The Virtual Lab Experience

Hewlett Packard

Educators Advisory Council

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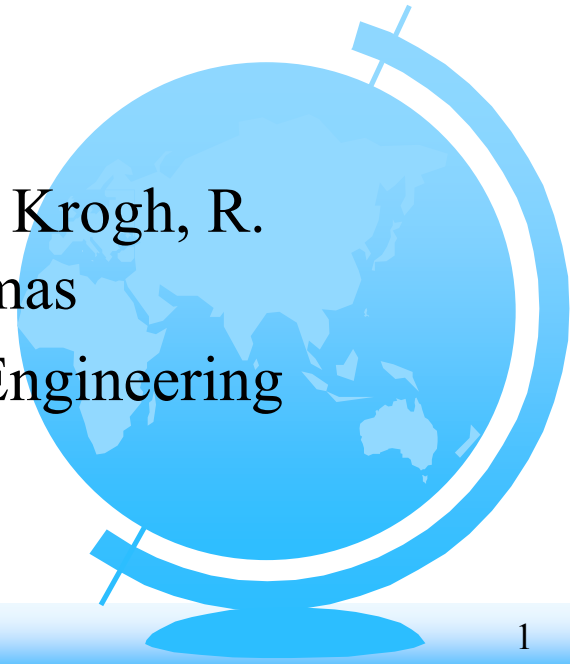
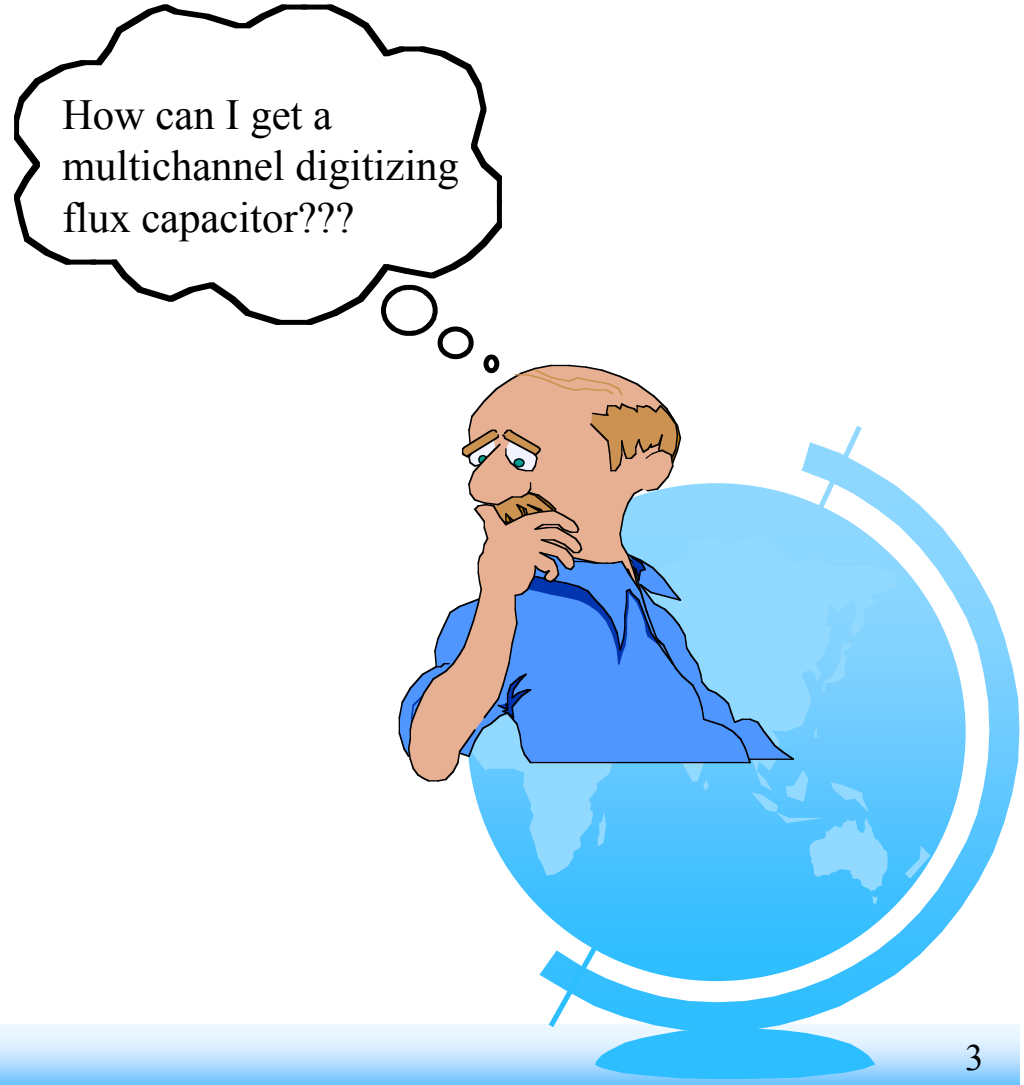


Outline

- The Virtual Laboratory Concept
- Experience from Fall 1995 Semester
- Future Directions

