



先进制造网格

支持航空工业异地联合设计和仿真

Advanced Manufacturing Grid

Supporting Aviation Industry Extensive Collaborative Design and Simulation



Cui Degang

BEIHANG University

China Aviation Industry Corporation II (AVIC II))

2006.2

AVIC II BUAA Copy Right





1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

1.1 国民经济与航空工业

1.1 The Growth of National Economy and Aviation Industry in China

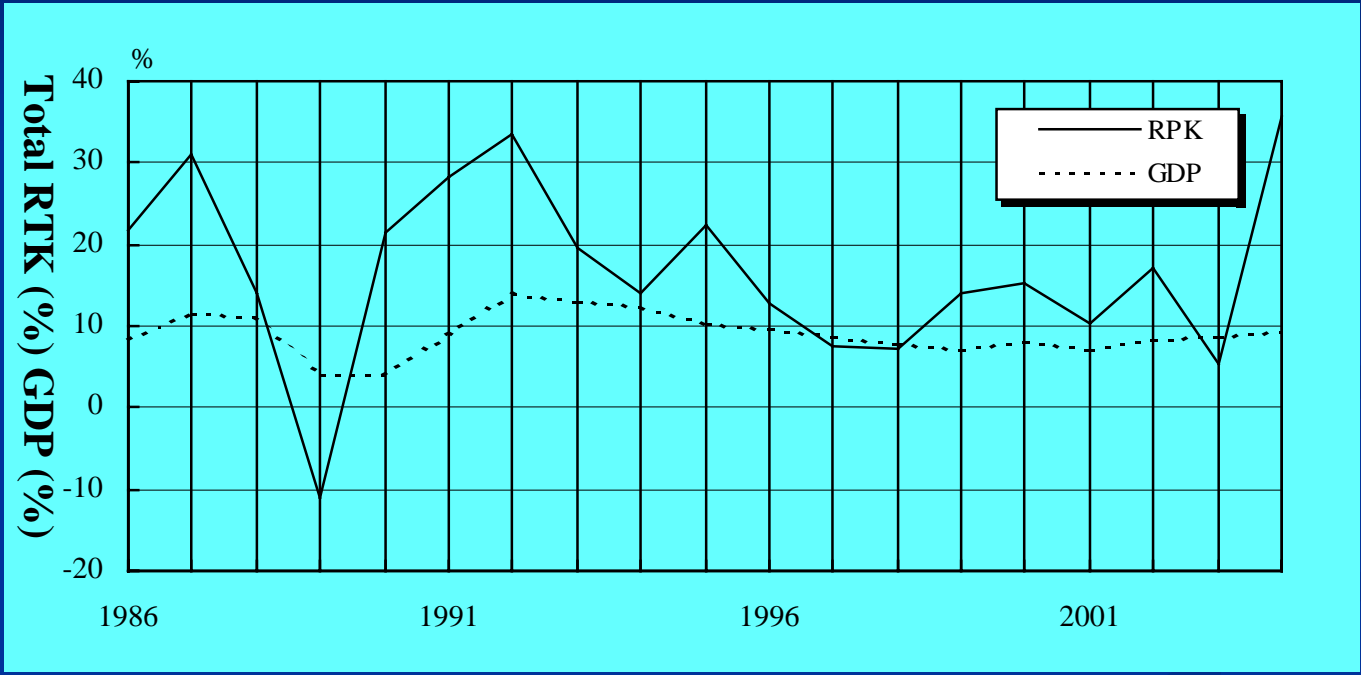
航空工业对国民经济发展起着重大推动作用，也是国民经济的增长的反映。世界、亚洲及我国近15年的统计表明，航空运输业的增长一般是国民经济GDP增长速度的一倍。

Aviation industry is represented the economy growth situation of the country. The growth rate of air travel normal is double rating of the GDP rate of the national after review the 15 years statistics in China.



1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future



.航空运输总周转量增长情况与国民经济GDP增长情况
 The growth rate of air travel and GDP (1983-1998)
 (China market outlook for civil aircraft 2004-2023)



1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

B. 中国民机市场需求明显

B. A Large Market Requirement for Passenger Aircraft

12,123万旅客2004年, 增长38.4%

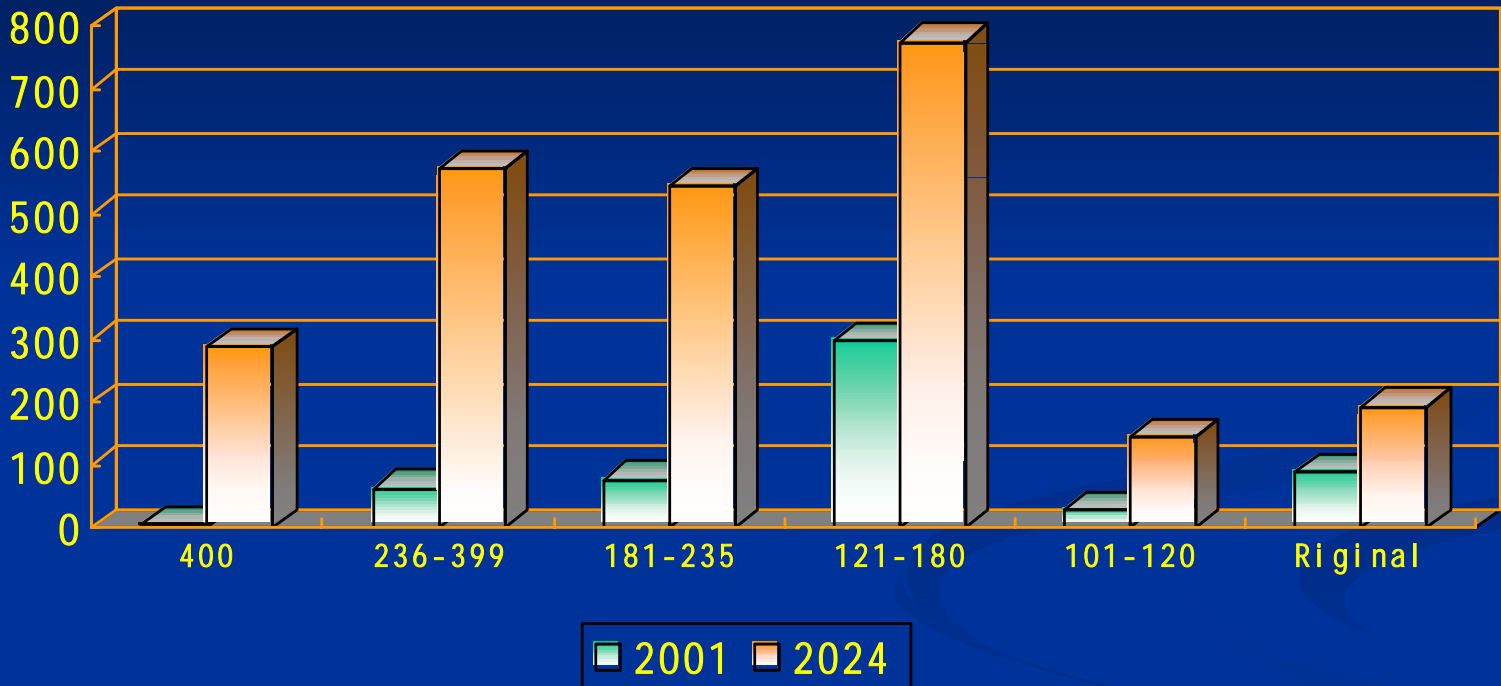
121.23 Million Passengers in 2004, increasing 38.4%

在未来20年中国需要2541架民用客机, 货机448架

Forecast Required 2541 Passenger Aircraft and 448 Freights, it costs \$120 billion in the China Market during 20 Years

C. 2004年中国航空运输周转量增长35.2%, 高于往年

C. The total RTK of China air transportation is 35.2%, much high than before.



根据中国航空发展研究中心的预测，目前和到2024年
中国民航需要的各种类型飞机数量

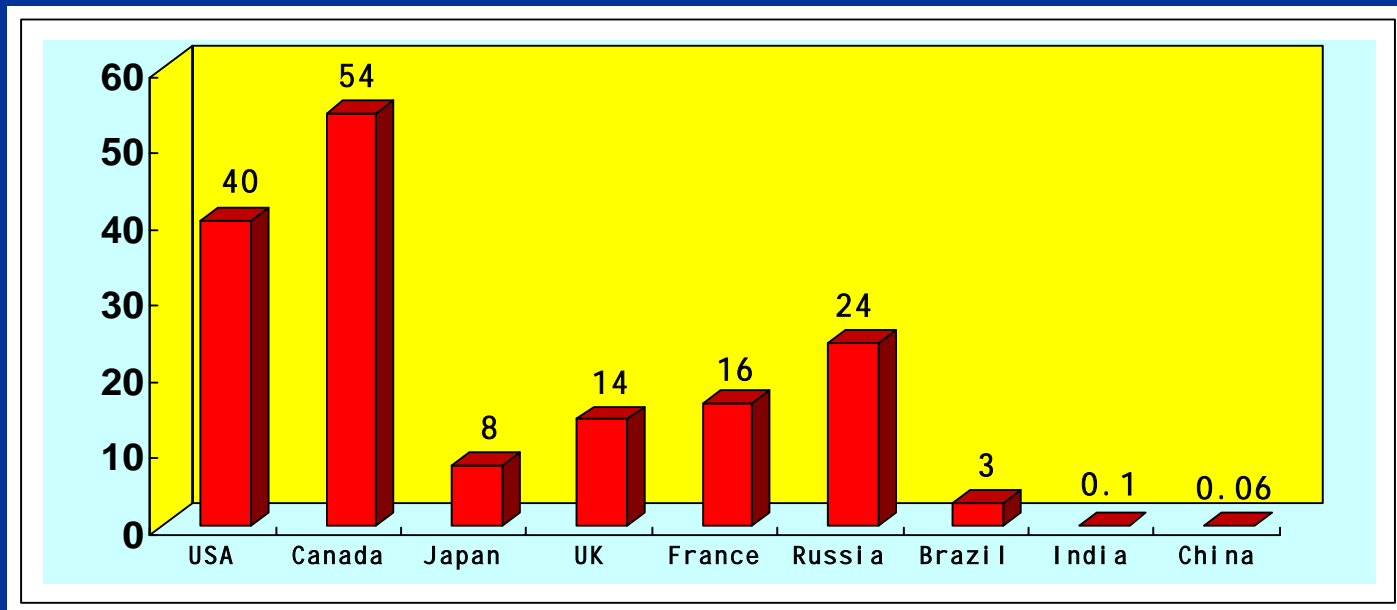
The fleet forecast 2021 of China airline providing
by China Aviation Development Research Center

1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

A . 中国直升机市场潜力极大

A . A Great Potential Market in China for Helicopter



世界直升机百万人占有量（架）

The occupation of per helicopter within 1 million populations



1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

- 中国是欧洲航空产品的巨大市场
- There is huge market of EU aviation products in China
 - 2005年中国购买了150架空客A320飞机
 - China has purchased 150 A320 in 2005
 - 中国购买了5架A380飞机
 - China has purchased 150 A320
 - 中国是A350飞机的启动用户
 - China is a lunch customer for A350

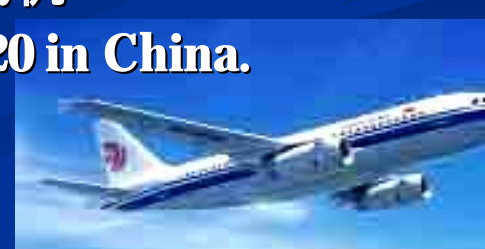




1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

- 中国航空工业与空客公司有着广泛的合作
- **AVIC and AIRBUS have good cooperation widely.**
 - AVIC II 和欧洲直升机公司签订共同发展6吨级直升机的项目
 - AVIC II and EUROCOPT have signed agreement to jointed developing 6 ton helicopter project
 - 空客公司与中国航空工业联合成立了研发中心
 - AIRBUS and AVIC have established jointed Research & Development Center
 - 中国航空工业承担大量空客转包生产项目
 - AVIC has take big AIRBUS subcontract for aviation parts, such as A320 wing manufactory in Xian Aircraft Corporation
 - 空客公司与中国航空工业将联合组装A320系列飞机
 - AVIC and AIRBUS have decided to assembly A320 in China.





1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

中国航空工业通过协同设计制造解决目前的力量分散、新产品开发研制周期长、产品全生命周期成本高的问题。

The AVIC is going to solve the problem of distributed jointed aircraft development, Long aircraft development schedule for new projects, High Product Live Circle Cost by using collaborative design, manufactory and simulation.

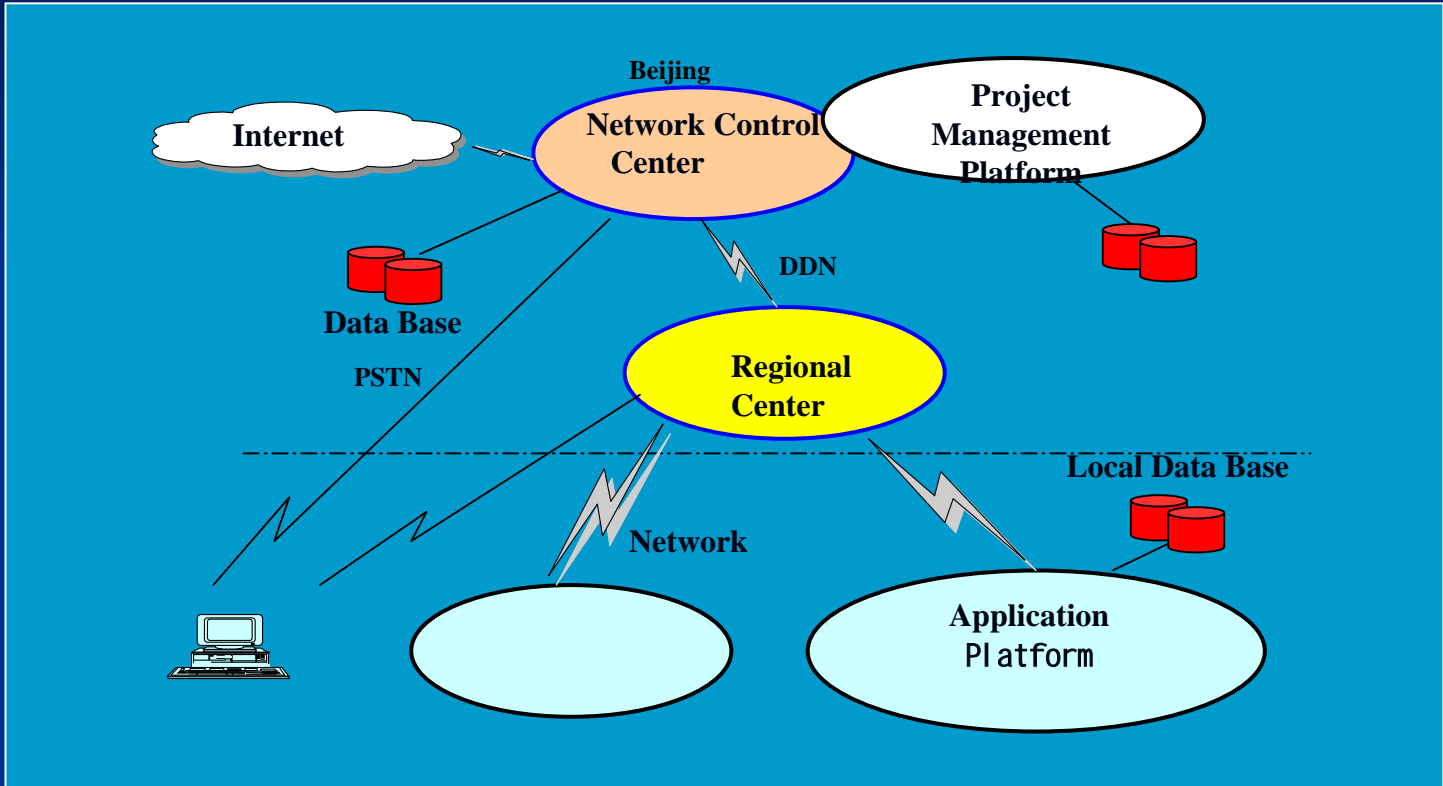


中航第二集团公司直升机的异地设计制造 The distributed helicopter manufactory in AVIC-II



中航第二集团公司直升机的异地设计制造

The distributed helicopter manufactory in AVIC-II



航空网情况示意图
AVICNET structure



1. 充满挑战与希望的中国航空工业

1. China Aviation Industry Faces to a Strange Challenge and a Bright Future

协同设计制造通过信息集成和资源共享来实现

Collaborative design, manufactory and simulation is supported by Information integration technology and GRID technology

A. 利用现代集成技术实现信息集成

A. The information integration technology realize the aviation industry information flow integration

B. 网格技术实现了航空工业的资源共享

B. GRID technology realize the share resource in China aviation industry

航空工业对技术发展的需求

The Technique Requirement of China Aviation Industry

- 要求建立先进制造网格平台, 支持异地联合设计制造与仿真
- **Create advanced manufactory **Avi - Grid Platform** to support the extensive collaborative design, manufactory and simulation**

3. 先进的制造网格支持异地联合设计和仿真

3. Advanced Manufacturing Grid Supporting Extensive Collaborative Design and Simulation

A. 航空工业对先进制造网格平台的需求

A. The requirement of the advanced manufactory **Avi - Grid Platform**

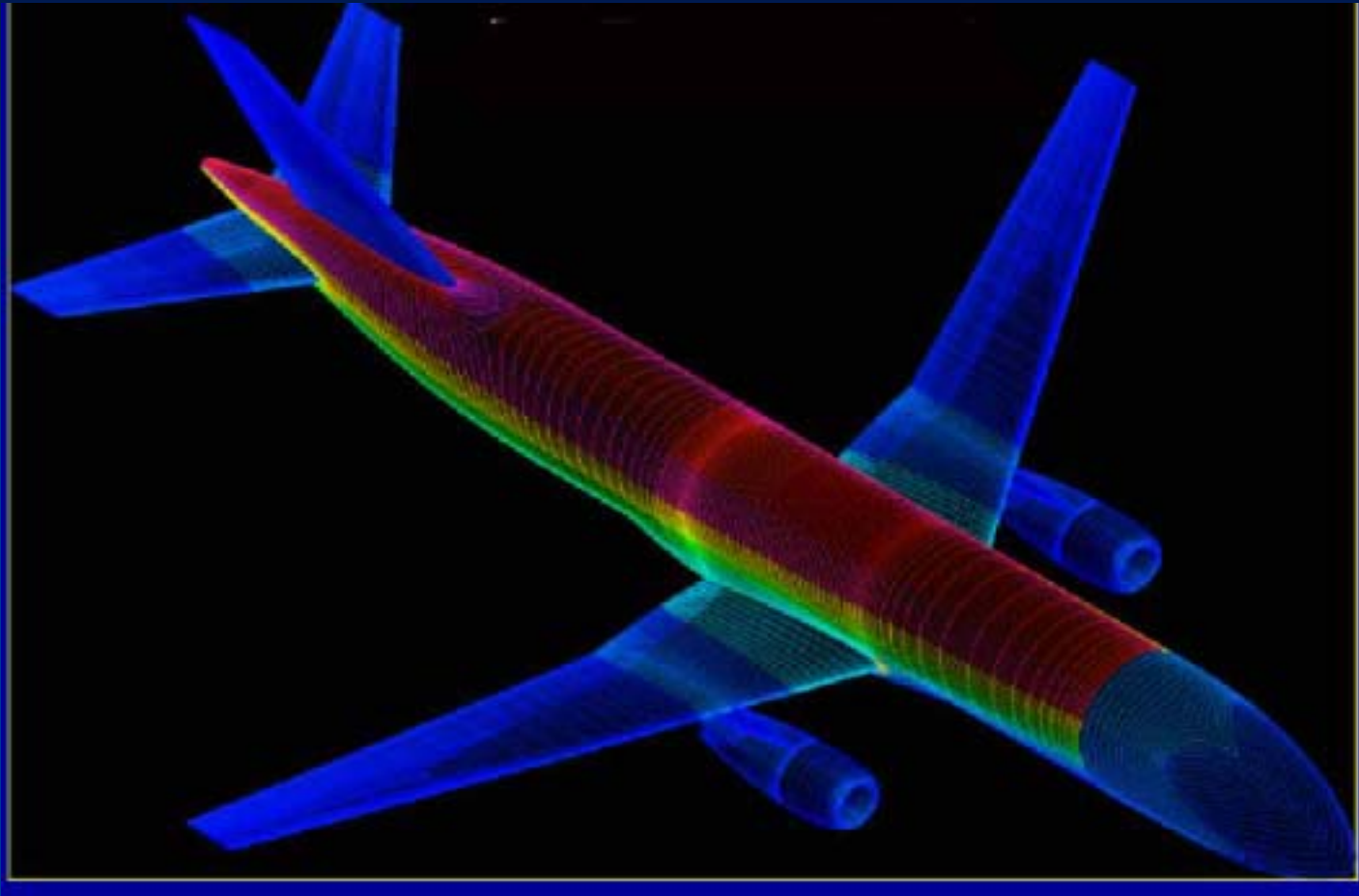
- 采用数字化设计的企业面临着资源的短缺
- Each enterprise in AVIC is face resource shortage problem during digital design and manufactory
- 中国航空工业现有的资源又大量的闲置
- There are large resources not fully used in AVIC, the efficacy is only 10-30%
- 解决硬件、软件和信息资源的共享成为航空工业对网格平台的需求
- The hardware, software and information resource share by using Avi - Grid Platform is the strong requirement for AVIC.

