

# **Emerging scientific and design issues for wireless mobile learning: *A time for collective intelligence and action***

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## *and Challenge Problems* Technologies for

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blems: *Criteria*

blems: *Candidates*

and closing comments

# Grand Challenge Problems: History

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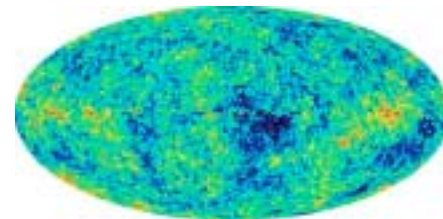
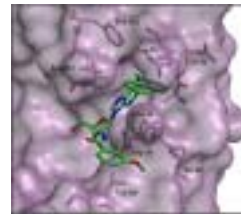
- *A **grand challenge** defines a commitment by a scientific community to work together towards a common goal, considered to be valuable and achievable within a predicted timescale.*
- **Hilbert's** 1900 address to International Congress of Mathematicians on 23 major mathematical problems to be studied for the next century
- **“Grand Challenges”**: major problems of science and society whose solutions require 1000-fold or greater increases in the power and speed of supercomputers and their supporting networks, storage systems, software and virtual environments
  - *High Performance Computing and Communications Program (HPCC, started 1991)*



Larry Smarr, NCSA  
Director, c. 1989

# Grand Challenge Problems: Computing

- HPCC defined Grand Challenges as fundamental problems in science and engineering, with broad economic and scientific impact, whose solutions can be advanced by applying high performance computing techniques and resources, especially simulation, e.g.
  - Environmental modeling and prediction
  - Analyzing fuel combustion
  - Rational design of drugs
  - Aircraft design
  - Mapping the origin of structure of the universe



# Grand Challenge Problems: Environment

- **2001: National Academy Press** publishes *Grand Challenges in Environmental Sciences* to identify high-priority environmental science projects for the next generation: “areas of opportunity that—with a concerted investment—could yield significant new findings.”
- Nominations for environmental science “grand” challenges solicited from thousands of scientists worldwide



**Eight grand challenges were defined; the first four are recommended for most immediate research investment and attention**

- **Biological Diversity and Ecosystem Functioning**
- **Hydrologic Forecasting**
- **Infectious Disease and the Environment**
- **Land-Use Dynamics**
- **Biogeochemical Cycles**
- **Climate Variability**
- **Institutions and Resource Use**
- **Reinventing the Use of Materials**

# Grand Challenge Problems: Health



- January 2003: World Economic Forum, Bill Gates announced a \$200 million grant to establish the Grand Challenges in Global Health initiative, a major new effort and partnership with the National Institutes of Health (NIH).
- The initiative will “identify critical scientific challenges in global health and increase research on diseases that cause millions of deaths in the developing world.”
- Today only 10 percent of medical research is devoted to the diseases that cause 90 percent of the health burden in the world.

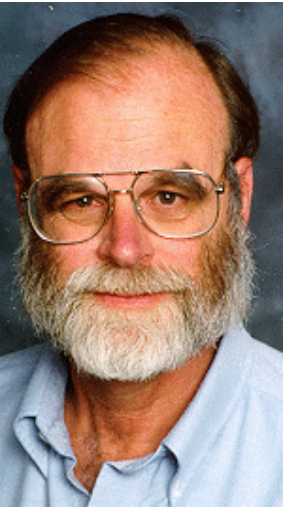
# Grand Challenge Problems: WMTE?

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- ***Much is different*** about grand challenges in education and learning using WMT than advanced computing, environment, and health, e.g.
  - Education is a *normative* enterprise, with very *diverse standards* across the USA and globally.
  - Fragmented researchers and knowledge, rare “collaboratory” arrangements for collective intelligence and action.
- ***Yet much is the same*** for WMTE:
  - We need *specialized forms* of the GCPs developed for computing research.
  - And perhaps very unique ones of our own—at the intersection of wireless mobile computing and communications, learning sciences, and education.

