



OSCAR Automatic Parallelizing Compiler

Automatic Speedup and Power Reduction



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OSCAR Automatic Parallelizing Compiler

To improve **effective performance**, **cost-performance** and **software productivity** and **reduce power**

Multigrain Parallelization

coarse-grain parallelism among loops and subroutines, **near fine grain parallelism** among statements in addition to **loop parallelism**

Data Localization

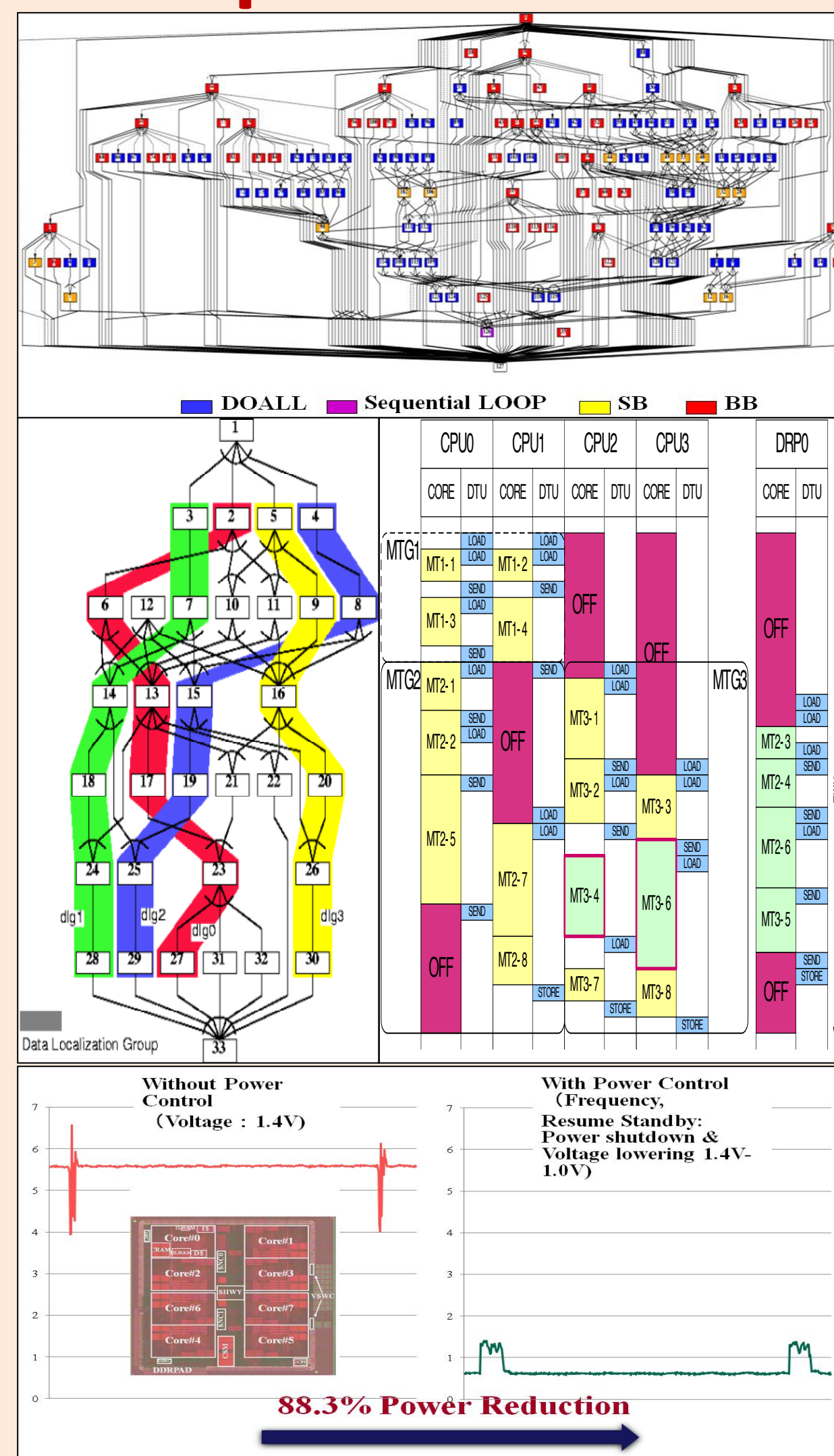
Automatic data management for **distributed shared memory**, **cache** and **local memory**