Resource shortage



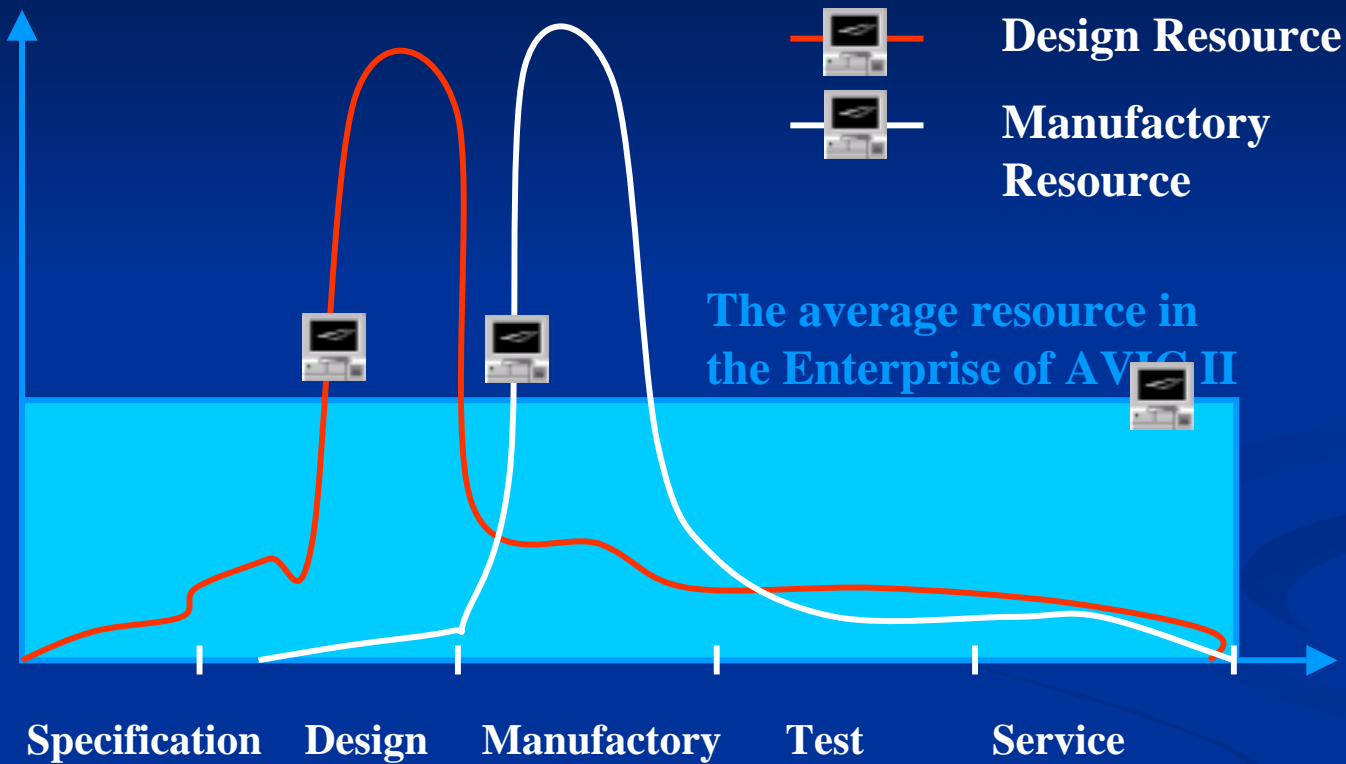
Resource not fully used





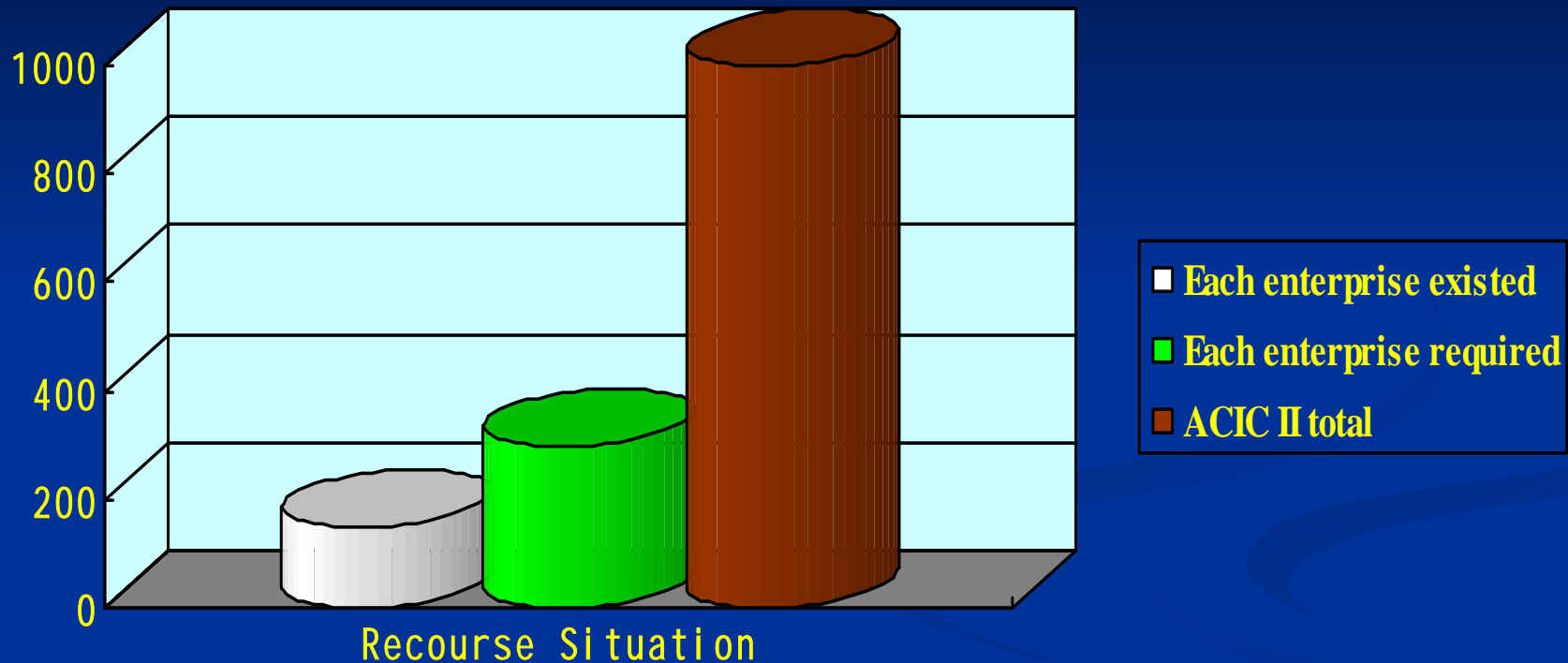
CFD和结构分析需要巨大的计算资源

The CFD and structure analysis need great computation resource



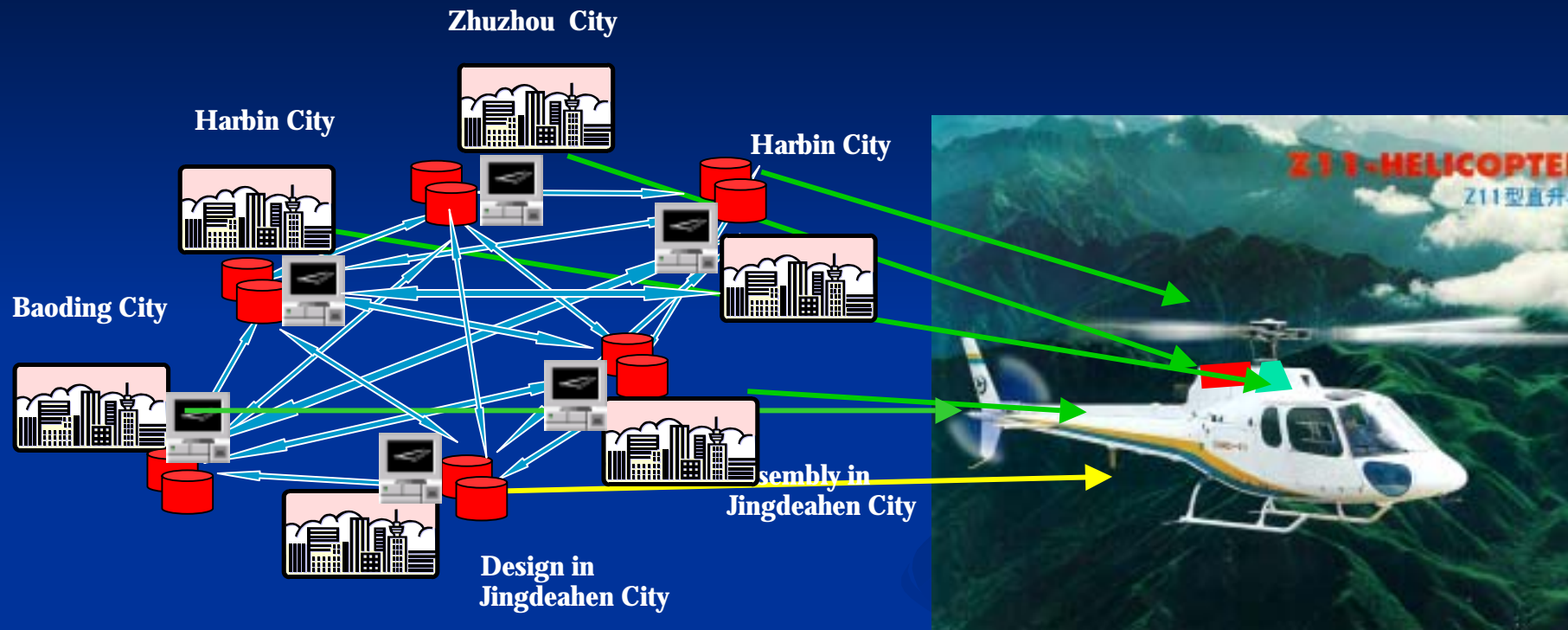
航空产品全生命期的软硬件资源需求情况

The software and hardware resource required in the aviation period life cycle



中航第二集团公司CAD软件资源与企业资源需求情况

The CAD software resources in each company and AVIC-II total
(There are more than 50 enterprises in AVIC II)



飞机的异地设计制造要求信息资源的共享代替电子邮件

The collaborative aircraft development faces to share the information resource not only by email

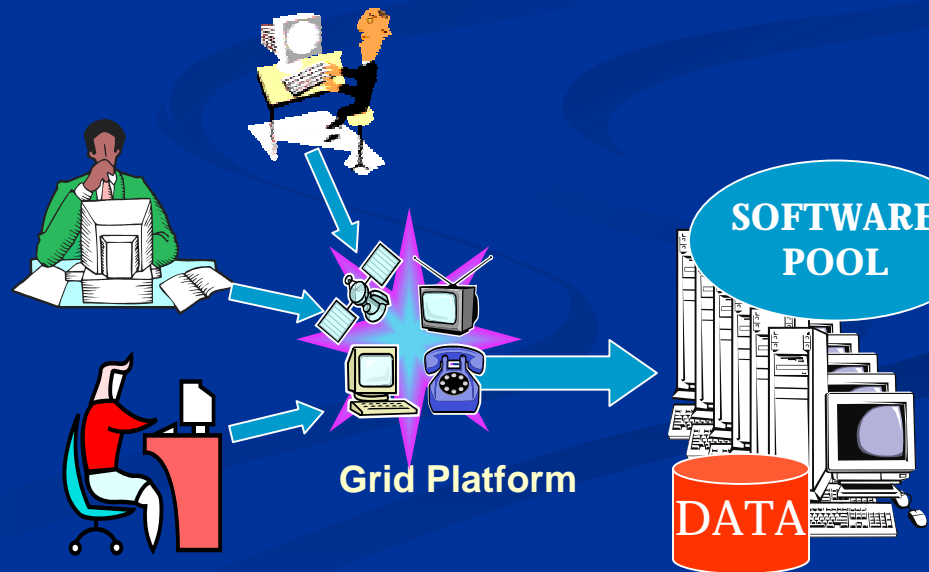
3. 先进的制造网格支持异地联合设计和仿真

3. Advanced Manufacturing Grid Supporting Extensive Collaborative Design and Simulation

A. 航空先进制造网格平台的三个目标

A. The target of the advanced manufactory Avi-Grid Platform for aviation industry

- 共享硬件资源
- Share the hardware in AVIC
- 共享软件资源
- Share the software in AVIC
- 共享信息资源
- Share the data in AVIC



3. 先进的制造网格支持异地联合设计和仿真

3. Advanced Manufacturing Grid Supporting Extensive Collaborative Design and Simulation

■ B. 网格技术在中航第二集团公司的应用

B. GRID technology in AVIC-II

■ 中航第二集团公司于2002年开始实施国家高科技八六三计划，建立网格平台原型系统，以支持航空工业的发展

■ AVIC-II started to develop a Avi - Grid Platform Prototype in 2002 supported by National High-tech 863 program. The application plan has given great support to China Aviation Industry.

■ 网格技术应用突出：**共享、标准、服务**

■ Grid application key points:

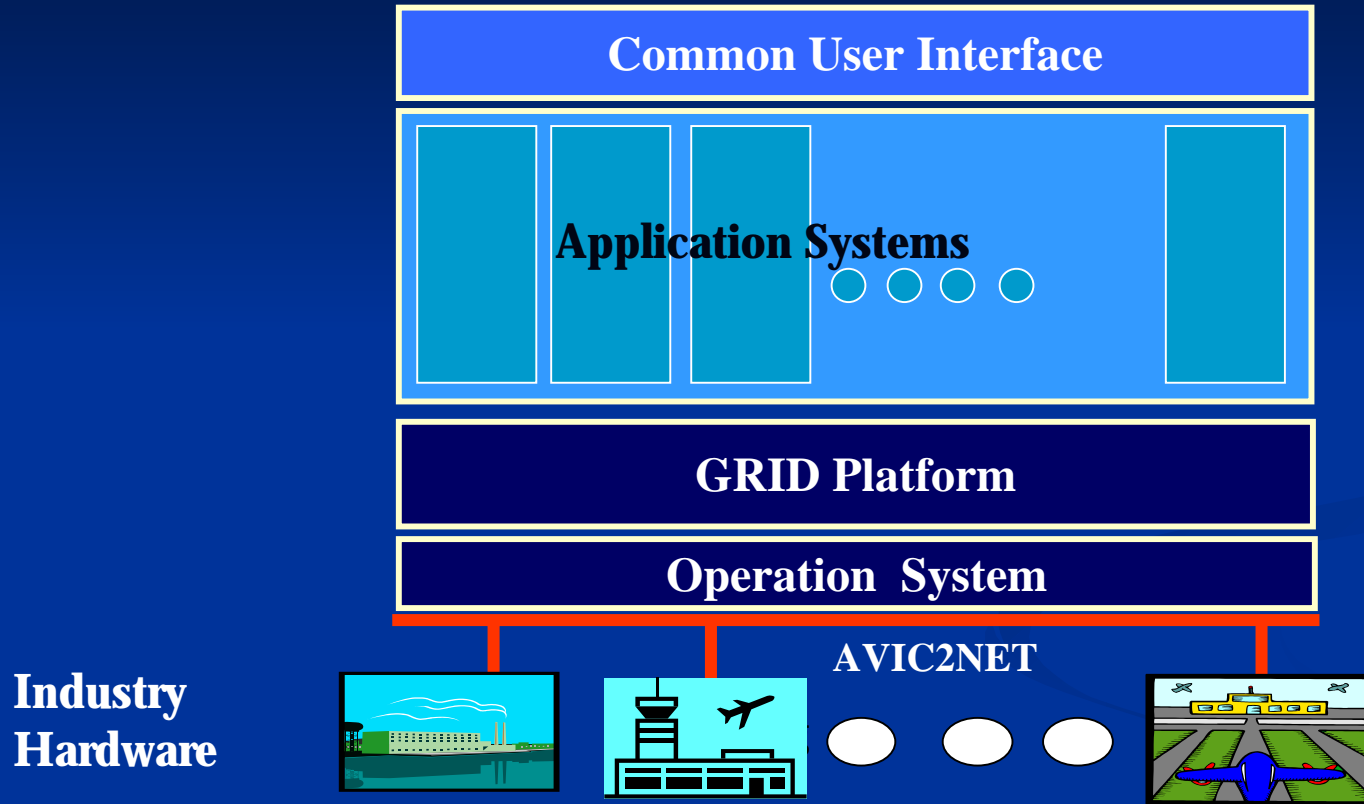
■ **Share resource, Standardization, Service**

3. 先进的制造网格支持异地联合设计和仿真

3. Advanced Manufacturing Grid Supporting Extensive Collaborative Design and Simulation

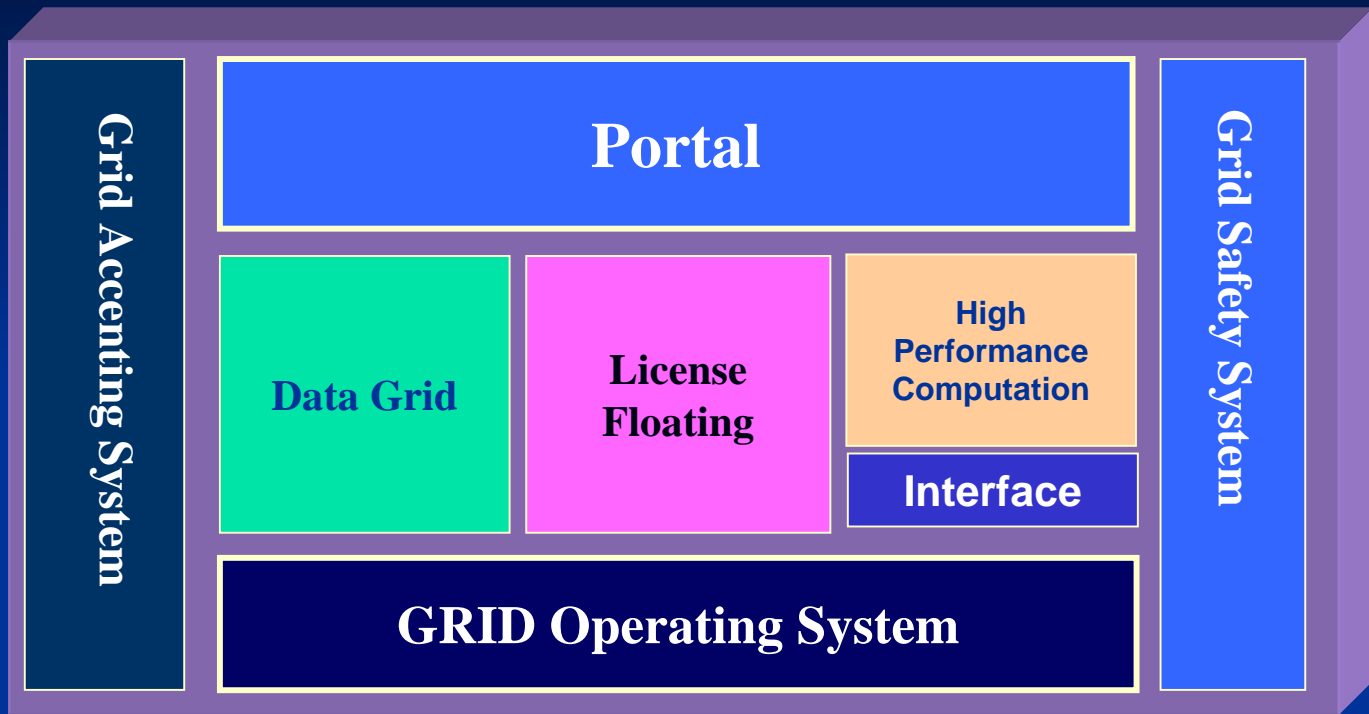
- 网格平台工作在以下几方面
- The Avi-Grid Platform effort is in the following direction as following:
 - 建立集团网格平台，解决硬件资源共享和服务原型系统
 - Hardware resource sharing for high speed computation and service prototype
 - 建立企业间许可证浮动，解决软件资源共享
 - License floating **in** the Grid Platform for Software resource sharing
 - 建立数据网格原型系统，解决数据共享问题
 - Data Grid prototype for Information resource sharing
 - 应用上述平台，开发基于网格的领先应用系统
 - Developing pilot application system based Grid Platform