# G4P Criteria: Jim Gray's Turing Address

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*Jim Gray:  
Director,  
Microsoft  
Research Lab,  
San Francisco*

- ***Understandable.***
  - Goal is simple to state. Helps recruit colleagues, support.
- ***Challenging.***
  - Should not be obvious how to achieve the goal - which has often been around for a long time. Some may believe goal is impossible.
- ***Useful.***
  - If the goal is achieved, the results should be clearly useful to many people at large.
- ***Testable.***
  - Solutions should have a simple test so that one can measure progress - one can tell when the goal is achieved.
- ***Incremental.***
  - Very desirable that the goal has intermediate milestones so that progress can be measured along the way. Keeps most researchers going.

# GCP Criteria: UK Computing Research

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- ***Impact.***
  - Will its promotion as Grand Challenge contribute to long term benefits to science, industry and society? Is it supported by the established scientific community? Does it appeal to the general public's imagination?
- ***Timeliness.***
  - When first proposed as a challenge and why so difficult? Why is it now expected feasible within 10-15 years?
- ***Significance.***
  - Driven by scientific curiosity? Promising a profound shift in thinking?
- ***Scale.***
  - Does it have international scope?
- ***Metrics.***
  - Clear criterion for the success or failure of the project?
  - How does the project split into sub-phases with identifiable goals?

# WMTE Grand Challenge Problem Criteria

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1) ***Understandable, with Significance.***

Clearly stated compelling case for contributing to long term benefits for science, industry and society.

2) ***Challenging, and Timely.***

Hard problems within conceivable reach in 15-20 years with concerted coordinated efforts.

3) ***Clearly useful, in terms of Impact and Scale, if problem is solved.***

Contributes to long term benefits for many people at large, and with international scope.

4) ***Metrics: Testable and Incremental.***

Can measure progress, incremental milestones.

# John Gray's Turing Address. GCPS (1 of 2)

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1. **Scalability:** Devise a SW and HW architecture that scales up by a factor of  $10^6$
2. **Turing Test:** Build a computer system that wins the imitation game at least 30% of the time.
3. **Speech to text:** Hear as well as a native speaker.
4. **Text to speech:** Speak as well as a native speaker.
5. **See as well as a person:** Recognize objects and motion.
6. **Personal memex:** Record everything a person sees and hears, quickly retrieve any item on request.
7. **World memex:** Build a system that, given a text corpus, can answer questions about the text and summarize the text as precisely and quickly as a human expert in the field. Do the same for music, images, art and cinema.

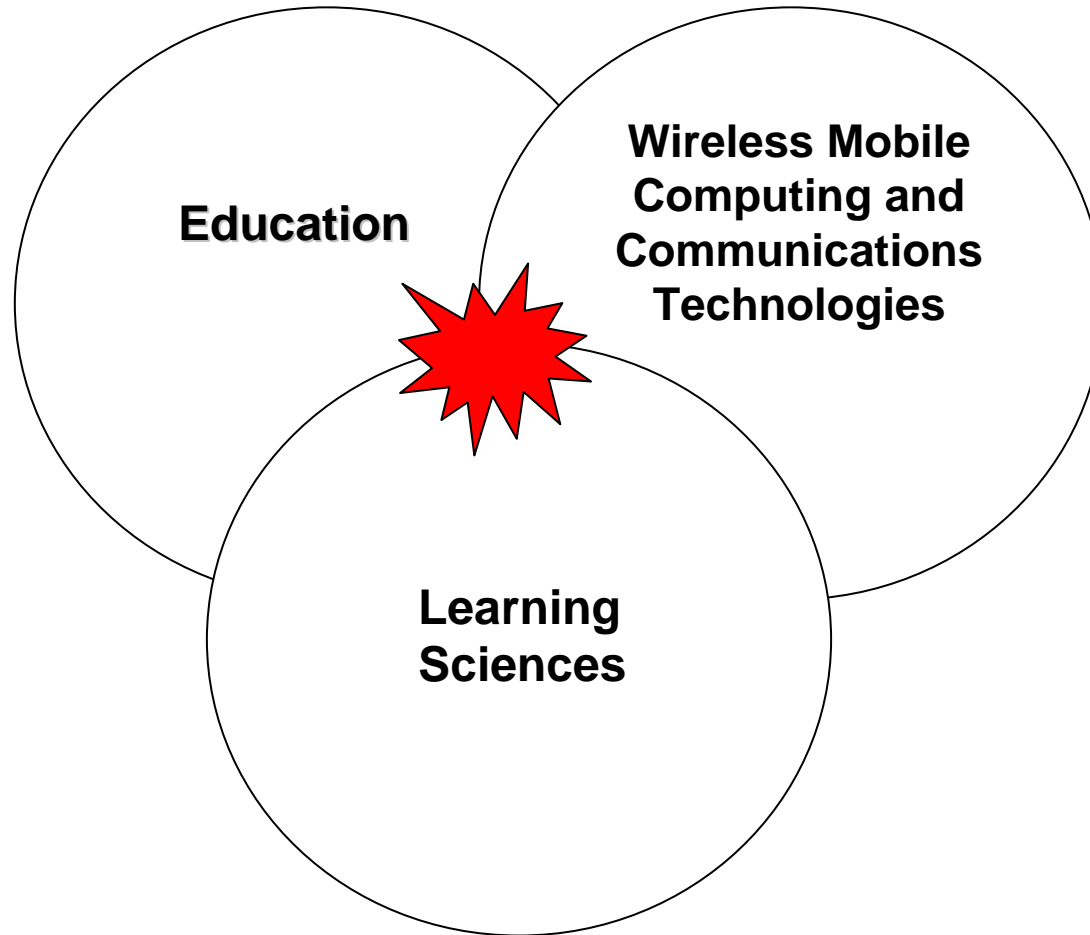
# Jim Gray's Turing Address: GCPS (2 of 2)

