STAR-HPC

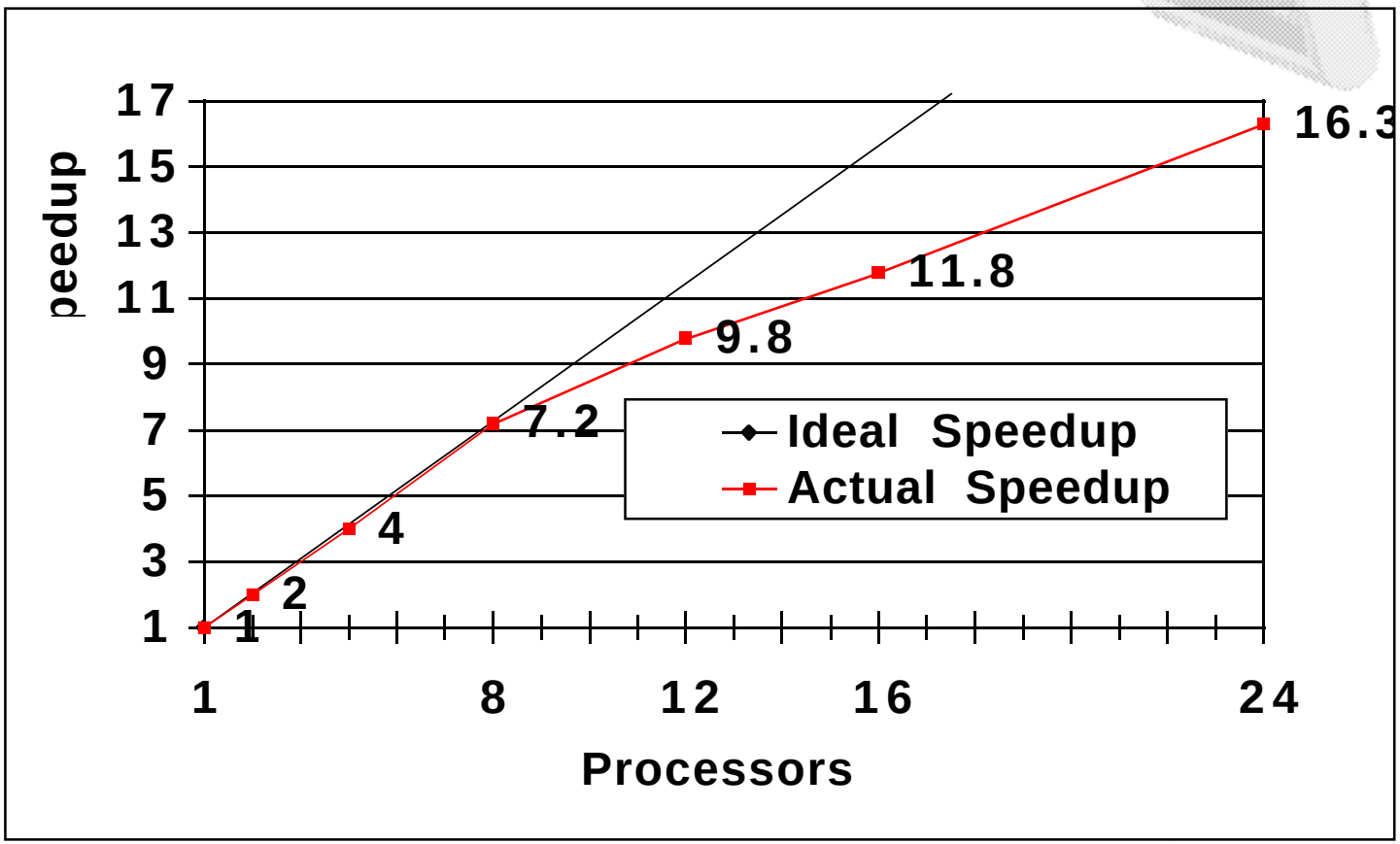
Automotive CFD CRAY T3E and CRAY J90 Results

NPES	Cells per PE	Total Haloes	Boundary	Elapsed Time (sec)	Iteration 0 time	Total Sweeps	Machine
1	2819922	0	263602	22973.8	3674.9	7408	J90
16	176245	393436	289185	1830.4	176.1	7426	J90
24	117496	455950	292059	1472.7	140.5	7416	J90
30	93998	481289	291900	1253.2	117.1	7404	J90
40	70498	570442	299597	1315.3(+)	135.7	7175	T3E
60	47000	646617	304508	951.8(+)	123.1	7160	T3E

