parXXL:

Benchmark of a new cellular application environment for the Grid

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**parXXL: Benchmark of cellular applications**

**Project overview**

- **Device control – IO data**
- **Software suite parXXL:**
  - par::cellnet
  - par::cell
  - par::cntrl
  - par::mem
  - par::sys
  - par::cpp
  - par::bench

**Client machine:**
- Comfortable
- Fine grained development env.

**Distributed server:**
- Coarse grained arch.

→ Minimize \(T_{dev} + \sum T_{exec}\)

Interactive debugging and visualization tool of fine grained systems on distributed architecture (Supélec & System@tic)

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**Software architecture**

- `par::cellnet`: Cellular network creation library
- `par::cell`: Fine grained programming model
- `par::cntrl`: Coarse grained comm. & runtime control
- `par::mem`: Memory management and data abstraction
- `par::sys`: High-level Posix system interface
- `par::cpp`: Optimized C++ toolbox

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Programming model

Fine grained parallelism

Coarse grained parallelism

Cell net creation

Cell net computation

Cell comm.

Cell net evolution

BSP super-steps
- model of ParCeL
- model of SSCRAP
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Programming model: Cellular net creation

TCP-Client → TCP-Server & Worker → Worker → Worker → Worker

Cell net creation
Loop:
  - Cell net computation
  - Cell communications
  - Cell net update

User code
or
optimized \texttt{par::cellnet}

routines for standard
cellular networks
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Programming model: Cell computation

A cell:

- Cell Parameters
- Cell Variables
- Cell input channels
- Cell output channels
- Cell external IO mechanisms

//Init function
...
 ...

//Iter function
...
 ...

//Term function
...
 ...

User code

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Program ex: Cubic relaxation

User code: ... before a new API

```c
// - Define a ParCeL cubic cell network
T_CubeCellNet theCellNet(); // par::cellnet

// - Init the cell net variable (function of the pgm arguments)
theCellNet.Init(argc, argv, &p6ProcInfo);

// - Define and create the cell network
theCellNet.CubeCellLocalizedDefAndCreate(&p6ProcInfo);

// - Define and install the cell parameters
theCellNet.CubeCellParamDefAndInstall(&p6ProcInfo);

// - Connect the cell of the cell net
theCellNet.Connection(&p6ProcInfo);

// - Relaxation loop: loop of net computation and output update
for (p6Size_t cycle = 0; cycle < theCellNet.CycleNb; cycle++)
    theCellNet.RelaxOneStep(P6FORWARD, 0, &p6ProcInfo);

// - Stop the ParCeL processes (on each processor)
p6ProcInfo.p6_net_proc_halt(); // par::cell
```
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Program ex: Cubic relaxation

Centralized cell creations:

Server process

User code

User code

Centralized & localized cell creation:

Advanced user code / par::cellnet

Distributed and localized cell creations

par::cellnet

par::cellnet
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**Benchmark: Cellular net creation**

![Graph showing cell creation and parameter installation for GridExplorer across different numbers of processors (2, 8, 20, 32, 44, 62) with a logarithmic scale for both axes (cells and seconds).]
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Benchmark: Cellular net computation

Jacobi iteration (flat cube), GridExplorer, average time per iteration
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Benchmark: Cellular net computation

Jacobi iteration (flat cube), GridExplorer, average time per iteration per cell

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Conclusion

• Operational – First benchmarks in December 2005.

• First real user application planned for January 2006.

• Next development steps of parXXL planned for February 2006.
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Questions?