Team InteGrated-Electronic Response

http://www.ecrc.gatech.edu/tiger/

Enabling Advanced Prime-Supplier Collaboration in TIGER Using STEP Product Model-Driven Analysis

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Abstract

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The DARPA-sponsored TIGER project (Team Integrated Electronic Response) demonstrates advanced engineering collaboration between primes and suppliers using standards-based design and manufacturing tools. In the TIGER scenario, a large manufacturer provides its suppliers early printed wiring assembly/board (PWA/B) design information in a standard STEP format. Suppliers use the TIGER toolset via an Internet-based engineering bureau to supplement this information with their process expertise. They then perform a variety of process-specific design checks, including design-for-manufacturability (DFM) and thermomechanical analysis. As members of the product team, suppliers feedback design improvement suggestions via a negotiation facility.

This presentation overviews this prime-supplier interaction with an emphasis on product model-driven analysis and the underlying CAD/CAE integration techniques (illustrated via thermomechanical applications). Accomplishments include the world's first usage of the STEP draft standard for PWA/Bs (AP210 DIS) to drive DFM and Ansys finite element analyses - all using live data that originates in the Mentor Graphics circuit board layout tool. The electronic commerce context is also highlighted which deals with business aspects of collaborative engineering such as electronic request for proposals, technical data exchange, and Internet-based security.

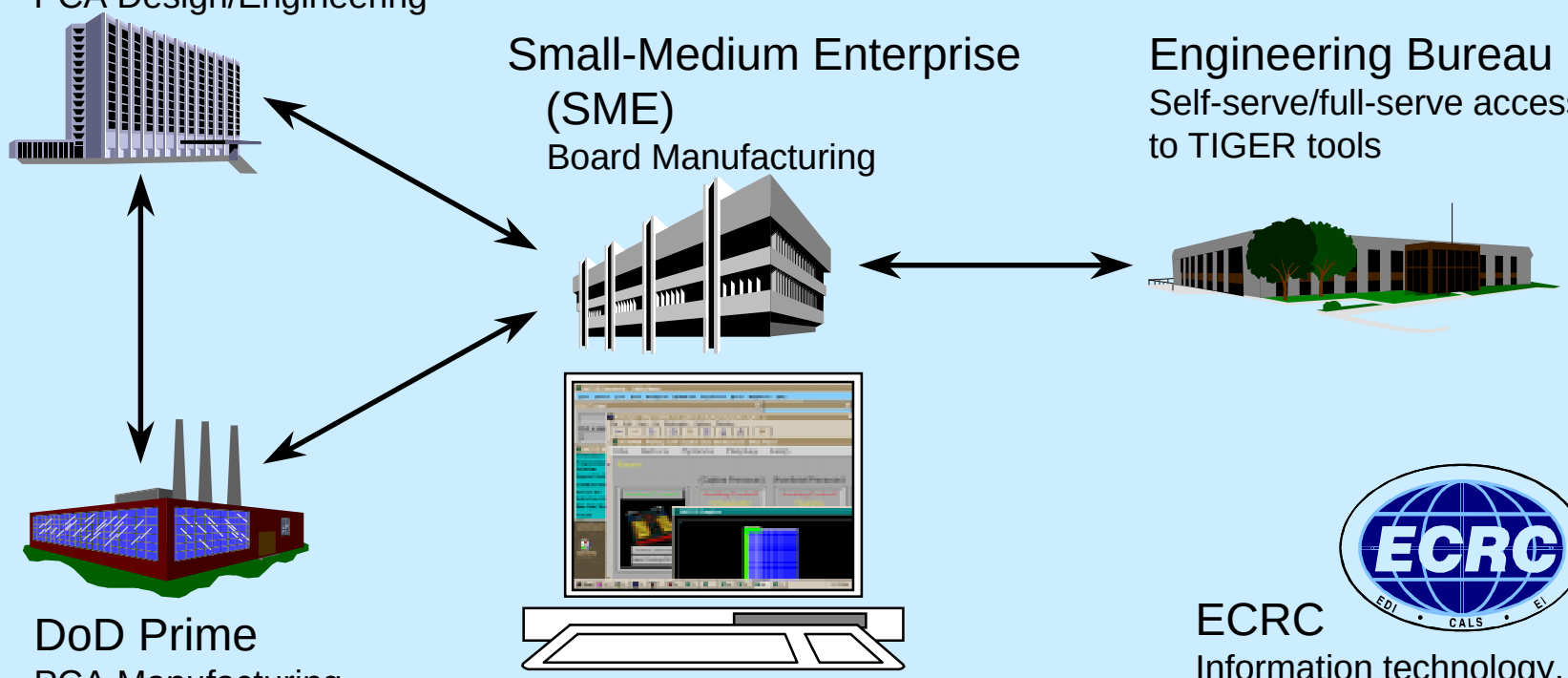
The TIGER scenario has been tested with Boeing and Holaday Circuits as a representative prime and supplier, respectively. Other team members are Arthur D. Little, Atlanta Electronic Commerce Resource Center, Georgia Tech, International TechneGroup Inc., and South Carolina Research Authority. Related activities underway at the Atlanta Electronic Commerce Resource Center to support small businesses are included.

Experiences indicate TIGER leverages the expertise of suppliers to provide certain design checks that are more precise than those typically done by primes. The Internet-based engineering bureau offers these checks to suppliers on a cost-effective basis ranging from self-service (for highly automated routine analyses) to full- service (for challenging new analyses). This paradigm provides suppliers advanced capabilities without requiring expensive in-house tools and expertise. Overall, the advantage of TIGER techniques is the effective inclusion of suppliers in the product team, resulting in timely, cost-saving design improvements. Further information is available at http://eislab.gatech.edu/tiger/

TIGER: Advanced Engineering Collaboration

BAA 95-23

... among DoD Primes & SMEs,
using standards-based tools (TDI/EDI & STEP),
facilitated by ECRC technology & services



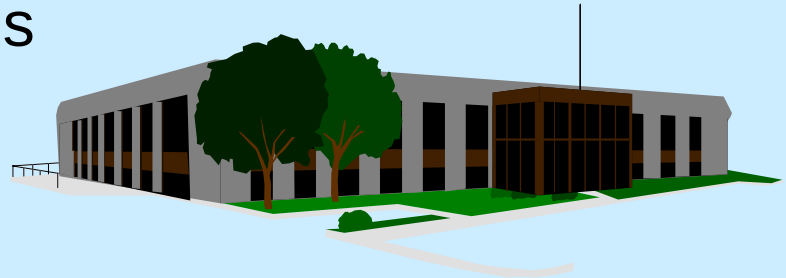
Electronic Commerce Resource Centers (ECRCs)

