SACRED-MA: Safe And seCure REmote Direct Memory Access

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SACRED-MA: General Info

- Funded by EPSRC under the auspices of VeTSS

- Investigators: Brijesh Dongol, Surrey (PI), Azalea Raad, Imperial (PI), Gregory Chockler, Surrey (Co-I)

- Post-docs: Guillaume Ambal (Imperial), Milad Ketabi (Surrey)

- Partners: NVIDIA, Tel-Aviv University, University of Colorado Boulder, Cornell, MPI
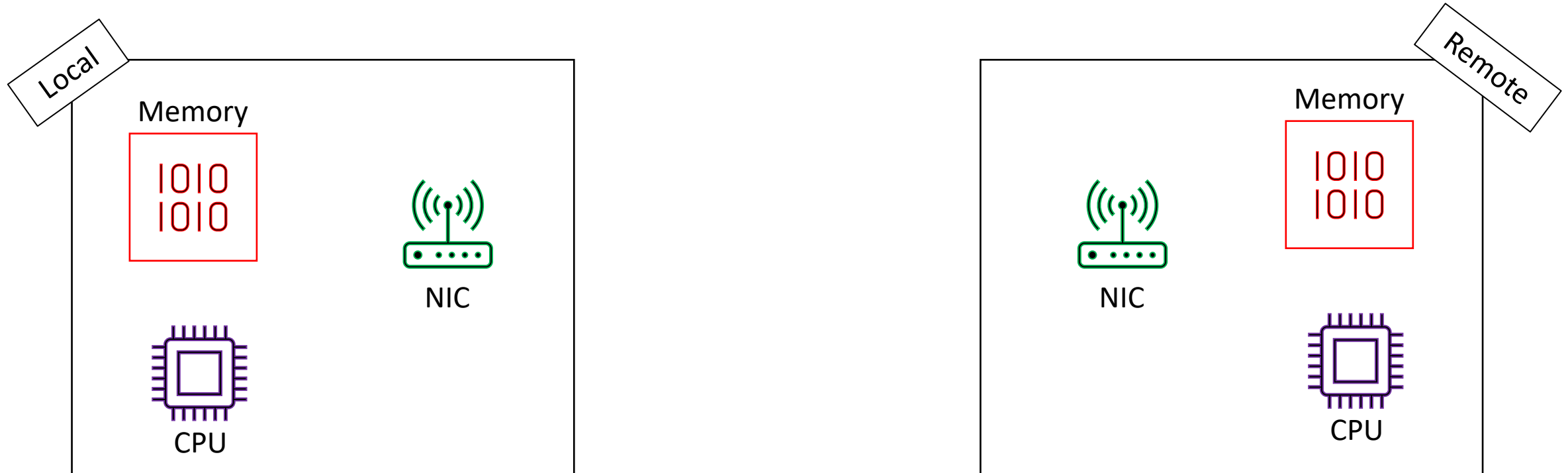
RDMA (Remote Direct Memory Access)