CRAY J90 1-30 PE speedup: 98.17% parallel
CRAY J90 16-30 PE speedup: 97.09% parallel
CRAY T3E 40-60 PE speedup: 99.49% parallel

PAM-CRASH v96 Distributed Memory Scalability Example

47073 Element Example



CRAY RESEARCH
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Automotive Acoustic Optimization

Goal: Minimize noise at the riders ear by adjusting auto body thickness

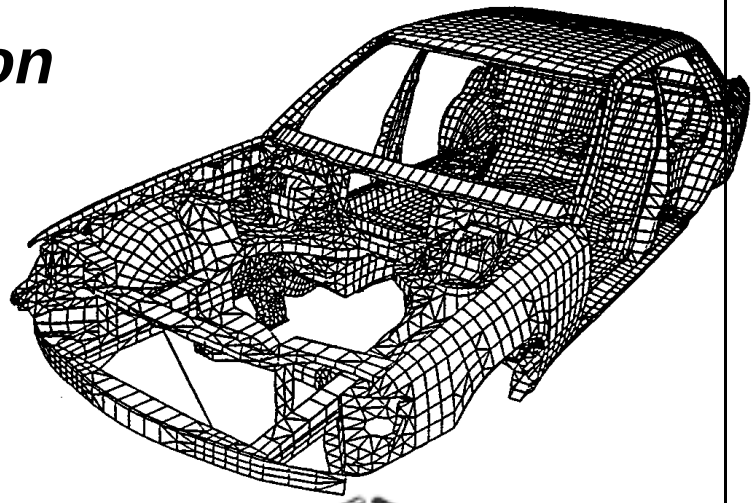
FEM Model:	***195,000***	***structural dof***
	10,000	***fluid dof***
	138	***design variables***
Computer Requirements:	***CRAY C90***	
	20,000	***CPU seconds***
	37,000	***elapsed seconds***
	802,000	***MBYTES transferred***

Automotive Acoustic Optimization Required Software Tools

- *MSC/NASTRAN V68*
  - *SPARSE Solvers*
  - *Cray EAG FFIO Libraries*
- *Cray developed DSGV1*
  - *Linked in using CRAY ISHELL feature*
- *"Adjoint Response Methods" DMAP*
  - *developed by Mladin Chargin, CDH*
- *FE Model, "body in white"*
  - *developed by auto customer*

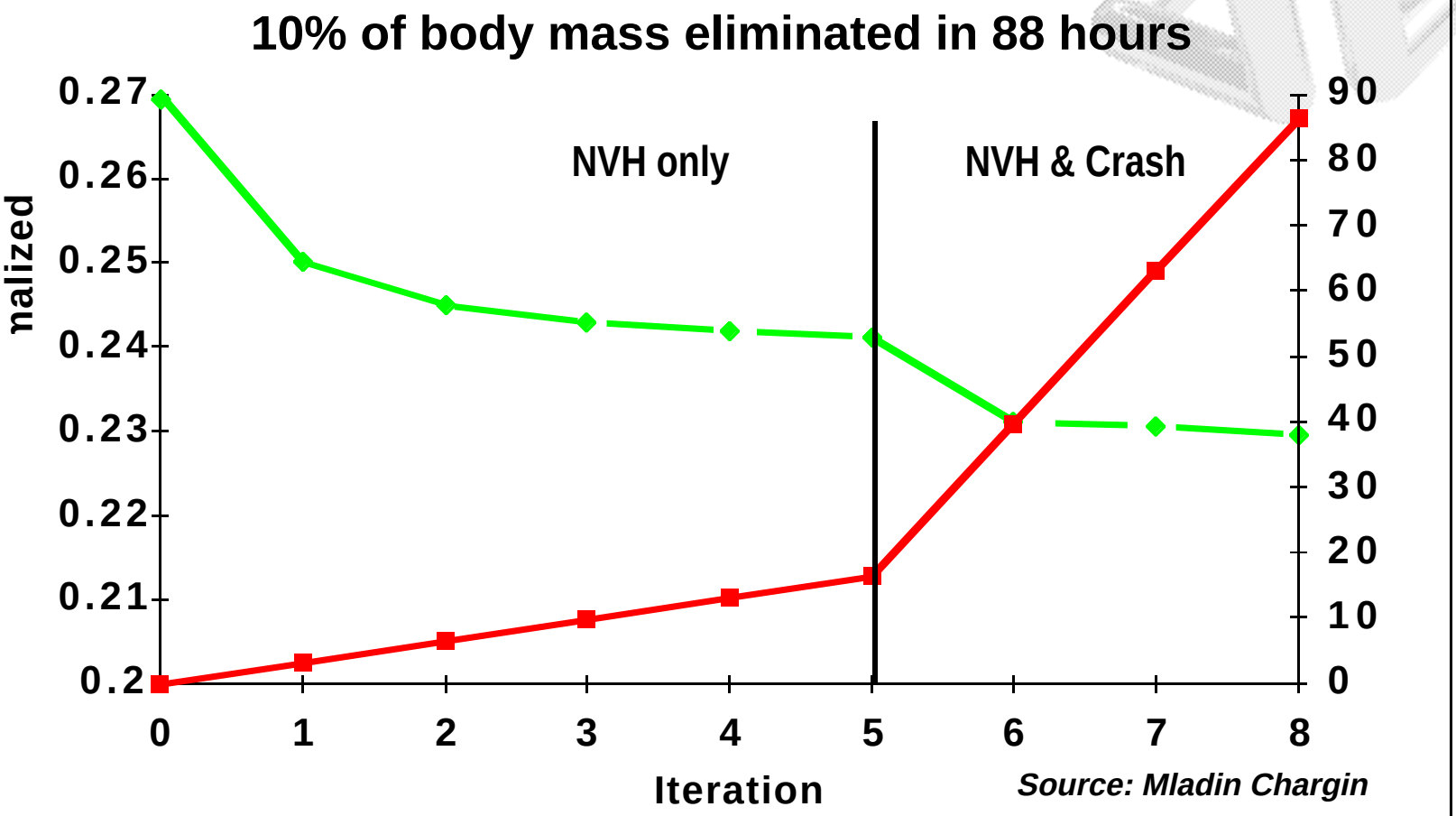
NVH & Crash Optimization of 1.1M DOF Body-in-white