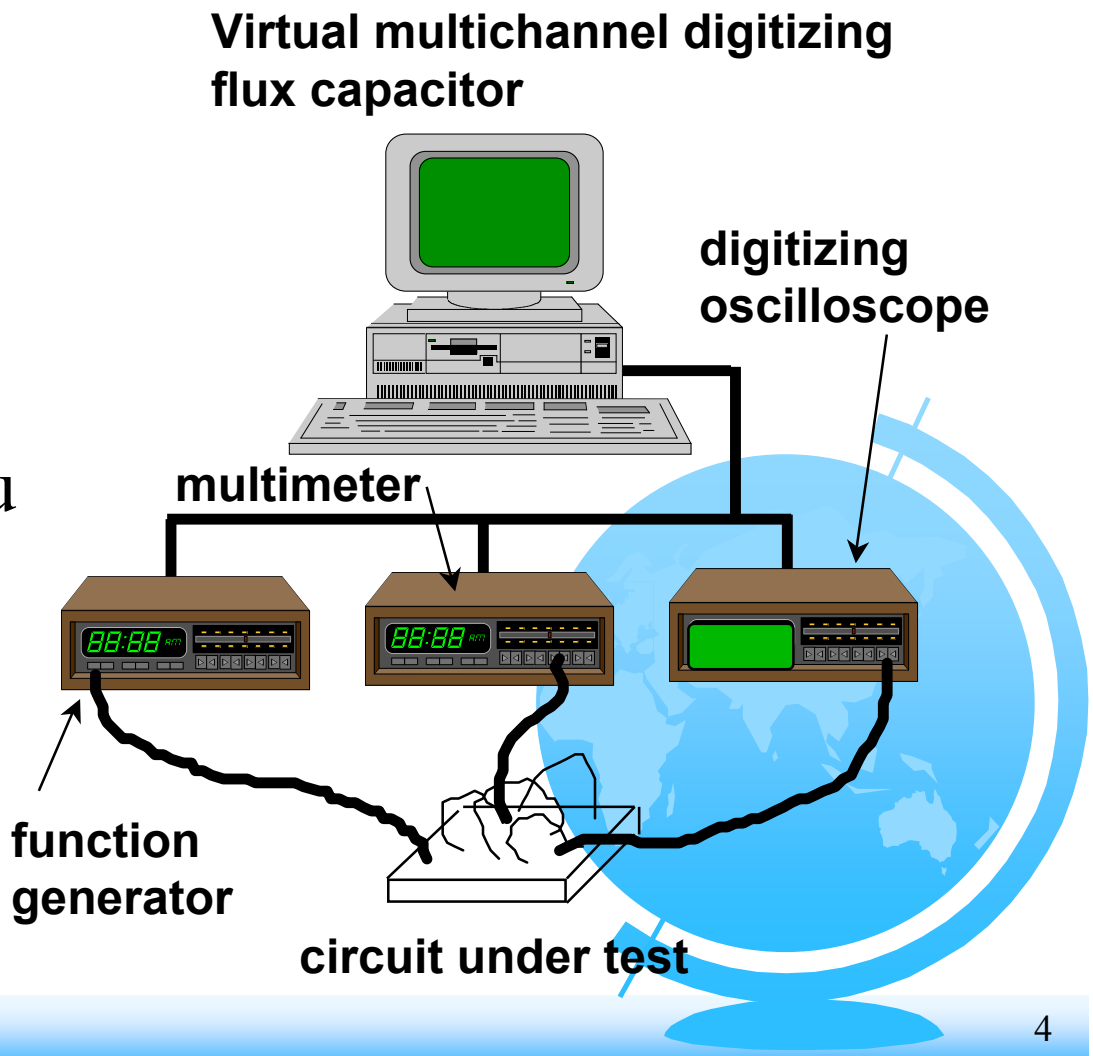
Problem: Instrument not Available

- Needs for special purpose instruments may exceed budgets
- Special purpose instruments may not be available in an isolated remote location (e.g., space!)



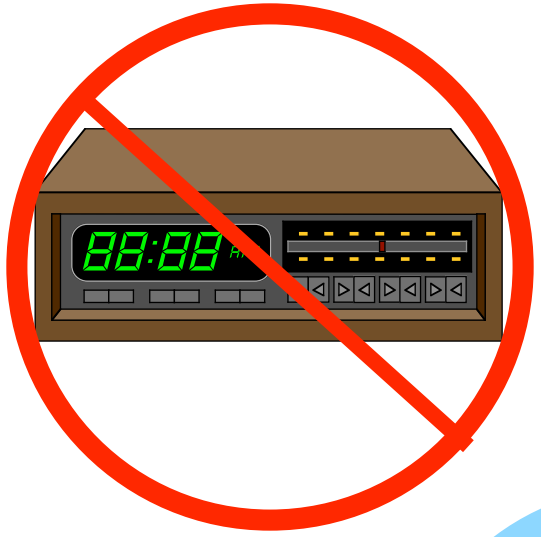
Solution: Virtual Instrument

General purpose instruments can be programmed with a computer to behave like special purpose instruments that you don't have!



Problem: Instruments not Accessible

- Needed instruments exist only at a distant location
- University lab is locked at 3:00am when student wants to do assignment
- University equipment under-utilized outside of scheduled lab times

