CL*EAN*ER, FAME, and CYBERINFRASTRUCTURE

NSF Workshop on Cyberinfrastructure
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Minneapolis and Saint Paul

CLEANER

Collaborative **L**arge-scale ***E**ngineering*
***A**nalysis **N**etwork* for **E**nvironmental **R**esearch

An initiative of the Environmental Engineering Program in NSF's Engineering Division

CLEANER (*click hyperlink to learn details about CLEANER*) **will be a networked infrastructure of environmental field facilities to enable formulation and development of engineering and policy options for restoring and protecting environmental resources.**

see http://cleaner.ce.berkeley.edu

ELEMENTS OF CL*EAM*ER

1. A **network** of highly instrumented field facilities
   for acquisition and analysis of environmental data

2. A **virtual repository** of data and information technology
   for engineering modeling, analysis and visualization of data,
   i.e. an **environmental cyberinfrastructure**

3. A mechanism for multi-disciplinary research and education
   to exploit instrumented sites and networked information; formulate engineering and policy options to protect, remediate, and restore stressed environments and promote sustainable environmental resources

4. A **collaboration**
   among engineers, natural and social scientists, educators, policy makers, industry, NGOs, the public, and other stakeholders

CLEANER Workshop 1:

Stanford University, December 2001

Defining the concept of CLEANER

CLEANER Workshop 2: (*click hyperlink for workshop report and agenda, which is linked to workshop presentations*)

University of Minnesota, October 2002

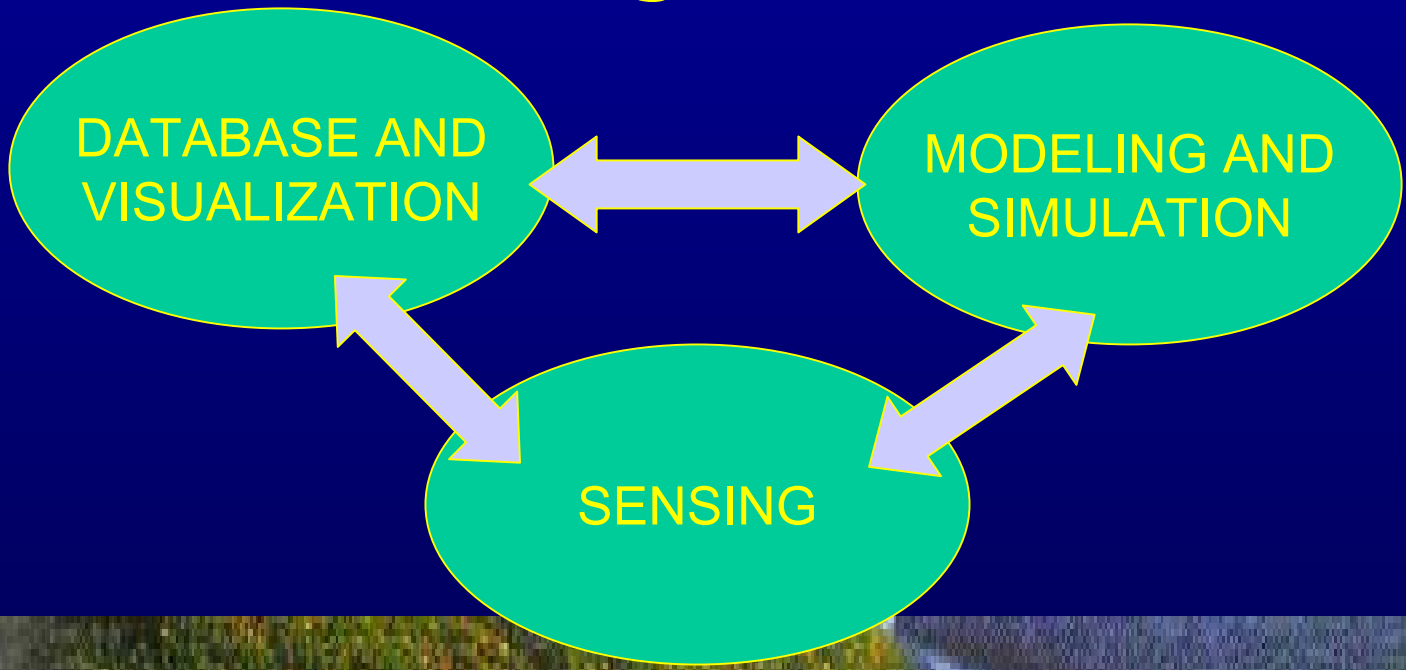
Defining the concept of environmental field facilities (EFFs); sensor development; and cyberinfrastructure