Data Transfer Overlapping

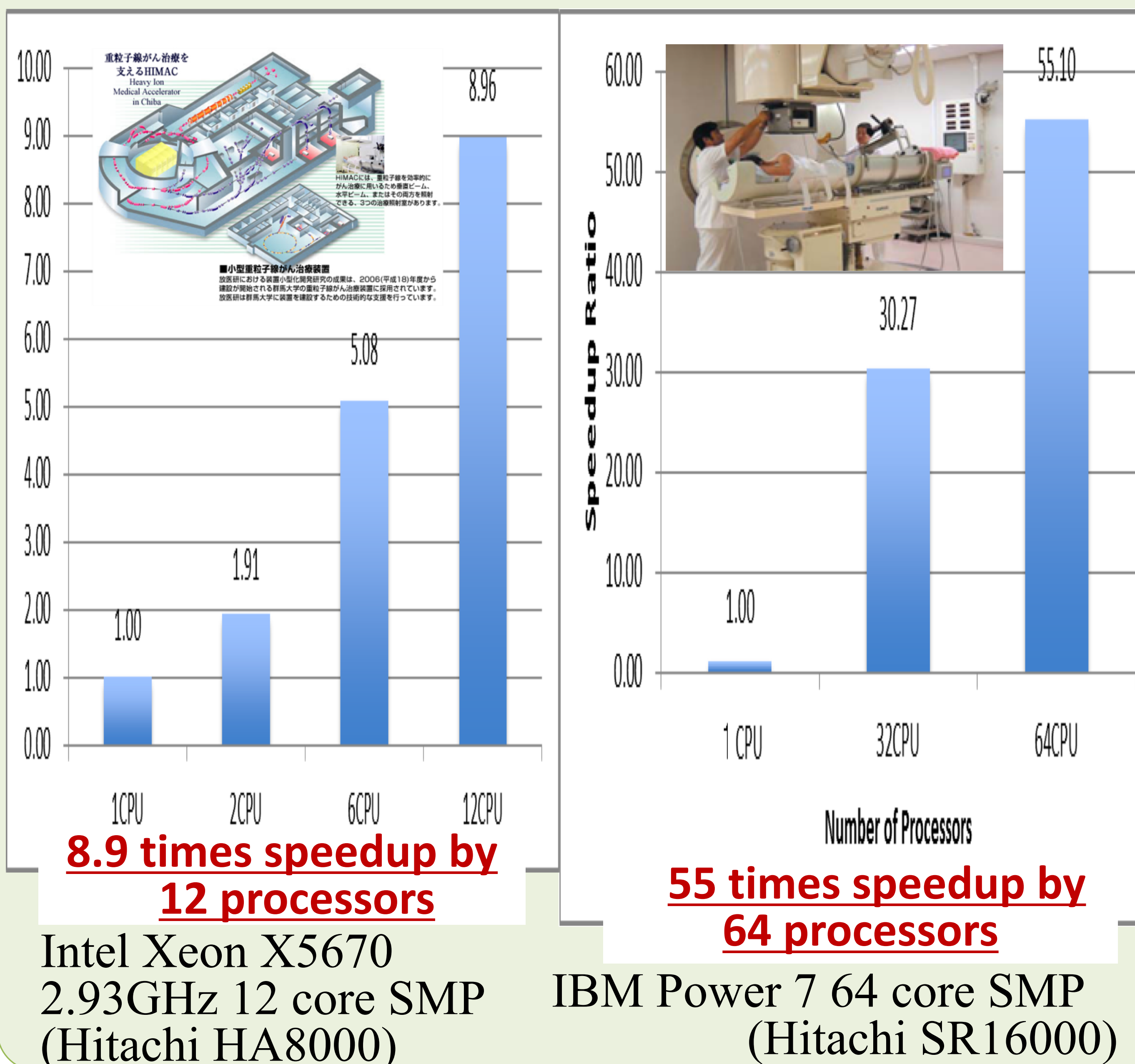
Data transfer overlapping using Data Transfer Controllers (DMAs)

Power Reduction

Reduction of consumed power by compiler control DVFS and Power gating with hardware supports.