- *Minimize the MASS using 126 design variables)*
  - *1.1 M DOF*
  - *≈ 90,000 elements*
- *Constrain 1st bending and 1st torsion modes*
- *Calculate 15 modes per iteration*
- *MSC/NASTRAN & LS-DYNA*
- *C90, 4 CPU's, 80MW memory*



Source: Mladin Chargin

NVH-Crash Optimization of 1.1M DOF Body-in-white



Source: Mladin Chargin

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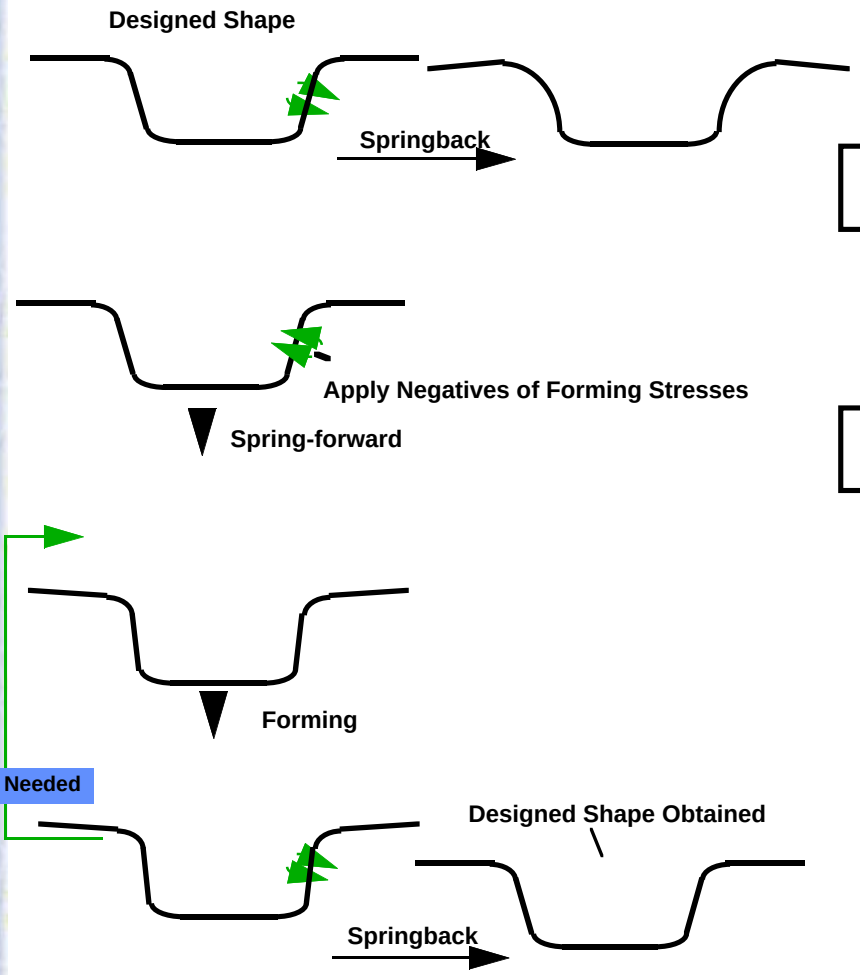
Understanding the Customer's Problems: Chemical Process CFD Users Group

