

Telehealth in the United States



Arnauld E. Nicogossian, M.D.
Associate Administrator,
Office of Life & Microgravity Sciences and
Applications,
NASA

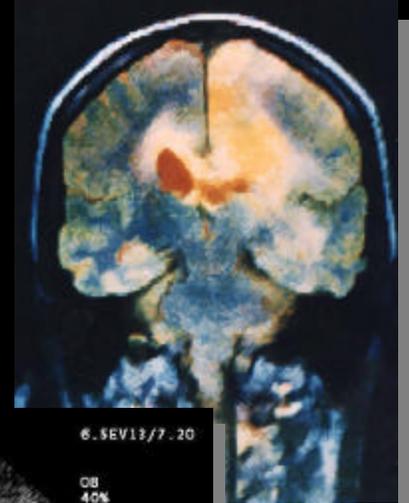
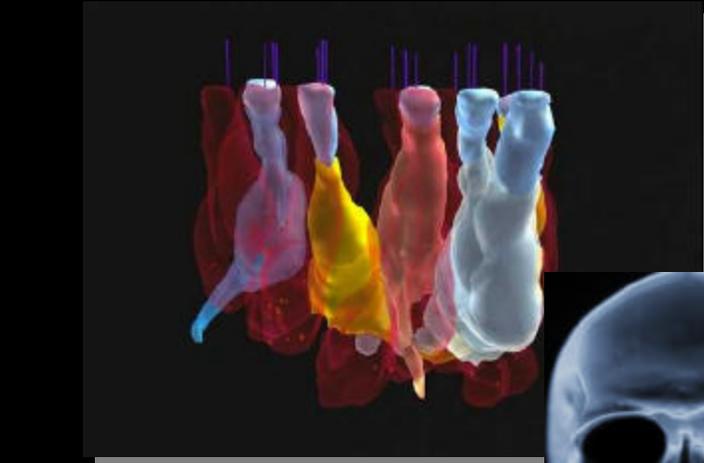


Contents

- What is telehealth?
 - Benefits of telehealth
 - Telehealth requirements
 - History of telehealth
- Telehealth in the United States
 - Civil sector
 - Department of Defense (DoD)
 - National Aeronautics and Space Administration (NASA)
- The future of telehealth and the U.S. space program

Benefits of Telehealth

Enhance traditional tools



Benefits of Telehealth



Minimize geographic inequality



Benefits of Telehealth



Enhance the quality of care



Benefits of Telehealth



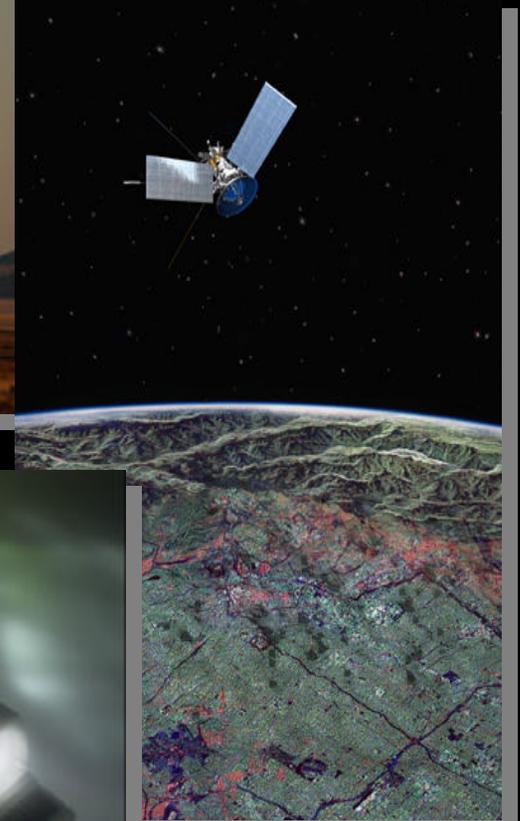
Contain expenditure/infrastructure cost



Telehealth Requirements

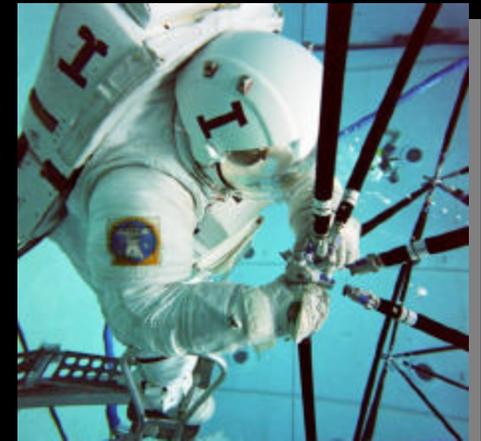
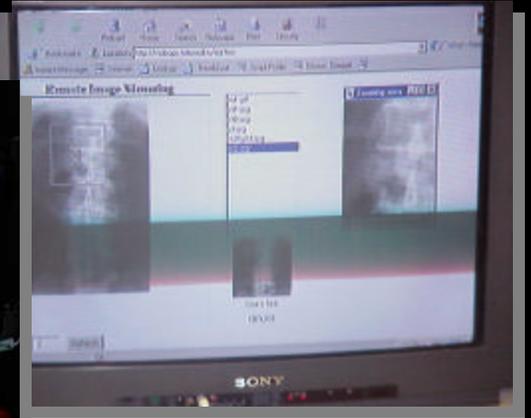


