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An initial categorization of foundational research in complex technical systems

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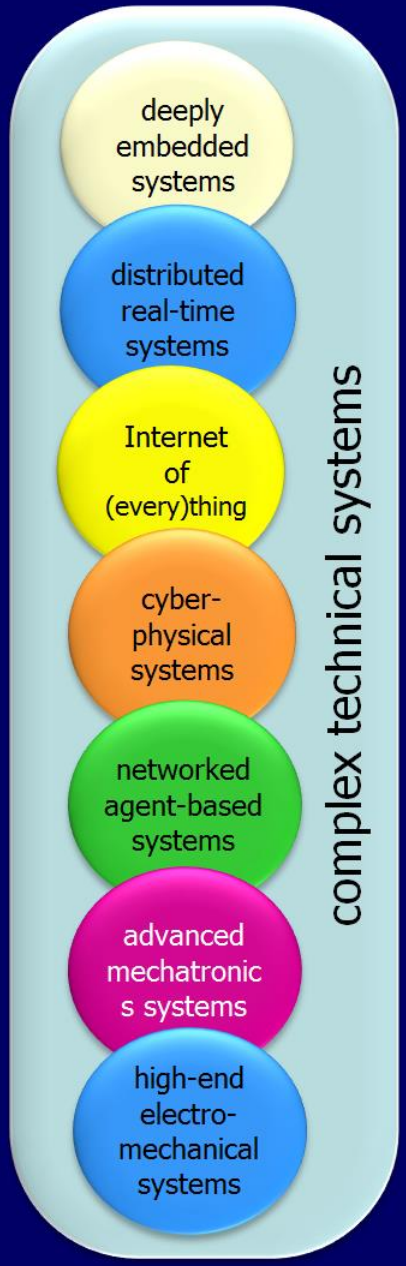
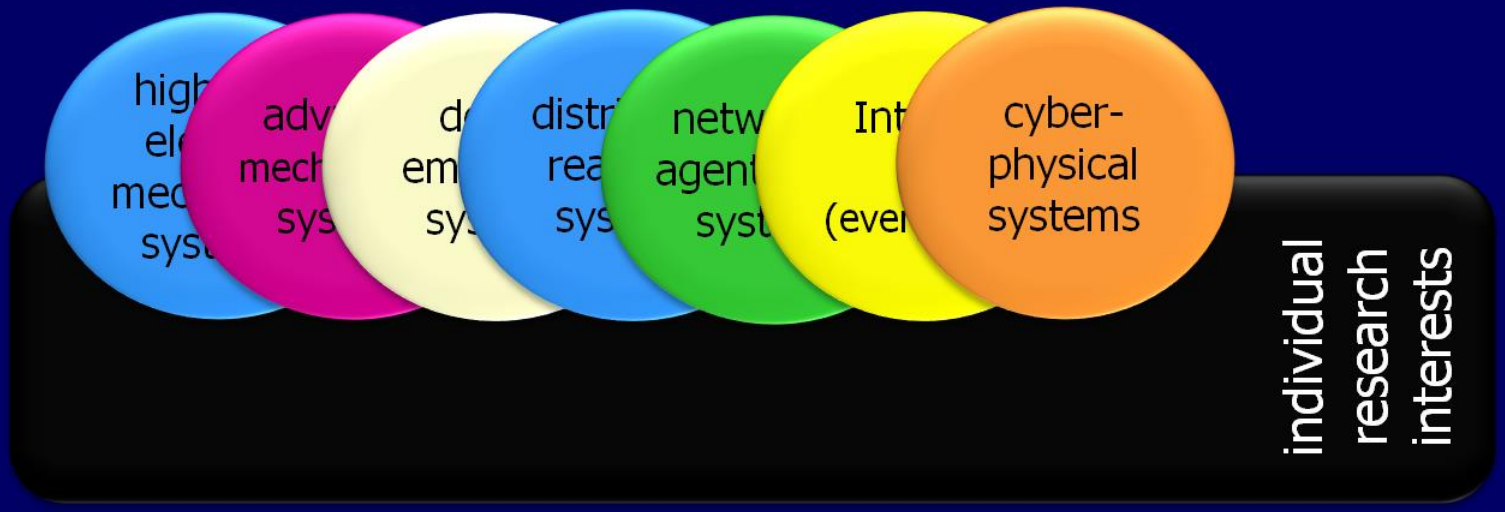
Domain of interest and objective

