网格技术在航空制造业

Aviation GRID

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2005.6

1. 充满挑战与希望的航空工业

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.

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

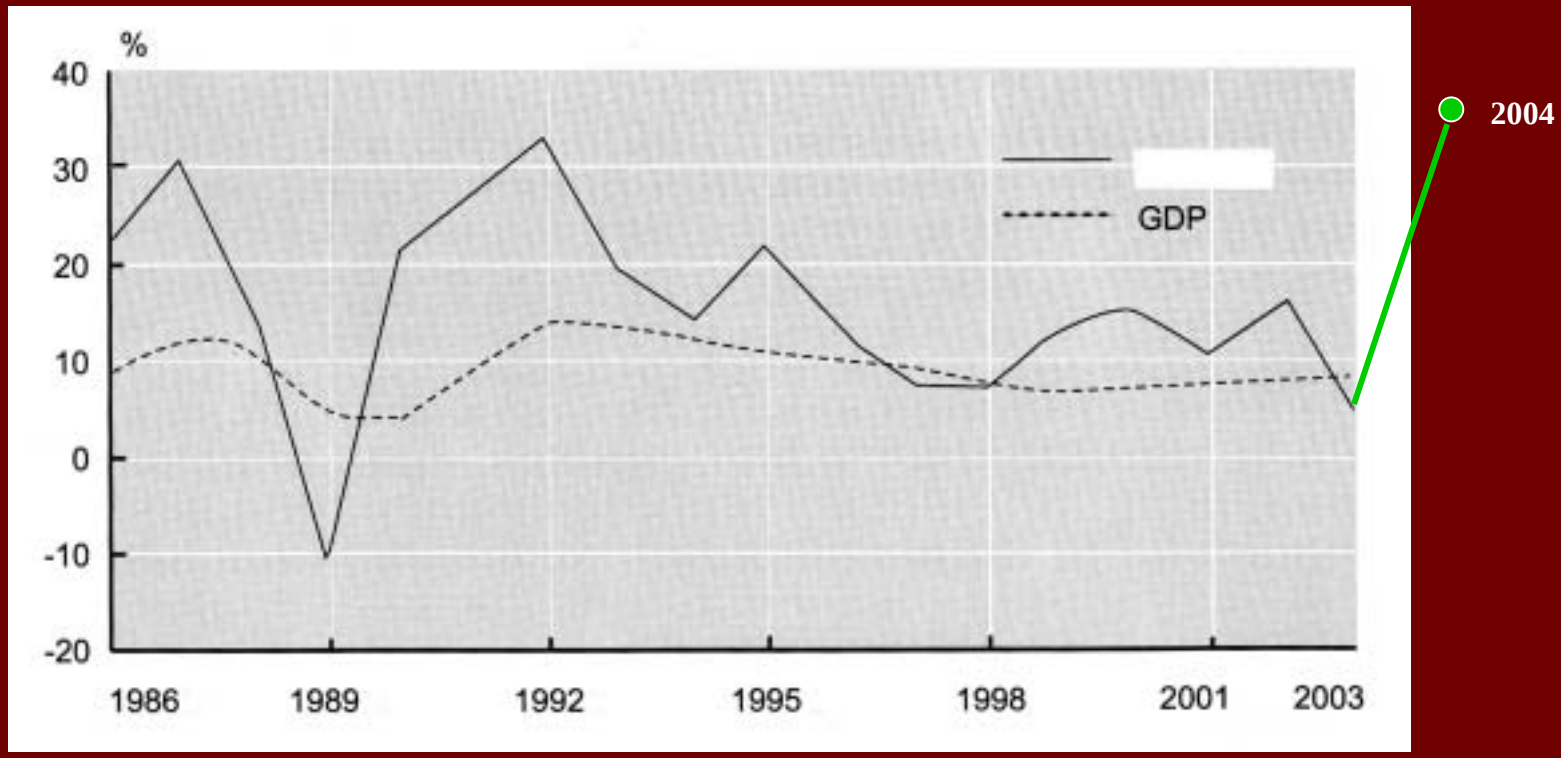


图 1 .航空运输总周转量增长情况与国民经济GDP增长情况

Fig1. The growth rate of air travel and GDP (1983-1998)

(China market outlook for civil aircraft 2004-2023)

1. 充满挑战与希望的航空工业

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

A．只有第一流的民机才能进入航空市场

A．Only first level civil aircraft could be in the market

B．只有联合才能承受巨大的风险和投入

B．Cooperation and merge will reduce the risk and the challenge

C．只有掌握高技术才能生存

C．High technology for aviation industry is necessary

D．只有得到政府的支持才能发展

D. Government support is important

E．只有配套的优良的售后服务，飞机工业才能长期发

E. Support and Maintains Network is key point for Aviation Industry long term development

1. 充满挑战与希望的航空工业

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

8759万旅客2003年

87.59 Million Passengers in 2003

在未来20年中国需要2194架民用客机,货机396架

Forecast Required 2194 Passenger Aircraft and 396 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.

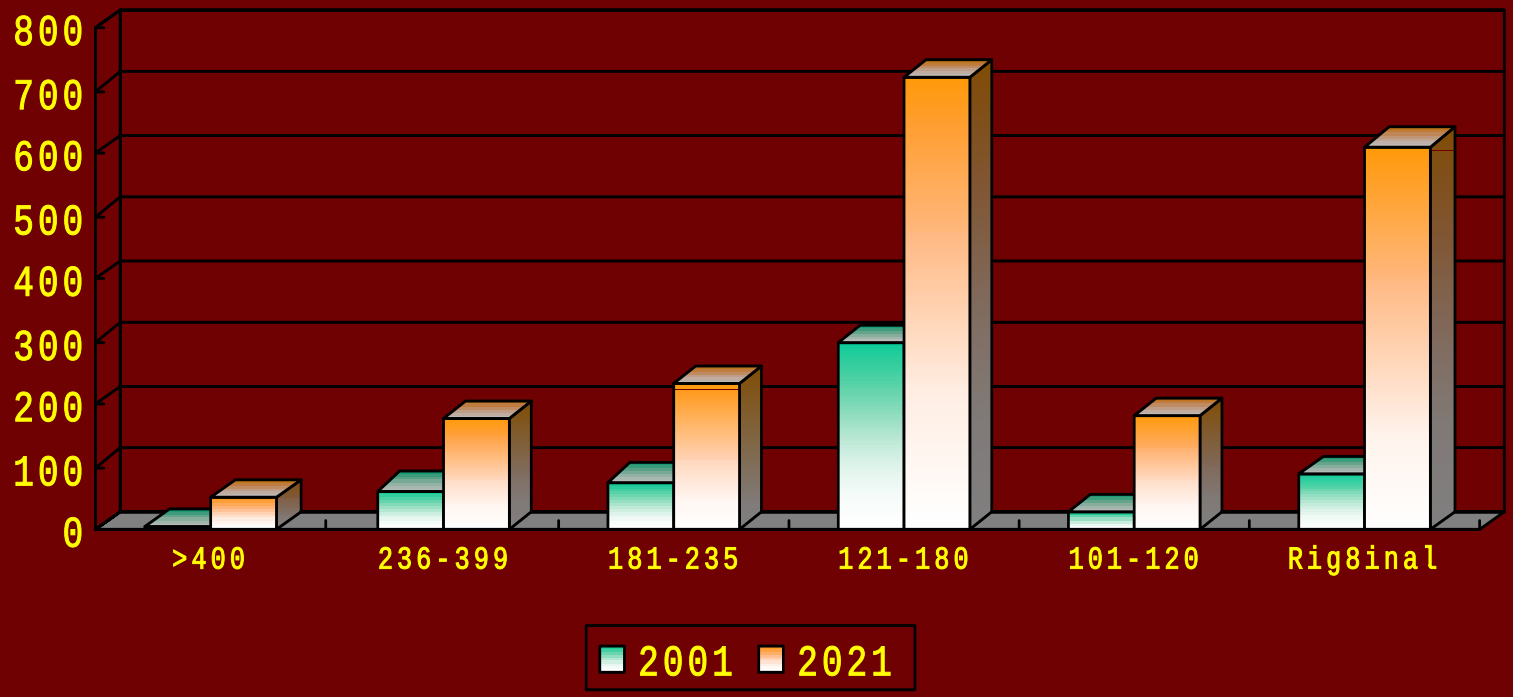


图2.根据中国航空发展研究中心的预测，目前和到2021年中国民航需要的各种类型飞机数量

Fig 2. The fleet forecast 2021 of China airline providing by China Aviation Development Research Center

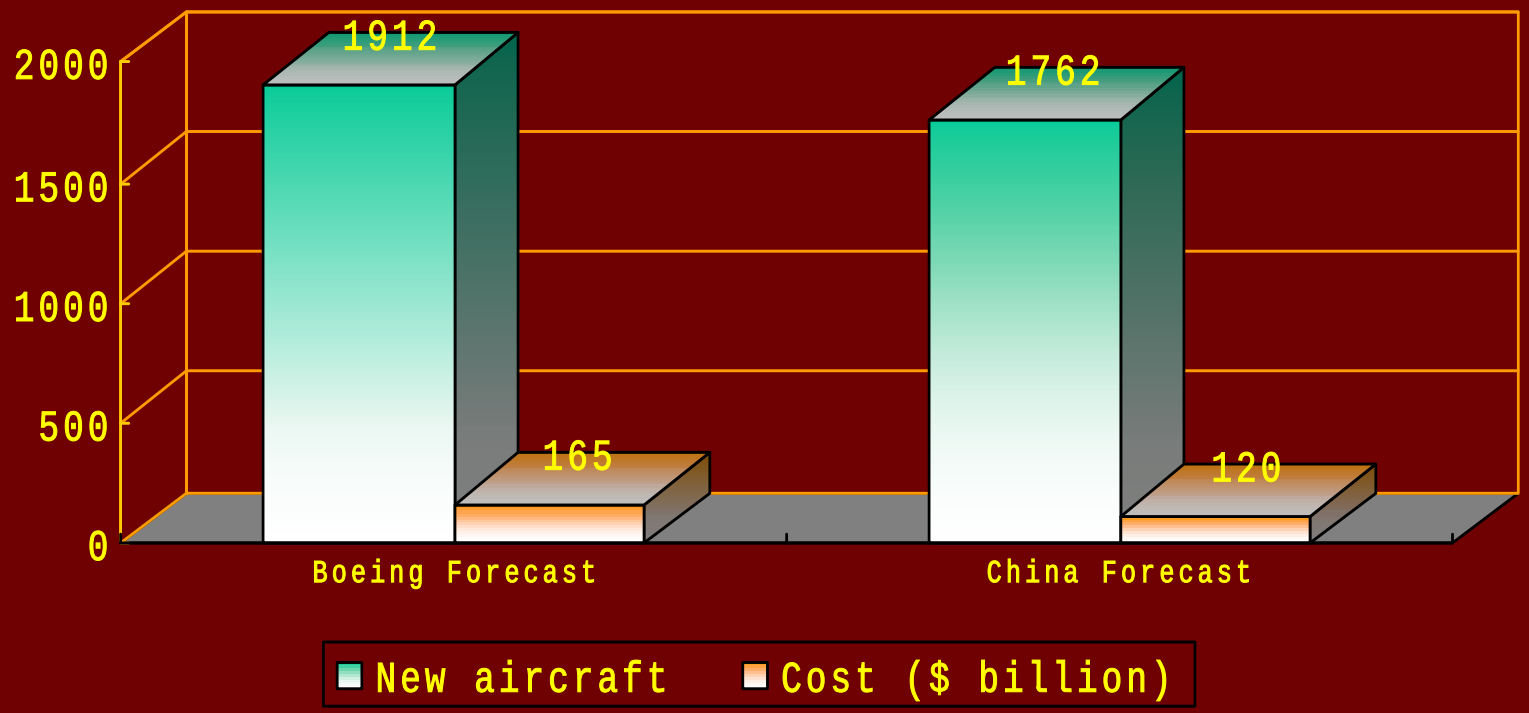


图3. 根据波音公司和中国航空发展研究中心的预测，
2021年中国民航客机需求量和采购费用（十亿美元）

Fig 3. The New Aircraft forecast 2021 of China airline providing by Boeing and China Aviation Development Research Center

1. 充满挑战与希望的航空工业

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

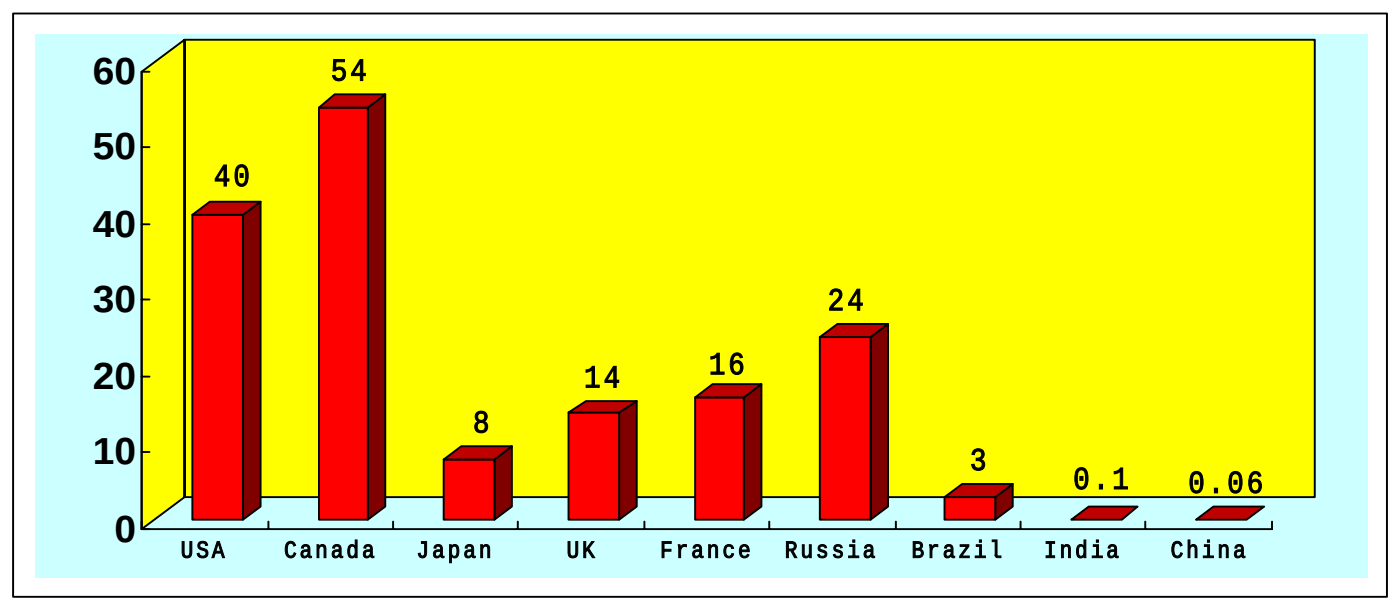
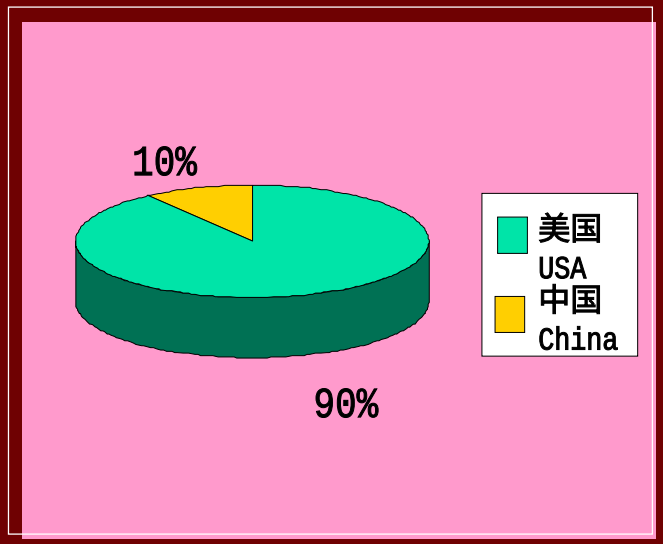


图4. 世界直升机百万人占有量（架）

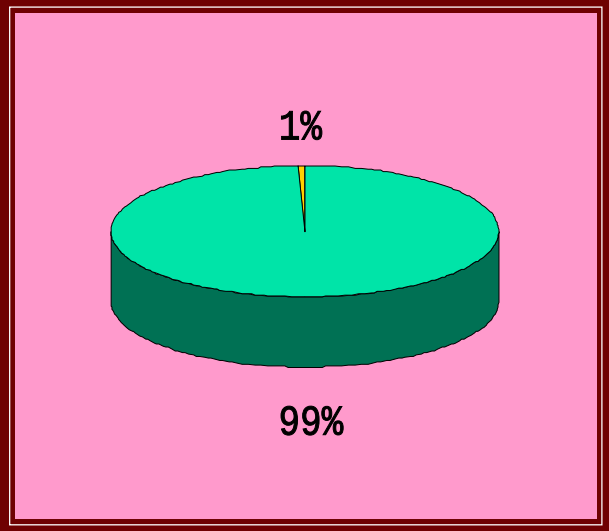
Fig4 .The occupation of per helicopter within 1 million populations

A．中国直升机市场潜力极大

A． A Great Potential Market in China for Helicopter



GDP



直升机量对比
Helicopter N

图5．中国与美国GDP和直升机量对比

Fig 5. The helicopter number and GDP comparison between China and USA

1. 充满挑战与希望的航空工业

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

A．力量分散

A．A Scattered Aviation Companies

B．新产品开发研制周期长

B．Long aircraft development schedule for new projects

C. 新产品开发手段落后

C. Measures and Tools Behind

D. 管理需要改善

D. Improve Management

E. 产品全生命期成本高

E. High Product Live Circle Cost

1. 充满挑战与希望的航空工业

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

信息技术促进中国航空工业的发展

Information technology accelerate the development of China aviation industry

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 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