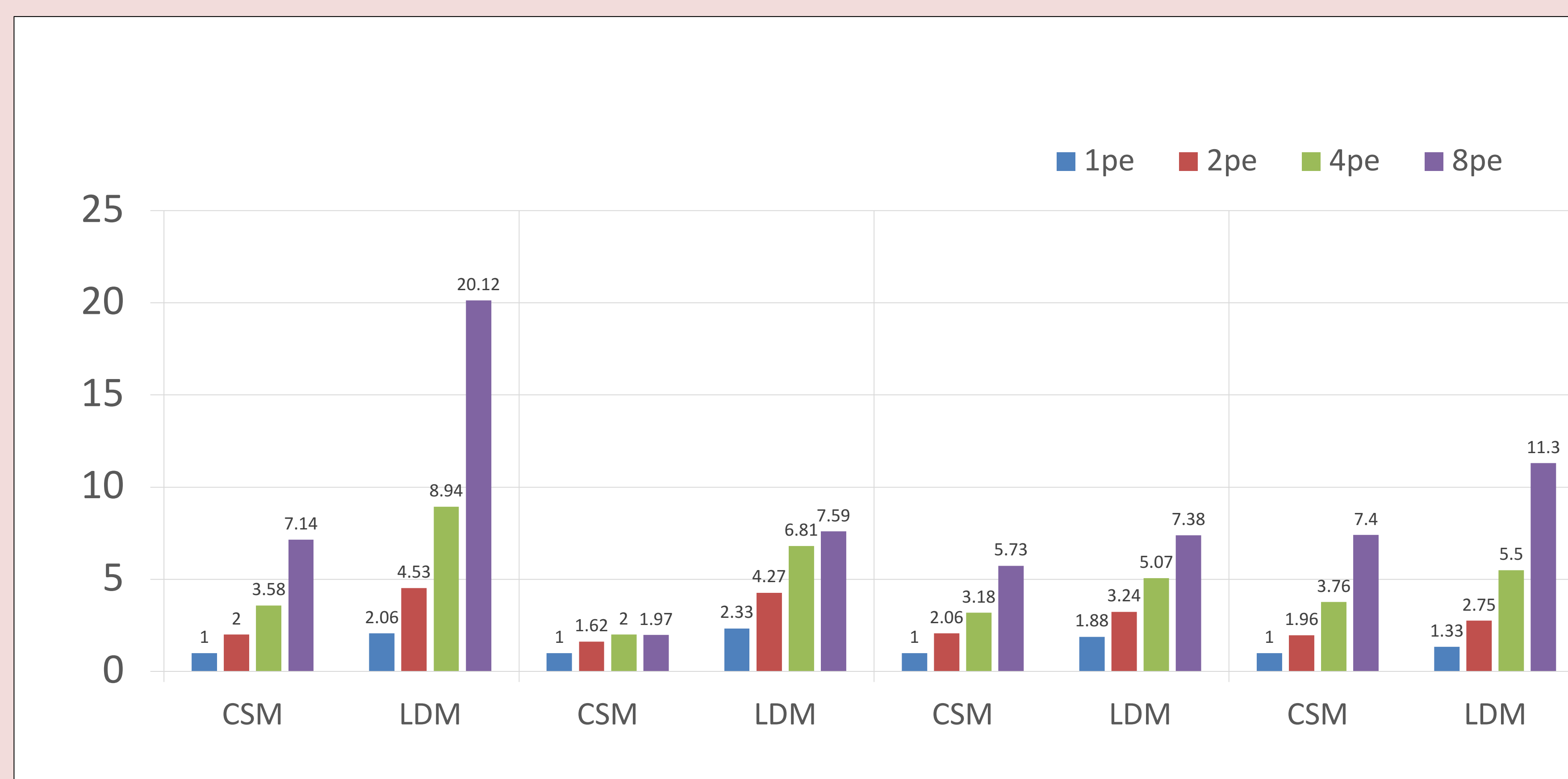
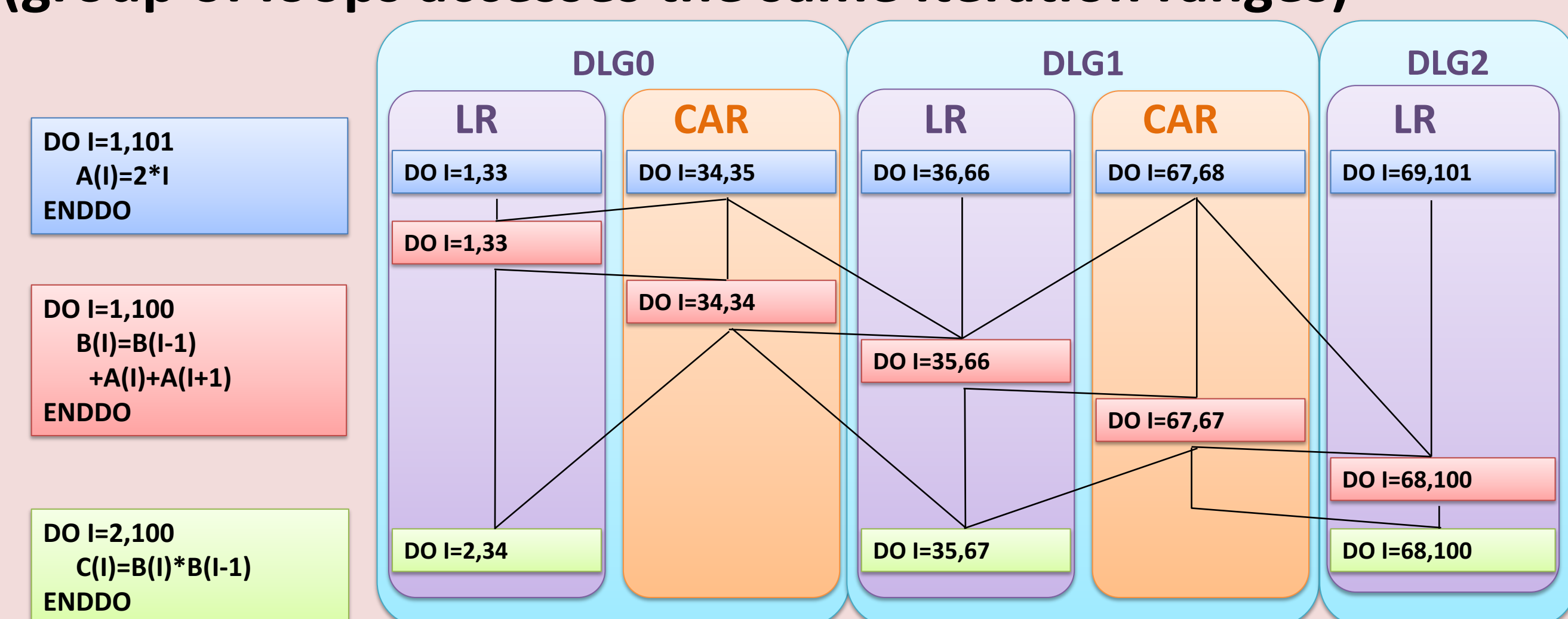