- This study focuses on the area of complex technical systems (CTSs)
- There has been intense foundational and operative research in this area
- The objective of the work was to overview the progress in research and to propose and initial classification
- The findings reported in this articale concerns foundational research only
- Identified are research categories, domains, subdomains, strands, interests



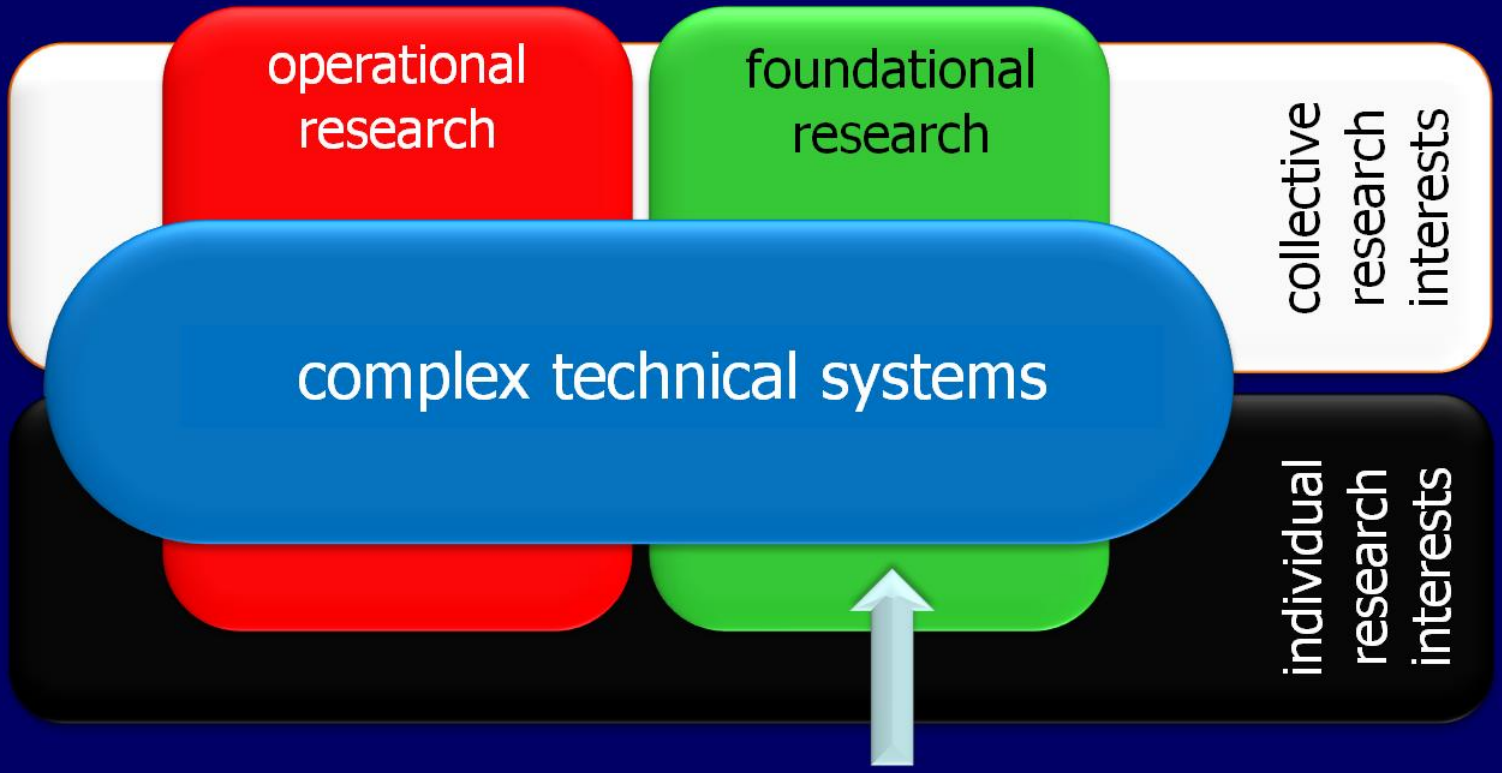
Initial observation

The research field of CTSs is represented by an extreme large number of scientific journal