Telecommunications infrastructure



Telehealth Requirements

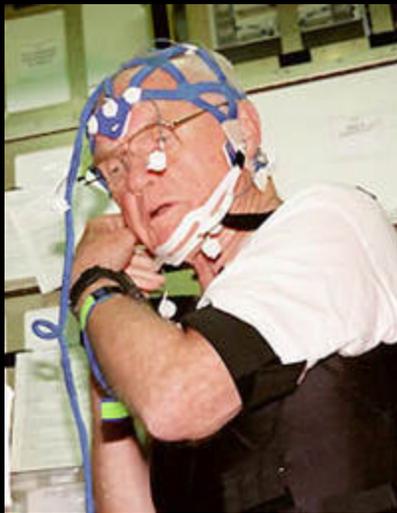
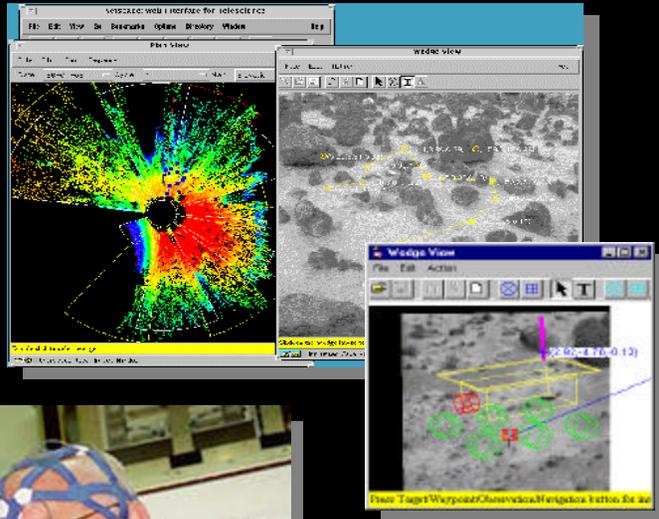
Capability

