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NATIONAL LABORATORY

Hands-on Session

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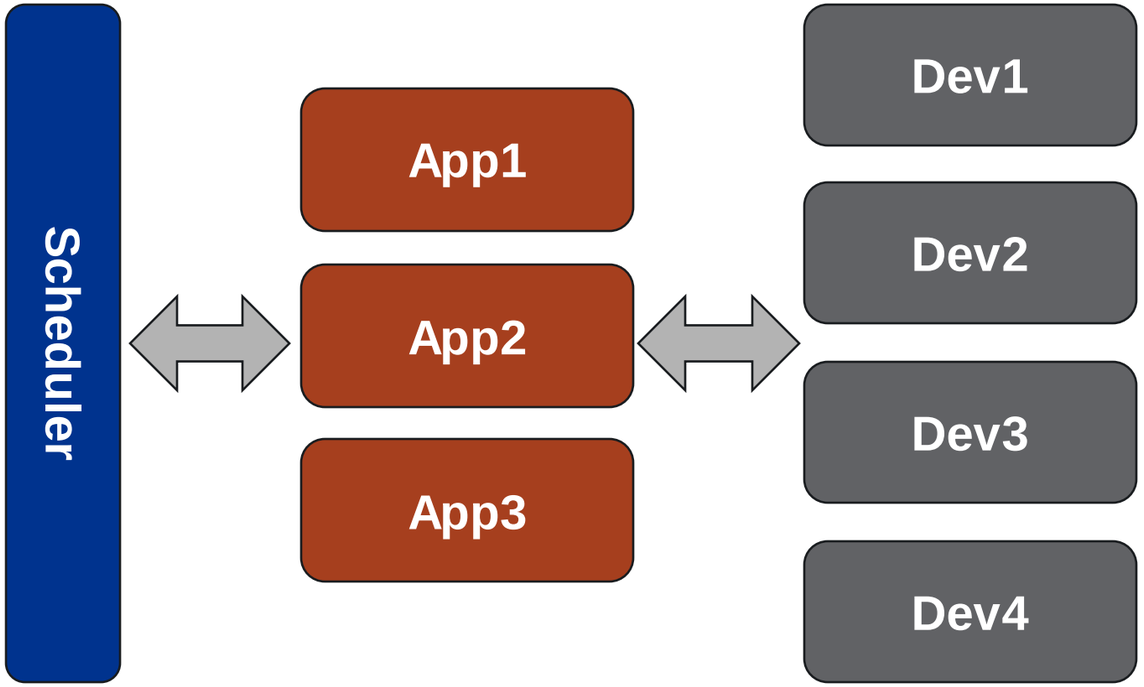
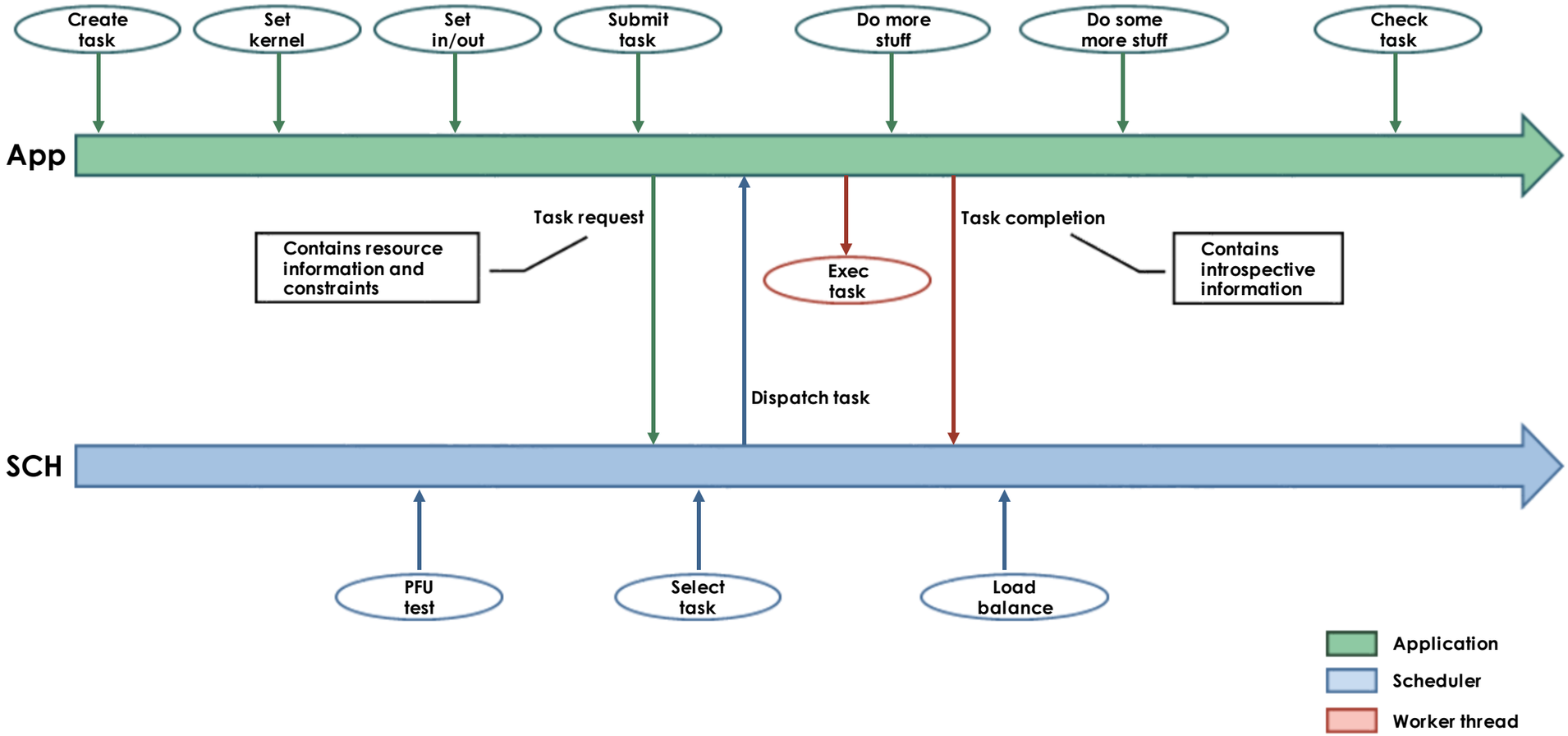
MCL Environment

