META Metrics Toolbox for quantifying complexity and adaptability of system designs

Main Goal of META is to develop a methodology in system design. Based on current practice, in order to do so the metrics need to be used to synthesize and select the best possible system architectures.

- A key element is to choose system architectures and designs that achieve desired performance with minimum necessary structural and dynamic complexity as well as minimum adaptation requirements.

  - Structural Complexity is based on the type and number of system elements, their interconnections as well as the structural arrangement.
  - Captures both component as interface complexity
    - Key concept: Graph Energy
  - Dynamic Complexity is based on the number and correlation amongst functional performance attributes of the system.
  - Captures correlation and uncertainty
    - Key concept: Shannon Entropy
  - Organizational Complexity captures the number of staff required and rework
    - E.g. META Program Cost and Schedule
  - Adaptable – the ease with which changes can be made to a design in the future

A series of computational metrics and models have been developed to capture the structural, dynamic, and organizational complexity of a design.

Conclusion: META-speedup factor of 5 compared to current practice appears feasible, but will require multiple “mechanisms” to work together (C2M2L library coverage > 0.8, structural complexity reduction of 40% thanks to extensive architecture enumeration, 75% probability of early detection of design flaws, >2 layers of abstraction etc...). The current META metrics toolbox produced by the UTRC team contains structural, dynamic and organizational metrics of complexity.