National Program

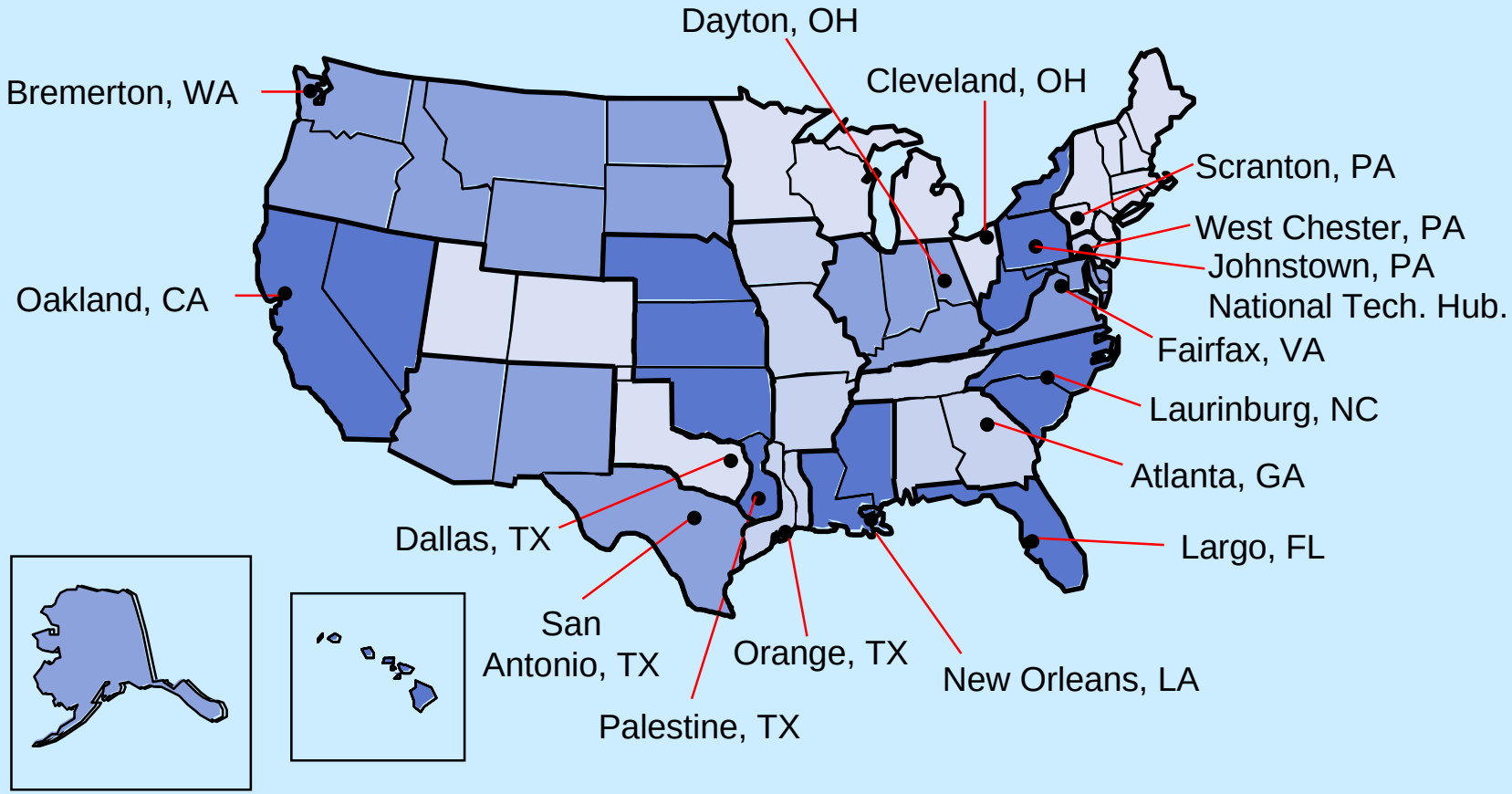
Provide assistance to government organizations and small-to-medium-sized businesses by introducing electronic commerce into their business practices

Atlanta ECRC Role in TIGER

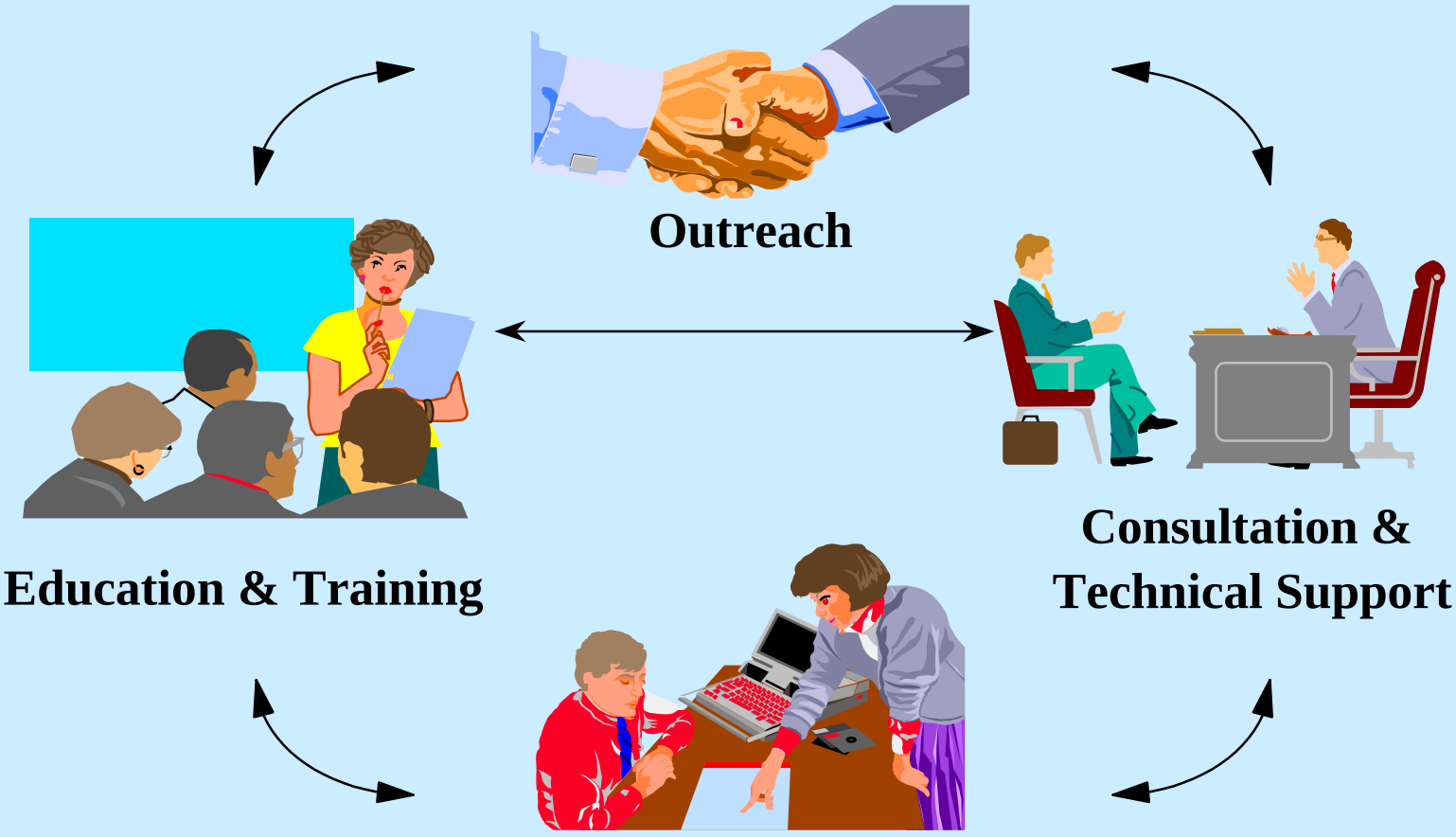
- Information technology support for SMEs (Small-Medium Enterprises)
- Demonstration engineering service bureau
- Technology transfer to SMEs