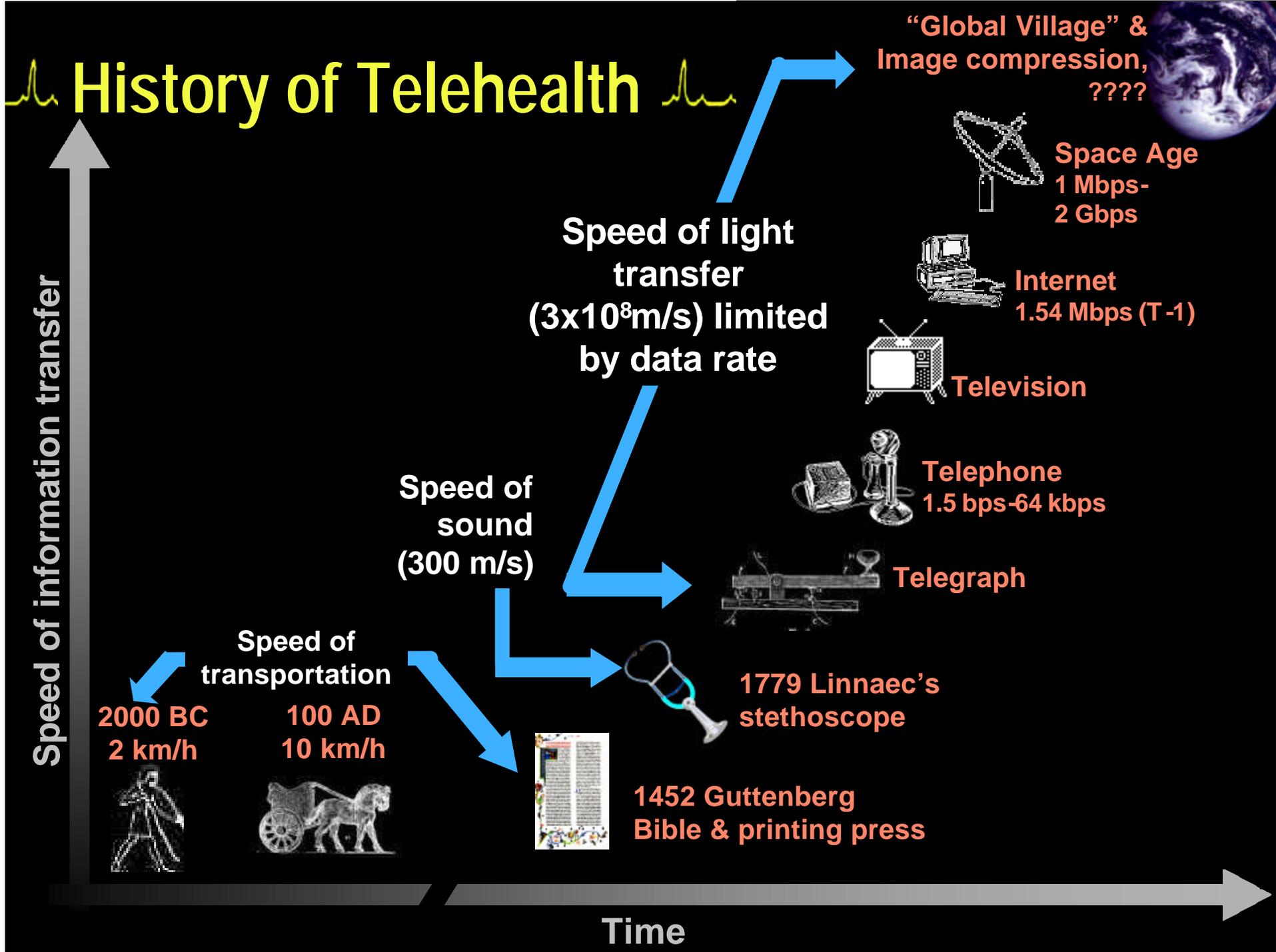


Telehealth Requirements

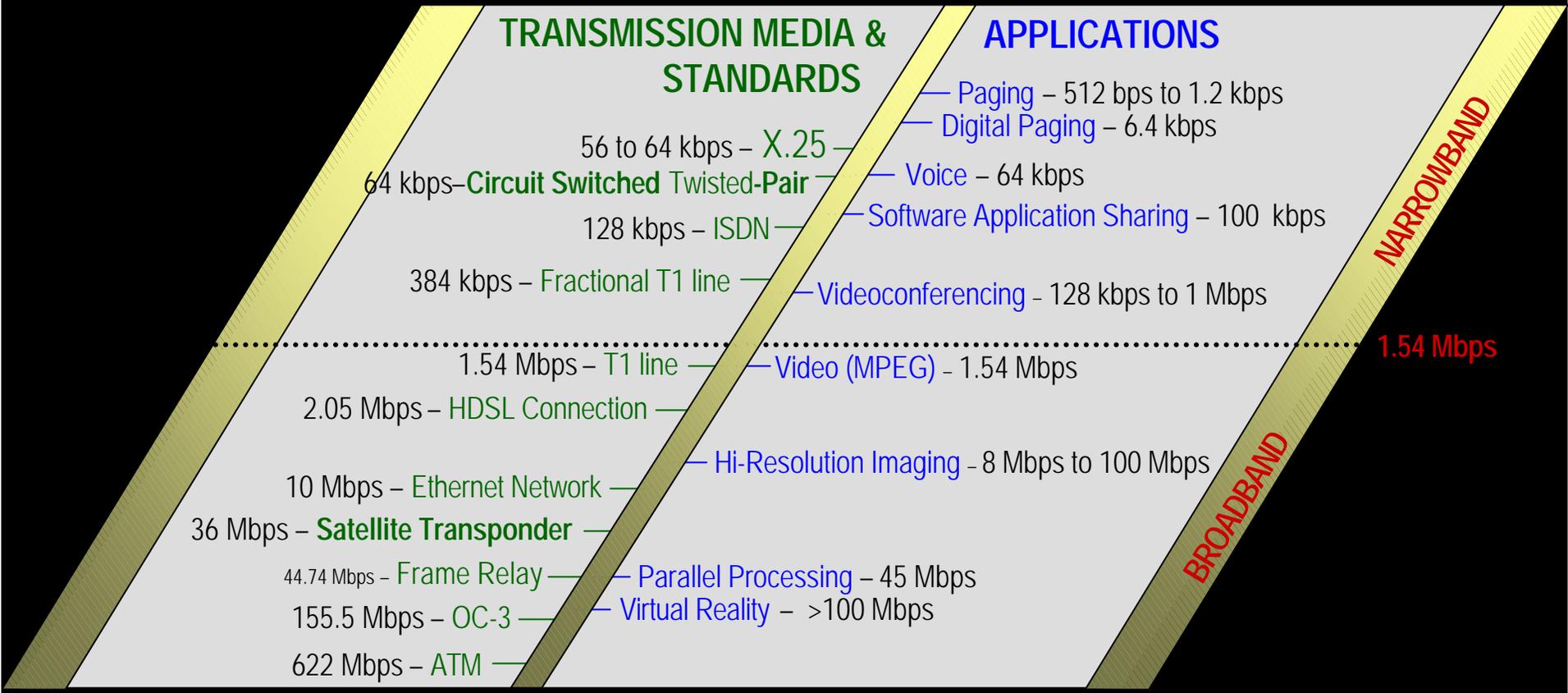


Applications





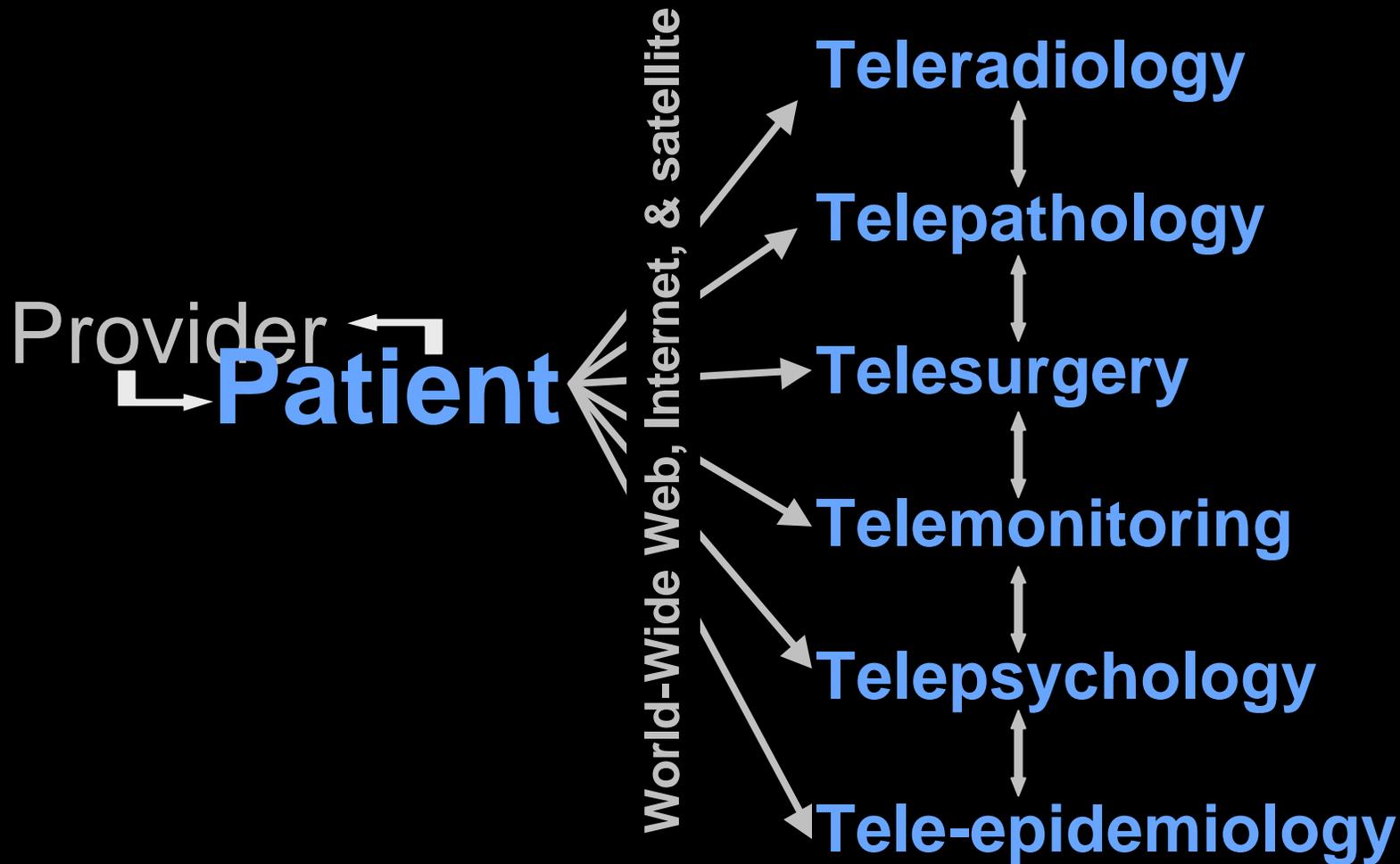
How Fast Can Data Move Today?



Note: Current spectral efficiency of satellites: 1 bps/Hz (36 MHz = 36 Mbps)

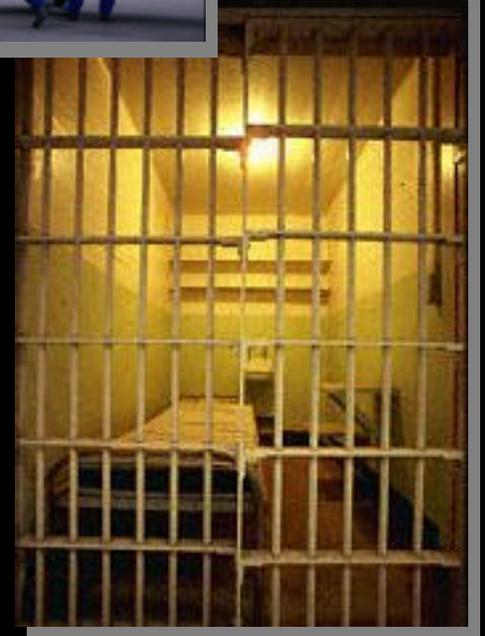
Telehealth

...moves bits, not patients.



U.S. Telehealth: the Civil Sector

- Applications
 - EMS/rescue
 - Education (including “Dot-Com” companies)
 - Teleimaging
 - Outpatient care (home-remote)
 - Maritime telecare
 - Prison telemedicine
 - Automated patient record systems
 - Disaster relief/humanitarian efforts
- Barriers
 - Security
 - Insurance reimbursement/liability
 - Medical licensure (across states)
 - Technology (bandwidth)



U.S. Telehealth: Dept. of Defense

- 1976: digital tooth
- 1985: digital x-rays
- 1990's: telepathology
- 1990's: teledermatology
- TATRIC (Army/NASA)
- Maritime telehealth (Navy)
- Deployments
 - Bosnia
 - Somalia
 - Persian Gulf
- Disaster relief



Lessons Learned from the DoD

- Telehealth requirements
 - Full-time support
 - Reliable, mobile, user-friendly communications
 - Easy coordination
 - Information security
- Future considerations
 - Changes in health care patterns
 - Medical business reengineering
 - New technology



NASA Telehealth



Initial NASA telehealth efforts monitored survivability in microgravity.



Today, all aspects of NASA telehealth--**communications, capabilities, and applications**--improve health care in space and on Earth.