Cancer Treatment Carbon Ion Radiotherapy



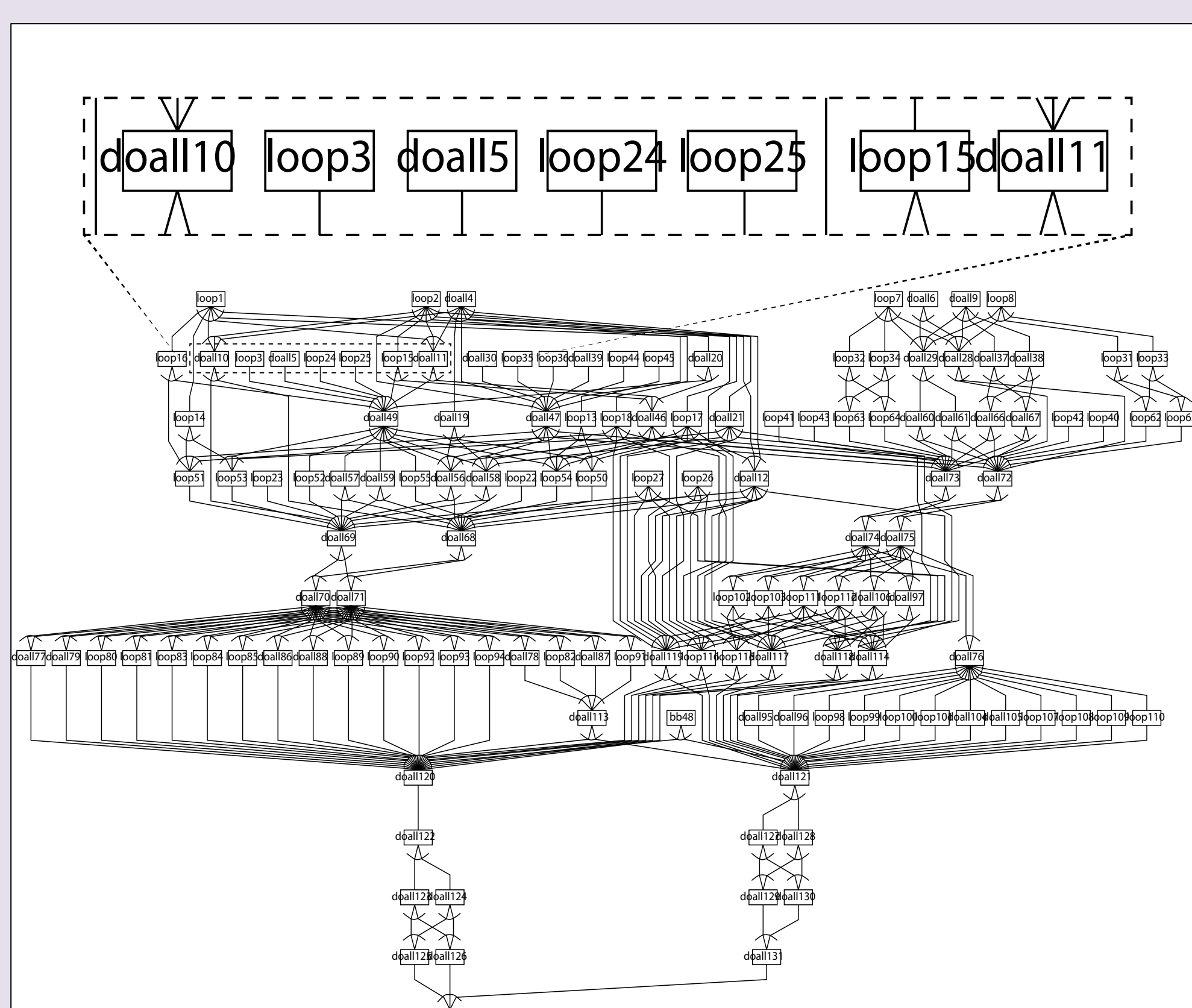
Automatic Localization

LR: Localizable Region
(data can be passed through LDM)
CAR: Commonly Accessed Region
(possibly data transfers are required among processors)
DLG: Data Localization Group
(group of loops accesses the same iteration ranges)

