Hartree Centre

Science & Technology Facilities Council

DL_MESO Data layout

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DL_MESO_LBE

- Lattice Boltzmann code to model fluids at mesoscale.
- Hybrid MPI/OpenMP running natively on Phi.
- Using Intel compiler 16.0.042 (beta).
- This project optimize the fGetEquilibriumF hotspot.

Array of Structures

- Data Structure Layout:

lvm	lvm1x	lvm1y	lvm1z	lvm2x	lvm2y	lvm2z	…	lvm19y	lvm19z

- Data Structure Properties:
  - Not aligned
  - Vectorization with non-unit stride loads
  - Vectorization with remainder loops

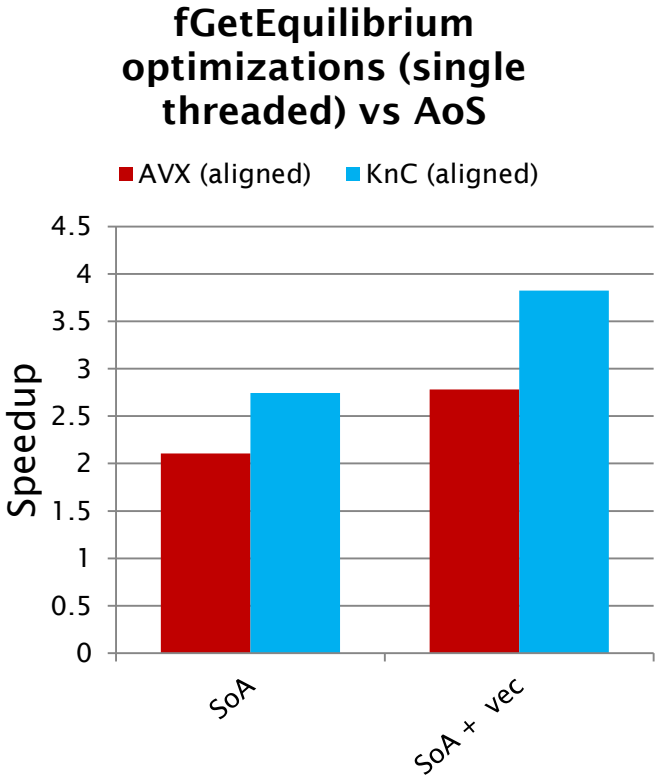
- Additional characteristics:
  - Double precision
  - Length = connection lattices

Structure of Arrays

- Data Structure Layout:

lvmx	lvm1x	lvm2x	lvm3x	…	lvm19x
lvmy	lvm1y	lvm2y	lvm3y	…	lvm19y
lvmz	lvm1z	lvm2z	lvm3z	…	lvm19z

- Data Structure Properties:
  - Aligned
  - Vectorization with unit stride loads
  - Vectorization with remainder loops

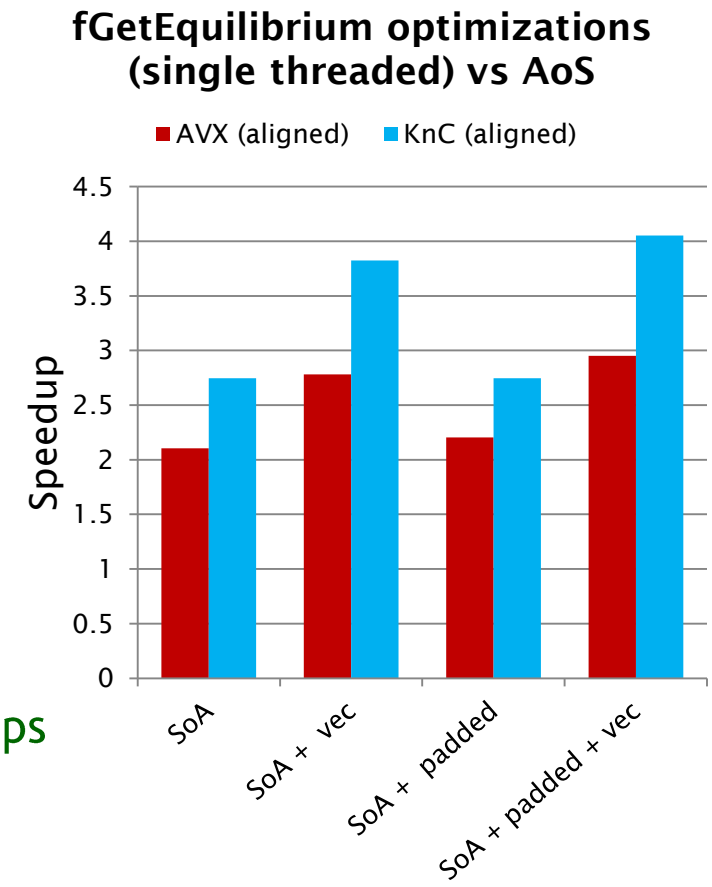


Padding

- Data Structure Layout

lvmx	lvm1x	lvm2x	lvm3x	…	lvm19x	lvm_pad
lvmy	lvm1y	lvm2y	lvm3y	…	lvm19y	lvm_pad
lvmz	lvm1z	lvm2z	lvm3z	…	lvm19z	lvm_pad

- Data Structure Properties:
  - Aligned
  - Vectorization with unit stride loads
  - Vectorization without peel/remainder loops



Insights

- AoS -> SoA is a key data layout transformation to achieve good vectorization.
  - Data alignment
  - Unit-stride loads
- Bigger gains in KnC
- Manual padding required to avoid remainder loops in Xeon, Intel compiler auto-padded properly the remainder loop in KnC.