NASA Communications Infrastructure

- **Ground-to-ground (testbeds)**

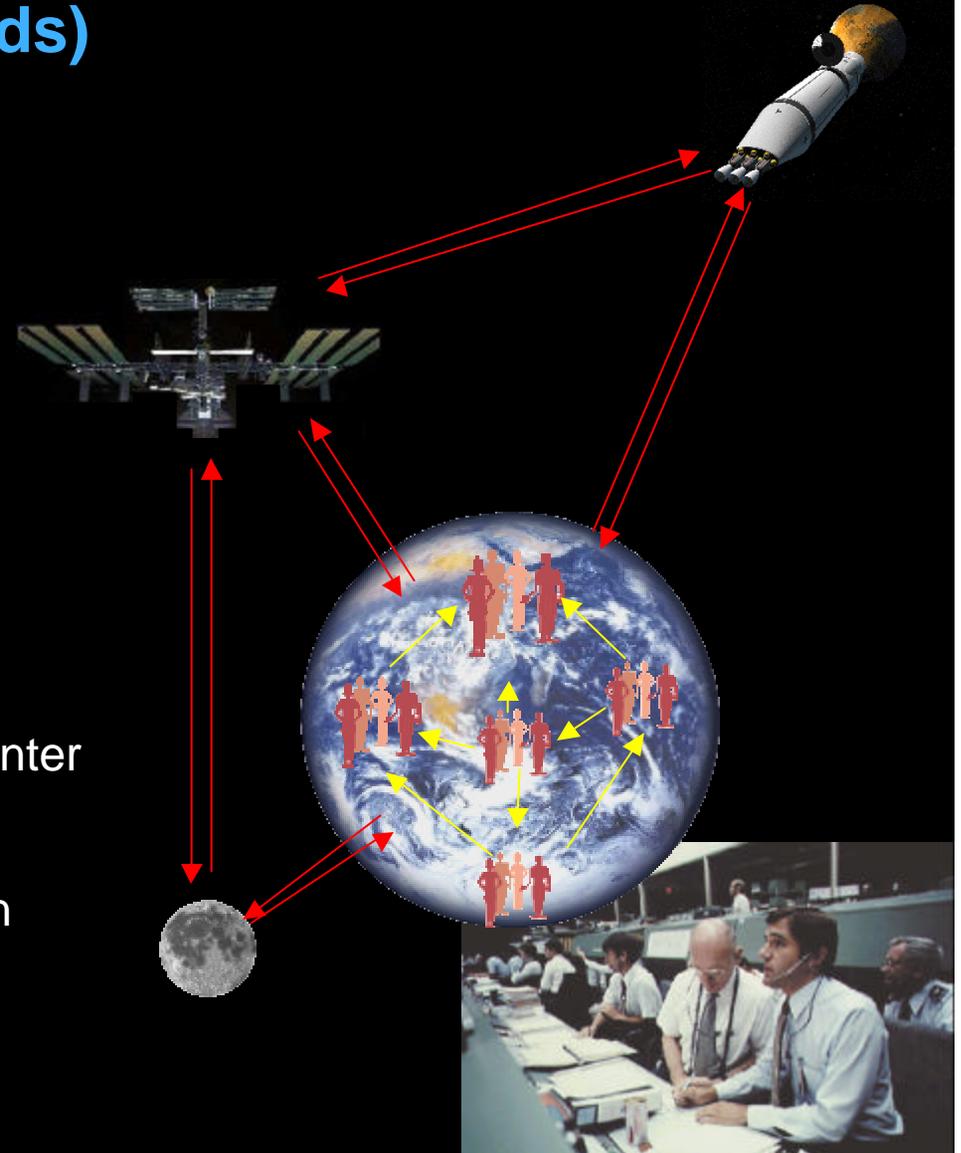
- Broadband

- Satellite-based
 - Higher quality, higher cost
 - Spacebridge to Moscow

- Narrowband

- 5 kbs-45 Mbs
 - T-1 line, store-and-forward
 - Good quality, lower cost
 - East-West Space Science Center
 - HQ education
 - December 1999 telesurgery in Ecuador (MITAC)