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- 8. *Telepresence:*** Simulate being some other place retrospectively as an observer (teleobserver): hear and see as well as being there, and as well as a participant. Simulate being some other place as a participant (telepresent): interacting with others and the environment as though you are actually there.
- 9. *Trouble-free systems:*** Build a system used by millions of people each day and yet administered and managed by a single part-time person.
- 10. *Secure system:*** Assure that the system of problem 9 services only authorized users, service cannot be denied by unauthorized users, and information cannot be stolen (and prove it).
- 11. *AlwaysUp:*** Assure that the system is unavailable for less than one second per hundred years—eight 9's of availability (and prove it).
- 12. *Automatic programmer:*** Devise a specification language or user interface that: makes it easy for people to express designs (1000x easier), computers can compile, and can describe all applications (is complete).

# WMTE Grand Challenges at the Intersect

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# WMTE Grand Challenges: Candidates (1 of 3)

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- 1. Developmentally-Relevant Learning Support:** Provide real-time access for any learner—whatever their current developmental capabilities or interests—to relevant WMTE support that can guide them toward meeting any learning standard. For any desired performance competency, configure in real time a distributed learning system that will identify requisite learning resources and, if needed, peers or mentors with verifiable reputations to help one attain such competencies in a certifiable manner.
- 2. Systems for Learning Performance Certification and Reputation Management** on a global scale, to truly enable distributed learning that can leverage distributed expertise, and make possible goal-directed mobile learning outside classrooms, as well as scenarios such as “learning cooperatives,” in which learners, tutors and teachers can broker needs and services via WMTE.

# WMTE Grand Challenges: Candidates (2 of 3)

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- 3. Tacit Interest Analysis:** Diagnose a learner's interests from digital capture of what they read, talk about, and attend to, so as to automatically create an interest profile that can be used for compiling engaging content and scenarios for their pursuit of learning goals using WMTE. Appropriate privacy safeguards.
- 4. Language-to-Language Translation Capabilities** that are compellingly useful for multilingual learning interchanges between learners and mentors, or for access to learning resources, using WMTE.
- 5. Lifelong Digital Learning Portfolios** for easy WMTE management of all information media developed by a learner over a lifetime, in a manner that is usefully indexed for one's reflective learning and certification purposes.

# WMTE Grand Challenges: Candidates (3 of 3)

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6. **'Reflexive' WMTE systems** that are able to report on their own behavior, with purposes such as diagnosing whether they are meeting desired performance criteria.
  
7. **“World-Board”-like RF information-tagging of the physical environment** to enable location-specific ubiquitous opportunistic learning with wireless nomadic technologies.
  
8. **Simulating learning with WMTE systems.** Develop more effective learning support conditions by simulating learners in multi-agent social simulations. Examine the probable success in achieving specific learning outcomes under different designs of WMTE learning interactions (e.g., teacher-led vs. small-group; same or mixed-ability groups; levels of challenge, interest, background knowledge). Use new knowledge to address other Grand Challenge Problems.