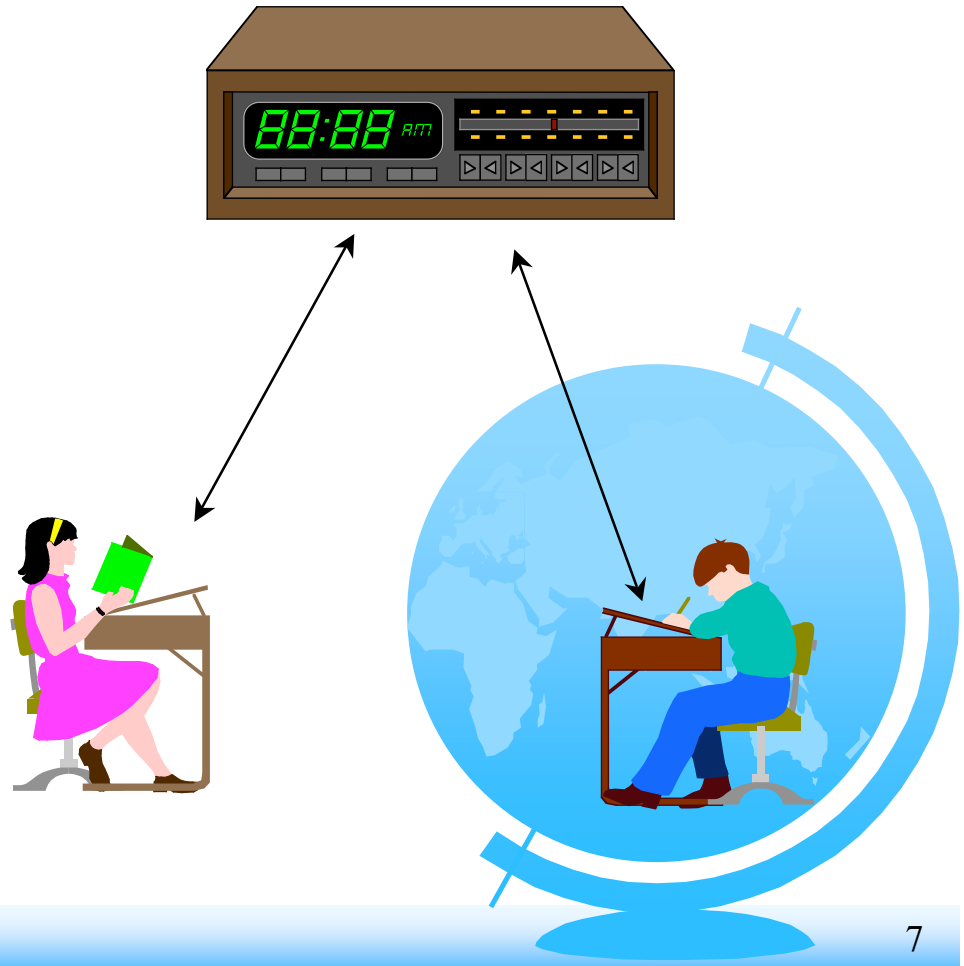


Solution: Remote Instrumentation Access

- Make instruments available over the internet (or company intranet)
- Remote access paradigm is increasingly being used in industry along with telecommuting and teleconferencing
- CMU activity: introduce this paradigm into the undergraduate laboratory experience

Remote Access Application 1

- Students can use university laboratory instruments when the lab is not open
- Instruments can be shared among multiple universities

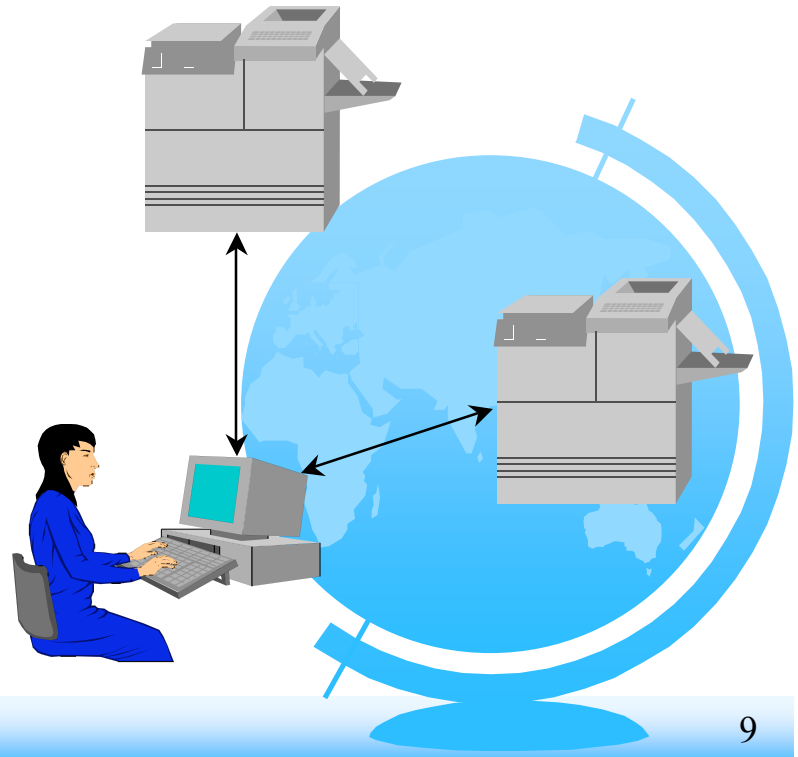


Remote Access Application 2

- Engineers/Scientists have remote access to a large, expensive piece of equipment
- saves travel expenses
- gives wider access to equipment

Remote Access Application 3

- Adjustments to equipment on a manufacturing line from a central (perhaps remote) location
- Saves travel time and expense

