**Motivation**
- HPC applications constrained by computational resources
- Host network bandwidth scales poorly with respect to processor, bus and link bandwidths
- As network speeds increase, incoming network data may overwhelm host processor
- Applications may starve under high network loads
- Host overhead due to communication processing degrades application performance

**Goal**
- Study NIC/OS interaction
- OS bypass
- Cache Injection
- Matching on the NIC
- Protocol Offloading
- Interrupt direction and filtering
- Develop and evaluate next-generation Smart Network Interface Controllers

**Network Infrastructure**
- Build an infrastructure to:
  - Study NIC/OS interaction
  - OS bypass
  - Cache Injection
  - Matching on the NIC
  - Protocol Offloading
  - Interrupt direction and filtering
  - Develop and evaluate next-generation Smart Network Interface Controllers

**The Shim Layer**
- Allows module header space to be independent of internal Mambo headers
- Provides a Mambo-independent interface to library modules
- Export functions, not data structures
- Data Structures encapsulated by Shim Handle
- Handle is opaque to Libraries
- Pluggable Modules
- Dynamically loaded using dlopen
- Mambo entry points explicitly defined by the Shim Interface

**NIC API / Shim Interface**
- **mem_write**
- **mem_read**
- **memmap_define**
- **memmap_delete**
- **set_memmap_io_funcs**
- **schedule_job**
- **delay_cycles**
- **raise_interrupt**

**Fast UDP**
- Splinter data from control information
- Application’s data bypasses the Kernel
- Make data available to applications fast
- Reduce host overhead due to communication
- NIC has enough information to perform data placement directly
- NIC Offload
- Splinter, Message Matching, Data Placement, UDP/IP checksum semantics

**Results**
- Developed an infrastructure to investigate communication mechanisms that:
  - Improve host scalability
  - Reduce host overhead
  - Improve overall application performance
- Proof of concept: Fast UDP
  - 5% improvement on an 80% computation-bound application
- Extend Shim Interface to allow cache injection
  - Simulated NIC injects data directly into an L2/L3 data cache
  - Investigate the scenarios when this optimization provides positive and negative impact on applications