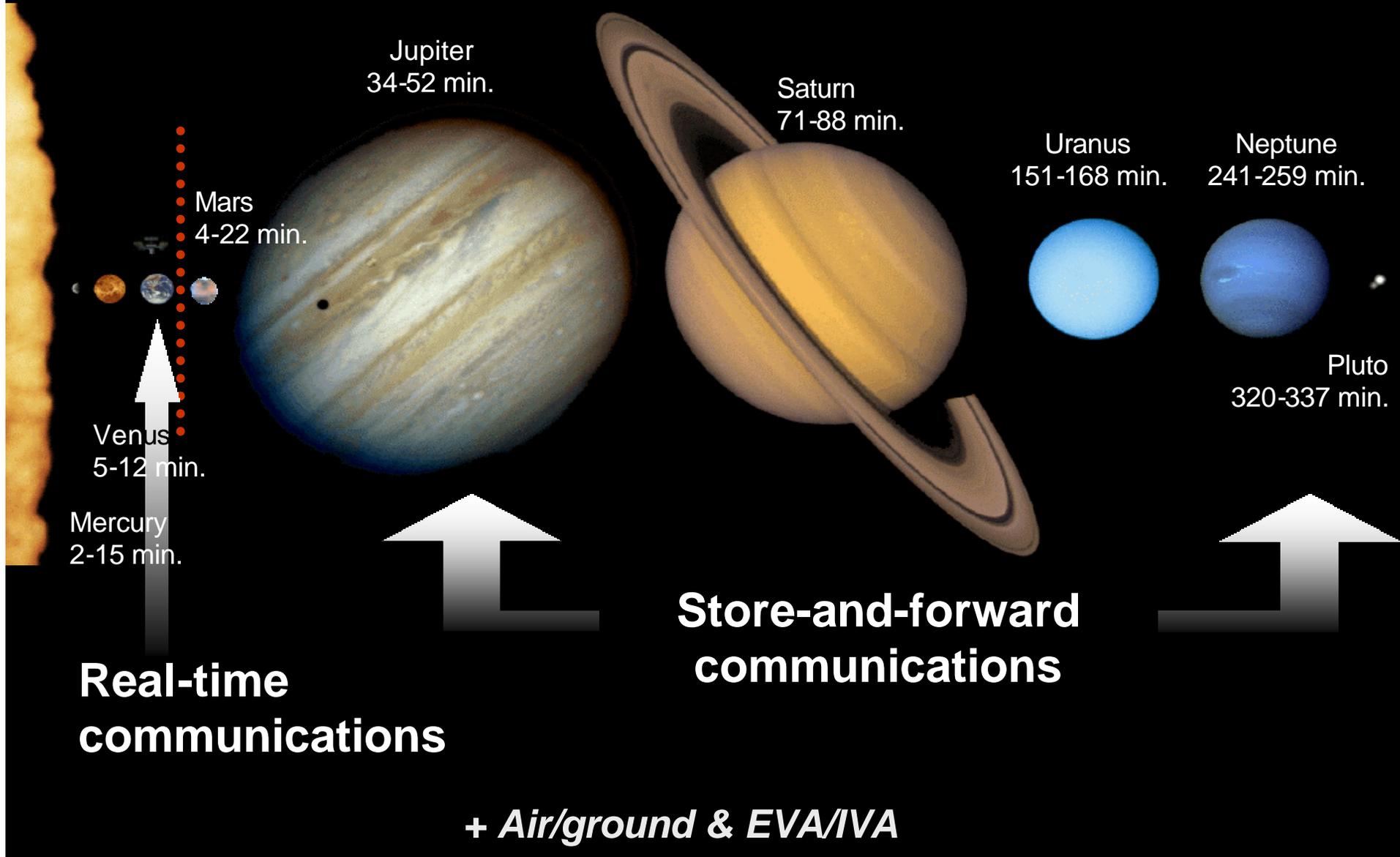
- **Ground-to-flight**



NASA Communications Infrastructure



NASA Communications Through Time & Space



NASA Capability: Care Criteria

- Ability to treat crew members and return them to duty
- Minimize impact on remainder of crew
- Provide for stabilization and evacuation
- Provide for crew safety
- Provide for remote consultation

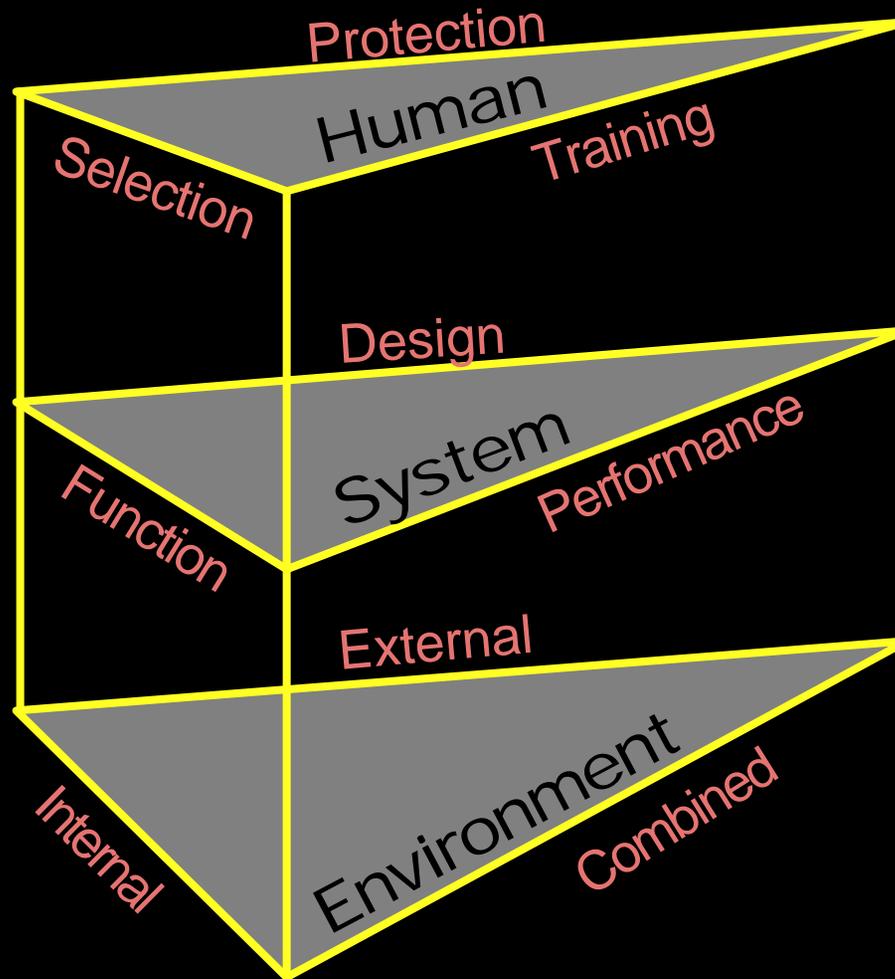
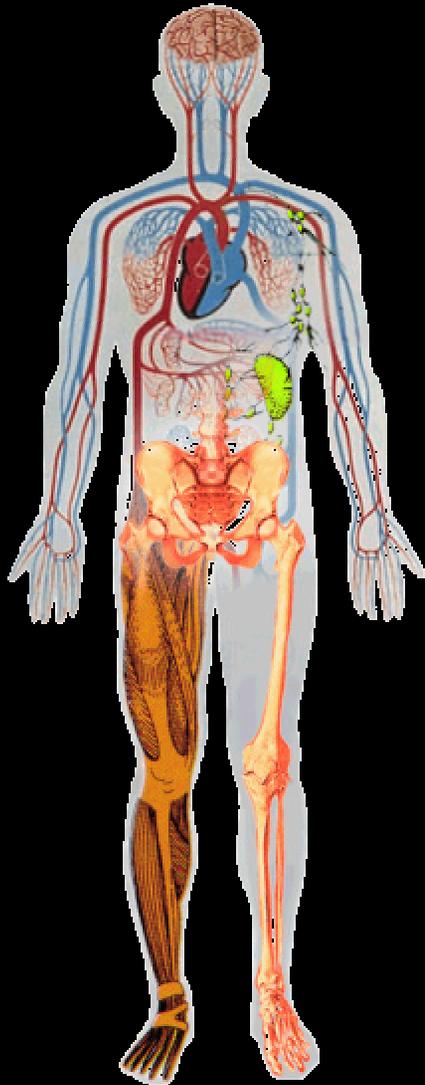