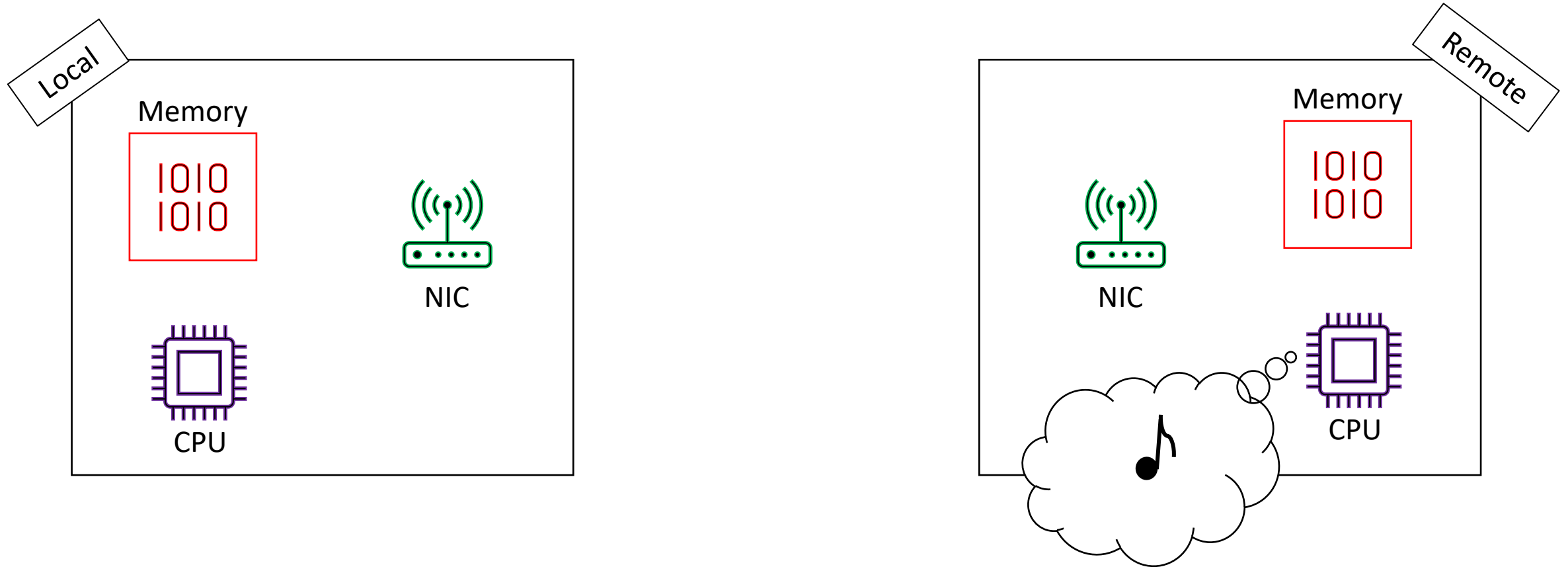- A new, fast, network protocol, off-loaded to the network card...

