



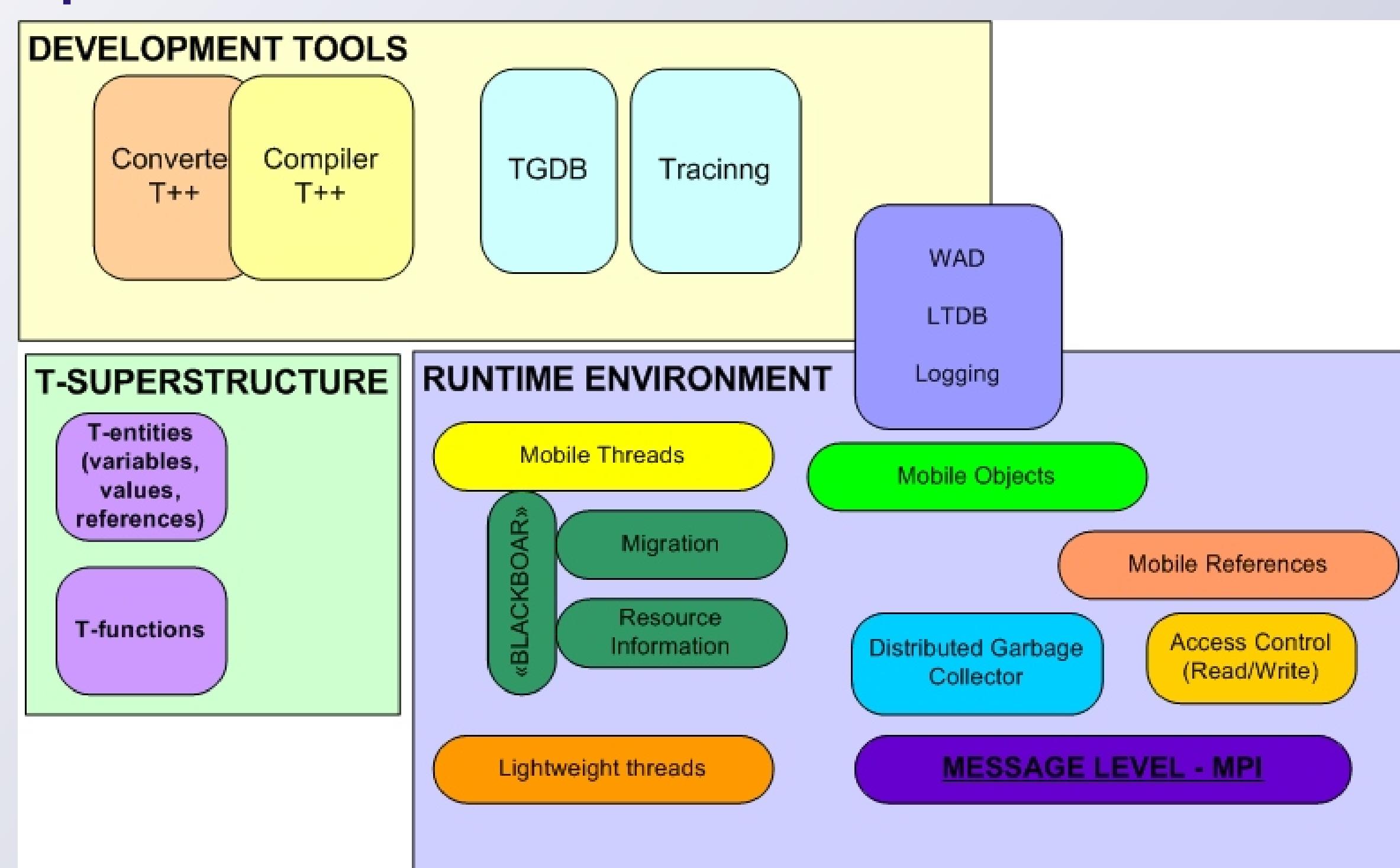
# Russian Academy of Sciences Program Systems Institute

