**Research Challenges**

Creating an MPI programming infrastructure that can integrate performance analysis capabilities more directly, through the MPI Tools Information Interface, and deliver greater optimization opportunities for scientific applications.

- Can the existing support for MPI_T PVARs/CVARs in MVAPICH2 be extended and enhanced?
- How can TAU be redesigned to take advantage of the MPI_T variables exposed by MVAPICH2?
- Can TAU and MVAPICH2 be enhanced with the ability to generate recommendations and engineering performance report?
- What are the fundamental design changes required to make MPI libraries like MVAPICH2 “reconfigurable” at runtime?
- What support needs to be added to MVAPICH2 and TAU to support interactive performance engineering sessions?

**Proposed Approach**

- Enhance existing support for MPI_T in MVAPICH2 to expose a richer set of performance and control variables
- Get and display MPI Performance Variables (PVARs) made available by the runtime in TAU
- Control the runtime’s behavior via MPI Control Variables (CVARs)

**Enhancing MPI_T Support in MVAPICH2 and Utilizing Enhanced MVAPICH2-based MPI_T Support in TAU**

- Several new MPI_T based PVARs/CVARs added to MVAPICH2
  - `mv2_vbuf_max_use`, `mv2_total_vbuf_memory` etc
- Enhanced TAU with support for tracking of MPI_T PVARs and CVARs for uninstrumented applications
  - ParaProf, TAU’s visualization front end, enhanced with support for displaying PVARs and CVARs

**List of Pvars exposed by MVAPICH2 as displayed by ParaProf**

- Introduced support for new MPI_T based CVARs to MVAPICH2
  - `MPIR_CVAR_MAX_INLINE_MSG_SZ`
    - Controls the message size up to which “inline” transmission of data is supported by MVAPICH2
  - `MPIR_CVAR_VBUF_POOL_SIZE`
    - Controls the number of internal communication buffers (VBUFs) in MVAPICH2 allocates initially
  - `MPIR_CVAR_VBUF_SECONDARY_POOL_SIZE`
    - Controls the number of VBUFs MVAPICH2 allocates when there are no more free VBUFs available
- TAU enhanced with support for setting MPI_T CVARs in a non-interactive mode for uninstrumented applications
- To set CVARs or read PVARs using TAU for an uninstrumented binary:
  - `% export TAU_MPI_T_CVAR_METRICS=MPIR_CVAR_VBUF_POOL_SIZE`
  - `% export TAU_MPI_T_CVAR_VALUES=16`
  - `% export PATH=/path/to/tau/x86_64/bin:$PATH`
  - `% mpirun -np 1024 ./a.out`

**List of CVars exposed by MVAPICH2 as displayed by ParaProf**

**Future Work & Research Dissemination**

- Further enhancing the MPI_T support in MVAPICH2 and co-designing TAU to take advantage it
- Study and understand benefits of properly utilizing various CVARs exposed by MVAPICH2 at application level on large supercomputing systems
- Co-design MVAPICH2 and TAU with enhanced understanding of the impact of CVARs to generate performance engineering reports and recommendations
- Study challenges in providing an interactive performance engineering functionality for end users
- Release MVAPICH2 and TAU with enhanced support

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