2. 信息技术将促进航空工业的发展
2. Information Technique Accelerate the Aviation Industry Growth

图6. 中航第二集团公司直升机的异地设计制造

Fig6. The distributed helicopter manufactory in AVIC-II

图7. 中航第二集团公司直升机的异地设计制造

Fig7. The distributed helicopter manufactory in AVIC-II

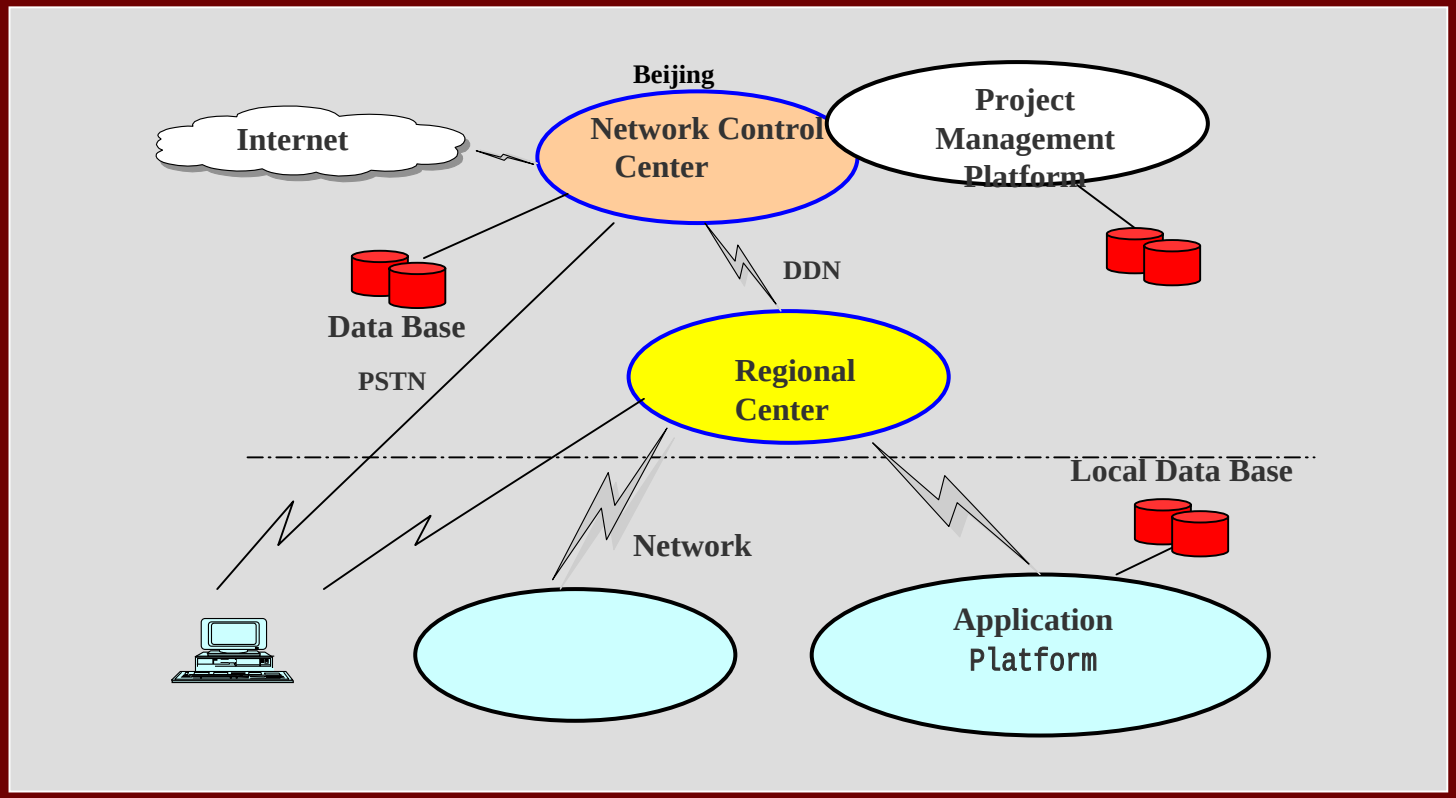


图8. 航空网情况示意图

Fig8. AVICNET structure

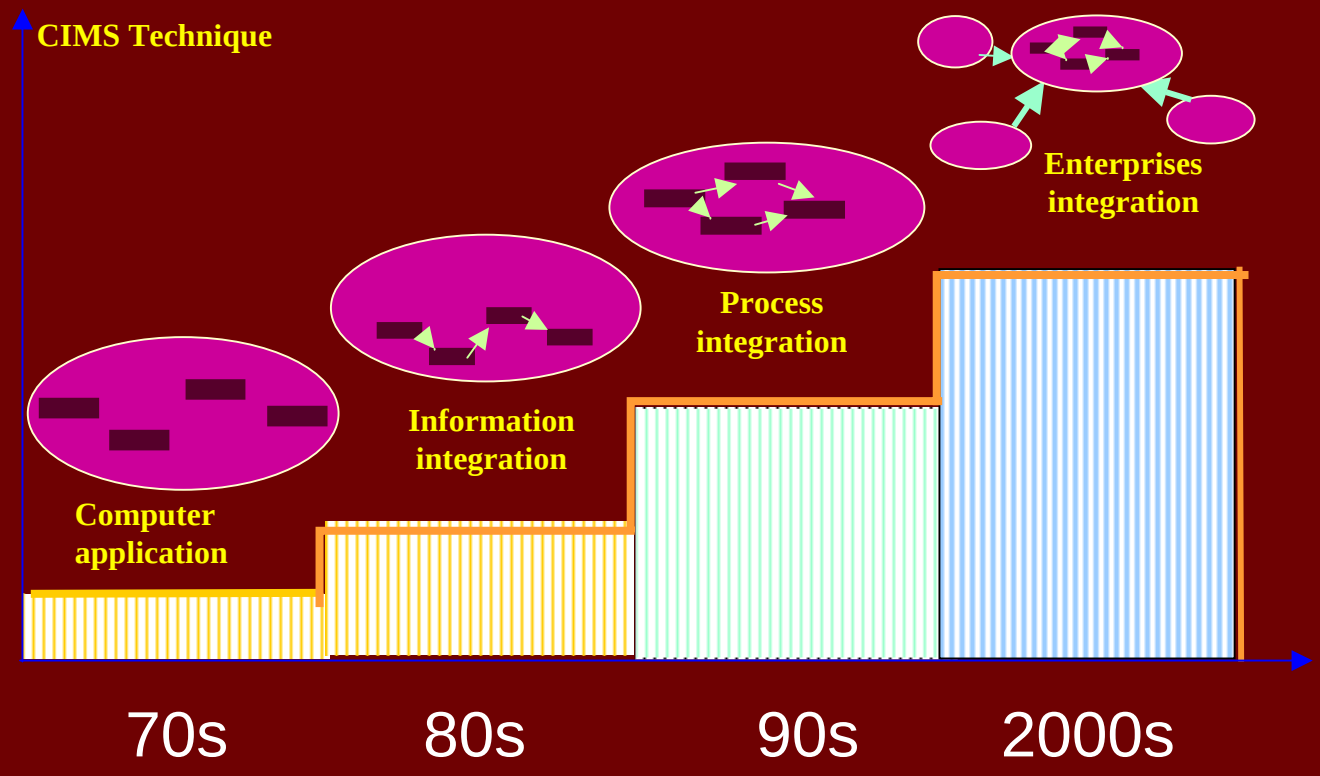


图9. 中航第二集团公司信息技术应用历程

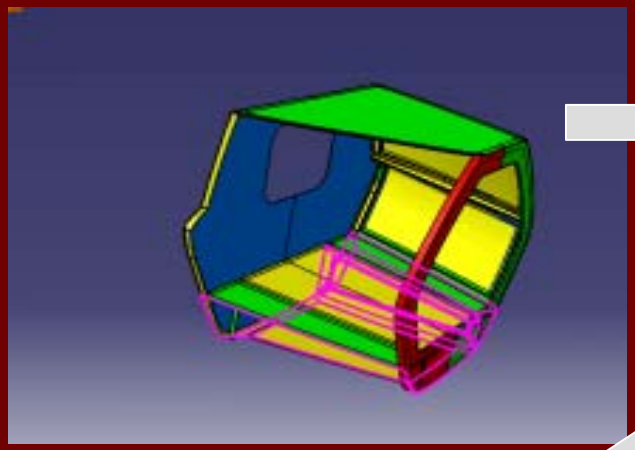
Fig9. The information technique used in AVIC step by step

2. 信息技术将促进航空工业的发展
2. Information Technique Accelerate the Aviation Industry Growth

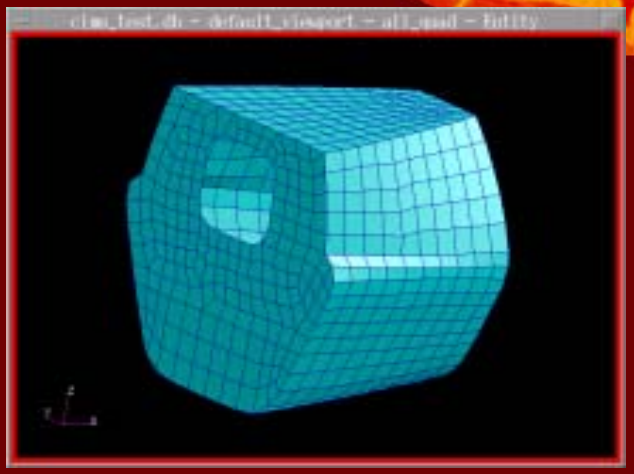
C. 飞机型号应用

C. The Application in Aircraft Development Projects

- 100%三维化设计
- 100% 3D digital definition for the new projects
- 数字样机和装配检查
- Pre-assembly for main structure using 3D digital mockup.
- 所有图纸和文件通过网络进行交换
- All digital drawing and the documents transmission by network
- 利用PDM和RPE实现产品全生命期数据管理
- PDM and ERP system will be used in products data life circle management

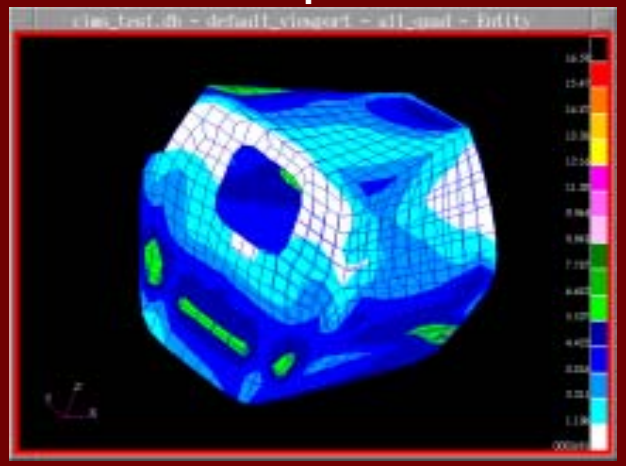


CATIA3D Drawing



Pre-process

VPM Data



Post-process

图10．虚拟分析

Fig10.Virtue Analysis

3. 网格技术在中航第二集团公司的应用
3.The GRID technology in AVIC-II

A. 背景

A. Background

（1） 航空工业需要解决硬件资源的缺乏问题

（1）More power computation capability is required when the CIMS technology is implementation in the enterprise in AVIC

（2）航空工业需要解决软件资源的缺乏问题

（2）There are large software resource is required in the peak period, but there are lot of resource unused during normal time.

（2）航空工业异地设计制造需要解决信息资源的共享问题

（2）The distributed aircraft development faces to share the drawing, the design and manufactory documents.

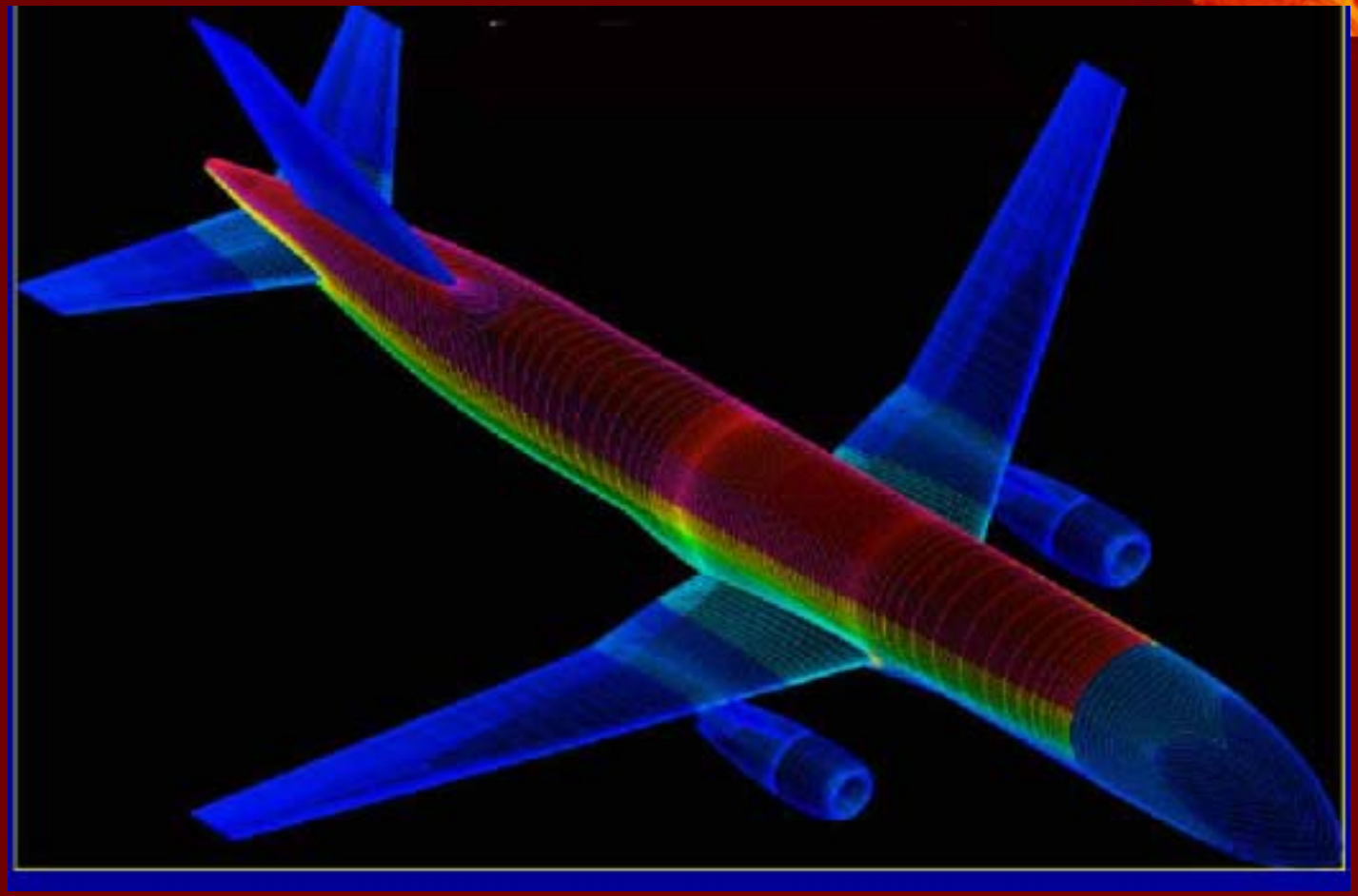


图 11 CFD和结构分析需要巨大的计算资源

Fig. 11 The CFD and structure analysis need great computation resource

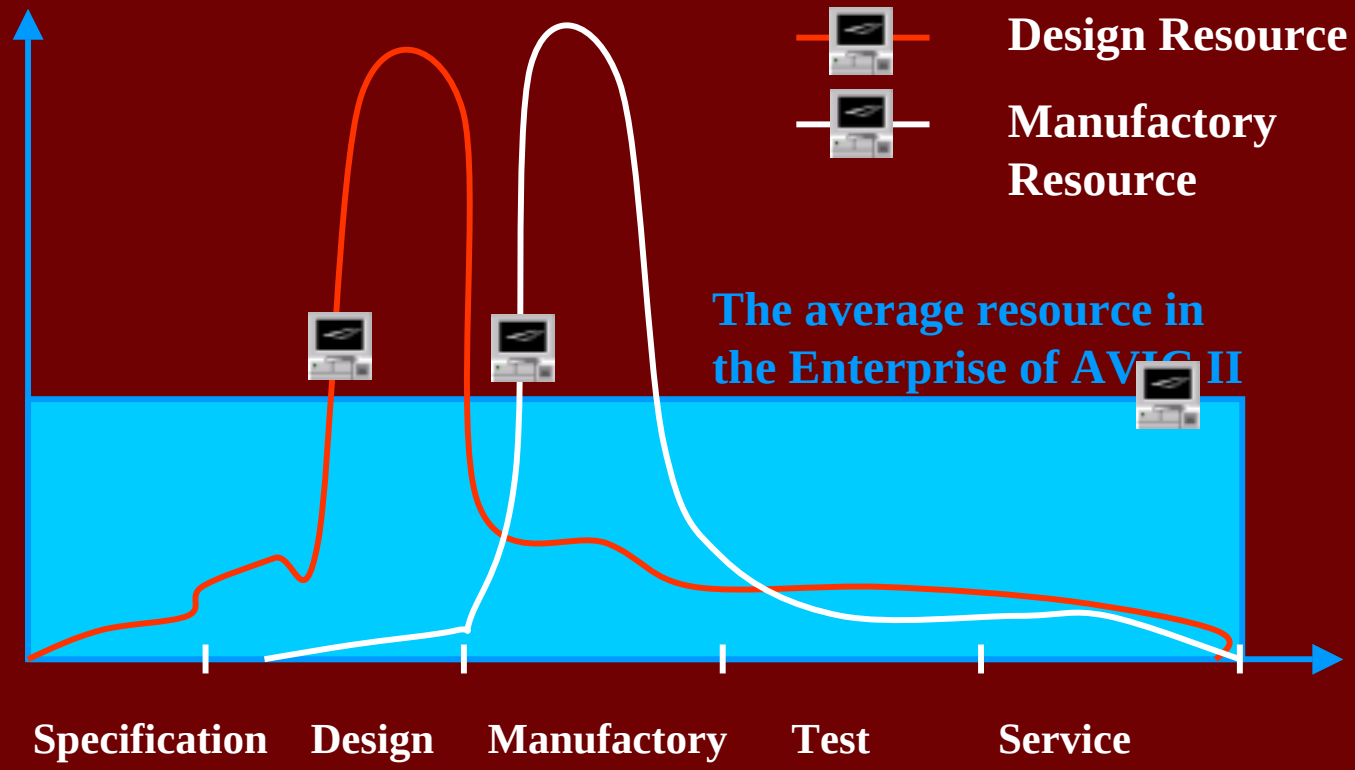


图12.航空产品全生命期的软硬件资源需求情况

Fig.12. The software and hardware resource required in the aviation period life cycle

