Real-Time Communications Infrastructures for Cyber-Physical Systems
计算机–物理系统一体化的实时通信底层

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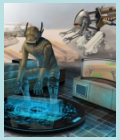
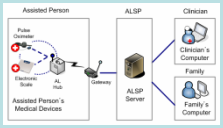
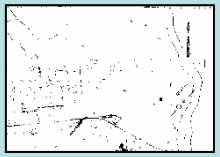


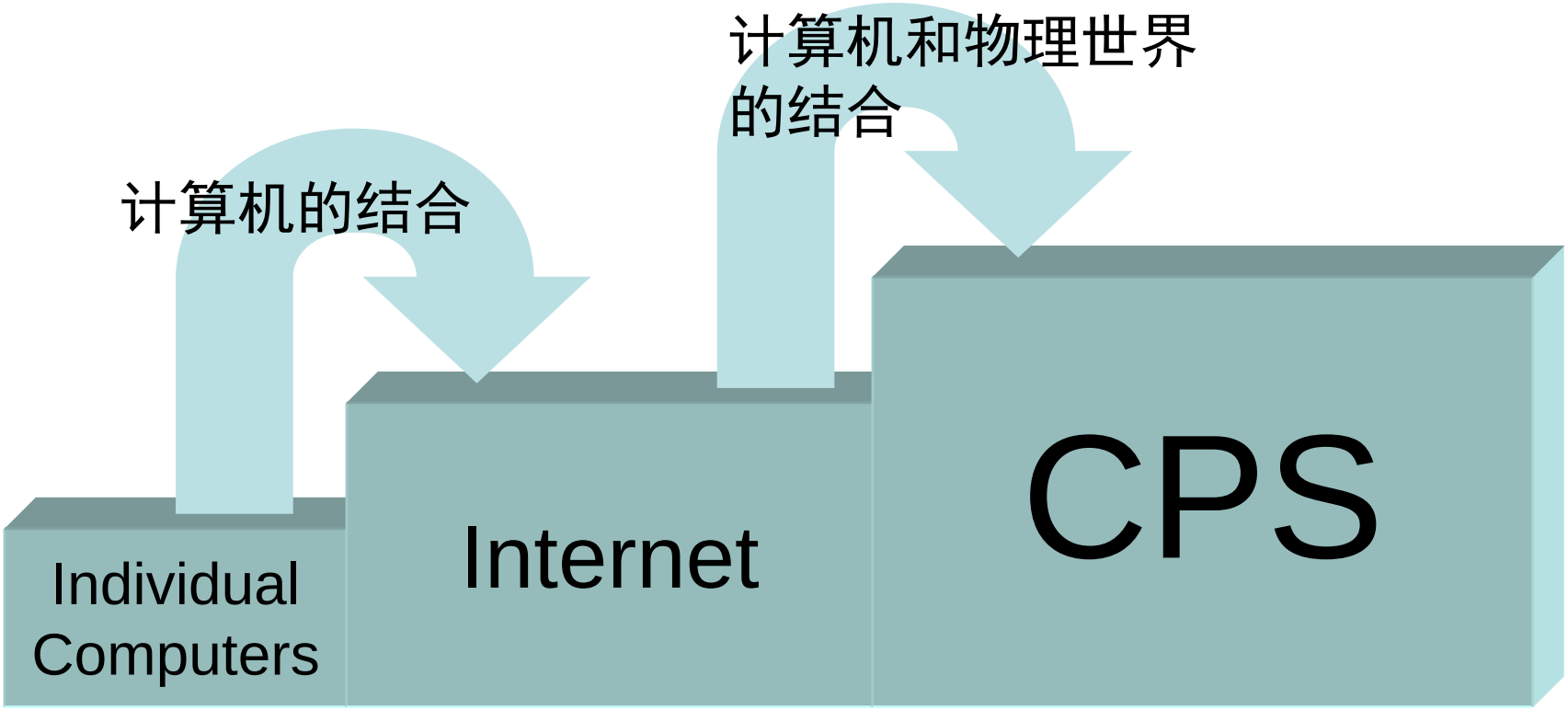


