com/upload/publications/scribd/231387642-The-Urban-On-Line-Water-UOW-System-for-Zurich-DHI-Case-Story.pdf

Horizontal Integration: Sewer Network Operation
(AI → efficiency)

Source:
www.l.de/file/download/99b71258b753693e785161350
b6e75c3.pdf

Horizontal Integration: Rainwater and Sewer Network Management



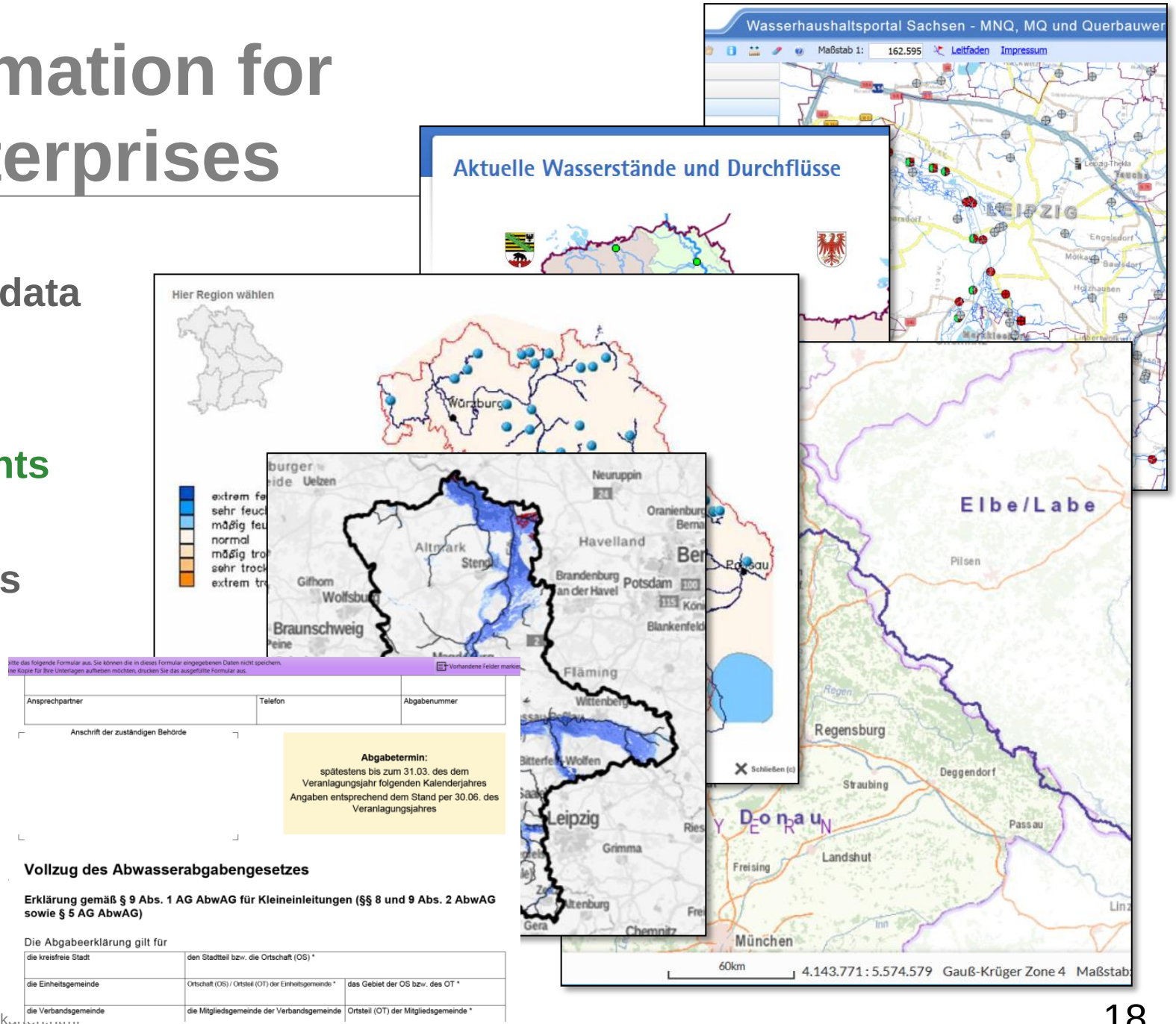
Effectiveness and efficiency:

- Radar storm water prognosis
- Combined sewer overflow
- Bathing water modelling
- …..

Examples: Aarhus, Copenhagen,etc….