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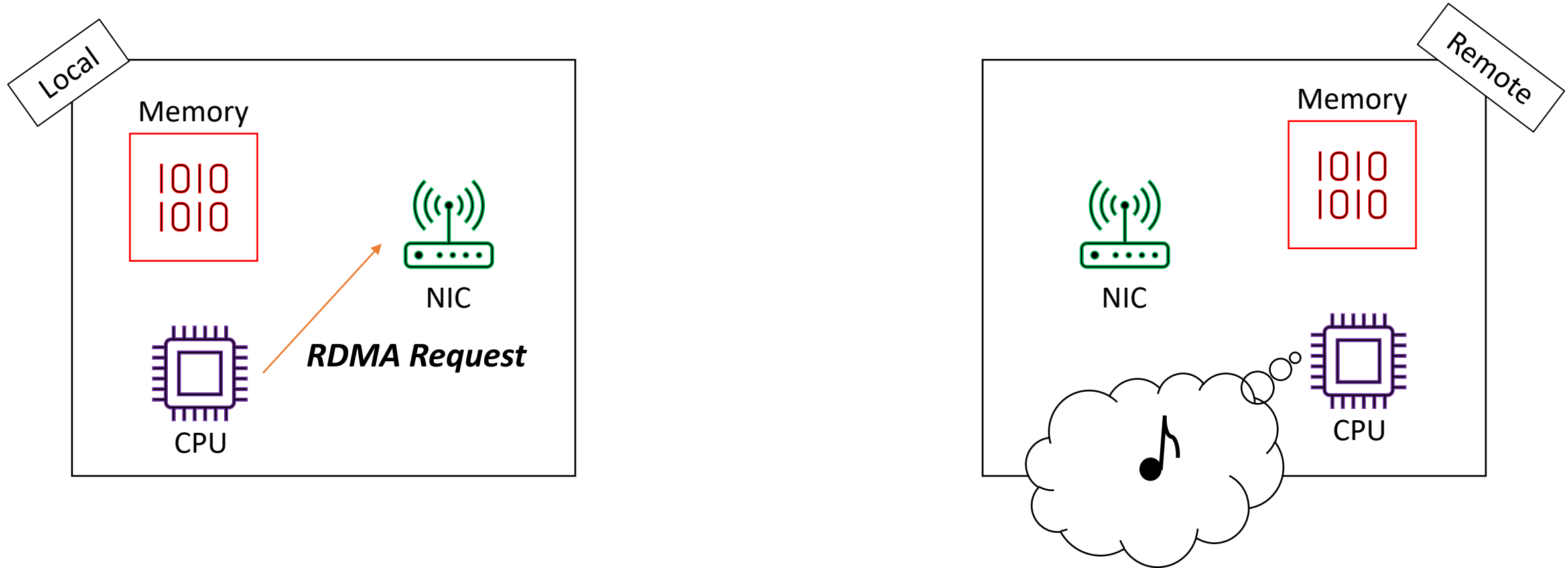
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