Cyber-Physical Systems
计算机-物理系统一体化



计算机–物理系统一体化(Cyber-Physical Systems, CPS) 是计算机科学发展的一个主题

下一步的普适计算



CPS 的应用涉及广泛，影响深远

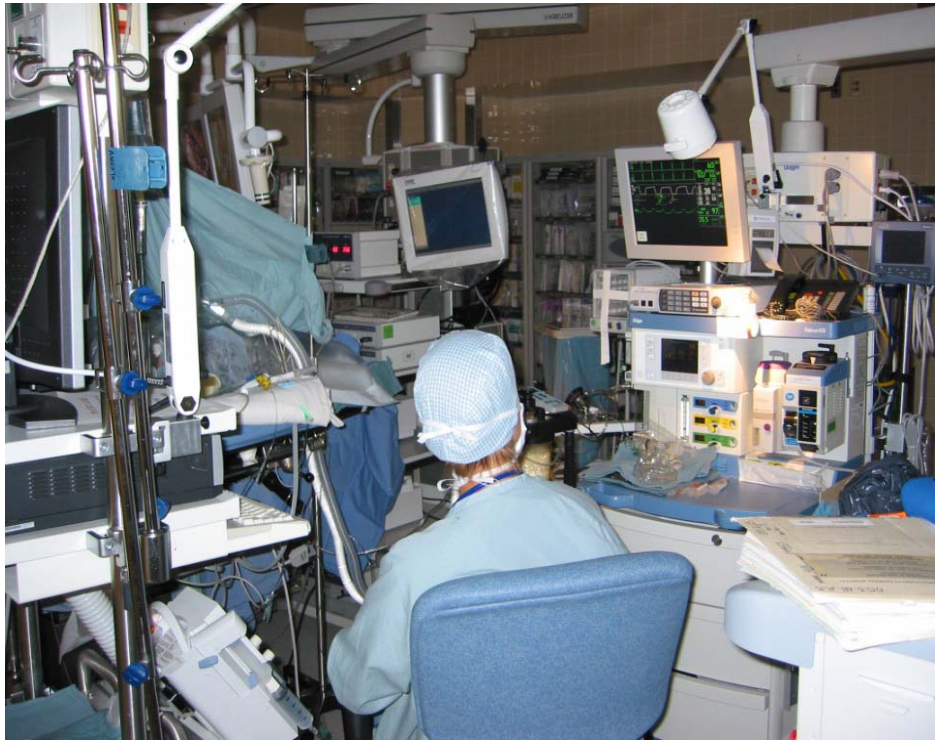
医疗设备即插即用（MDPnP）集成上万种用于医院和辅助生活的医疗设备

在手术麻醉中用于连接电子医疗记录仪（anesthesia EMR）的各种导线

手术室自动化

错综复杂的导线造成隐患

目标



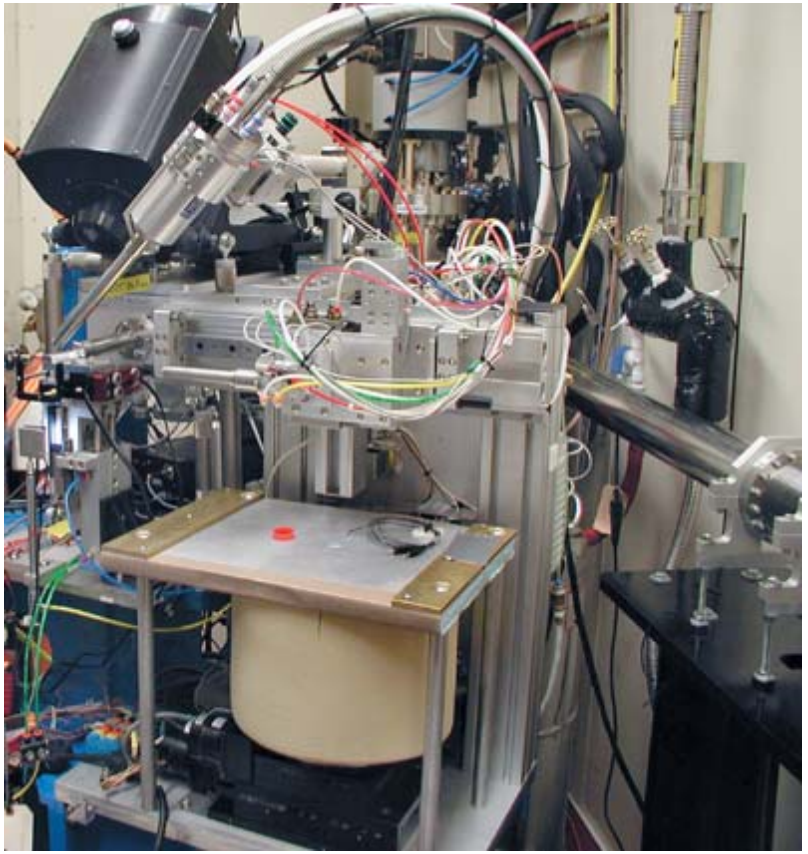
现状

下一代的工业自动控制

