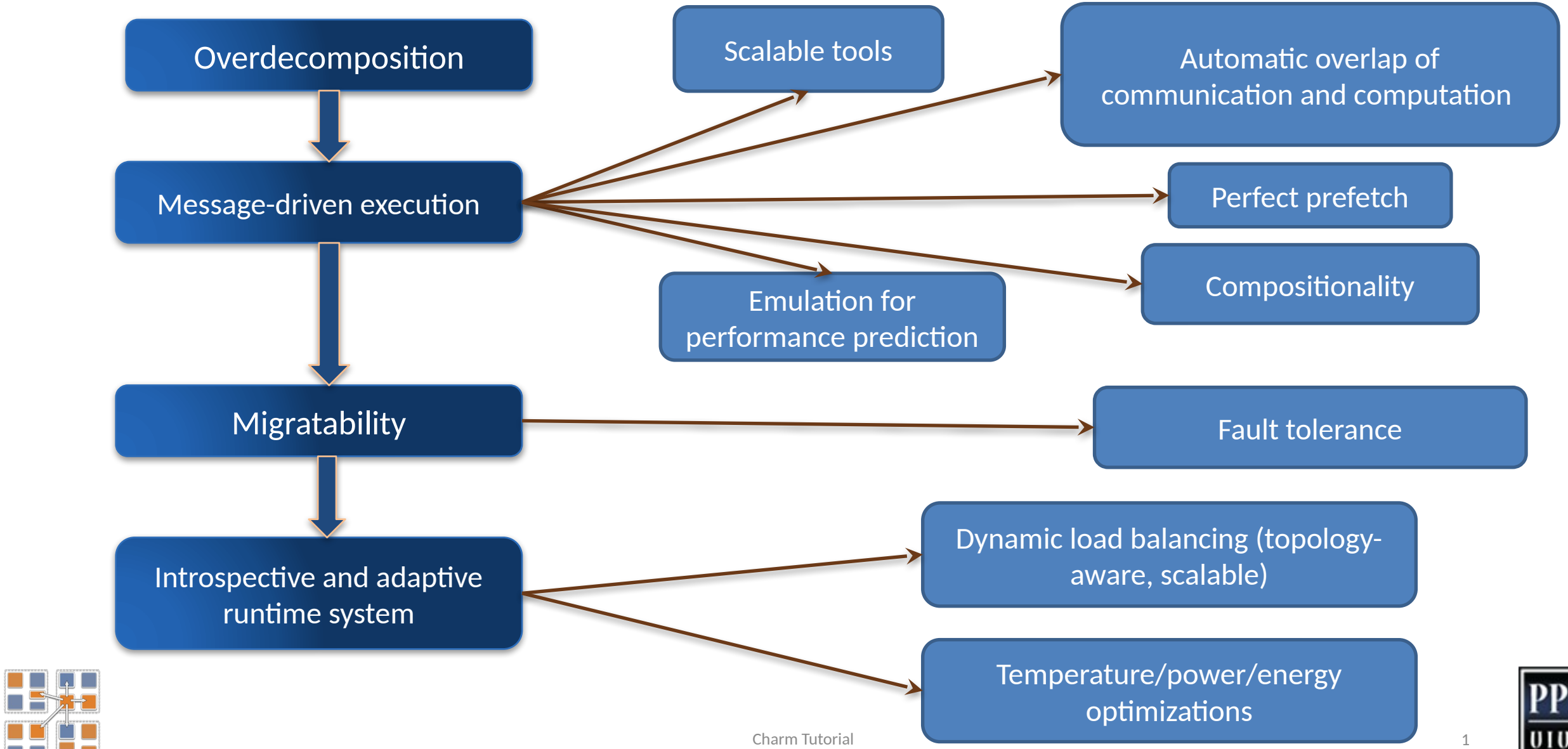
Charm++ Benefits



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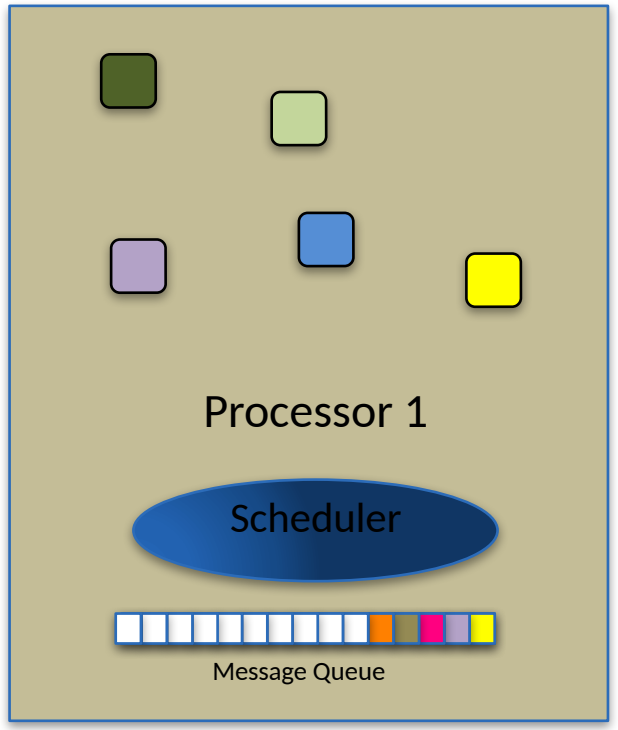
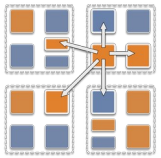
Locality and Prefetch

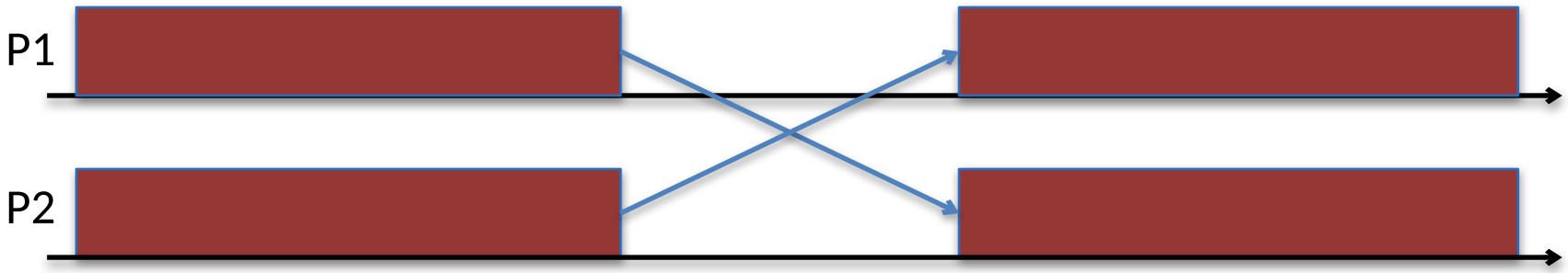
- Objects connote and promote locality
- Message-driven execution
  - A strong principle of prediction for data and code use
  - Much stronger than principle of locality
    - Can use to scale memory wall:
    - Prefetching of needed data:
      - Into scratchpad memories, for example



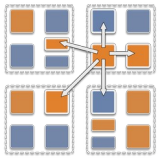


Impact on Communication

- Current use of communication network:
  - Compute-communicate cycles in typical MPI apps
  - The network is used for a fraction of time
    - And is on the critical path
- Current communication networks are over-engineered by necessity

