Exercici 4:

```
#include <mpi.h>
#include <stdio.h>

int main(argc,argv)
int argc;
char **argv;
{

        int MyProc, tag=1, nProcs, i;
        char msg='A', msg_recpt;
        MPI_Request request;
        MPI_Status status;

        MPI_Init(&argc, &argv);
        MPI_Comm_rank(MPI_COMM_WORLD, &MyProc);

        // Getting number of threads
        MPI_Comm_size(MPI_COMM_WORLD, &nProcs);

        // Sending a message to the rest of threads
        for (i=0; i<nProcs; i++) {

                // Excluding sending the message to itself
                if (MyProc != i) {
                        printf("Proc #%d sending message to Proc #%d\n", MyProc, i);
                        MPI_Isend(&msg, 1, MPI_CHAR, i, tag, MPI_COMM_WORLD, &request);
                }
        }

        // Receiving a message from the rest of threads
        for (i=0; i<nProcs; i++) {

                // Excluding receiving the message from itself
                if (MyProc != i) {
                        printf("Proc #%d received message from Proc #%d\n", MyProc, i);
                        MPI_Irecv(&msg_recpt, 1, MPI_CHAR, i, tag, MPI_COMM_WORLD, &request);
                }
        }

        //MPI_Barrier or waits can be considered
        MPI_Finalize();

        return 0;
}
```

Exercici 4 (alternativa):

```
#include "mpi.h"
#include <stdio.h>

int main(argc,argv)
int argc;
char **argv;
{

        int current, total, i, tag=1;
        char msg='A', msg_recpt;
        MPI_Status status;

        MPI_Init(&argc, &argv);
        MPI_Comm_size(MPI_COMM_WORLD, &total);
        MPI_Comm_rank(MPI_COMM_WORLD, &current);

        printf("Process # %d started \n", current);
        MPI_Barrier(MPI_COMM_WORLD);


        for(i = 0; i<total ; i++){
                if(i < current){
                        MPI_Recv(&msg_recpt, 1, MPI_CHAR, i, tag, MPI_COMM_WORLD, &status);
                        printf("Proc #%d received message from Proc #%d\n", current, i) ;
                }
                if(i > current){
                        printf("Proc #%d sending message to Proc #%d\n", current, i) ;
                        MPI_Send(&msg, 1, MPI_CHAR, i, tag, MPI_COMM_WORLD);
                }
        }

        for(i = 0; i<total ; i++){
                if(i < current){
                        printf("Proc #%d sending message to Proc #%d\n", current, i) ;
                        MPI_Send(&msg, 1, MPI_CHAR, i, tag, MPI_COMM_WORLD);
                }
                if(i > current){
                        MPI_Recv(&msg_recpt, 1, MPI_CHAR, i, tag, MPI_COMM_WORLD, &status);
                        printf("Proc #%d received message from Proc #%d\n", current, i) ;
                }
        }



        printf("Finishing proc %d\n", current);

        MPI_Barrier(MPI_COMM_WORLD);
        MPI_Finalize();
}
```

Exercici 5:

```
#include "mpi.h"
#include <stdio.h>

int main(argc,argv)
int argc;
char **argv;
{

  int MyProc, tag=1, size;
  char msg='A', msg_recpt ;
  MPI_Status *status ;
  int left, right ;


  MPI_Init(&argc, &argv);
  MPI_Comm_rank(MPI_COMM_WORLD, &MyProc);
  MPI_Comm_size(MPI_COMM_WORLD, &size);


  left = (MyProc + size - 1) % size;
  right = (MyProc + 1) % size;

  if (MyProc == 0)
  {
    printf("Proc %d sending message to proc %d \n", MyProc, right);

    MPI_Send(&msg, 1, MPI_CHAR, right, 1, MPI_COMM_WORLD);
    MPI_Recv(&msg_recpt, 1, MPI_CHAR, left, 1, MPI_COMM_WORLD, status);
  }
  else
  {
    MPI_Recv(&msg_recpt, 1, MPI_CHAR, left, 1, MPI_COMM_WORLD, status);
    MPI_Send(&msg, 1, MPI_CHAR, right, 1, MPI_COMM_WORLD);
    printf("Proc %d : received message from proc %d and sending message to %d\n", MyProc, left, right);
  }

  MPI_Barrier(MPI_COMM_WORLD);
  MPI_Finalize();
}
```