更大量的嵌入式计算机

更复杂的分布式系统

有线 → 有线 + 无线



下一代的飞行器

协和式飞机

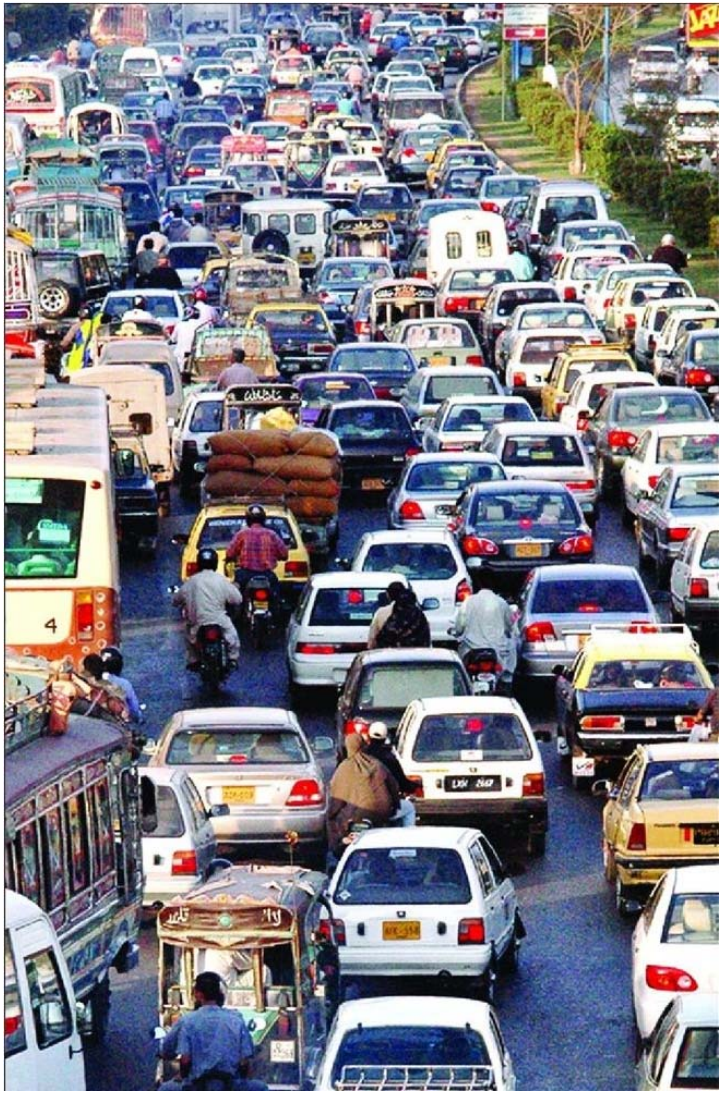
1976

下一代的飞行器

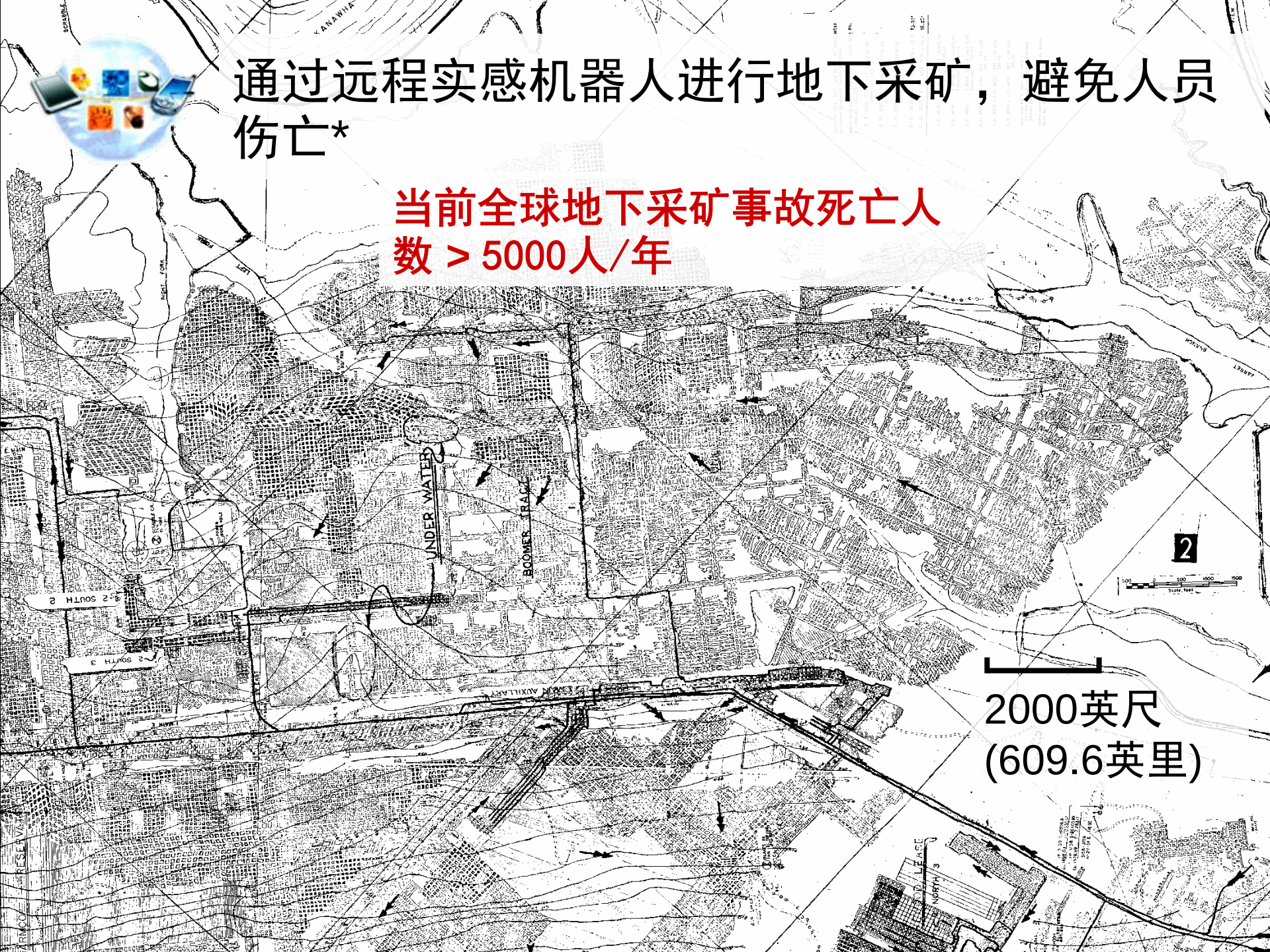
空客A380

2007

远程实感（Telepresence）遏制城市恶性膨胀*

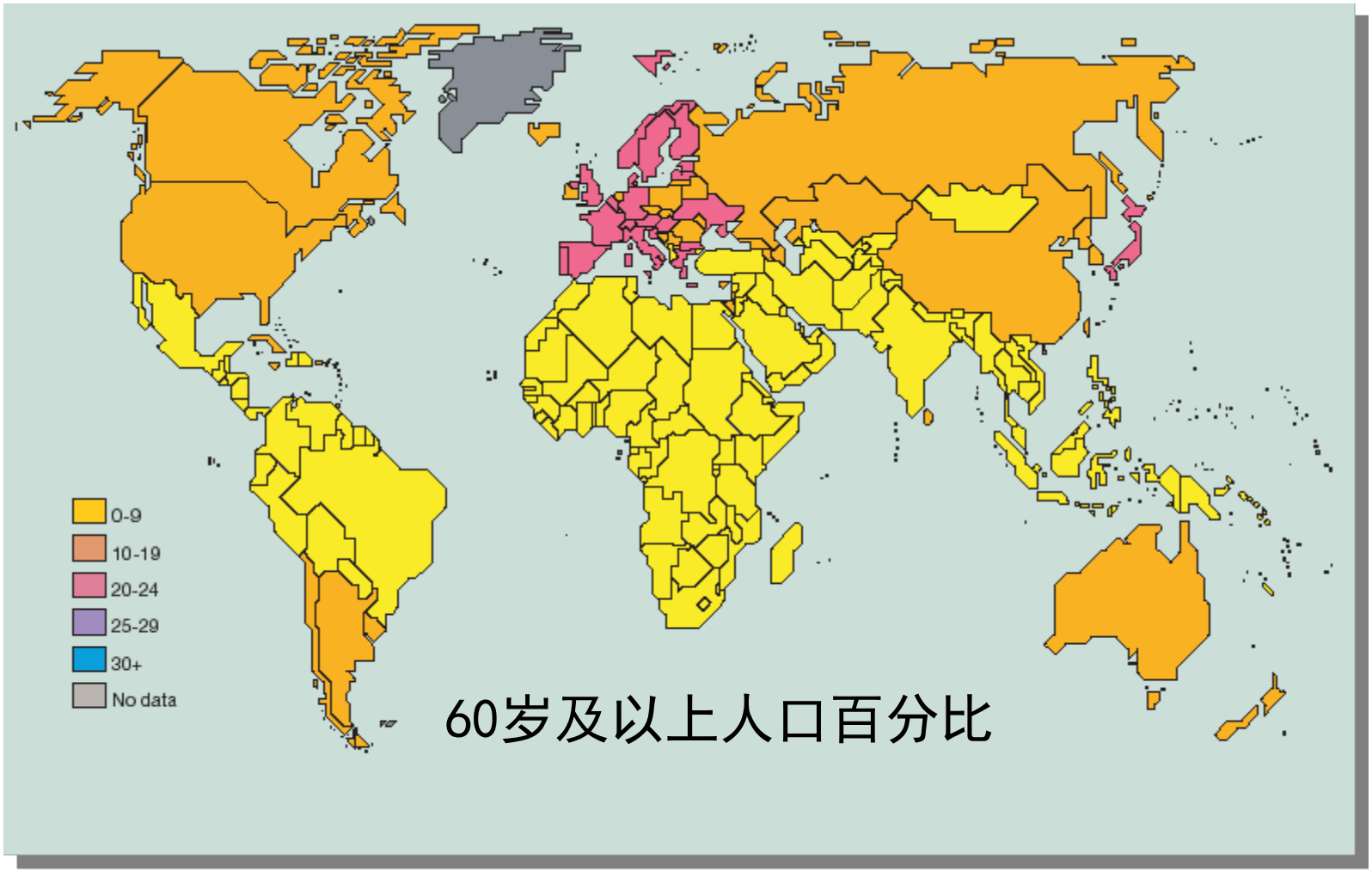


远程医疗、远程手术拯救更多生命*


通过远程实感机器人进行地下采矿，避免人员伤亡*
当前全球地下采矿事故死亡人数 > 5000人/年
2000英尺
(609.6英里)