Regional ECRCs



ECRC Core Functions



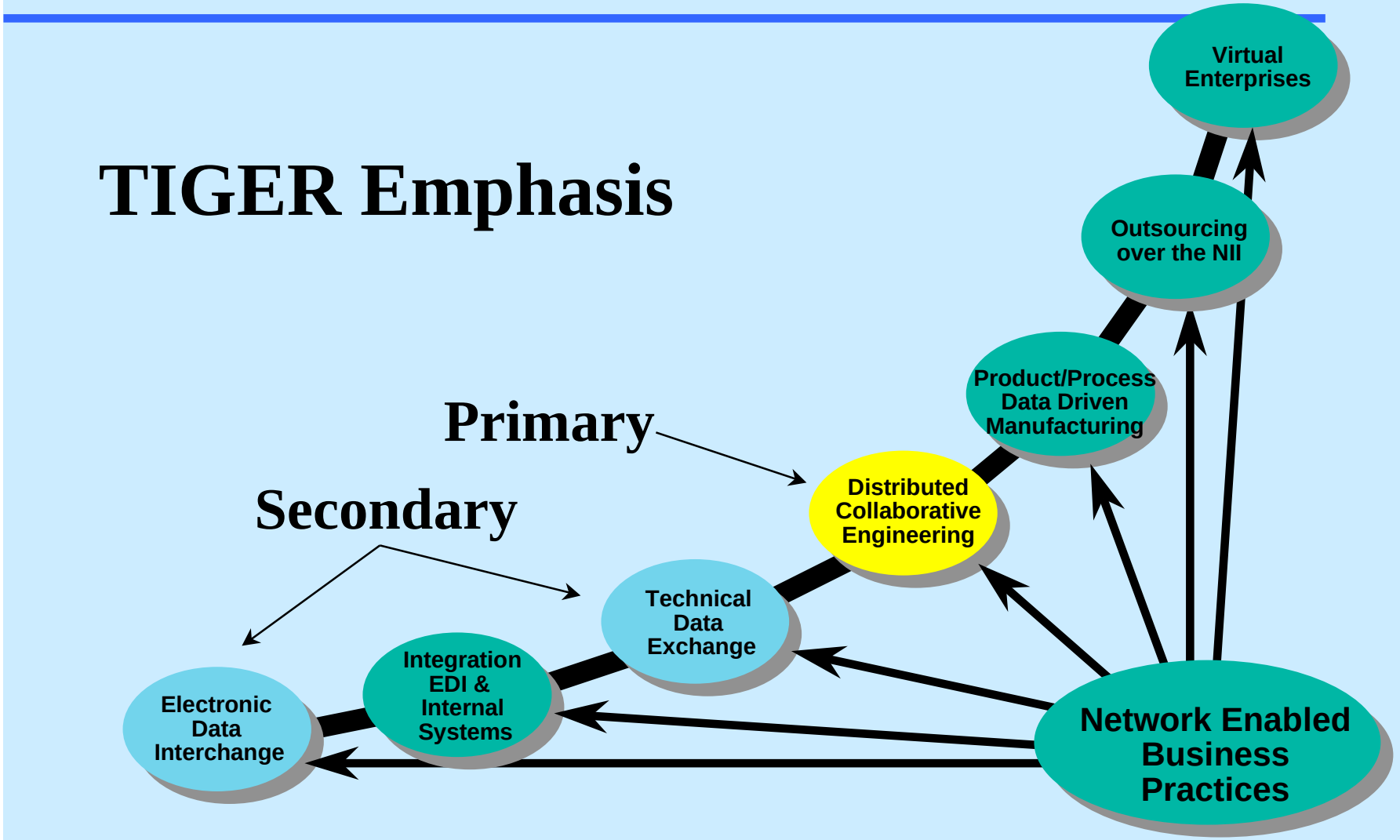
ECRC Course Curriculum

- Getting Started with Electronic Commerce
- Business Opportunities With the DoD Through EDI
- Electronic Funds Transfer
- Internet Basics for Small & Medium-sized Companies

- Technical Data Exchange
- Legacy Data Management
- STEP and Product Data Modeling

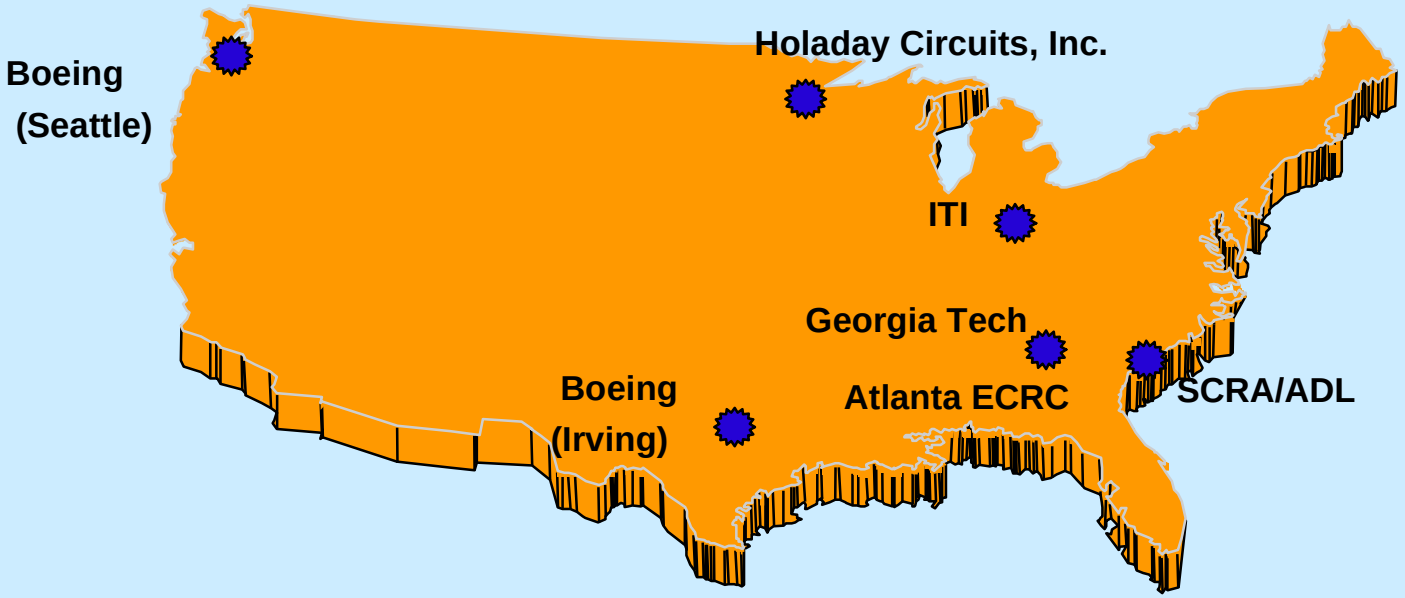
Contacts for ECRC Services &Course Schedules:
Atlanta ECRC: www.ecrc.gatech.edu, ecrcinfo@ecrc.gatech.edu, 800-894-8042
National ECRC: www.ecrc.ctc.com

Electronic Commerce Continuum



Team InteGrated-Electronic Response

TIGER Team Members



Team Roles:

Holaday
- Pilot SME
- Board Mfg. Expert

SCRA
- Software Enhancement, Integration
- Technical Management
- Technical Support

