Not everyone needs the same tools!

Which are you using?

&

What do you need?
Are you building Skyscrapers
Or
Dog Houses?
A Disruptive Solution to the HPC (Parallel Processing) Problem
MEASURABLE GOALS:

- Provide multiple orders of magnitude improvement in application run-time speed;

- Provide an order of magnitude reduction in the time and cost to develop software;

- Allow application experts to design, build, and test software directly;

- Allow newcomers to a project to quickly learn and understand complex software;
Disruptive Solution To HPC

REPRESENTATIVE APPLICATIONS:

- Adaptive Control of Large Groups of Autonomous Moving Platforms
- Human Body Organ simulation
- Global Climate prediction
- Fluid Flow simulation
- Biological Particle simulation
- Chemical - Molecular structure simulation
- Scanning, sorting, and correlating massive databases (Big Data)
- Weather prediction in mountainous terrain
- Power distribution simulation
- Electro-magnetic wave simulation
- Global HF power transmission
- Global Military Planning - Multiple moving platform simulation
MUST DISTINGUISH BETWEEN SERVERS & PARALLEL PROCESSORS

MASTER CONTROLLER & BACKUPS

MASTER OS

SERVERs

SERVER OS-1
SERVER OS-2
SERVER OS-3
SERVER OS-4
SERVER OS-5
SERVER OS-6

PARALLEL PROCESSORS
# Disruptive Solution To HPC

## Seven Layer Model for Computer Technology

<table>
<thead>
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<th>Layer</th>
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<td><strong>HARDWARE REQUIREMENTS</strong></td>
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<td><strong>COMPUTER HARDWARE SPACE</strong></td>
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<tr>
<td><strong>HARDWARE ENVIRONMENT</strong></td>
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</table>

- **Input Data**
  - Output Results
  - Speed & Accuracy
- **User Interface**
  - Initialization
  - Visualization
- **Application Data Space**
- **Application Algorithm Space**
- **Architectural Drawings**
  - Data, Algorithmic, & Graphic Languages
- **Run-Time System**
  - Parallel OS
  - System OS
- **Assembly Language**
  - Micro Code
- **Servers**
  - Parallel Processors

*Seven_LAYER_Model 11/07/16*
Disruptive Solution To HPC

Spaces for Translation of Application Requirements into Software & Hardware
Disruptive Solution To HPC

Spaces for Translation of Application Requirements into Software & Hardware
MODEL SPACE HIERARCHY

ENVIRONMENTS

GEOGRAPHIC  ATMOSPHERIC  IONOSPHERIC  ELECTROMAGNETIC
ACOUSTIC  WATER SURFACE  WATER SUBSURFACE  OTHER

PLATFORMS

GROUND STATIONS  GROUND VEHICLES  AIRCRAFT / HOVERCRAFT  SPACECRAFT
SATELLITES  UAVS / MISSILES  SURFACE VESSELS  SUBSURFACE VESSELS

EQUIPMENT/ETC.

SENSORS  WEAPONS  COMM SYSTEMS  HOST COMPUTERS
CONTROL SYSTEMS  EW SYSTEMS  NAVIGATION SYSTEMS  POWER SYSTEMS

C2 DECISION MODELS

6 DOF MOVEMENT MODELS
Disruptive Solution To HPC

APPLICATION EXPERTS USE
- CAD GUI
- Engineering Drawings
- Natural Language
- Large Libraries

- Graphical User Interface
- Large Geographic Libraries
- Interactive Facilities

APPLICATION SYSTEM TO BE DEVELOPED

INHERENT PARALLELISM

SUBSYS 1

INDEPENDENT APPLICATION SUBSYSTEMS

SUBSYS M

SUBSYS N

DESIGN DEVELOPMENT ENVIRONMENT

VISUAL DESIGN ARCHITECTURE & PRODUCE CODE

INDEPENDENT MODULES

MODULE 1

MODULE 2

MODULE M

MODULE N

CAD ARCHITECTURE THREE LANGUAGES

RUN-TIME SYSTEM (RTS)

USER OS

VisiSoft PARALLEL OPERATING SYSTEM (VPOS)

PARALLEL PCs
- 72 Processors
- 1000 GIG each Semiconductor Memory

HARDWARE

SOFTWARE-HARDWARE RUN-TIME ENVIRONMENT

Visual Software Engineering Using A CAD System For Building Complex Software
Disruptive Solution To HPC

A Space - Data Structure (a RESOURCE)
**Disruptive Solution To HPC**

**A Transformation - Rule Structure (a PROCESS)**

<table>
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<tr>
<th>PROCESS: RECEPTION</th>
<th>RESOURCES: TRANSCEIVER</th>
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<tr>
<td>INSTANCES: TRANSMITTER</td>
<td>MESSAGE_FORMATS</td>
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<tr>
<td>RECEIVER</td>
<td>TRANSMITTER_OUTPUT</td>
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**START_RECEPTION**

IF TRANSMITTER IS IDLE

EXECUTE GOOD_RECEPTION

ELSE IF TRANSMITTER IS RECEIVING

EXECUTE CONFLICTING_RECEPTION

ELSE IF TRANSMITTER IS TRANSMITTING

EXECUTE CONFLICTING_BROADCAST .