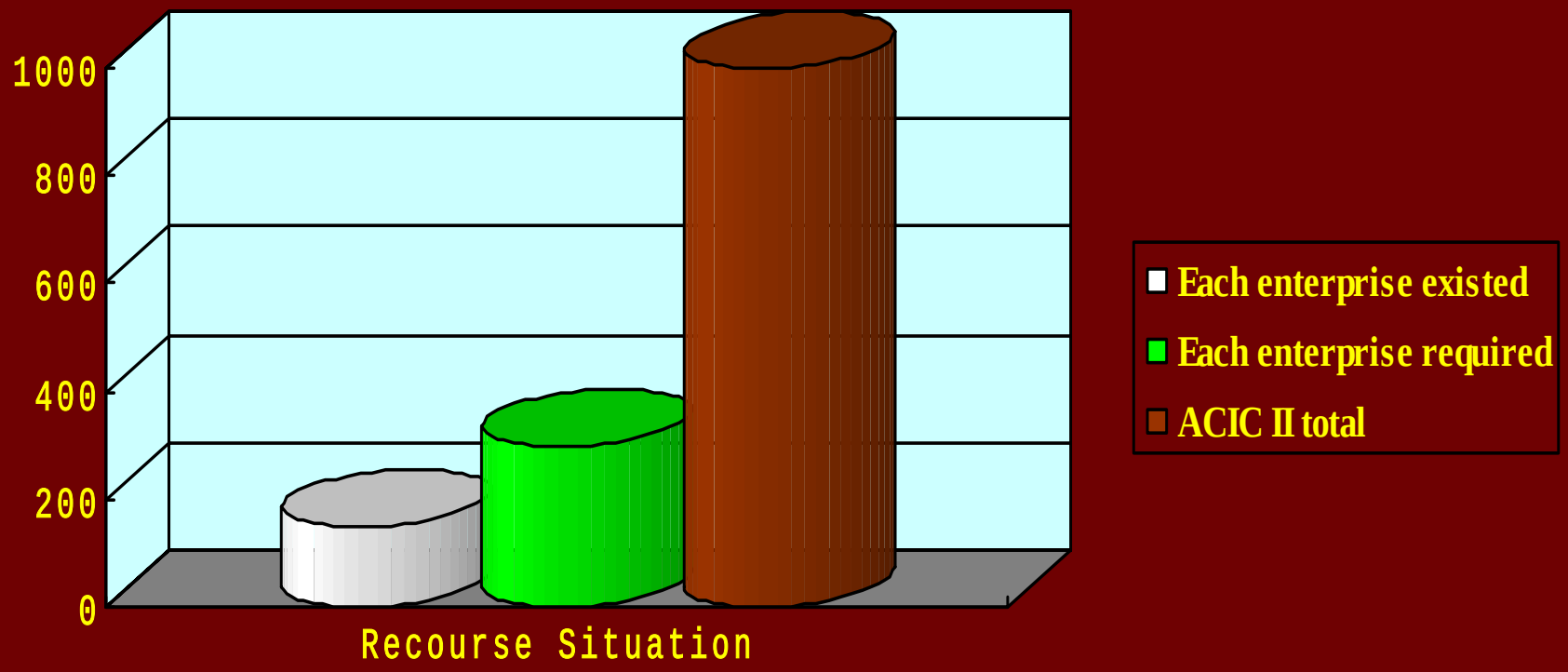


图13.中航第二集团公司CAD软件资源与企业资源需求情况

Fig.13 The CAD software resources in each company and AVIC-II total (There are more than 50 enterprises in AVIC II)

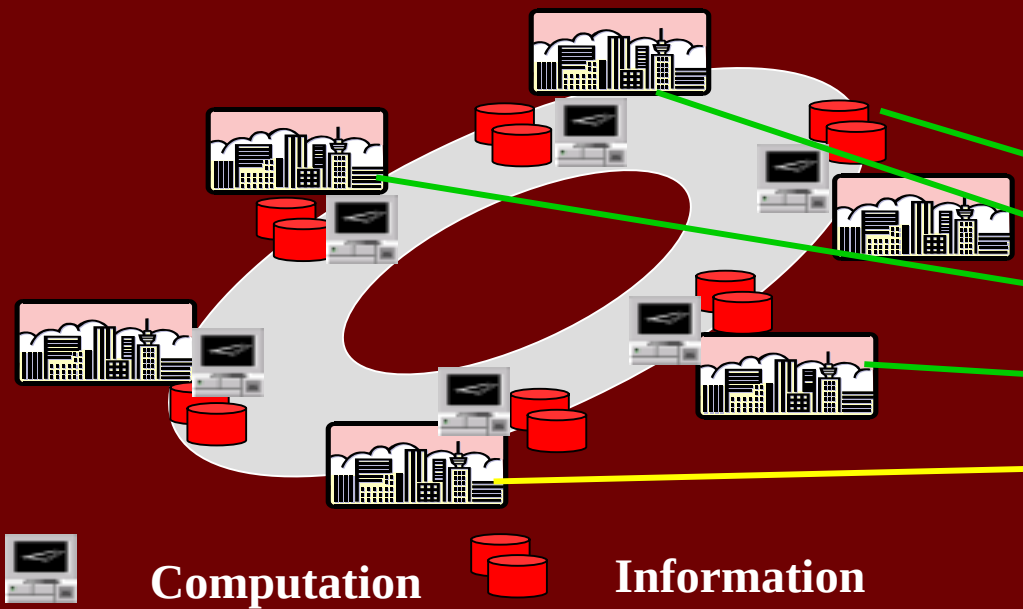


图14.飞机的异地设计制造面临着信息资源的共享

Fig 14. The distributed aircraft development faces to share the information resource

3. 网格技术在中航第二集团公司的应用
3.The GRID technology in AVIC-II

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年开始设施国家高科技八六三计划，建立网格系统，以支持航空工业的发展
- AVIC-II started to apply the GRID technology 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. 网格技术在中航第二集团公司的应用
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The application 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
- Software resource sharing for reduce the software cost
- 建立数据网格，解决数据共享问题
- Information resource sharing for ambient intelligence
- 应用上述平台，开发基于网格的应用系统
- Developing application system

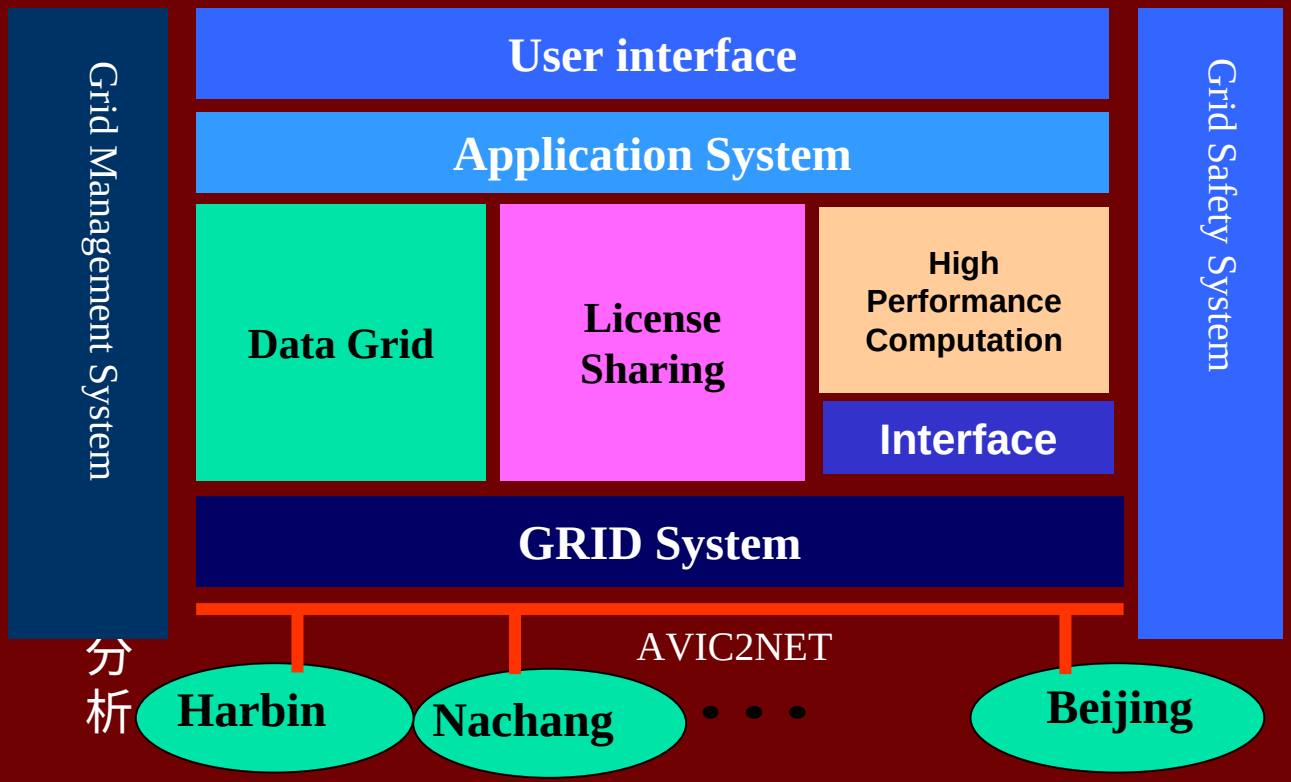


图15.中航第二集团公司的网格结构

Fig.15. Architecture of Aviation Grid in AVIC-II

HW: 8台双至强专用高性能
机架式集群服务器
SW: UG(bin), Catia(bin)
GenAlgorithm (Bin)