Boeing
- Pilot DoD Prime
- Software Enhancement, Integration

Georgia Tech
- Analysis Tools
- Software Integration

Atlanta ECRC
- EC Services/Support
- Technology Transfer

ITI
- Software Development, Integration

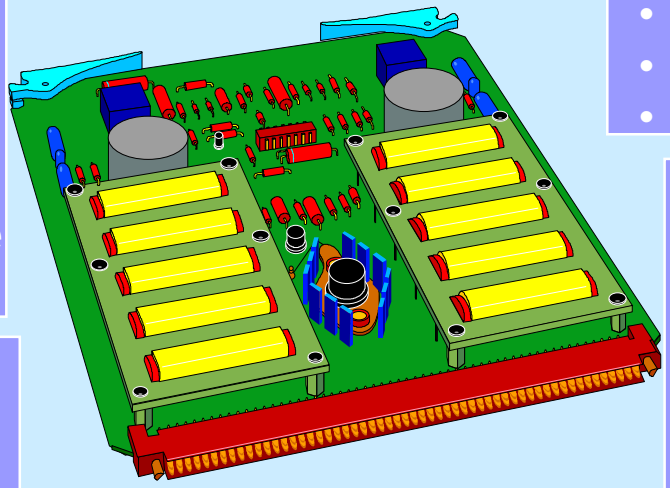
ADL
- Technical Support
- Management Support

STEP AP 210
PCA Design Information

Product Structure/ Connectivity
- Functional
- Packaged

Part
- Functionality
- Termination
- Shape 2D, 3D
- Single Level Decomposition
- Material Product
- Characteristics

Physical
- Component Placement
- Bare Board Geometry
- Layout items
- Layers non-planar, conductive & non-conductive
- Material product



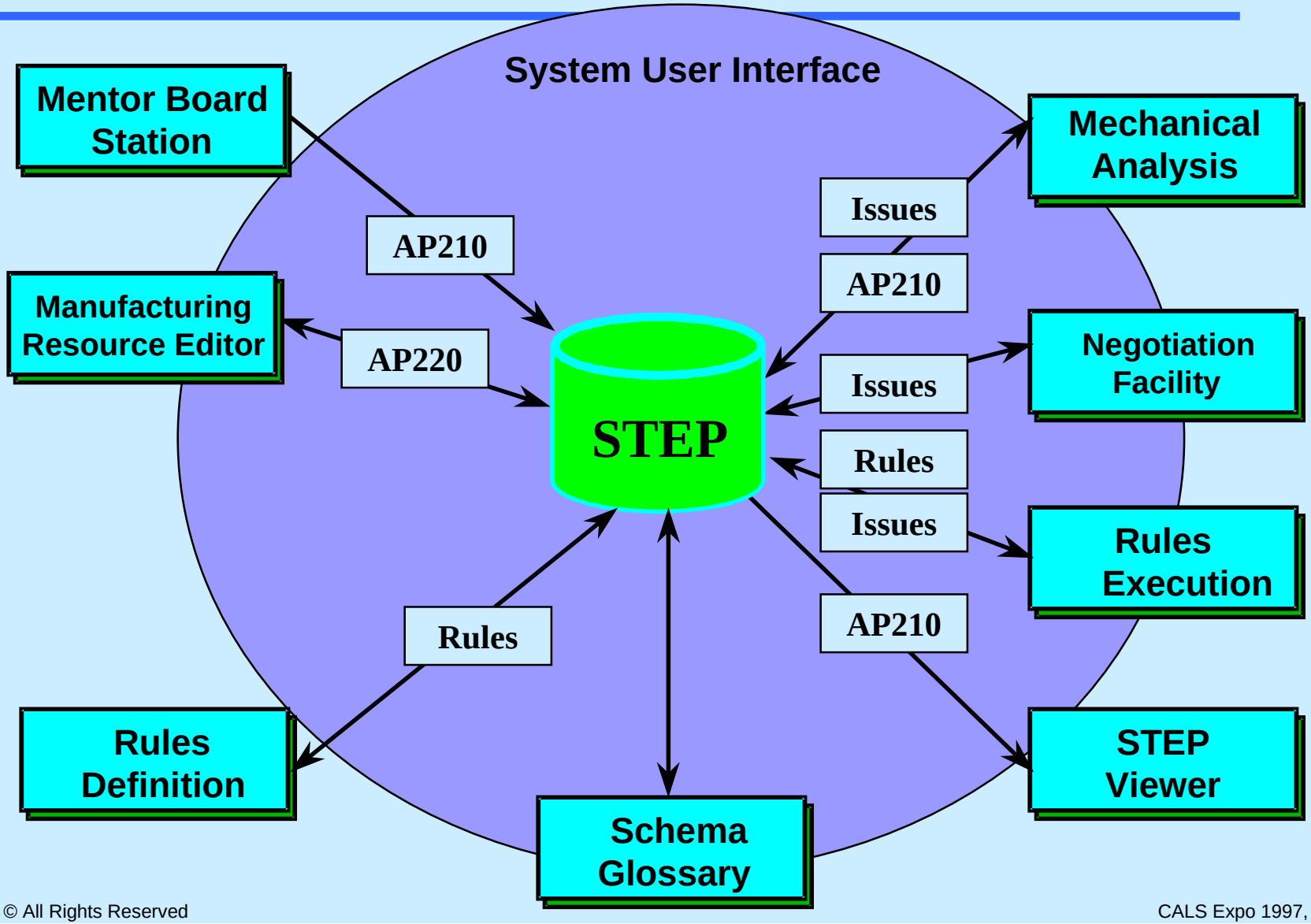
Configuration Mgmt
- Identification
- Authority
- Effectivity
- Control
- Requirement Traceability
- Analytical Model
- Document References

Geometry
- Geometrically Bounded 2-D Shape
- Wireframe with Topology
- Advanced BREP Solids
- Constructive Solid Geometry

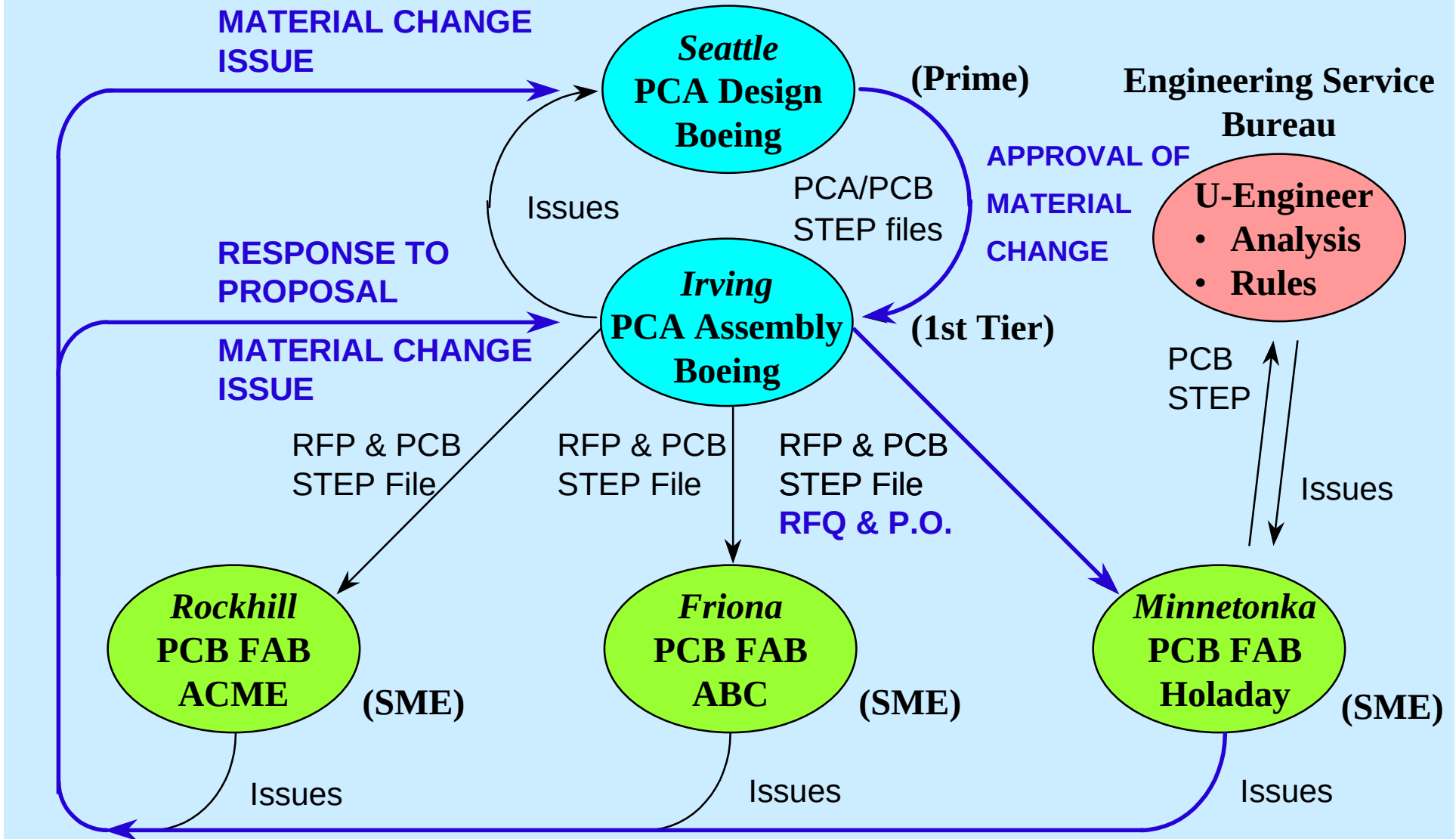
Requirements
- Design
- Allocation
- Constraints
- Interface