## Open TS: Dynamic Parallelization System for Multicore CPUs, SMPs, Clusters, and GRIDs

### Overview

- High-performance computing: Automatic dynamic parallelization
- Combination of functional and imperative approaches, high-level parallel programming
- T++ language: “Parallel dialect” of C++ — an approach popular in the 90s

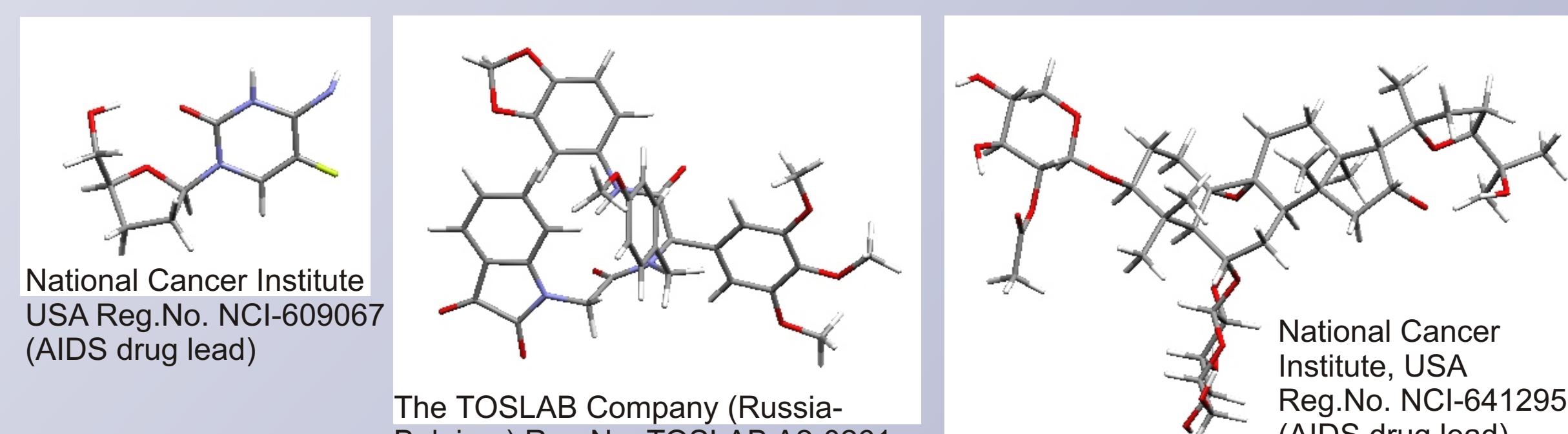
### Open TS Environment



### T-Applications

MultiGen – biological activity estimation; Remote sensing applications; Plasma modeling; Protein simulation; Aeromechanics; Query engine for XML; AI Applications; etc.

### MultiGen (Chelybinsk State University, Russia)



### MultiGen: Speedup

Substance	Atom number	Rotations number	Conformers	Execution time (min.:s)		
				1 node	4 nodes	16 nodes
NCI-609067	28	4	13	9:33	3:21	1:22
TOSLAB A2-0261	82	18	49	115:27	39:23	16:09
NCI-641295	126	25	74	266:19	95:57	34:48

### T-Approach

- “Pure” functions (**tfunc**) invocations produce grains of parallelism
- T-Program is
  - Functional – on higher level
  - Imperative – on low level (optimization)
- C-compatible execution model
- “Seamless” C-extension (or Fortran extension)
- Multiple assignment
- Optimality through usability