辅助生活（Assisted Living）缓解老龄化危机*

2002

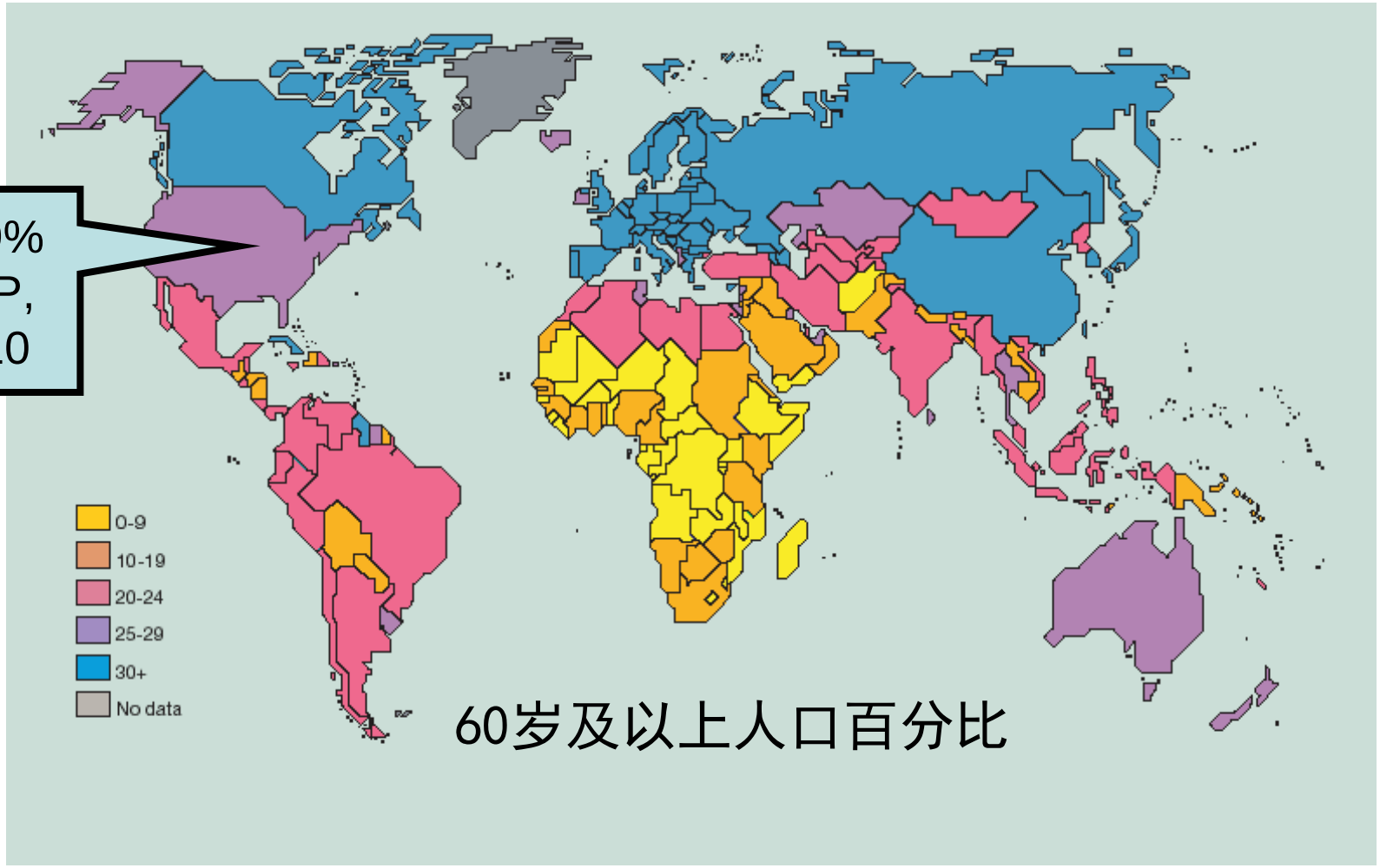


来源：联合国 ▪ “人口老龄化 ▪ 2002”

辅助生活（Assisted Living）缓解老龄化危机*

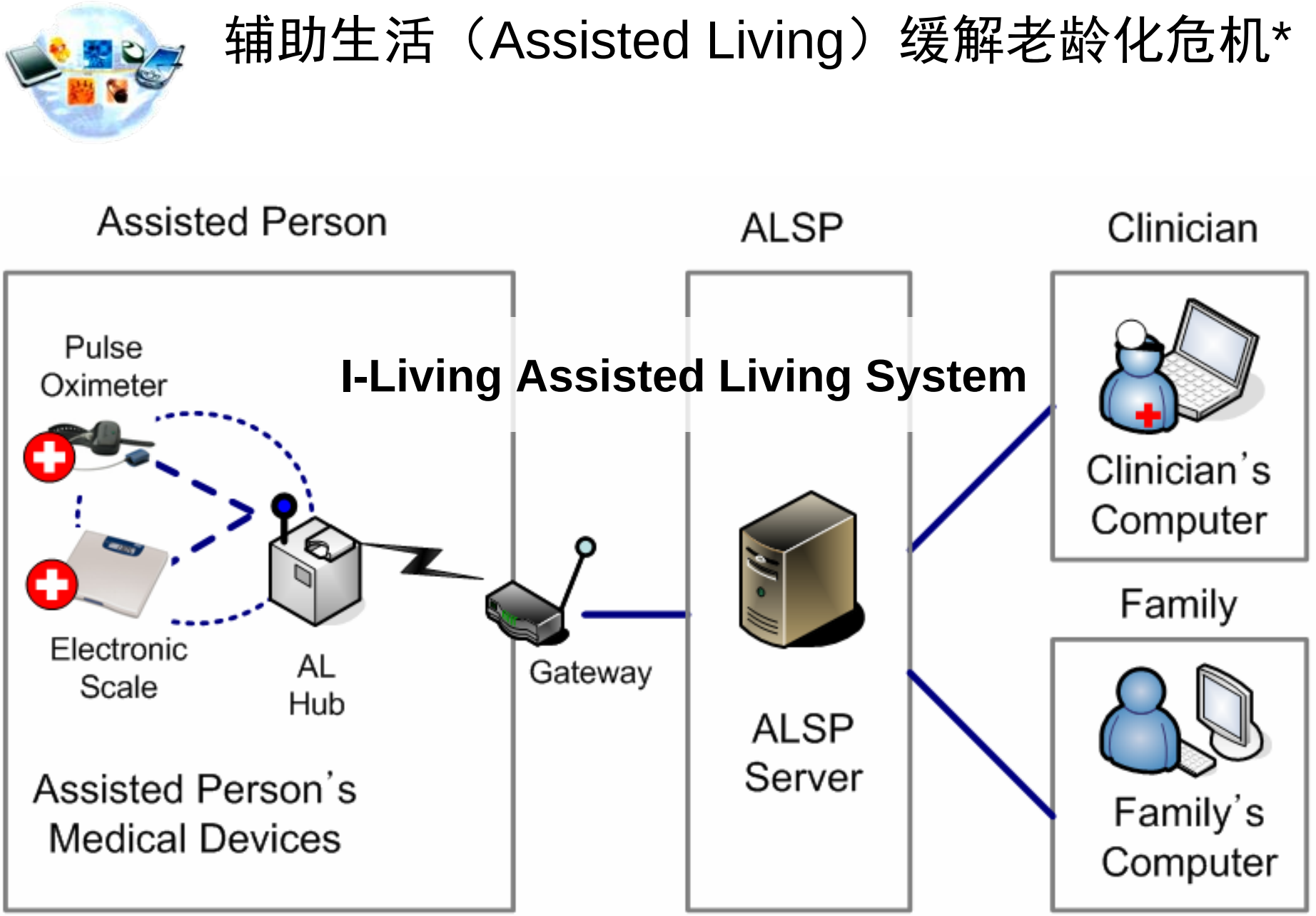
2050

15.9% GDP, 2010



来源：联合国 ▪ “人口老龄化 ▪ 2002”