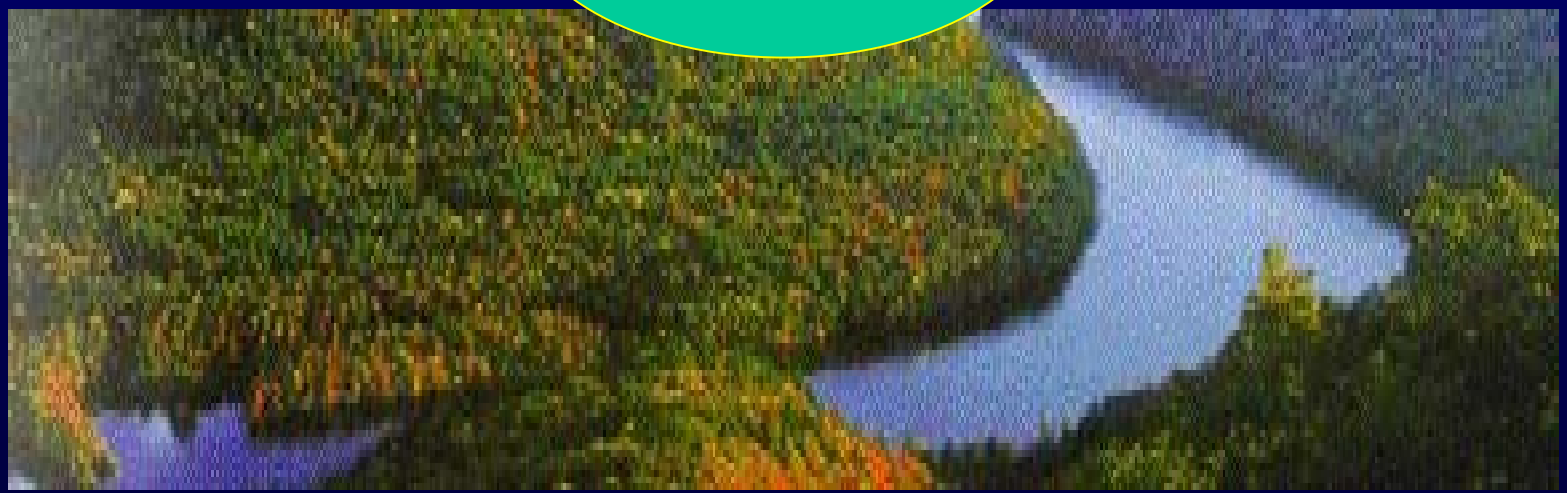
CLEANER Workshop 3:

Duke University, February 2003

Developing ideas for environmental field facilities, cyberinfrastructure needs, and engineering analysis networks