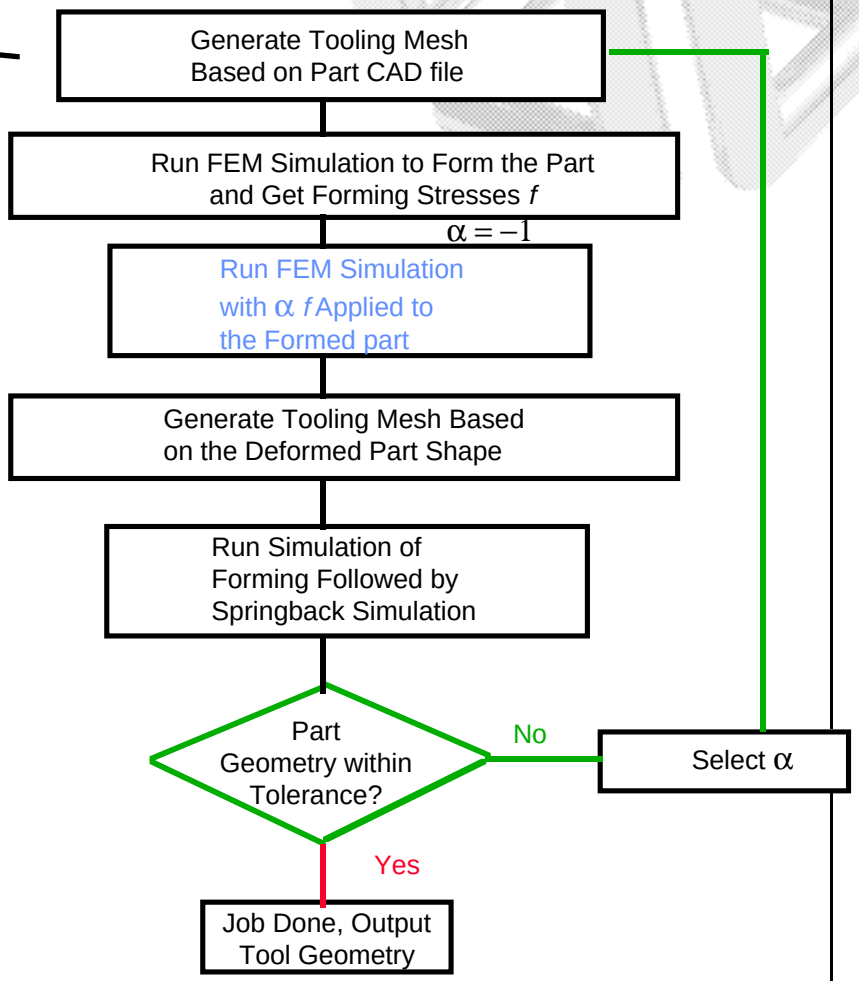
"Promote and enhance the value of CFD in the chemical process industries for competitive and economic benefit."
Founded in April, 1993

- *DOE*
- *Chemineer*
- *SGI/Cray*
- *Dow Chemical*
- *Dow Corning*
- *Du Pont*
- *Eastman Chemical*
- *Phillips Petroleum*
- *Lightnin*
- *Eli Lilly*
- *NIST*
- *Shell Oil*
- *3M*
- *Monsanto*
- *Chevron*
- *UOP*
- *Air Products*
- *Proctor & Gamble*

