Multi-Paradigm Modeling for Policy-Driven Socio-Technical Systems (MPM4STS)

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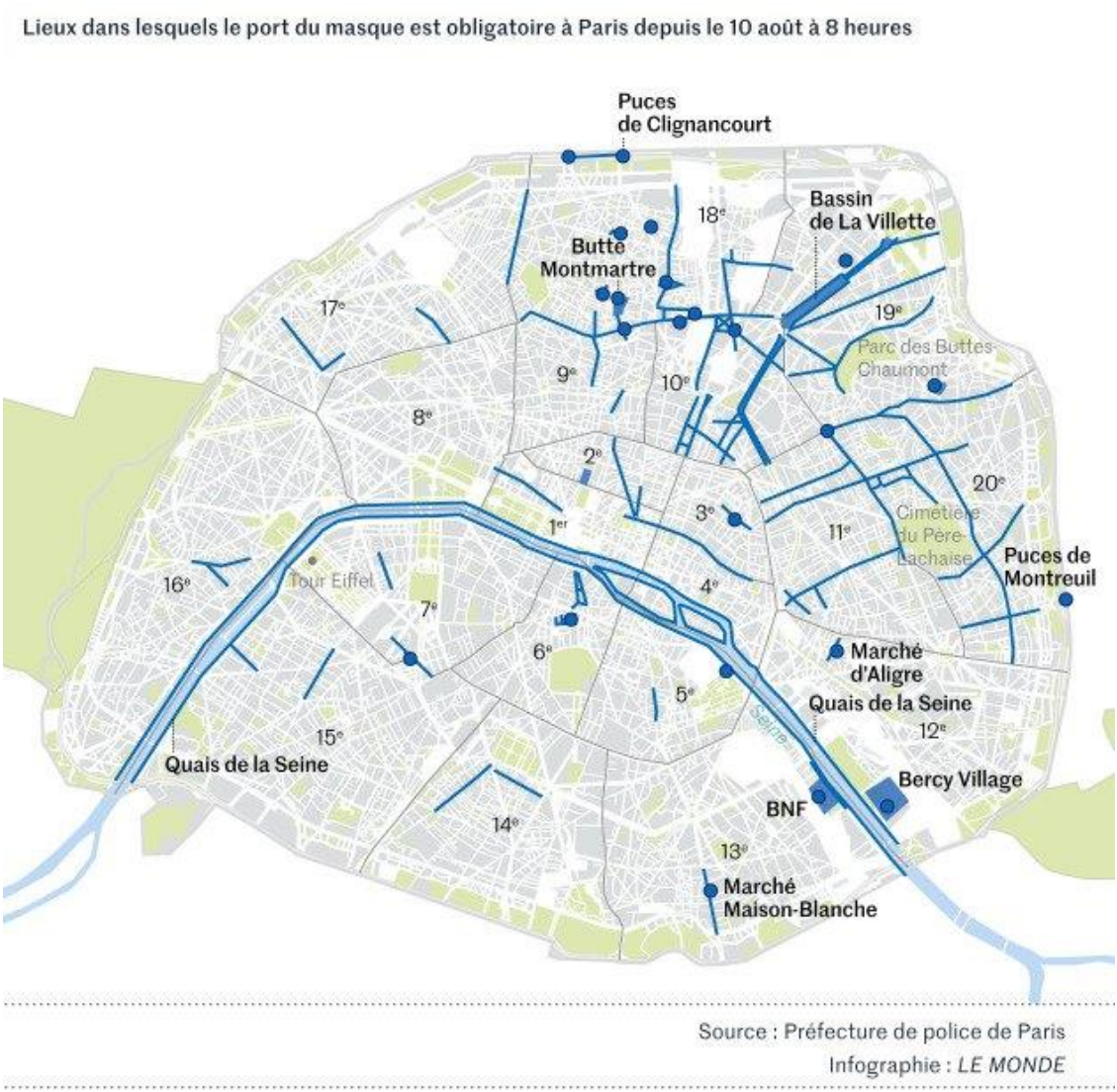
Policy Making for Socio-Technical Systems Problems

