HIGH-LEVEL PARTITIONING OF DISCRETE SIGNAL TRANSFORMS FOR DISTRIBUTED HARDWARE ARCHITECTURES

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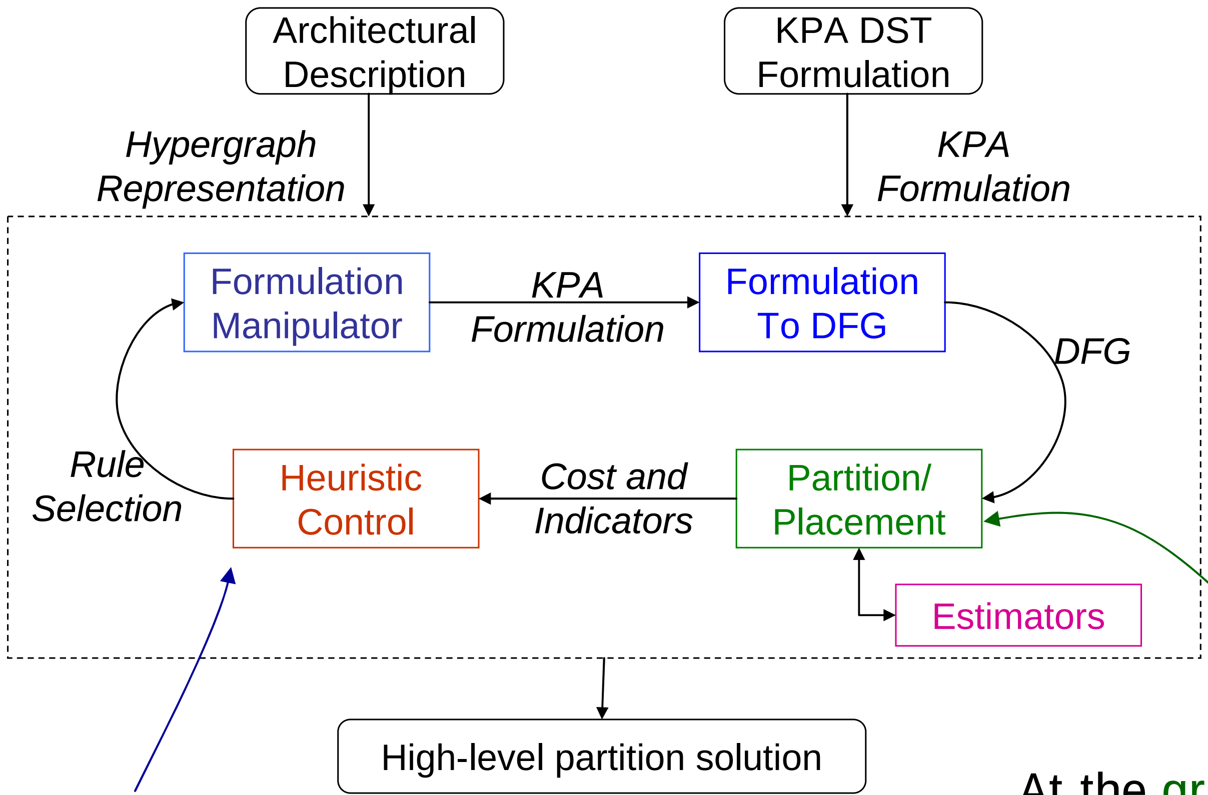
Motivation

- Discrete Signal Transforms (DSTs)
  - Examples: DFT, DCT = lots of applications in science, communications,..
  - Cab be hardware-accelerated but at high resource cost
- Distributed (dedicated) hardware architectures (DHAs)
  - Cost-effective platform for high-performance implementations
  - Partitioning plays key role
    - Current high-level partitioning methods limited to generic graph strategies
    - Meanwhile, effective (manual) DST implementations utilize intrinsic DST properties to their advantage

DHA

- **Objective**: Use inherent properties of DSTs to improve automated hardware partitioning to distributed hardware architectures.

Proposed High-Level Partitioning Methodology



DST-features are introduced in two abstraction levels as part of our methodology: at the **graph level** and the **algorithmic-level**.

At the algorithm-level, an exploration is conducted in search of equivalent transform formulations that are more suitable for the target topology.

At the graph partitioning level, a series of DST-specific structural considerations have been taken to improve the graph partitioning heuristic.