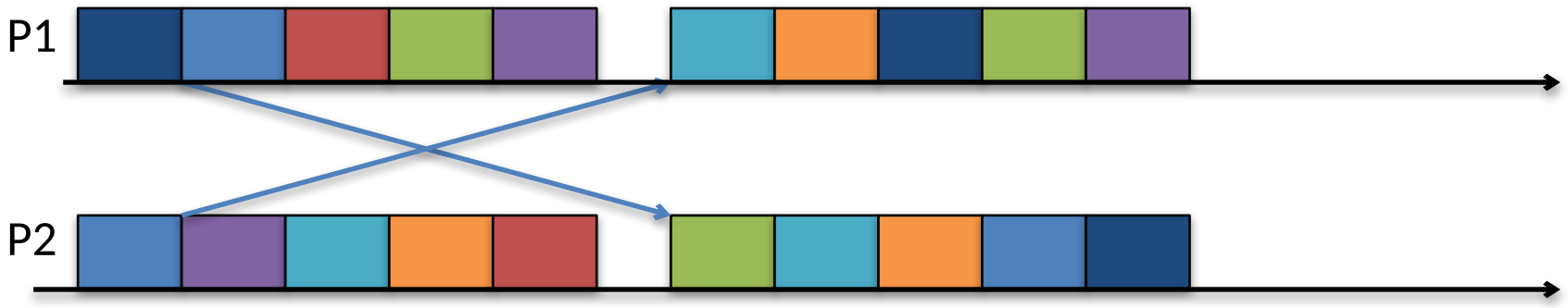


BSP based application

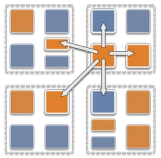


Impact on Communication

- With overdecomposition:
  - Communication is spread over an iteration
  - Adaptive overlap of communication and computation

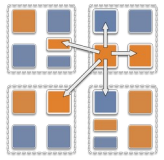


Overdecomposition enables overlap



Decomposition Challenges

- Current method is to decompose to processors
  - This has many problems
  - Deciding which processor does what work in detail is difficult at large scale
- Decomposition should be independent of number of processors – enabled by object based decomposition
- Let runtime system (RTS) assign objects to available resources adaptively



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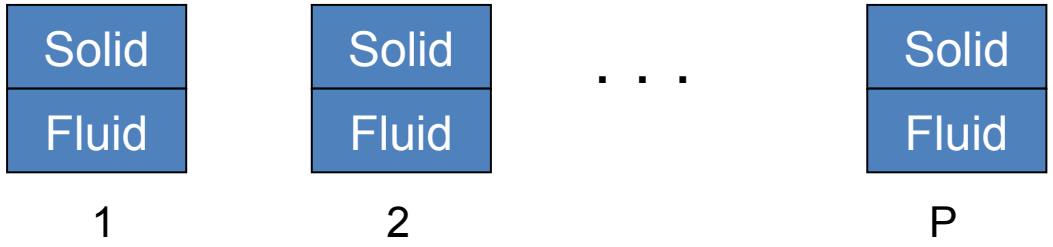
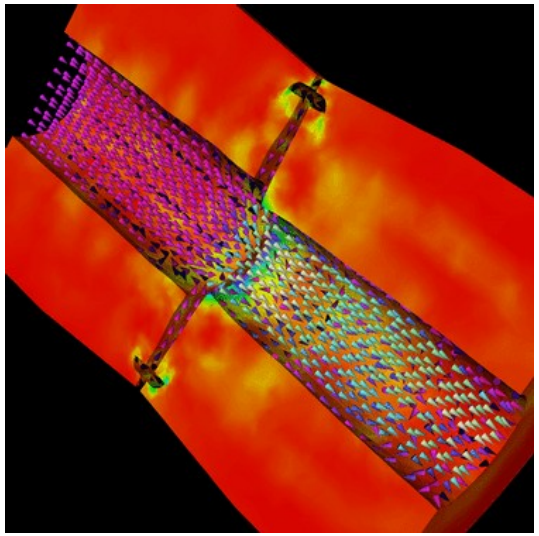
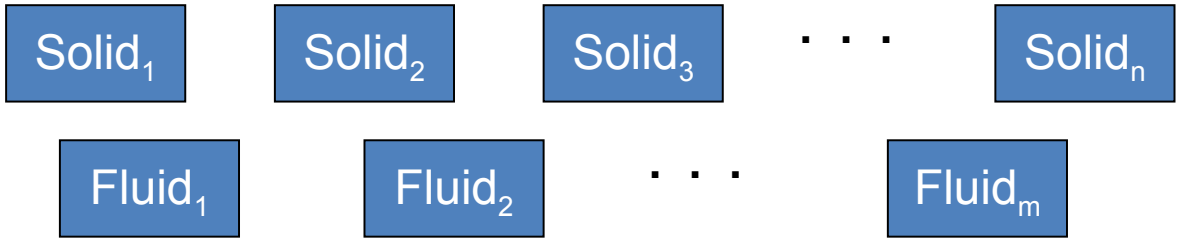
Decomposition Independent of numCores

- Rocket simulation example under traditional MPI

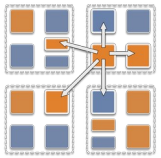




- With migratable-objects:

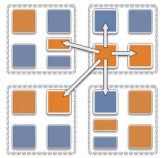


  - Benefit: load balance, communication optimizations, modularity



Compositionality

- It is important to support parallel composition
  - For multi-module, multi-physics, multi-paradigm applications…
- What I mean by parallel composition
  - B || C where B, C are independently developed modules
  - B is parallel module by itself, and so is C
  - Programmers who wrote B were unaware of C
  - No dependency between B and C
- This is not supported well by MPI
  - Developers support it by breaking abstraction boundaries
    - E.g., wildcard recvs in module A to process messages for module B
  - Nor by OpenMP implementations



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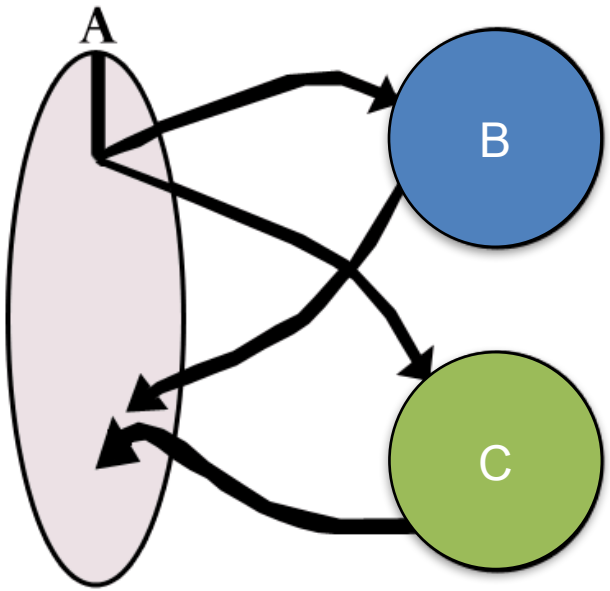
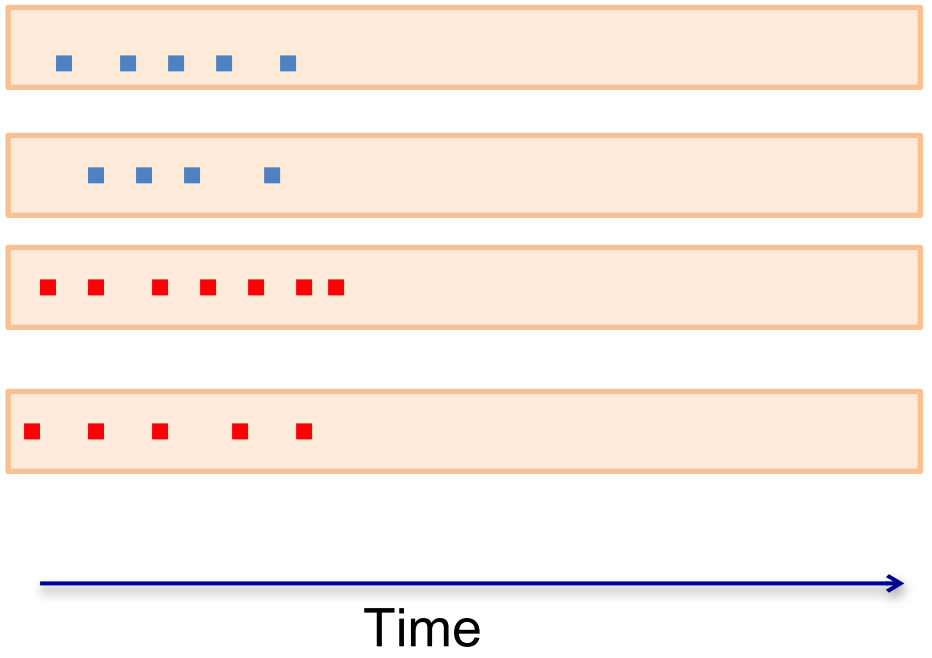
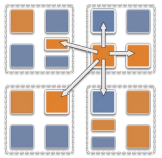
Without message-driven execution (and virtualization), you get either:

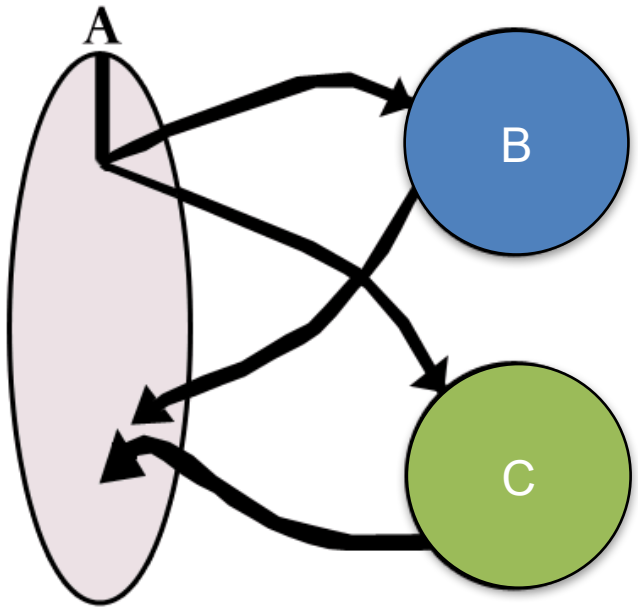
Space-division

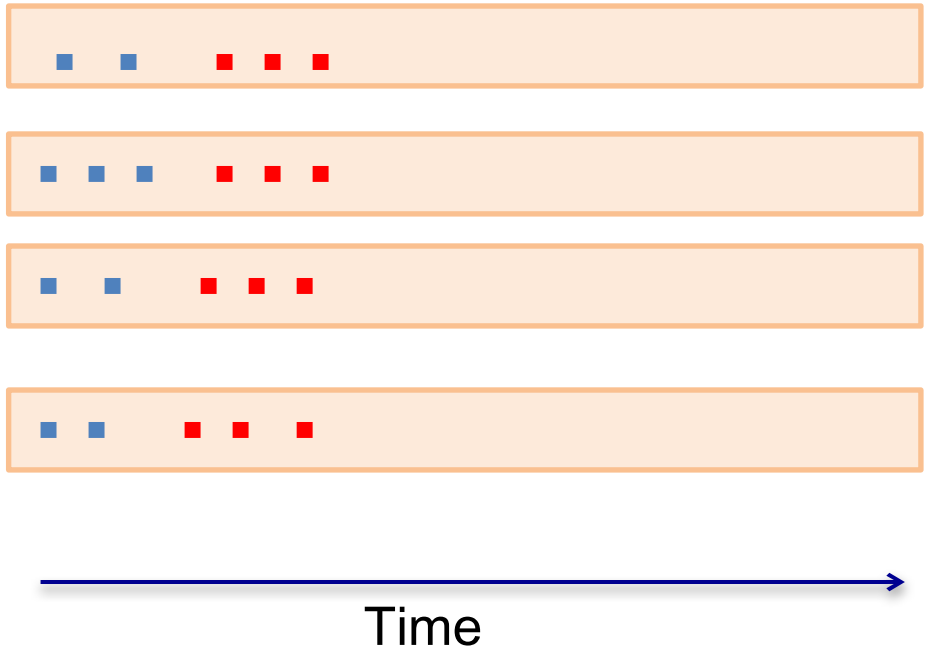


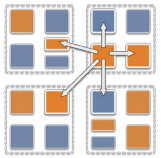




OR: Sequentialization







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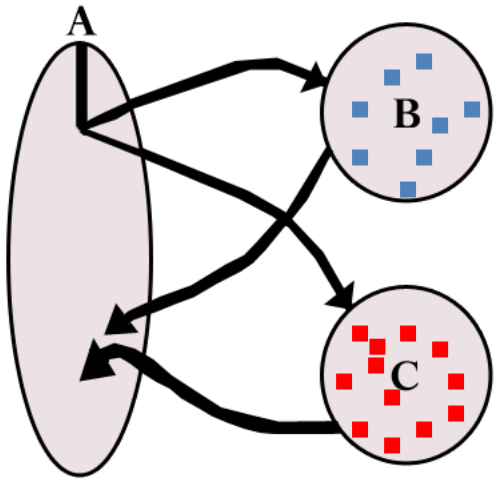
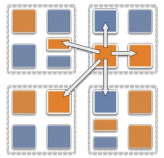
Parallel Composition: A1; (B || C); A2



Recall: different modules, written in different languages/paradigms, can overlap in time and on processors, without programmer having to worry about this explicitly



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