Beijing 628

Multi Cluster platform

Harbin

HW: 20台高性能计算机集群
SW: Catia(5)， Nastran

Nanchang

HW: 20台高性能计算机集群
SW: UG (100), Nastran

图16.跨企业网格平台初具规模

Fig. 16 Multi enterprises Grid platform

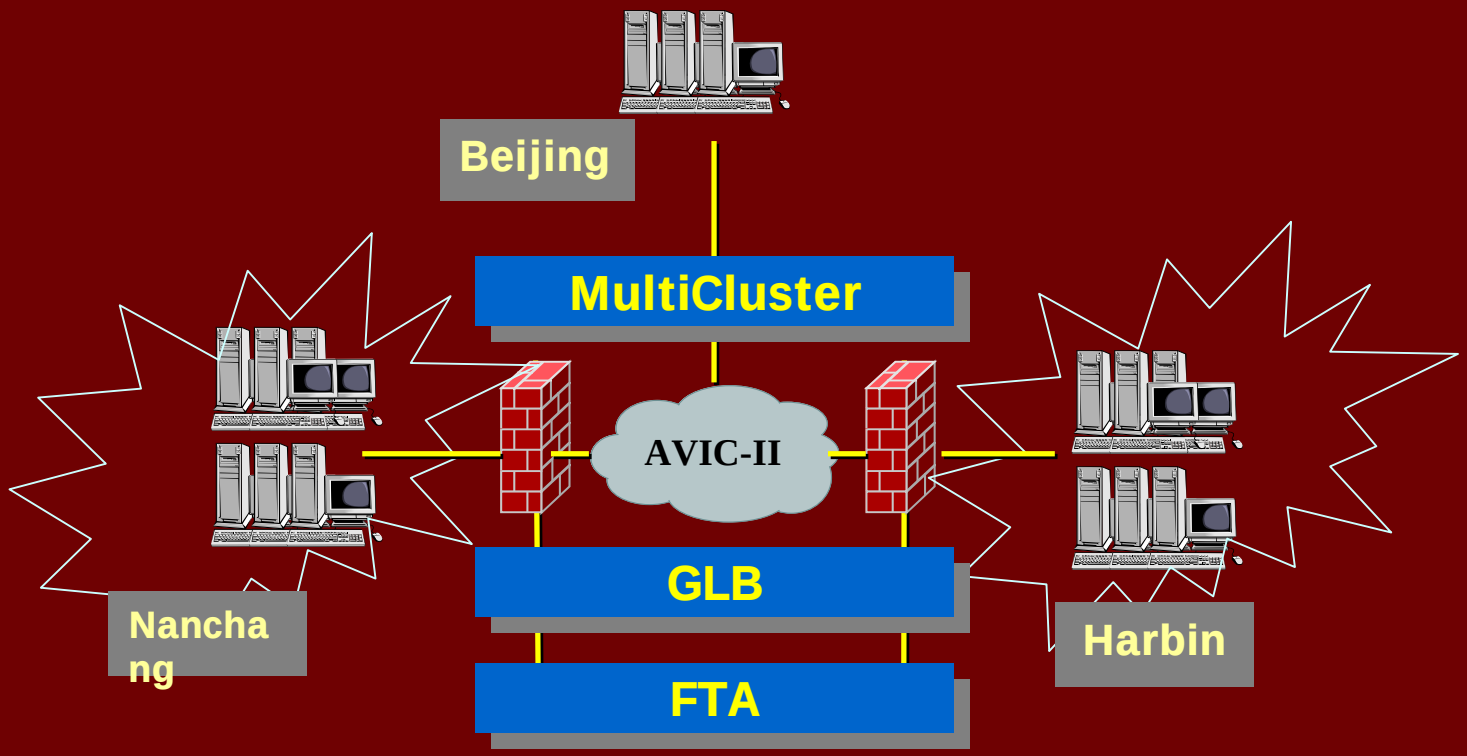


图17.中航第二集团公司网格系统第一阶段的硬件共享结构

Fig. 17. The first step AVIC-II GRID System hardware share structure

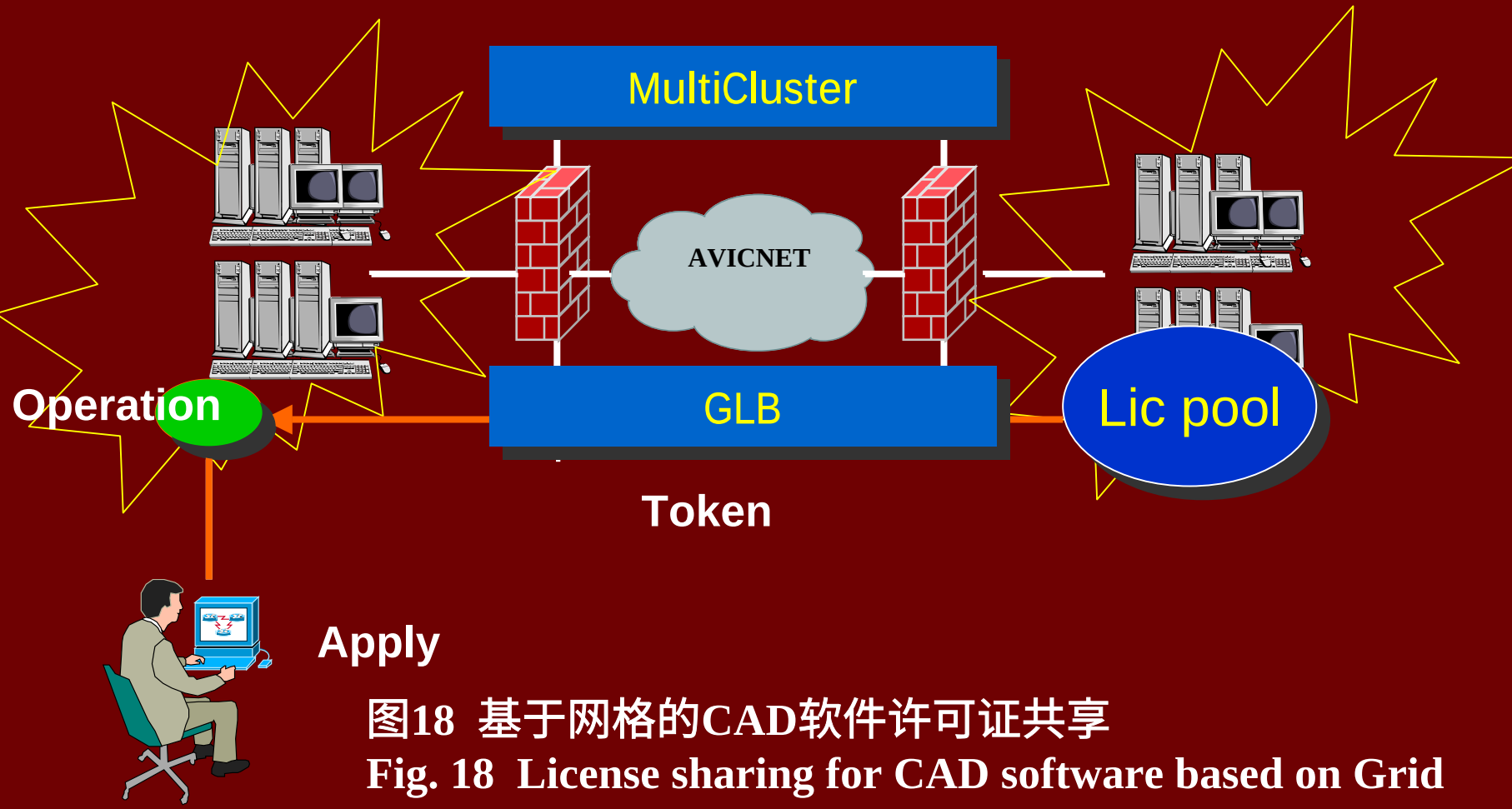


图18 基于网格的CAD软件许可证共享

Fig. 18 License sharing for CAD software based on Grid

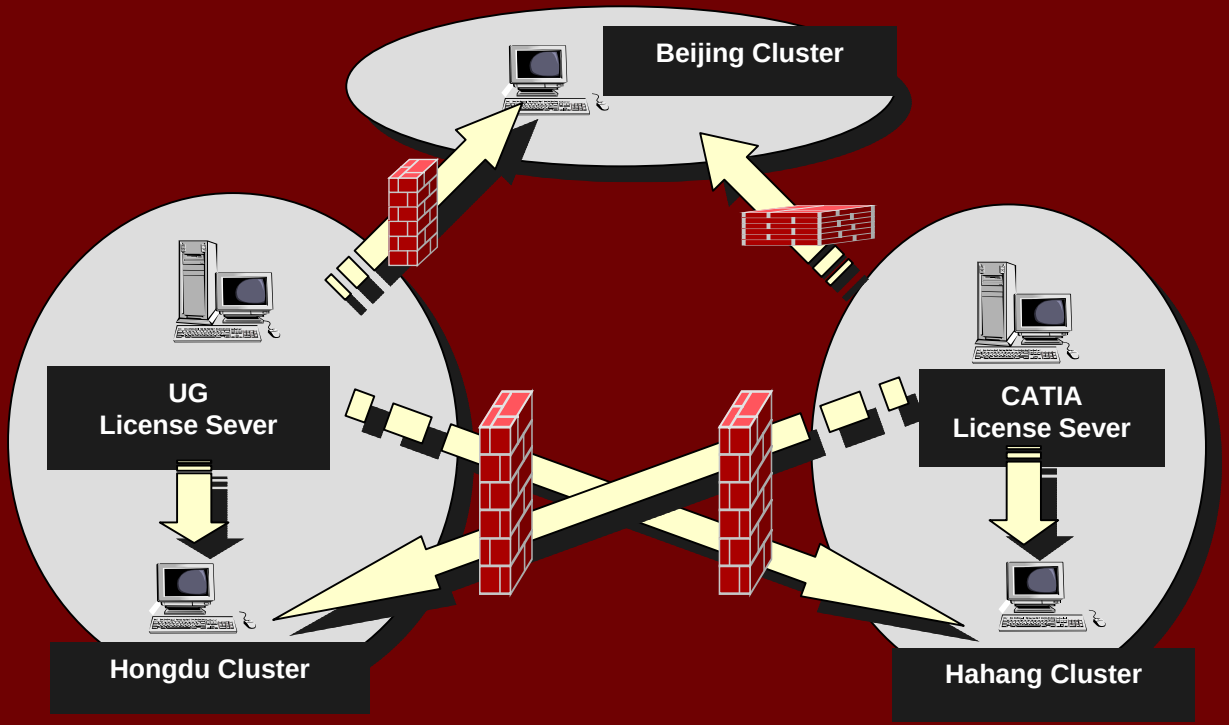


图19.中航第二集团公司网格系统软件许可证共享

Fig 19 AVIC-II GRID System realize the license floating

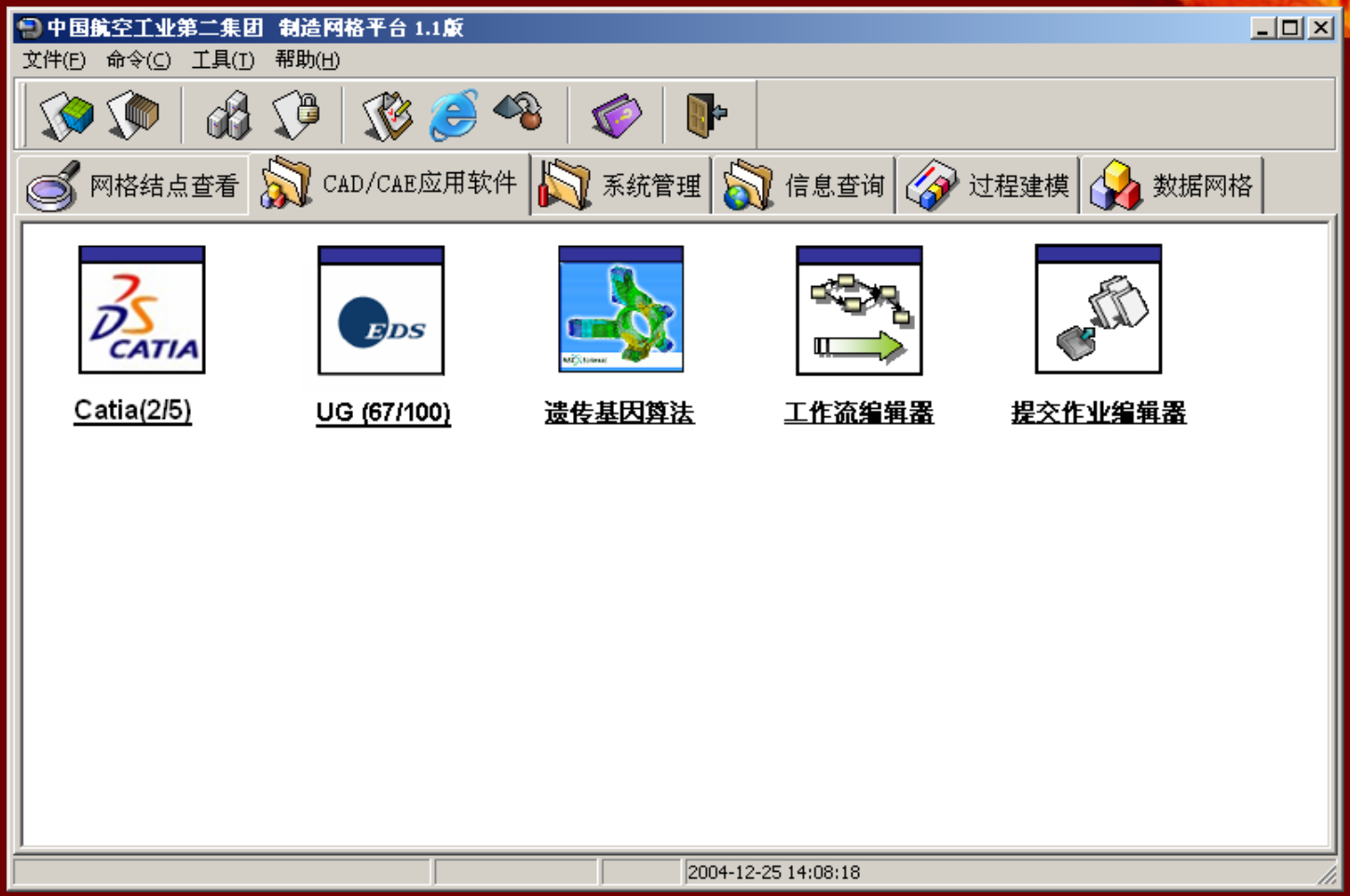
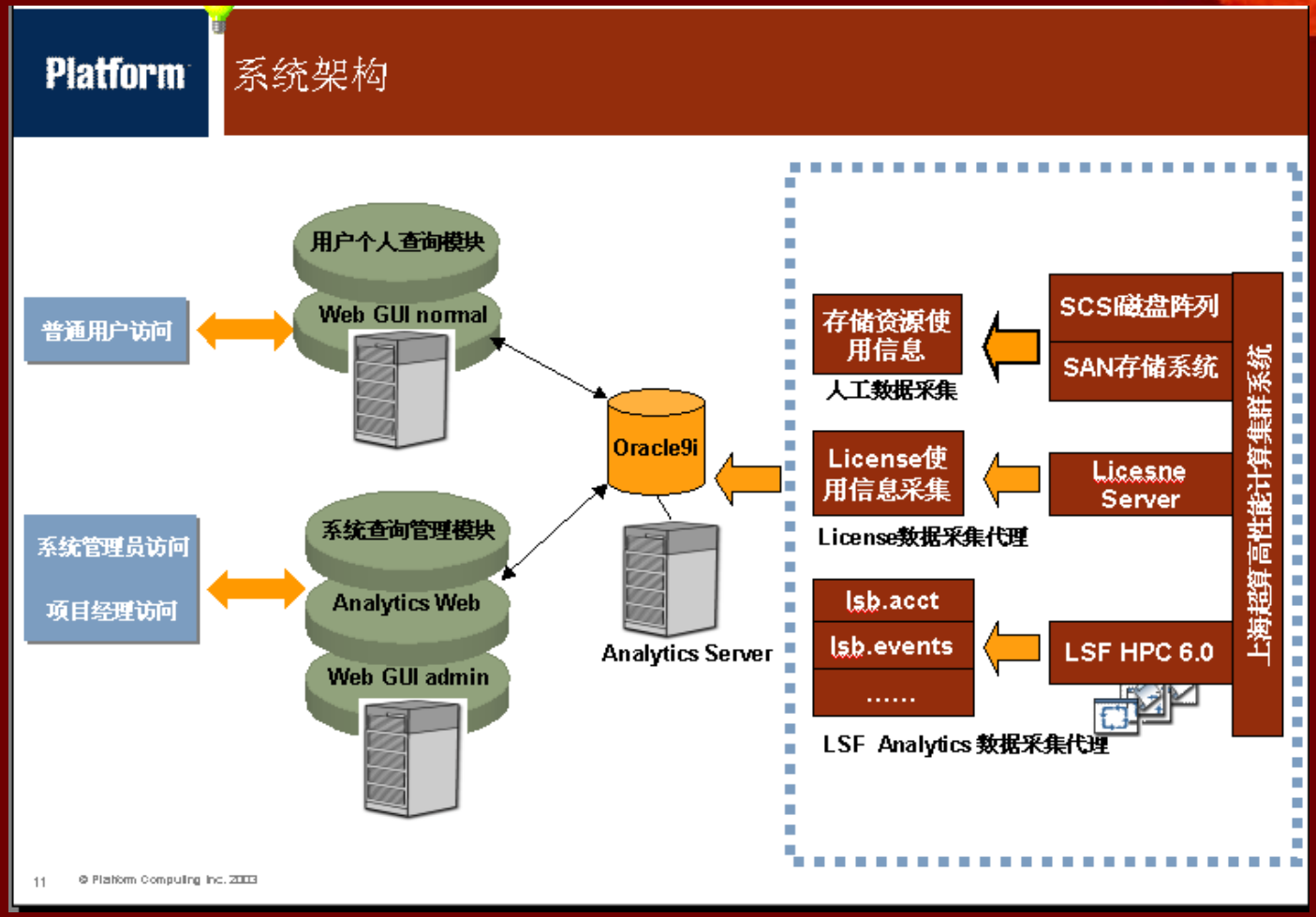