- 1 system-level scheduler
- 1+ MCL applications
  - Applications interact directly with hardware devices
  - No additional data copy between applications and scheduler
- 1+ (heterogeneous) devices
  - CPU cores can also be used as devices



Simple Execution Trace



MCL Scheduler

- Manage hardware resources
- Perform load balancing
- Track memory objects allocated on devices
- Implement scheduling framework:
  - Multiple scheduling algorithms
    Additional schedulers can be added (MCL Scheduler ABI)
- Generally runs in background
- Trace resource utilization

Scheduler	Objective
First Fit (ff)	Power efficiency
Round-robin (rr)	Load balancing
Delay	Locality
Hybrid	Load Balancing + Locality

Current Scheduling Algorithms

```
Usage: ./src/sched/mcl_sched [options]
        -s, --sched-class {fifo|fffs}  Select scheduler class (def = 'fifo')
        -p, --res-policy {ff|rr|delay|hybrid}  Select resource policy (def = class dependent)
        -h, --help                     Show this help
```

Anatomy of an MCL application 1/4

```
#include <minos.h>
int main(int argc, char** argv){
        mcl_handle**    hdl = NULL;
        uint64_t        pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t    msize   = N * N * sizeof(double);

        mcl_init(workers,0x0);
        A = (double*) malloc(size * size * sizeof(double));
        B = (double*) malloc(size * size * sizeof(double));
        C = (double*) malloc(size * size * sizeof(double));
        hdl = (mcl_handle**) malloc(sizeof(mcl_handle*) * rep);

        for(int i=0; i<rep; i++){
                hdl[i] = mcl_task_create();
                mcl_task_set_kernel(hdl[i], "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
                mcl_task_set_arg(hdl[i], 0, (void*) A, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
        mcl_task_set_arg(hdl[i], 1, (void*) B, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 2, (void*) &n, sizeof(int), MCL_ARG_INPUT|MCL_ARG_SCALAR);
        mcl_task_set_arg(hdl[i], 3, (void*) C, msize,    MCL_ARG_OUTPUT|MCL_ARG_BUFFER);
                mcl_exec(hdl[i], pes, NULL, MCL_TASK_GPU);
        }
        mcl_wait_all();

        for(i=0; i<rep; i++)
                mcl_hdl_free(hdl[i]);
        free(hdl);
        mcl_finit();
        return 0;
}
```

MCL API header file

Init function:

- Define # MCL worker threads
- Register app w/ scheduler
- Device discovery

Finit function:

- Check pending tasks
- De-register app w/ scheduler

Anatomy of an MCL application 2/4

```
#include <minos.h>
int main(int argc, char** argv){
        mcl_handle**    hdl = NULL;
        uint64_t        pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t    msize   = N * N * sizeof(double);

        mcl_init(workers,0x0);
        A = (double*) malloc(size * size * sizeof(double));
        B = (double*) malloc(size * size * sizeof(double));
        C = (double*) malloc(size * size * sizeof(double));
        hdl = (mcl_handle**) malloc(sizeof(mcl_handle*) * rep);

        for(int i=0; i<rep; i++){
                hdl[i] = mcl_task_create();
                mcl_task_set_kernel(hdl[i], "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
                mcl_task_set_arg(hdl[i], 0, (void*) A, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
mcl_task_set_arg(hdl[i], 1, (void*) B, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 2, (void*) &n, sizeof(int), MCL_ARG_INPUT|MCL_ARG_SCALAR);
mcl_task_set_arg(hdl[i], 3, (void*) C, msize,    MCL_ARG_OUTPUT|MCL_ARG_BUFFER);
                mcl_exec(hdl[i], pes, NULL, MCL_TASK_GPU);
        }
        mcl_wait_all();

        for(i=0; i<rep; i++)
                mcl_hdl_free(hdl[i]);
        free(hdl);
        mcl_finit();
        return 0;
}
```

Task handle
- Track status
- Report errors
- Provide stats

Create task
- Allocate task resources

Remove task handle

Anatomy of an MCL application 3/4

```
#include <minos.h>
int main(int argc, char** argv){
        mcl_handle**    hdl = NULL;
        uint64_t        pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t    msize   = N * N * sizeof(double);

        mcl_init(workers,0x0);
        A = (double*) malloc(size * size * sizeof(double));
        B = (double*) malloc(size * size * sizeof(double));
        C = (double*) malloc(size * size * sizeof(double));
        hdl = (mcl_handle**) malloc(sizeof(mcl_handle*) * rep);

        for(int i=0; i<rep; i++){
                hdl[i] = mcl_task_create();
                mcl_task_set_kernel(hdl[i], "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
                mcl_task_set_arg(hdl[i], 0, (void*) A, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
        mcl_task_set_arg(hdl[i], 1, (void*) B, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 2, (void*) &n, sizeof(int), MCL_ARG_INPUT|MCL_ARG_SCALAR);
        mcl_task_set_arg(hdl[i], 3, (void*) C, msize,    MCL_ARG_OUTPUT|MCL_ARG_BUFFER);
                mcl_exec(hdl[i], pes, NULL, MCL_TASK_GPU);
        }
        mcl_wait_all();

        for(i=0; i<rep; i++)
                mcl_hdl_free(hdl[i]);
        free(hdl);
        mcl_finit();
        return 0;
}
```

Select kernel:

- Source file
- Kernel name
- # args
- Compiler flags

Set kernel argument

- Arg ID
- Host address
- Size
- Input/output + scalar/buffer

Anatomy of an MCL application 4/4

```
#include <minos.h>
int main(int argc, char** argv){
        mcl_handle**    hdl = NULL;
        uint64_t        pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t    msize   = N * N * sizeof(double);

        mcl_init(workers,0x0);
        A = (double*) malloc(size * size * sizeof(double));
        B = (double*) malloc(size * size * sizeof(double));
        C = (double*) malloc(size * size * sizeof(double));
        hdl = (mcl_handle**) malloc(sizeof(mcl_handle*) * rep);

        for(int i=0; i<rep; i++){
                hdl[i] = mcl_task_create();
                mcl_task_set_kernel(hdl[i], "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
                mcl_task_set_arg(hdl[i], 0, (void*) A, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
        mcl_task_set_arg(hdl[i], 1, (void*) B, msize,    MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 2, (void*) &n, sizeof(int), MCL_ARG_INPUT|MCL_ARG_SCALAR);
        mcl_task_set_arg(hdl[i], 3, (void*) C, msize,    MCL_ARG_OUTPUT|MCL_ARG_BUFFER);
                mcl_exec(hdl[i], pes, NULL, MCL_TASK_GPU);
        }
        mcl_wait_all();

        for(i=0; i<rep; i++)
                mcl_hdl_free(hdl[i]);
        free(hdl);
        mcl_finit();
        return 0;
}
```

Queue a task:

- # PEs (global, local)
- Device class or ANY
- Return immediately

Wait for completion

- Block until all tasks are completed

Computational Kernel

- OpenCL source code
  - Same code, many devices
- SPIRV binary IR
  - Same IR, many devices
- Binary (FPGA, NVDLA)
  - Device specific

```
#ifdef DOUBLE_PRECISION
#define FPTYPE double
#else
#define FPTYPE float
#endif

__kernel void gemmN(        const __global FPTYPE* A,
                            const __global FPTYPE* B, int N,
                            __global FPTYPE* C)
{
        // Thread identifiers
        const int globalRow = get_global_id(0); // Row ID of C (0..N)
        const int globalCol = get_global_id(1); // Col ID of C (0..N)

        // Compute a single element (loop over K)
        FPTYPE acc = 0.0f;
        for (int k=0; k<N; k++) {
                acc += A[globalRow*N + k] * B[k*N + globalCol];
        }
        // Store the result
        C[globalRow*N + globalCol] = acc;
}
```

