

“Breakthrough” Earth-to-Orbit Space Transportation Technologies



Now

Delta II ELV



Blast Wave Accelerator



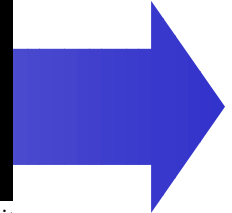
Pulse Detonation Wave Rocket

5-10 yrs



Momentum Transfer Tether Facility

15-25 yrs



Application

Missions:

Robotic Missions to LEO

Cargo to LEO

Cargo and Spacecraft to LEO

Metrics:

Cost

\$7-10 K/pound

\$100 - \$1000 / pound

< \$100 / pound

Flight Rate

< 20/year

>100/year

>1000/year

Objective:

100X reduction in cost of mass to orbit with high launch rate and sustainable systems

Current Funding for Evolutionary RLV

Technologies (source):

- FY'99 ~\$400M (R)
- FY'00 ~\$400M (R)

Current Funding for *Revolutionary* Technologies

- FY'99 ~\$1.5M (R)

Recommendation

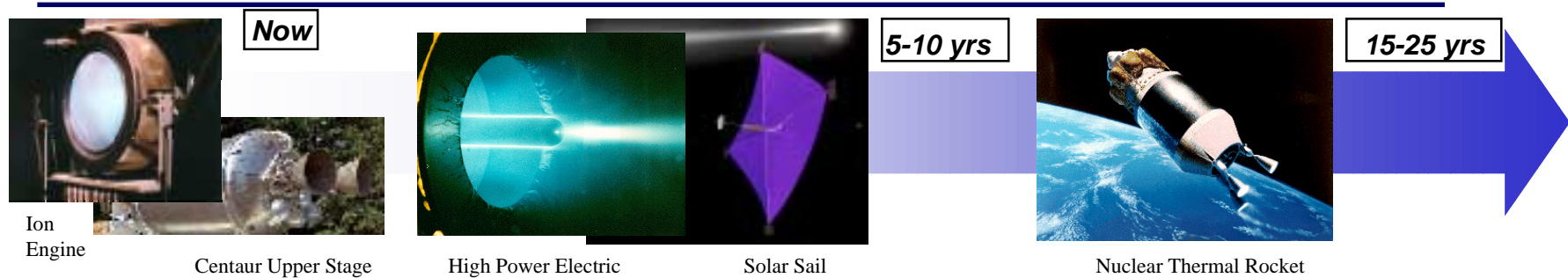
Ramp up to \$50M/year over 2000 - 2005, then upward to begin flight experiments

Leading Candidates with potential high payoff (further refinement required):

- Blast Wave Acceleration
- Tethers and Elevators
- Pulse Detonation Wave
- High Energy Density Materials
- Carbon nanotubes for structures and materials



“Breakthrough” Space Transfer Technologies



Ion Engine

Centaur Upper Stage

High Power Electric

Solar Sail

Nuclear Thermal Rocket

Application Missions:

Upper Stages for LEO-to-GEO and interplanetary

Low-cost, continuous thrust robotic & human missions beyond LEO

Continuous human & robotic exploration beyond LEO

Metrics:

Cost (price)
Trip Time

\$7000/pound
Minimum energy transfers

10X cheaper
10X faster (non-min. energy)

100X cheaper
up to 100X faster (non-min. energy)

Leading Candidates with potential high payoff (further refinement required):

- Nuclear (Electric and/or Thermal)
- Chemical with inexpensive ETO-launched fuel
- Tethers and Elevators
- Mag Sails
- Solar Sails
- Minimagnetospheric Plasma Propulsion

Current Funding for NASA Space Transfer Technology Development* (source):

- FY'99 \$1M (R) <\$10M (S)
- FY'00 \$3M (R) <\$10M (S)

Recommendation

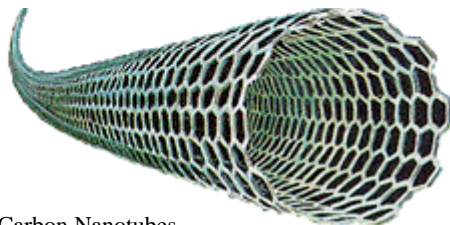
Ramp up to \$75M/year over 2000 - 2005, then upward to begin flight experiments

* not including flight experiments

Commercial Impact of DPT-Recommended Breakthrough Technologies



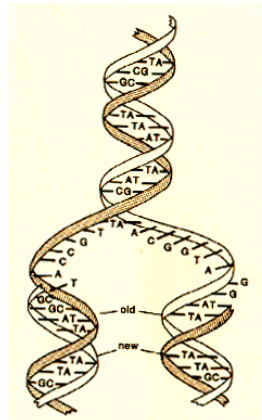
Space Tourism



Carbon Nanotubes



Space Business Park



- Truly low-cost access to space
 - Tourism to LEO and beyond
 - Space manufacturing
 - Lower cost and higher performance telecom
- Telepresence
 - Bringing space to people
- High strength-to-weight materials
 - strong, light-weight structures
 - super-strong materials for cars, boats, clothes, etc.
- Enabler for space solar power
 - Electrical energy without adding greenhouse gases to the atmosphere
- Satellite refueling
- Safe waste removal from the biosphere
- Biotech



Commercial Partnerships in Exploration



Commercial Space Launch



Toys and Entertainment



Hollywood

- Form partnerships with established and fledgling space launch companies to facilitate transfer and development of breakthrough technologies
- Provide significant new government incentives to space entrepreneurs (tax breaks, awards, etc.)
- Must work with entertainment industry from the start to bring the public with us in this new era of Exploration (IMAX, Nintendo, Hollywood, toy industry, etc.)
- Partner with industry for development and operation of interplanetary networks and advanced telecom
- Partner with industry, other government agencies for biotechnology and nanotechnology research and commercialization