Fig. 20 User interface for AeroGrid



Clusters

图21.基于服务的PLATFORM 公司平台的网格记账系统

Fig. 21 Accounting system for service using PLATFORM Grid tool

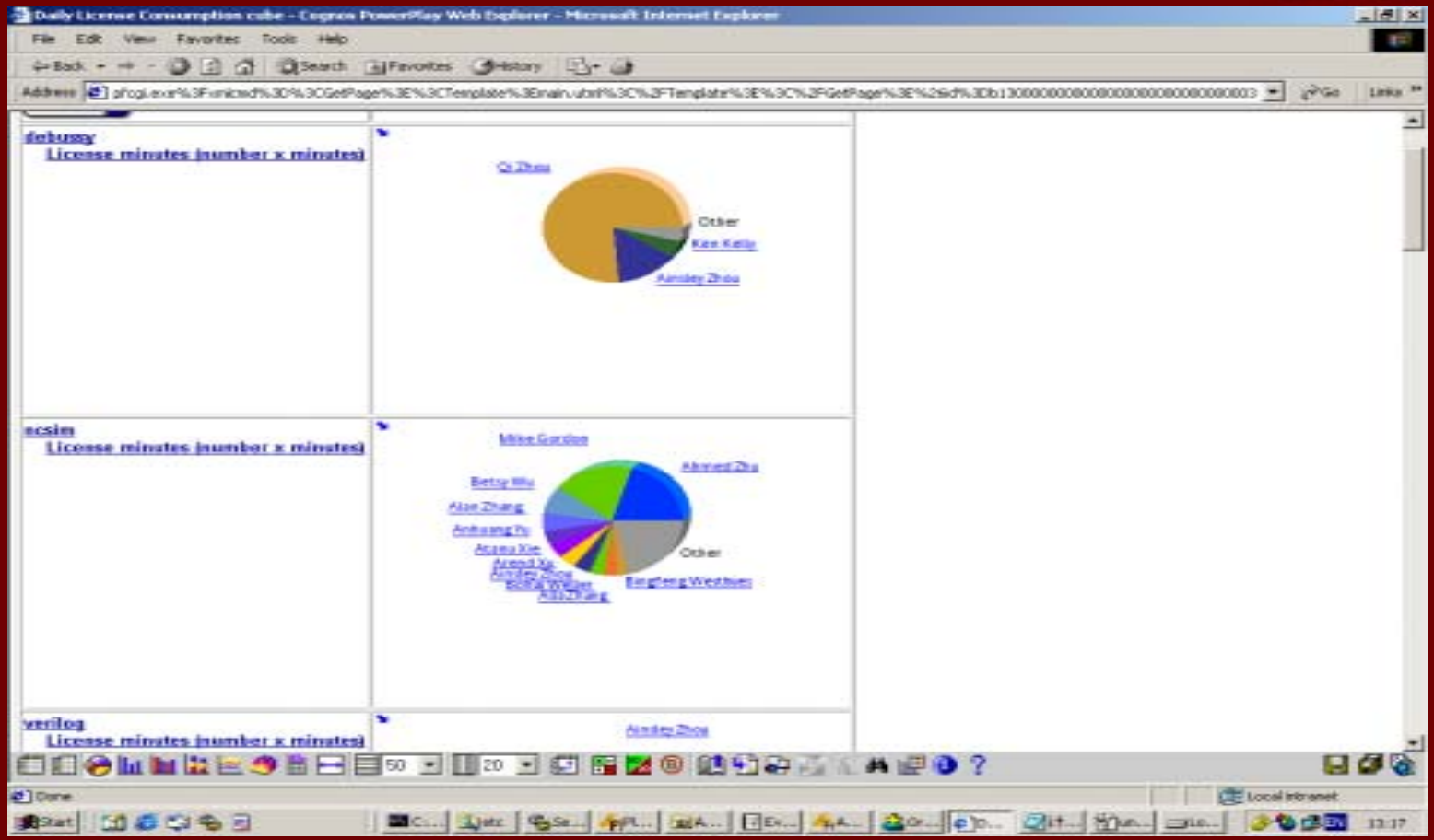


图22.基于服务的账目报告系统

Fig. 22 Accounting report system for service

开发数据网格
Developed Data Grid

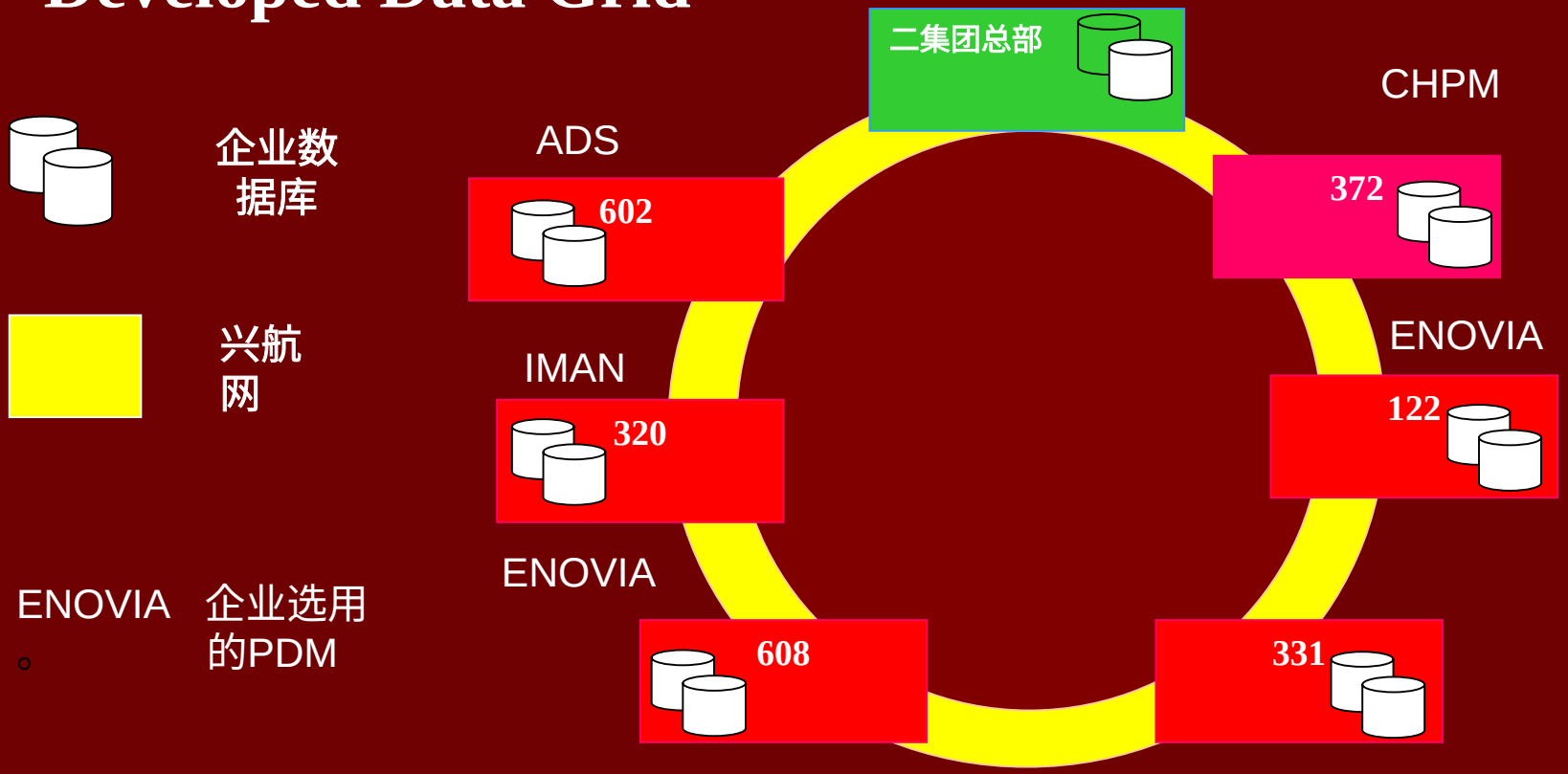


图23.企业采用不同的PDM 管理各自管理的数据

Fig23 The data in each enterprise are managed by deferent PDM system

图24.中航第二集团将实现基于网格技术的企业间数据共享

Fig. 24. Data sharing between enterprises in AVIC II based on Grid

数据网格
Data Grid

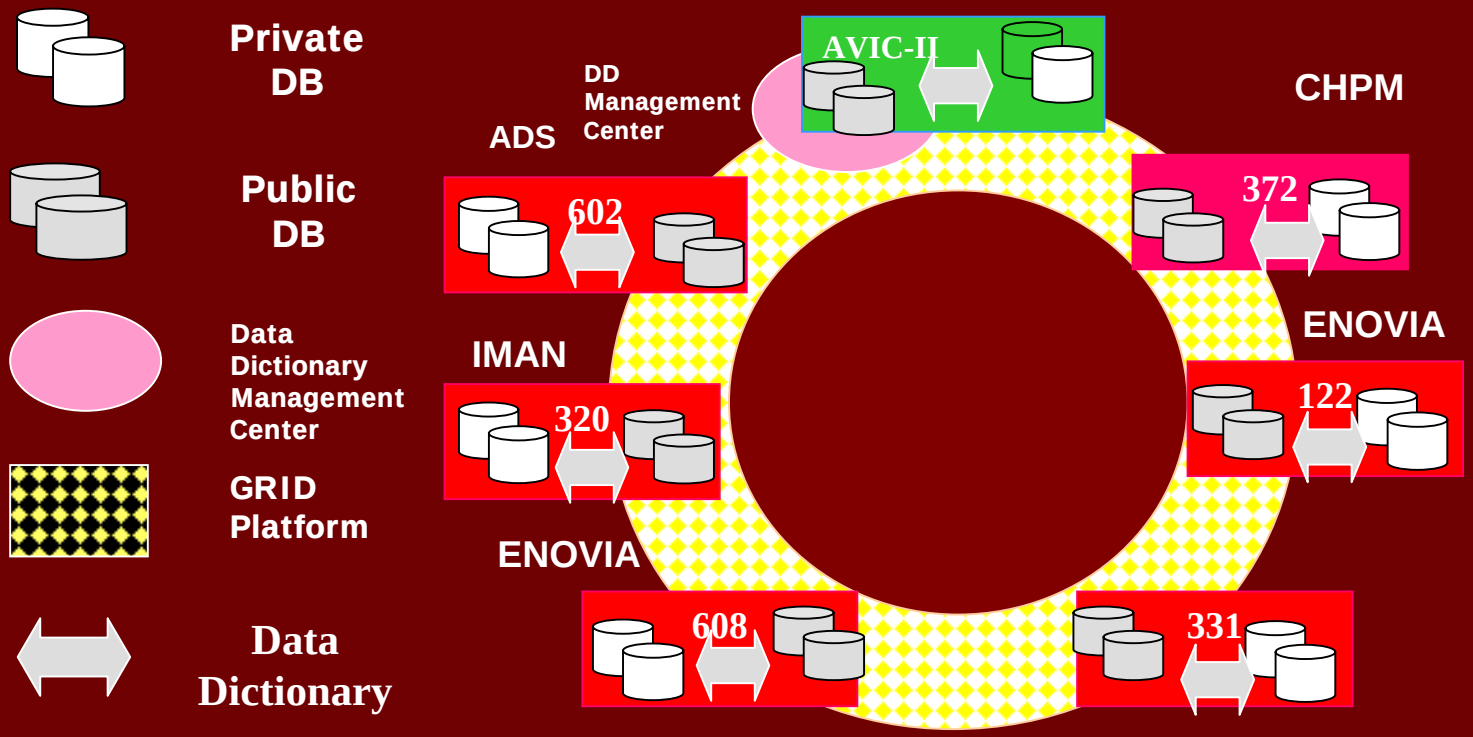


图25.数据网格系统实现了企业间的信息共享和单一数据源

Fig25 Data GRID System realize the data sharing and keep the single data resource in AVIC-II