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in the process of defining  
problems (GCPs).

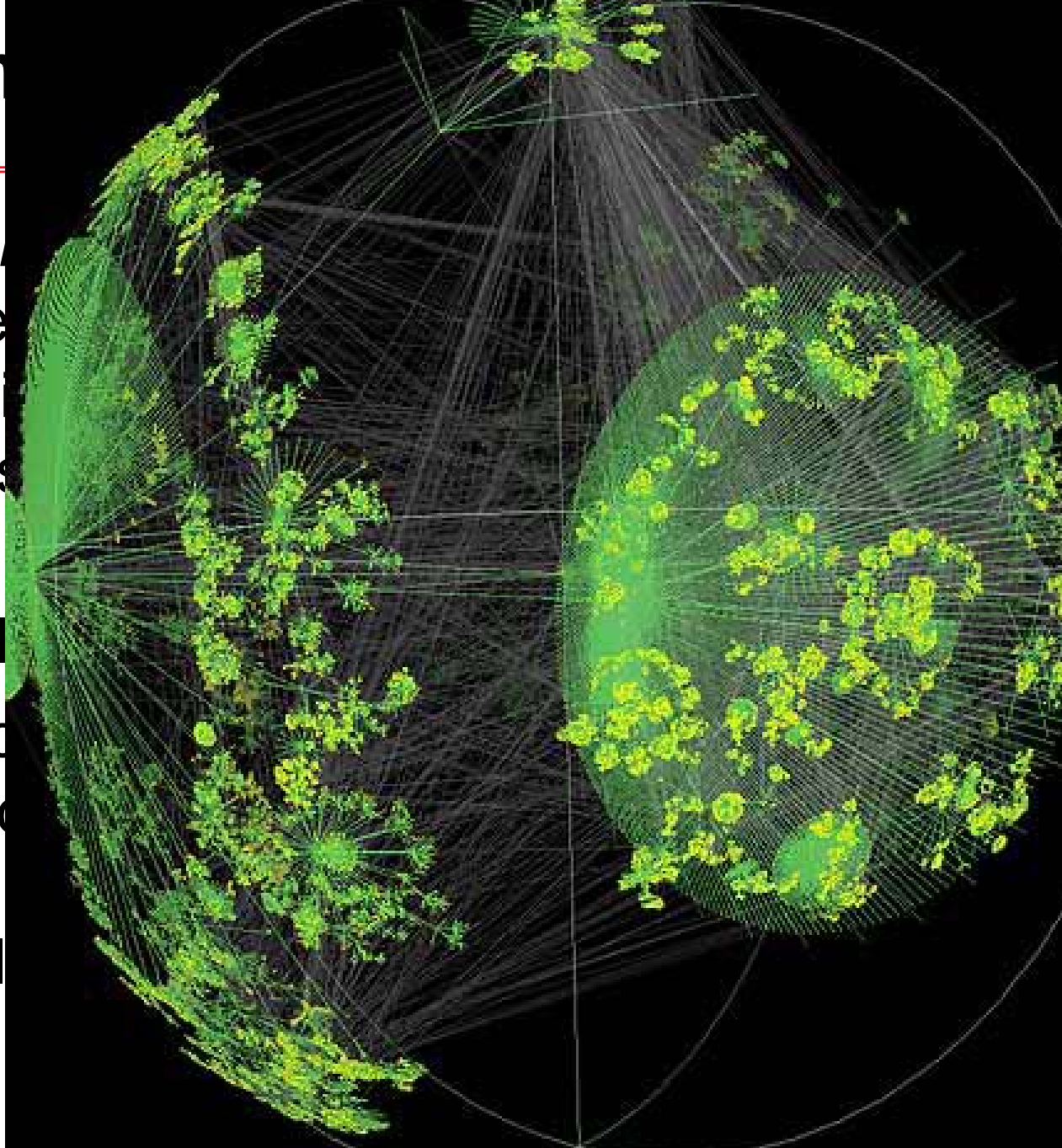
the (2002) model for  
GCPs for the WMTE field:

**GCPs were received,  
and vetted in a workshop  
'top 10'. Process underway...**

WMTE GCPs become a valid  
in long-term research  
in E sciences.

# Closing Con

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