Interactive Information for Citizens and Enterprises

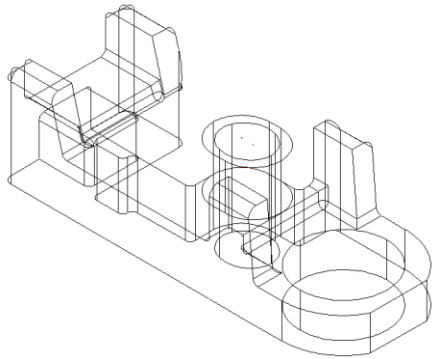
- **Interactive maps**
  - Real time precipitation data
  - Real time water levels
- **Planning support documents**
  - Geo-data / maps
  - Precipitation time series
  - Flood risk maps
- **Application forms**



Quellen: www.lfu.bayern.de/wasser/index.htm
www.umwelt.sachsen.de/umwelt/wasser/15.htm
www.geofachdatenserver.de/de/lhw-hochwassergefahrenkarten.html
http://include-st.zfinder.de/215172123

Waterways, Weirs and Gauges

- Automated weir control at waterways (h)
- Equipment of inland water vessels for interactive water depth measurement (h)
- Building Information Modelling (BIM) for bridges, harbours, gauges, locks, weirs,.. ….. (v)
- ……



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commons.wikimedia.org/wiki/File:07182jfValdefuente_Gauging_Rain_River_Bridge_Mayapyap_Sur_Cabanatuan_Ecijafvf_06.JPG /commons.wikimedia.org/wiki/File:Gehaeuse.gif
User Garitzko

Intermediate conclusions

- **Water technology**
  - Driven by technology development,
  - Improving efficiency
  - Focus on automatisation and horizontal integration,
  - **Need of more vertical integration (GIS, asset management, business information systems, planning software, ageing of pipes..)**
- **Water administration**
  - Improving efficiency,
  - Improving effectiveness,
  - **Need of more horizontal integration,**
  - **Limitations caused by administrative competences („silos“)**
  - Development of significant local disparities (future interface problems)

3 Chances

Chances

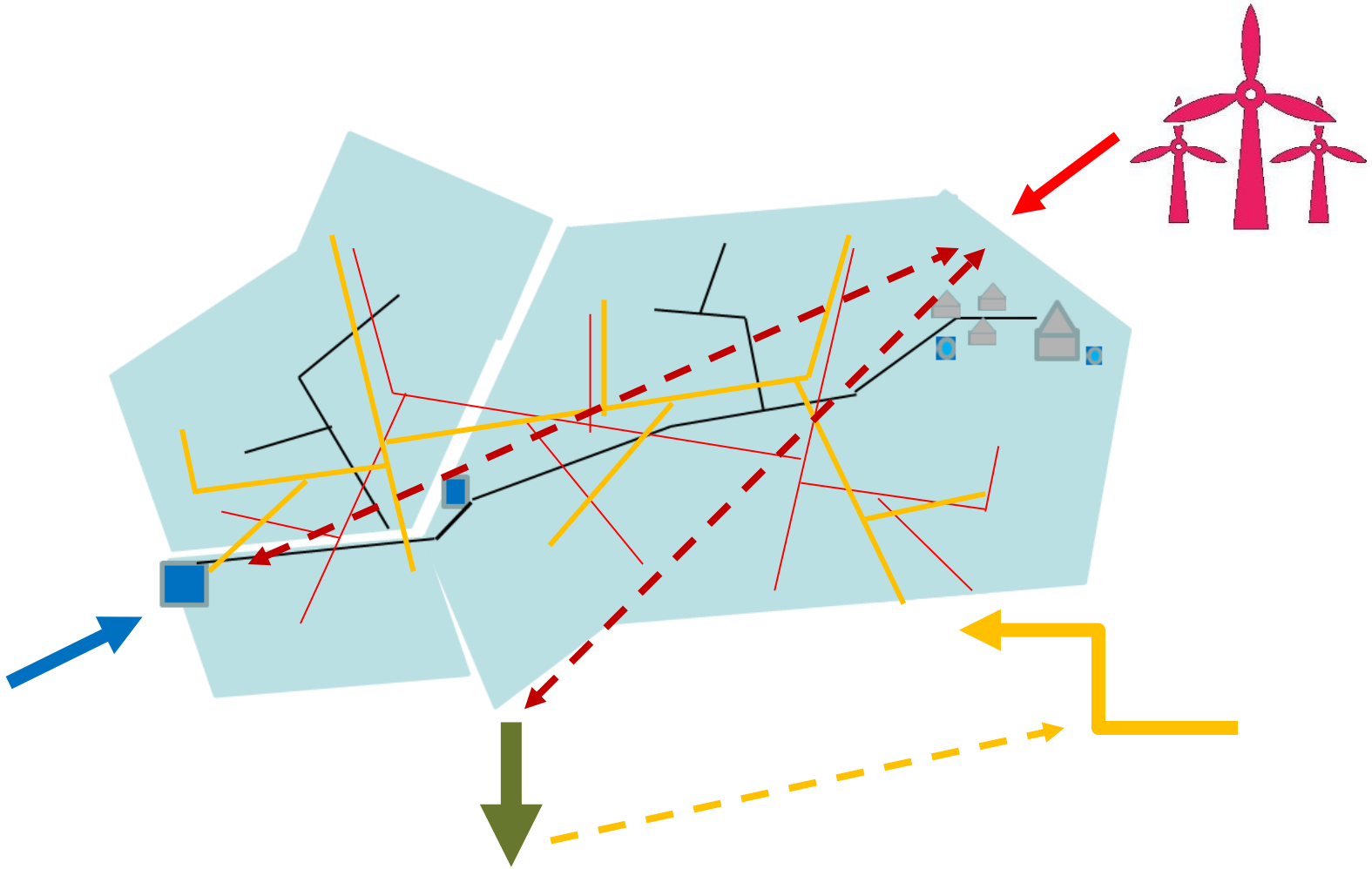
- Improving public services
- Improving environmental quality
- Improving environmental safety