GemmN.cl

MCL “Hello World” 1/2

- Kernel NxN GEMM
- MCL workers: 1,8
- Testbed: NVIDIA DGX-1 V100
  - 8 V100 GPUs
- Device Class: GPU

```
int main(int argc, char** argv)
{
        double *A, *B, *C;
        int i, j, ret = -1;

        mcl_banner("GEMM N Test");
        parse_global_opts(argc, argv);
        mcl_init(1,0x0);

        A = (double*) malloc(size * size * sizeof(double));
        B = (double*) malloc(size * size * sizeof(double));
        C = (double*) malloc(size * size * sizeof(double));
        if(!A || !B || !C){
                printf("Error allocating vectors. Aborting.");
                goto err;
        }

        srand48(13579862);
        for(i=0; i<size; ++i){
                for(j=0; j<size; ++j){
                        A[i*size+j] = (double)(0.5 + drand48()*1.5);
                }
        }

        for(i=0; i<size; ++i){
                for(j=0; j<size; ++j){
                        B[i*size+j] = (double)(0.5 + drand48()*1.5);
                }
        }

        ret = test_mcl(A,B,C,size);

        mcl_finit();

        free(A);
        free(B);
        free(C);
err:
        return ret;
}
```

MCL “Hello World” 2/2

```
int test_mcl(double* A, double* B, double* C, size_t N)
{
        struct timespec start, end;
        mcl_handle* hdl = NULL;
        uint64_t pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t msize = N * N * sizeof(double);
        uint64_t i;
        unsigned int errs = 0;
        float rtime;
        int ret;

        printf("MCL Test...");
        clock_gettime(CLOCK_MONOTONIC,&start);

        hdl = mcl_task_create();
        mcl_task_set_kernel(hdl, "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
        mcl_task_set_arg(hdl, 0, (void*) A, msize, MCL_ARG_INPUT|MCL_ARG_BUFFER);
        mcl_task_set_arg(hdl, 1, (void*) B, msize, MCL_ARG_INPUT|MCL_ARG_BUFFER);
        mcl_task_set_arg(hdl, 3, (void*) C, msize, MCL_ARG_OUTPUT|MCL_ARG_BUFFER);
        ret = mcl_exec(hdl, pes, NULL, MCL_TASK_GPU));
        mcl_wait(hdl);
        clock_gettime(CLOCK_MONOTONIC, &end);

        if(hdl->ret == MCL_RET_ERROR){
                printf("Error executing task %"PRIu64"!\n", i);
                errs++;
        }
        if(errs)
                printf("Detected %u errors!\n",errs);
        else{
                rtime = ((float)tdiff(end,start))/BILLION;
                printf("Done.\n Test time : %f seconds\n", rtime);
                printf(" Throughput: %f tasks/s\n", ((float)rep)/rtime);
        }
        mcl_hdl_free(hdl);
        return errs;
}
```

- Execute on a GPU class device
- Could use MCL_TASK_ANY to execute on any device class
- Use either MCL_TASK_ANY (or MCL_TASK_CPU) if running in the tutorial container

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Running MCL "Hello World!"

- Compile application:
  - `gcc -Wall -O2 -I$HOME/include -I. -o example1 example1.c utils.c -L$HOME/lib -lmcl -lOpenCL -lm -lrt`
- Launching the scheduler
  - `mcl_sched -p rr &`
- Run application
  - `./example1`

```
==========================================
    Minos Computing Library
    GEMM N Test
==========================================
Version:    0.5
Start time: Fri Feb 26 00:42:07 2021
------------------------------------------
Parsed options:
            Number of workers      = 1
            Type of test           = Async
            Matrix size            = 64
            Number of repetitions  = 1
            Type of PEs            = 1
            Verify test            = No
MCL Test...Done.
  Test time : 0.007895 seconds
  Throughput: 126.655640 tasks/s
```