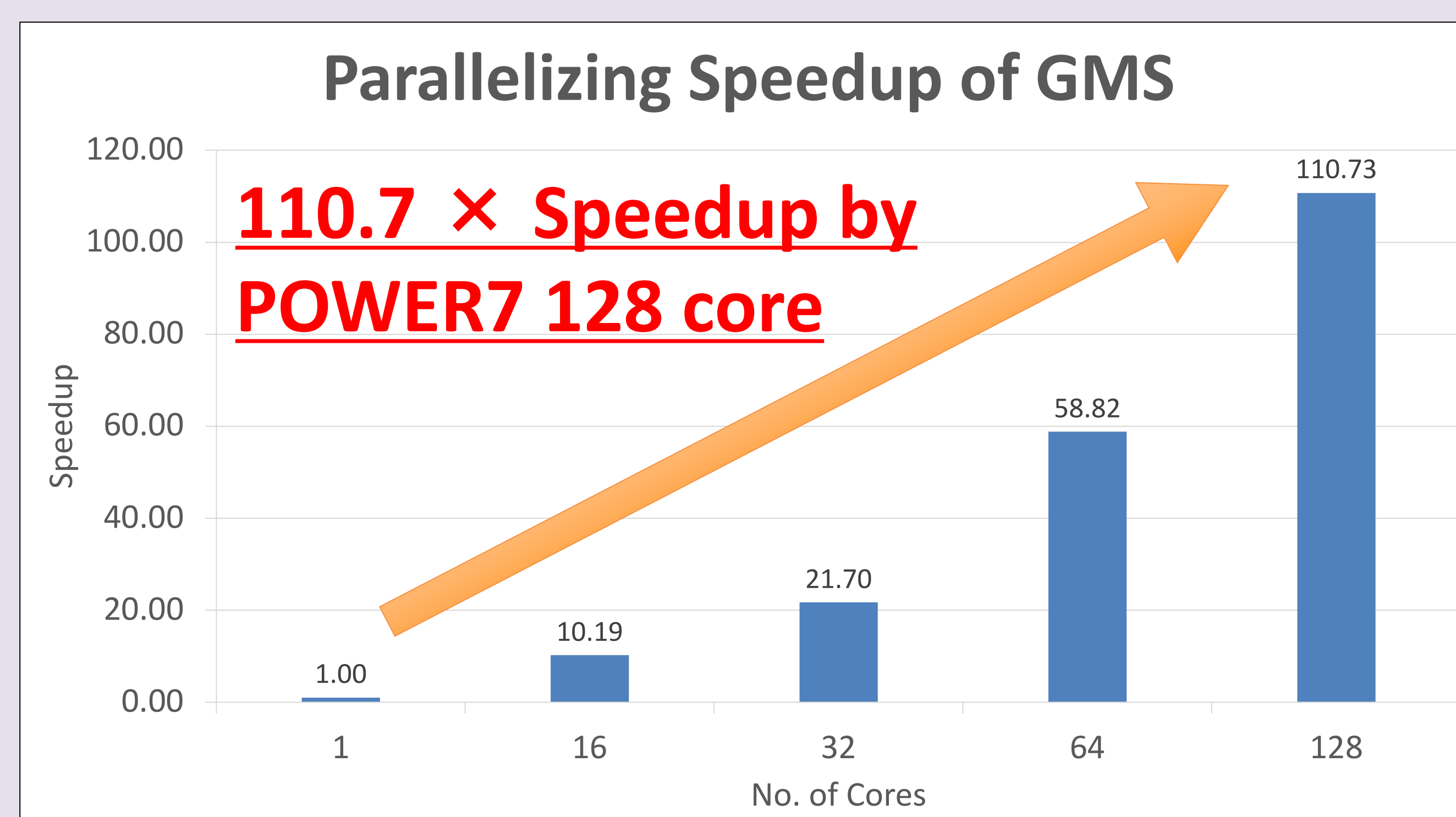


LCPC 2016, "Automatic Local Memory Management ...", Yamamoto et al.

Parallelizing of "National Research Institute for Earth Science and Disaster Resilience" Earthquake Wave Simulation GMS by OSCAR Compiler



Task graph of OSCAR API Program

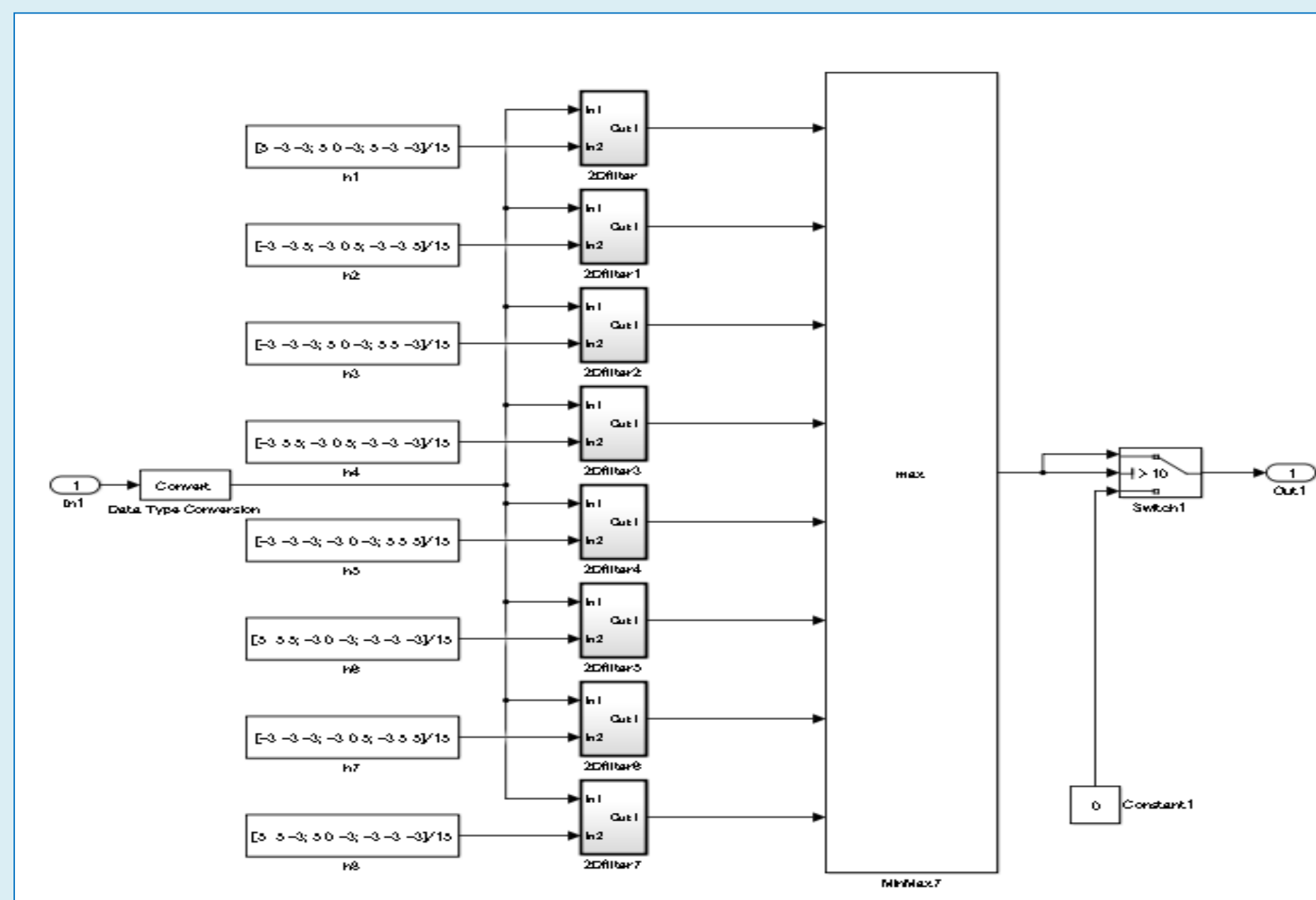


Execution environment: Hitachi SR16000 Model VM1 (IBM POWER7 Processor: 128core)