Architecture of Application Manufacturing Grid Platform in AVIC-



中航第二集团公司的网格结构

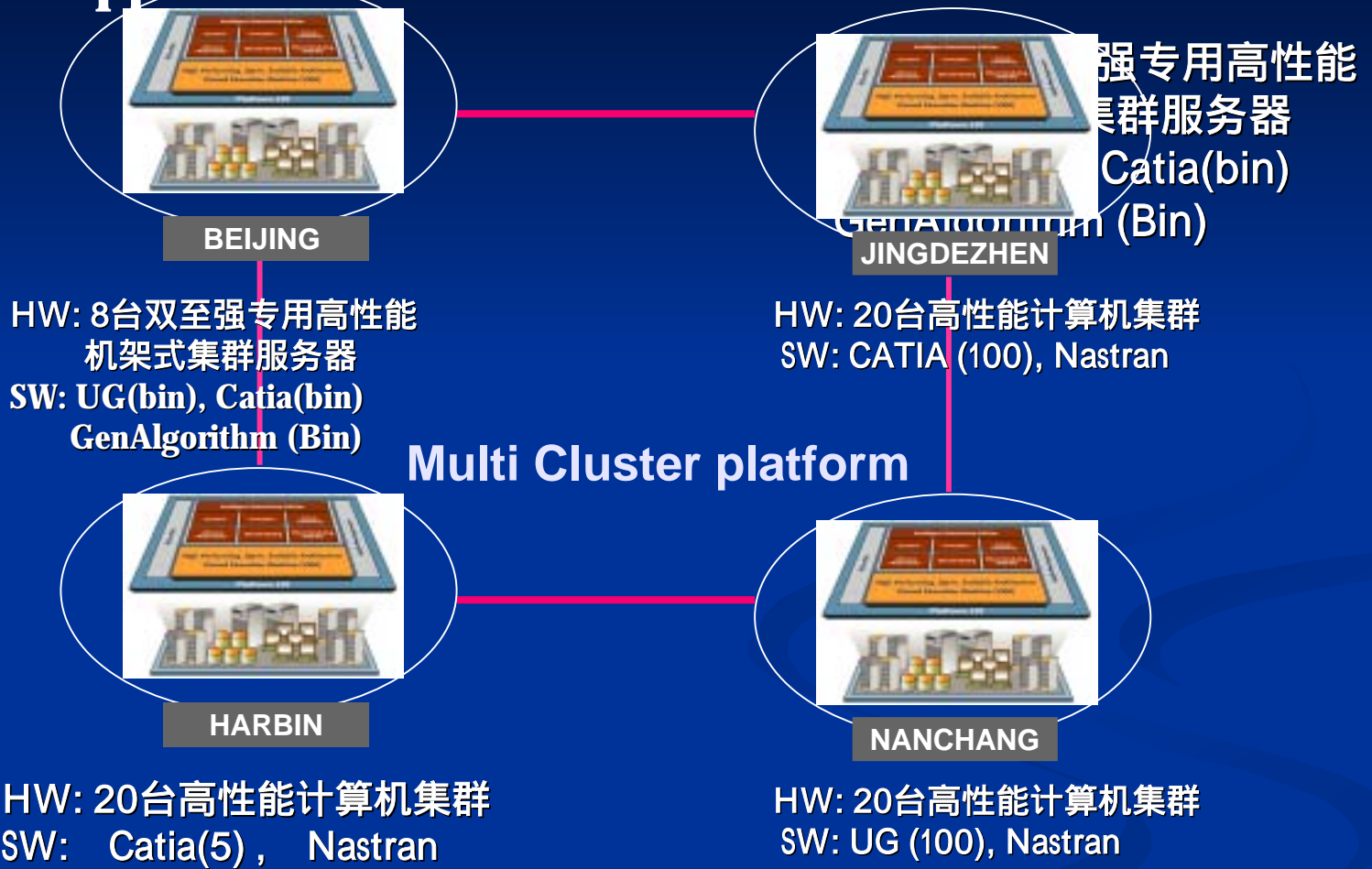
Architecture of Advanced Manufacturing Grid Platform in AVIC-II



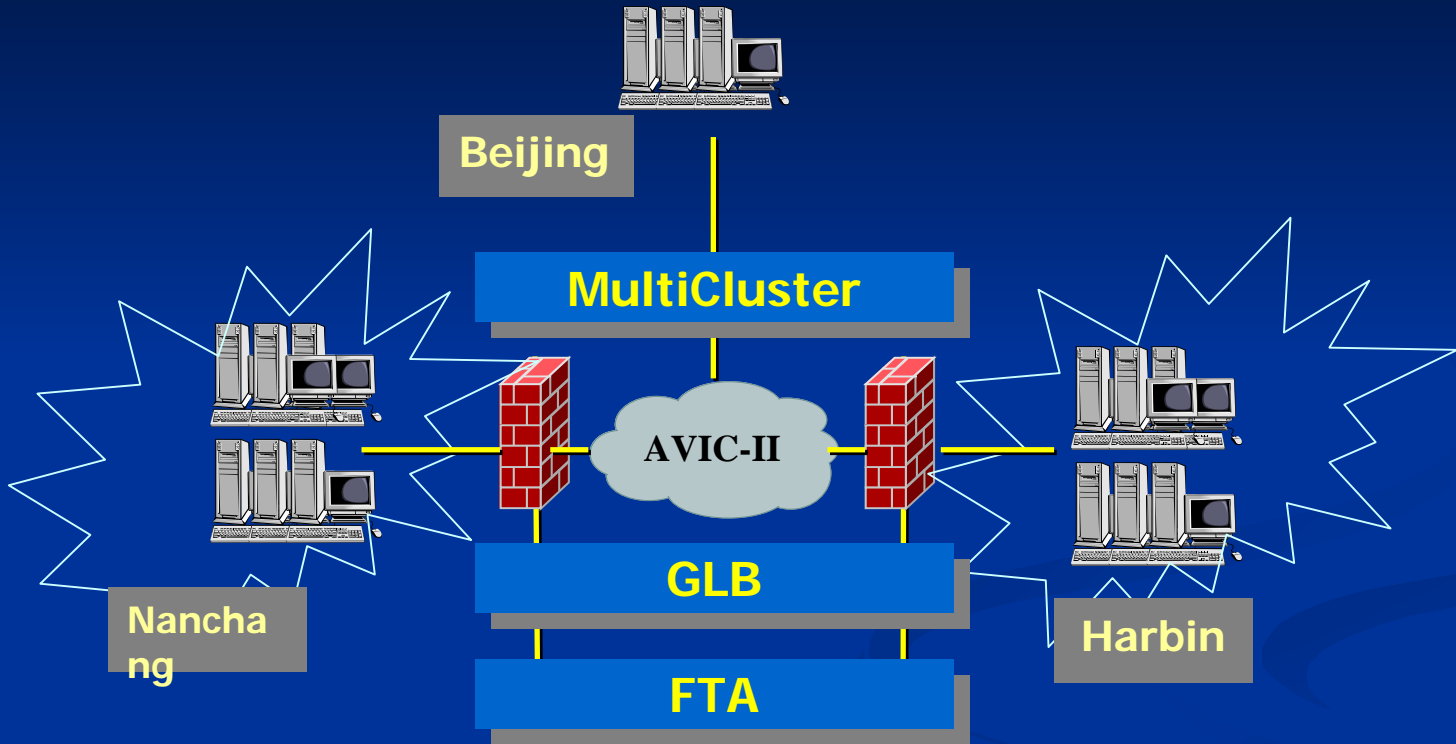
中航第二集团公司的网格平台

Advanced Manufacturing Grid Platform in AVIC-II

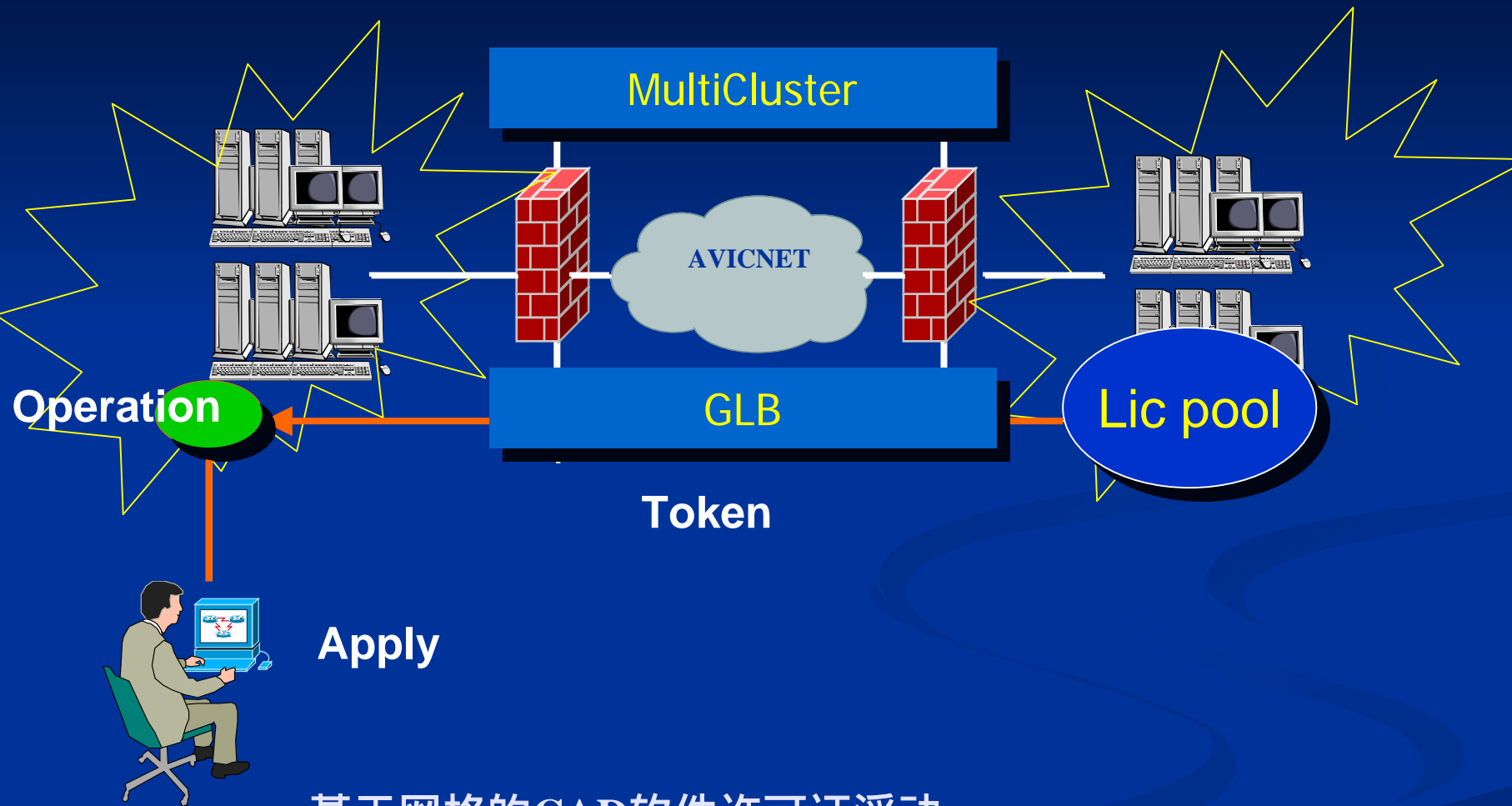
The efforts for Avi - Grid Platform application



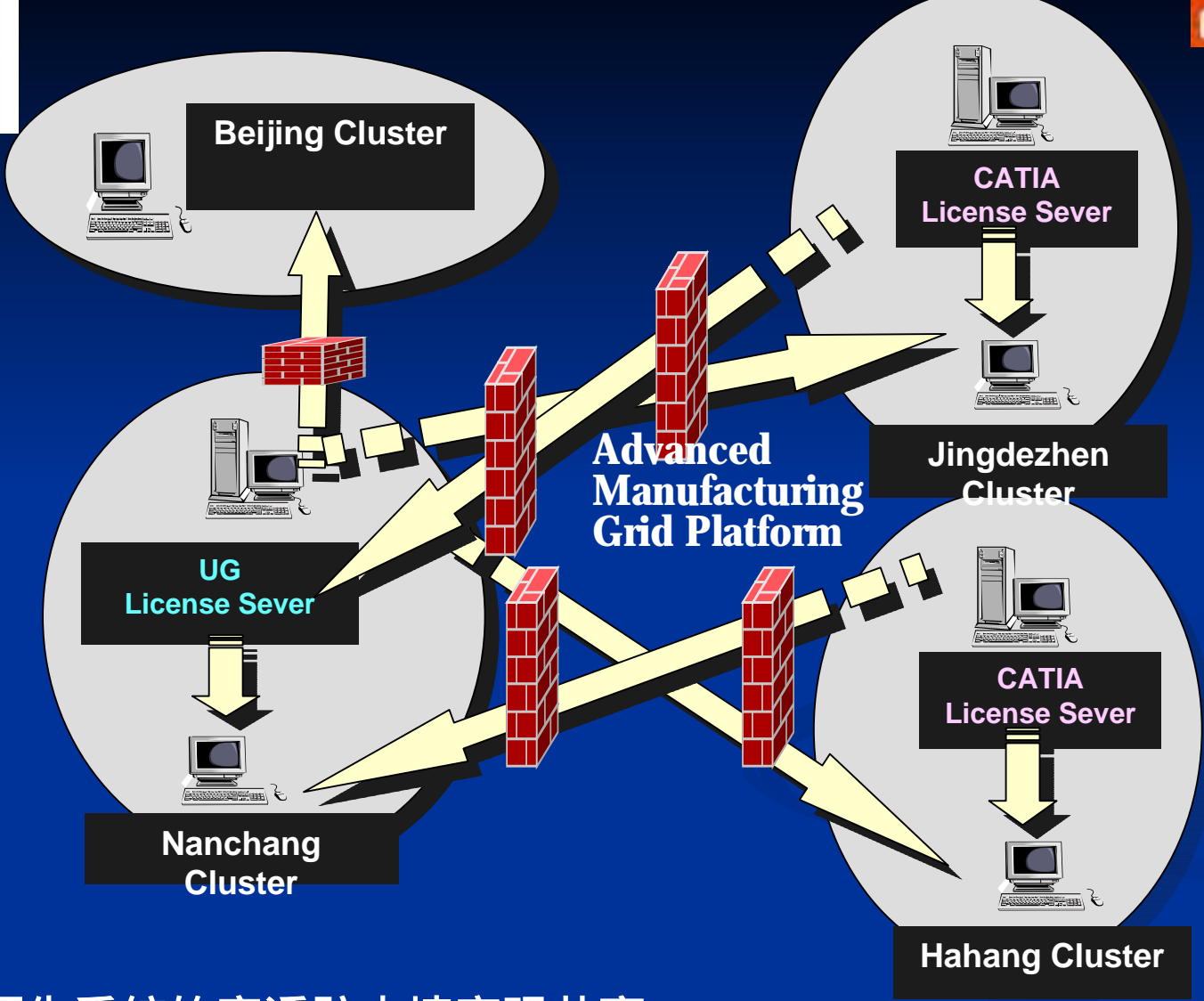
跨企业网格平台领先系统 The Pilot System of Avi-Grid Platform



中航第二集团公司网格领先系统的硬件共享结构
The AVIC-II GRID Pilot System hardware share structure

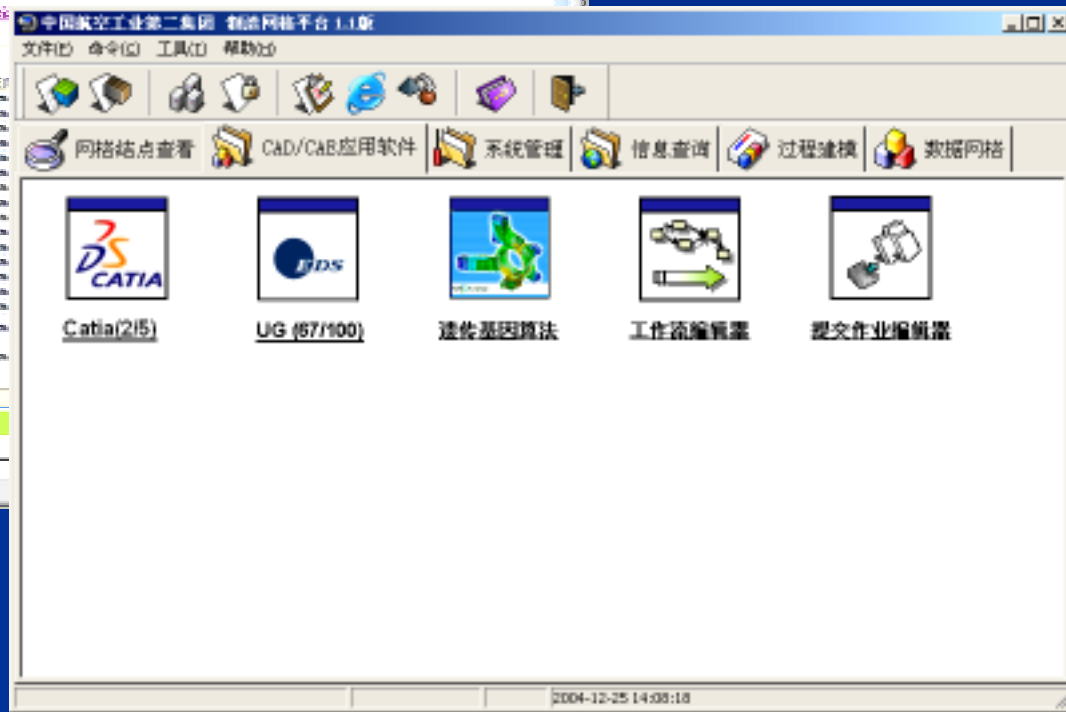
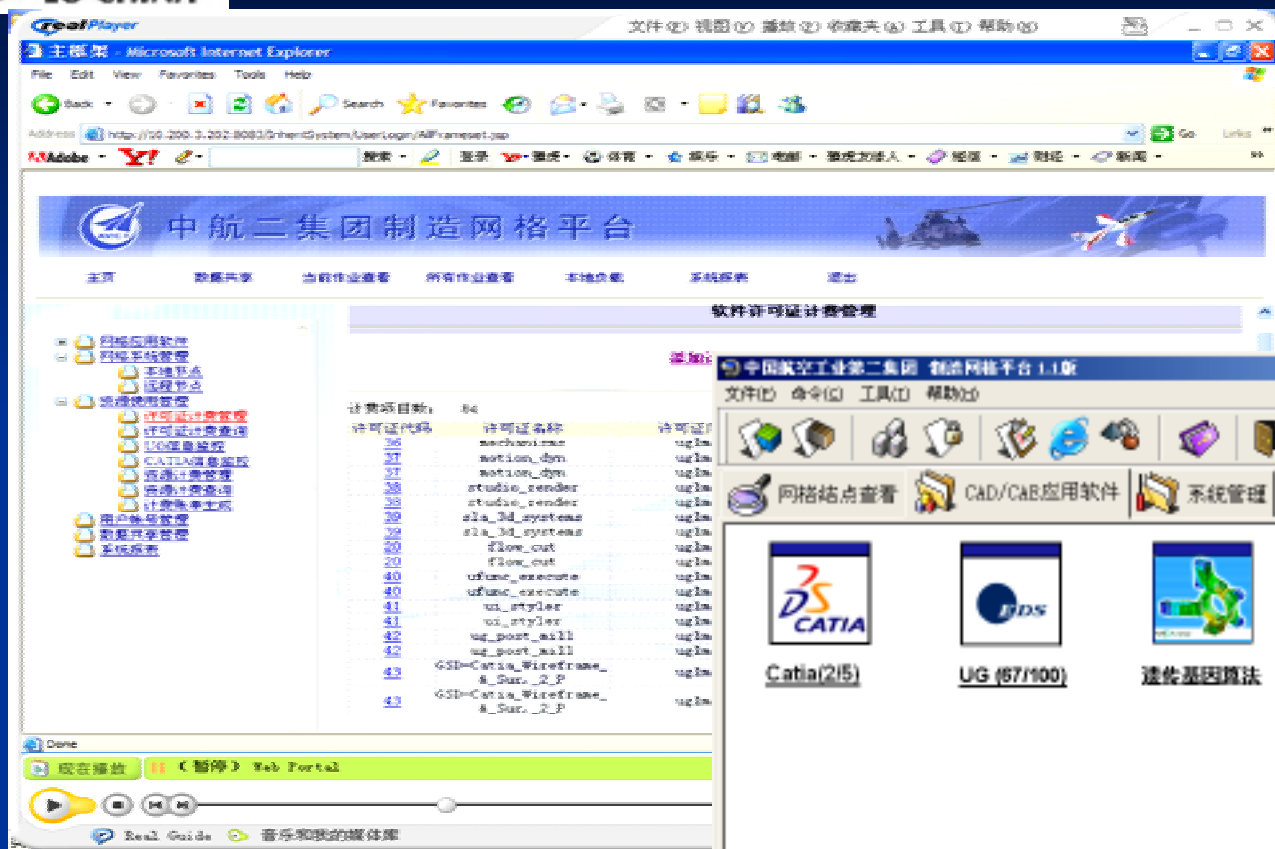