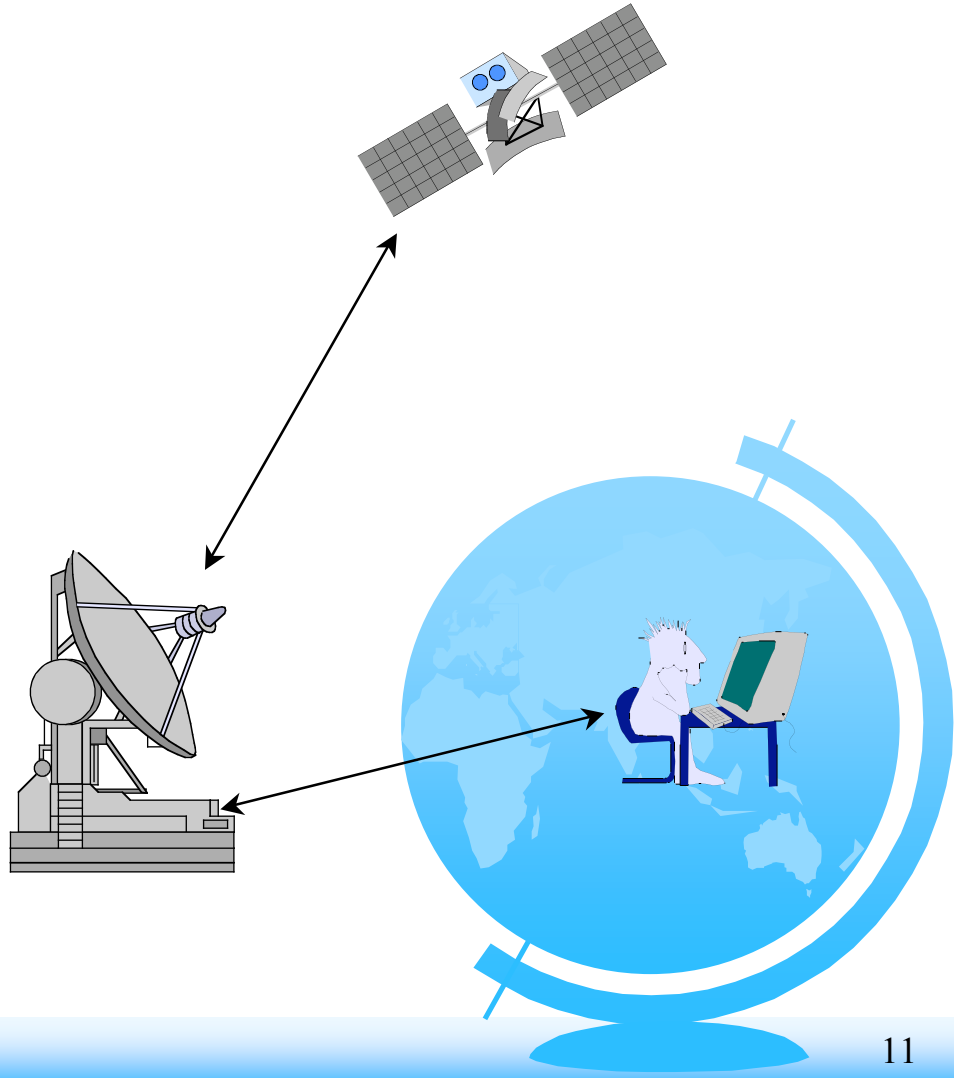


Remote Access Application 4

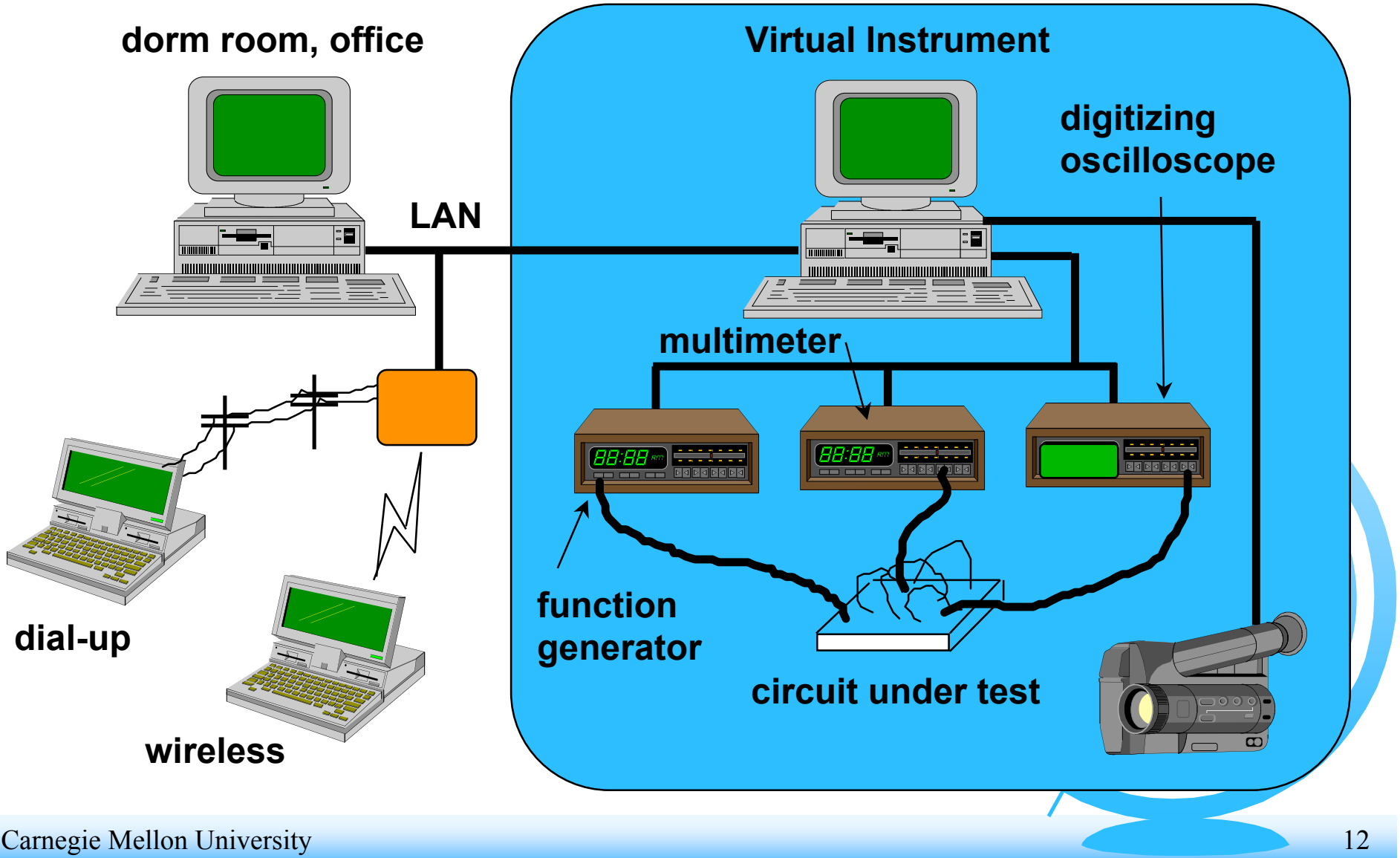
- Support Engineer can make adjustments to client's system remotely
- Saves travel time and expense

Remote Access Application 5

- Remote exploration: space, sea, volcanoes, etc.
- Travel not physically possible



CMU ECE Virtual Laboratory



What's in a Name?