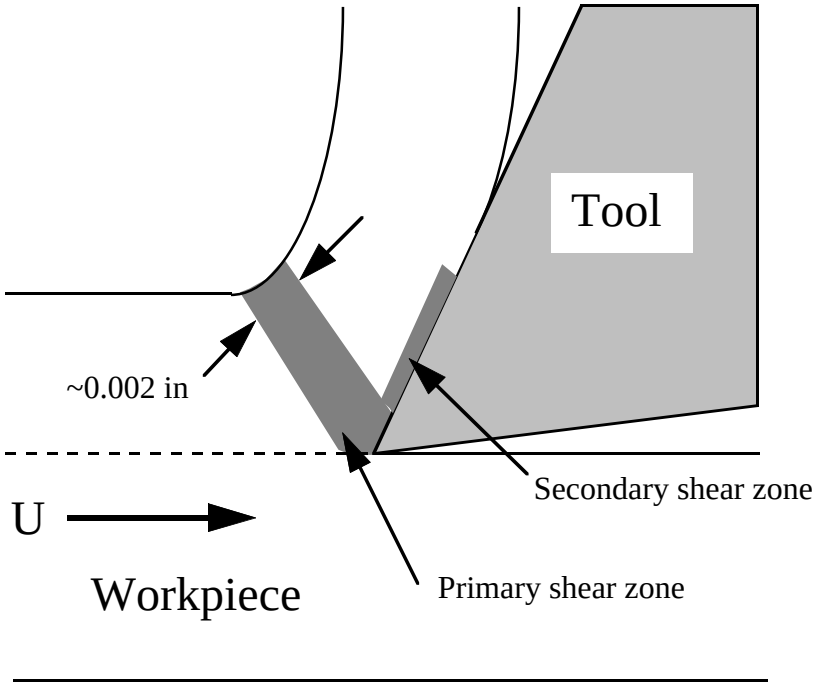
Iterative FEM Die Surface Design Algorithm to Compensate for Springback



Flow Chart of FEM Die Design Algorithm



High Speed Machining
Geometry and Physics of Metal Cutting



High Speed Machining Characteristics

- ***High strain (>2000 percent)***
- ***High strain rate (>10^6)***
  - ***Ballistic impact conditions***
- ***High gradients***
- ***Intense local heating (~1 MW/mm³)***
- ***High local temperatures***
  - ***Aluminum: > 1000 F***
  - ***Titanium: much higher***
- ***Conditions outside documented material properties***

Metal Cutting Simulation

Technology: Finite element simulation of coupled heat transfer-deformation.

Application Vendor: Third Wave Systems.

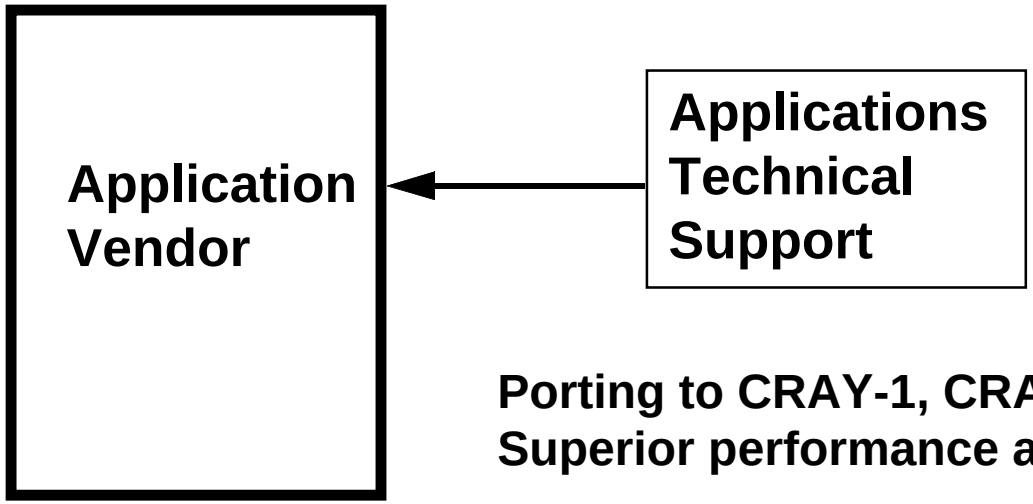
Partners: SGI/Cray, plus leaders in automotive, aerospace, materials, and tooling industries.

Status: 2D code available, 3D code under development. 2D results matching experimental data.

Challenges: materials characterization, adaptive remeshing, computing resource requirements.