Technology
- Fabrication Design Rules
- Product Design Rules

TIGER Tool Architecture



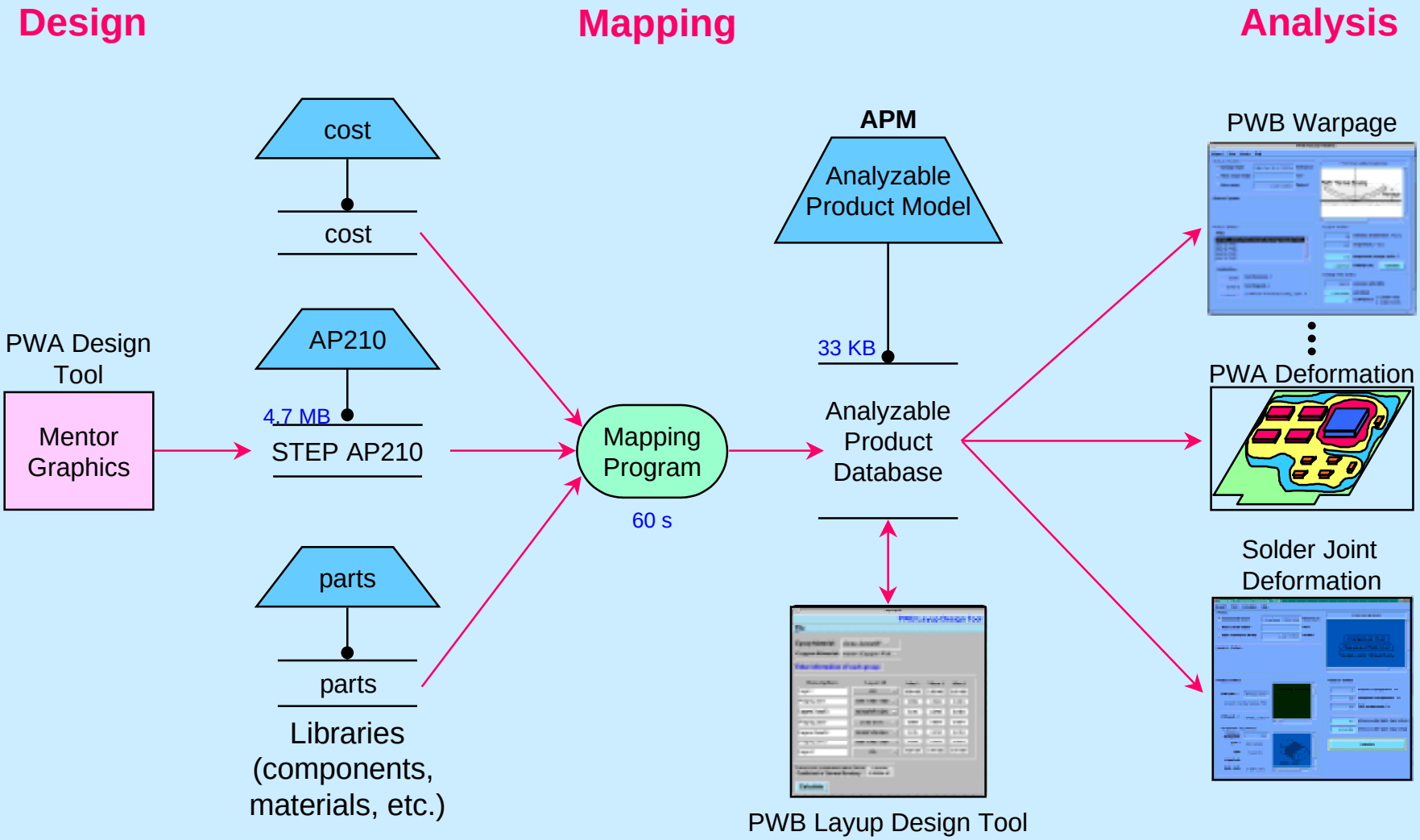
Collaborative Engineering Scenario



Engineering Service Bureau

- Provides SMEs with cost effective, Internet-based access to TIGER Tools
- STEP-based
- Secure Data Transfer (encryption)
- Self-serve and Full-serve analysis
- Highly Automated PWA/B Analysis
  - Warpage Analysis
  - Plated Through Hole Fatigue
  - Solder Joint Stress Analysis

STEP Product Data-Driven Analysis



Iterative Design & Analysis

PWB Layup Design Tool

Layup Redesign

Thermal Bending Model

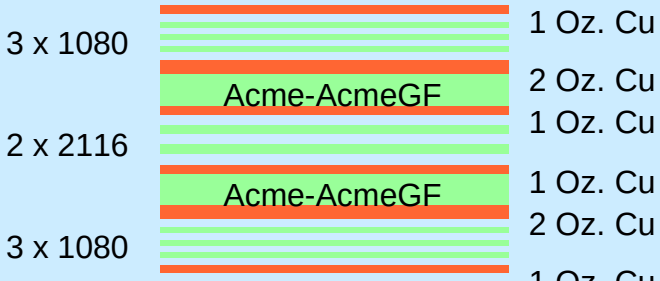
Quick Formula-based Check

$$\delta = \frac{\alpha_b L^2 \Delta T}{t}$$

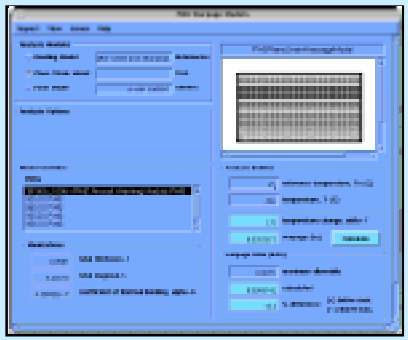
$$\alpha_b = \frac{\sum w_i \alpha_i y_i}{t/2 \sum w_i}$$

