

# Potentially “Revolutionary” Space Applications

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# Space Applications improve life on Earth

**Transportation**

- Marine & land navigational services
- Rail management
- Stolen vehicle recovery
- Infrastructure planning
- Logistics management
- Freight security

**Environmental**

- Reforestation
- Watershed & vegetation management
- River basin management
- Urban planning

**Education**

- Distance learning
- Satellite-linked classrooms & schools
- Participatory "real-time science"

**Government**

- Flood & storm warnings
- Forest fire prevention
- Disaster management
- Public safety
- Crime control
- Urban planning

**National/Homeland Security**

- Intelligence communication & delivery systems
- Ground launch strike coordination

**Business/Telephony**

- Digital voice, fax & paging
- High-speed data transfers
- Satellite internet
- Videoconferencing

This is and will continue to be one of civilization's greatest success stories

# “Revolutionary” space applications are becoming commonplace

An advertisement for GTX Corp. featuring a woman walking with a dog and a suitcase. A satellite in space is shown with dotted lines connecting it to a mobile phone. The text reads: "GTX Corp. makes everything trackable! A signal is sent from the GTX transmitter to a satellite which sends the message to the internet-enabled device". A yellow speech bubble from the dog says "Don't lose me!". A yellow circle contains the text "\$3.2 MILLION spent in R&D!".

**GTX Corp. makes everything trackable!**

A signal is sent from the GTX transmitter to a satellite which sends the message to the internet-enabled device

Don't lose me!

**\$3.2 MILLION spent in R&D!**


An advertisement for the Thuraya SG-2520 satellite phone. It features a man in a suit talking on the phone. The phone is shown in the bottom left corner. The text reads: "Thuraya SG-2520 World's smartest satellite phone".

**Thuraya SG-2520**

World's smartest satellite phone




# Many new space applications are being developed




**Climate zones**

**California Climate Regions**

- California-specific climate drivers, – natural and human
- Regions not resolved by today's global models
- Californians understand their own concerns



**Water Regions and Rivers**



**California Air Districts**



**NEXT Communications Services**

	Now	NEXT
Core Voice and Data Services	300-500 Mbps with 50% latency	Bandwidth comparable to 10 Mbps services. Flexible prioritization and usage of resources
High Speed Data Services	1.5 Mbps 1.5 meter dish High cost, limited capacity	Enhanced and transparent services. Up to 10 Mbps
Private Network Subnetwork	High cost gateway Dish, Cable	Low cost gateway. In orbit, control of orbit and health. Shared infrastructure (SNA, NetSis)
Wide Area Broadcast Services	Feeding	Regional Broadcast. Bandwidth sharing
Subsolar Sail Equipment	Unusable Mission time limited	100-1000 km/s orbit for 100% integration

NEXT offers new high performance global services, enabling cost effective and flexible allocation of bandwidth to the user.

**Global Earth Observation System of Systems (GEOSS)**




**INTEGRATED**

Space-based Sensors, Earth-based Sensors, Earth-based Sensors

**Data Management System**

Information Services, Information Services, Information Services

**Ames Research Center**  
in Silicon Valley



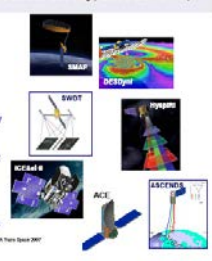
**Space based observations are critical to the stewardship of our home planet!**

**Thank You**

**Examples of Earth Science missions from NAS Decadal Survey, 2010-2016**

Future Active

- Cloud, and land use
- Vegetation, and
- Water/Ocean
- Clouds/Ecosystems



**TOMORROW**

Urban Transformation



Not the same thing as “spinoffs”

# Emerging space applications offer significantly improved products and services

- New mobile and broadband communications capabilities
- Improved remote sensing
- Next generation global navigation/locating
- New surveillance capabilities from space
- Improved weather applications
- New biotechnology and materials development capabilities using low gravity environment
- Lower cost, safe transportation for suborbital, orbital and circum-lunar rides

# These new capabilities will benefit people everywhere

- Emerging applications directly address regional, national and global needs, e.g.
  - Regional climate monitoring and prediction
  - First responder and law enforcement effectiveness
  - Agricultural productivity
  - Fire control
  - Traffic management
  - Strengthen education
  - Health care
- New programs and services will generate significant additional tax revenues
- New companies will increase employment, especially in high-tech areas

**We have only begun to apply space capabilities to  
improve life (on Earth and elsewhere)**

# Futurist methods can be applied to foresee longer term potential space applications

Trend extrapolation  
Technology forecasting  
Demand satisfaction  
Scenario development  
“Wild cards”  
Cross-impact analysis  
Delphi  
Brainstorming