Cray Application Vendor Support Model

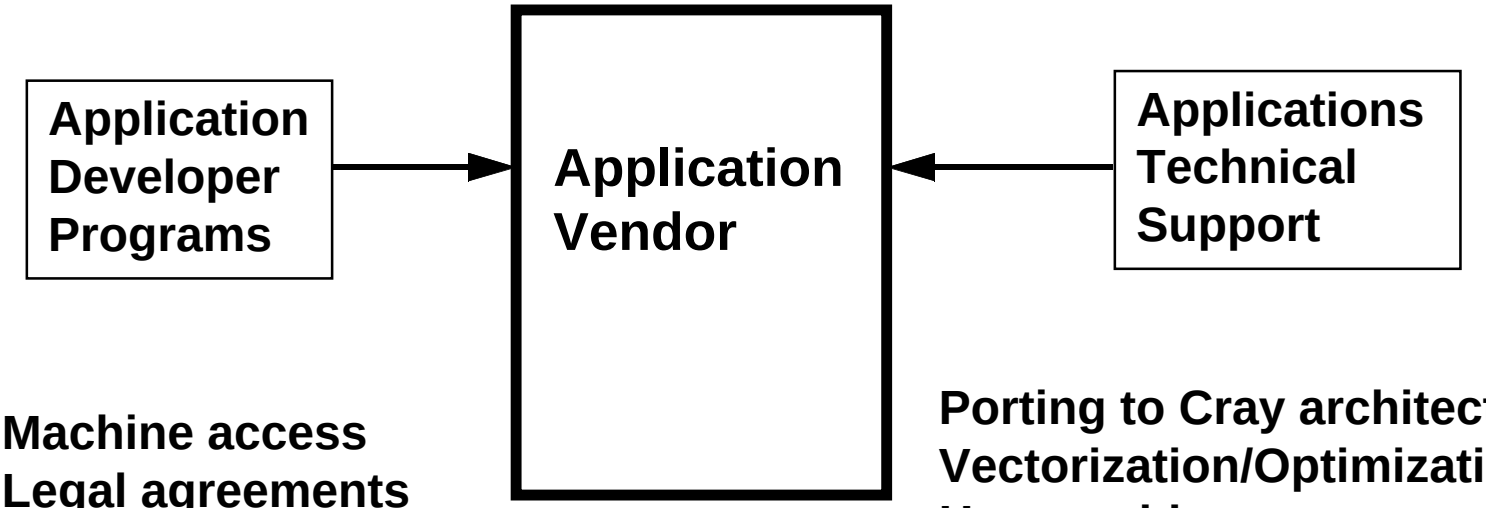
Early 1980's



Porting to CRAY-1, CRAY X-MP
Superior performance automatic

Cray Applications Support Model

- *Since Late 1980's*

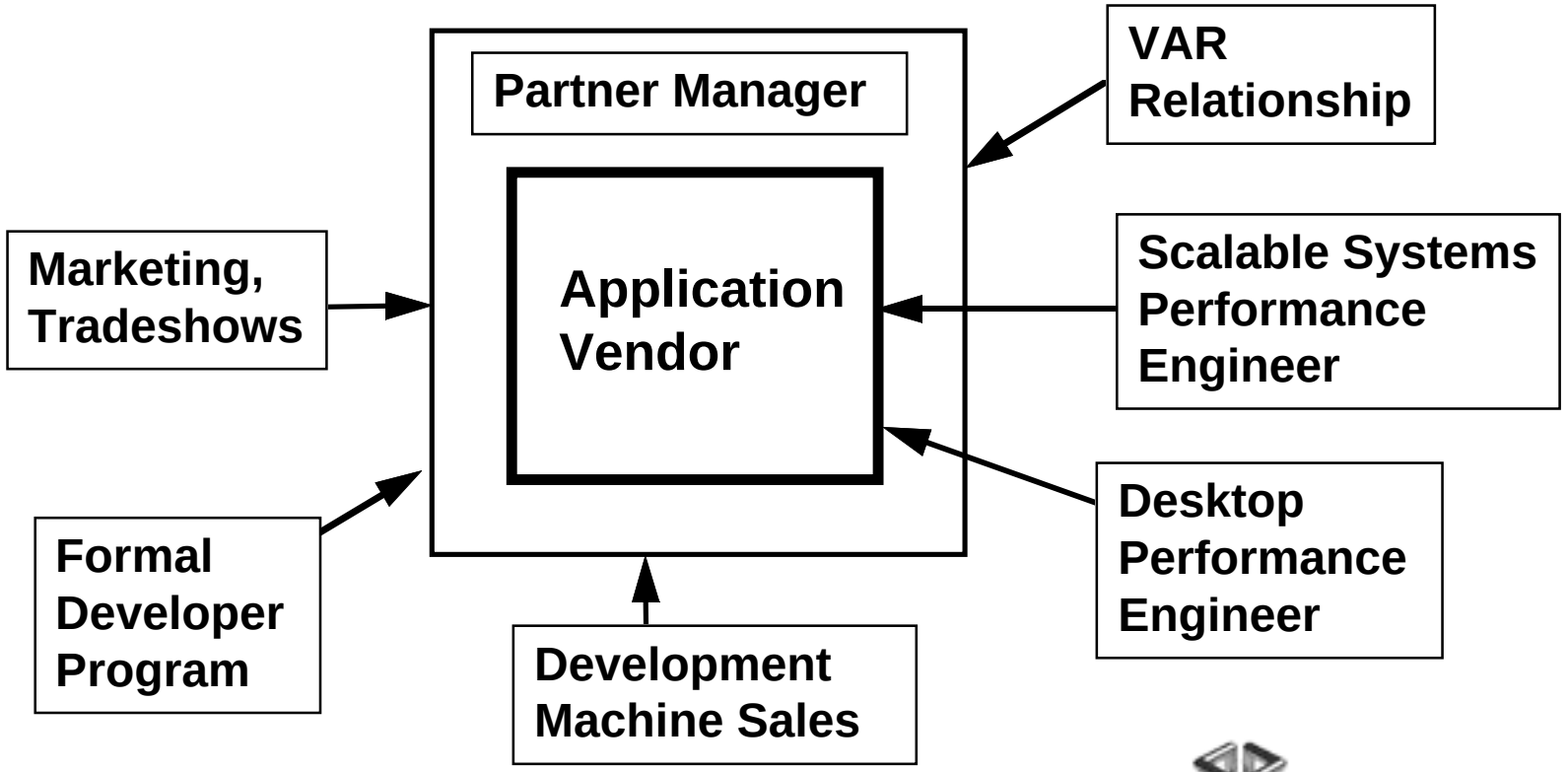


Machine access
Legal agreements
Marketing
Loaner machines