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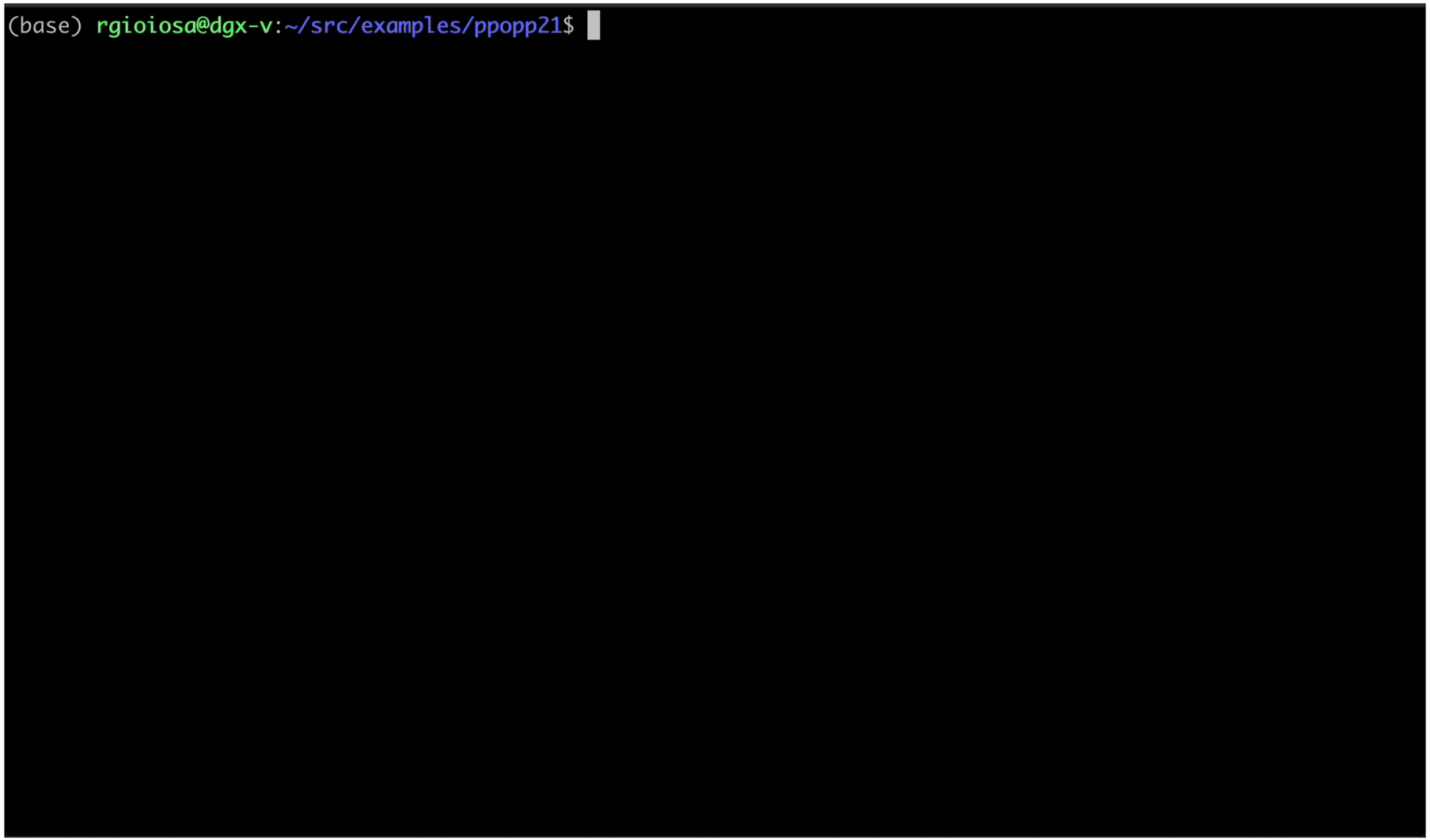
MCL Demo



MCL Improved “Hello World”

```
int test_mcl(double* A, double* B, double* C, size_t N)
{
        struct timespec start, end;
        mcl_handle** hdl = NULL;
        uint64_t pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t msize = N * N * sizeof(double);
        uint64_t i;
        unsigned int errs = 0;
        float rtime;
        int ret;

        printf("MCL Test...");

        hdl = (mcl_handle**) malloc(sizeof(mcl_handle*) * rep);

        clock_gettime(CLOCK_MONOTONIC,&start);
        for(i=0; i<rep; i++){
                hdl[i] = mcl_task_create();
                mcl_task_set_kernel(hdl[i], "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
                mcl_task_set_arg(hdl[i], 0, (void*) A, msize, MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 1, (void*) B, msize, MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 2, (void*) &N, sizeof(int), MCL_ARG_INPUT|MCL_ARG_SCALAR);
                mcl_task_set_arg(hdl[i], 3, (void*) C, msize, MCL_ARG_OUTPUT|MCL_ARG_BUFFER);

                ret = mcl_exec(hdl[i], pes, NULL, MCL_TASK_GPU);

                mcl_wait(hdl[i]);
        }
        clock_gettime(CLOCK_MONOTONIC, &end);

        rtime = ((float)tdiff(end,start))/BILLION;
        printf("Done.\n Test time : %f seconds\n", rtime);
        printf(" Throughput: %f tasks/s\n", ((float)rep)/rtime);

        for(i=0; i<rep; i++)
                mcl_hdl_free(hdl[i]);
        free(hdl);

        return 0;
}
```