- **Modern societies are increasingly complex (interwined with fast changing cyber-physical infrastructures)**
- **Unplanned events (COVID19, climate changes, etc.)**
- **Policy-making need to keep-up with these rapid changes**



Multi-Paradigm Modeling Approach for Policy-Driven Socio-Technical Systems

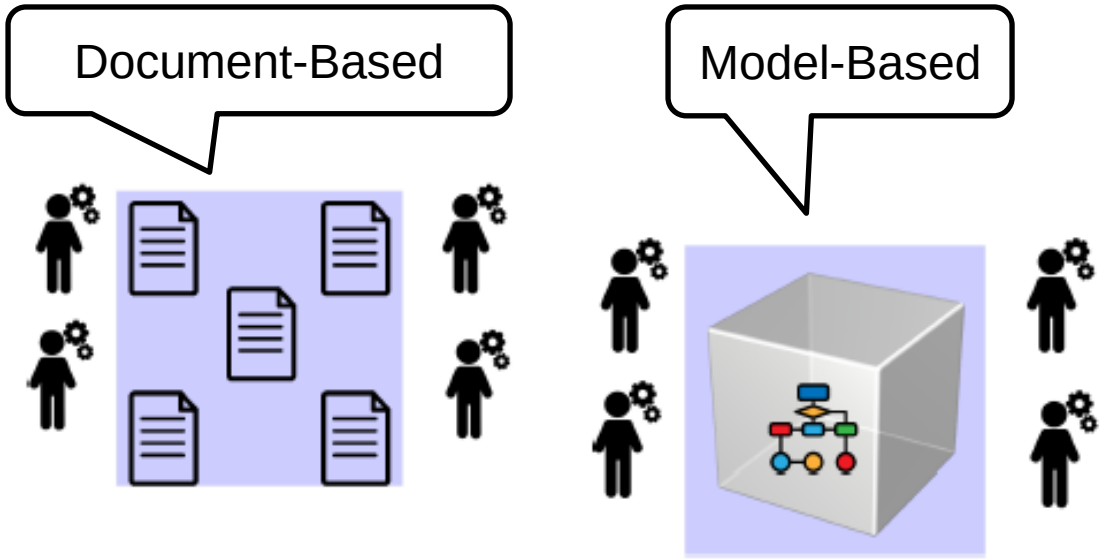
- **Improve policy making by reusing approaches that have been successful for other types of systems (e.g. Cyber-Physical Self-Adaptive Systems)**

- **Theories / approaches:**
  - Model-Based System Engineering (MBSE)
  - Multi-Paradigm Modeling (MPM)

  - Goal Oriented Requirements Engineering (GORE)
  - Goal Oriented Multi-Scale Control Systems (GoMSS)
  - Self-Adaptive Systems (SAS)

Model-Based System Engineering (MBSE)