SC17 members

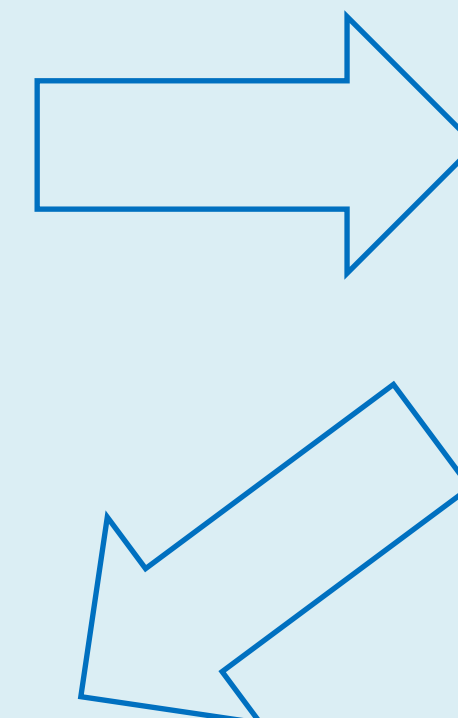
H.Mikami
B.A.Adhi
T.Kashimata
T.Karino
K.Miyamoto
T.Kawata
K.Takahashi
T.Makita
T.Shirakawa
Y.Oki
Prof. T.Kitamura
Prof. K.Kimura
Prof. H.Kasahara