Execute multiple tasks across all GPUs

Synchronous execution

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Running MCL Improved "Hello World!"

- Compile application:
  - `gcc -Wall -O2 -I$HOME/include -I. -o example2 example2.c utils.c -L$HOME/lib -lmcl -lOpenCL -lm -lrt`
- Launching the scheduler
  - `mcl_sched -p rr &`
- Run application
  - `./example2 –r 1024`

```
==========================================
    Minos Computing Library
    GEMM N Test
==========================================
Version:    0.5
Start time: Fri Feb 26 00:42:22 2021
------------------------------------------
Parsed options:
            Number of workers     = 1
            Type of test          = Async
            Matrix size           = 64
            Number of repetitions = 1024
            Type of PEs           = 1
            Verify test           = No
MCL Test...Done.
  Test time : 0.354675 seconds
  Throughput: 2887.153076 tasks/s
```

MCL Asynchronous "Hello World"

```
int test_mcl(double* A, double* B, double* C, size_t N)
{
        struct timespec start, end;
        mcl_handle** hdl = NULL;
        uint64_t pes[MCL_DEV_DIMS] = {N, N, 1};
        const size_t msize = N * N * sizeof(double);
        uint64_t i;
        unsigned int errs = 0;
        float rtime;
        int ret;

        printf("MCL Test...");

        hdl = (mcl_handle**) malloc(sizeof(mcl_handle*) * rep);

        clock_gettime(CLOCK_MONOTONIC,&start);
        for(i=0; i<rep; i++){
                hdl[i] = mcl_task_create();
                mcl_task_set_kernel(hdl[i], "./gemmN.cl", "gemmN", 4, "-DDOUBLE_PRECISION", 0x0);
                mcl_task_set_arg(hdl[i], 0, (void*) A, msize, MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 1, (void*) B, msize, MCL_ARG_INPUT|MCL_ARG_BUFFER);
                mcl_task_set_arg(hdl[i], 2, (void*) &N, sizeof(int), MCL_ARG_INPUT|MCL_ARG_SCALAR);
                mcl_task_set_arg(hdl[i], 3, (void*) C, msize, MCL_ARG_OUTPUT|MCL_ARG_BUFFER);

                ret = mcl_exec(hdl[i], pes, NULL, MCL_TASK_GPU);
        }
        mcl_wait_all();

        clock_gettime(CLOCK_MONOTONIC, &end);

        rtime = ((float)tdiff(end,start))/BILLION;
        printf("Done.\n Test time : %f seconds\n", rtime);
        printf(" Throughput: %f tasks/s\n", ((float)rep)/rtime);

        for(i=0; i<rep; i++)
                mcl_hdl_free(hdl[i]);
        free(hdl);

        return 0;
}
```

mcl_init(8,0x0);

Execute multiple tasks across all GPUs

Multiple workers run/check tasks in parallel

Asynchronous execution

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Running MCL Asynchronous "Hello World!"

- Compile application:
  - `gcc -Wall -O2 -I$HOME/include -I. -o example3 example3.c utils.c -L$HOME/lib -lmcl -lOpenCL -lm -lrt`
- Launching the scheduler
  - `mcl_sched -p rr &`
- Run application
  - `./example3 –r 1024 –w 8`

```
==========================================
    Minos Computing Library
    GEMM N Test
==========================================
Version:    0.5
Start time: Fri Feb 26 01:13:51 2021
------------------------------------------
Parsed options:
            Number of workers     = 8
            Type of test          = Async
            Matrix size           = 64
            Number of repetitions = 1024
            Type of PEs           = 1
            Verify test           = No
MCL Test...Done.
  Test time : 0.038343 seconds
  Throughput: 26706.570312 tasks/s
```