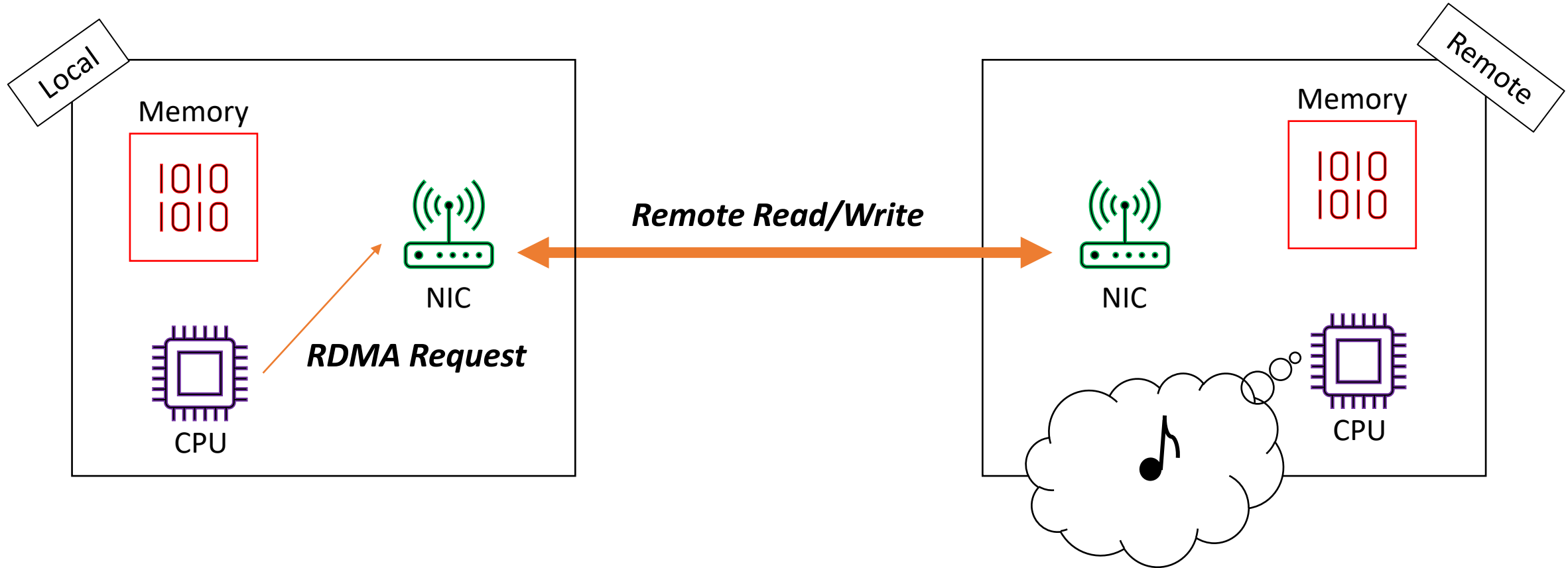
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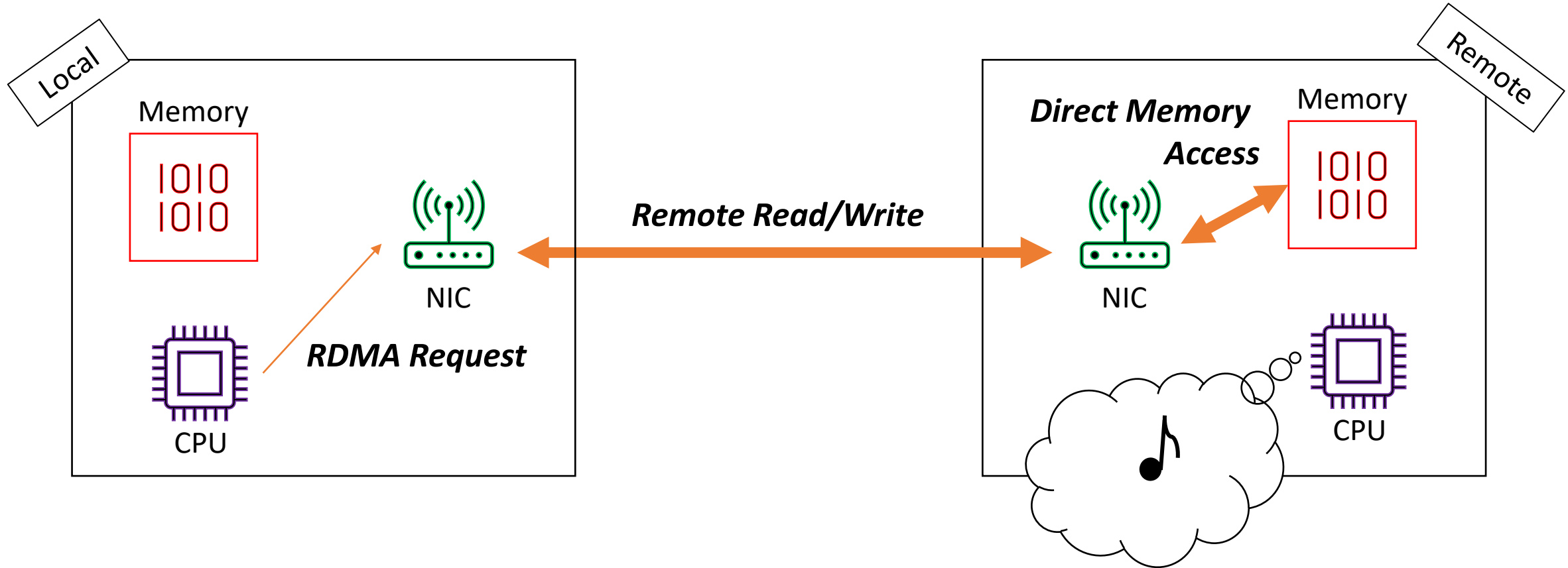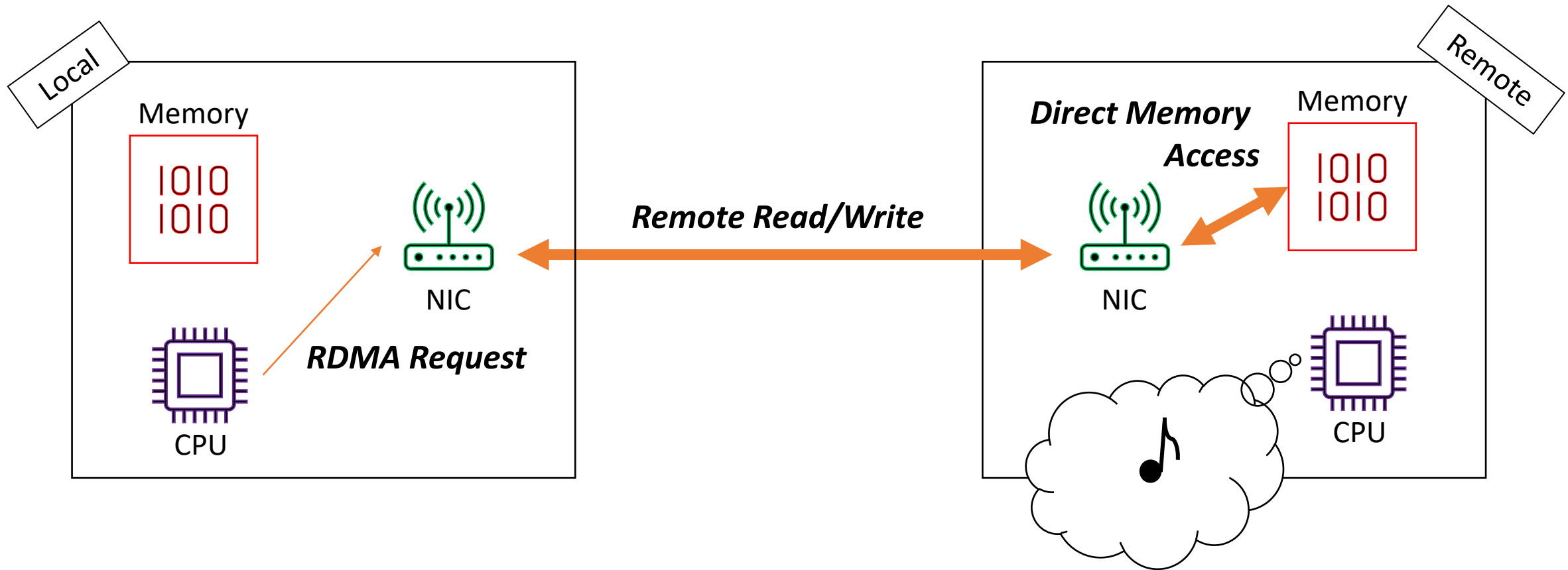
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RDMA is fast, but the interface and properties are different ... how can we leverage for distributed computing?