Exercici 7a

```
#include<stdio.h>
#include<mpi.h>
#include<stdlib.h>
#include<time.h>

int main(int argc, char **argv){

  int i, sum=0, grand_sum=0, n=1000;
  MPI_Status status;

  MPI_Init(&argc, &argv);
  int world_size;
  MPI_Comm_size(MPI_COMM_WORLD , &world_size);
  int world_rank;
  MPI_Comm_rank(MPI_COMM_WORLD , &world_rank);

  srand(time(NULL)+world_rank);
  for(i=0; i<n; i++)
  {
   sum += rand() % 100;
  }

  if (world_rank == 0)
  {
    grand_sum += sum;
    for (i = 1; i < world_size; ++i)
    {
        MPI_Recv(&sum, 1, MPI_INT, i, 0, MPI_COMM_WORLD, &status);
        grand_sum += sum;
    }
    printf("%d", grand_sum);
  }
  else
  {
    MPI_Send(&sum, 1, MPI_INT, 0, 0, MPI_COMM_WORLD);
  }

  MPI_Finalize();
}
```

Exercici 7b

```
#include<stdio.h>
#include<mpi.h>
#include<stdlib.h>
#include<time.h>

int main(int argc, char **argv){

  int i, sum=0, n=1000, sender=0;
  int *rbuf;

  MPI_Init(&argc, &argv);
  int world_size;
  MPI_Comm_size(MPI_COMM_WORLD , &world_size);
  int world_rank;
  MPI_Comm_rank(MPI_COMM_WORLD , &world_rank);

  srand(time(NULL)+world_rank);
  if (world_rank == 0)
  {
    rbuf = (int *) malloc(world_size * 1 * sizeof(int));
  }
  for(i=0; i<n; i++)
  {
   sender += rand() % 100;
  }

  MPI_Gather(&sender , 1 , MPI_INT , rbuf , 1 , MPI_INT , 0 , MPI_COMM_WORLD);
  if (world_rank == 0)
  {
    for (i = 0; i < world_size; ++i)
    {
        sum += rbuf[i];
    }
    printf("%d", sum);
  }

  MPI_Finalize();
}
```

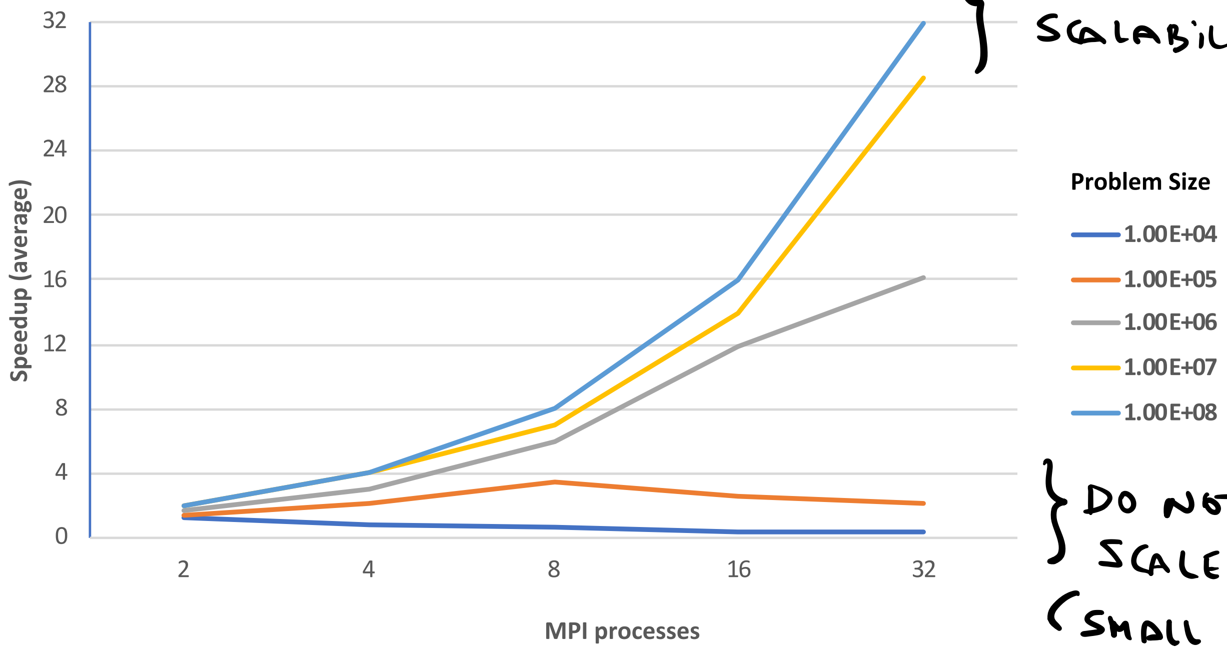
Exercici 7c

```
#include<stdio.h>
#include<mpi.h>
#include<stdlib.h>
#include<time.h>

int main(int argc, char **argv){

  int i, sum=0, grand_sum=0, n=1000;

  MPI_Init(&argc, &argv);
  int world_size;
  MPI_Comm_size(MPI_COMM_WORLD , &world_size);
  int world_rank;
  MPI_Comm_rank(MPI_COMM_WORLD , &world_rank);

  srand(time(NULL)+world_rank);
  for(i=0; i<n; i++)
  {
   sum += rand() % 100;
  }

  MPI_Reduce(&sum, &grand_sum, 1 , MPI_INT , MPI_SUM , 0 , MPI_COMM_WORLD);
  if (world_rank == 0)
  {
    printf("%d", grand_sum);
  }

  MPI_Finalize();
}
```