# Future applications drivers include

## ■ Societal Needs

- Energy
- Food
- Water
- Natural Resource management
- Communications
- Entertainment & Adventure
- Health & Medical Care
- Recreation
- Process efficiency
- Security
- Disaster recovery
- Crime fighting
- Education & Training

## ■ Space Technology Trends

- Very large/very small spacecraft
- Distributed/coordinated spacecraft constellations
- Higher power/power beaming
- Large/precise antennas
- Very large throughput/lasercom
- Hyperspectral and active sensors
- Superresolution imaging
- Precision timing/ clocks
- Higher speed /capacity on-board data processing
- Micro-g manufacturing facilities
- Lower cost, higher reliability space transportation
- Human space operations
- Lunar/cis-lunar capabilities



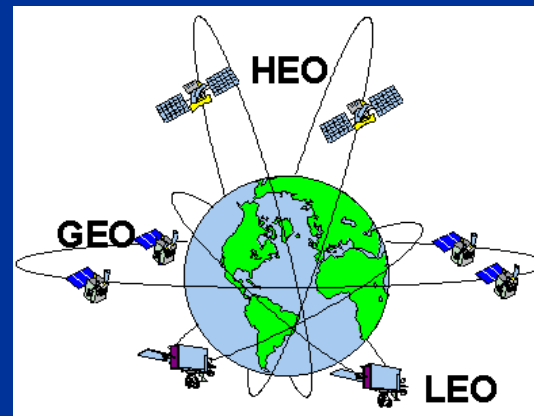
# Potential “revolutionary” space applications

- Weather modification and control
- Orbital factories for production of unique products
- Famine avoidance
- Global water management
- Global integrated transportation systems
- Global border integrity
- Earthquake avoidance
- Entertainment, including film production and sports in space
- Planetary defense
- Orbital and lunar excursions
- Orbital and lunar resorts
- Lunar-based surveillance and management of the cis-lunar environment
- Commercial lunar resource exploitation (ISRU, etc)
- In-space medical procedures
- Control human aging
- Toxic and nuclear waste disposal
- Energy generation in space,
- Solar energy reflection to Earth

And there are many others

# Space-based IR Sensor Applications

- New generation of satellite IR sensors can detect signatures having significant civil applications (e.g. fire detection and fighting)



# Orbital Research & Manufacturing Facilities



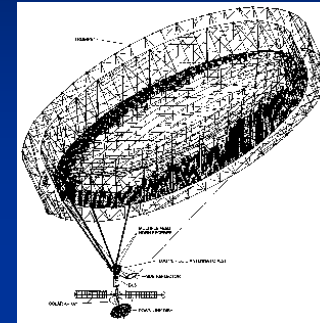
A new generation of industrial facilities is being created





# Climate Alteration / Water Management

- Studies suggest that climate can be influenced from space (microwave or reflected sunlight)
- Water availability is one of the world's most pressing problems
- Potential to impact the hydrosphere from space