基于网格的CAD软件许可证浮动 License floating for CAD software based on Grid



领先系统的穿透防火墙实现共享

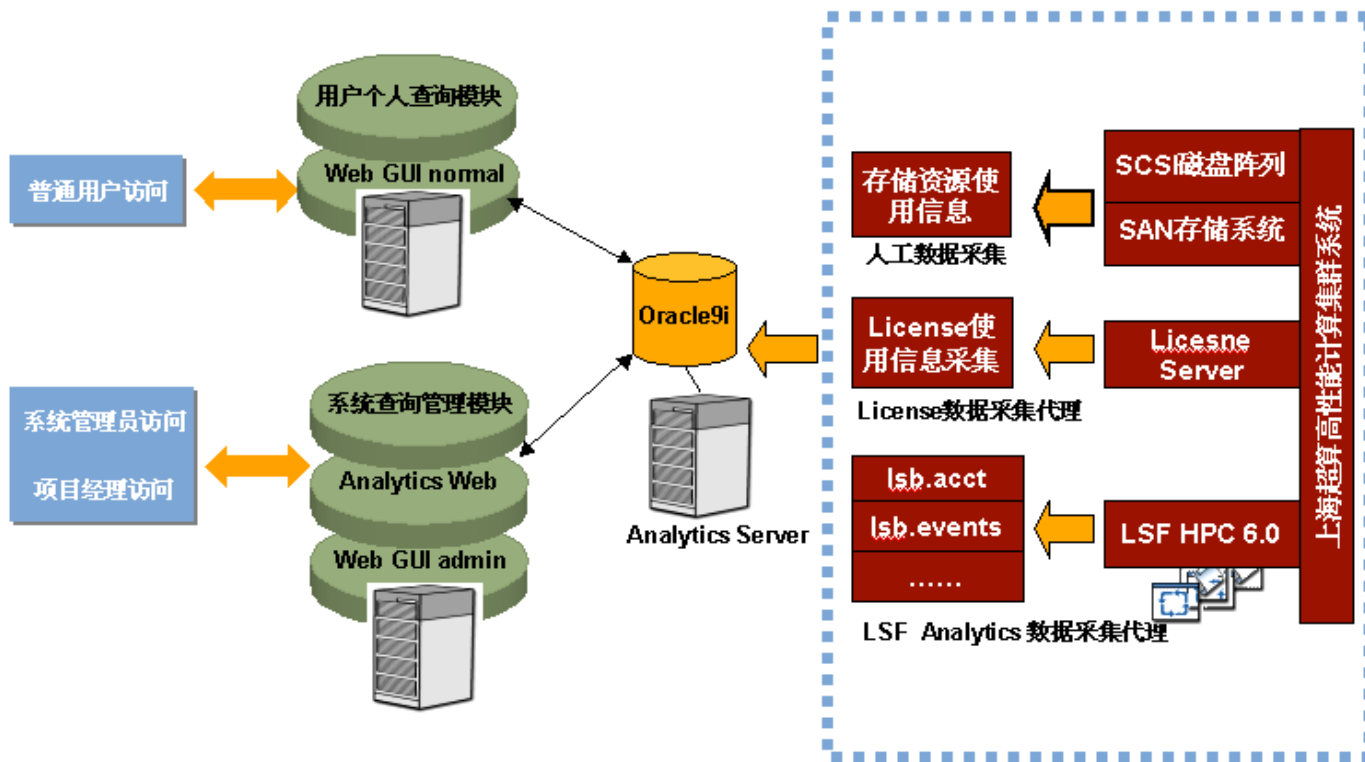
The Pilot System realize the license floating by pass firewall



User interface for Grid Platform

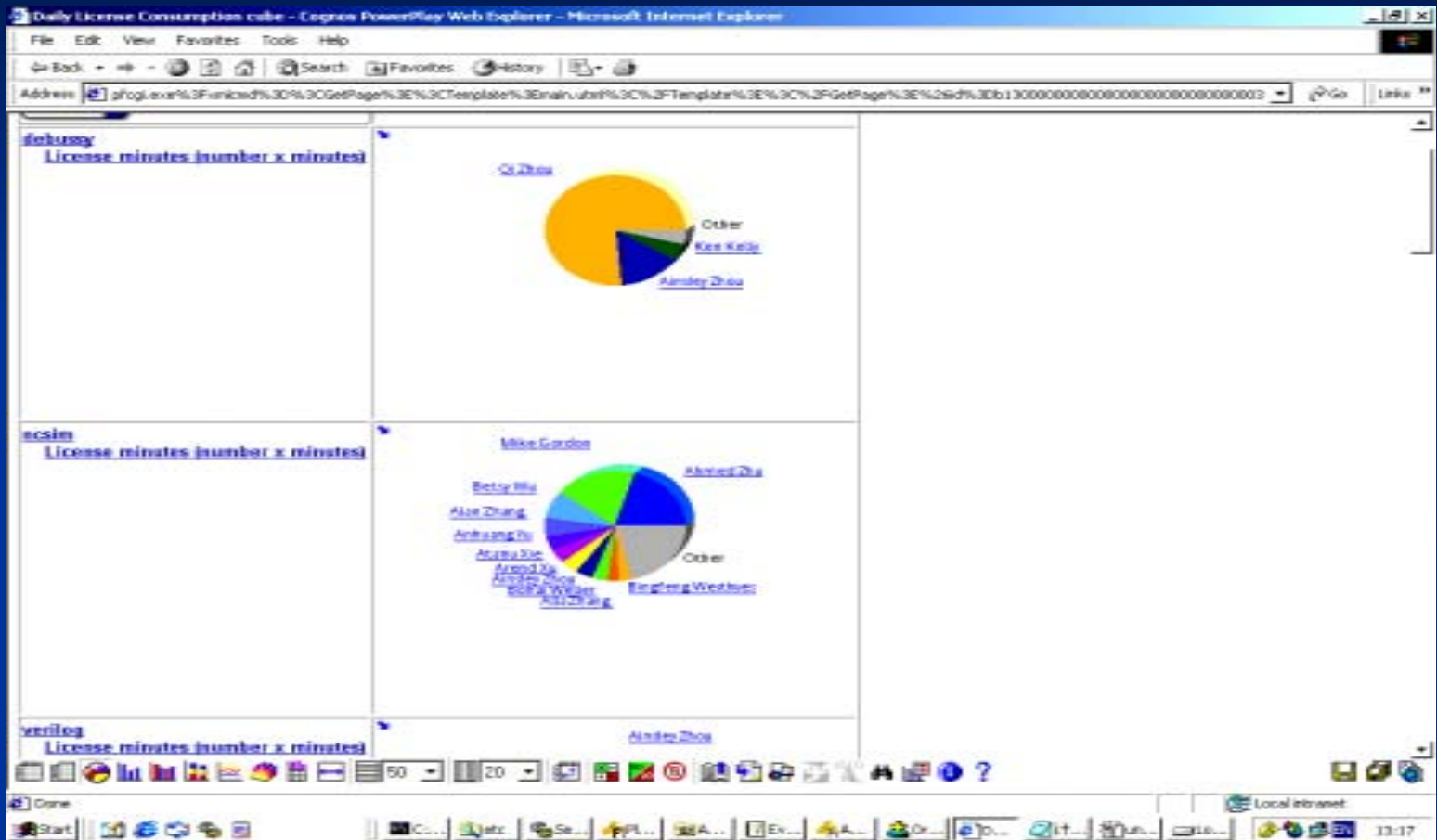
Platform

系统架构



11 © Platform Computing Inc. 2003

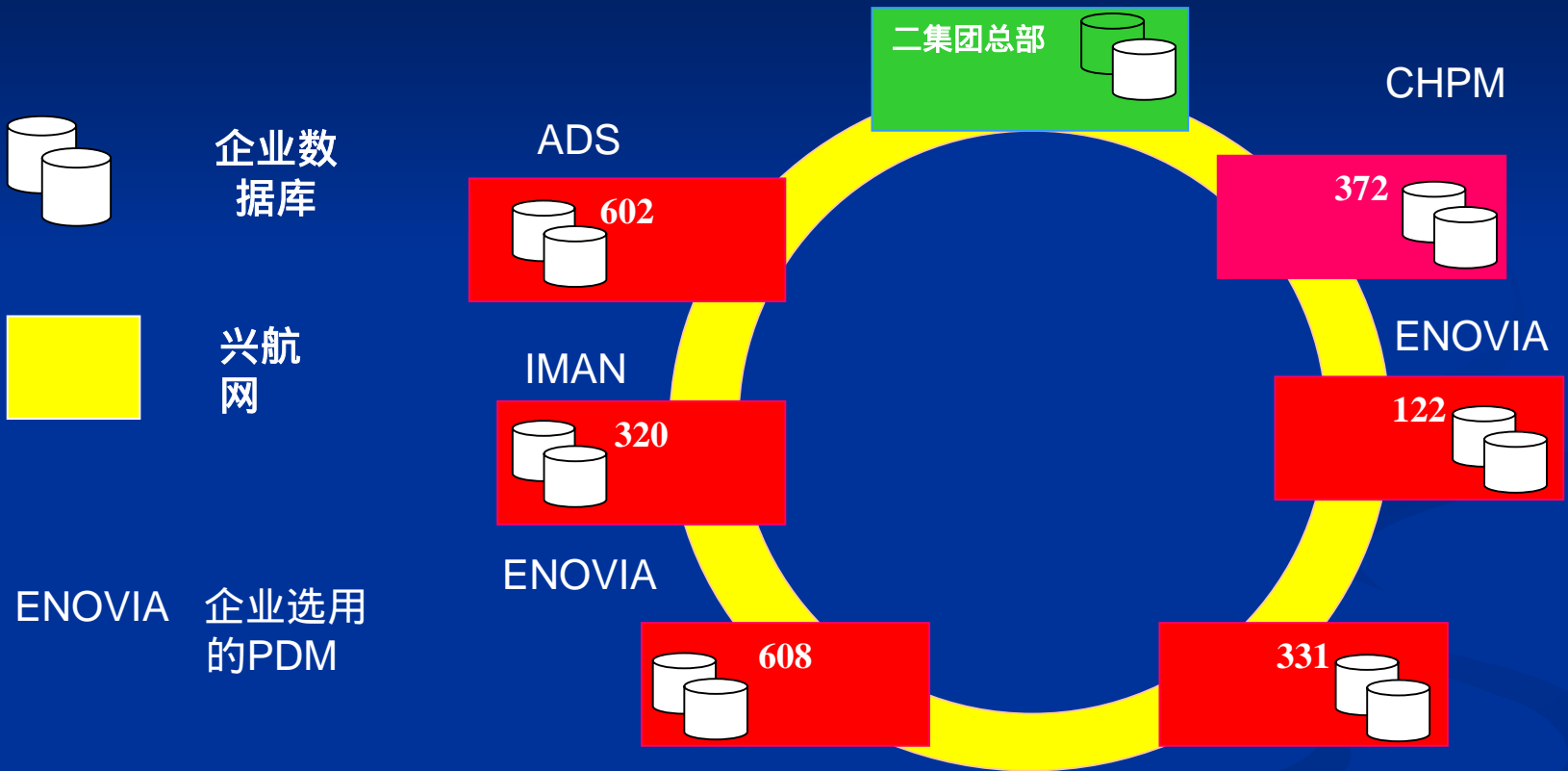
基于服务的PLATFORM 公司平台的网格记账系统
Accounting system for service using PLATFORM Grid tool



基于服务的账目报告系统 Accounting report system for service

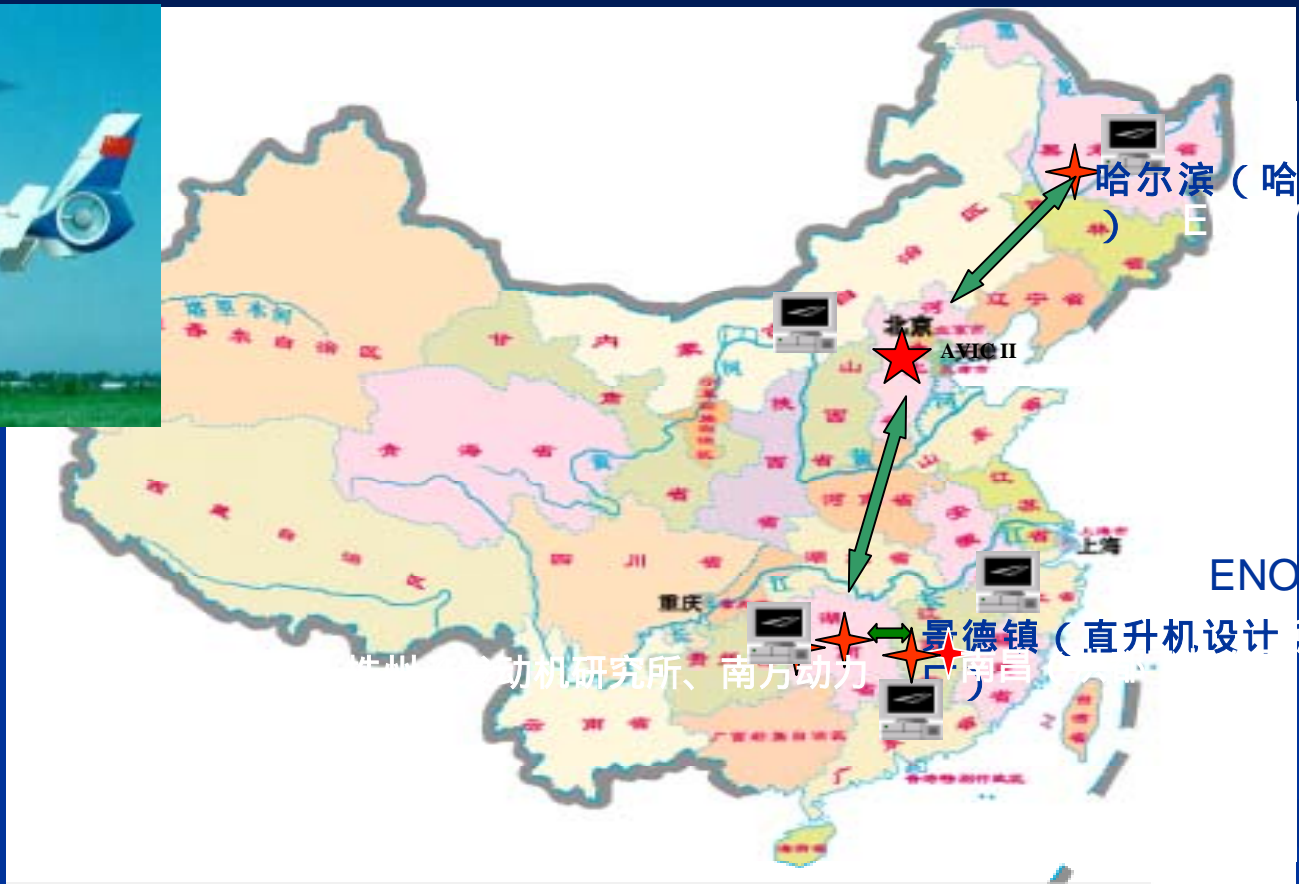
数据网格实现信息共享

Data Grid to realize the information share



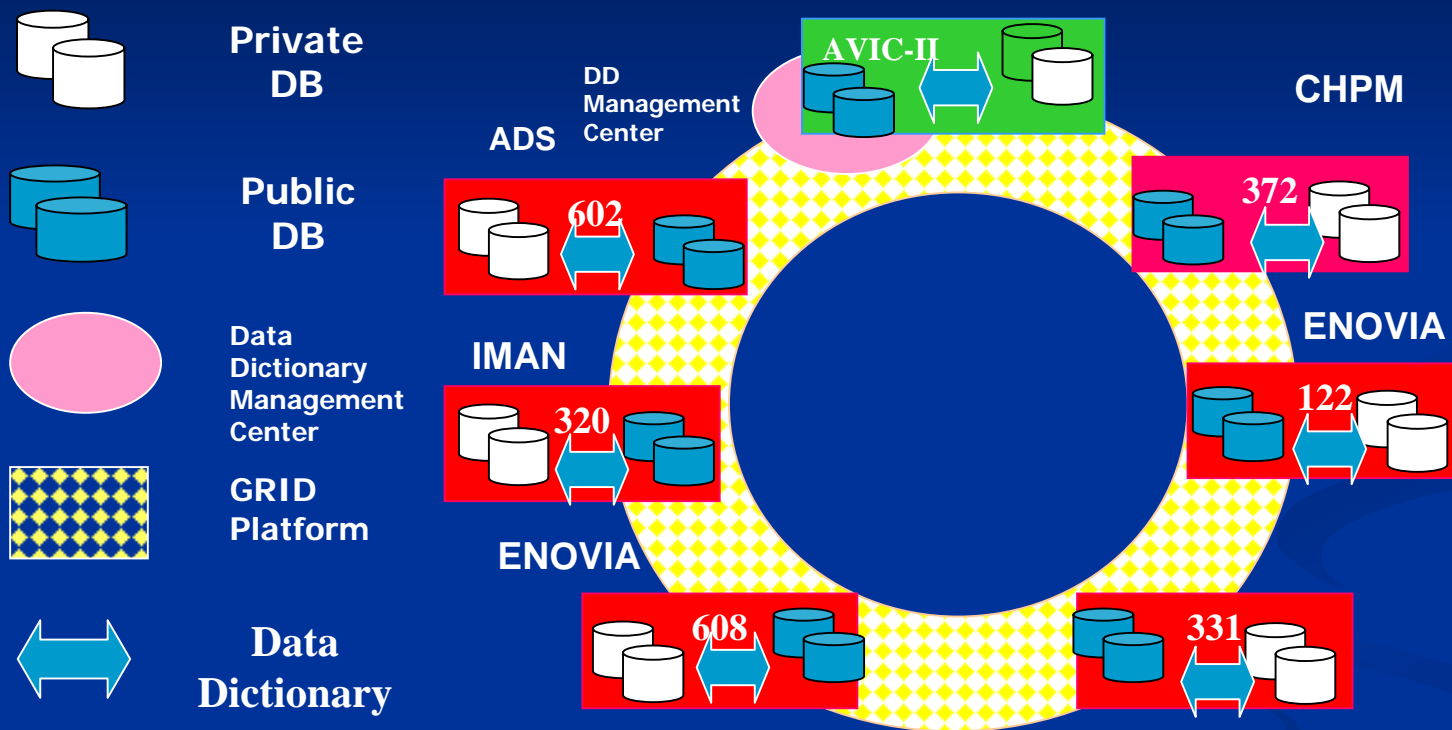
航空企业采用不同的PDM 管理各自管理的数据

The data in each enterprise are managed by deferent PDM system



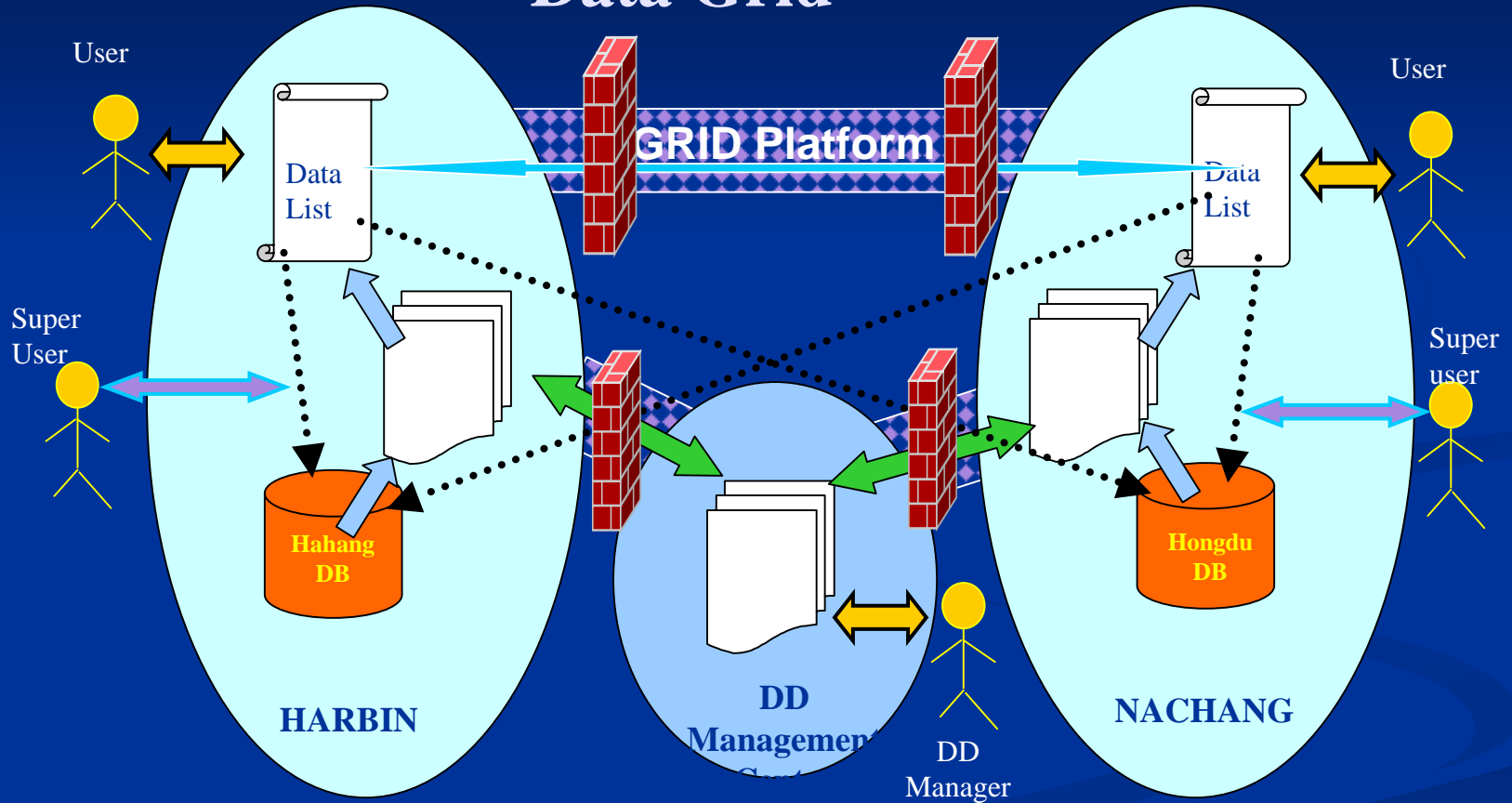
中航第二集团将实现基于网格技术的企业间数据共享
Data sharing between enterprises in AVIC II based on Grid