数据网格
Data Grid

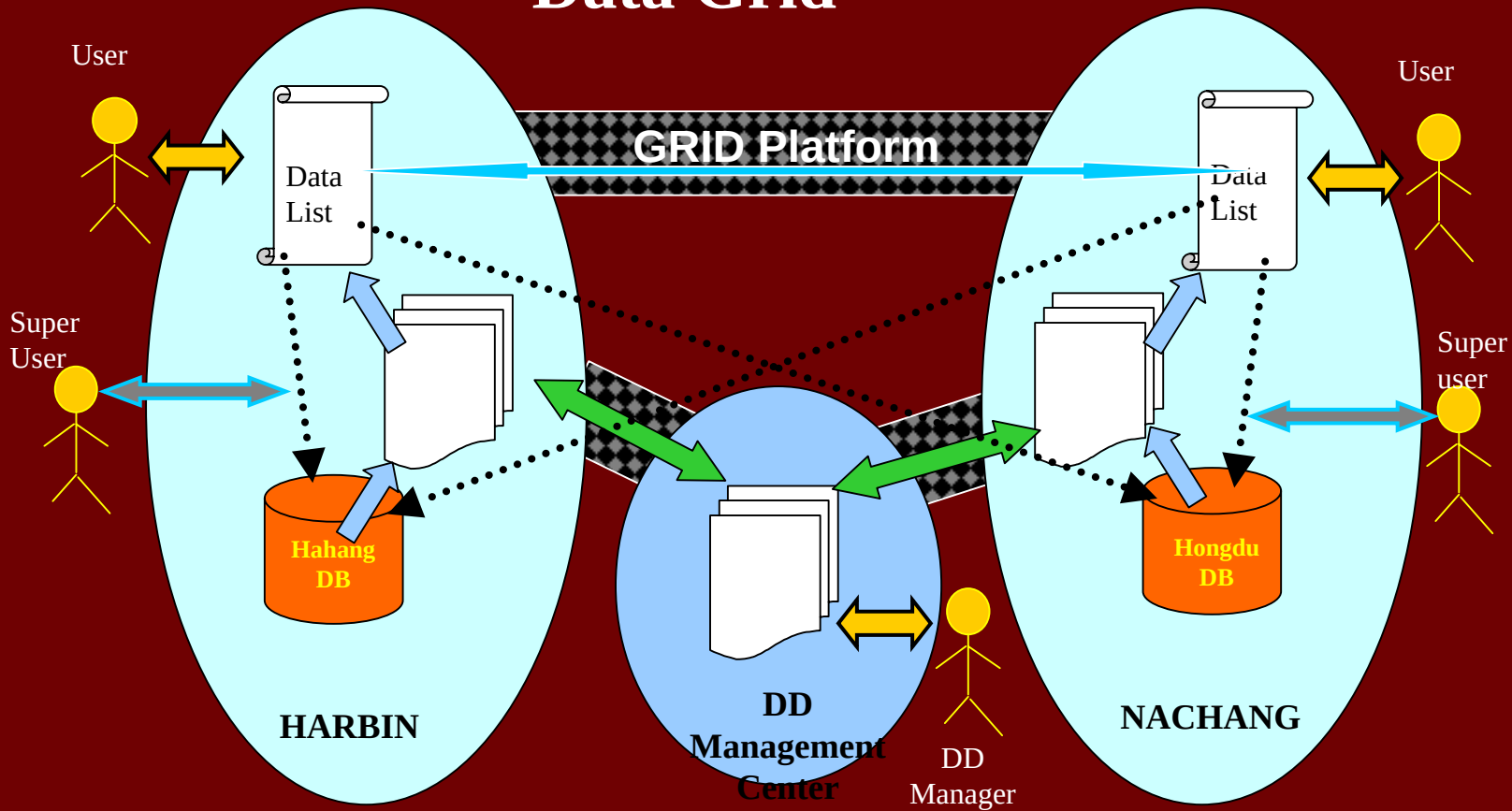


图26.数据网格以及管理原理

Fig. 26 Data GRID and its management principle

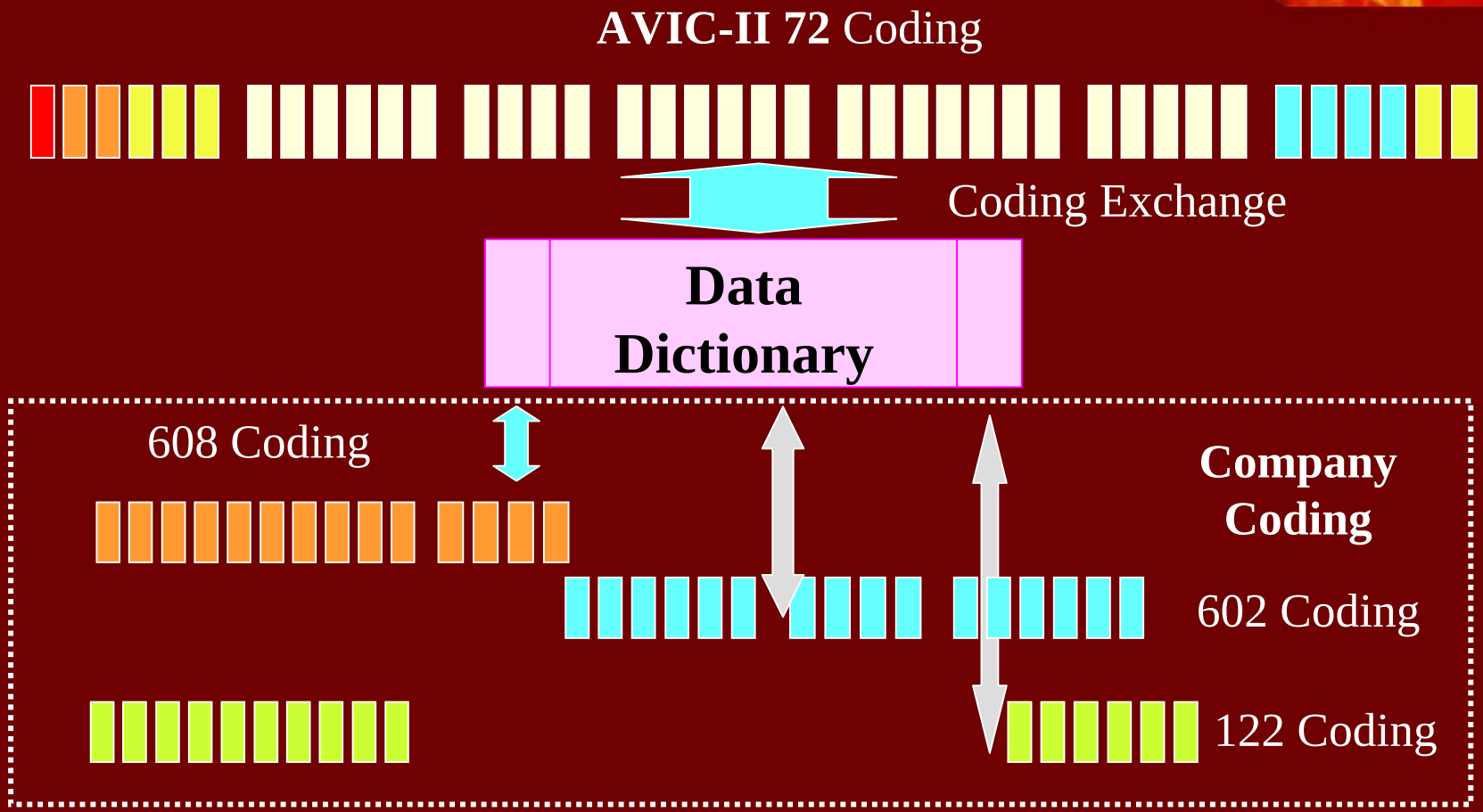


图27.统一编码与数据字典转换保障了查询和单一数据源

Fig 27 72 Coding and Data Dictionary keep single data resource and easy inquire

数据网格
Data Grid

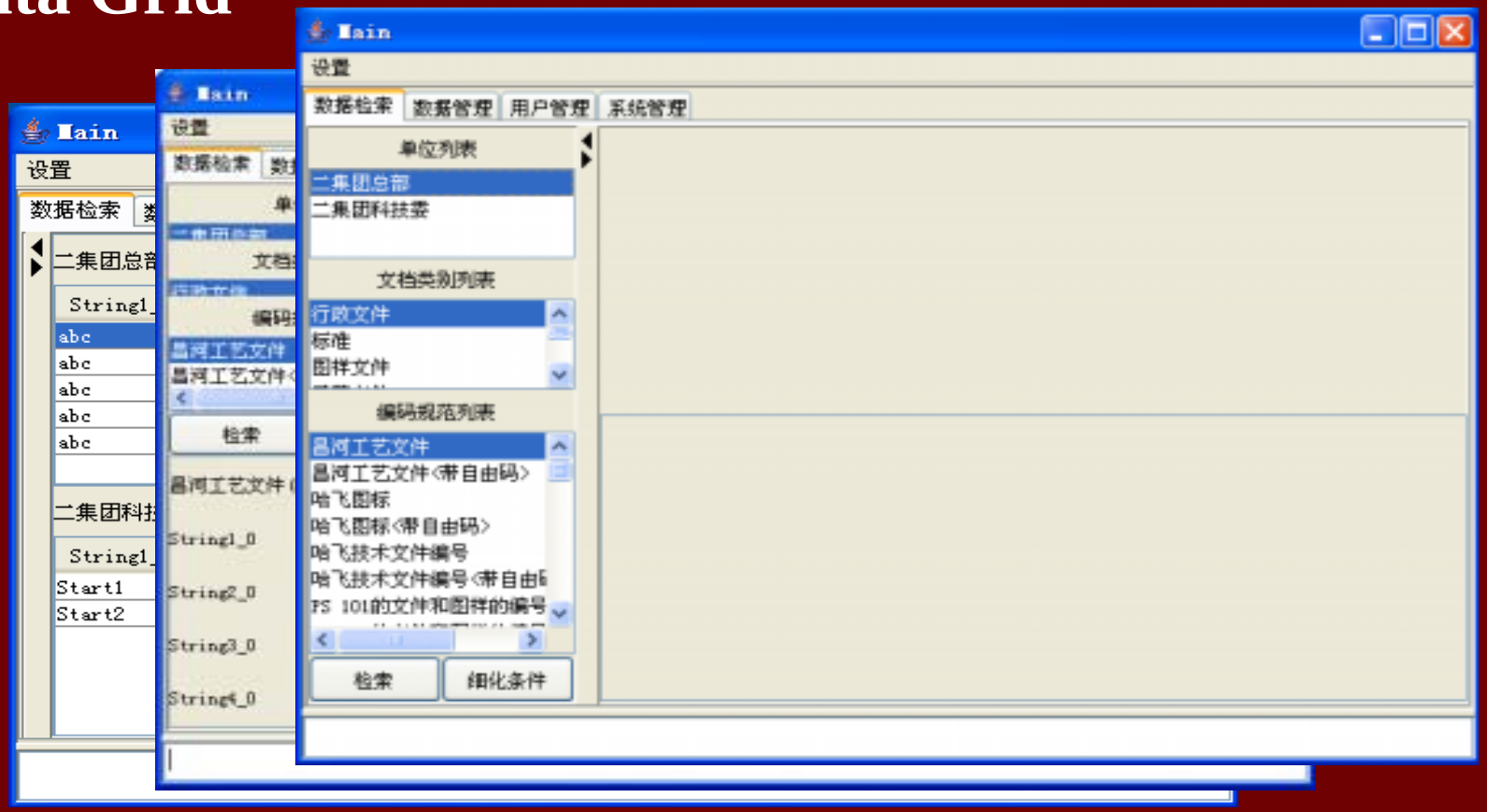


图28. 数据网格软件的用户界面

Fig. 28 Data Grid software interface

3. 网格技术在中航第二集团公司的应用
3.The GRID technology in AVIC-II

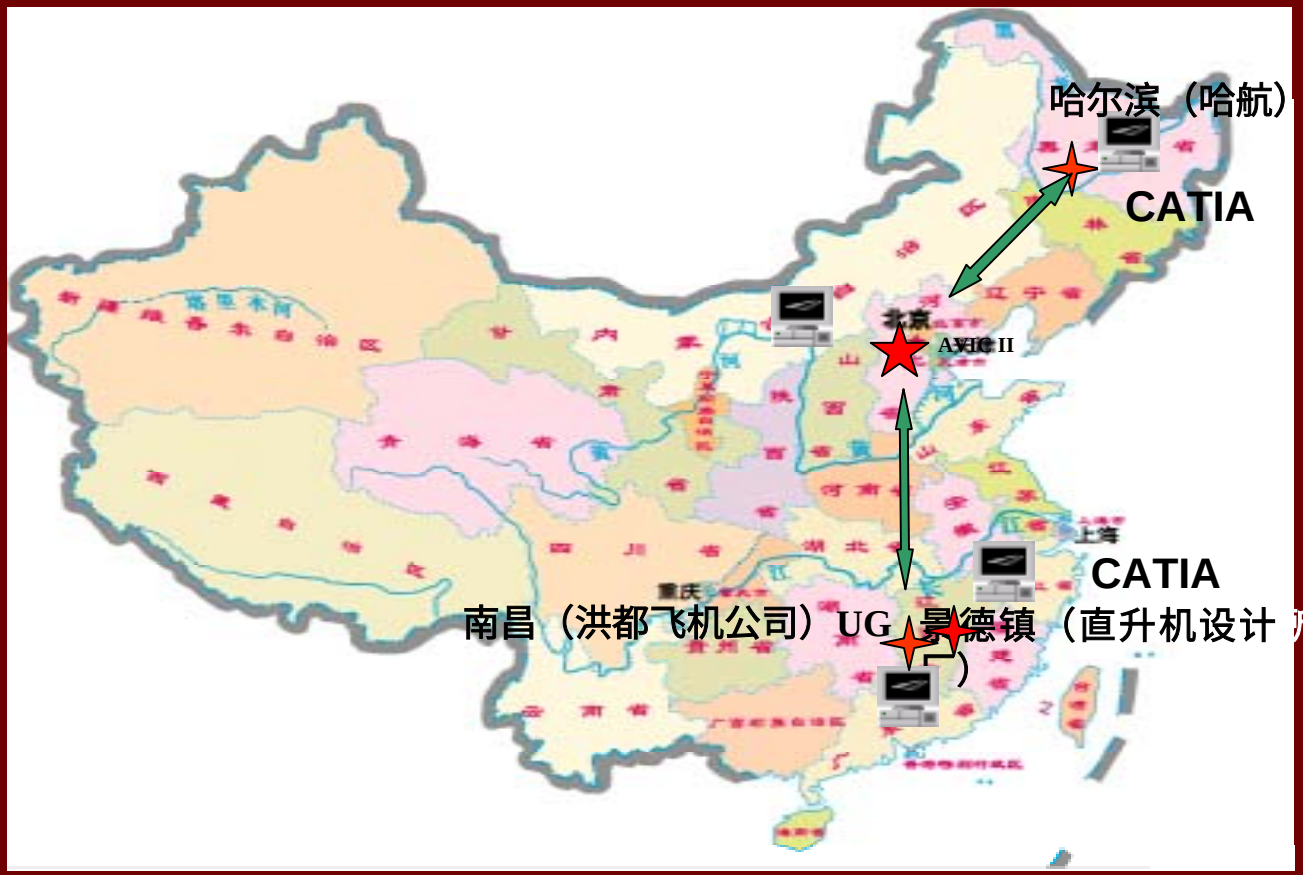


Fig. 29 The license share between HAFEI (CATIA) & HONGDU (UG)

数据网格正应用到直升机的研制中景德镇设计所和哈航工厂的信息交换中。

The Data Grid is used in data share between design institute in Jingdezhen and HAHANG factory in Harbin for new helicopter development.

Fig. 30 Data Grid application

应用网格技术的遗传算法优化系统
The Genetic Algorism optimization based on GRID platform in AVIC

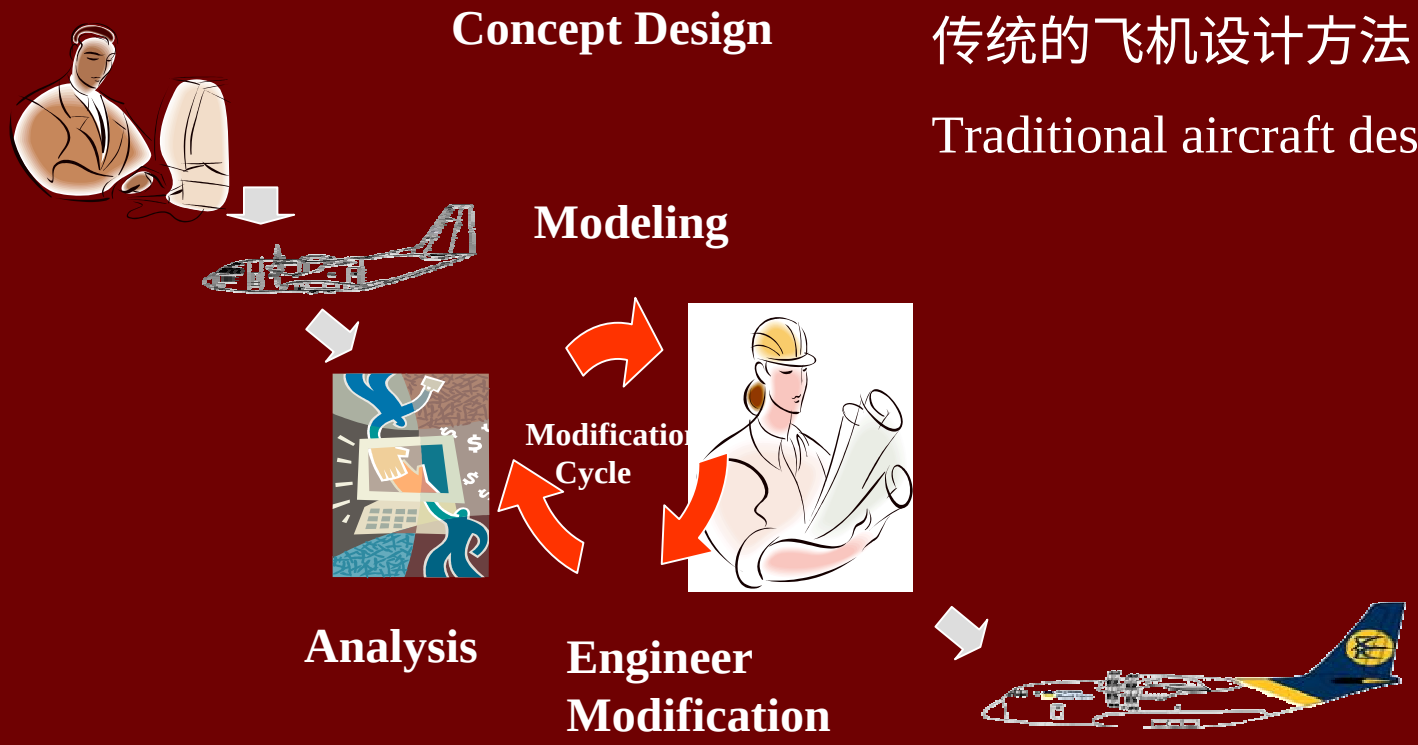


图31.飞机设计应用示例

Fig 31 The application example of aircraft design

Base Aviation Grid developing a GA optimization systen

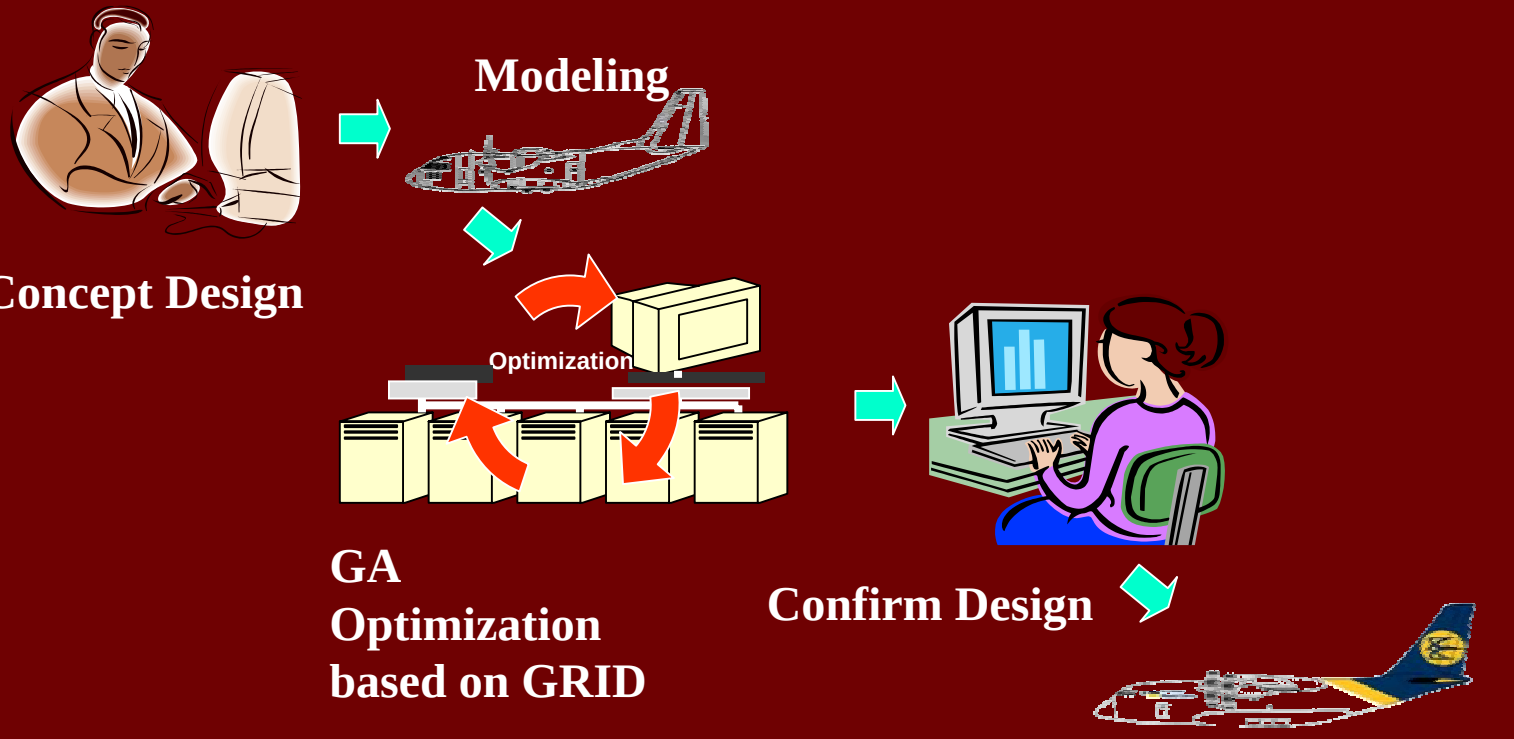


图32.基于网格的飞机优化设计系统

Fig 32 Optimization Design system based on GRID

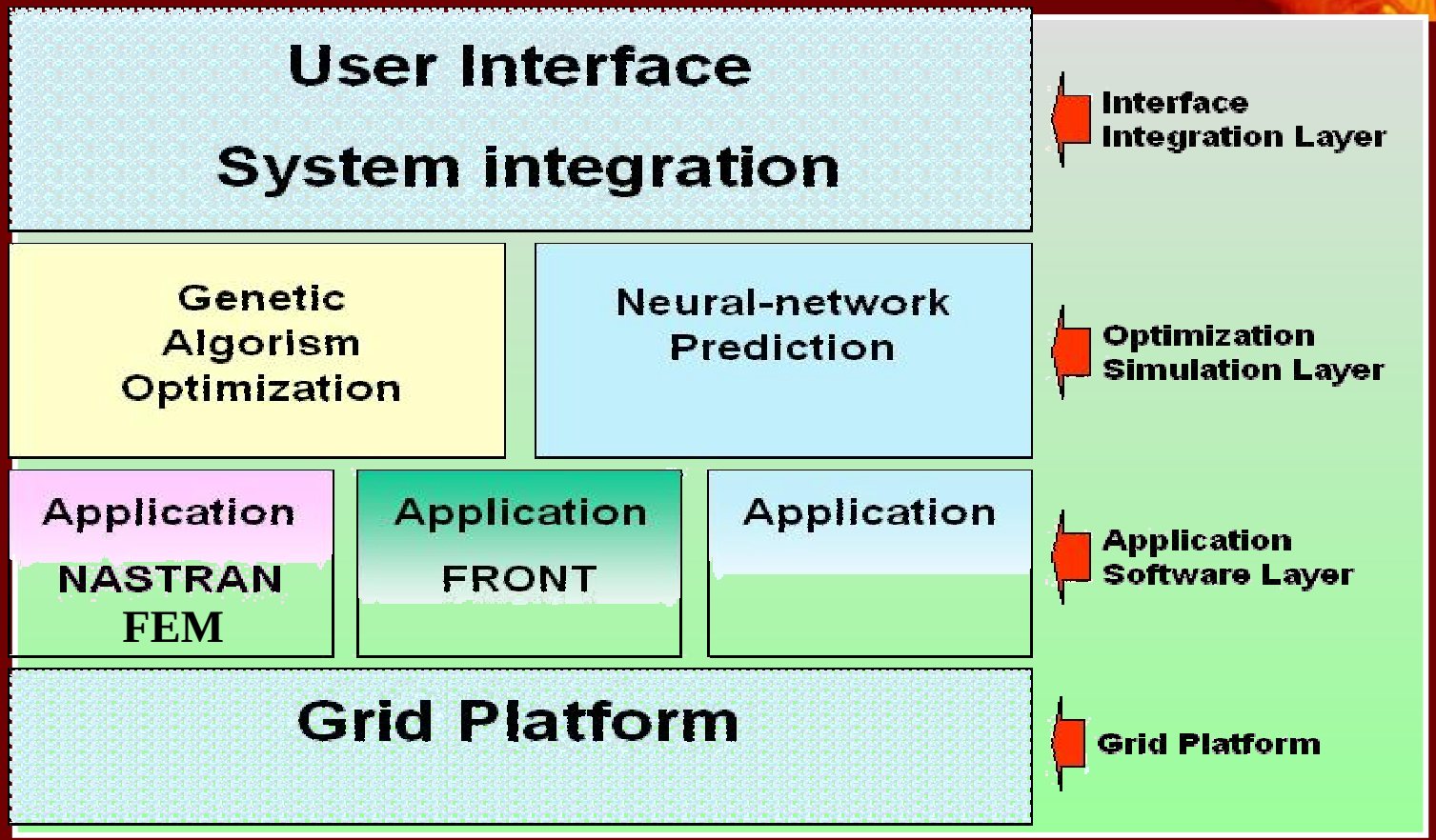


图 33　遗传算法优化集成系统的结构

Fig. 33 GA optimization integrated system architecture

图34　采用两种网格平台：Platform公司和863开发的平台

Fig.34 There are two Grid platform: PLATFORM and 863 Grid platform

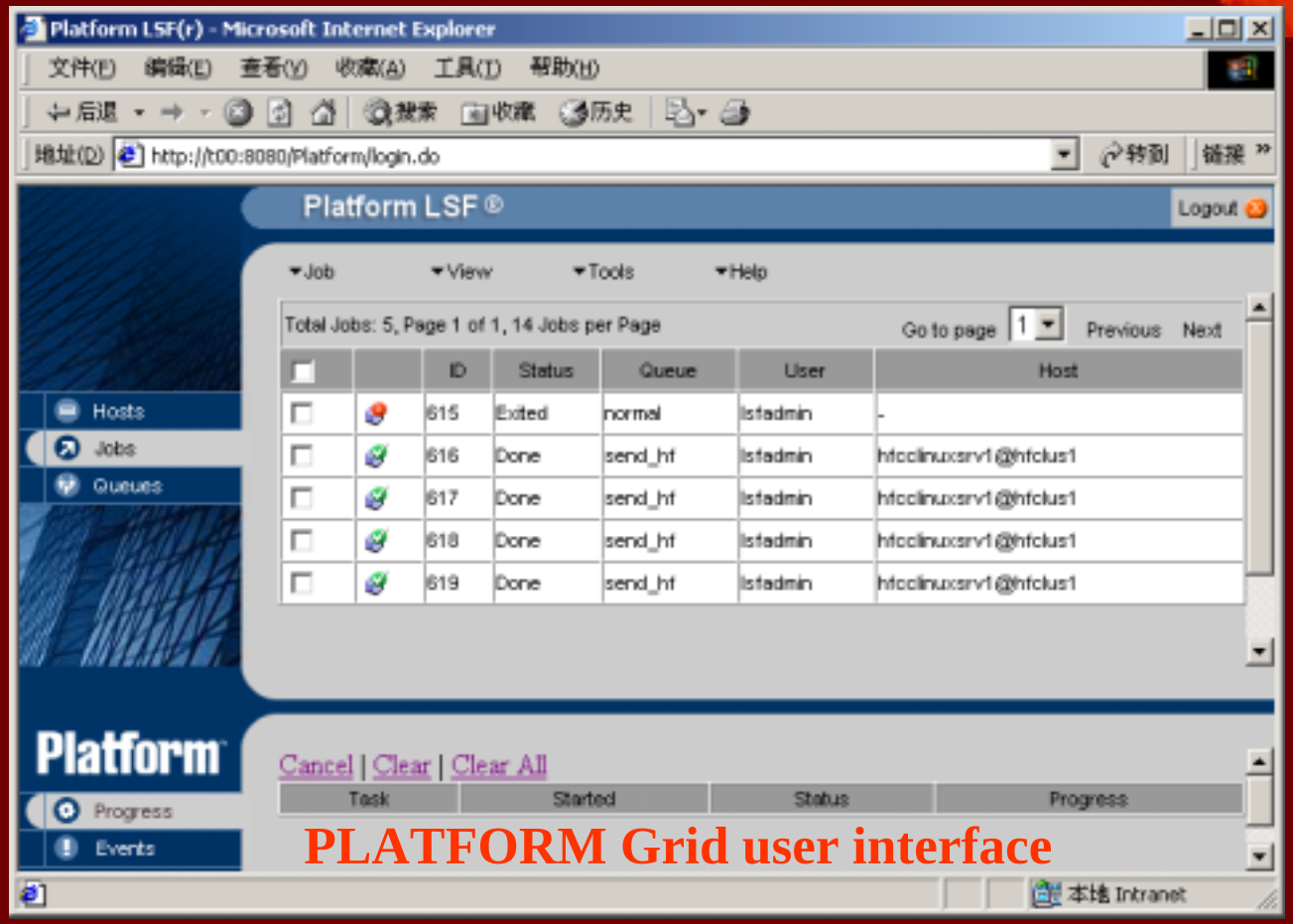


图35　采用两种网格平台：Platform公司和863开发的平台

Fig.35 There are two Grid platform: PLATFORM and 863 Grid platform

应用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 Δ is needed to be increased 20% and the weight of vertical stabilizer skin is added not more than 20% .