Analyzable Product Database

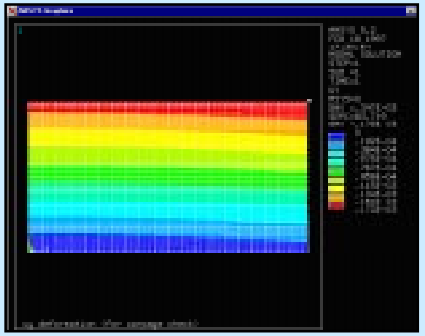
PWB Warpage Modules



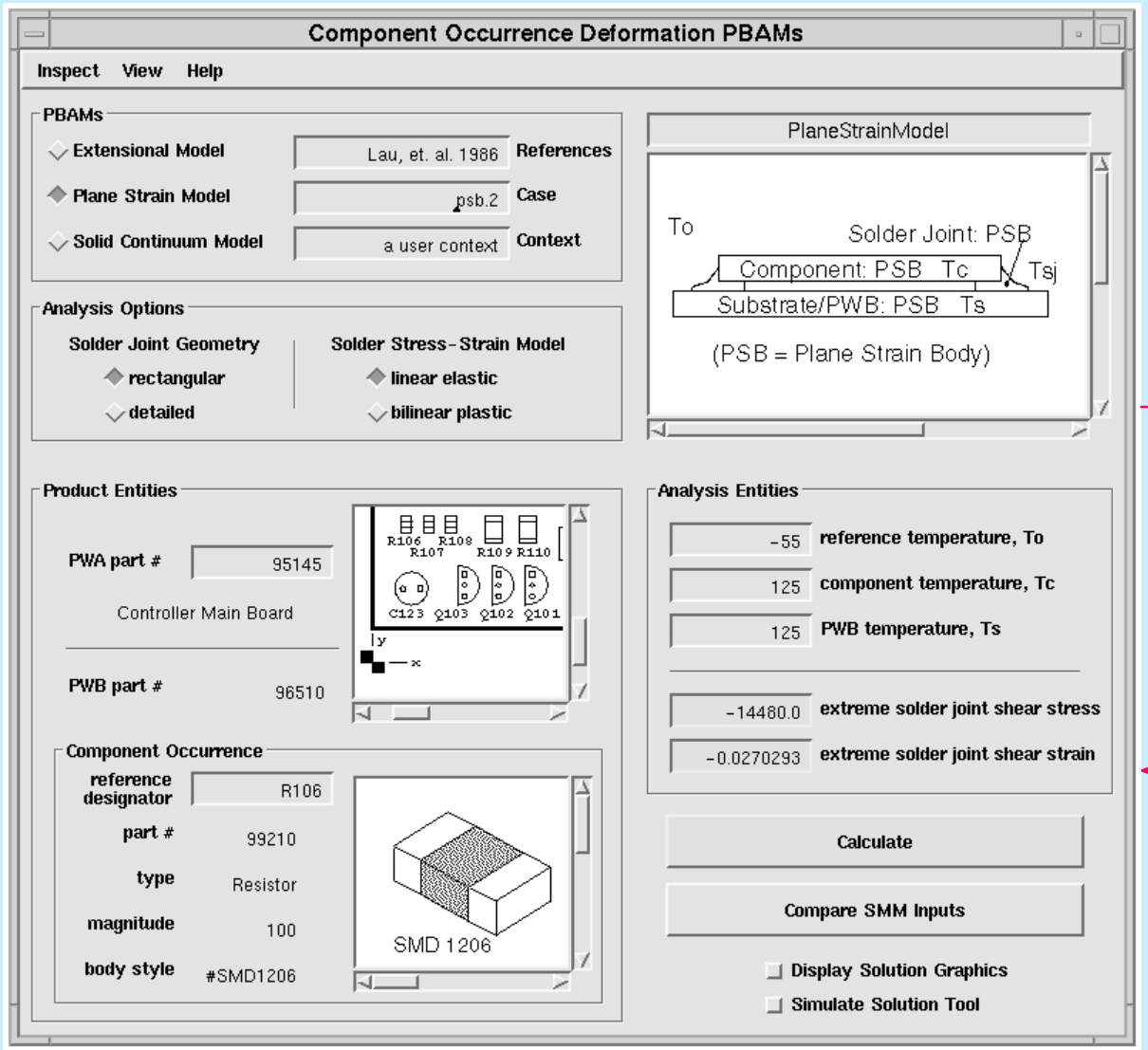
Plain Strain Model



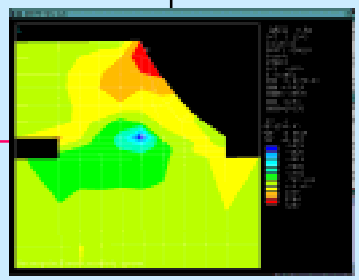
Accurate FEA Check



Solder Joint Deformation Catalog: Plane Strain Model (FEA-based)



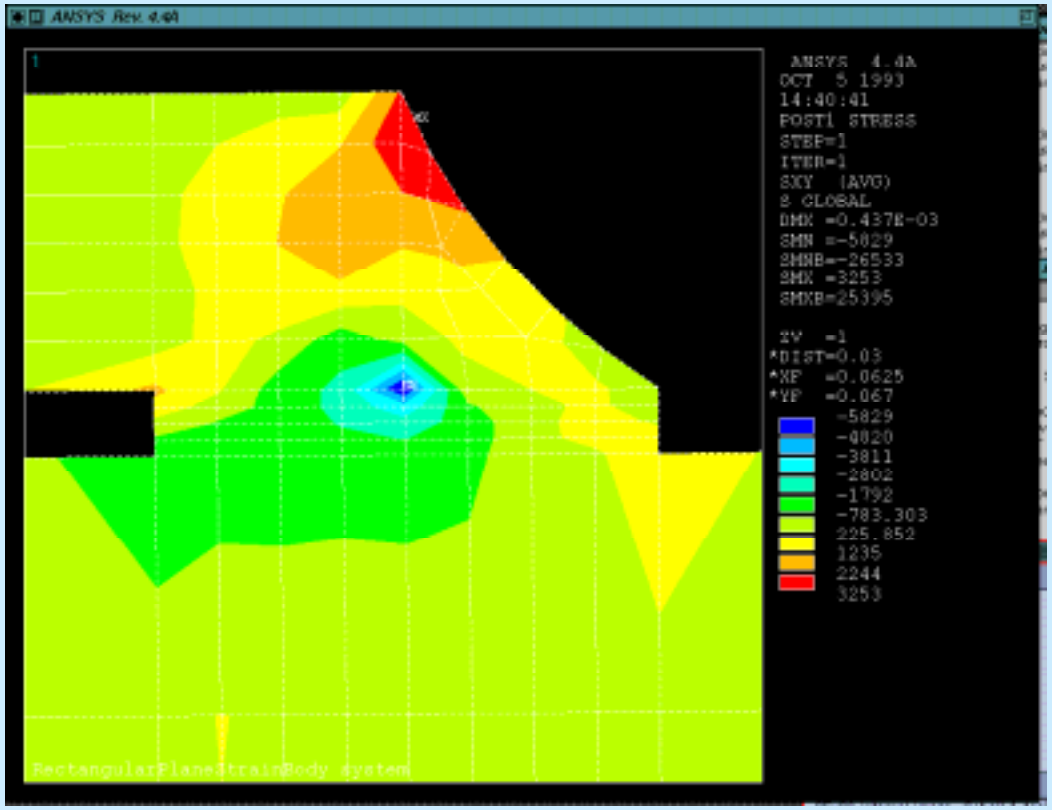
FEA Tool (Ansys)