articles, conference papers, professional documents and website contents reflecting individual research interests of researchers

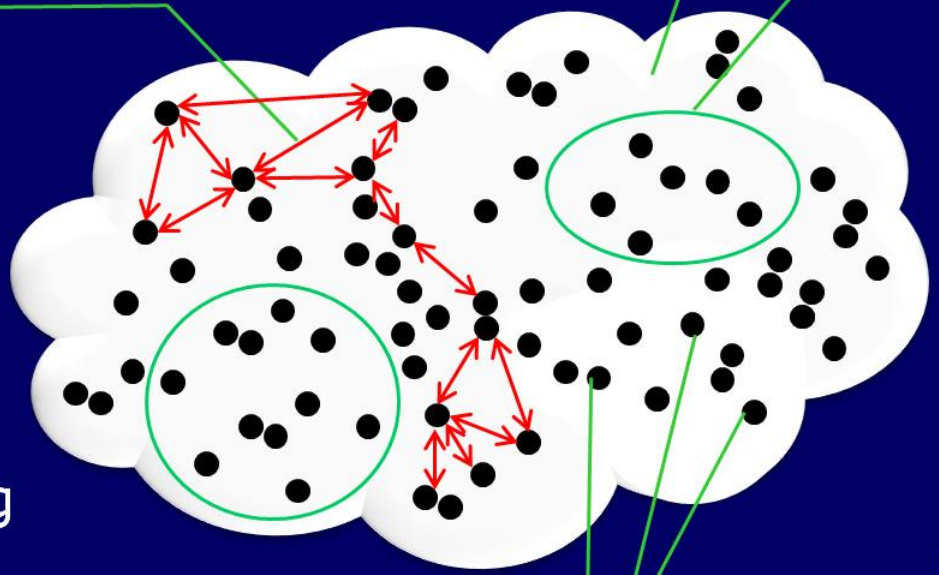


Research question

Can any order imposed on the 'mess' as much as collective interest in foundational research in CTSs is considered?



Possible approaches of processing literature



approach 1

applying the methods of citation networks analysis and detecting emerging research fronts

approach 2

imposing and critically testing an experience- and intuition-based semantic reasoning model