NASA Capability: Health Criteria

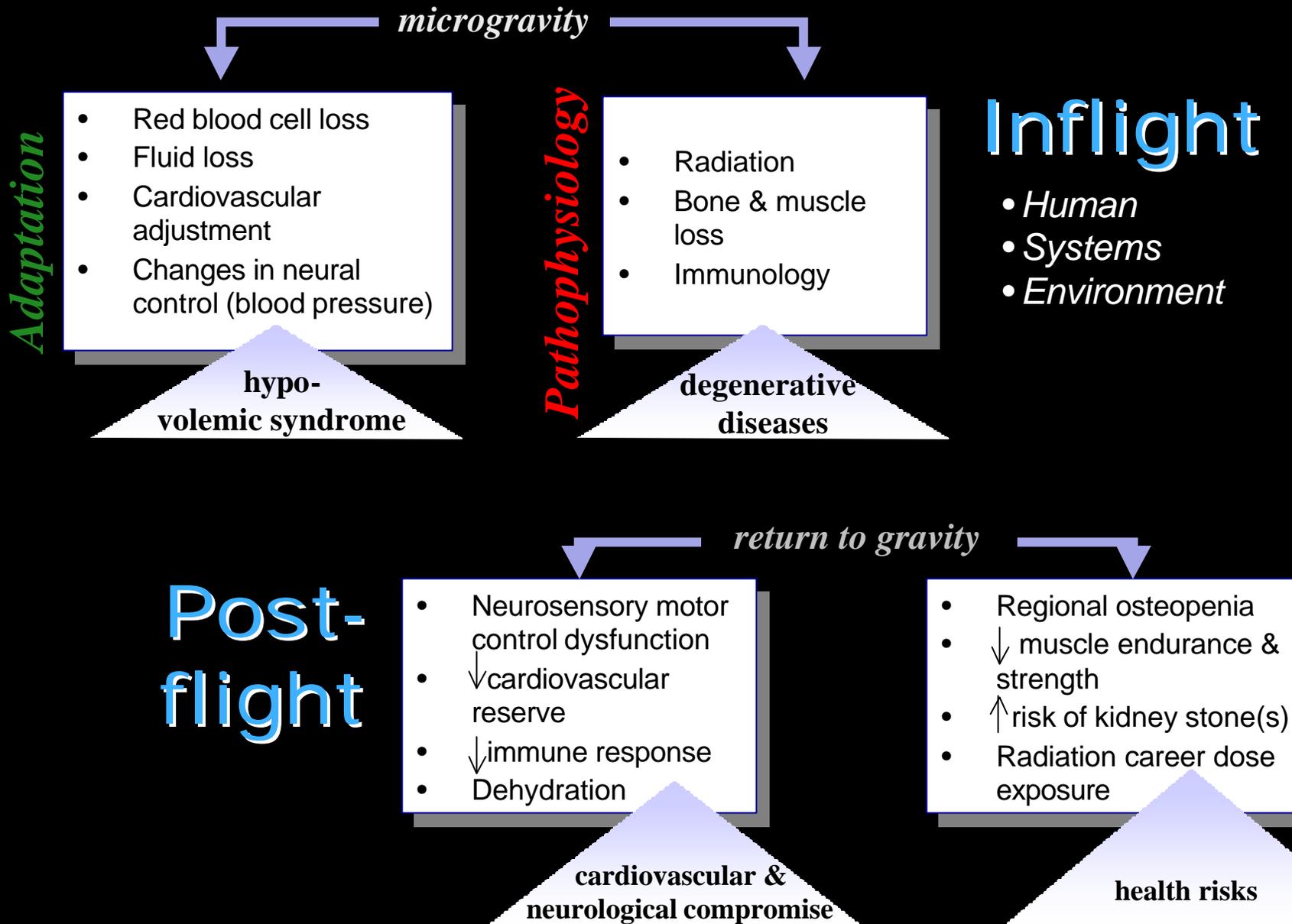
- Maintain health and well-being before, during, and after mission
- Ensure rapid re-adaptation to Earth's gravity



NASA Capability: Space Mission Infrastructure



NASA Capability: Health Care Models



NASA Telehealth Applications



- **1972-3**
 - ✓ STARPAHC
- **1975**
 - ✓ Applied Technology Satellite
 - ✓ COSPAS/SARSAT
 - ✓ PEACESAT



- **1985**
 - ✓ Mexico City earthquake
- **1989**
 - ✓ Spacebridge to Armenia/Ufa



- **1993**
 - ✓ ACTS demonstrations
 - ✓ Spacebridge to Moscow



- **1994**
 - ✓ GHNet (WHO/USAID)
 - ✓ Pan-American Health Organization (PAHO)
 - ✓ Spacebridge to Russia (through 1997)