数据网格原型系统 Data Grid Prototype



数据网格系统实现了企业间的信息共享和单一数据源
Data GRID System realize the data sharing and keep the single data resource in AVIC-II

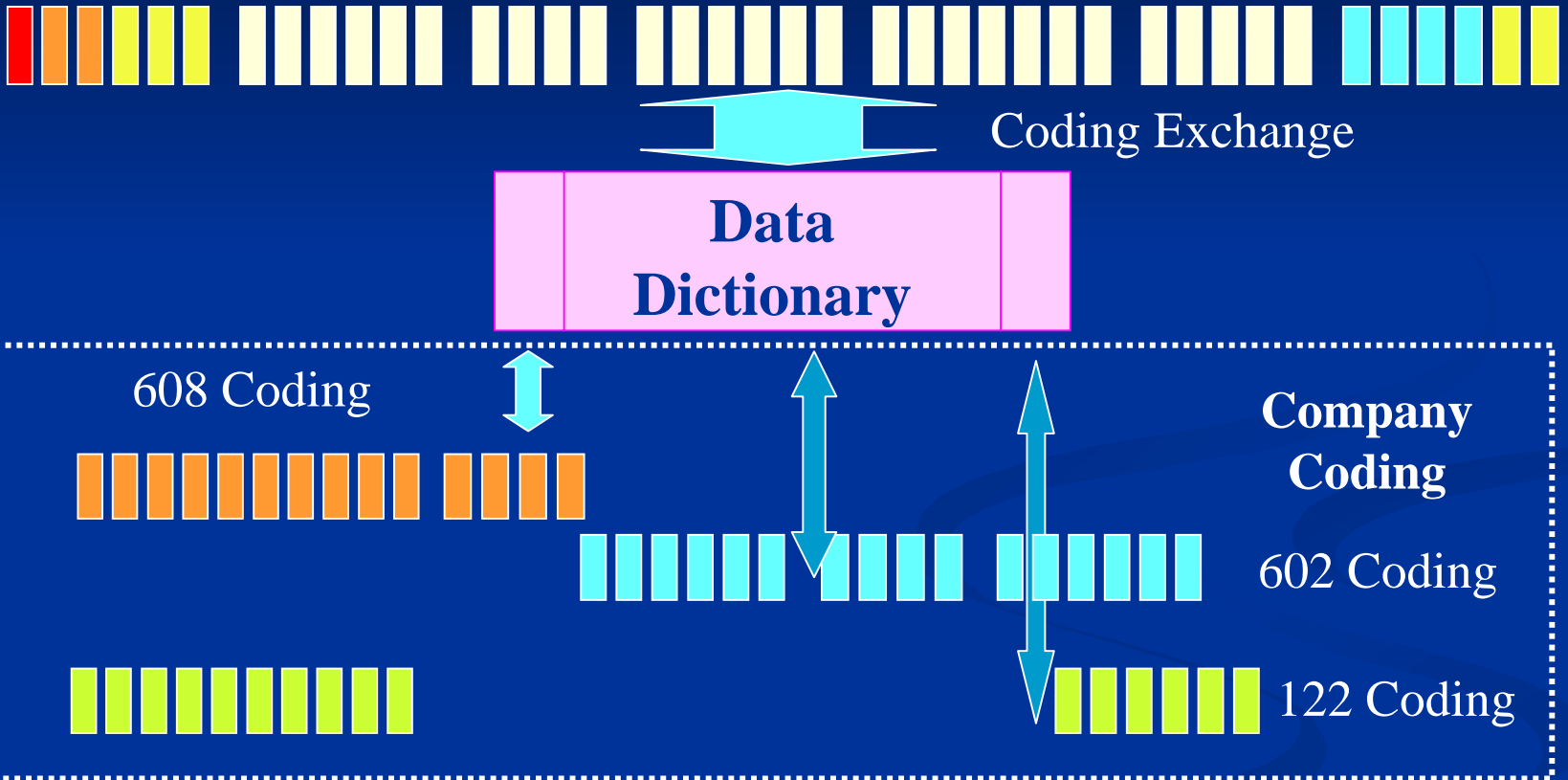
数据网格 Data Grid



数据网格及管理原理

Data GRID and its management principle

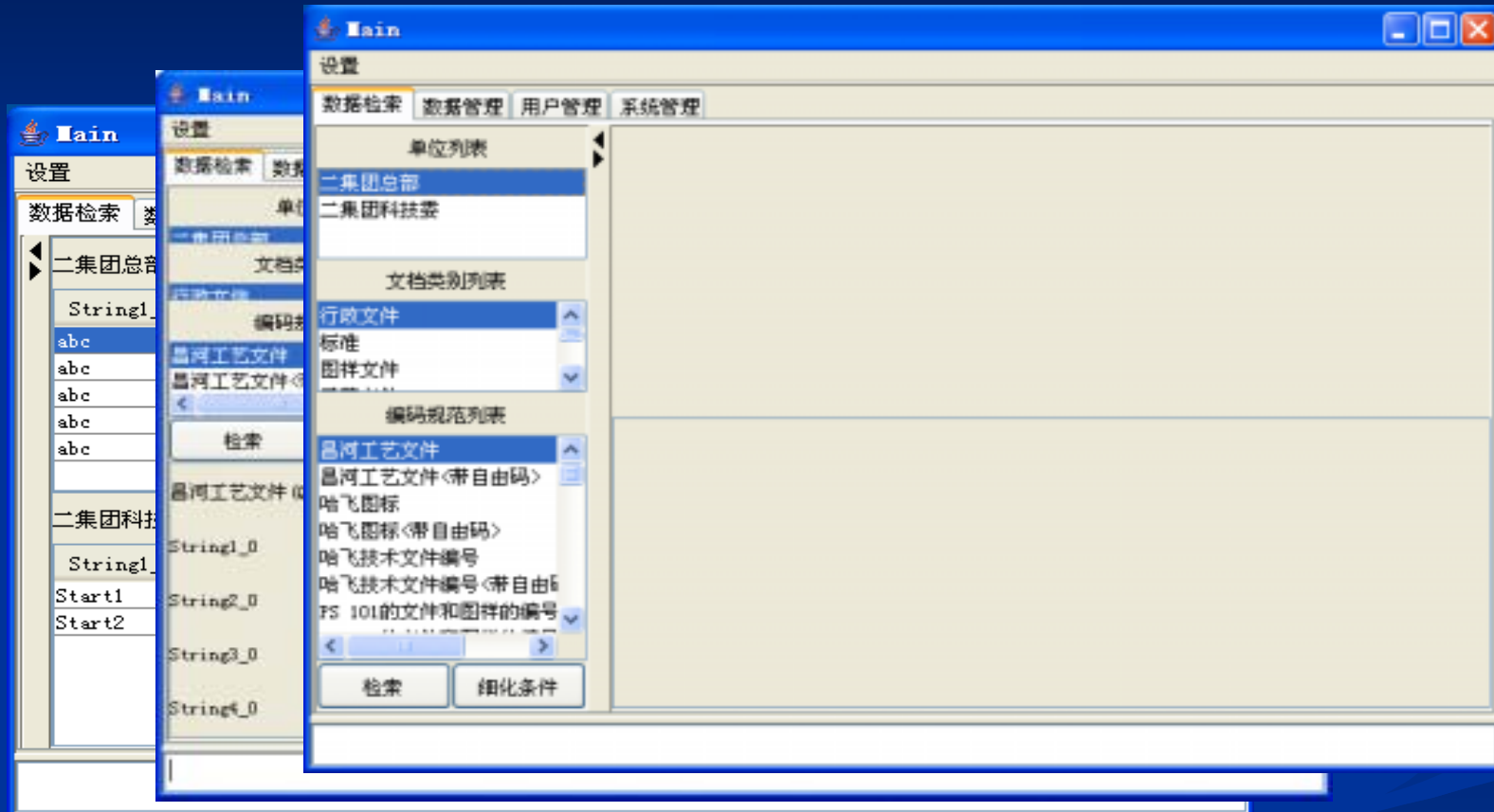
AVIC-II 72 Coding



统一编码与数据字典转换保障了查询和单一数据源

72 Coding and Data Dictionary keep single data resource and easy inquire

数据网格 Data Grid



数据网格软件的用户界面
Data Grid software interface



4. 领先系统的应用

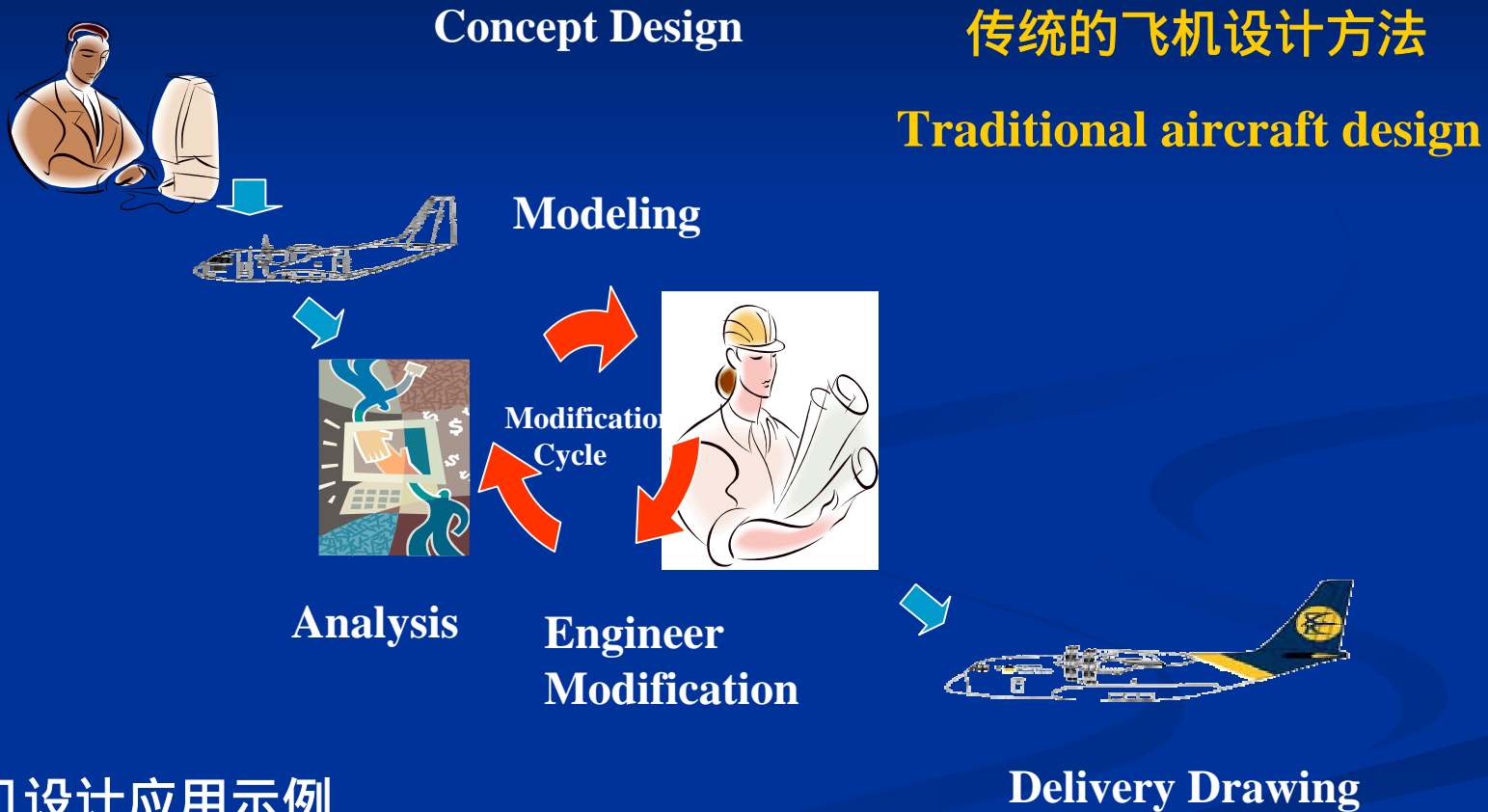
3. The Application of Pilot Advanced Manufacturing

Avi - Grid Platform

- 领先网格平台的应用
- The application of Pilot Grid Platform
 - 软件许可证浮动
 - License floating for share software resource
 - 实现大型的科学计算
 - Applied in high performance computation
 - 用于遗传算法优化系统
 - Applied in Genetic algorism optimization system
 - 装配干涉检查分析
 - Applied in interference checking calculation
 - 数据网格用于直升机异地联合协同设计
 - The Data Grid used for collaborative design for a helicopter development

应用网格平台的遗传算法优化系统

The Genetic Algorithm optimization based on Grid Platform

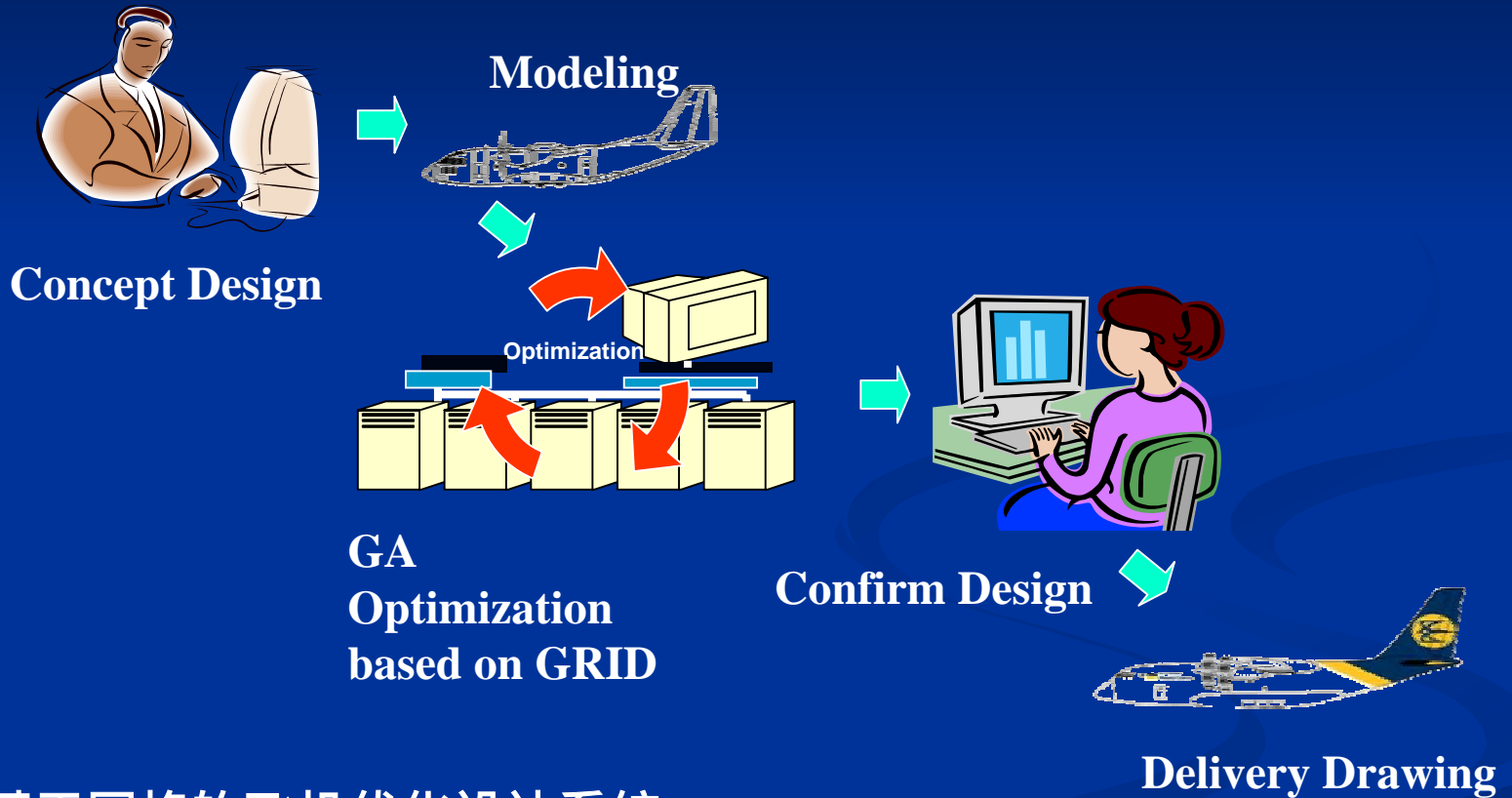


飞机设计应用示例

The application example of aircraft design

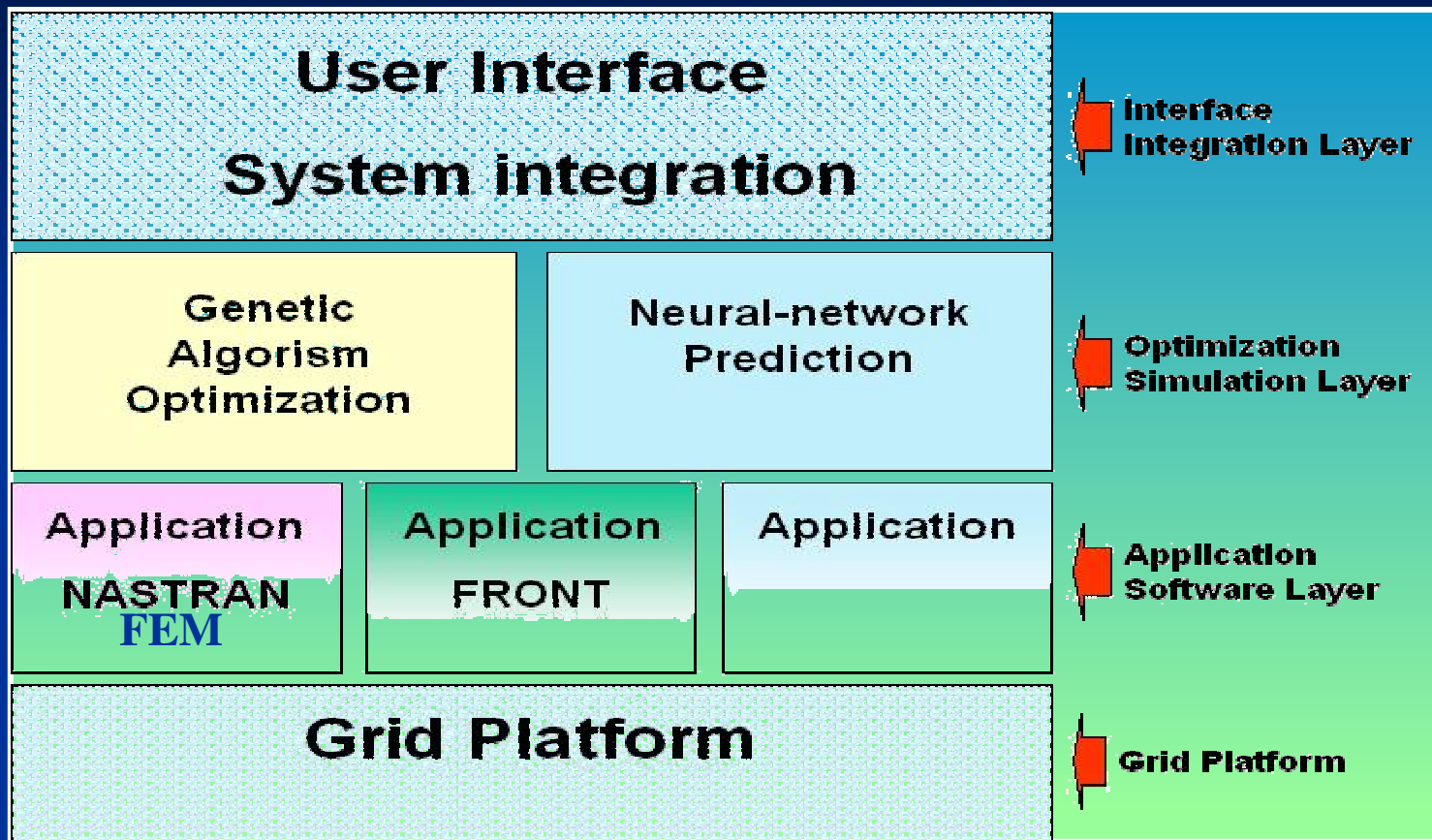
应用网格平台的遗传算法优化系统

The Genetic Algorithm optimization based on Grid Platform



基于网格的飞机优化设计系统

Optimization Design system based on GRID



遗传算法优化集成系统的结构

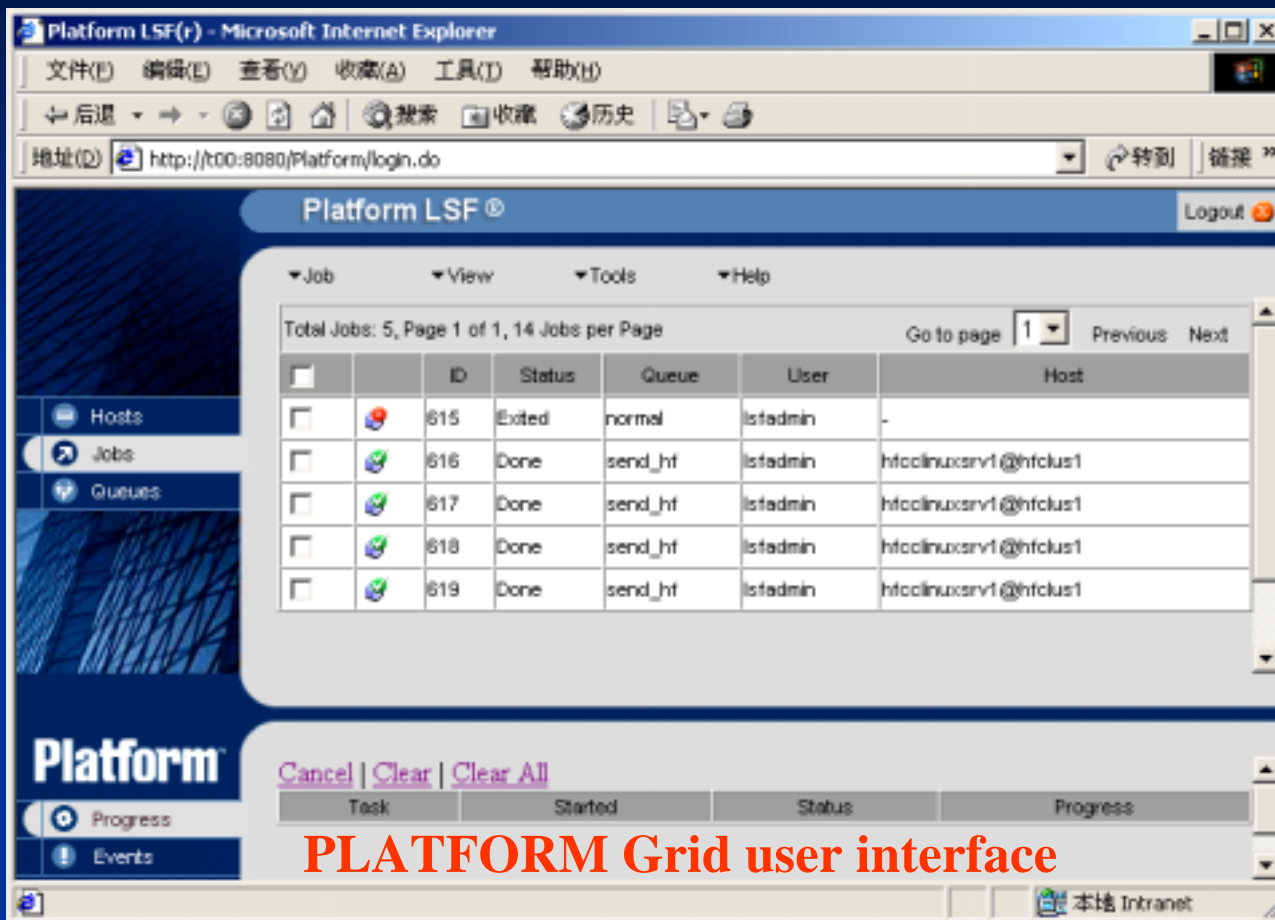
GA optimization integrated system architecture