Kronecker Products Algebra

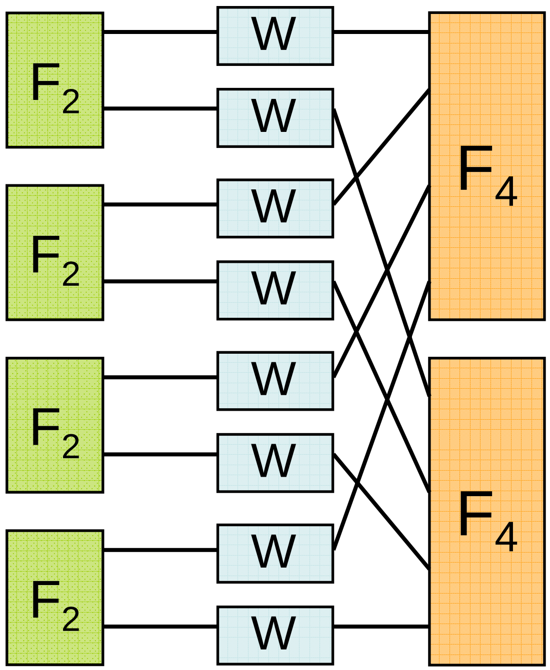
- Compact framework for formulation of DSTs
  - Multidimensional, e.g. $F_{4x4} = F_4 \otimes F_4$
  - Fast versions of DSTs $F_8 = (F_4 \otimes I_2) T_{4,2} (I_4 \otimes F_2)$

- Governed by well known rules and properties

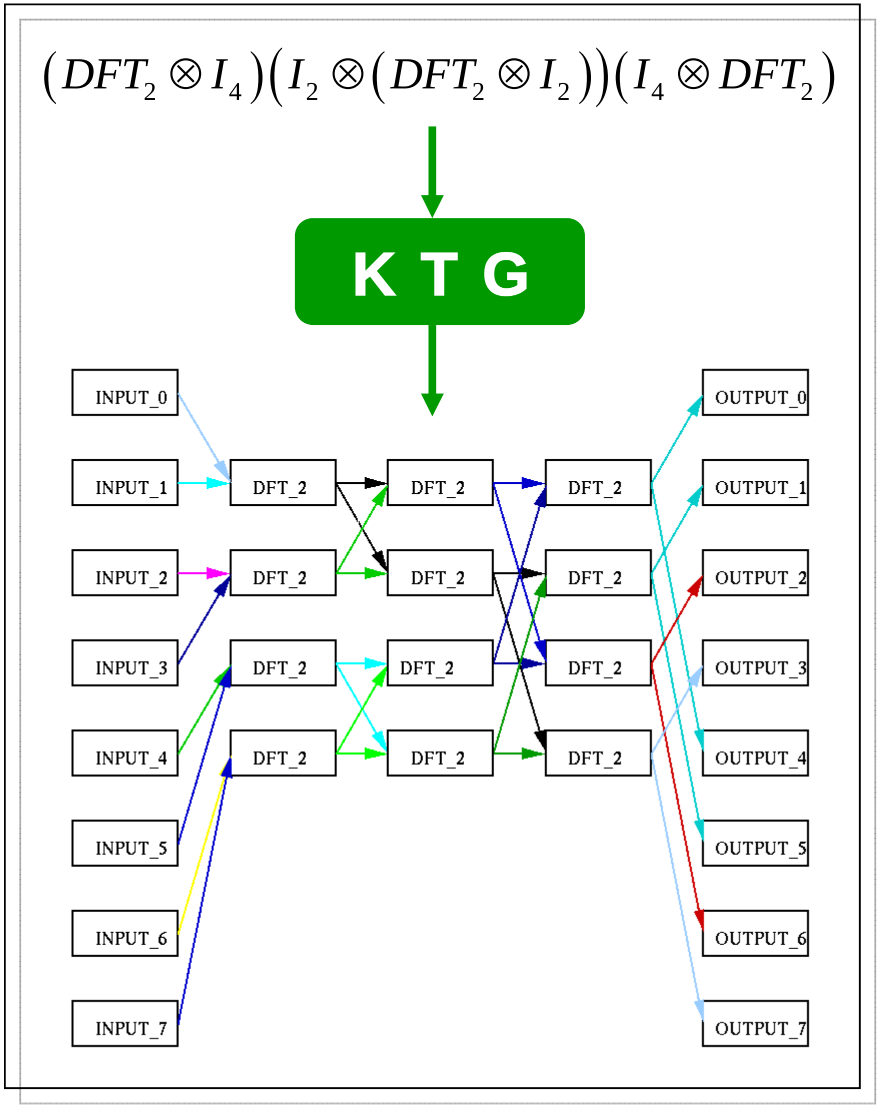
- Commonly used to explore alternate formulations which better exploit architectural features

- Formulation 'implies' structure

$$F_8 = (F_4 \otimes I_2) T_{4,2} (I_4 \otimes F_2) P_4^8$$



KTG TOOL



- Generates of dataflow graph based on Kronecker expressions
- Allows exploration of alternate DST formulations as part of the partition optimization process
- Input: Kronecker expression using common operators (e.g. $\oplus$,$\otimes$) and operands (I_m, $P_{n,m}$,$T_{n,m}$).
- Output formats:
  - *.fig* format – used with Xfig program
  - *.gph* format – used with METIS
  - link list data structure for the rest of partition process

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