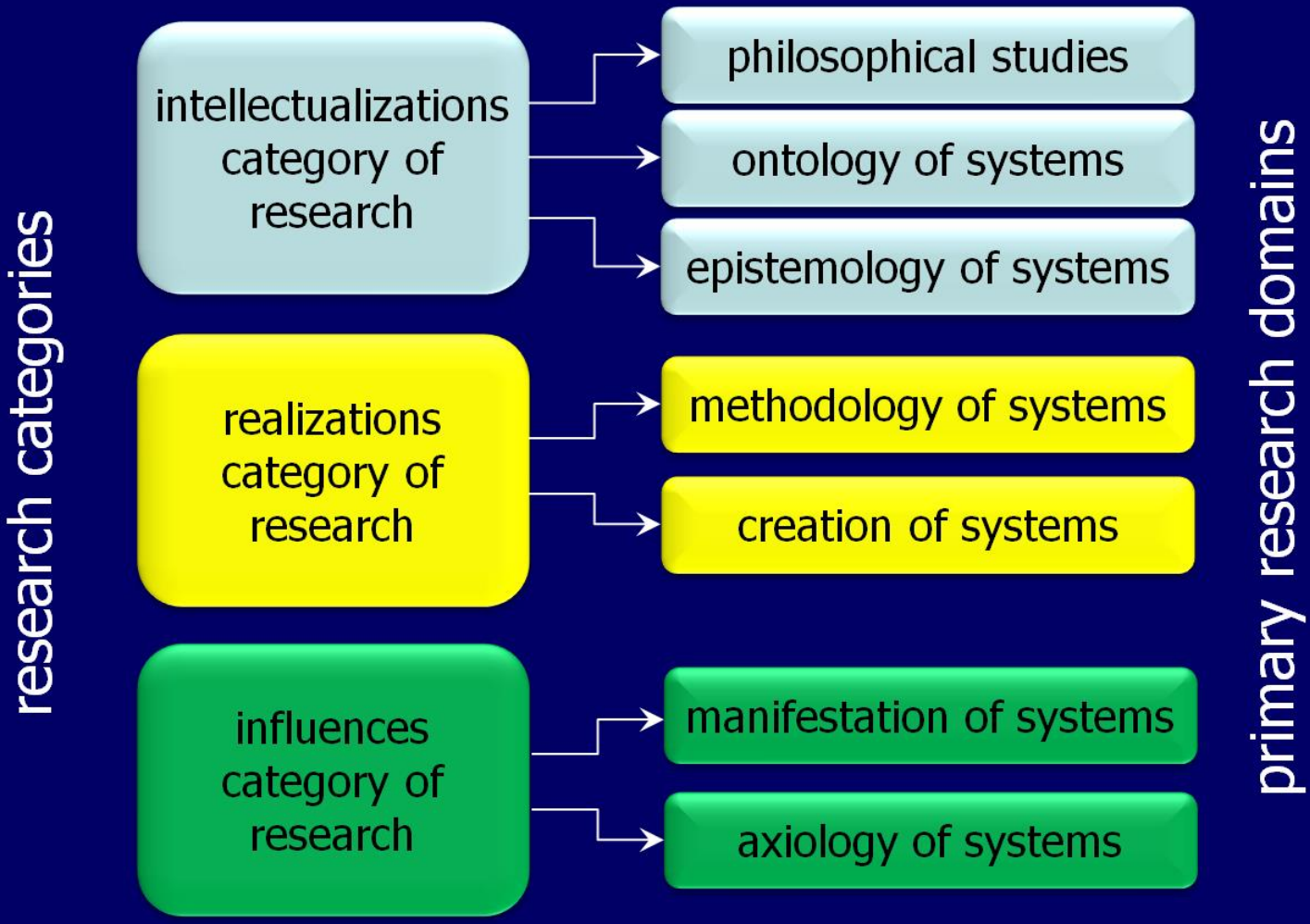
Operationalization of approach 2

- This secondary research has been done in three stages:
  - intuition-driven exploration of a reference set of related academic publications,
  - evidence-based specification of a categorization of the domains and subdomains of research, and
  - refinement and validation of the proposed classification based on a control set of related academic publications
- A pool of papers were aggregated by searching with keywords such as 'complex systems', 'system science', 'engineered systems', and 'system development
- More than 860 academic publications were studied in two years