863Grid portal

采用两种网格平台：Platform公司和863开发的平台

There are two Grid platform: PLATFORM and 863 Grid platform



Platform LSF(r) - Microsoft Internet Explorer

地址(D) http://t00:8080/Platform/login.do

Platform LSF © Logout

▼ Job ▼ View ▼ Tools ▼ Help

Total Jobs: 5, Page 1 of 1, 14 Jobs per Page Go to page 1 Previous Next

<input type="checkbox"/>		ID	Status	Queue	User	Host
<input type="checkbox"/>		615	Exited	normal	lsfadmin	-
<input type="checkbox"/>		616	Done	send_ht	lsfadmin	htoolinuxsrv1@hfclus1
<input type="checkbox"/>		617	Done	send_ht	lsfadmin	htoolinuxsrv1@hfclus1
<input type="checkbox"/>		618	Done	send_ht	lsfadmin	htoolinuxsrv1@hfclus1
<input type="checkbox"/>		619	Done	send_ht	lsfadmin	htoolinuxsrv1@hfclus1

Platform

Cancel | Clear | Clear All

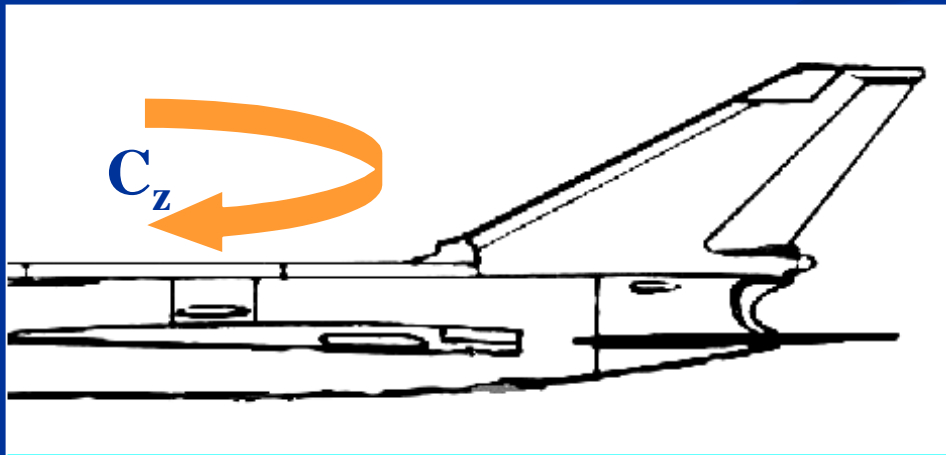
Task	Started	Status	Progress

Platform Grid user interface

采用两种网格平台：Platform公司和863开发的平台

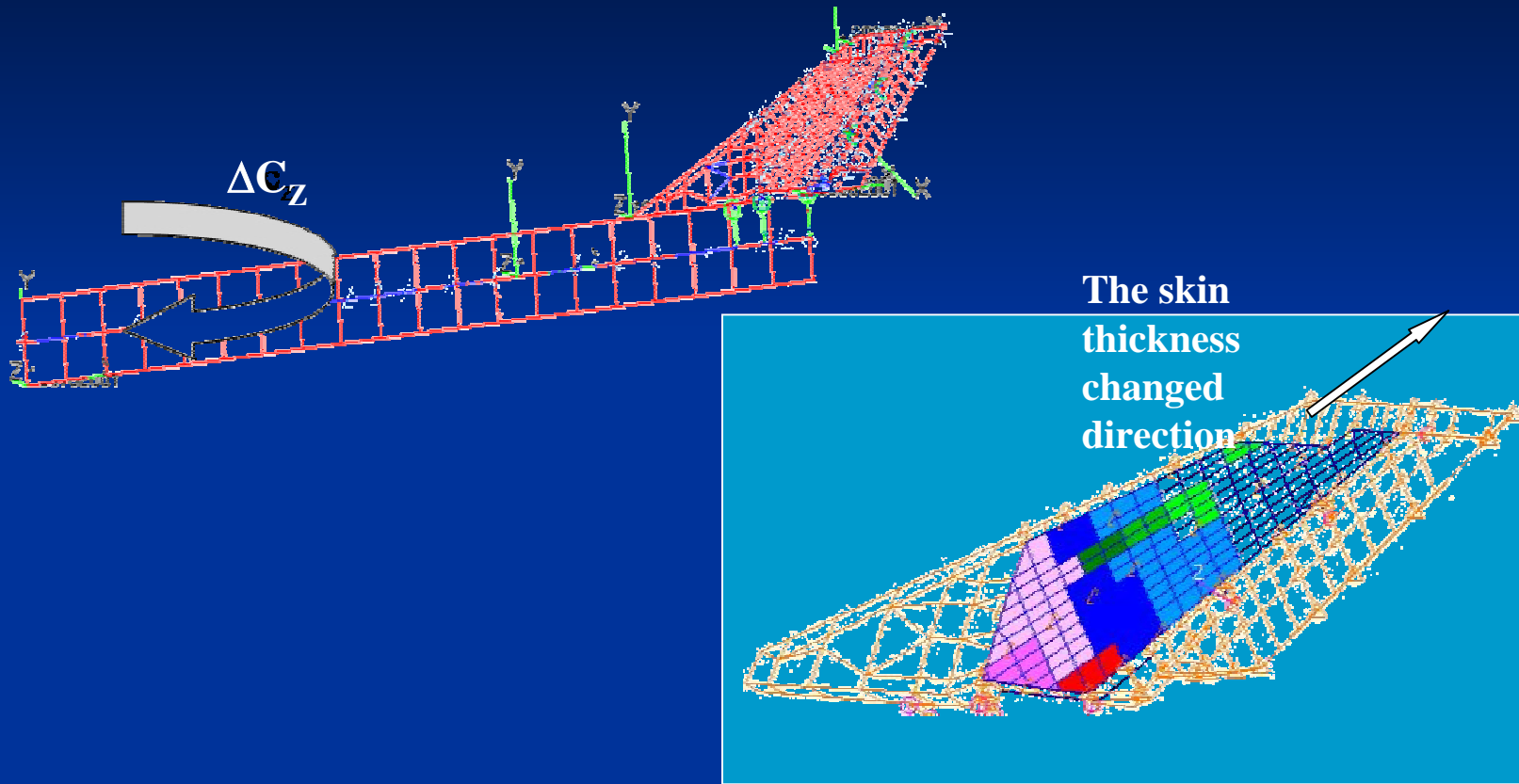
There are two Grid platform: PLATFORM and 863 Grid platform

- 算例1. 要求飞机的方向安定性增加20% , 结构重量增加小于蒙皮重量的20%。
- Application 1: The aircraft direction stability C_z is needed to be increased 20% and the weight of vertical stabilizer skin is added not more than 20% .



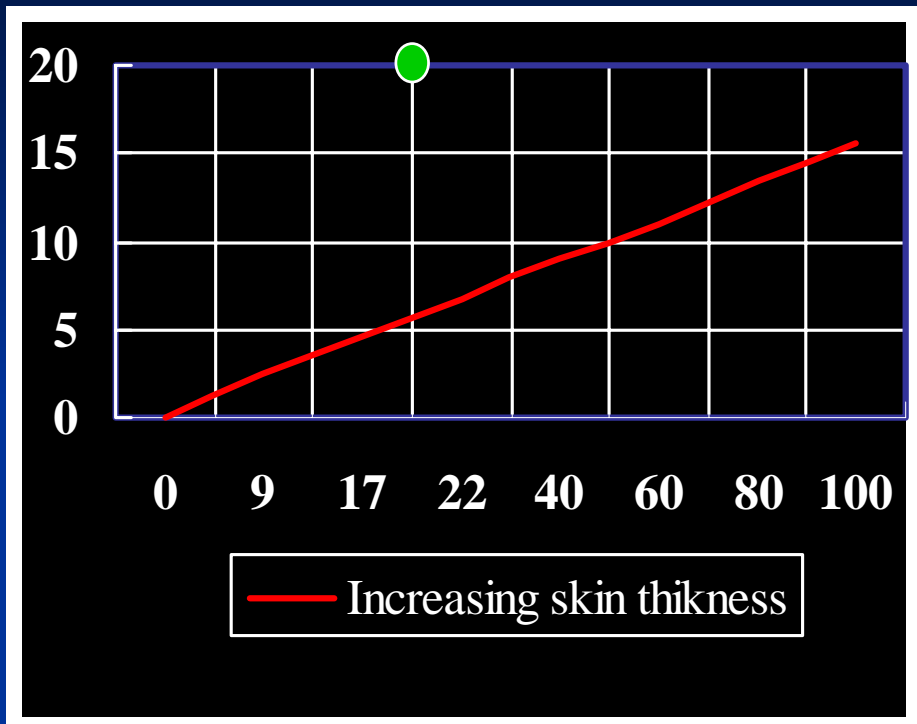
研究的目标
The research tasks
of application 1

The Genetic Algorithm optimization based on Grid Platform



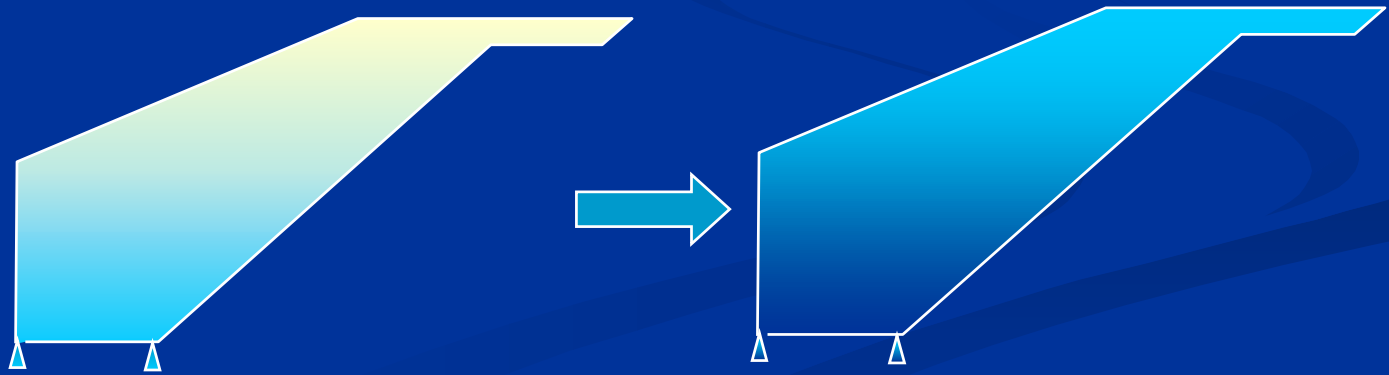
优化前垂尾蒙皮厚度分布

The vertical stability skin thickness distribution and the FEM model before optimization

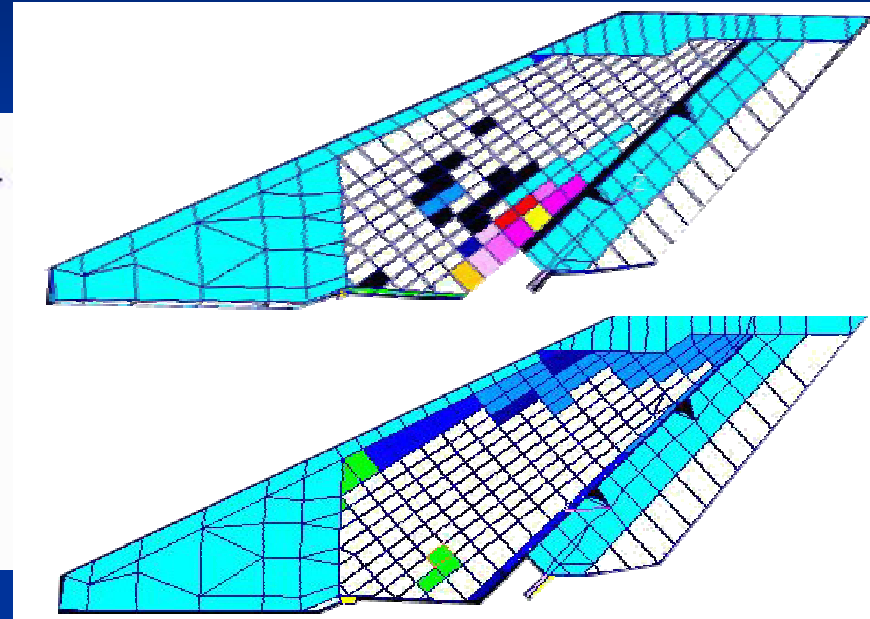
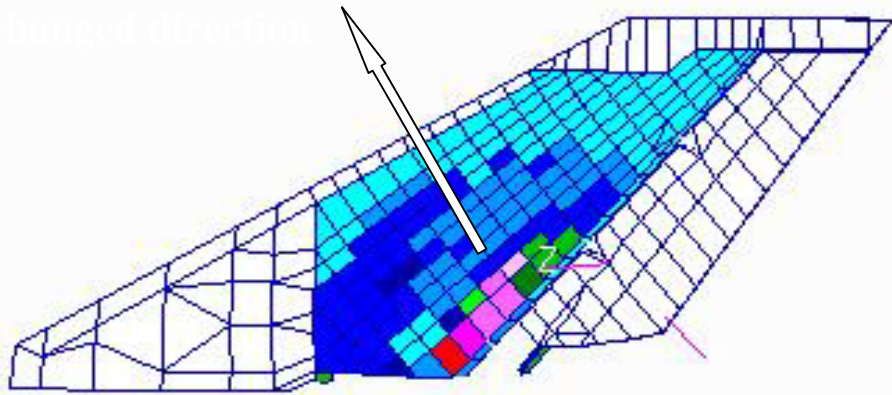


当简单增加蒙皮厚度的时候，蒙皮重量增加100%时， C_z 仅增加15.6%。远不能满足设计需求。

The ΔC_z is only increasing 15.6% when the skin thickness doubled.



Re-configuration composite material vertical stabilizer by using GA optimization after 550 hours computation



优化后垂尾蒙皮厚度分布

The vertical stability skin thickness distribution and the FEM model after optimization

利用遗传算法成功的进行结构优化设计

Re-configuration composite material vertical stabilizer

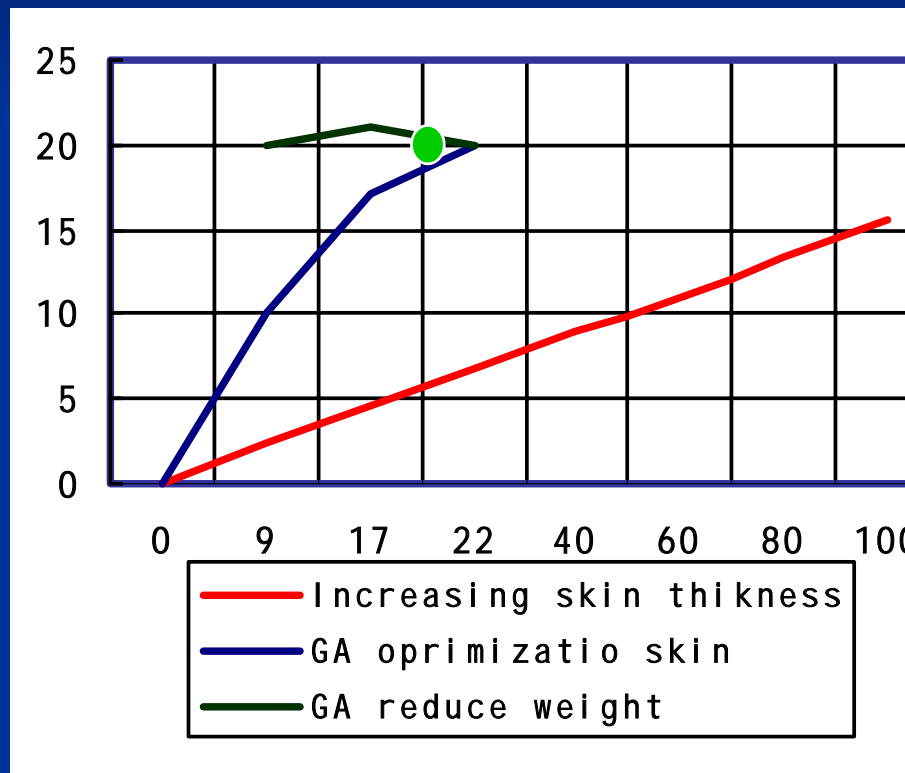
reached the goal by using

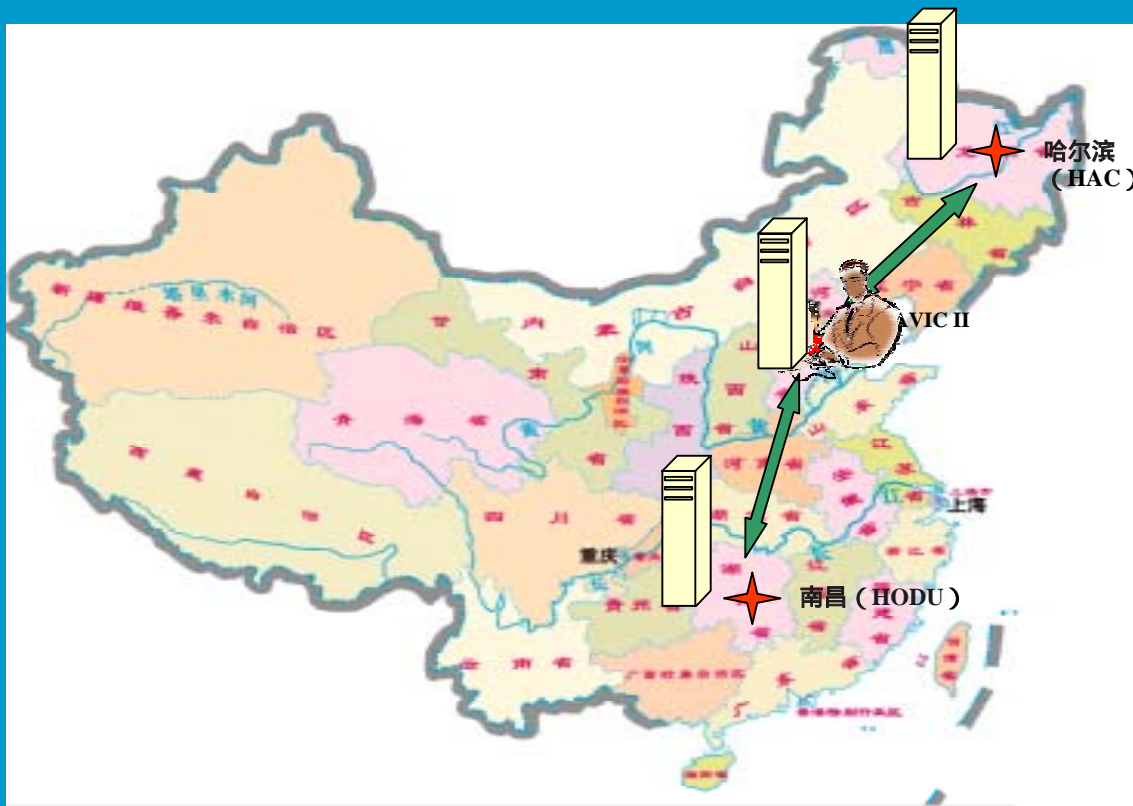
Genetic Algorithm .