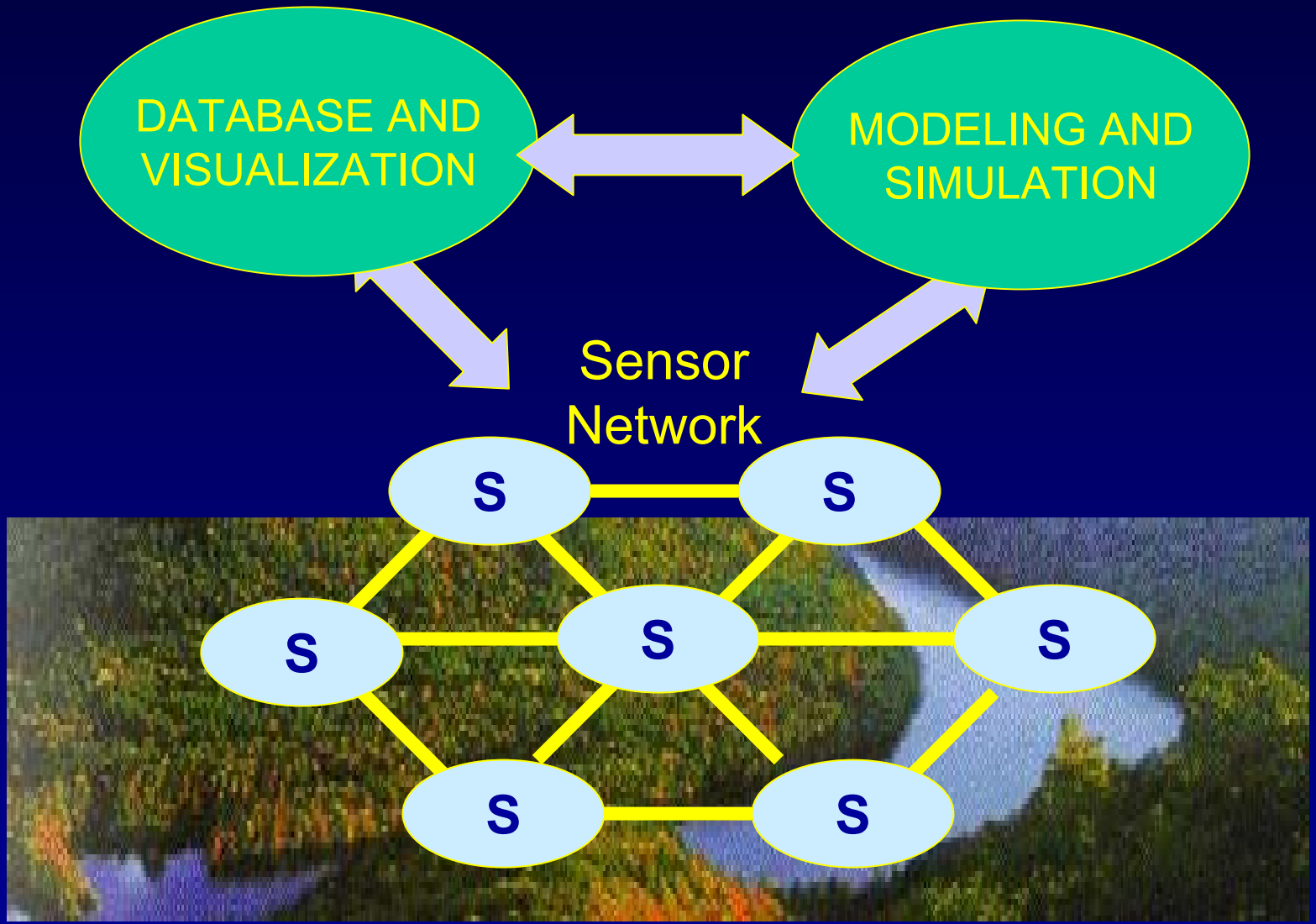
Three elements of environmental monitoring in CL*EAM*ER