- "Virtual Laboratory" is a bit of a misnomer
  - We are not *simulating* laboratory experiments
  - We are providing remote access to *real instruments and experiments*
- Perhaps better name: "Telelaboratory"

Key Virtual Lab Software

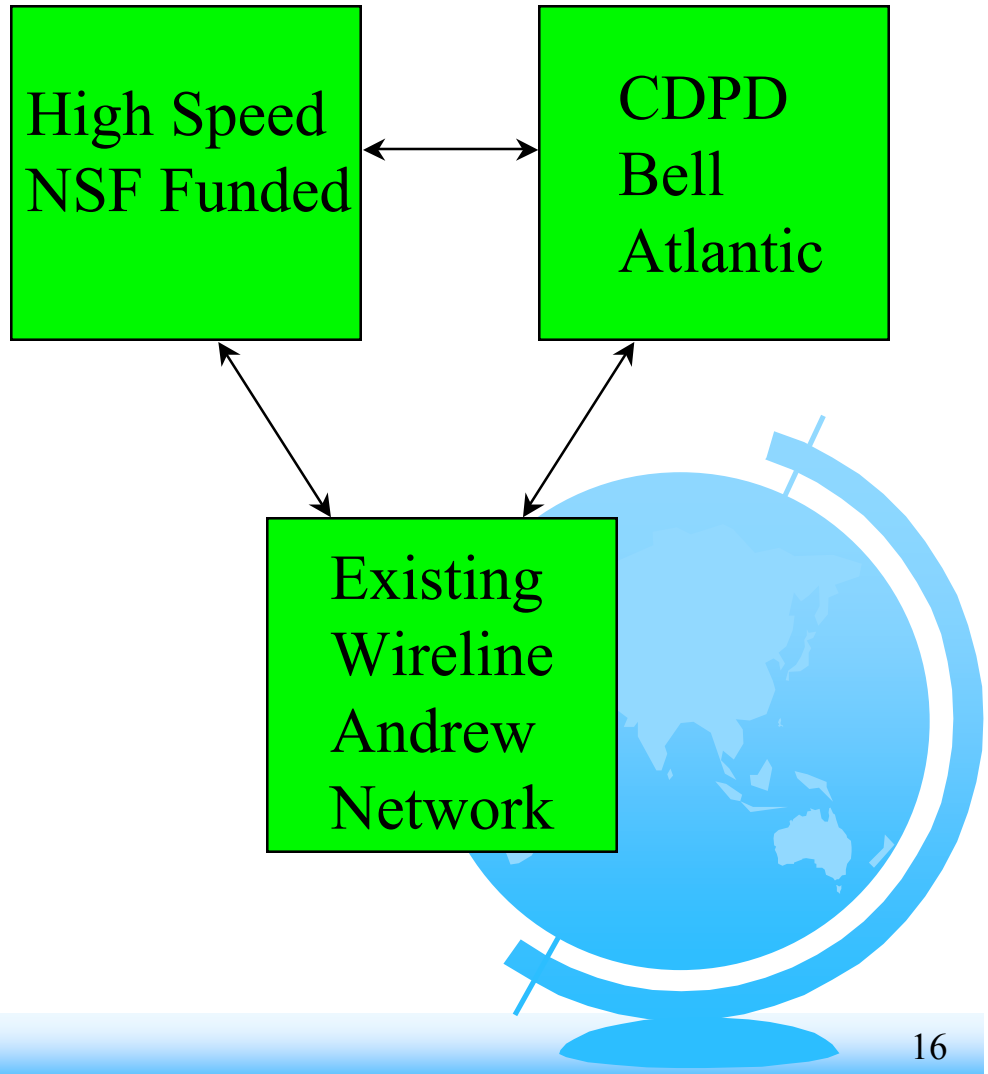
- HP-VEE (Hewlett-Packard)
- QuickCam Software (Connectix)
- PC/TCP (FTP Software + CMU)
- Timbuktu (Farallon)
  - Complete cross-platform control from Macs or PCs

Key Virtual Lab Hardware

- Intel 100 MHz Pentium computers running Windows, with ethernet, HPIB interfaces
- HP54601B 100 MHz digitizing oscilloscopes
- HP34401A digital multimeter
- HP8116A 50 MHz Pulse/Function generator

CMU Wireless Initiative Infrastructure

- Ben Bennington, Alex Hills, and John Leong
- 915 MHz, 2 Mb/s AT&T WaveLAN in 5 main campus bldgs
- Bell Atlantic Mobile CDPD, 19.2 kb/s, all Pittsburgh area
- Mac & PC support