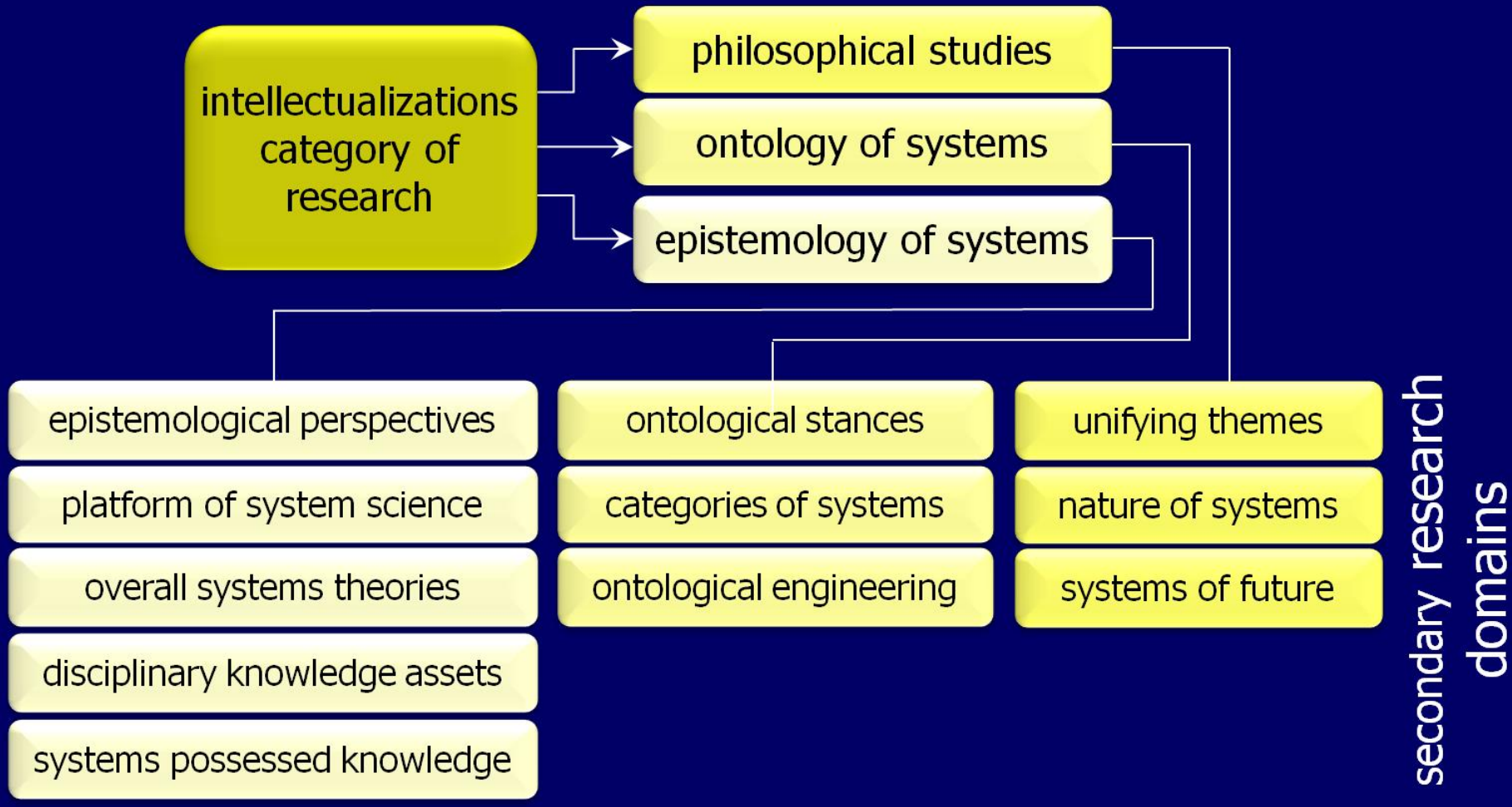
Conduct of the secondary research

- 'Proper' publications have been sorted based on four factors:
  - measure of topical compliance to a category
  - proportion of contributing to a given domain
  - measure of relative significance of the publication
  - factor of relative visibility of the publication
- Selected papers were sorted into approximately equal sized reference set and control set in an arbitrary manner
- The reference set was used as evidence that a particular research interest does exist, and the control set was used to validate the derived taxonomy and to introduce refinements
- Papers were sorted into three abstract categories and (sub)domains were identified by a critical contents analysis