✓ *completed*

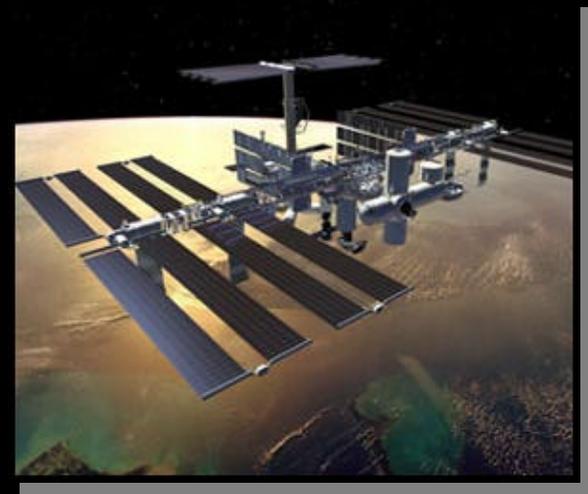
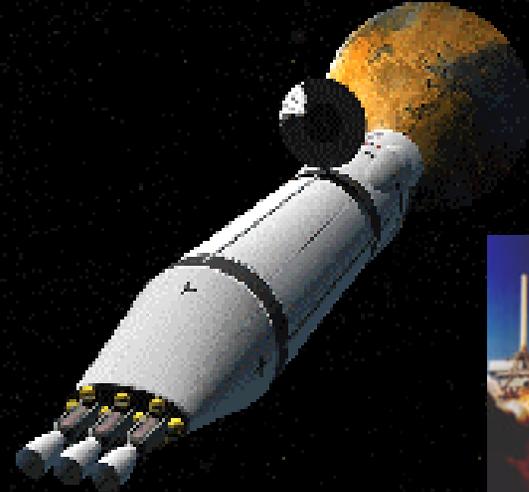
NASA Telehealth Applications

- **1995**
 - ✓ ARC telemed demo with Trident & Mt. Sinai Medical Center
- **1997**
 - NASA-MITAC established
 - East-West Space Science Training Center
- **1998**
 - ✓ Ecuador “keyhole” surgery
 - ✓ Everest Extreme Expedition I
- **1999**
 - ✓ Virtual Hospital demo with ARC, Stanford, Salinas
 - ✓ Everest Extreme Expedition II
 - ✓ TIP demonstration in Texas and Montana
- **2000**
 - Low-bandwidth telemonitoring in Ecuador
 - Low bandwidth telemonitoring in Dominican Republic
 - Kosovo disaster response
 - Devon Island telemedicine



NASA Telehealth Applications

- 1961-1972
 - Monitoring
 - Automation
 - Minimal command
- 1981-present
 - Telemonitoring
 - Telescience
- 2000+
 - Telemonitoring
 - Telescience
 - Telecare
 - Teleimaging
 - Teleconsultation
 - Telediagnosis



A Comparison: Who Does What?

Teleradiology

Telecare/Telediagnosis

Telepathology

Telecardiology

Teledermatology

Tele-education

Teleconsultation

Telemonitoring

Humans

Systems

Environment

Telescience

Testbeds

	NASA	Civil Sector	DoD
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓	✓	✓
	✓		✓
	✓		
	✓		
	✓		
	✓		
	✓	✓	✓

Future of Telehealth & the U.S. Space Program

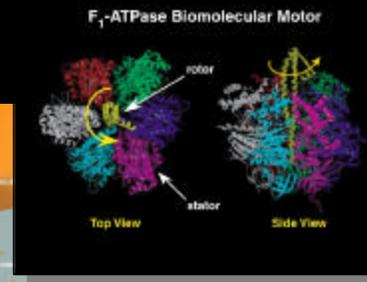
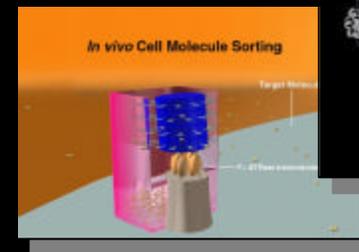
From **telecare** to **autonomy** and **teleconsult...**

- Adaptive Automation
- Multipurpose Tactile Interface
- Maintaining Spacecraft Operator Alertness
- Performance Measurement, Evaluation, and Modeling
- Non-Invasive Video Motion Capture of Astronaut Activity
- Cognitive Prostheses
- Biologically-Inspired Robots
- Manipulation & Locomotion
- Functionally-Adaptive Biomimetics
- Wireless Biosensor
- Medical informatics
- Smart/haptic systems



Hair cell sensors

Biomotors



Conclusion



1924



1969

2000+



The insight we have gained from U.S. telehealth, combined with tomorrow's nanotechnology and informatics, will allow NASA to send astronauts on safe, productive long-term explorations.



Backup

NASA's Health Criteria

Medical standards are tailored to meet the specific needs of each class: pilot (I), mission specialist (II), or payload specialist (III).

Evaluation approach

- Selection criteria
 - Medical history and physical
 - Lab & functional testing
- Retention criteria
 - Health maintenance
 - Acceptance of certain risks with changes

Areas of Emphasis

- Short-duration mission
 - Neurosensory
 - Neuromotor
 - Cardiovascular/ cardiopulmonary
 - Fluid & electrolyte
- All missions
 - Performance
 - Psychosocial suitability
 - Survival
- Long-duration mission
 - All short-duration concerns
 - Musculoskeletal
 - Radiation exposure
 - Metabolic/endocrine
 - Hematology/immunology