Automatic Parallelization of MATLAB/Simulink by OSCAR Compiler



Simulink model

Generate C code
using Embedded Coder



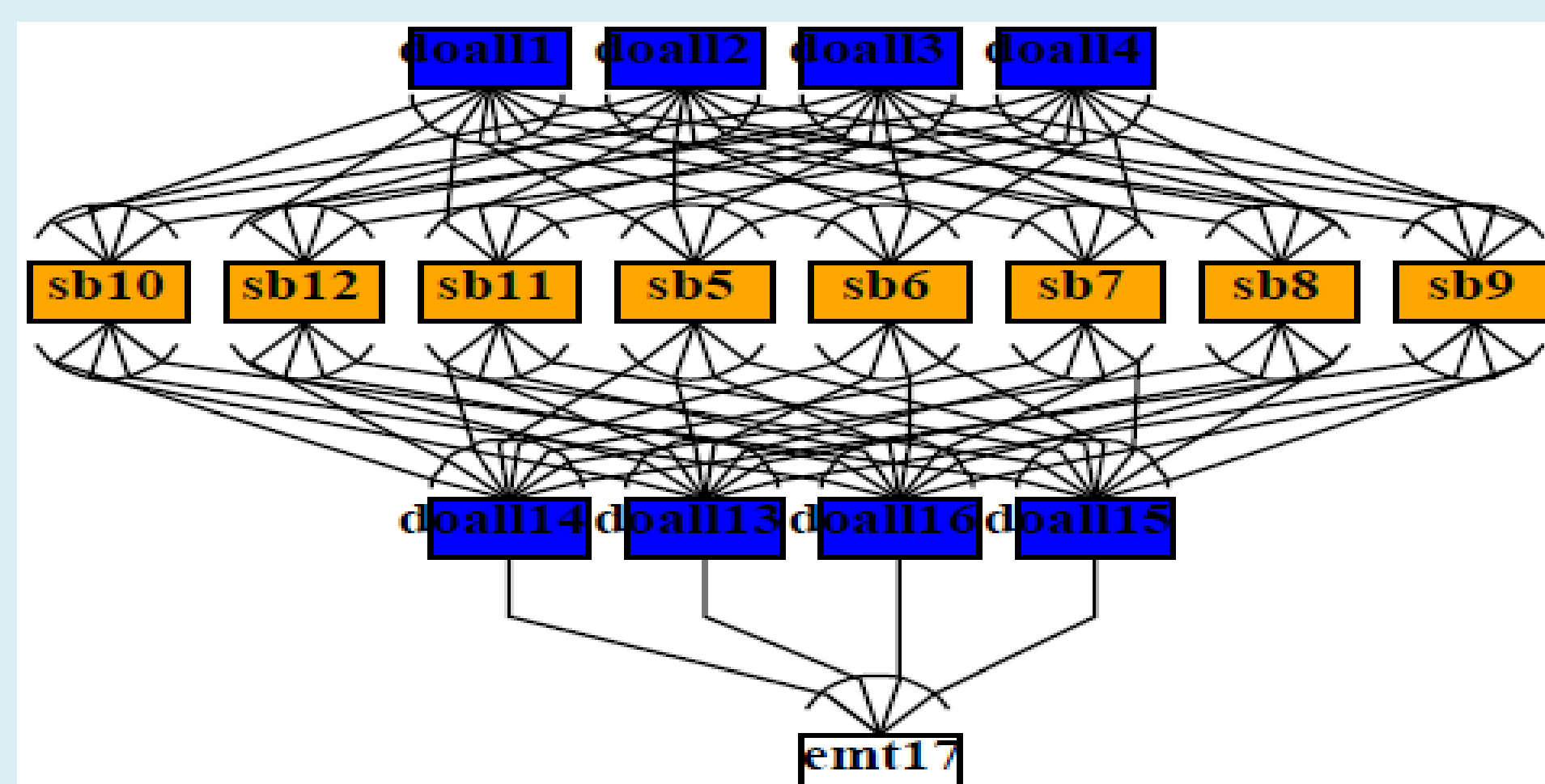
```
/* Model step function */
void VesselExtraction_step(void)
{
    int32_T i;
    real_T u0;

    /* DataTypeConversion: '<S1>/Data Type Conversion' incorporates:
     * Import: '<Root>/In1'
     */
    for (i = 0; i < 16384; i++) {
        VesselExtraction_B.DataTypeConversion[i] = VesselExtraction_U.In1[i];
    }

    /* End of DataTypeConversion: '<S1>/Data Type Conversion' */
    /* Outputs for Atomic SubSystem: '<S1>/2Dfilter' */
    /* Constant: '<S1>/h1' */
    VesselExtraction_Dfilter(VesselExtraction_B.DataTypeConversion,
        VesselExtraction_P.h1_Value, &VesselExtraction_B.Dfilter,
        (P_Filter_VesselExtraction_T *)&VesselExtraction_P.Dfilter);

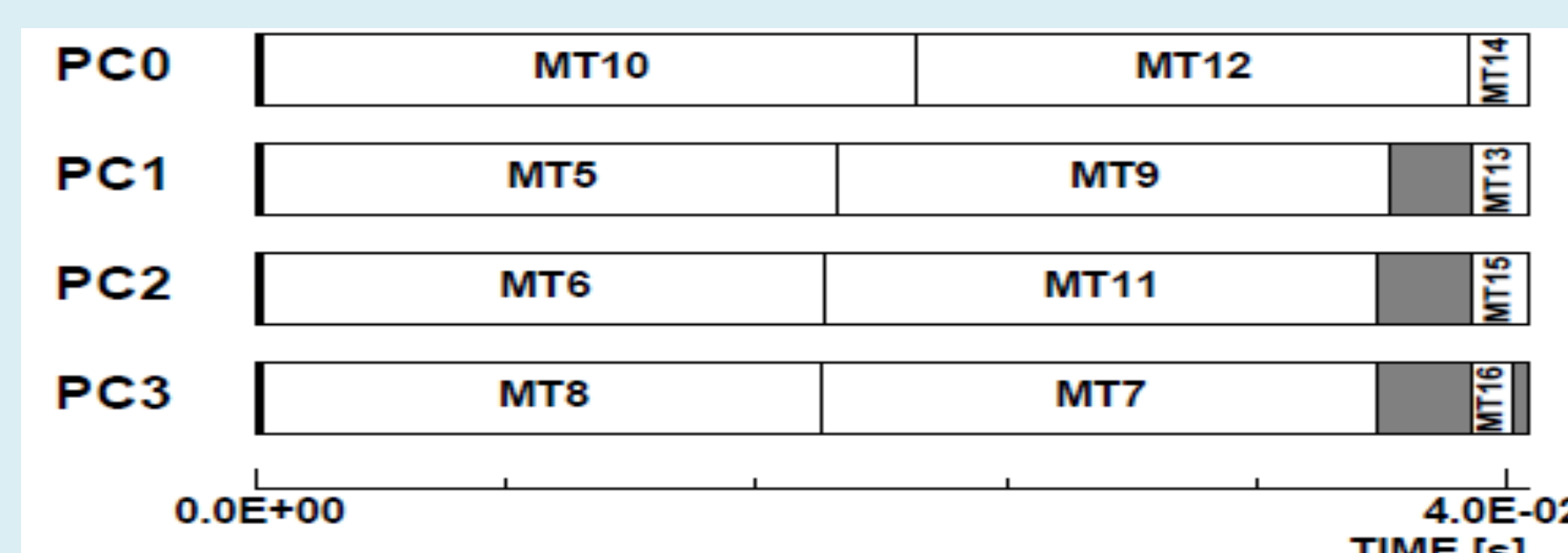
    /* End of Outputs for SubSystem: '<S1>/2Dfilter' */
    /* Outputs for Atomic SubSystem: '<S1>/2Dfilter1' */
    /* Constant: '<S1>/h2' */
    VesselExtraction_Dfilter(VesselExtraction_B.DataTypeConversion,
        VesselExtraction_P.h2_Value, &VesselExtraction_B.Dfilter1,
        (P_Filter_VesselExtraction_T *)&VesselExtraction_P.Dfilter1);
}
```