辅助生活（Assisted Living）缓解老龄化危机*



CPS的应用不止于此*


Assisted Person
ALSP
Clinician
Pulse Oximeter
Electronic Scale
AL Hub
Gateway
Assisted Person`s Medical Devices
ALSP Server
Clinician`s Computer
Family
Family`s Computer
CPS

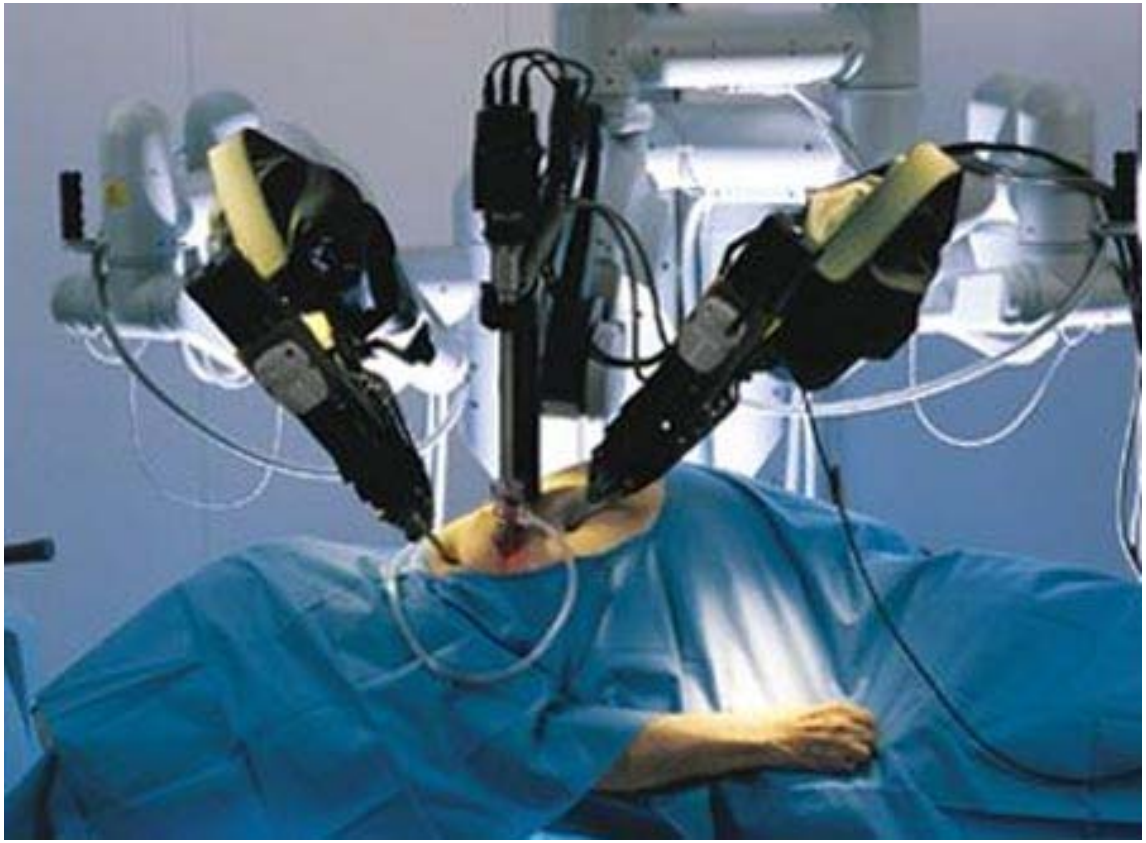
CPS需要各种底层结构来奠定基础

其中重要的一环是其实时底层结构

手术机器人：每项任务都是连续的传感/传动操作

每个操作:

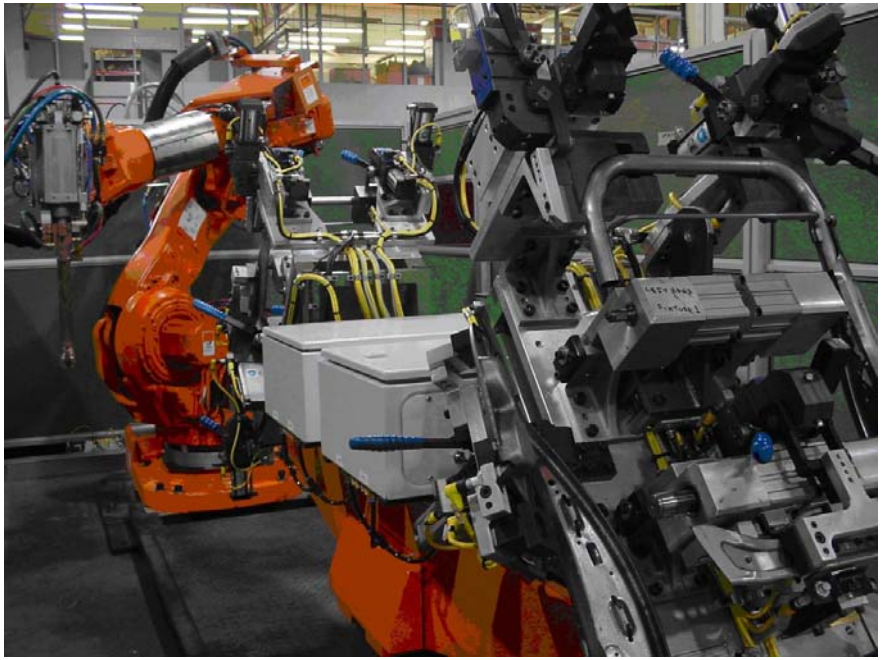
1. 必须按时完成
2. 不必快速完成

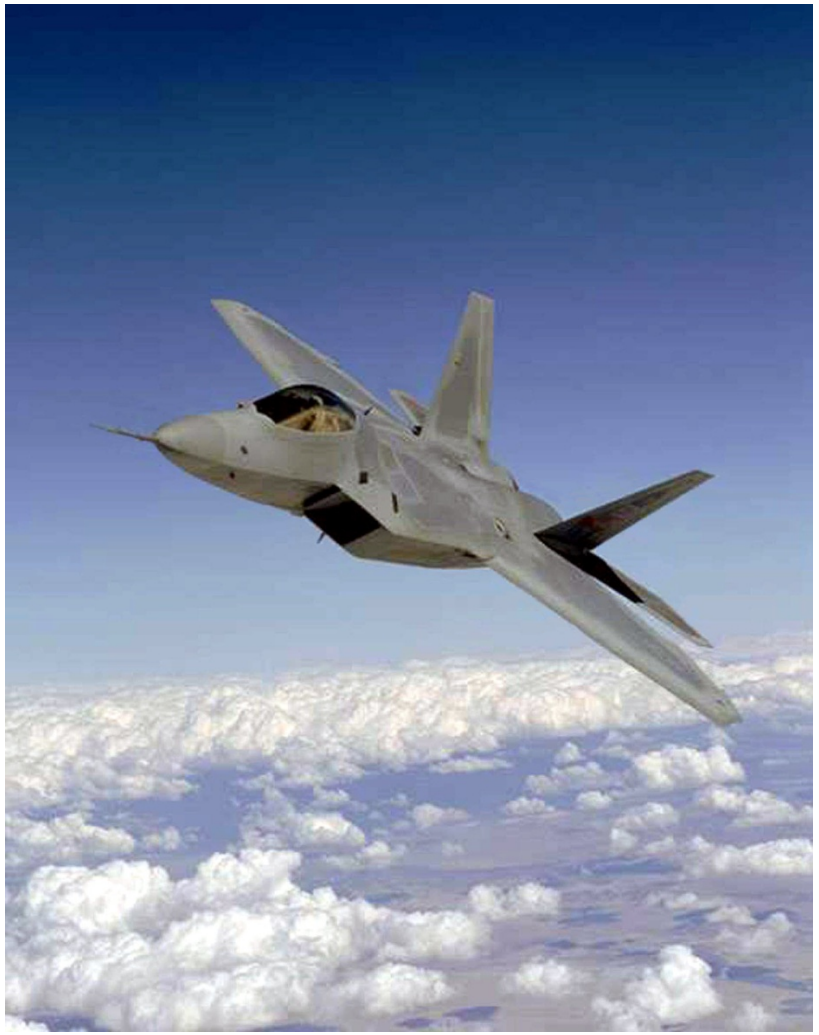


航空和工业控制：每项任务都是连续的传感/传动操作

每个操作:

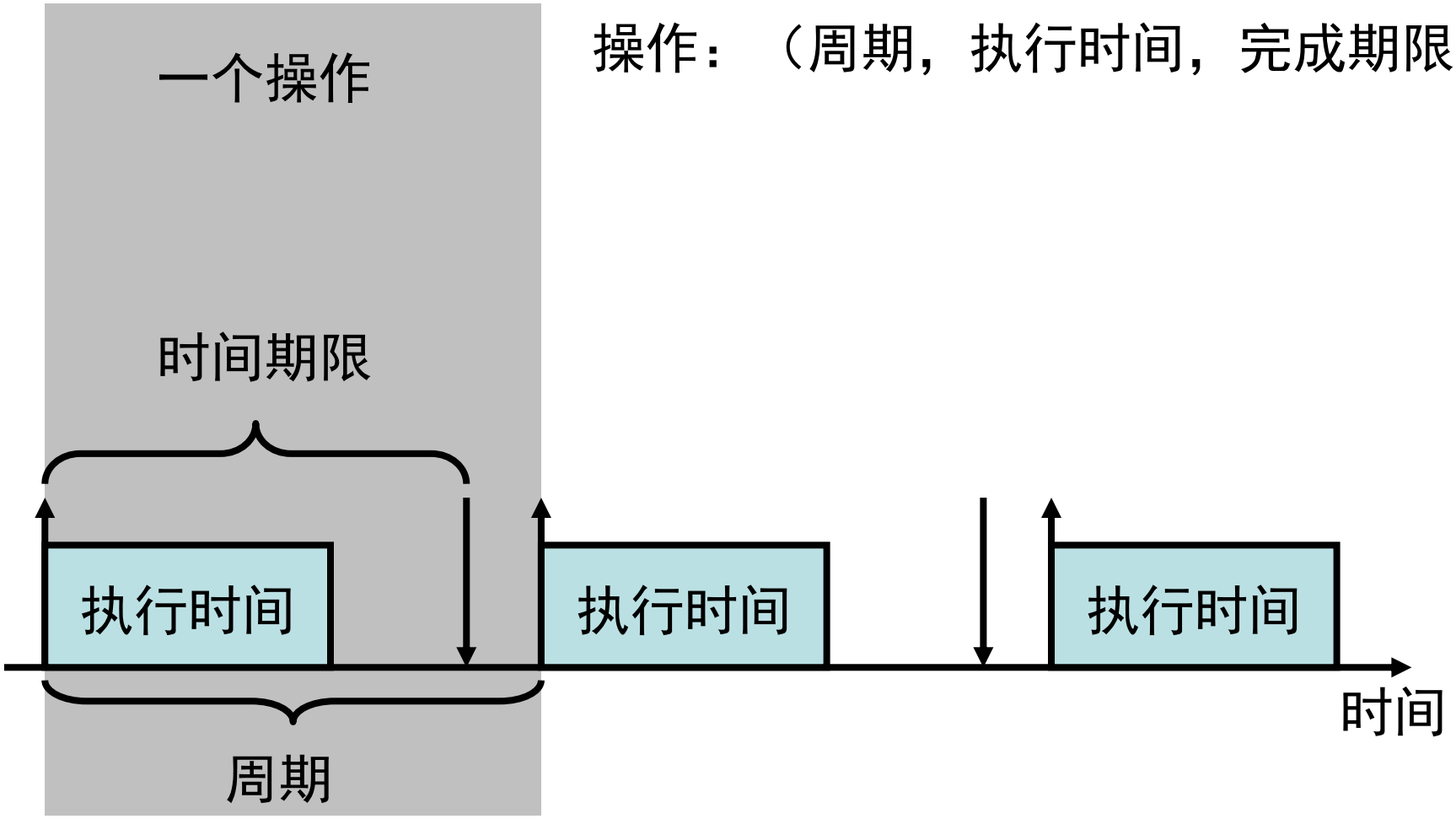
1. 必须按时完成
2. 不必快速完成





实时任务一般是连续不断的周期操作

操作：（周期，执行时间，完成期限）

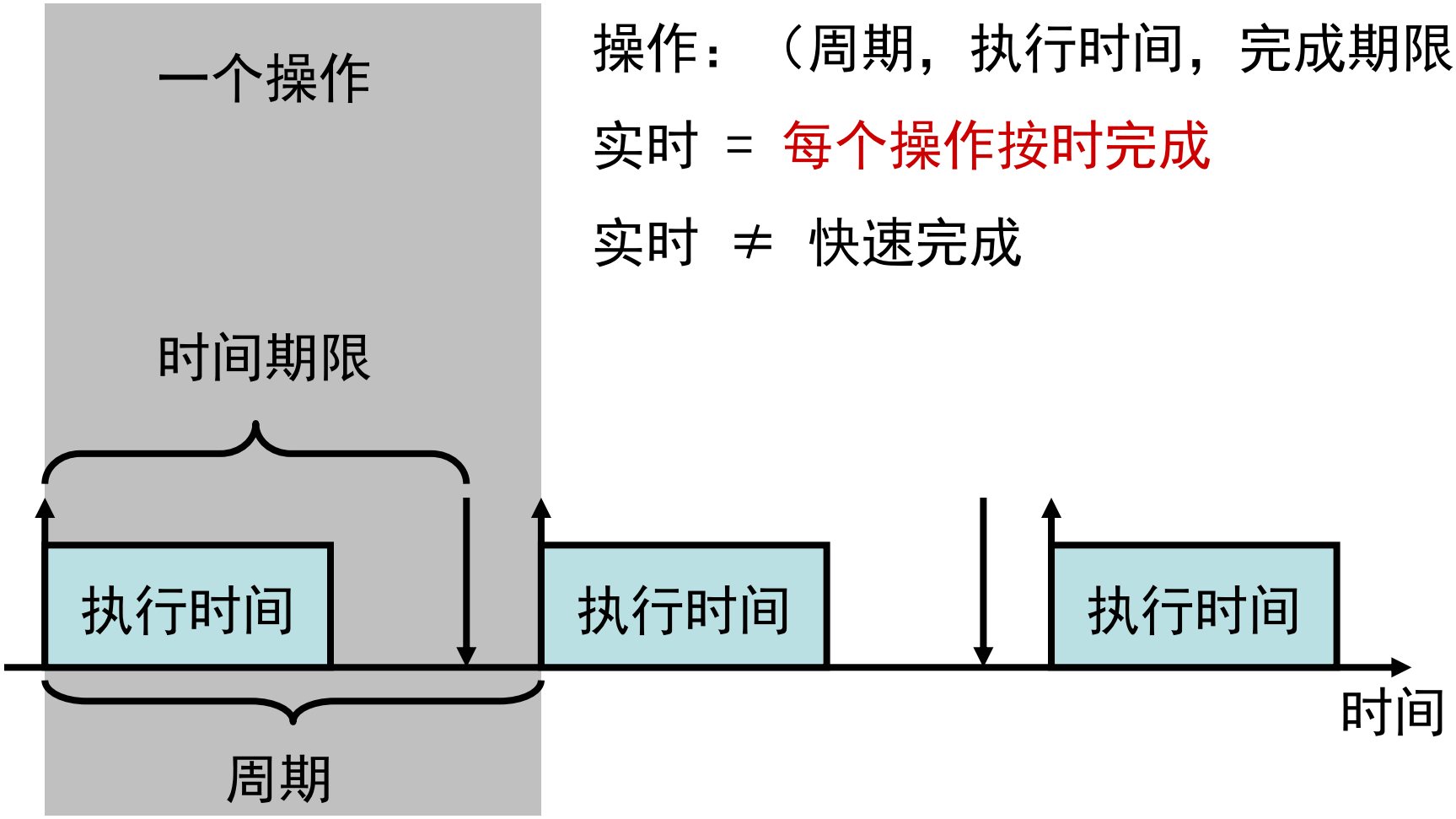


实时任务一般是连续不断的周期操作

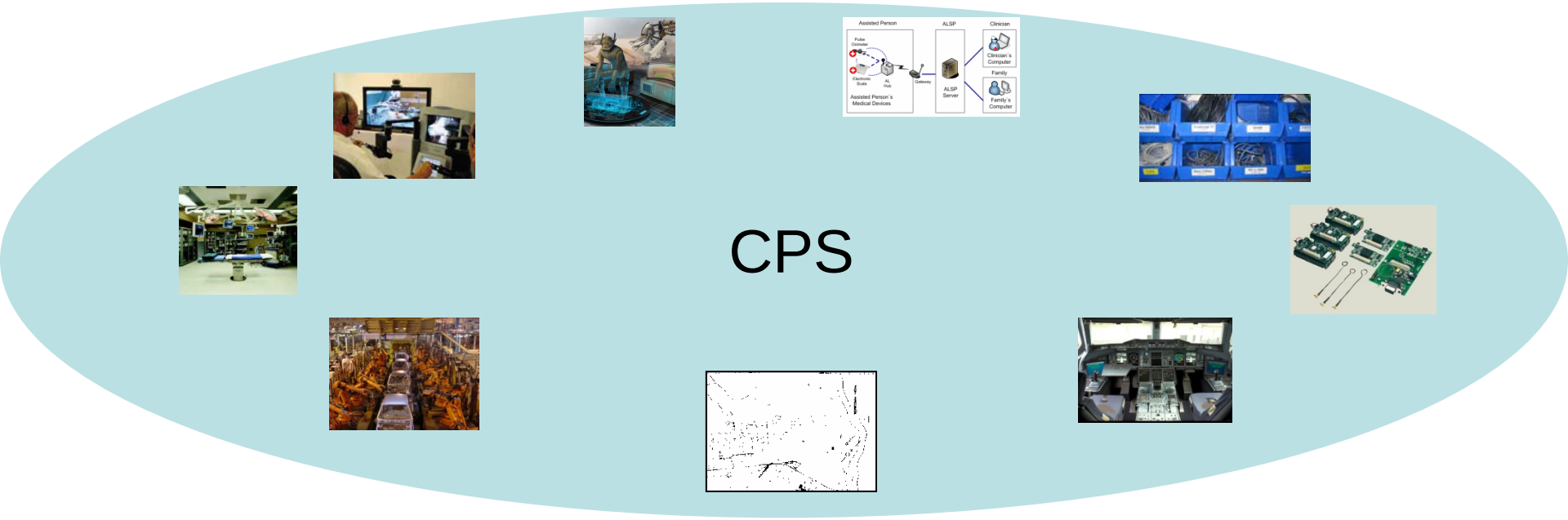
操作：（周期，执行时间，完成期限）

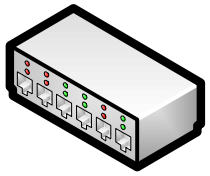
实时 = 每个操作按时完成

实时 ≠ 快速完成



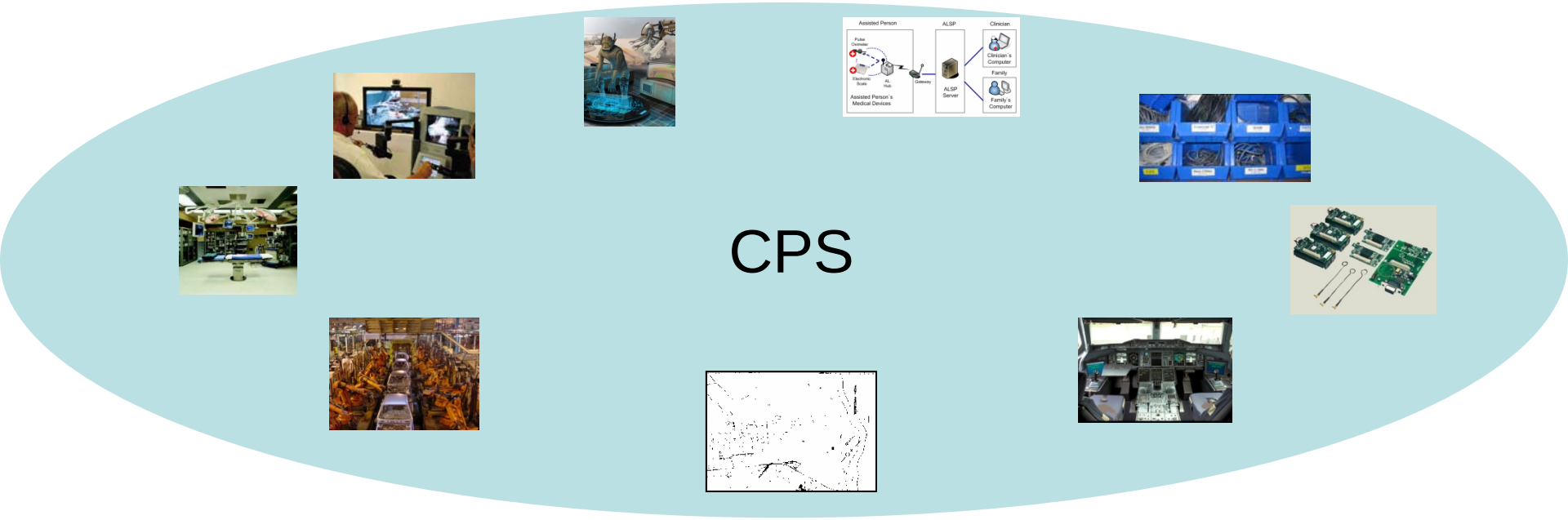
CPS 需要实时通讯底层

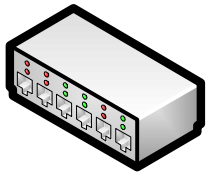




Real-Time Switch

实时交换器





Real-Time
Switch

Real-Time
Wireless LAN
实时无线局域网

发表的论文

Journal Publications:

1. **[TMC] Qixin Wang**, Rong Zheng, Ajay Tirumala, Xue Liu, and Lui Sha, “Lightning: A Hard Real-Time, Fast, and Lightweight Low-End Wireless Sensor Election Protocol for Acoustic Event Localization”, (accepted for publication) in IEEE Transactions on Mobile Computing.
2. **[TMC07] Qixin Wang**, Xue Liu, Weiqun Chen, Marco Caccamo, and Lui Sha, “Building Robust Wireless LAN for Industrial Control with the DSSS-CDMA Cell Phone Network Paradigm”, in IEEE Transactions on Mobile Computing, vol 6, number 6, June, 2007.
3. **[TOSN06]** Xue Liu, **Qixin Wang**, Wenbo He, Marco Caccamo, and Lui Sha, "Optimal Real-Time Sampling Rate Assignment for Wireless Sensor Networks", in ACM Transactions on Sensor Networks, vol 2, issue 2, May, 2006.

Conference, Workshop and Other Publications:

4. **[RTAS08] Qixin Wang**, Sathish Gopalakrishnan, Xue Liu, and Lui Sha, "A Switch Design for Real-Time Industrial Networks", (full paper accepted for publication) in Proceedings of the 14th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS 2008), 2008.
5. **[RTSS07] Qixin Wang**, Xue Liu, Jennifer Hou, and Lui Sha, "GD-Aggregate: A WAN Virtual Topology Building Tool for Hard Real-Time and Embedded Applications", in Proceedings of the 28th IEEE Real-Time Systems Symposium (RTSS 2007), pp. 379-388, Tucson, Arizona, Dec. 3-6, 2007.
6. **[HCMDSS07a]** Mu Sun, **Qixin Wang**, and Lui Sha, “Building Safe and Reliable MD PnP Systems”, in Joint Workshop on High Confidence Medical Devices, Software, and Systems (HCMDSS) and Medical Devices Plug-and-Play (MD PnP), June, 2007.