Exercici 8

```
#include <mpi.h>
#include <stdio.h>
#include <stdlib.h>

double f(double x)
{
        return(4.0/(1.0+x*x));
}

double fragment(double a, double b, double num_fragments, double h)
{
        double est, x;
        int i;

        est = (f(a) + f(b))/2.0;
        for (i=1; i<=num_fragments-1; i++){
                x = a + i*h;
                est += f(x);
        }
        est = est*h;
        return est;
}

int main(int argc, char **argv) {

        MPI_Init(&argc, &argv);
        int i, MyProc, size;
        double n=1000000000.0, a=0.0, b=1.0, h, result;

        MPI_Comm_rank(MPI_COMM_WORLD, &MyProc);
        MPI_Comm_size(MPI_COMM_WORLD,&size);

        h=(b-a)/n;

        /*Fragments per a un procés, simplificat*/
        double inter_for_proc = n/size;
        /*Intervals  per procés*/
        double a_for_proc = a + (MyProc * inter_for_proc * h);
        double b_for_proc = a_for_proc + (inter_for_proc * h);

        double r = fragment(a_for_proc, b_for_proc, inter_for_proc, h);

        MPI_Reduce(&r, &result, 1, MPI_DOUBLE, MPI_SUM, 0, MPI_COMM_WORLD);

        if (MyProc == 0) {
                printf("Resultat total: %.20ff\n", result);
        }

        MPI_Finalize();
}
```

Exercici 9



ALMOST LINEAR SCALABILITY

DO NOT SCALE (SMALL SIZE)