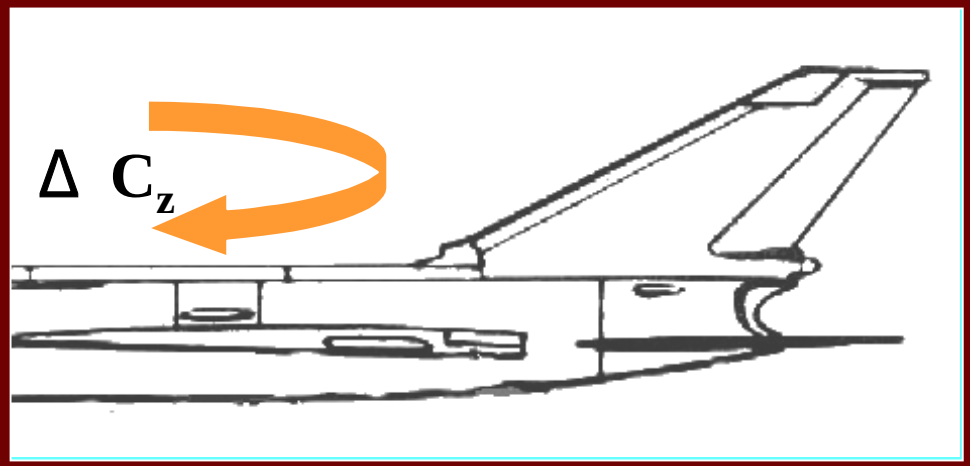
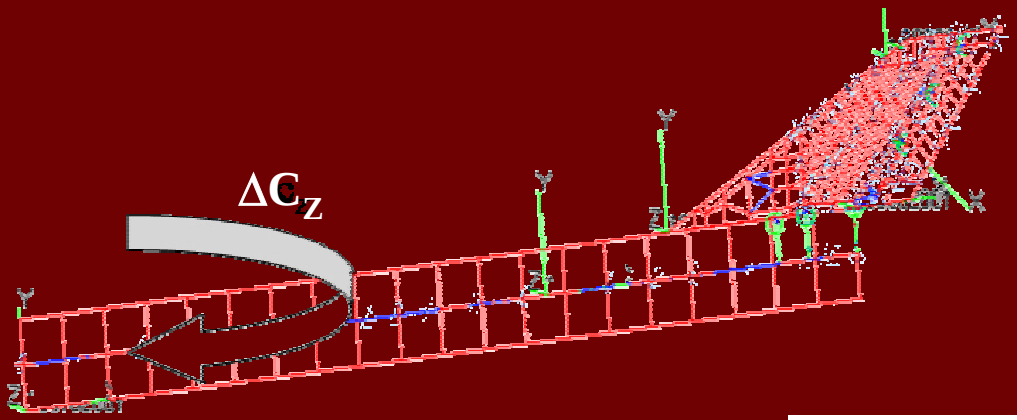


图36 研究的目标

Fig 36 The research tasks



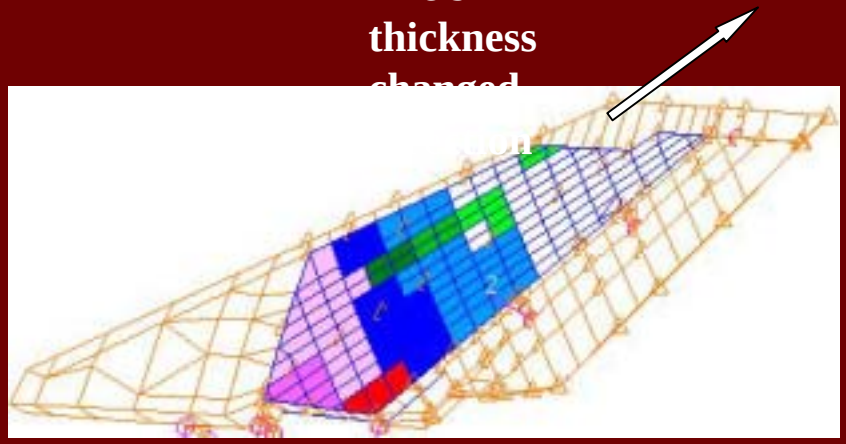


图37 优化前垂尾蒙皮厚度分布

Fig.37 The vertical stability skin thickness distribution and the FEM model before optimization

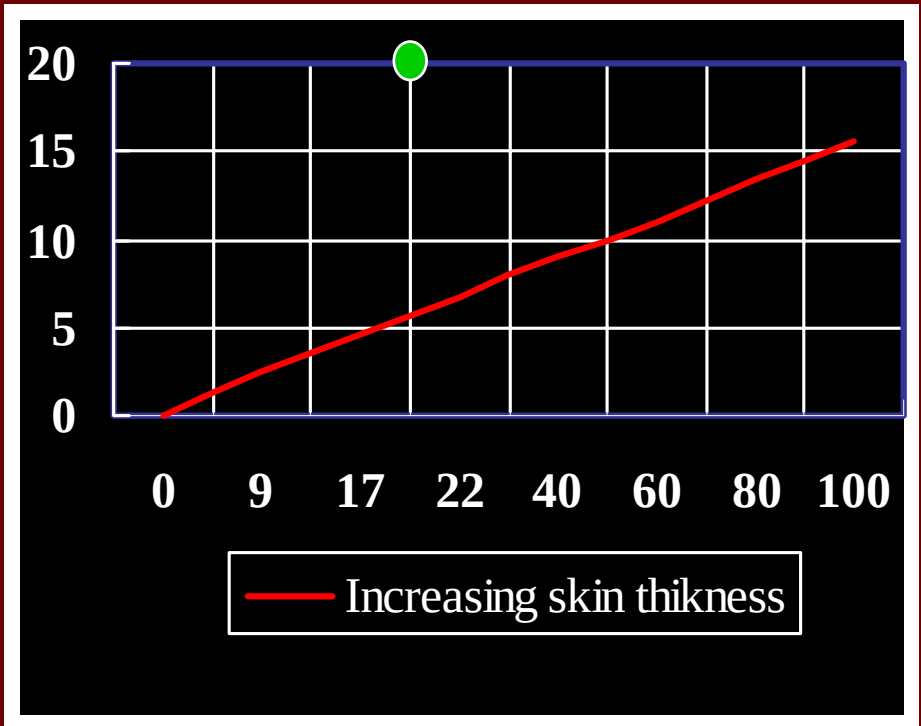
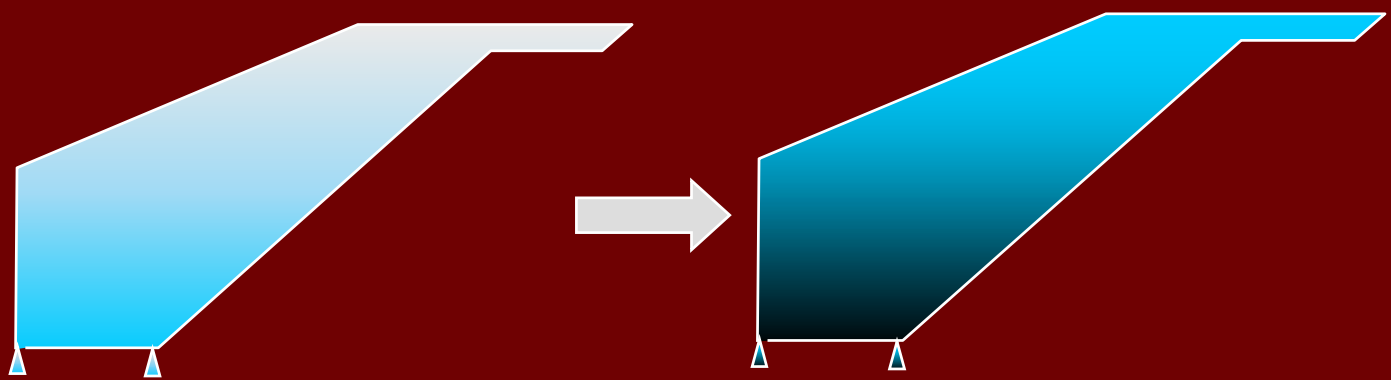
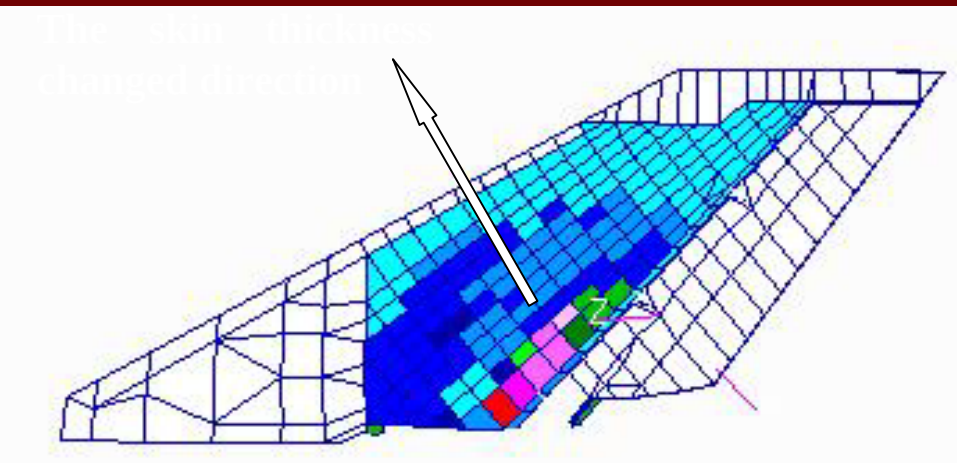


图38 当简单增加蒙皮厚度的时候，蒙皮重量增加 100% 时， ΔCz 仅增加 15.6% 。远不能满足设计需求。

Fig. 38 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



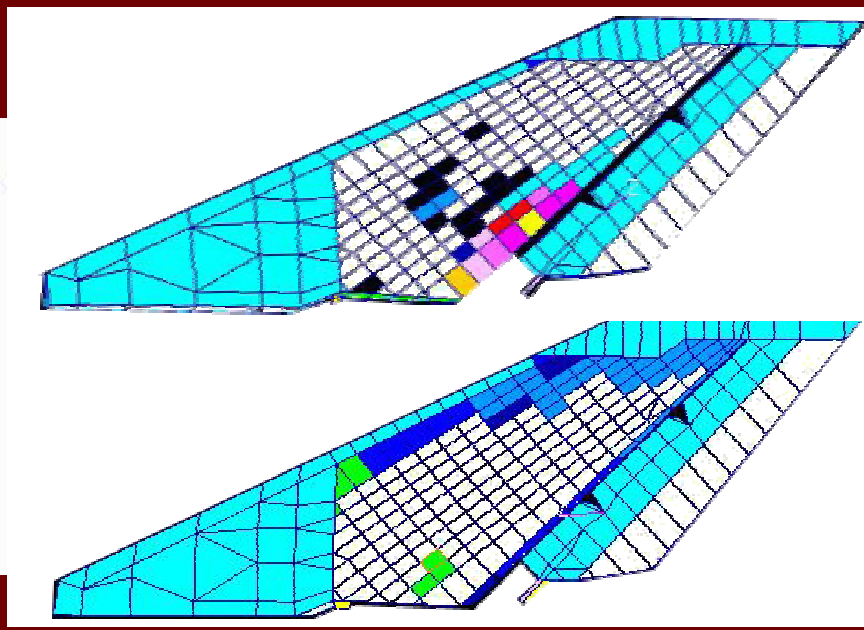


图39 优化后垂尾蒙皮厚度分布

Fig.39 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 Algorism .

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

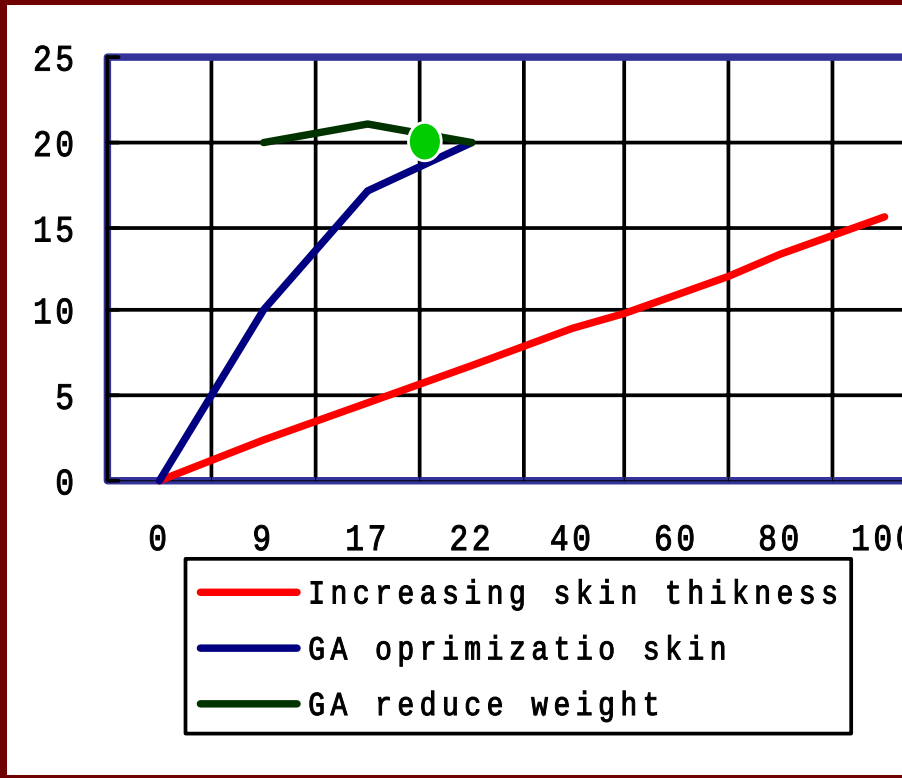
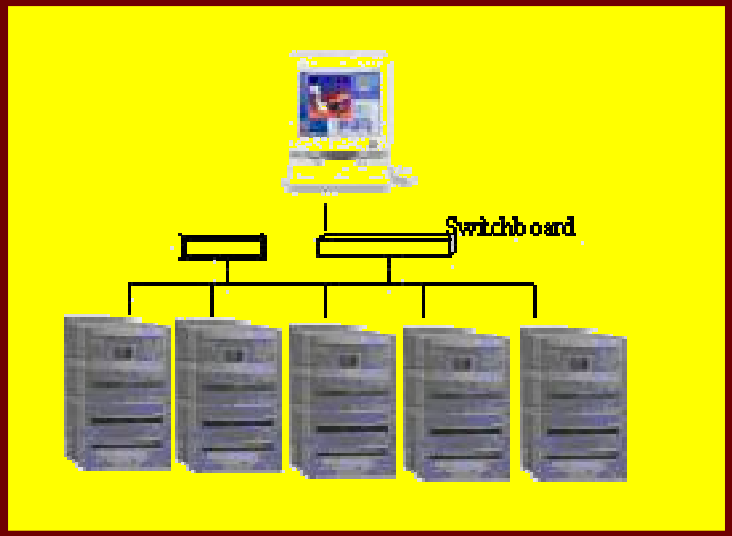


图 40 优化和未优化情况下方向安定性ΔCz 和结构重量的关系

Fig.40 The relationship between ΔC_z and weight increasing before and after optimization



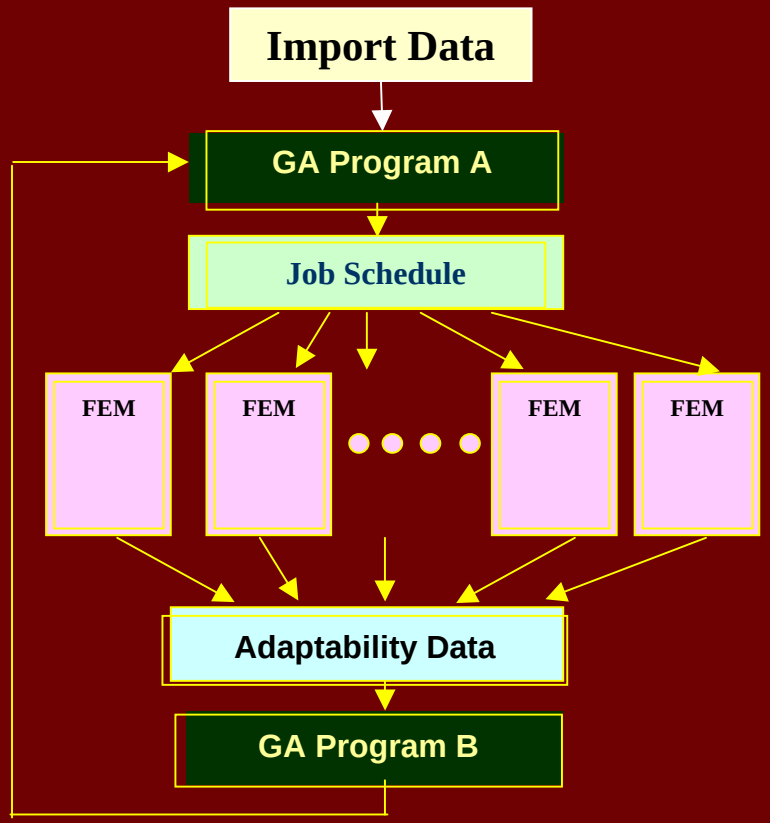


图41. 基于网格平台，实现了五台计算机的并行计算。

Fig. 41 The advantage for the grid system “Job Schedule” is that the 5 hardware resource can be shared to run the GA optimization and the FEM programs automatically.