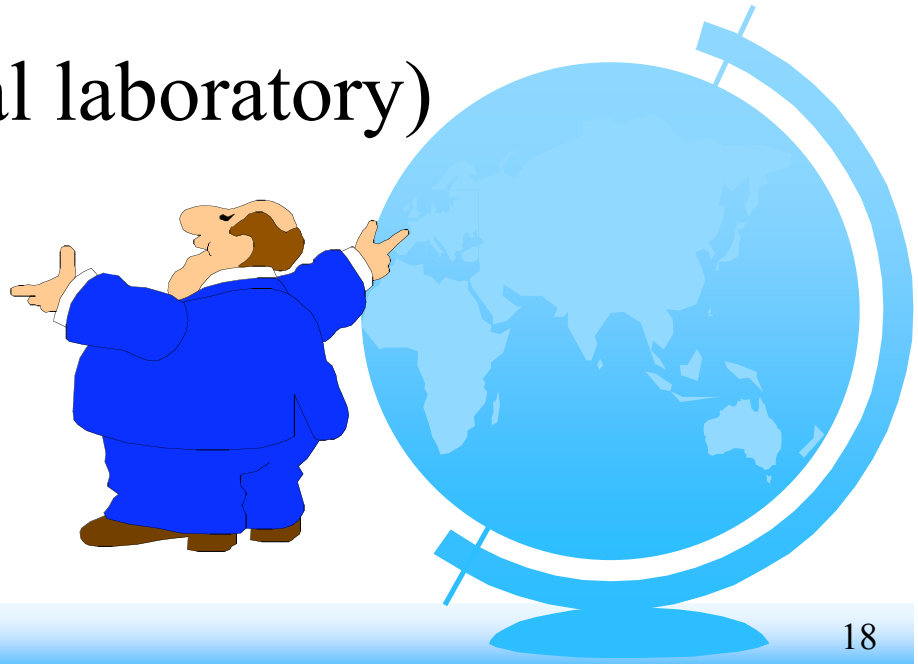


Course Experience

- 18-439 Special Topics in ECE: “Advanced ECE Laboratory Techniques: Virtual Laboratory,” Fall 1995
- Wireless capability not yet used
- Will be offered again in Fall, 1996
- Labs will be improved based on experience gained in Fall 1995

Course Goals

- Increase the usefulness of general purpose test instruments
  - Improved understanding of basic capability
  - Virtual instruments
- Explore remote (virtual laboratory) capability

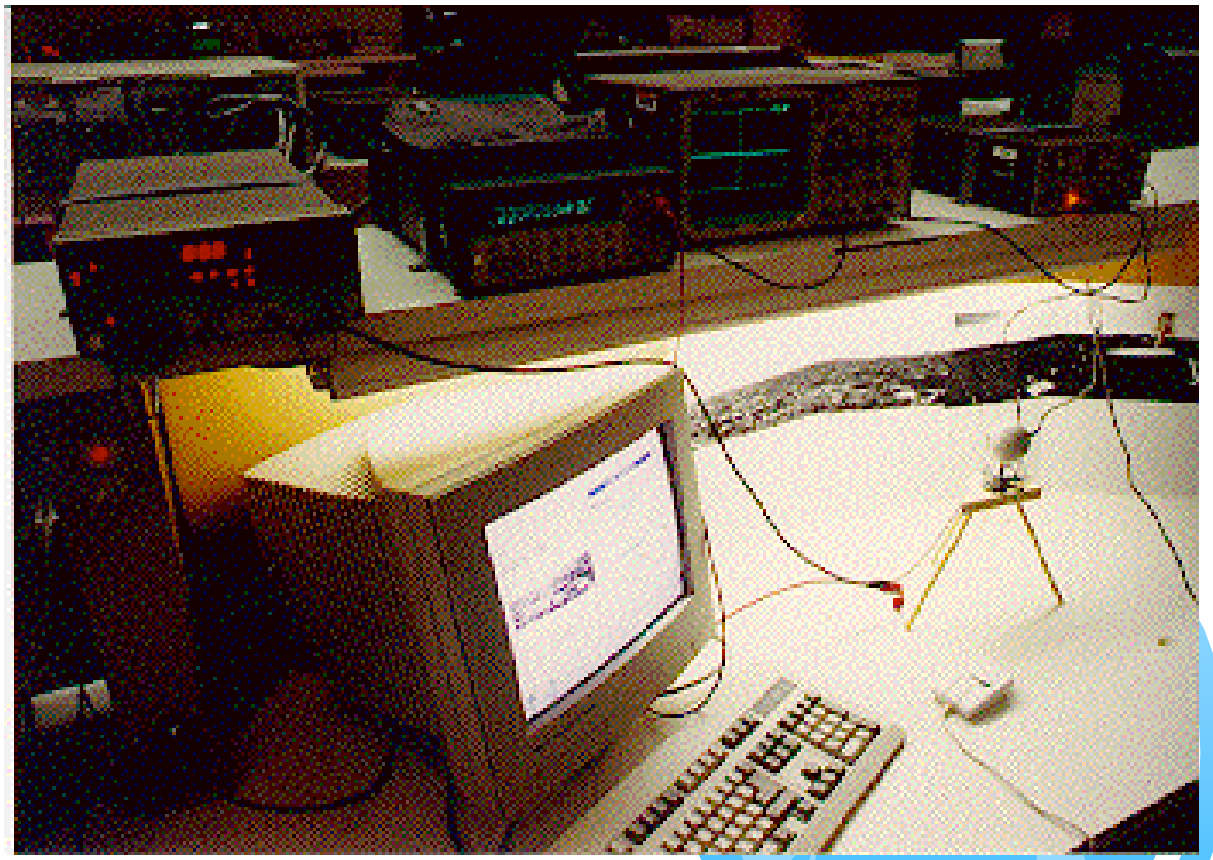


“Black Box” Lab

- Failure has occurred in remote telemetry filter
- Students given correct schematic diagram
- Limited to electrical measurements at input and output ports
- Students must remotely diagnose component failure

Martian Rescue

- Camera positioner failure on Martian Lander
- Students must program a new camera positioner remotely
- Use functioning camera to search for life on Martian landscape

