High performance computing is at a critical crossroads in at least three areas:

(i) **Hardware**: Radically new petascale architectures exceeding a million processors are being designed for deployment;

(ii) **Software**: Standard approaches to system software are outdated;

(iii) **Complex Applications**: Traditional, simplified, static applications, developed by single groups, are evolving towards highly complex codes that require teams of researchers and computer scientists to develop and use.

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**Alpaca**

**Cactus Tools for Application Level Profiling and Correctness Analysis**

E. Schnetter (PI), G. Allen, T. Goodale, M. Tyagi

Center for Computation & Technology, LSU

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**Application of Alpaca**

<table>
<thead>
<tr>
<th>Application</th>
<th>Alpaca Users</th>
<th>Abbreviated List of Requirements</th>
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</thead>
<tbody>
<tr>
<td>Numerical Relativity</td>
<td>Pablo Laguna</td>
<td>Large-scale simulations; viscous and gravitating astrophysical algorithms require new architectures and paradigms. Dynamic mesh refinement introduces new performance issues which Alpaca tools can address.</td>
</tr>
<tr>
<td>Computational Fluid Dynamics</td>
<td>Mayank Tyagi (LSU), (PL), Yu-Lin Yang, Kuan Wen-Chao (KISTI)</td>
<td>Multi-block simulations and unstructured meshes lead to difficulties in load balancing. Many existing packages need to be integrated Using the Cactus IDE Toolkit as educational tool.</td>
</tr>
<tr>
<td>Reservoir Simulations</td>
<td>Christopher White (SL), MB microscope (SL), (PL)</td>
<td>High-flowrate simulations, complex geometries, adapting physical models.</td>
</tr>
<tr>
<td>Coastal Modeling</td>
<td>R. Chen (LSU), Mayank Tyagi (LSU), (PL)</td>
<td>Simulations require robustness &amp; reliability. Long-term simulations (many time steps) on massively parallel systems.</td>
</tr>
<tr>
<td>Quantum Gravity</td>
<td>Chris Reading (Imperial College, UK)</td>
<td>Using Alpaca, requires experimentation with a wide variety of algorithms, not necessarily PDE-based. Performance testing of parallelizing modes.</td>
</tr>
<tr>
<td>Astrophysics</td>
<td>Joel Ehlert (LSU)</td>
<td>Large scale simulations. Interest and involvement in new architectures and paradigms. Efficient solvers for elliptic equations need Alpaca tools.</td>
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</tbody>
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**Alpaca**

will develop, at the application level:

(i) **New fault tolerant capabilities** that will be needed for increasingly large scale machines

(ii) **New performance monitoring capabilities** which will make it much easier to determine how the more complex application codes perform on current and future hardware

(iii) **New interactive debugging capabilities**, critical to locate and cure software or algorithmic errors

(iv) **Integration with Eclipse**, the increasingly popular code development environment.

Alpaca will be developed with full involvement from application developers across a broad range of areas.