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A test case: NWChem-Proxy

- CCSD(1) method from NWChem
  - Coupled cluster (CC) methods are commonly used in the post Hartree-Fock ab initio quantum chemistry and in nuclear physics computation.
  - The CC workflow is composed of iterative set of excitation (singles (S), doubles (D), triples (T), and quadruples (Q)) calculations
- Tensor Contractions are the main computational kernels:
  - Often reformulated as TTGT to take advantage of high-performance GEMM kernels
- Testbed:
  - NVIDIA DGX-1 V100
  - 2x Intel Xeon E5-2680, 768GB memory
  - 8x NVIDIA V100, 16GM memory, NVLink

```
#include <iostream>
#include "taco.h"
#include "utils.h"

using namespace taco;

int main(int argc, char* argv[]) {
  if (argc != 2){
    std::cout << "Please enter input problem size" << "\n";
    exit(1);
  }

  int idim = atoi(argv[1]);

  Format csr({Dense,Sparse});
  Format csf({Sparse,Sparse,Sparse});
  Format  sv({Sparse});

  Format dense2d({Dense,Dense});
  Format dense4d({Dense,Dense, Dense, Dense});

  Tensor<double> i0("i0", {idim,idim}, dense2d);
  Tensor<double> F("F", {idim, idim}, dense2d);
  Tensor<double> V("V", {idim, idim, idim, idim}, dense4d);
  Tensor<double> t1("t1", {idim,idim}, dense2d);
  Tensor<double> t2("t2", {idim, idim, idim, idim}, dense4d);

// Initialization...

  IndexVar i, m, n, a, e, f;

  std::cout << "Computation started" << "\n";
  i0(a, i) = F(a, i);                                                    //#1
  i0(a, i) +=  -2.0 * F(m, e) * t1(a, m) * t1(e, i) +  F(a, e) * t1(e, i);  //#2
  i0(a, i) +=  -2.0 * V(m, n, e, f) * t2(a, f, m, n) * t1(e, i);         //#3
  i0(a, i) +=  -2.0 * V(m, n, e, f) * t1(a, m) * t1(f, n) * t1(e, i);    //#4
  i0(a, i) +=   V(n, m, e, f) * t2(a, f, m, n) * t1(e, i);               //#5
  i0(a, i) +=   V(n, m, e, f) * t1(a, m) * t1(f, n) * t1(e, i);          //%6
  i0(a, i) +=  -1.0 * F(m, i) * t1(a, m);                                //#7
  i0(a, i) +=  -2.0 * V(m, n, e, f) * t2(e, f, i, n) * t1(a, m);         //#8
  i0(a, i) +=  -2.0 * V(m, n, e, f) * t1(e, i) * t1(f, n) * t1(a, m);    //#9
  i0(a, i) +=  V(m, n, f, e) * t2(e, f, i, n) * t1(a, m);                //#10
  i0(a, i) +=  V(m, n, f, e) * t1(e, i) * t1(f, n) * t1(a, m);           //#11
  i0(a, i) +=  2.0 * F(m, e) * t2(e, a, m, i);                           //#12
  i0(a, i) +=  -1.0 * F(m, e) * t2(e, a, i, m);                          //#13
  i0(a, i) +=  F(m, e) * t1(e, i) * t1(a, m);                            //#14
  i0(a, i) +=  4.0 * V(m, n, e, f) * t1(f, n) * t2(e, a, m, i);          //#15
  i0(a, i) +=  -2.0 * V(m, n, e, f) * t1(f, n) * t2(e, a, i, m);         //#16
  i0(a, i) +=  2.0 * V(m, n, e, f) * t1(f, n) * t1(e, i) * t1(a, m);     //#17
  i0(a, i) +=  -2.0 * V(m, n, f, e) * t1(f, n) * t2(e, a, m, i);         //#18
  i0(a, i) +=  V(m, n, f, e) * t1(f, n) * t2(e, a, i, m);                //#19
  i0(a, i) +=  -1.0 * V(m, n, f, e) * t1(f, n) * t1(e, i) * t1(a, m);    //#20
  i0(a, i) +=  2.0 * V(m, a, e, i) * t1(e, m);                           //#21
  i0(a, i) +=  -1.0 * V(m, a, i, e) * t1(e, m);                          //#22
  i0(a, i) +=  2.0 * V(m, a, e, f) * t2(e, f, m, i);                     //#23
  i0(a, i) +=  2.0 * V(m, a, e, f) * t1(e, m) * t1(f, i);                //#24
  i0(a, i) +=  -1.0 * V(m, a, f, e) * t2(e, f, m, i);                    //#25
  i0(a, i) +=  -1.0 * V(m, a, f, e) * t1(e, m) * t1(f, i);               //#26
  i0(a, i) +=  -2.0 * V(m, n, e, i) * t2(e, a, m, n);                    //#27
  i0(a, i) +=  -2.0 * V(m, n, e, i) * t1(e, m) * t1(a, n);               //#28
  i0(a, i) +=  V(n, m, e, i) * t2(e, a, m, n);                           //#29
  i0(a, i) +=  V(n, m, e, i) * t1(e, m) * t1(a, n);                      //#30

  i0.compile();
  i0.assemble();
  i0.compute();
}
```