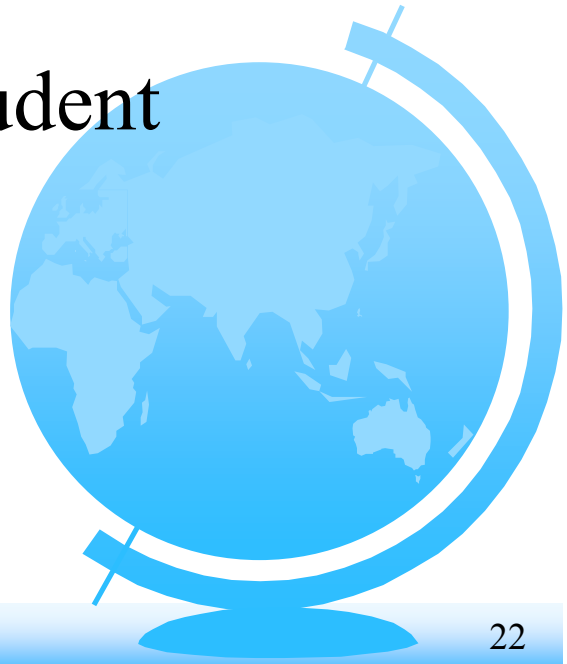


Future Directions

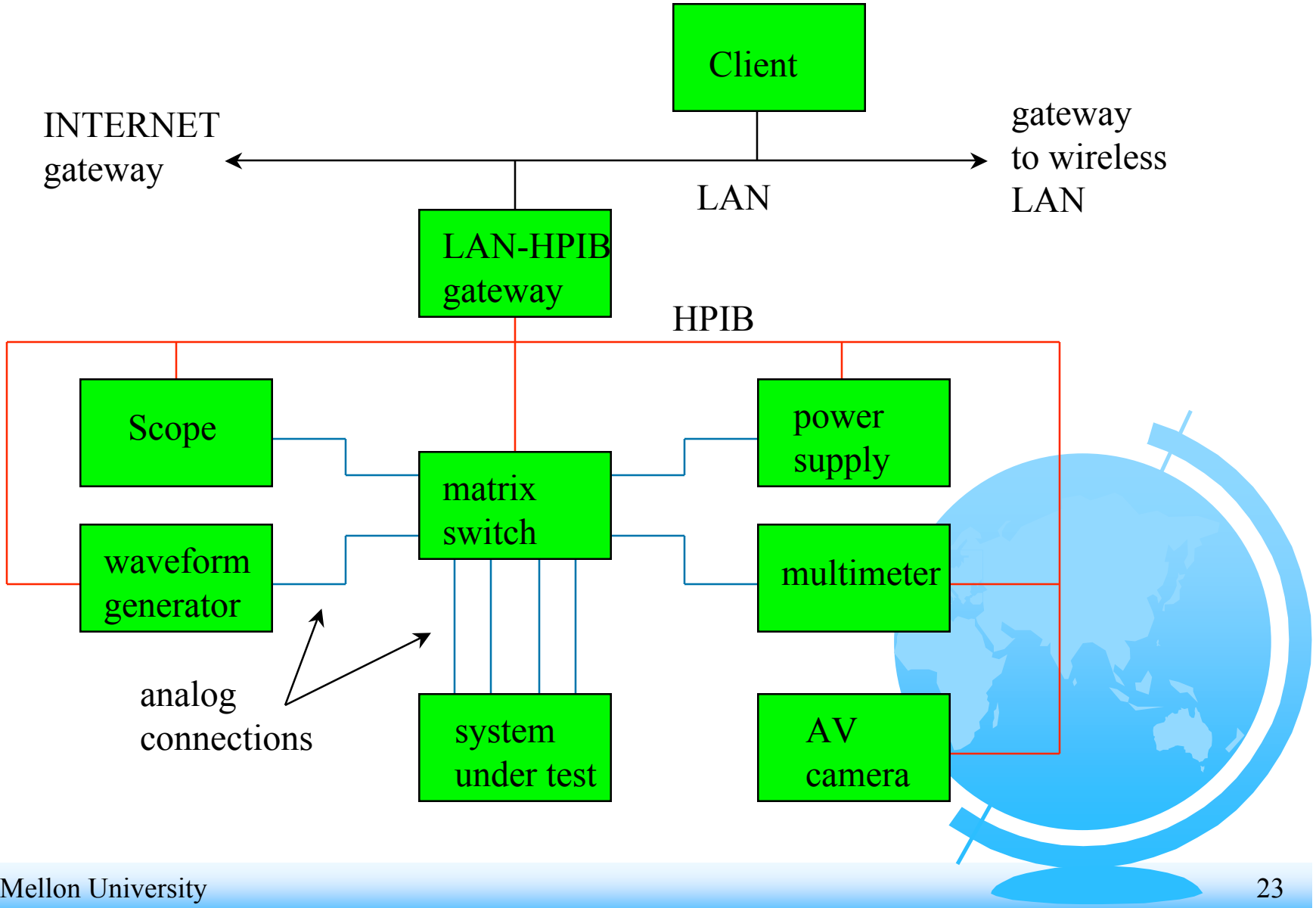
- Add matrix switch, programmable power supply
- Improved real-time audio and video
- Integrate wireless capability into course
- Access via HPIB-LAN gateway instead of PC?
  - low-cost student version of HP-VEE needed
  - Audio/video may need direct LAN connection

Future Directions (cont.)