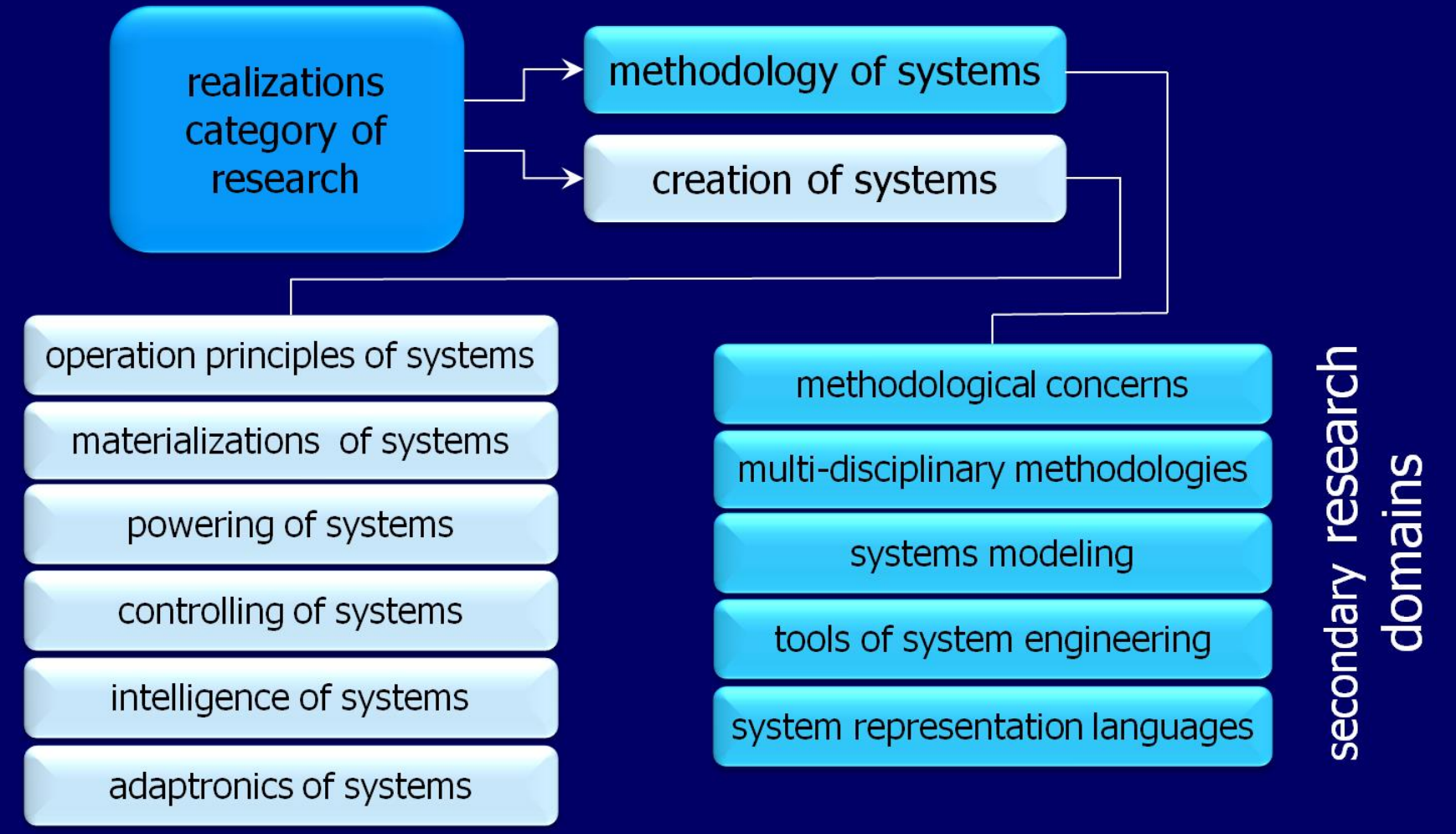
Categories of foundational research in CTSs