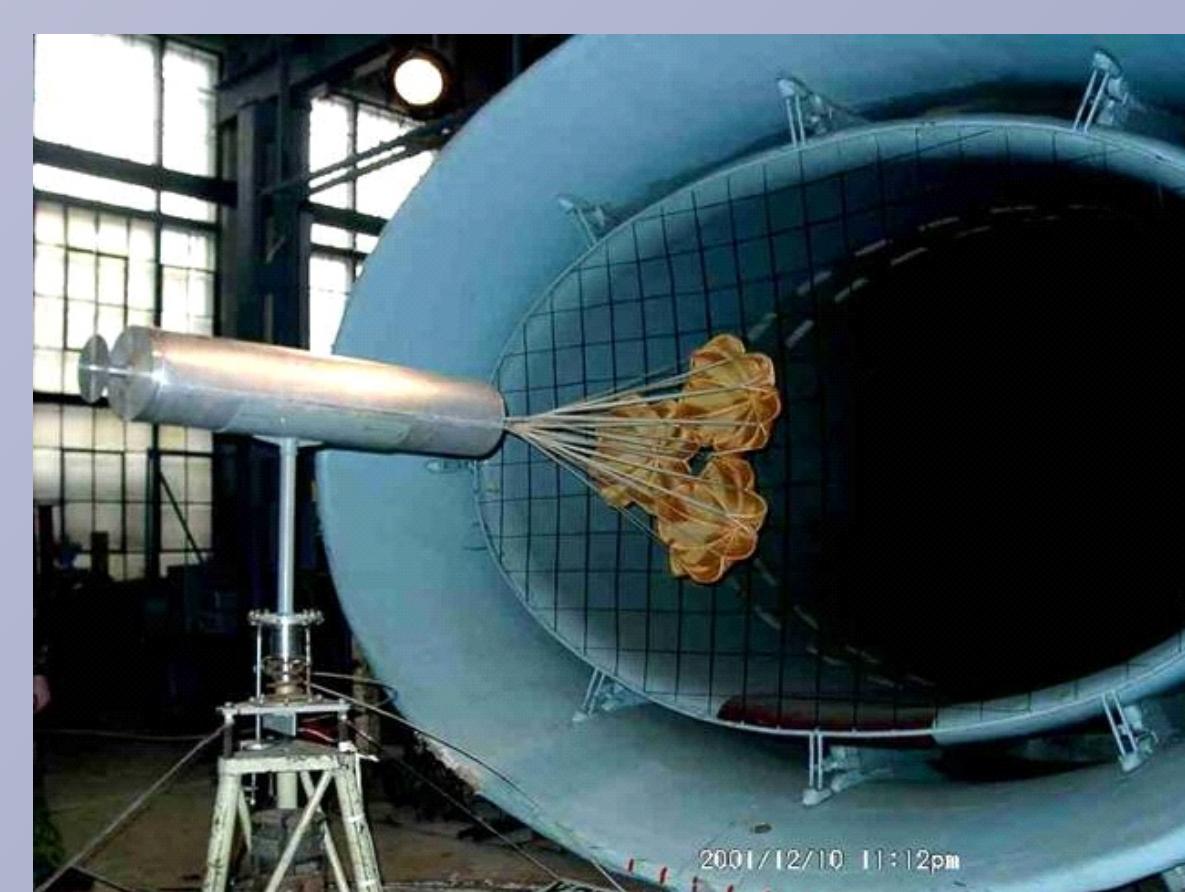
### Open TS Runtime

- Three-tiered architecture (T, M, S)
- Design: microkernel , 10 extensions currently
- «Supermemory»
- Lightweight threads
- DMPI: Dynamic MPI
  - auto selection of an MPI implementation
  - dynamic loading and linking