- Expand to cover more labs and instrumentation
- INTERNET tutorial capability for distance learning
- Virtual INTERNET space for student interactions
- Remote manipulation of objects

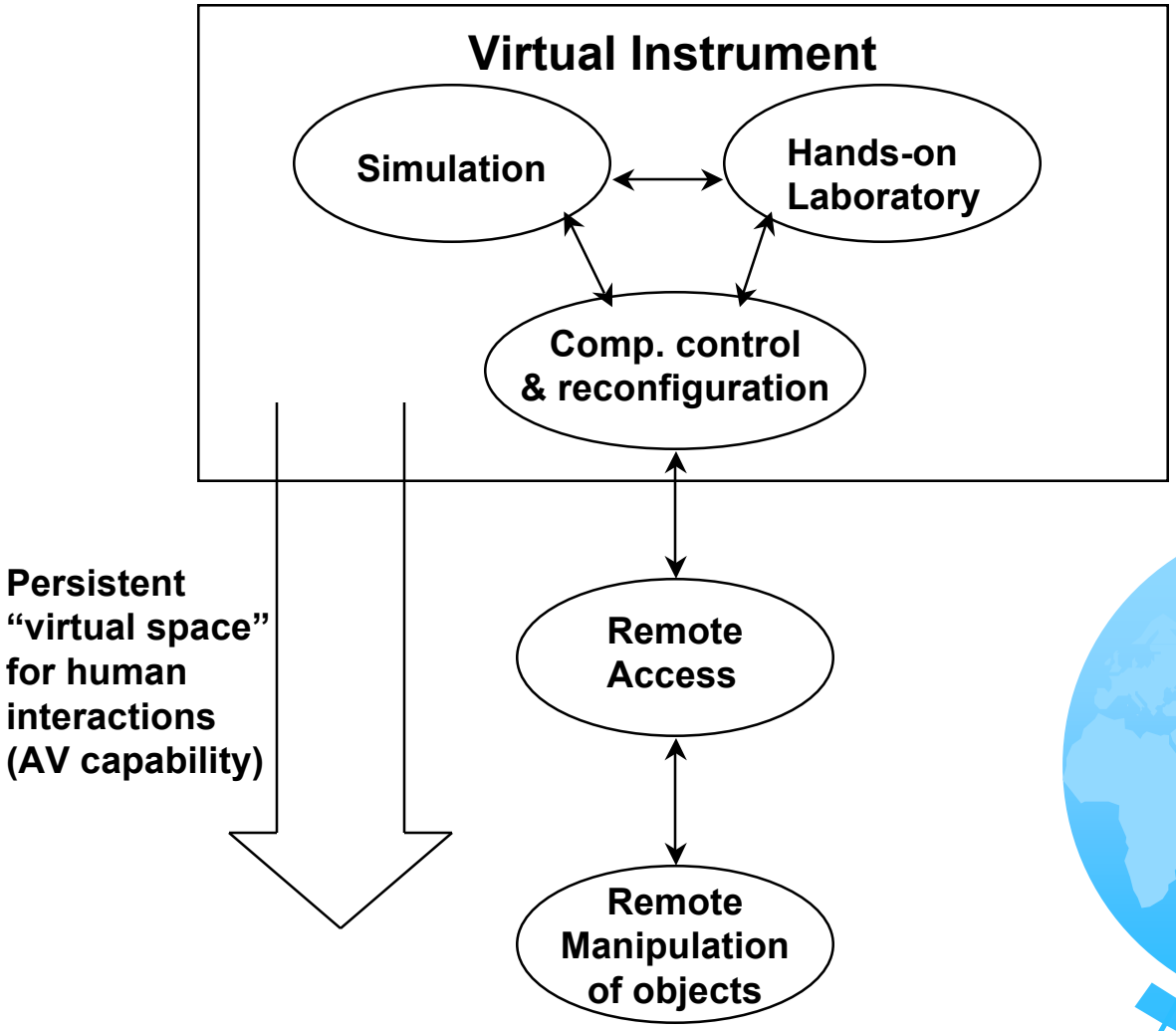


Next Generation Virtual Lab



Wireless Telelaboratory Access

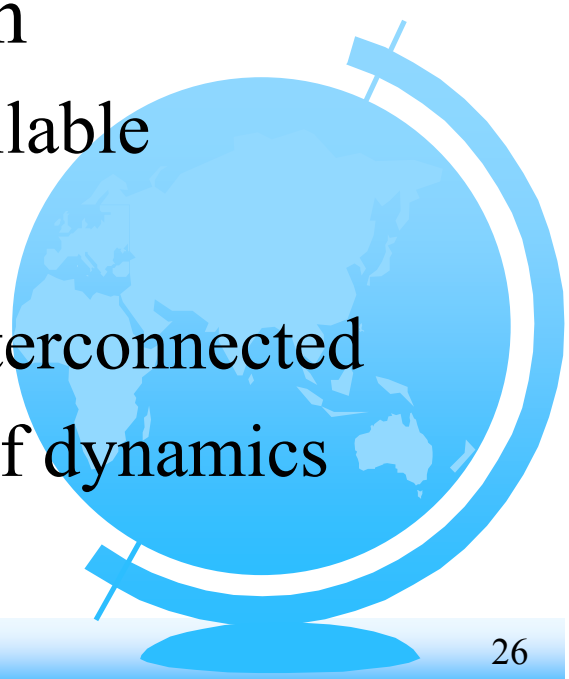
Virtual Laboratory Paradigm



Technology-Based Distance Learning

Prof. Dawn Tilbury, Univ. of MI; Prof. Bill Messner, CMU

- Self-paced study over the World Wide Web
- Advantages of WWW instruction
  - Course materials immediately available
  - Learn by "seeing and doing"
  - On-line educational aids highly interconnected
  - Moving images aid visualization of dynamics



Summary

- Remote experimentation (telelaboratory) paradigm will spread along with telecommuting and teleconferencing
- ECE at CMU has introduced this paradigm to the undergraduate educational experience
- Future directions include extending the concept to additional instruments and distance learning