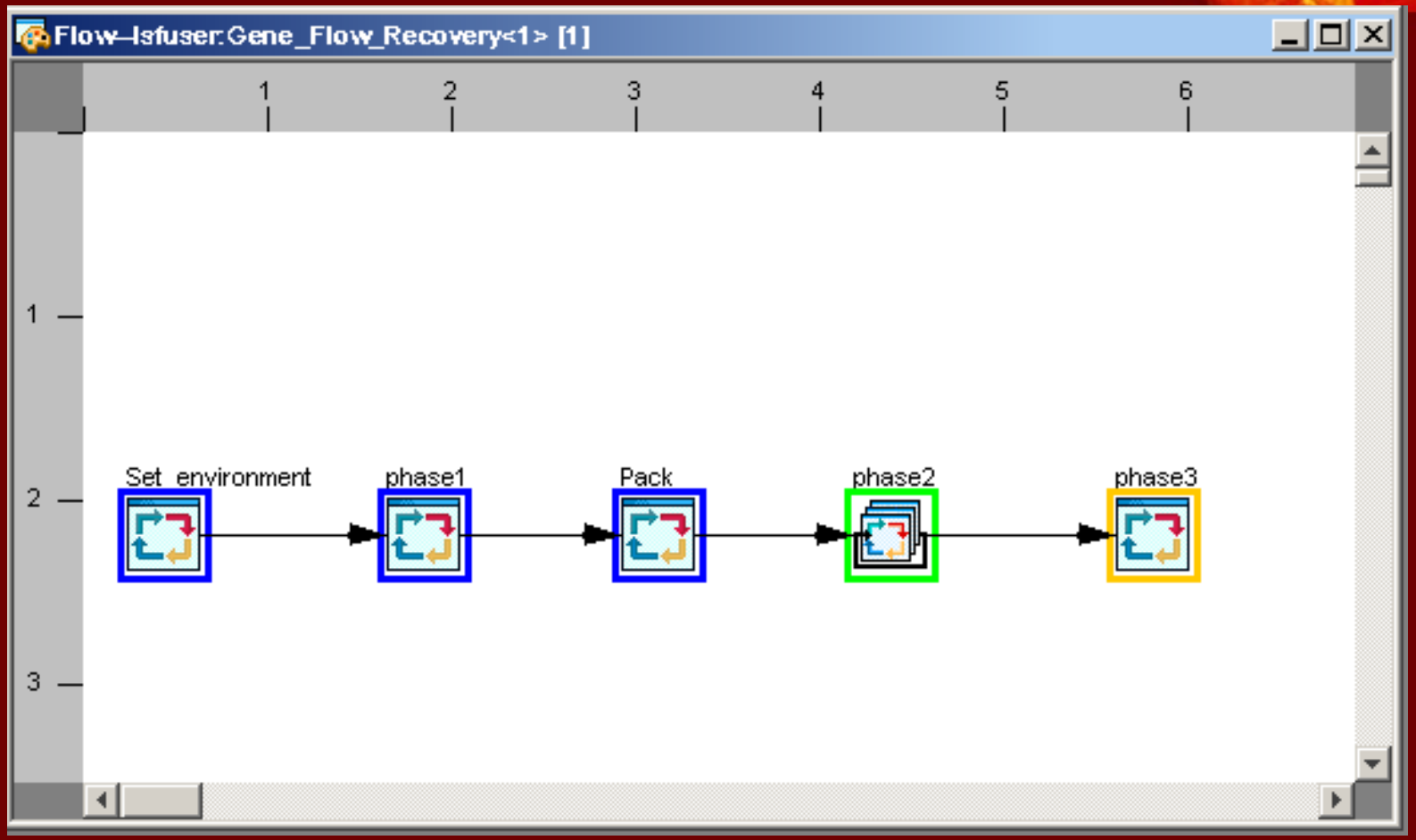


Fig.42 Working flow for the GA optimization system by Grid platform

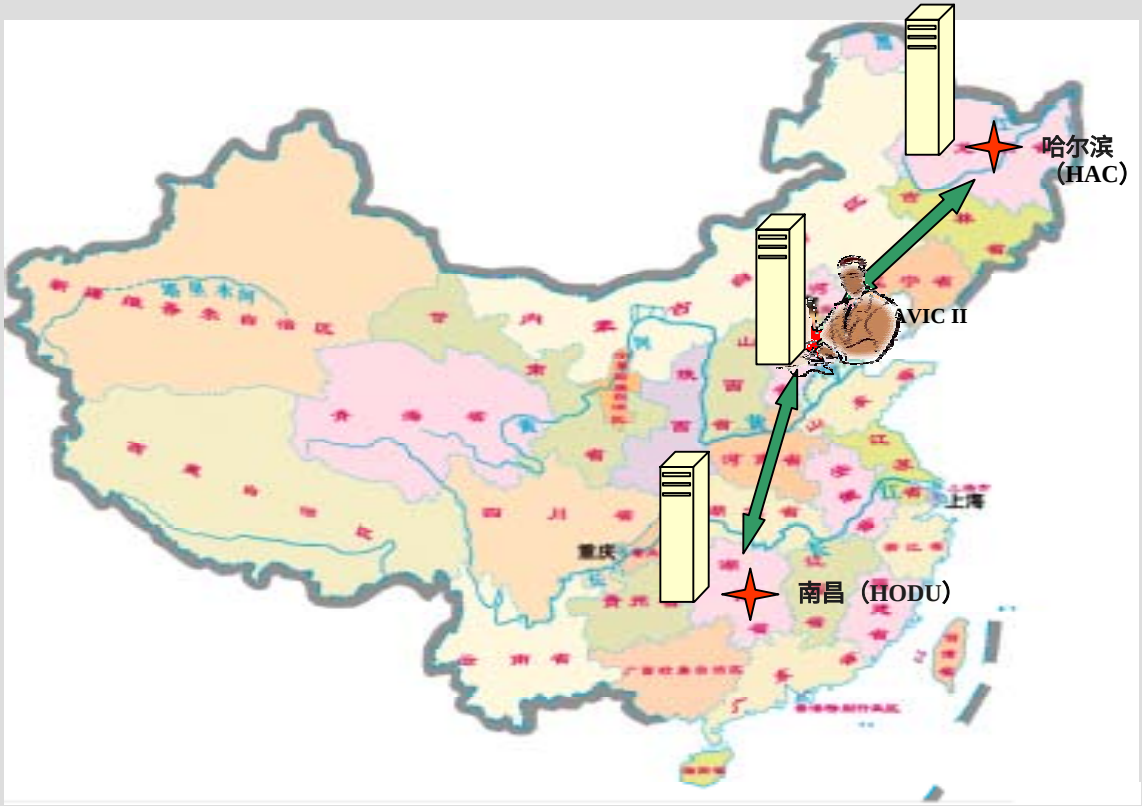


图43 基于网格平台的系统可以实现异地资源共享

Fig. 43 The three clusters resource has been shared based on GRID platform

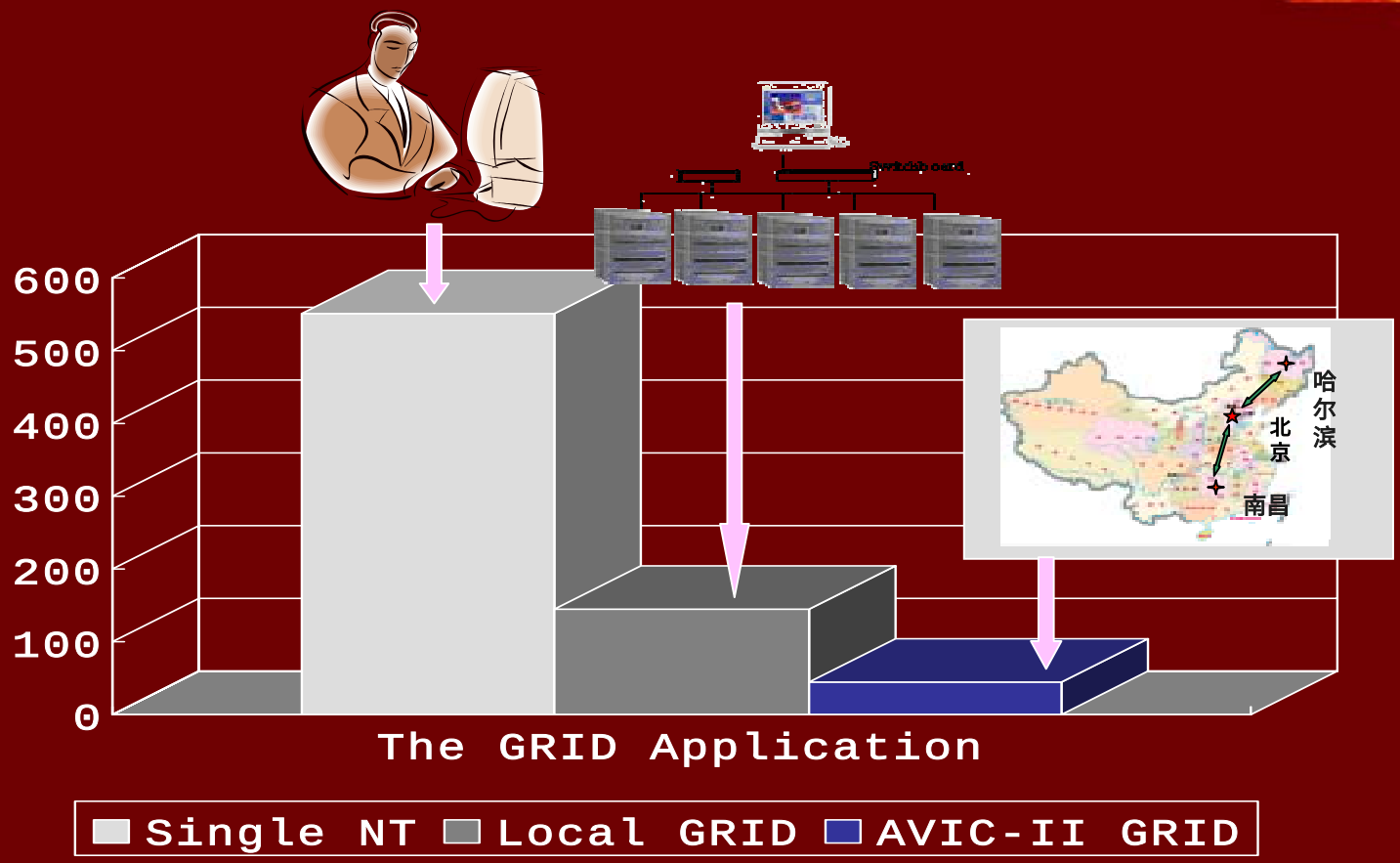


图44 网格的应用明显的减少了计算时间

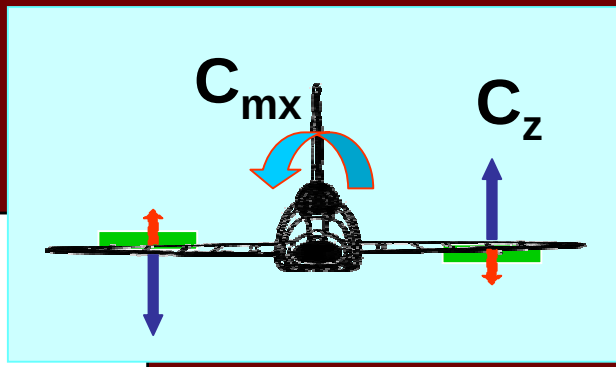
Fig. 44 The computation time is great reduced by using GRID technology

3. 网格技术在中航第二集团公司的应用
3.The GRID technology in AVIC-II

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.



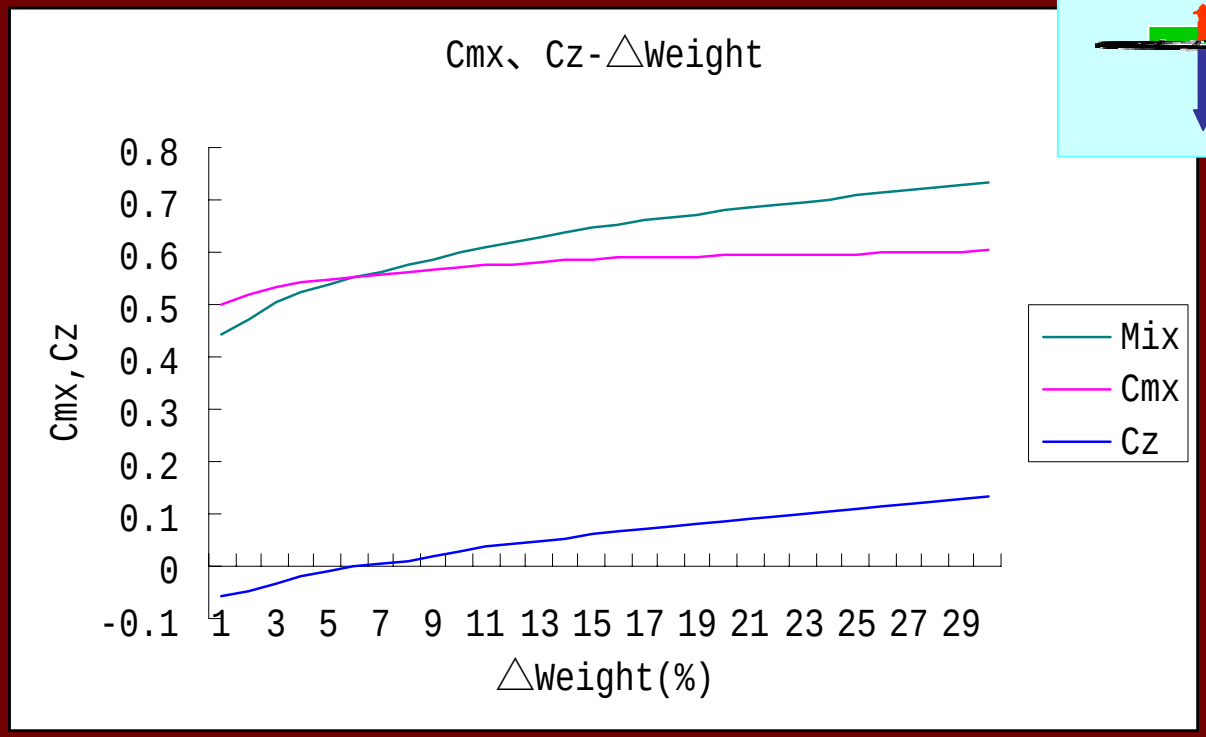


Fig. 45. **An application on Multi Goal Optimization**

4、结束语
4. 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

CENNET

China Europe Network on the NET

4、结束语

4. Conclusion

与Cranfield大学的工程学院开展基于网格的飞机气动弹性合作以近一年时间。2005年4月共同在AIAA国际会议上发表了文章。并研究共同进一步开展合作，希望建立基于中国北航和Cranfeild两个机群的网格系统，用于该课题的计算。

Our team has cooperated with Engineer School of Cranfeild university on "Aero-elastic Optimization Based on Grid Technology" for more than one year. Our jointed paper has been presented on 46th AIAA/ASME/ASCE/ AHS/ASC "Structures, Structural Dynamics & Materials Conference " April 18-21, 2005 Hyatt Regency Hotel, Austin, TX, USA .

The cooperation wish to create a grid platform between Cranfield and BUAA for the next jointed research after the talking with Prof. Frank Wang and Dr. Guo.

4、结束语
4. Conclusion

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 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.

4、结束语
4. Conclusion

信息技术特别是网格技术在带动了中国航空工业的发展，也推动了新飞机发展的国际合作。信息技术的合作将推动中国和欧洲联合发展飞机和直升机。同时也为中欧航空工业在更广泛领域长远合作发展打下良好的基础。

The information technique，especially the Grid technology is supporting the growth of China aviation industry and also supporting the international cooperation in new aircraft development. We think that the information technology cooperation will promote the jointed aircraft and helicopter co-development between China and Europe. The information cooperation will also create a good foundation for long-term cooperation in aviation field widely.

希望在网格应用领域有更多合作！

Wish more cooperation in Grid!

Thank You!