Presentation of Cray strategy

Porting to Cray architecture
Vectorization/Optimization
Hero problems

Silicon Graphics Applications Vendor Support Model

Before Cray Acquisition



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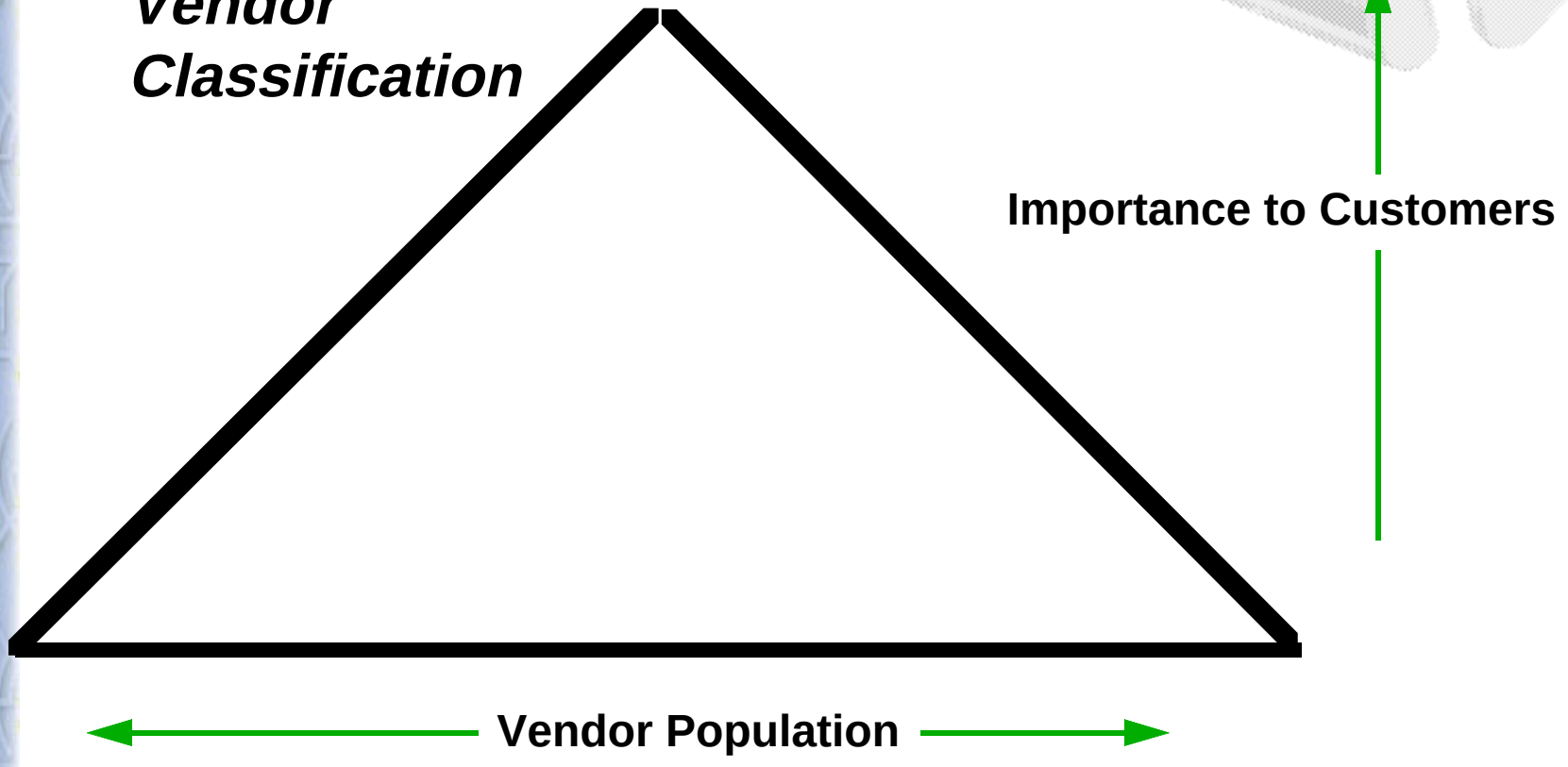
Support According to Market Demand