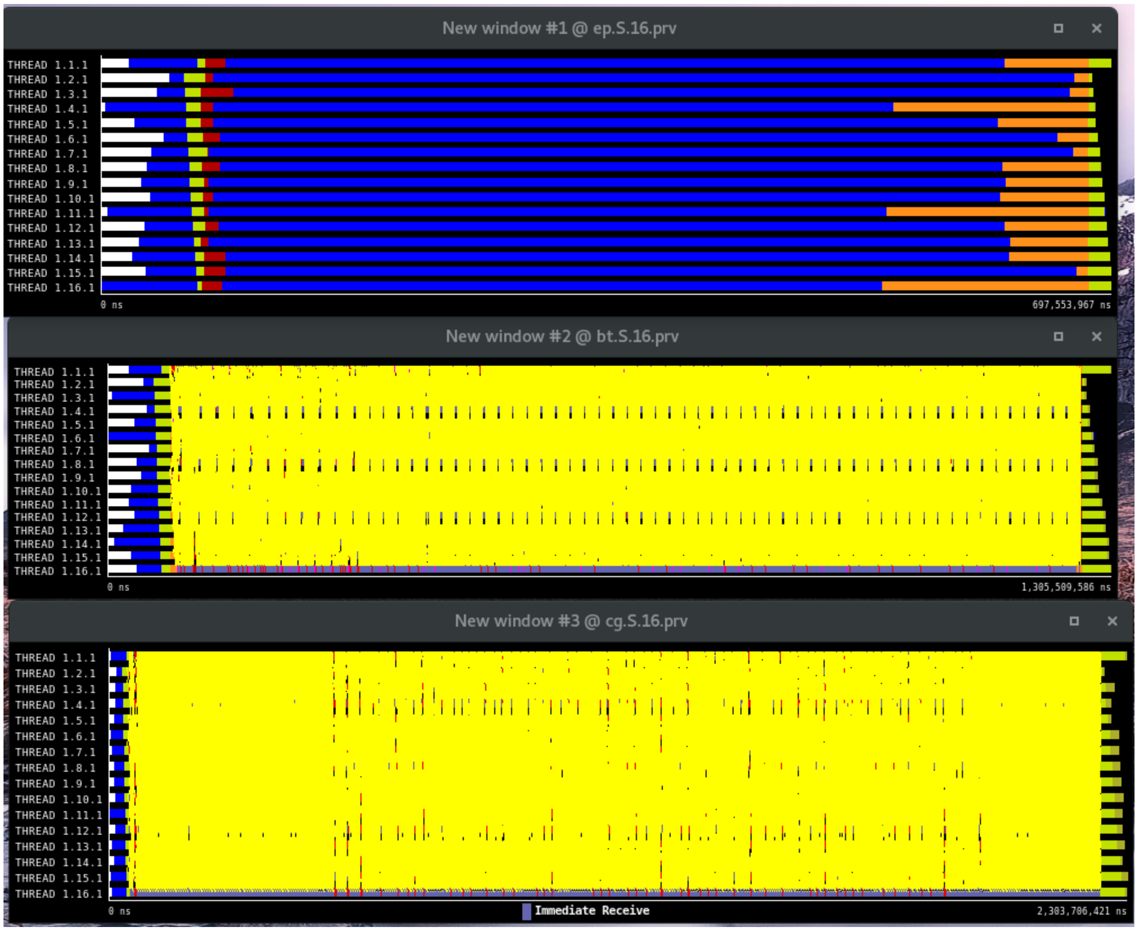
#NODES : 1 | 2 | 4 | 8

Al vídeo publicat es va fer una demostració de d'utilització de les eines i de les principals diferències entre les dues implementacions del solver amb MPI (una amb crides síncrones i una altra amb crides asíncrones) fent servir TAU/jumpshot.

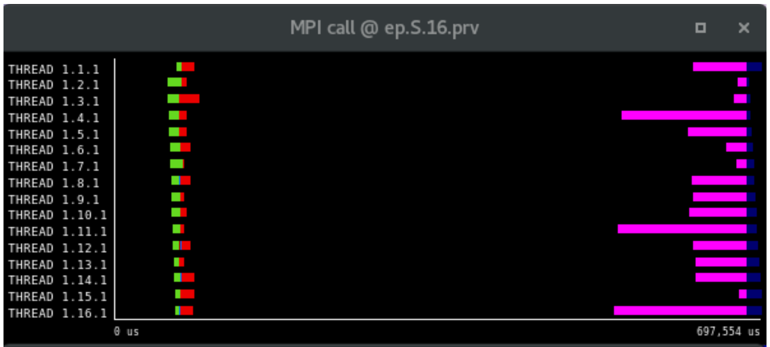
Exemple extrae/paraver

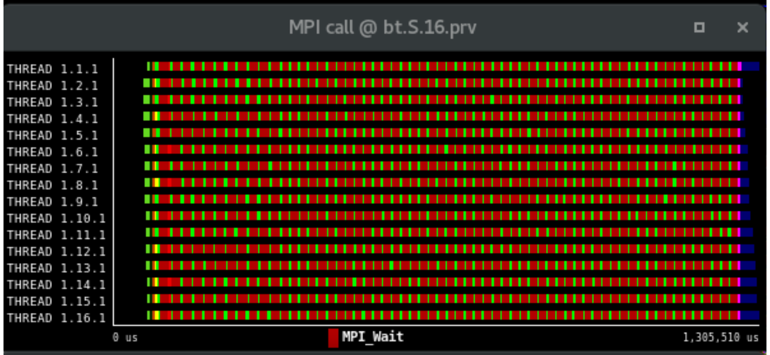
Hi ha diferències importants entre els tres benchmakrs seleccionats, especialment en el patró de pas de missatges. Alguns exemples es mostren a continuació.

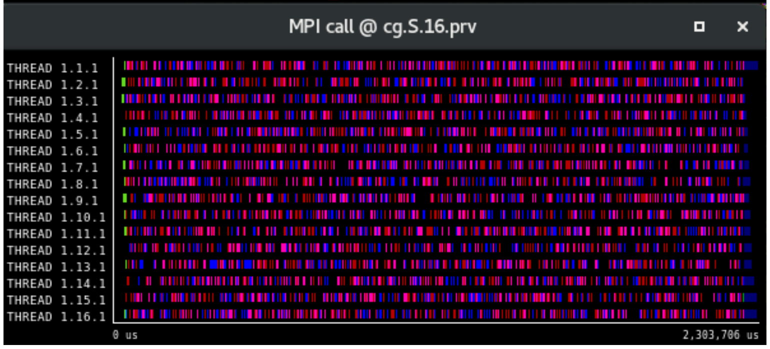
Vista general:



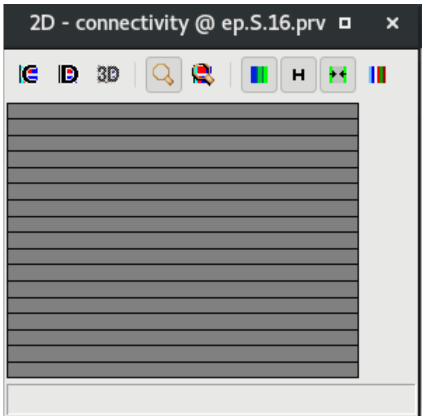
Crides MPI:

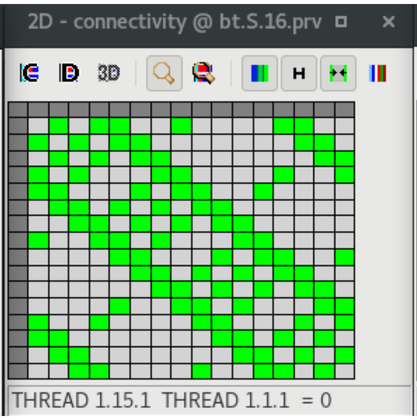


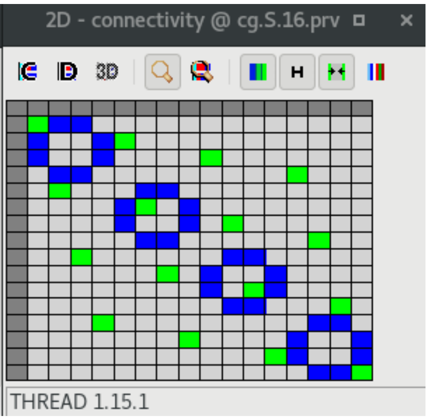




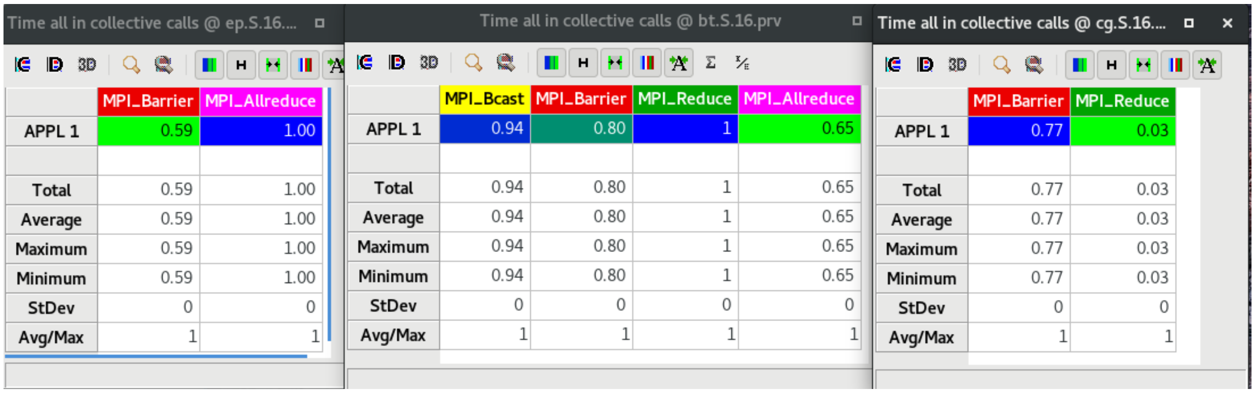
Patrons de pas de missatges, és interessant veure el pas de missatges entre nodes (més freqüent al BT) i dins d'un mateix node (al CG).




2D - connectivity @ bt.S.16.prv
3D
H
THREAD 1.15.1 THREAD 1.1.1 = 0



Crides col·lectives:



Time all in collective calls @ ep.S.16....

	MPI_Barrier	MPI_Allreduce
APPL 1	0.59	1.00
Total	0.59	1.00
Average	0.59	1.00
Maximum	0.59	1.00
Minimum	0.59	1.00
StDev	0	0
Avg/Max	1	1

Time all in collective calls @ bt.S.16.prv

	MPI_Bcast	MPI_Barrier	MPI_Reduce	MPI_Allreduce
APPL 1	0.94	0.80	1	0.65
Total	0.94	0.80	1	0.65
Average	0.94	0.80	1	0.65
Maximum	0.94	0.80	1	0.65
Minimum	0.94	0.80	1	0.65
StDev	0	0	0	0
Avg/Max	1	1	1	1

Time all in collective calls @ cg.S.16....

	MPI_Barrier	MPI_Reduce
APPL 1	0.77	0.03
Total	0.77	0.03
Average	0.77	0.03
Maximum	0.77	0.03
Minimum	0.77	0.03
StDev	0	0
Avg/Max	1	1