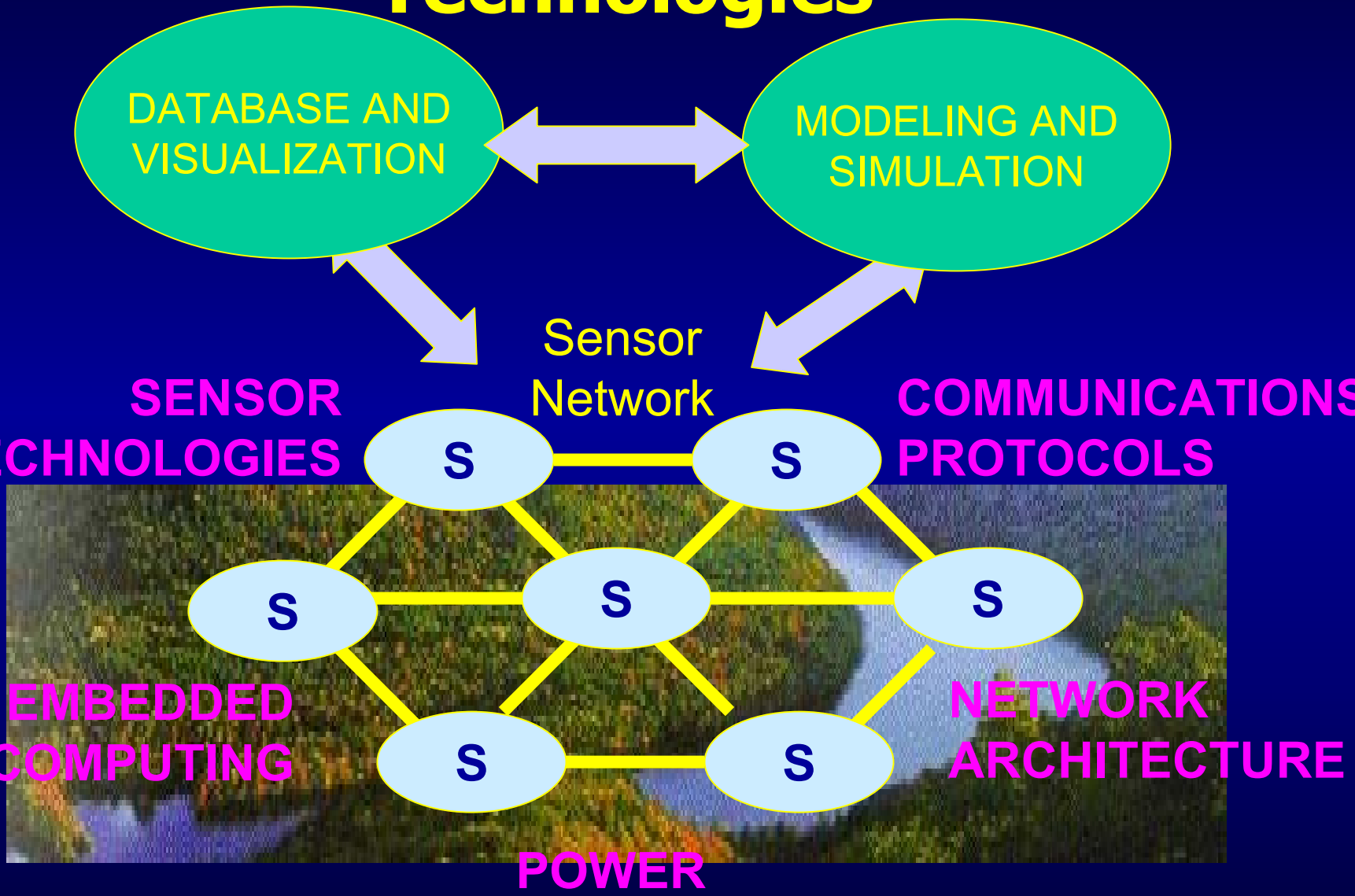
Adapted from Art Sanderson, RPI

Distributed Sensor Nets



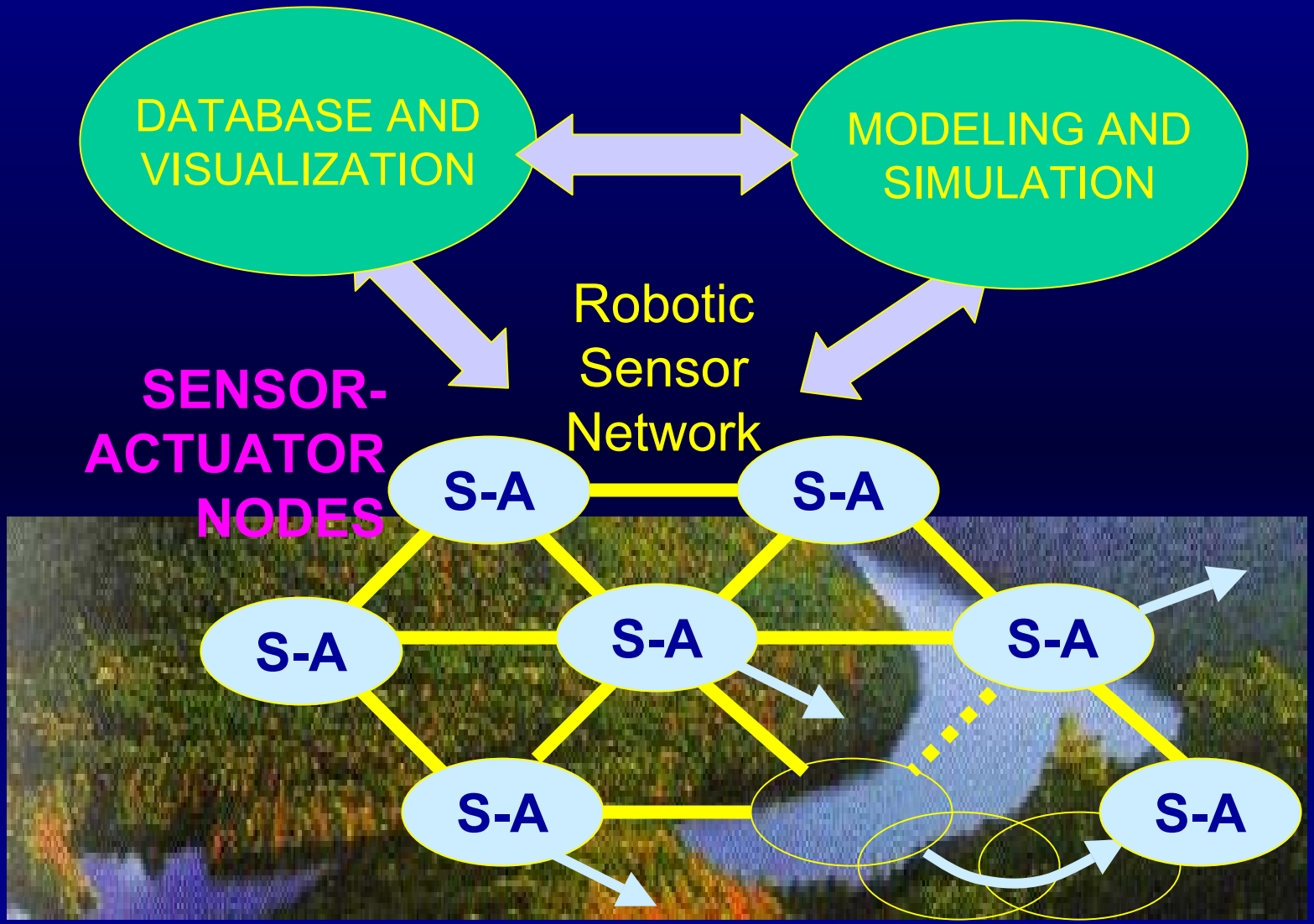
Adapted from Art Sanderson, RPI

Distributed Sensor Net Technologies



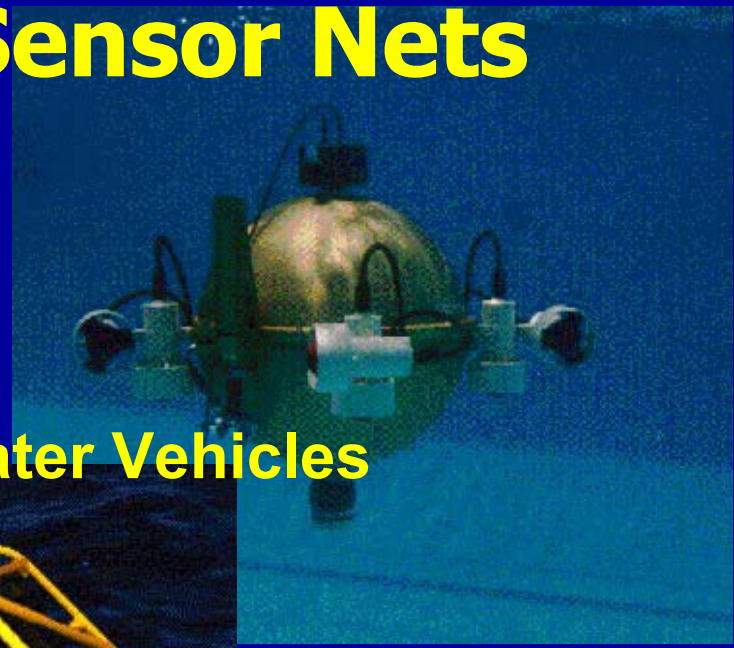
Adapted from Art Sanderson, RPI

Distributed Robotic Sensor Nets



Adapted from Art Sanderson, RPI

Distributed Robotic Sensor Nets



Autonomous Underwater Vehicles

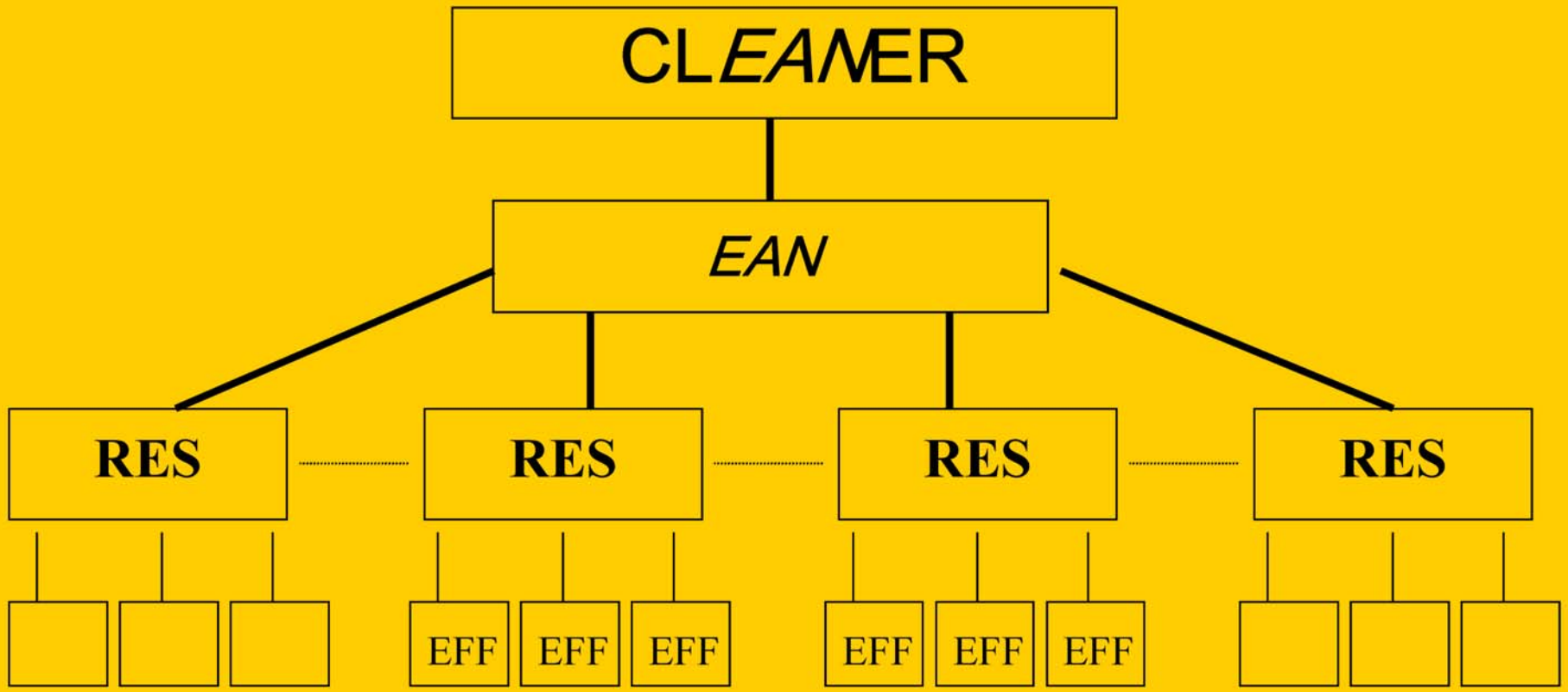
Photos courtesy of Art Sanderson, RPI

Key Technologies – Devices and Hardware

- Integrated Sensor Microsystems
  - Systems on a chip
  - Specific chemical and physical sensitivity
- Pervasive Computing
  - Local processing
  - Signal compression
  - Low power
- Wireless Communications
  - Transmitter, Receivers, Protocols
  - Electromagnetic, Ultrasound
- Node Mobility and Robotics
  - Locomotion principles – land, water, air
  - Degrees of freedom
  - Power

Adapted from Art Sanderson, RPI

CL*EAN*ER Research Structure



EAN=*E*ngineering *A*nalysis *N*etwork
RES = Regional Environmental Systems
EFF = Environmental Field Facilities

Courtesy of P. Goodwin and O. Loucks

LARGE-SCALE ENVIRONMENTAL CHALLENGES: THE ENGINEERING APPROACH

Objectives for an Engineering Analysis Network (*EAN*):

- **Pursue a synthesis** of the knowledge base on anthropogenically-stressed, large-scale, geographically-distributed, but interdependent systems/regions (RES).
- Foster and exploit new developments in information sensing, imaging, transmission, storage, processing, and visualization.
- Quantify fluxes of materials and energy changed due to anthropogenic impacts over time **at a cross-regional scale**.
- Identify hierarchies (scale and complexity) of environmental systems and their linkages through integrated assessment models for engineering implementation.