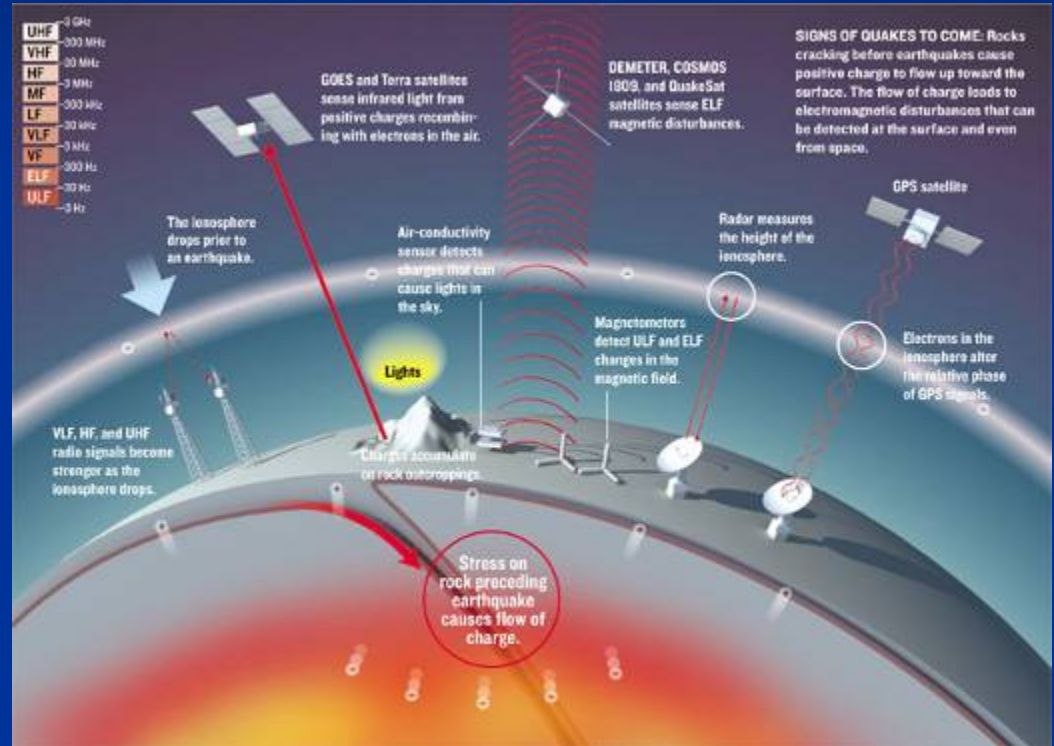
# Global Border Integrity Monitoring

- Space radar constellation can monitor traffic approaching all nations' borders



# Earthquake Warning

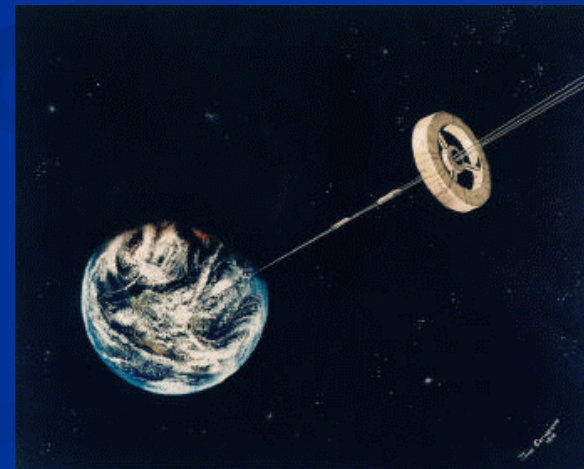
- Unusual electromagnetic signatures are precursors to major earthquakes in different parts of the world
- Using signal processing techniques, signatures can be detected and identified from space



Ref: Quakefinder

# Nuclear Waste Disposal in Space

- Nuclear waste disposal and containment is a 10,000 year problem
- In a few hundred years, we will have highly reliable, inexpensive space transportation
- Therefore the terrestrial waste disposal problem need only consider the next few hundred years, which changes the nature of today's



# Space Solar Reflector Applications



- **Nighttime power and daytime augmentation of terrestrial solar electric and solar thermal systems**
- **Nighttime illumination**
- **Livestock productivity enhancement**
- **Photosynthesis (agriculture) enhancement**
- **Enhanced CO<sub>2</sub> absorption**
- **Weather/climate modification**



# Precision Remote Sensing of the Earth from the Moon

- The lunar surface provides a unique vantage for observation of Earth and near-Earth space
- These capabilities may require human surface operations



# New Space Applications Will Be an Engine of the Future

- Space applications are postured to be a major driver of the future global economy
- These kinds of capabilities are being pursued by many space-faring countries
- Coordinated government and private investments will foster such opportunities
- These types of applications can provide high-value jobs now

Backup  
Top-level Technology  
Assessments

# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Biotechnology and materials development	Pharmaceutical development	Low-g facility	M
Biotechnology and materials development	Materials development	Low-g facility	M
Biotechnology and materials development	On-orbit manufacturing	Low-g facility	L



# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Disaster response/Law enforcement	First responder and law enforcement	Broadband communications to mobile platforms on the move	H
Education	Distance learning in remote locations	Multi-channel broadband communication	H
Entertainment	Broadband broadcasting	Broadband communications to mobile platforms	H

# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Security	Global border monitoring	Space radar constellation	M
Health care	Telesurgery	Teleoperations	M
Law enforcement	Counter drug operations	Remote sensing Communications	H

# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Agriculture	Crop management	Remote sensing, Navigation	H
Aquaculture	Fishery management	Remote sensing	H
Banking	Financial integration	Secure timing	H

# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Weather	Regional climate change characterization	Sensors Modeling	H
Weather	Precipitation monitoring	Sensors Modeling	M
Weather	Weather modification	Energy deposition from space	L



# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Fire monitoring and characterization	Forest fire management	Precise remote sensing (IR)	H
Traffic monitoring and management	Surface vehicle tracking	Space radar constellation	M
Traffic monitoring and management	Highway traffic management	Precise navigation	H
Traffic monitoring and management	Air traffic management (ADS-B)	Secure navigation Lower cost user equipment	H

# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Disaster mitigation	Improved hurricane warning	Remote sensing	H
Disaster mitigation	Earthquake warning	Signature identification	M
Disaster mitigation	Planetary defense	Sensing, Asteroidal repositioning	M/L

# Technology Assessment

<b>Domain</b>	<b>Application</b>	<b>Key Technologies</b>	<b>Maturity (H, M, L)</b>
Energy	New sources of terrestrial energy	Solar power from space (reflected, beamed)	L
Adventure travel	Space excursions	Reusable human transportation (suborbital, orbital)	M/L
Adventure travel	Orbital excursions	Privately developed habitats	L