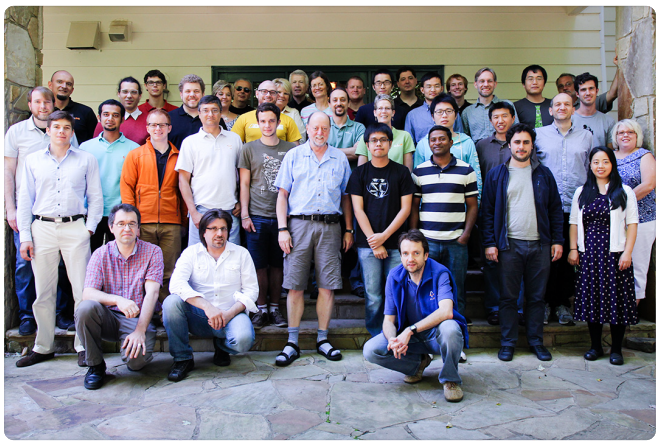
# ICL UT
# INNOVATIVE COMPUTING LABORATORY
THE UNIVERSITY of TENNESSEE

**The Innovative Computing Laboratory (ICL) is a large Computer Science research and development group situated in the heart of the University of Tennessee's Knoxville campus. ICL's mission is to establish and maintain the University of Tennessee as a world leader in advanced scientific and high performance computing through research, education, and collaboration.**

CLAXTON BUILDING
HOME OF ICL



ICL GROUP FALL 2014

ICL's founder, Dr. Jack Dongarra, established the lab in 1989 when he received a dual appointment as a Distinguished Professor at UTK and as a Distinguished Scientist at Oak Ridge National Laboratory. Since then, ICL has grown into an internationally recognized research laboratory, specializing in Numerical Linear Algebra, Distributed Computing, and Performance Evaluation and Benchmarking. The lab now employs over forty researchers, students, and staff, and has earned many accolades, including four R&D 100 awards.

## IGMCS

The University of Tennessee's Interdisciplinary Graduate Minor in Computational Science (IGMCS) offers students an opportunity to acquire the balanced package of knowledge and skills required in today's computationally intensive research methods. Through the IGMCS, graduate students can augment the curriculum of their chosen field with computationally rich courses from other science and engineering areas, creating a solid interdisciplinary foundation in Computational Science.

## CITR

The Center for Information Technology Research (CITR) was established in 2001 to drive the growth and development of leading edge information technology research at the University of Tennessee. As part of this goal, CITR staff members currently provide primary administrative support for ICL and the IGMCS, and have provided secondary support for other UT research centers.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# MAIN RESEARCH AREAS

BEAST
EASI
FT-LA
Keeneland
LAPACK
MAGMA
PLASMA
PULSAR
QUARK
RaPyDLI
ScaLAPACK

## NUMERICAL LINEAR ALGEBRA

Numerical Linear Algebra algorithms and software form the backbone of many scientific applications in use today. With the ever-changing landscape of computer architectures, such as the massive increase in parallelism and the introduction of hybrid platforms utilizing both traditional CPUs and GPUs, these libraries must be revolutionized in order to achieve high performance and efficiency on these new hardware platforms. ICL has a long history of developing and standardizing these libraries in order to meet this demand, and we have multiple projects actively underway in this arena.

ARGO
G8 ECS
GridPac
OpenMPI
PaRSEC
ULFM

## DISTRIBUTED COMPUTING

Distributed Computing is an integral part of the high performance computing landscape. As the number of cores, nodes, and other components in an HPC system continue to grow explosively, applications need runtime systems that can exploit all this parallelism. Moreover, the drastically lower meantime to failure of these components must be addressed with fault tolerant software and hardware, and the escalating communication traffic that they generate must be addressed with smarter and more efficient message passing standards and practices. Distributed Computing research at ICL has been a priority for nearly two decades, and the lab has several projects in that arena under active development.

CScADS
FutureGrid
HPCC
HPCG
HPL
MuMMI
PAPI
SUPER
TOP500

## PERFORMANCE EVALUATION AND BENCHMARKING

Performance Evaluation and Benchmarking are vital to developing science and engineering applications that run efficiently in an HPC environment. ICL's Performance Evaluation tools allow programmers to see the correlation between the structure of source/object code and the efficiency of the mapping of that code to the underlying architecture. These correlations are important for performance tuning, compiler optimization, debugging, and finding and correcting performance bottlenecks. ICL's benchmark software is widely used to determine the performance profile of modern HPC machines, and has come to play an essential role in the purchasing and management of major computing infrastructure by government and industry around the world.

## ICL RESEARCH TIMELINE

| | |
|---|---|
| 1989 | PVM<br>Level 3 BLAS |
| 1992 | LAPACK<br>BLACS |
| 1993 | TOP500 |
| 1994 | MPI |
| 1995 | ScaLAPACK |
| 1997 | NetSolve<br>ATLAS<br>RIB |
| 1999 | PAPI<br>HARNESS |
| 2000 | HPL |
| 2002 | FT-MPI<br>GCO |
| 2003 | LAPACK for Clusters<br>HPC Challenge |
| 2006 | Open MPI<br>FT-LA |
| 2008 | PLASMA<br>MAGMA |
| 2009 | Blackjack<br>MuMMI |
| 2010 | DPLASMA |
| 2011 | PULSAR |
| 2012 | PaRSEC |
| 2013 | BEAST<br>HPCG |
| 2014 | ARGO<br>RaPyDLI |