Highly Automated Analysis

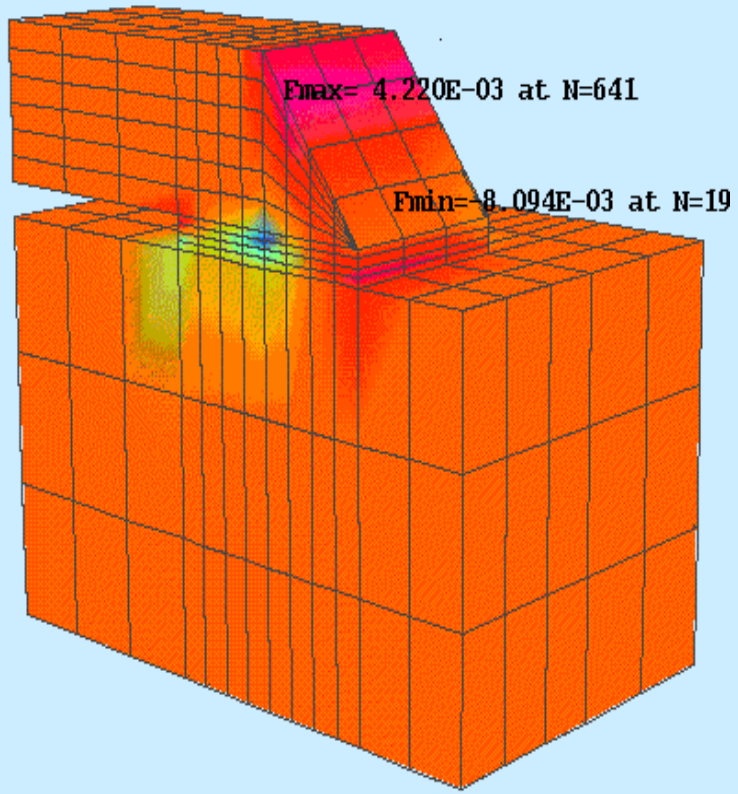
Solder Joint Deformation

Plane Strain Model
Shear Stress



Ansys FEA Tool

Solid Continuum Model
Shear Strain

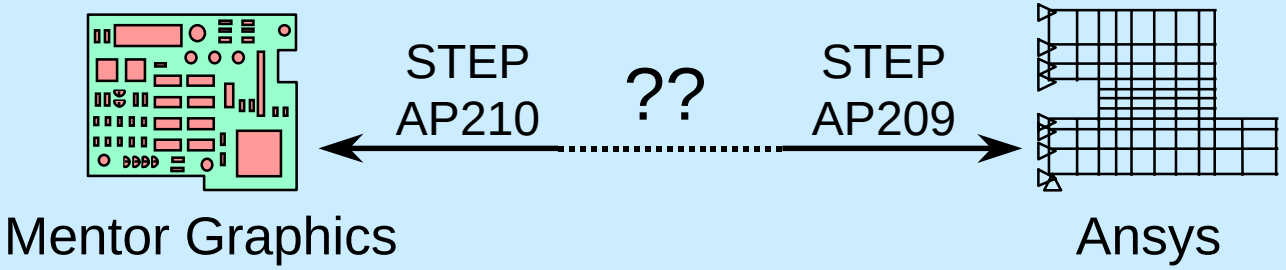


Hitachi FEA Tool

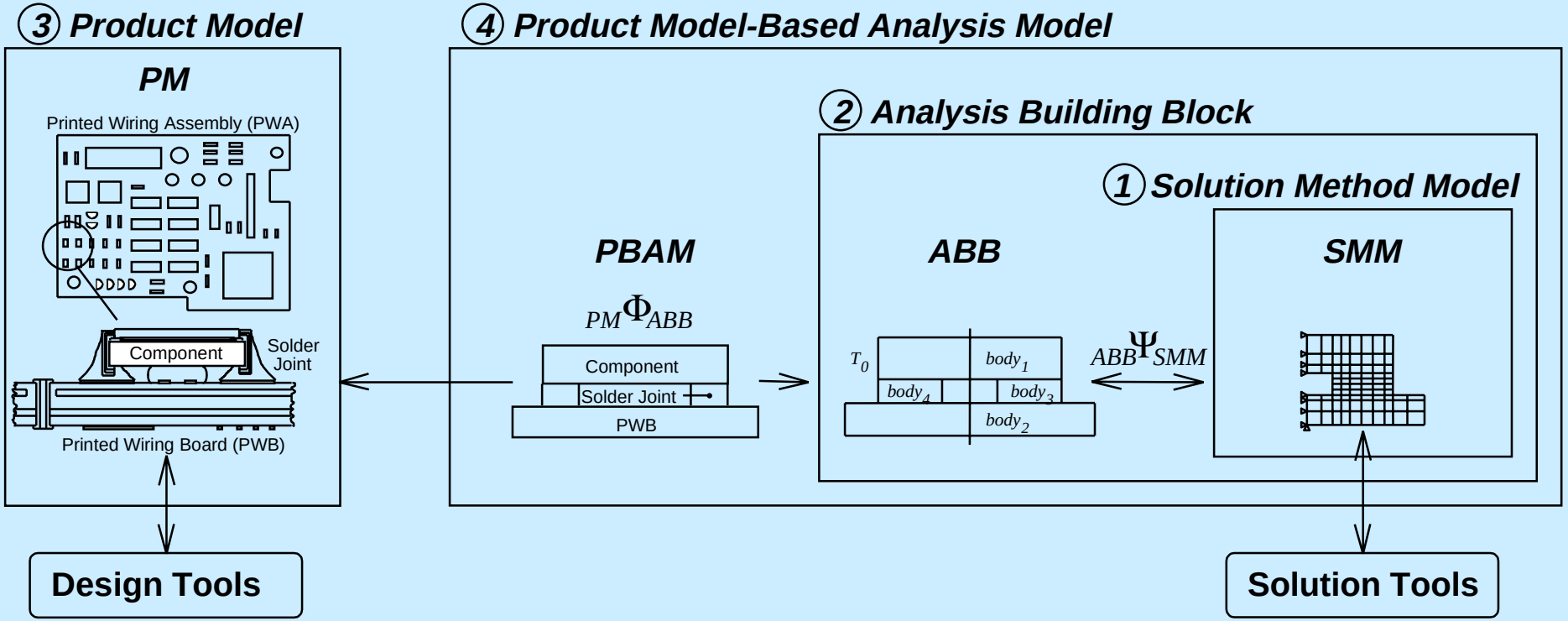
Analysis Integration Challenges: Heterogeneous Transformations