- Improved basis for decision making

- Citizen value?

- New products

Integration of Infrastructure Services



Icon made by Freepik from www.flaticon.com

New Product:
Balancing Power as an Infrastructure Service

- **Balancing energy by water service providers**
  - Tertiary balancing energy (over 15 min)
  - Through pump management at the wwtp
  - Through pump management at water tower operation
  - (Cascade of hydropower dams, river power plants, pump storage power plants)

- **Balancing energy provided by consumer behaviour**
  - Tariff incentives with intelligent electricity meters
  - Tariff incentives with intelligent water meters

Source: commons.wikimedia.org/wiki/File:Stromleitung_Etzenricht_Hradec.jpg , Timberwind
https://commons.wikimedia.org/wiki/File:Miele_Waschmaschine_02_(fcm).jpg, Frank Müller

4 Challenges

General set-up

for market development in water infrastructure

- **Global Shortfall of Investment and Re-Investment**
  - **in D: Investment currently between 0,4 and 1,2 % (still without global change adaptation!) (Branchenbild, 2015)**
  - **In USA: Reinvestment needs of additional 84 bn. USD until 2020. (Not closing this gap would entail costs 206 bn. USD for households and enterprises (ASCE, 2011))**
  - **Global: investment needs of 7,5 trn. USD for water infrastructure until 2030 (49 trn. USD for infrastructure in total) for maintaining economic growth (still without climate change adaptation costs) (McKinsey, 2013, 2016)**

Sources.: Branchenbild d. deutschen Wasserwirtschaft.(2015); Center for Sustainable Infrastructure Evergreen State College,(2014), Infrastructure Crisis, Sustainable Solutions; McKinsey Global Institute, Infrastructure Productivity: How to save $1 trillion a year, (2013. 2016); World Economic Forum und Boston Consulting Group (2014); World Economic Forum und PwC (2012)

General set-up

- Investment shortfall / back-log
- Scarcity of resources (climate change)
- Advance of urbanisation
- Higher requirements for purification and safety in urban agglomerations
- Limited public funds

→ A growing market will drive technology development

Benefits and costs

- **Savings**
  - Lower operating costs
  - Lower reinvestments in pipes and networks
- **Enlarged product portfolio**
  - Water, wastewater, energy, balancing energy, mineral and organic products
- **Investments**
  - Instrumentation and control equipment,
  - Software
  - High initial investments (small service providers?)

Reliability, Safety, Security

- **Increasing complexity**
  - Increasing systemic interdependency
- **Operational safety**
  - Improved functional safety, reliability and robustness,
  - Systemic constriction, less analogue redundancies,
  - Uninterrupted system availability not yet satisfactory everywhere
- **Operational security**
  - Higher efforts for data and systems protection,
  - Proactively, process oriented, hierarchical, ….

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many thanks ! merci bien!
dank u wel! muchas gracias!
molte grazie! vielen Dank!

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