- ***Application Vendor Classification***



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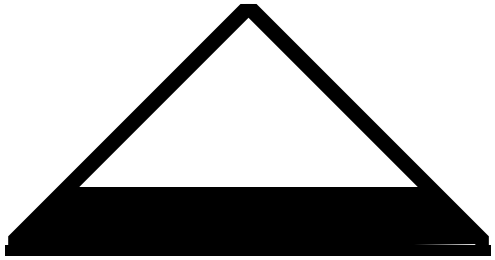
Support According to Market Demand (cont'd)

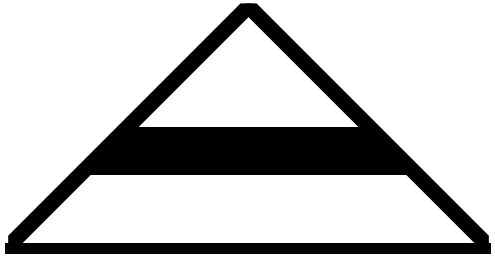


- ***Desktop Codes***
- ***(1000's in application directory)***

<u>Primary Support: SGI Developer's Program</u>

•Enterprise, Explorer, Artisan Levels
•Developer's Forum (yearly)
•Club Dev Web Site
•Dev Toolbox CD
•Hot Mix CD
•Apps Directory Listing
•Discounts on Development Machines

Support According to Market Demand (cont'd)



Locally Important Codes

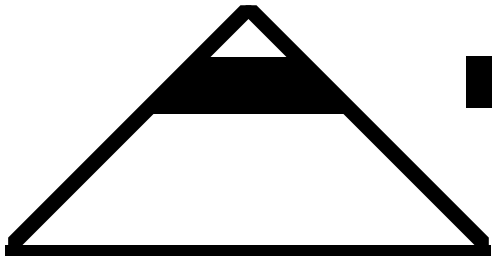
Examples

- **Traditional Cray Customers**
  - **National Labs**
  - **Environmental Centers**
- **Distant Lands**
  - **Japan (Software Cradle)**
  - **Austria (AVL/Fire)**
  - **Australia (Moldflow)**

Primary Support:

- ***Field Support from Local Offices***
- ***With Coordination from Corporate***

Support According to Market Demand (cont'd)

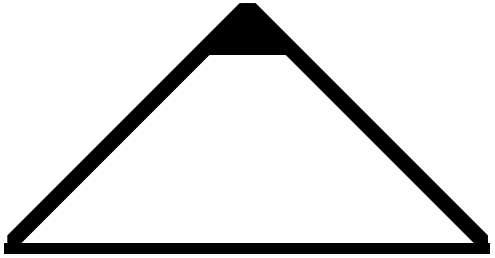


- ***Globally Important Codes***

<u>Headquarters and Worldwide Support</u>
<u>Any Combination of these Characteristics</u>

- **Dedicated performance engineer**
- **On-site porting hardware**
- **Dedicated connection to Eagan**
- **Trade Show and User Conference participation**
- **Hero Projects and Customer**
- **Marketing Materials (video, printed, ...)**

Support According to Market Demand (cont'd)



- ***Globally Critical Partners***
- ***Examples:***
  - ***Parametric Technology Corporation***
  - ***Gaussian, Inc.***

Unique Support Characteristics

•Dedicated on-site performance engineer (Gaussian)
•Global Partners Management (Parametric Technologies)

How Should We Work Together?

- *Silicon Graphics Influence with Vendors*
  - *Silicon Graphics/Cray typically among the most important, if not the most important, of the hardware platforms*
  - *Vendors largely remain independent*
- *Customer Influence with Vendors*
  - *Vendors typically much more responsive to customers*
  - *This is especially true of "Cray Customers"*
- *We are most effective working together*