- Homogeneous Transformation

- Heterogeneous Transformation



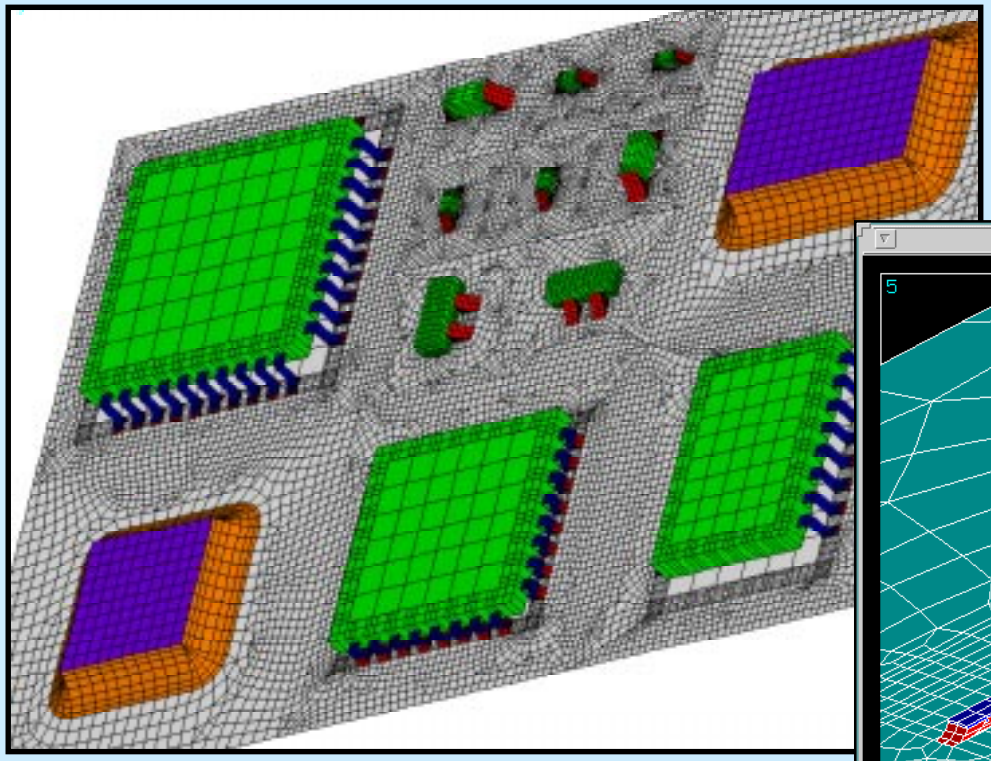
Multi-Representation Architecture for Design-Analysis Integration



- Composed of four representations (information models)
- Provides flexible, modular mapping between design & analysis models
- Creates automated, product-specific analysis modules (PBAMs)
- Represents design-analysis associativity explicitly

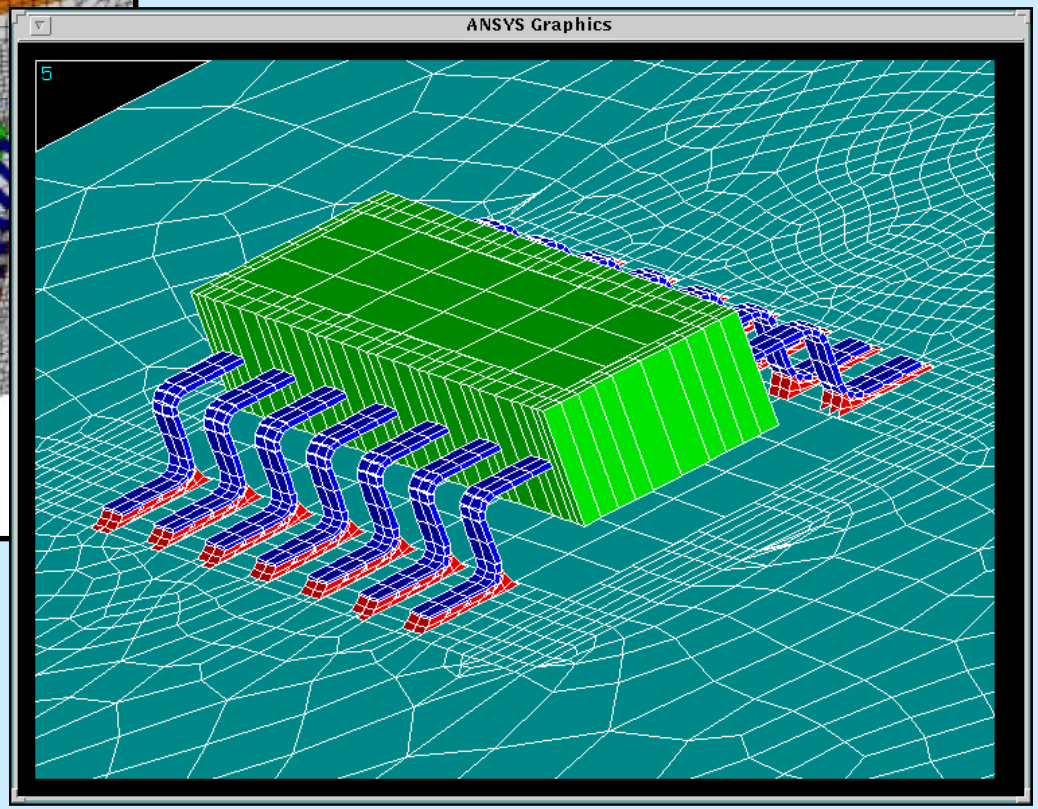
Product Data-Driven FEA

Full Board



PWA Warpage Models

SOIC-14 Close-up



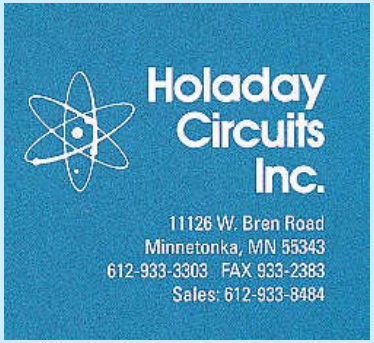
Design-Analysis Integration (DAI) Emphasis

- Multi-Representation Architecture (MRA)
  - Addressing fundamental DAI issues
  - General methodology --> Flexibility & broad application
- TIGER experience with AP210
  - One of the world's first STEP product data-driven analysis
- Research, applications, and tech. transfer
  - Baseline integration toolkit: *DaiTools v3.0*
  - STEP pilots
  - Demonstration engineering service bureau (at Atlanta ECRC)
- Industry & government collaboration

Integrated Product Team Solutions

Requirement	Solution
Distributed Sites	Internet Communications
Heterogeneous ECAD Systems	STEP AP210 Product Data Standards
Diverse Assembly & Fabrication Capabilities	STEP AP220 Manufacturing Data Standards
Diverse Business Systems	EDI Standards
Issue Resolution	Internet/STEP Negotiation Facility
SME Limited Resources	ECRC Training/ Service Bureau Access to TIGER Tools

Benefits for SMEs



- **Strengthens collaborative relationship with the Prime via the Negotiation Facility**
- **Enables cost-effective access to expensive, advanced DFM & analysis tools**
- **Provides a competitive advantage in terms of product quality improvement**

Benefits for Primes

BOEING

- **Strengthens the business relationship with SMEs**
- **Allows SMEs to bring more value to the IPT (Integrated Product Team)**
- **Supports the Design Anywhere, Build Anywhere philosophy**
- **Supports Digitally Driven Enterprise initiative**
- **Improves communications between engineering and manufacturing**

Supply Chain Benefits

- **Improved part performance, reliability, & mfg. yields**
- **High-potential engineering service bureau paradigm**
- **STEP product data-driven analysis technology**
- **Applications to diverse product domains**

- **Demonstrates benefits of STEP in Tech. Data Pkgs.**
  - **Provides SMEs rich product models vs. raster data**
  - **Enables automated data-driven manufacturing**
- **Expedites part delivery**

Summary

Goal ***Enable advanced collaboration between SMEs and DoD Primes***

A STEP Towards Printed Circuit Design Iterations In About an Hour!

For more information, please visit the Atlanta ECRC web at http://www.ecrc.gatech.edu/tiger/