### Multithreading & Communications

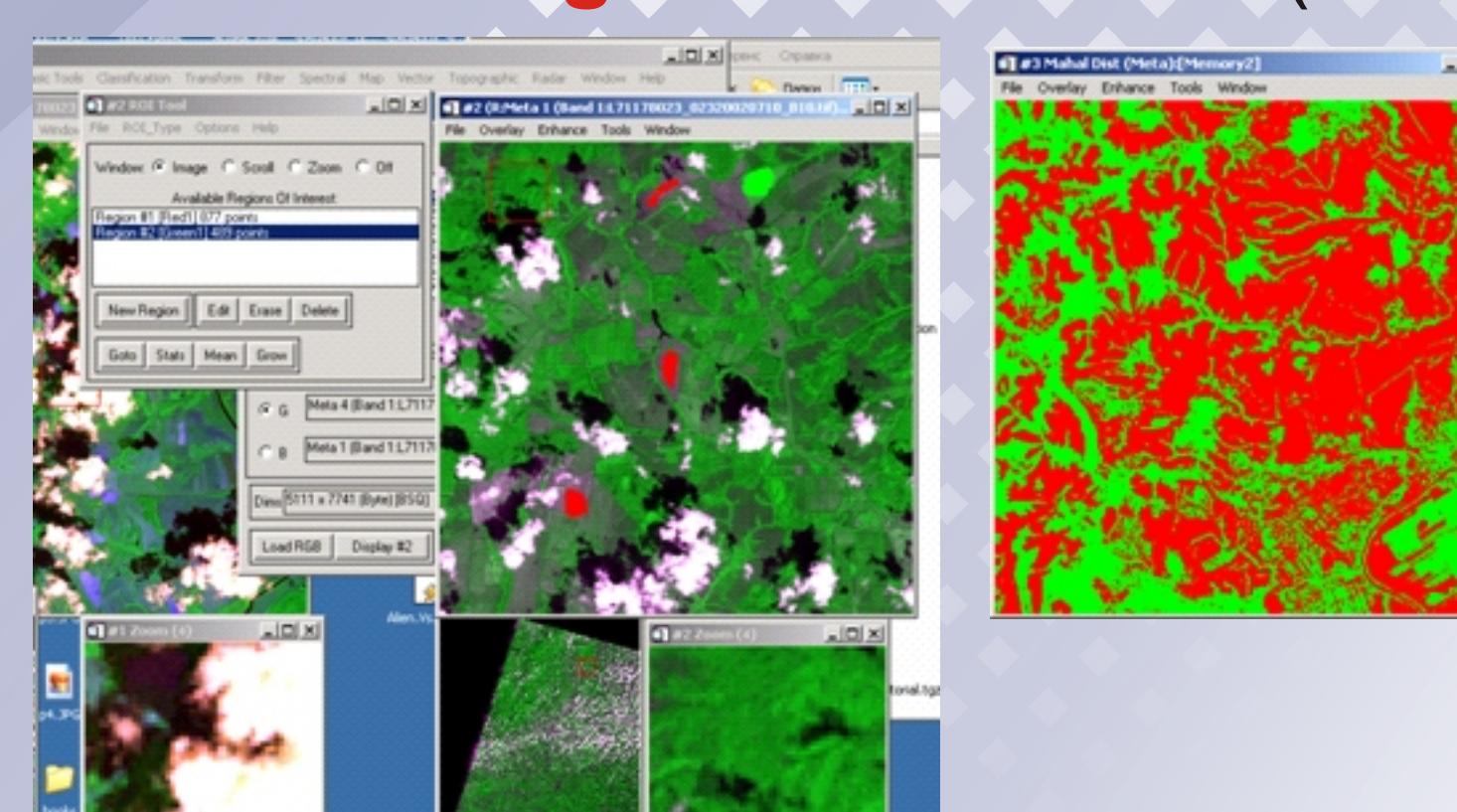
- Asynchronous** communications
  - A thread “A” asks a non-ready value (or new job)
  - Asynchronous request sends: Active massages & Signals delivery over network to stimulate data transfer to the thread “A”
  - Context switches (including a quant for communications)
- Latency Hiding** for node-node exchange
- Lightweight threads**
  - PIXELS (1'000'000 threads)

### Aeromechanics (Institute of Mechanics, MSU, Russia)



500 steps	1 node	2 nodes	4 nodes	8 nodes
C	160			
MPI	160	87	56	41
T	214	130	81	61

### Landsat Image Classification (PSI RAS, Russia)



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