- **Paradigm shift: From natural language documents to models**



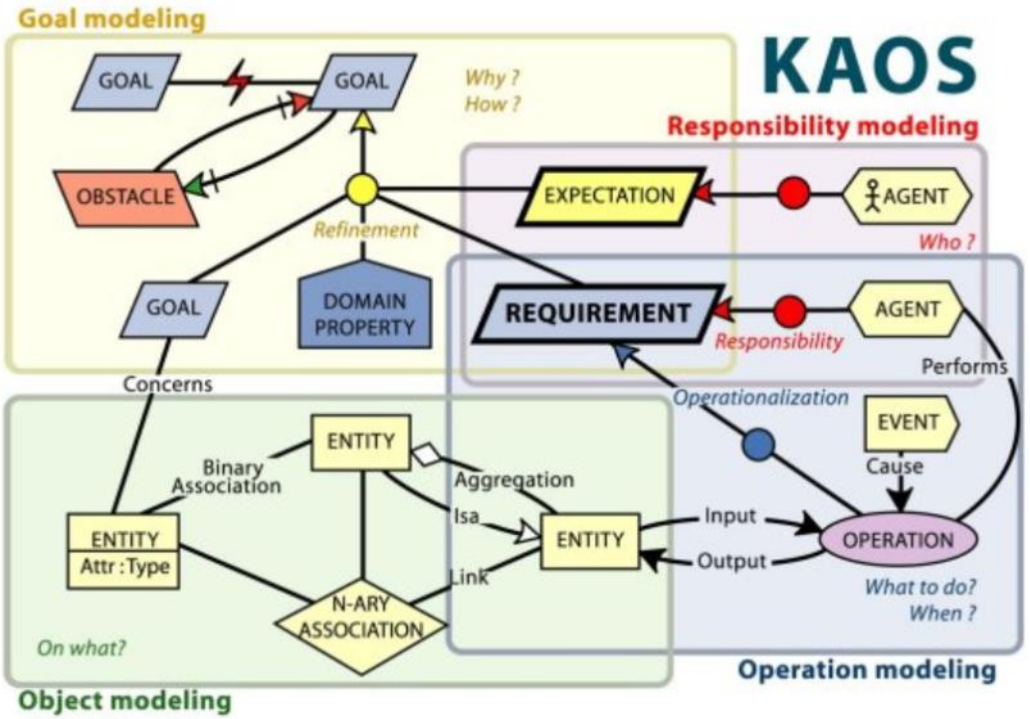
- **Provide common vocabulary**
- **Enforce more precision**
- **Allow building tools to process specifications (models)**
- **Allow detecting errors / inconsistencies early**
- **Quite effective for avionics development (> 25 % costs reduction)**

Multi-Paradigm Modeling (MPM)

- **Modeling: Model every relevant part and aspect of a system explicitly**
  - Should not be just in the head of engineers
- **Paradigm: Most appropriate level(s) of abstraction with the most appropriate formalism(s) for the activity to be performed with the models**
  - Avoid *accidental complexity*
  - E.g. Code compilation to increase level of abstraction
- **Multi: Do not try build a single modeling language that can capture everything: different needs per project**
  - *Combine* the most appropriate formalisms
  - At the expense of requiring *model management*

Goal-Oriented Requirements Engineering (GORE)