7. **[HCMDSS07b]** Jennifer C. Hou, **Qixin Wang**, et. al., “PAS: A Wireless-enabled, Sensor-integrated Personal Assistance System for Independent and Assisted Living”, in Joint Workshop on High Confidence Medical Devices, Software, and Systems (HCMDSS) and Medical Devices Plug-and-Play (MD PnP), June, 2007.
8. **[ICSMC06] Qixin Wang**, Wook Shin, Xue Liu, et. al., “I-Living: An Open System Architecture for Assisted Living”, (invited paper) in Proc. of IEEE International Conference on Systems, Man, and Cybernetics 2006.
9. **[RTSS05] Qixin Wang**, Xue Liu, Weiqun Chen, Wenbo He, and Marco Caccamo, "Building Robust Wireless LAN for Industrial Control with DSSS-CDMA Cellphone Network Paradigm", in Proc. of the 26th IEEE International Real-Time Systems Symposium (RTSS 2005), Miami, USA, December, 2005. (Power Point)(Poster-Sized Power Point)
10. **[ICAS05]** Xue Liu, Rong Zheng, Jin Heo, **Qixin Wang**, and Lui Sha, "Timing Control for Web Server Systems Using Internal State Information", in Proc. of Joint International Conference on Autonomic and Autonomous Systems and International Conference on Networking and Services (ICAS-ICNS 2005), 2005.
11. **[RTSS04] Qixin Wang**, Rong Zheng, Ajay Tirumala, Xue Liu, and Lui Sha, "Lightning: A Fast and Lightweight Acoustic Localization Protocol Using Low-End Wireless Micro-Sensors", in Proc. of the 25th IEEE International Real-Time Systems Symposium (RTSS 2004), Lisbon, Portugal, December, 2004. (Power Point) (Demo Video)
12. **[RTSS03]** Xue Liu, **Qixin Wang**, Lui Sha and Wenbo He, "Optimal QoS Sampling Frequency Assignment for Real-Time Wireless Sensor Networks", in Proc. of the 24th IEEE International Real-Time Systems Symposium (RTSS 2003), Cancun, Mexico, December, 2003.
13. **[IPSN03] Qixin Wang**, Wei-Peng Chen, Rong Zheng, Kihwal Lee, and Lui Sha, "Acoustic Target Tracking Using Tiny Wireless Sensor Devices", in Proc. of the 2nd International Workshop on Information Processing in Sensor Networks (IPSN'03), Lecture Notes in Computer Science 2634, Springer, 2003.