Karlsruher Institut für Technologie

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Decision-Making Trade-Offs for Resilient Transport Systems

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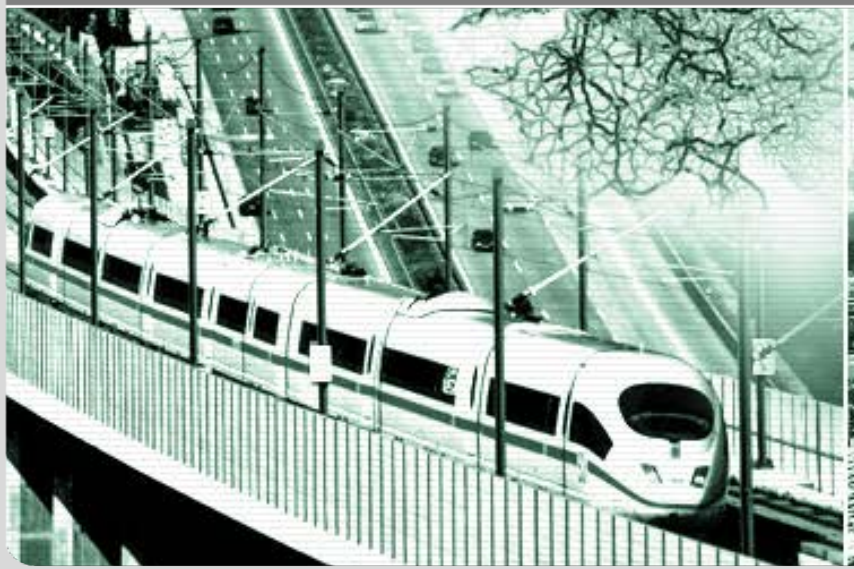

Agenda

- Part 1: Ex-ante decisions on expected technological disruptions concerning unexpected and unpredictable events
- Part 2: Ex-post decisions in case of an extreme event

Expected technological disruption 1: Total electrification of society

- For climate reasons, **transport will be predominantly electrical** in the future: railways, cars, trucks, buses
- Also telecommunications, household heating, and industry will be electrified

- **Therefore, the resilience of the electrical power system ranks first!**
  - **From „n-1“ to „n-2“** resilience of power systems
  - In countries like Germany, preserve parts of the **natural gas infrastructures as a backup for the electrical power system:** Gas power plants, long distance gas network, gas storage facilities

- In addition, preserve a portion of the **gasoline infrastructure** as resilience backup for heavy vehicles (like construction and military vehicles)

Decision making tradeoff concerning total electrification of society

- Don‘t go too lean into energy transition and future electric power system
- Spend some more money on resilience, i. e. redundancies in the power system
- Also keep some parts of the inherited technologies and infrastructures like gas or gasoline as a backup against extreme events (even if fossile based and almost not used in normal circumstances)

Expected technological disruption 2: Total digitalization of society

- Resilience of digital systems is vital

- Will a vital company of a non-digital domain (like a railway undertaking or a railway infrastructure manager) stay resilient against cyber attacks?
- Can it do so in an economically feasible way?

- As we do not know how vulnerable digital systems and applications will turn out to be, we have to take care:
  - **Besides „n+X“:** „every crises can be managed by intelligent systems“
    beware of „n-n = 0“: „intelligent internet-based systems may break down completely“

Decision making tradeoff concerning total digitalization of society

- Beware complete lock-in into digital systems
- Retain the ability to fall back to simple, locally controlled, non-digital modes:
  - Government and public administrations
  - Electric power system and its resilience backup
  - Basic traffic management (e. g. backup mode for light-signal systems)
- As automated driving is developing: A substantial portion of automated road vehicles must still be driver-controllable without recourse to network services
  - Car-owners should make „emergency driving licences“ in the future

Agenda

- Part 1: Ex-ante decisions on expected technological disruptions concerning unexpected and unpredictable events
- **Part 2: Ex-post decisions in case of an extreme event**

Resilience of road traffic ranks first

- Good news: Road traffic is (currently) very resilient
  - Many independent vehicles that are freely maneuverable by their drivers
  - A dense road network that provides many alternative and substitute routes from A to B

    → The road network is a safety network
- Main danger during an extreme event: Mass evacuation, bottlenecks and hyper-congestion, deadlocks
- Pivotal: Adequate information of the population

Decision making tradeoff concerning road traffic information

- Pivotal: Adequate information of the population
  - Crisis management by **detailed information** („go there, use this road at this time“) **if such information is reliable**
  - **But is such detailed information reliable?** Real-time realistic assessment by the authorities about the reliability of detailed information
  - **If unreliable: Fallback to general information**
    - Withhold unreliable detailed information
    - Warn about unreliabilty of detailed information from other sources
    - Give **general information** on situation and behavior („stay home and wait for more information, beware traffic jams“)

Tradeoff between smooth everyday functioning of systems and readiness for extreme events

- Societies, people and governments, should be prepared and trained for „moments of surprise“

- Luckily, training is already under way:
  - Financial crisis of 2008
  - Covid
  - Ukraine war
  - Extreme weather events
  - Strikes
  - …

Thanks for your attention

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