Cyberinfrastructure Issues for CL*EAN*ER

Needs

- Close, real-time collaboration among engineers/scientists at different locations (EFFs, RESs, the EAN): key to the vision and success of CLEANER

- Easy access to numerous, large and and very diverse types of databases

- Simple to use: environmental engineers/scientists have low "pain threshold" regarding the cyber learning curve

- Some high-end computing needs for large-scale models and molecular-scale calculations

Analogy to NEES

Data issues for CLEANER are similar to those articulated for NEES in the presentation by Cherri Pancake. If anything, the data issues in CLEANER will be even more complicated because of the very high diversity of types of environmental data CLEANER engineers will use.

Environmental data to be used in CLEANER are characterized by very high diversity with respect to:

- **spatial scales**: from molecular to global

- **temporal scales**: from sub-second to decades (or longer)

- **types of sensors used to obtain data**: from nano- and micro-scale to large-scale satellite sensors

- **types of variables**: physical, chemical, all kinds of biological, including non-numeric information

- **storage sites and owners**: government agencies at all levels, universities, private entities; numerous "grey databases" (not easily found/accessed); analogous to the "grey literature"

Frontiers in Assessment Methods for the Environment (FAME)

(*click to visit FAME Web site and learn details about the symposium*)

A symposium sponsored by the Association of Environmental Engineering and Science Professors with financial support from NSF

Minneapolis, August 10-13, 2003

FAME SYMPOSIUM TENTATIVE SCHEDULE

MONDAY, August 11

Opening Session

Chris Maziar: *Welcome*

Margaret Leinen: *NSF's vision for 21st century environmental research*

Sensor sessions:

Joe Hartman: *Low energy chemical sensors for ground-water contaminants*

Cliff Ho: *Solid-state electrometric chemical sensors*

Judith Erb: *Fiber optics bio-sensors*

Babak Ziaie: *MEMS technology*

John Kelly: *PCR on a chip;* Erdogan Gulari; *Proteomics on a chip*

Patrick Brezonik: *Remote sensing by satellite imagery*

Hans Paerl: *Airborne hyperspectral remote sensing*

Tonya Clayton: *Airborne lidar for aquatic investigations*

In situ Instruments, Arrays, Profilers

Ken Johnson: *In situ optical instruments for coastal contaminants*

Sally MacIntyre: *Measuring turbulence across spatial scales*

Bill Flanery: *In situ chemical and biological monitors*

Ron Calhoun: *Measuring aerosol properties by lidar and aerosol mass spectrometry*

Steve Oncley: *Atmospheric instrumentation*

Poster session

TUESDAY, August 12

Opening session

Ken Reckhow: *Preparing for a new era of environmental engineering research*

Modeling

Dominic DiToro: *Linked hydrodynamic/chemical-biological process models*
Bernard Engel: *Distributed watershed models*
Pete Loucks: *Ecological response – habitat models*
Don Mackay: *Organic chemical – fate/transport*
Christine Shoemaker: *Uncertainty analysis in modeling*
Joe Fernando: *Atmospheric transport models*

Cyberinfrastructure

Gary Olson: *Overview*
Robert Edson: *Web portals*
Barbara Minsker and Tom Prudhomme: *D2K: data to knowledge via cyberinfrastructure*

Education/Curriculum

Jim Bonner: *Coordinated research and education program*
George Host: *WOW and RUSS*
Andria Costello: *Field-based environmental engineering education in the Adirondacks*

Poster Session

WEDNESDAY, August 13

Examples of large-scale projects

William Boicourt: *In situ arrays in the Chesapeake Bay*
Jim Hurley: *METAALICUS*
Paul Capel: *Vision for a 21st century NAWQA*
Peter Adriaens: *A groundwater contamination field site*

Applications of CLEANER Concept to Solve Problems

Jon Fink: *Example of an urban EFF*
Jeff Peirce: *Example of a watershed-estuary EFF*
Ron Regal: *A process for representative site selection*
Orie Loucks: *Engineering Analysis Network – a key component of CLEANER*
Dick Luthy, *Jerry Schnoor, Joan Rose, Nick Clesceri,* ***closing Panel***