The problem is that It takes too many time (550h) to do the calculations.

优化和未优化情况下方向安定性 ΔC_z 和结构重量的关系

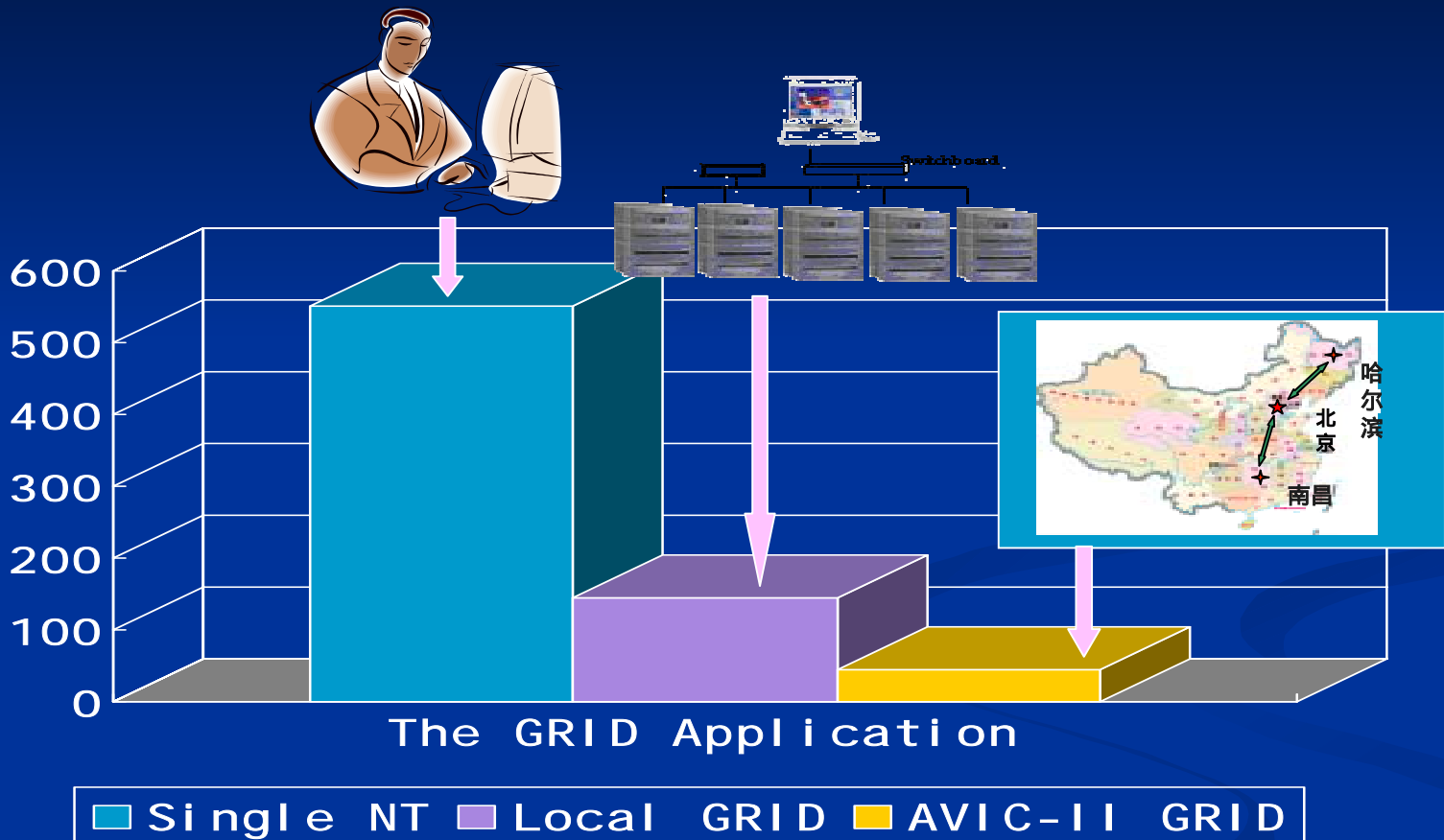
The relationship between ΔC_z and weight increasing before and after optimization





基于网格平台的系统可以实现异地资源共享

The three clusters resource has been shared based on GRID platform



网格的应用明显的减少了计算时间

The computation time is great reduced by using GRID technology

3. 先进的制造网格支持异地联合设计和仿真

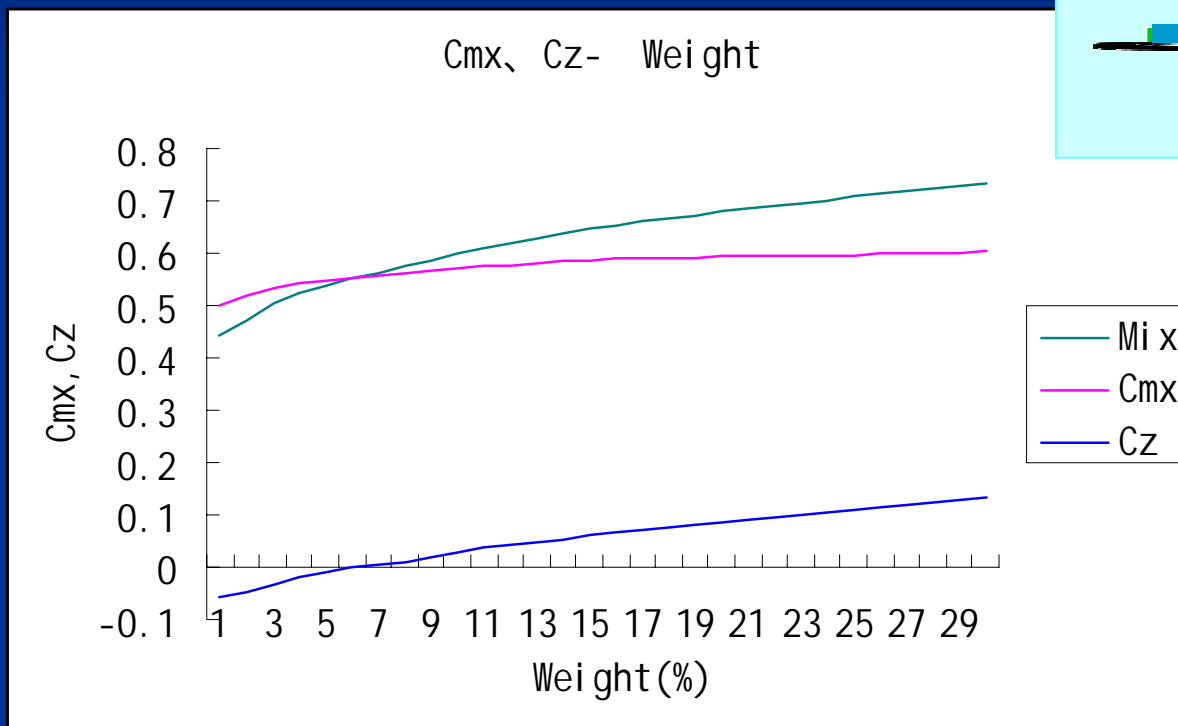
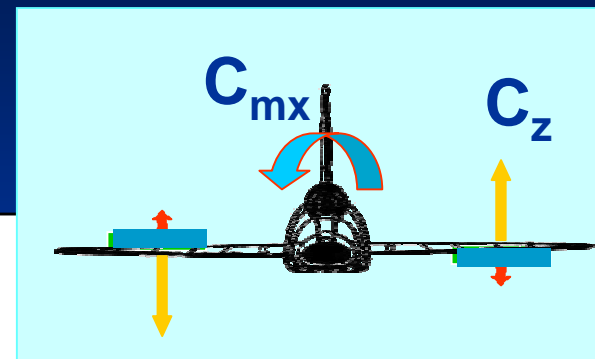
3. Advanced Manufacturing Grid Supporting

Extensive Collaborative Design and Simulation
采用网格技术降低了优化计算时间

The computation time reduced by GRID technology

Project	Single omputer (hrs)/ 1NT	Local GRID (hrs)/4 NT	AVIC-II GRID (hrs)/11 NT
Vertical stability	550	146	<80

应用2. 要求增加副翼效率和飞机的滚转力矩。
 Application 2: to increase the aileron efficiency and aircraft rolling moment.

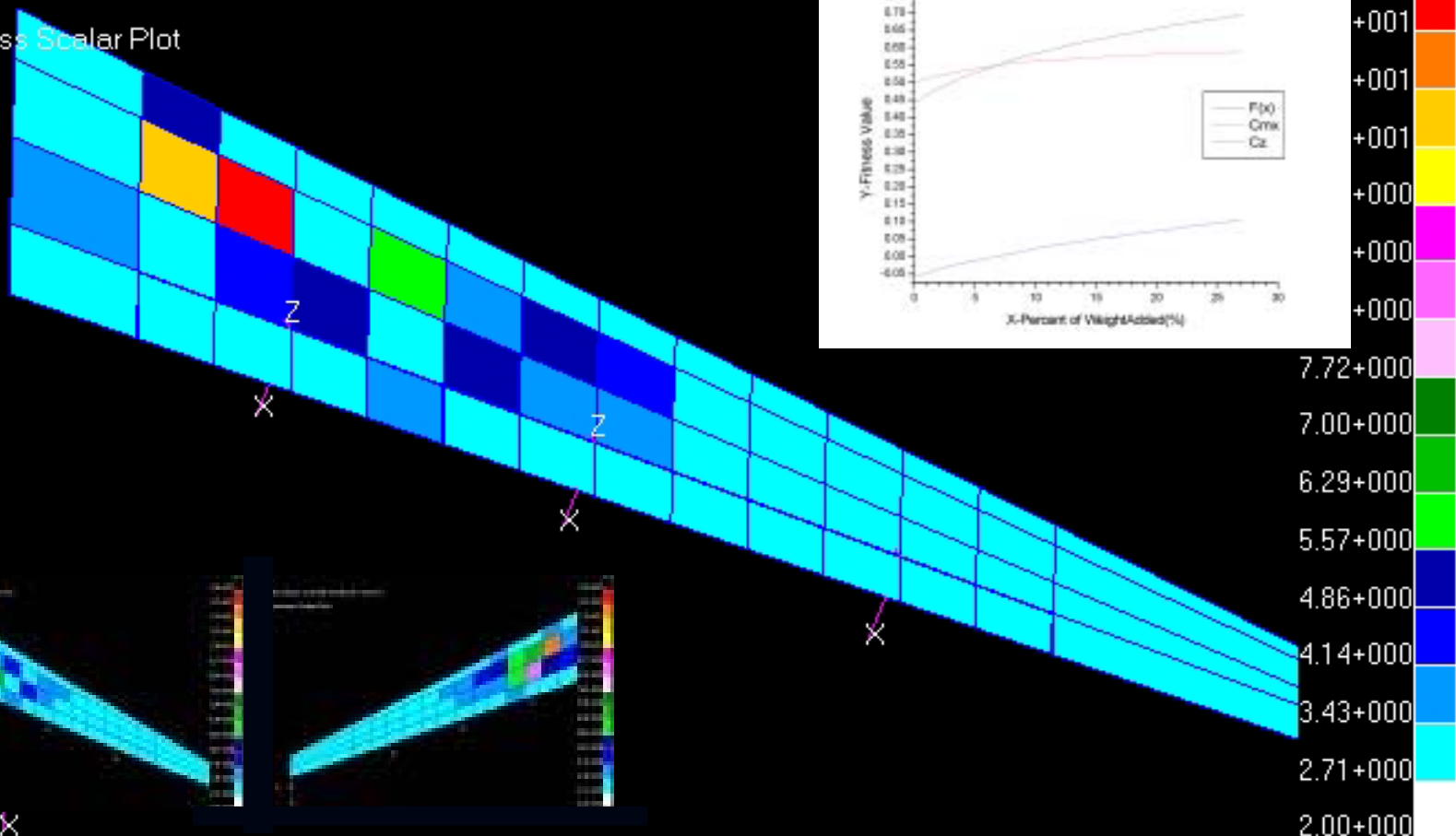


An application on Multi Goal Optimization

Computing time reduces from 760h to 80h by using Grid Platform

MSC.Patran 12.0.044 13-Jun-05 19:57:13

Thickness Scalar Plot

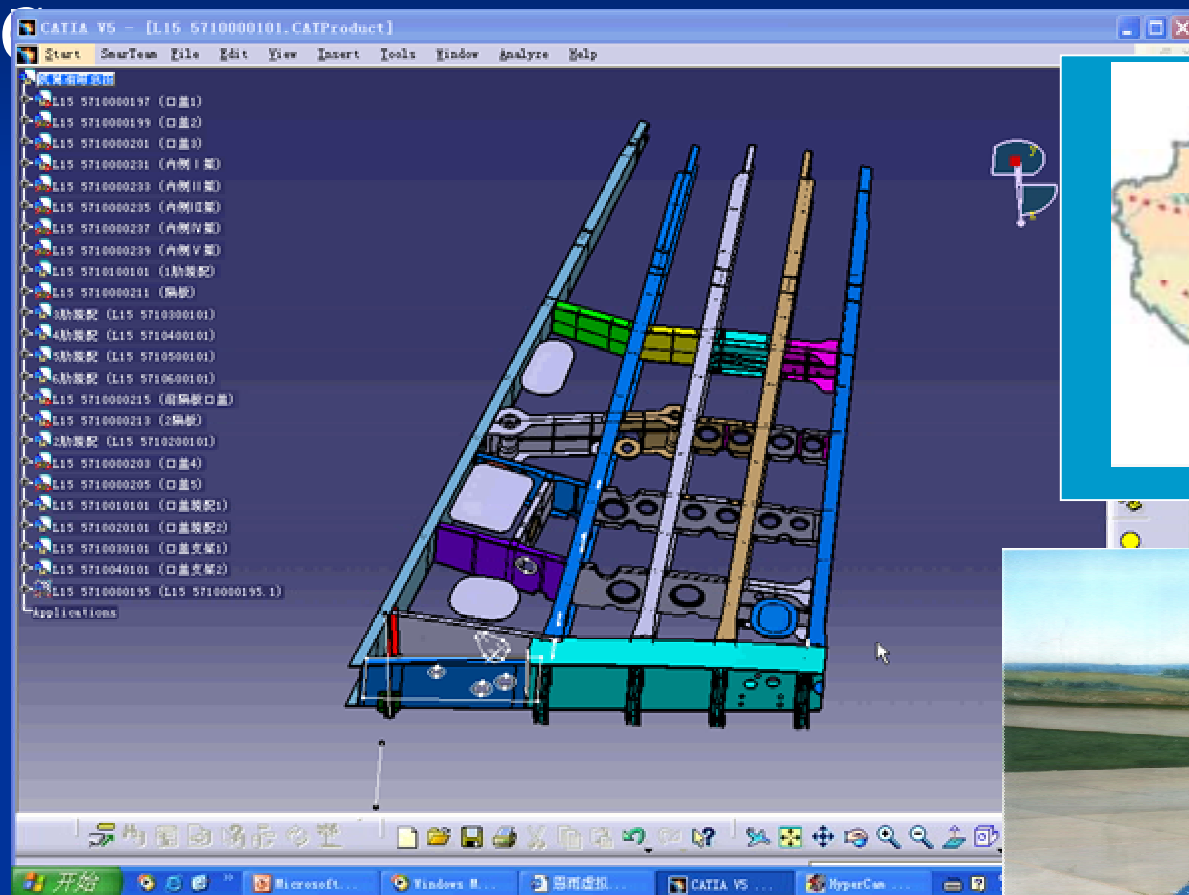


The results of application 2 based on Grid Platform



许可证浮动应用 License Flouting Application

- 不同工厂Cati a许可证浮动进行机翼设计制造
- Deferent factory flouting Catia License for wing design of a



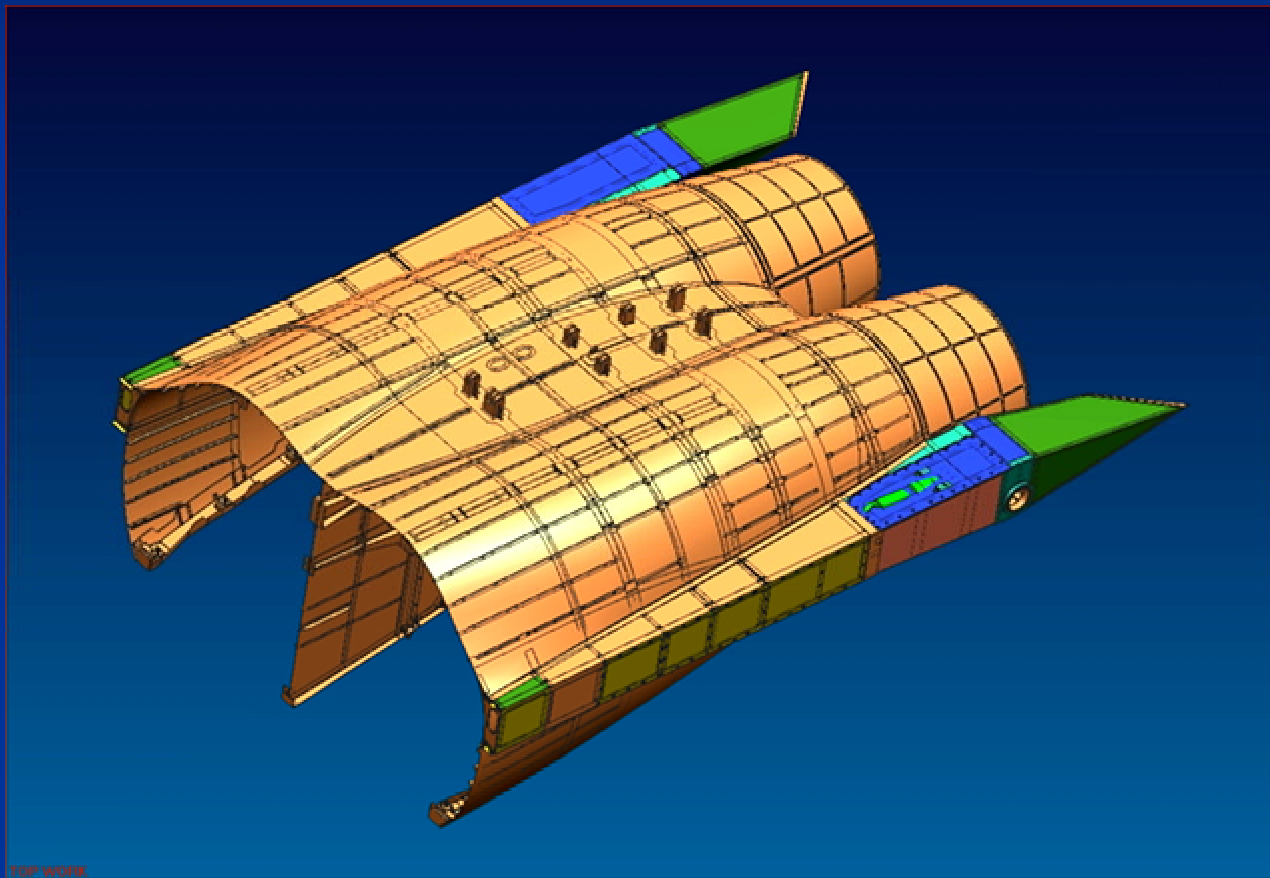
制造网格软硬件共享提高了虚拟装配效率

Advanced manufacturing Grid accelerate the efficiency of virtual assembly simulation

- **鉴于飞机的零组件数量太大，利用先进制造网格技术开发基于UG的大型分布式干涉检查系统，以解决传统的在一台机器上进行干涉检查速度太慢的问题**
- **Developed a interference check system using Advanced manufacturing Grid to accelerate the efficiency of virtual assembly simulation, the system is based on the UG interference check tools. It solve the time consuming problem in traditional way.**