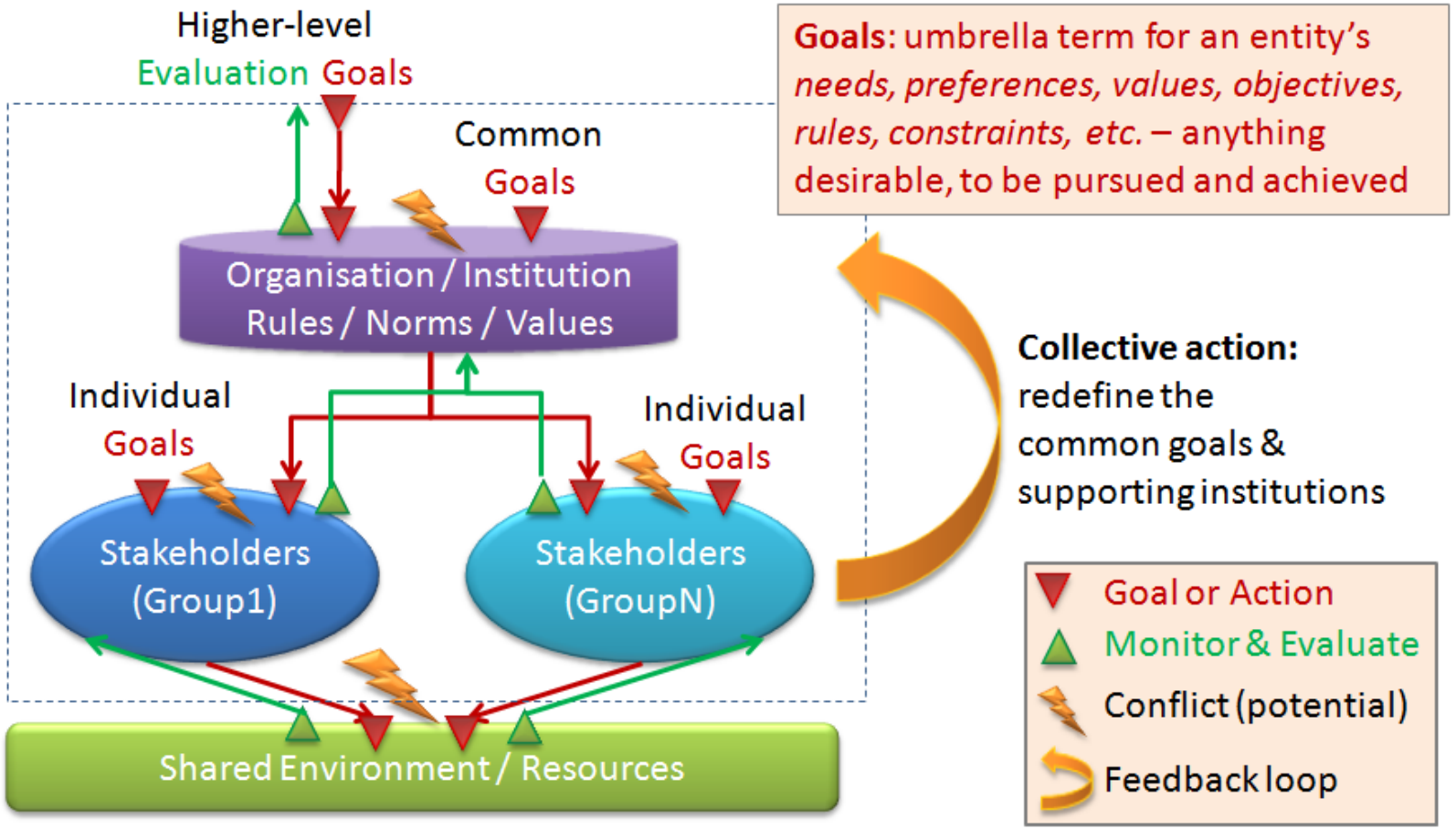
- **4 complementary and interrelated views on the system:**
  - Goals (owners, users, business managers, regulations, etc.)
  - Responsible agents
    - Human and automated
    - System or environment
  - Problem domain
    - Concepts and their relationships
  - Behaviors
    - In order to achieve goals



- **Typically used at system design time only**

Goal-Oriented Multi-Scale Control Systems (GoMSS)

- **Sort of GORE at runtime…**



Our Approach…

- **Multi-Paradigm Modeling to use and combine the most appropriate formalisms and their paradigms**
  - Support building a conceptual framework and its tools
  - Reuse existing paradigms and their formalism as much as we can (e.g. deontic logic?)
  - May need develop new ones (language engineering)…
  - Model management to integrate models (model transformation / synchronization)

- **GoMSS approaches to specify self-adaptive STSs**
  - No strict control like CPS
  - But policy maker guidance (decision making tools)

- **Develop domain-specific language(s) to better characterize specific systems (e.g. forest management)**

Our Assumptions

- **What works for CPS can at least work partially for STS**
  - Social science stakeholders can use modeling processes and tools
  - Very different kinds of users than engineers….
- **Substantial gain from modeling**
  - Common vocabulary / understanding
  - More precision
  - Better tool support
- **Substantial gain from analyses**
  - Basic static analyses (e.g. consistency of data)
  - Simulation (e.g. agent based)
  - Transformation of models towards existing tools