**GOOD_RECEPTION**

IF SIGNAL_TO_NOISE_RATIO IS GREATER THAN RECEIVER_THRESHOLD

SET TRANSMITTER TO RECEIVING

ADD SIGNAL_POWER TO TOTAL_POWER_AT_RECEIVER .

CALL DECODE_MESSAGE .

IF MESSAGE_TYPE IS FORMAT_A

AND SYNC_CODE IS VALID

AND LAST_SYMBOL IS A TERMINATOR

EXECUTE SEND_ACKNOWLEDGEMENT .

**CONFLICTING_RECEPTION**

IF POWER_AT_RECEIVER IS GREATER THAN SIGNAL_POWER

SCHEDULE ABORT_RECEIVE NOW .

**CONFLICTING_BROADCAST**

CANCEL END_RECEIVE NOW

SCHEDULE START_RECEIVE IN EXPON(0.83) MILLISECONDS

WITH PRIORITY 80

**SEND_ACKNOWLEDGEMENT**

MOVE ACKNOWLEDGEMENT TO TRANSMIT_MESSAGE_BUFFER

IF DESTINATION IS BROADCAST

SEARCH LINK_CONNECTIVITY_VECTOR OVER RECEIVER

EXECUTING TRANSMISSION

WHEN LINK IS GOOD

ELSE EXECUTE TRANSMISSION .

**TRANSMISSION**

SCHEDULE LINK_RECEPTION

IN LINK_DELAY MICROSECONDS

USING TRANSMITTER, RECEIVER
Disruptive Solution To HPC

Connecting Resources & Processes to Create a Sequence of Transformations
Create a Hierarchy of Software Modules
Disruptive Solution To HPC

Double Click To Edit The Code
Disruptive Solution To HPC

TYPES OF MODULES

TASK

IND_MODULE

HIERARCHICAL MODULE

ELEMENTARY MODULE

UTILITY_MODULE

LIBRARY_MODULE
Disruptive Solution To HPC

Types of Resources

- Shared Resource: Shared between processes
- Shared Alias: Shared between modules, utilities, and libraries
- Local Intertask: Shared between families of tasks
- Global Intertask: Shared between global tasks
- Inter Processor: Shared between processors
- IP Access: Access to IP resources
- Panel Resource: Shared with panels
- File Resource: Access to files
- Channel Resource: Access to channels

FILE_NAME

Access to Files

CHANNEL RESOURCE

Access to Channels

192.168.0.10

5004
Disruptive Solution To HPC

Air & Ground Platforms connected to Satellite Networks & GPS
Disruptive Solution To HPC

Must be able to visualize Connectivity details for Sensors & Smart Weapons as well as Radios.
Disruptive Solution To HPC

Must be able to create complex scenarios - fast!
Disruptive Solution To HPC

GLOBAL_PLANNER

IND_MAIN

PATH_MODULE

SECOND_PATH_POINTS
If you use VisiSoft to build complex Real-Time Control Systems & Simulations on Parallel Processors you can save many orders of magnitude of time and money!
SINGLE PROCESSOR SPEED COMPARISONS
- GAIN 100+ X SPEED WITH VISISOFT PRINCIPLES
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The IBM Blue Gene - Using Standard Languages - 100 Racks - 1,638,400 Processors
5,000 Sq Ft. - 8,000 KW

Versus

16 Sq Ft. - 32 KW
What does that do to memory boundary crossing delays?

What about 1 to 2 additional orders of magnitude?
It doesn’t stop there!

We can shrink it more
with our architectural drawings of software!

What about a total of 4 to 6 orders of magnitude?

Know what that does to energy utilization?
And, it doesn’t stop there!

We can shrink it even more – using our hierarchical data structures to support fast heterogeneous models (time & space).

What about a total of 6 to 8 orders of magnitude*?

Know what that does to the computer field?

*Depends on the application
It still doesn’t stop there!

We can make it even faster!

Separate Parallel Processor design from Server design.

Get rid of DMA Channel Comm-Routing

And use Direct Memory Access between PC boxes.
And still - not finally,

*Use VPOS - a tailored Parallel Processing OS.*

And get rid of big time wasters, e.g.:
- Cache Coherency
- Thread Synchronization
- Stacks
- Etc.
REVIEW OF HOW THIS LEVEL OF SPEED IS ACHIEVED

- VisiSoft SINGLE PROCESSOR SPEEDS vs C++, ..., Fortran
  - Gain 2+ Orders of magnitude (already tested)

- CAN MATCH 100 RACKS WITH 1 RACK
  - Gain 2+ Orders of magnitude (obvious distances/comm)

- VisiSoft PARALLEL PROCESSOR SPEEDS
  - Gain \approx 2 \text{ Orders of magnitude} (includes PUE - already tested)

- USE HETEROGENEOUS CELL SIZES
  - Gain \approx 1 \text{ Order of magnitude} (already tested)

- USE HETEROGENEOUS TIME STEPS
  - Gain \approx 1 \text{ Order of magnitude} (already tested)

VisiSoft - CAN BEAT REAL SPEED REQUIREMENTS BY
- 6 TO 8 ORDERS OF MAGNITUDE - ON PARALLEL PROCESSORS
Not everyone needs the same tools!
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QUESTIONS