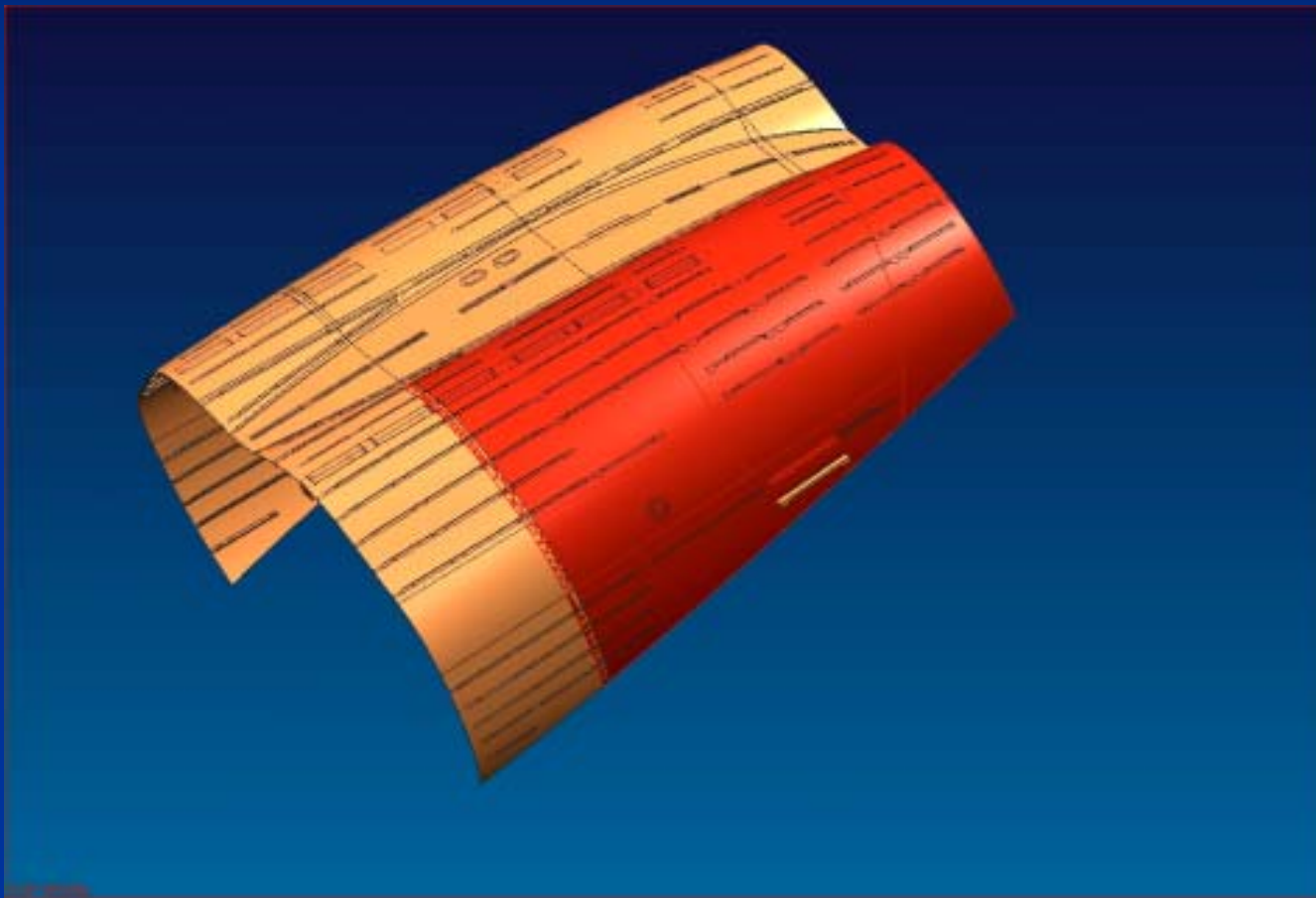
后机身的干涉检查示例

The example of a rear part fuselage for interference check

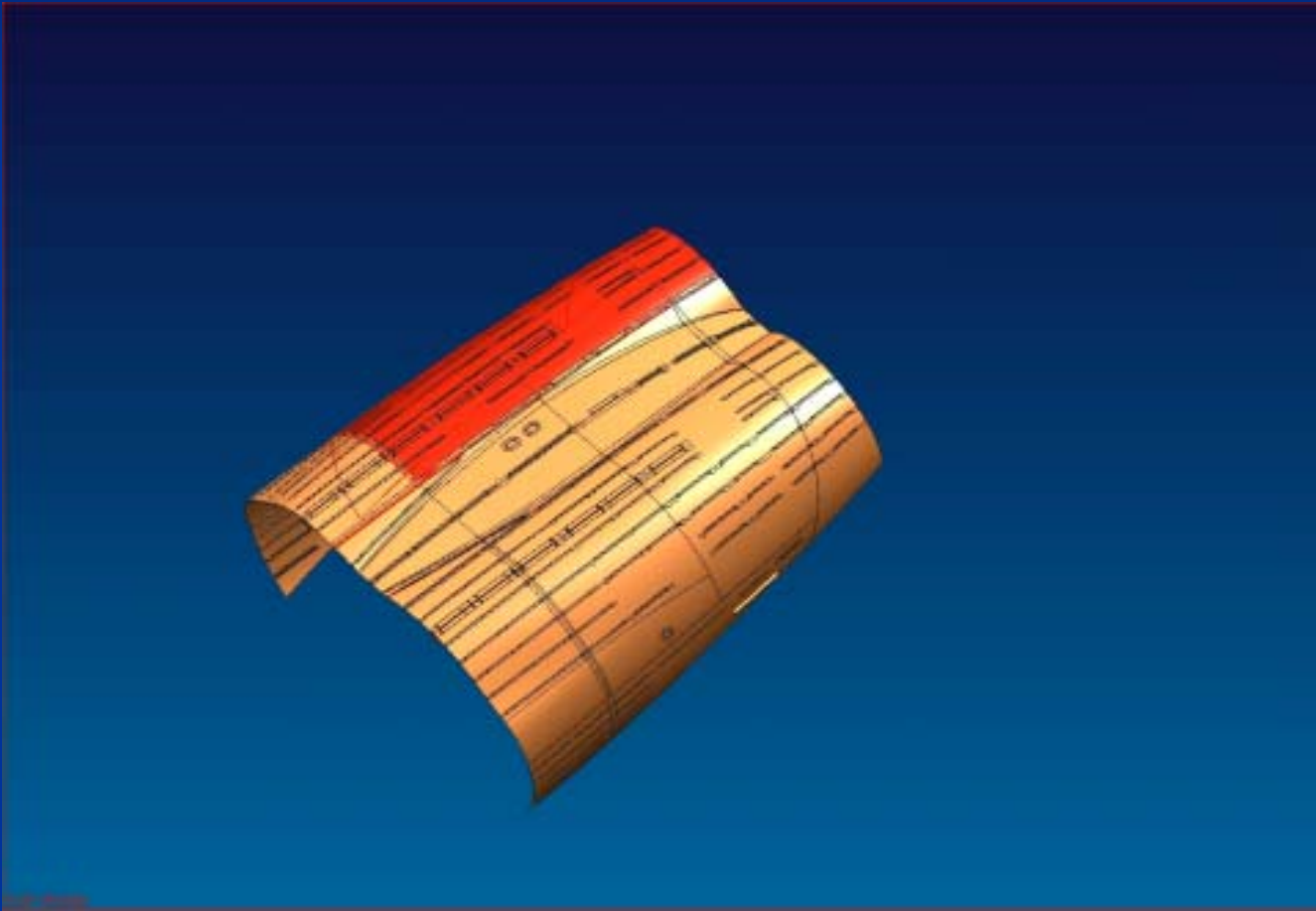


经过虚拟接触干涉检查后的结果

Touch interference results after virtue interference check



- 经过虚拟硬干涉检查后的结果
- **Hard interference results after virtue interference check**



结果

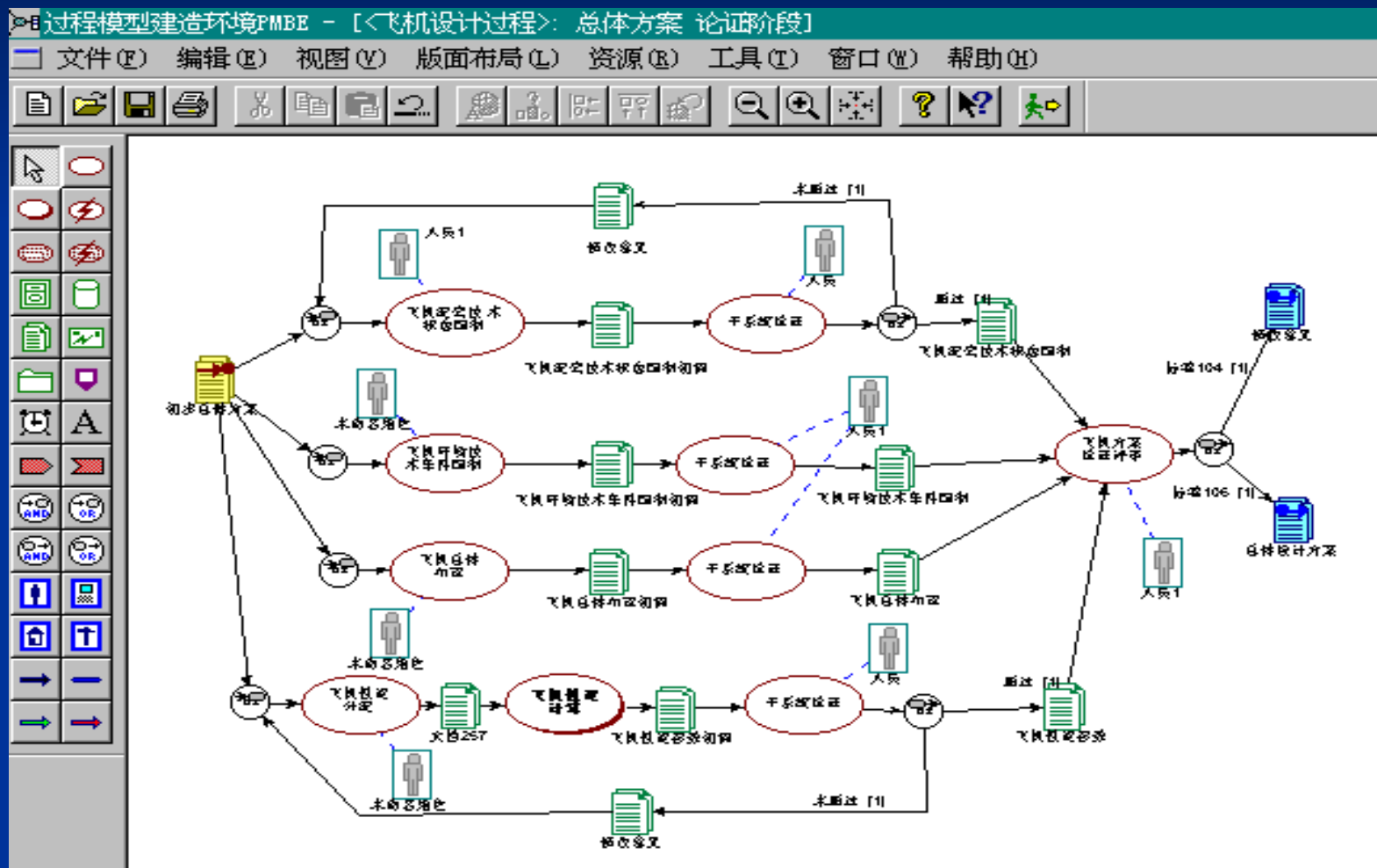
Result

- 35个部件，435次干涉检查算例
- The example of 35 parts interference check after 435 analysis

	Single Computer	Grid Platform
Operation System	3.06 GHz 2GB	2* 3.06 GHz / 2GB 4* 2.8 GHz / 1GB
Time	4h 43'	1h 03'

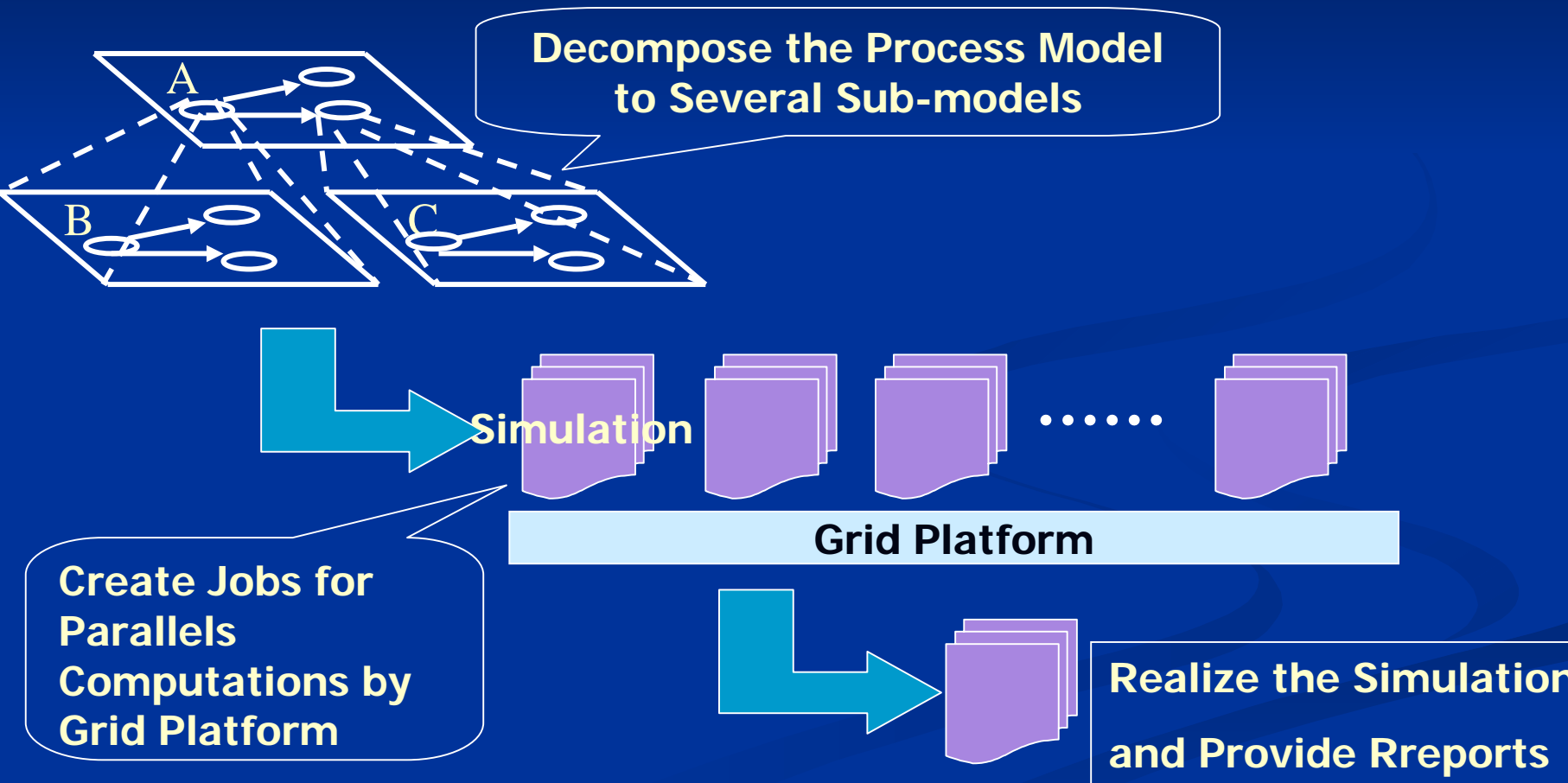
过程建模仿真的应用

Process modeling simulation application



过程建模仿真的应用

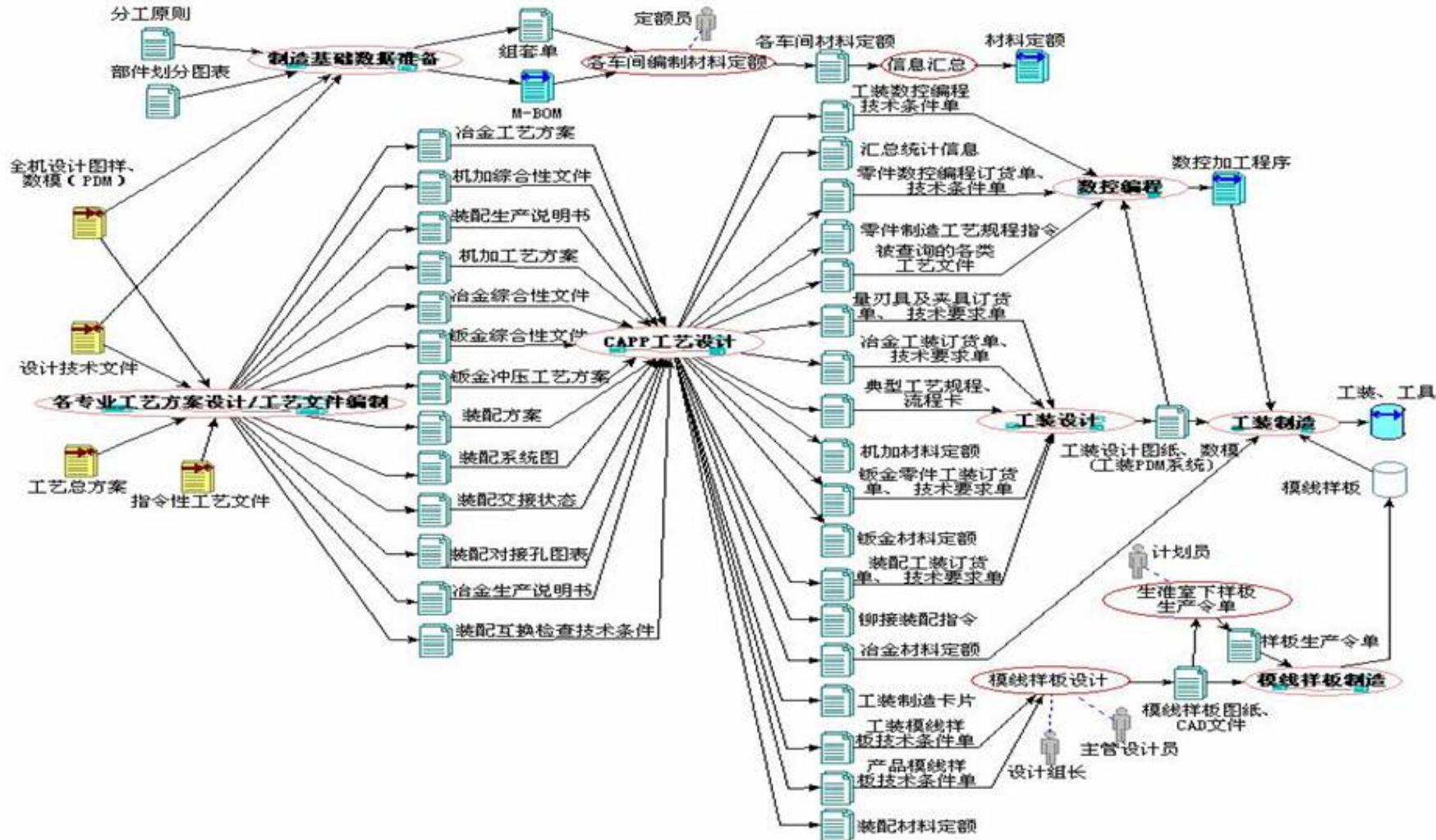
Process modeling simulation application



过程建模仿真的应用

Process modeling simulation application

工艺准备阶段过程图





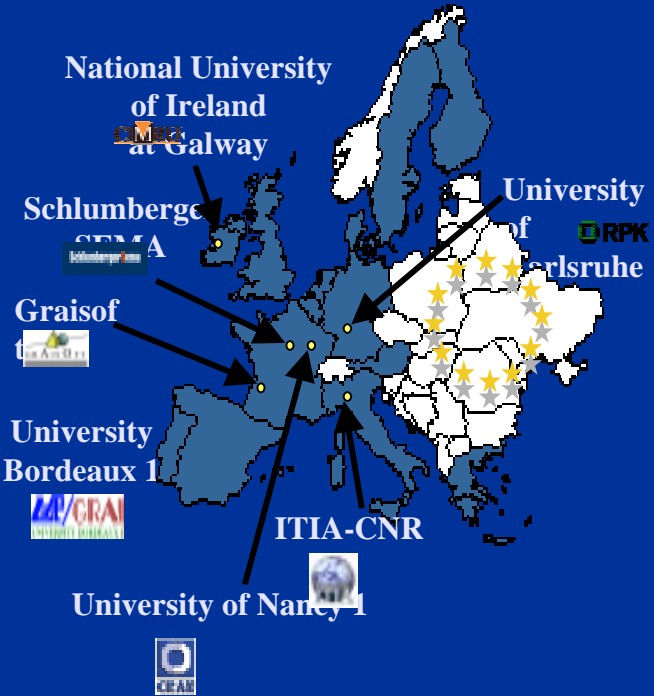
5、结束语

5. Conclusion

BUAA AVIC 长期参与中欧在信息领域的合作

BUAA & AVIC has long time jointed the EU China IST cooperatio

European Commission IST Project





5、结束语

5. Conclusion



A350

■ 中航集团公司与空客公司签订了协议，将共同建立技术中心，将参与A350项目。中航第二集团公司正与DADS公司开展共同发展6吨级直升机的项目。网格技术将对中欧的工业合作建立信息平台，并促进工业合作。

■ AVIC and AIRBUS has sign an agreement to create a technique Center in Beijing and take some work on A350. AVIC-II and EADS also has created some jointed developing 6 ton helicopter projects. The Grid technology will help to create a good information platform between EU and China Aviation Industry, also to support the international cooperation.



AIRBUS

Visit airbus.com

5、结束语

5. Conclusion

- 航空网格领先应用证明了航空网格将促进航空企业资源的效率。但目前的网格平台尚离企业的全面应用还需进行很大努力，希望在以下方向合作：改进目前的网格平台，进一步选择适合的平台；加大实施系统应用的努力，建立相应的服务功能；在与欧盟的飞机合作项目中得到应用。
- The pilot application of Grid technique in AVIC is just beginning, it has show great benefited for AVIC. We wish to cooperation with EU partners in the following field: Improve the Avi-Grid Platform; Added more service function for application; Support the international cooperation with EU in the new aircraft jointed development by Grid.

希望在信息应用领域有更多合作!

Wish more cooperation in information field!

Thank You!