RDMA for Distributed Computing

- **Low latency** point-to-point communication
  - One-sided reads/writes: comparable to shared memory
- **FIFO** memory updates
  - Acknowledging message receipt acknowledges all priors
- Efficient **catch-up** for slow replicas
  - Only need to acknowledge recent messages as they implicitly acknowledge all priors
- **Completion** mechanism to avoid explicit acknowledgments
- **Permissions** to prevent nodes from accessing unauthorized regions

Gaps

- Most current work is focused on systems engineering and performance improvements

- Correctness/security issues are often neglected/overlooked

- Existing specifications are ambiguous or incomplete

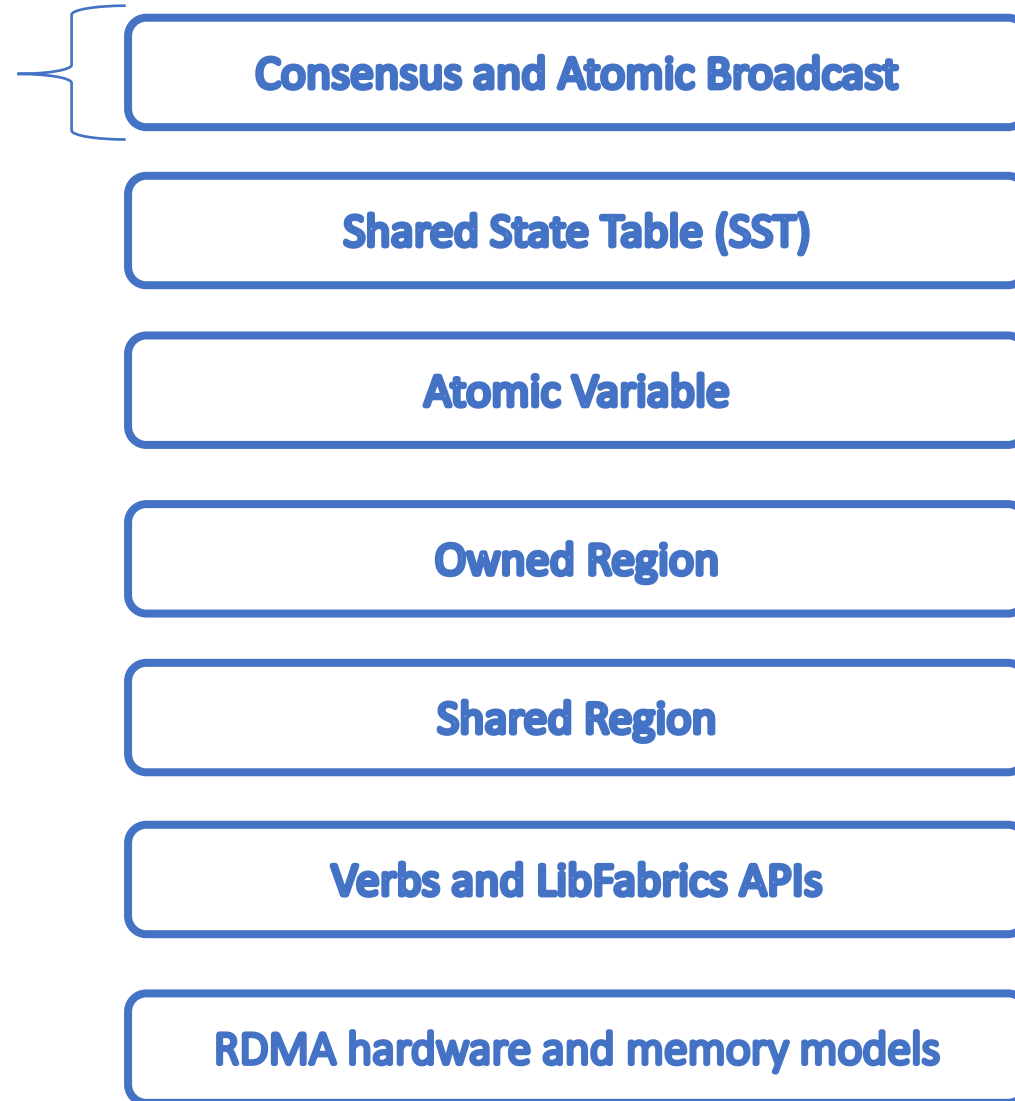- Semantics of interaction with local memory models is not well understood

SACRED-MA: Safe And seCure REmote Direct Memory Access

- Develop robust RDMA models suitable for formal correctness reasoning and verification of distributed protocols
- Full formally verified RDMA stack
  - From formal hardware models
  - To high-level abstractions useful for safe and secure distributed computing

Formally verified RDMA stack

Izraelevitz, Wang, Hanscom, Silvers, Lehman, Chockler, Gotsman, **Acuerdo: Fast Atomic Broadcast over RDMA**, ICPP'22

Consensus and Atomic Broadcast

Shared State Table (SST)

Atomic Variable

Owned Region

Shared Region

Verbs and LibFabrics APIs

RDMA hardware and memory models

Reusable compositional libraries of safe and secure abstractions

Hodgkins & Izraelevitz, **LOCO: Rethinking Protocols as Objects in Network Memory**

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Current Status

Consensus and Atomic Broadcast

Shared State Table (SST)

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Verbs and LibFabrics APIs

In-progress

RDMA hardware and memory models

Completed