What's XcalableACC?

XcalableACC (XACC) is a PGAS language for accelerated clusters, which is a directive-based language extension of C and Fortran based on an XcalableMP PGAS language by using OpenACC.

XACC supports typical parallelization under “global-view model” programming and enables parallelizing the original sequential code by using simple directives.

XACC also includes coarray features for “local-view model” programming.

Global-view model

Array a[] is distributed onto an accelerator on each node.

```c
int a[12];
#pragma xmp nodes p[3]
#pragma xmp template t[12]
#pragma xmp distribute t[block] onto p
#pragma xmp align a[i] with t[i]
#pragma acc enter data copyin(a)
```

Data mapping

```
0 1 2 3 4 5 6 7 8 9 10 11
p[0]
p[1]
p[2]
```

Distributed Array

Global index

Two directives parallelize a for-statement.

```c
#pragma xmp loop on t[i]
#pragma acc parallel loop
for(i = 0; i < 12; i++)
a[i] = func(i);
```

Work mapping

Local-view model

XACC C language defines array section and codimension equivalent to CAF.

```
x[start:length][node_number]
```

Above code means length elements from x[start] to x[start+length-1] located on node_number are referred.

```c
double a[5][*], b[5][*];
#pragma acc declare create(a, b)
if(xmp_node_rank()==1){
#pragma acc host_data use_device(a, b)
b[0:2][0] = a[3:2];
}
```

Performance (Source lines of Code)

<table>
<thead>
<tr>
<th></th>
<th>HIMENO</th>
<th>NPB CG</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPI + OpenACC (b)</td>
<td>328 (13)</td>
<td>772 (24)</td>
</tr>
<tr>
<td>XcalableACC (a, b)</td>
<td>198 (34, 9)</td>
<td>609 (48, 20)</td>
</tr>
</tbody>
</table>

Productivity (Source lines of Code)

- **HIMENO**
  - MPI: 8.6 Gops
  - OpenACC: 11.5 Gops

- **NPB CG**
  - MPI: 246.2 Gops
  - OpenACC: 236.2 Gops

Benchmark

- **HIMENO** is a stencil code which evaluates the performance of incompressible fluid analysis code.
- **NPB CG** is to solve minimum eigenvalue of symmetric and positive definite sparse matrix using the conjugate gradient method.

Performance on HA-PACS/TCA system

CPU: Ivy Bridge E5-2680v2 x 2
Mem.: DDR3 128GB 59.7GB/s x 2
GPU: NVIDIA K20X GDDR5 6GB 250GB/s x 4
Network: InfiniBand 8GB/s

For more information, please visit RIKEN AICS(#2345) and Univ. of Tsukuba(#3018)