C code

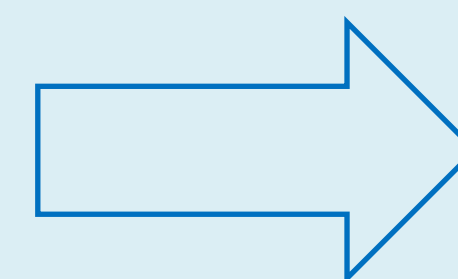


(1)Generate MTG
→ Parallelism

(2) Generate gantt chart
→ Scheduling in a multicore



OSCAR Compiler



```
void VesselExtraction_step ( )
{
    void thread_function_001 ( void )
    {
        VesselExtraction_step_PE1 ( );
    }

    int thr1 ;
    int thr2 ;
    int thr3 ;

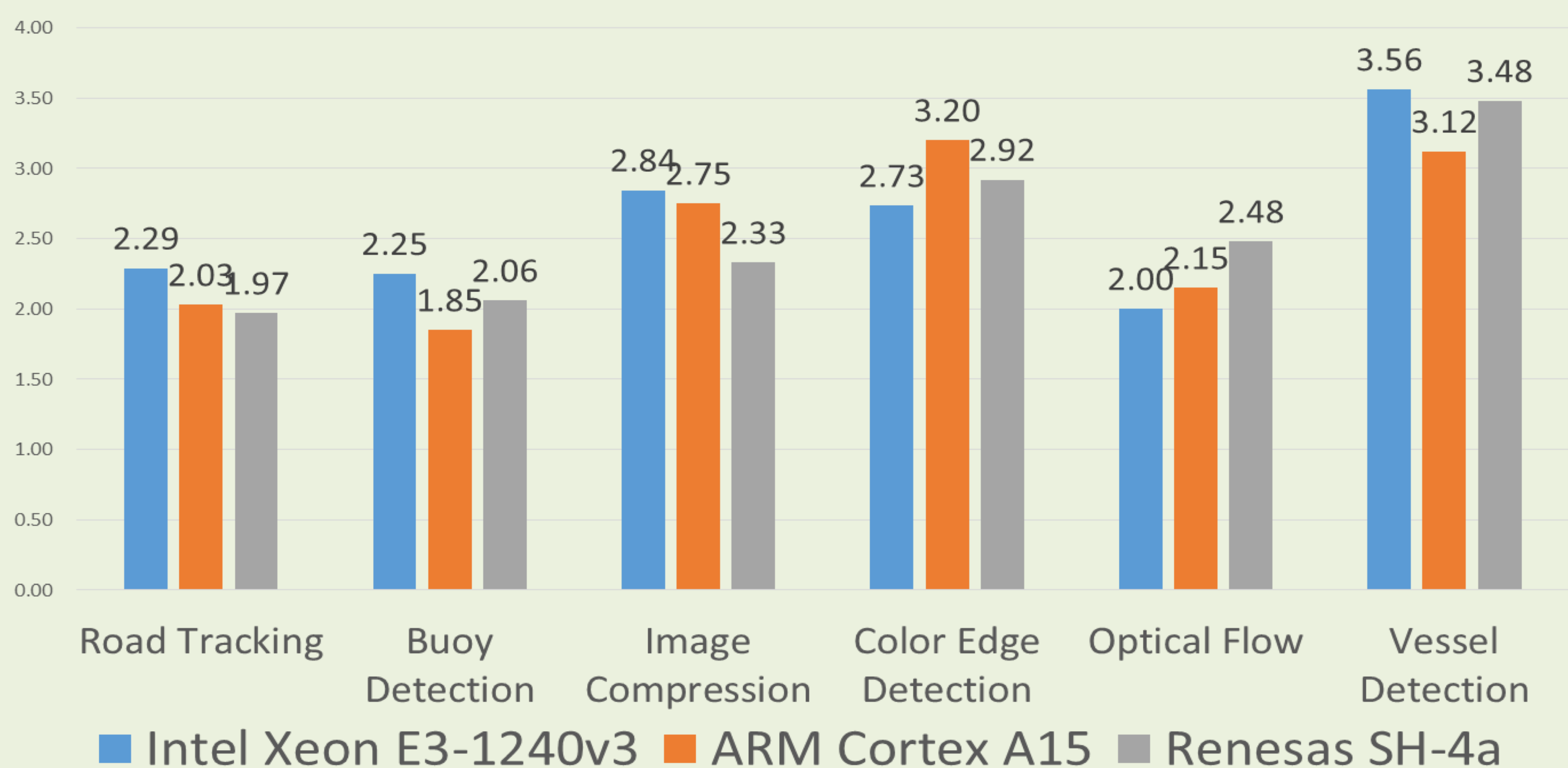
    oscar_thread_create ( & thr1 ,
        thread_function_001 , (void*)1 ) ;
    oscar_thread_create ( & thr2 ,
        thread_function_002 , (void*)2 ) ;
    oscar_thread_create ( & thr3 ,
        thread_function_003 , (void*)3 ) ;

    VesselExtraction_step_PEO ( );

    oscar_thread_join ( thr1 ) ;
    oscar_thread_join ( thr2 ) ;
    oscar_thread_join ( thr3 ) ;
}
```

(3) Generate parallelized C code
using the OSCAR API
→ Multiplatform execution
(Intel, ARM and SH etc)

Speedups of MATLAB/Simulink Image Processing on Various 4core Multicores (Intel Xeon, ARM Cortex A15 and Renesas SH4A)



Road Tracking, Image Compression : <http://www.mathworks.co.jp/help/vision/examples>
 Buoy Detection : <http://www.mathworks.co.jp/matlabcentral/fileexchange/44706-buoy-detection-using-simulink>
 Color Edge Detection : <http://www.mathworks.co.jp/matlabcentral/fileexchange/28114-fast-edges-of-a-color-image--actual-color--not-converting-to-grayscale/>
 Vessel Detection : <http://www.mathworks.co.jp/matlabcentral/fileexchange/24990-retinal-blood-vessel-extraction/>