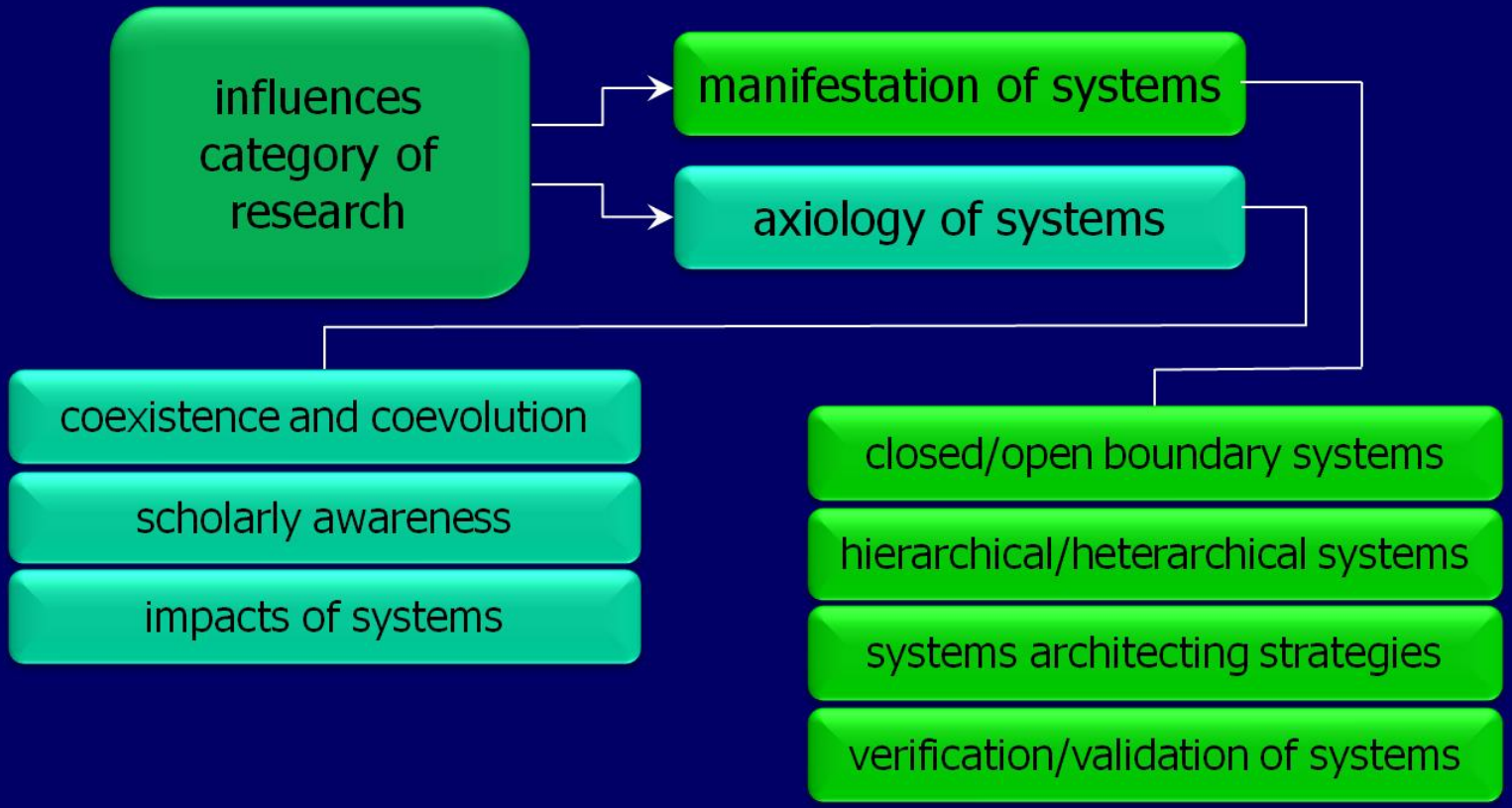
Intellectualizations categories of research



Realizations categories of research



Influences categories of research



Conclusions

- The engine behind the advancement of systems science and general system theory is foundational research
- However, it has in the past not been investigated from an ontological perspective
- A proper reasoning model could not be expected purely based on syntactic methods
- The proposed classification reflects some subjective elements, but is sufficiently underpinned by evidences
- The proposed classification can be extended towards operative research in CTSs
- It can also be adopted to other domains of systems science