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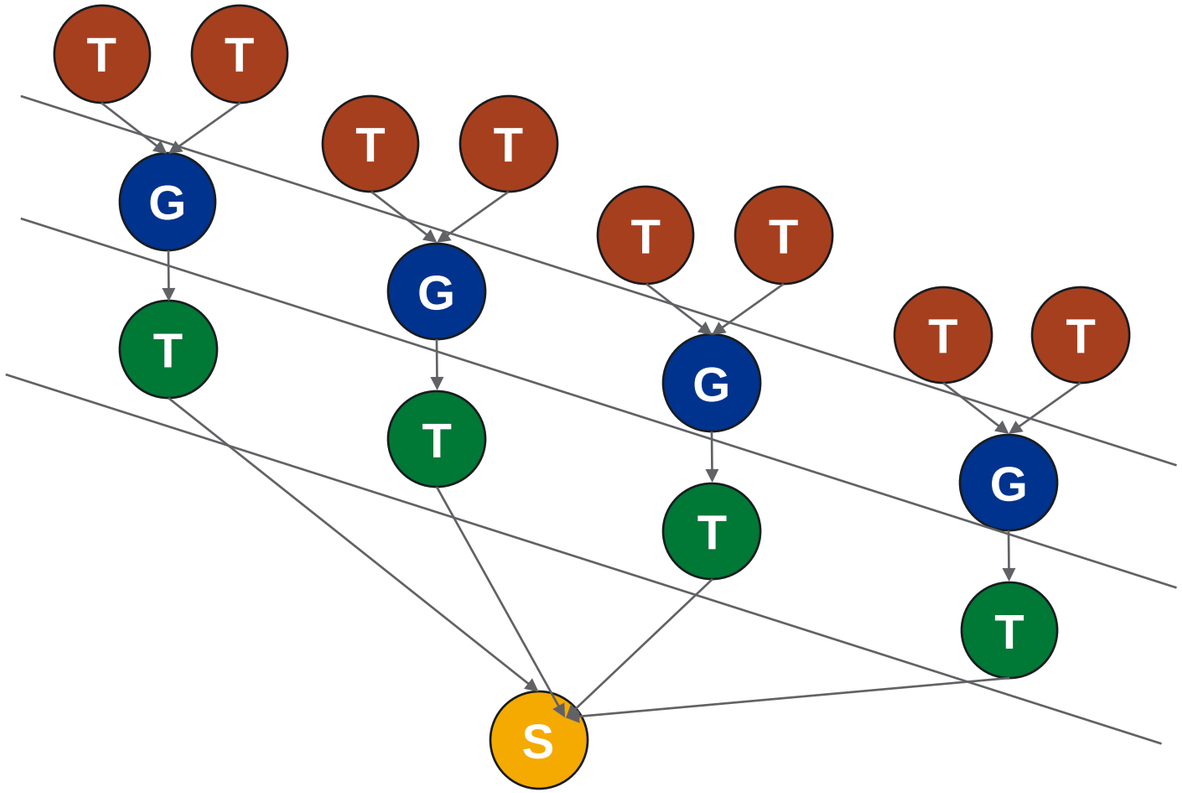
MCL Implementation of CCSD



- TC reformulated as TTGT
- There are ~30 contractions in CCSD(1)
- Can use wavefront algorithm
- Many tasks run in parallel on multiple GPUs

Task Dependencies

```
. . .
printf("-------------------------------------\n");
printf("\t Launching transposes...\n");

for(i=0; i<rep; i++){
                transpose(&(tc_hdl[i].hdl[0]), A, AT, size);
                transpose(&(tc_hdl[i].hdl[1]), B, BT, size);
}

for(i=0; i<rep; i++){
                mcl_wait(tc_hdl[i].hdl[0]);
                mcl_wait(tc_hdl[i].hdl[1]);
                gemm(&(tc_hdl[i].hdl[2]),CT, AT, BT, size);
}

for(i=0; i<rep; i++){
                mcl_wait(tc_hdl[i].hdl[2]);
                transpose(&(tc_hdl[i].hdl[3]), CT, C, size);
}

mcl_wait_all();
. . .
```

Start all transpose

For each TTGT, wait for transpose to complete, then start GEMM

For each TTGT, wait for GEMM to complete, then start transpose

Accumulate results

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CCSD(1) Demo

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Thank you