

# **IS THE SPACE TREATY OF 1967 ENOUGH TO ASSURE PROPER BEHAVIOR DURING RESOURCE ACQUISITION?**

- **LICENSING STATE CAN  
WITHDRAW LAUNCH,  
COMMUNICATIONS AND RETURN  
PAYLOAD LICENCES FOR CAUSE**
  - **ENFORCE COMPLIANCE  
BEFORE RE-ACTIVATION**

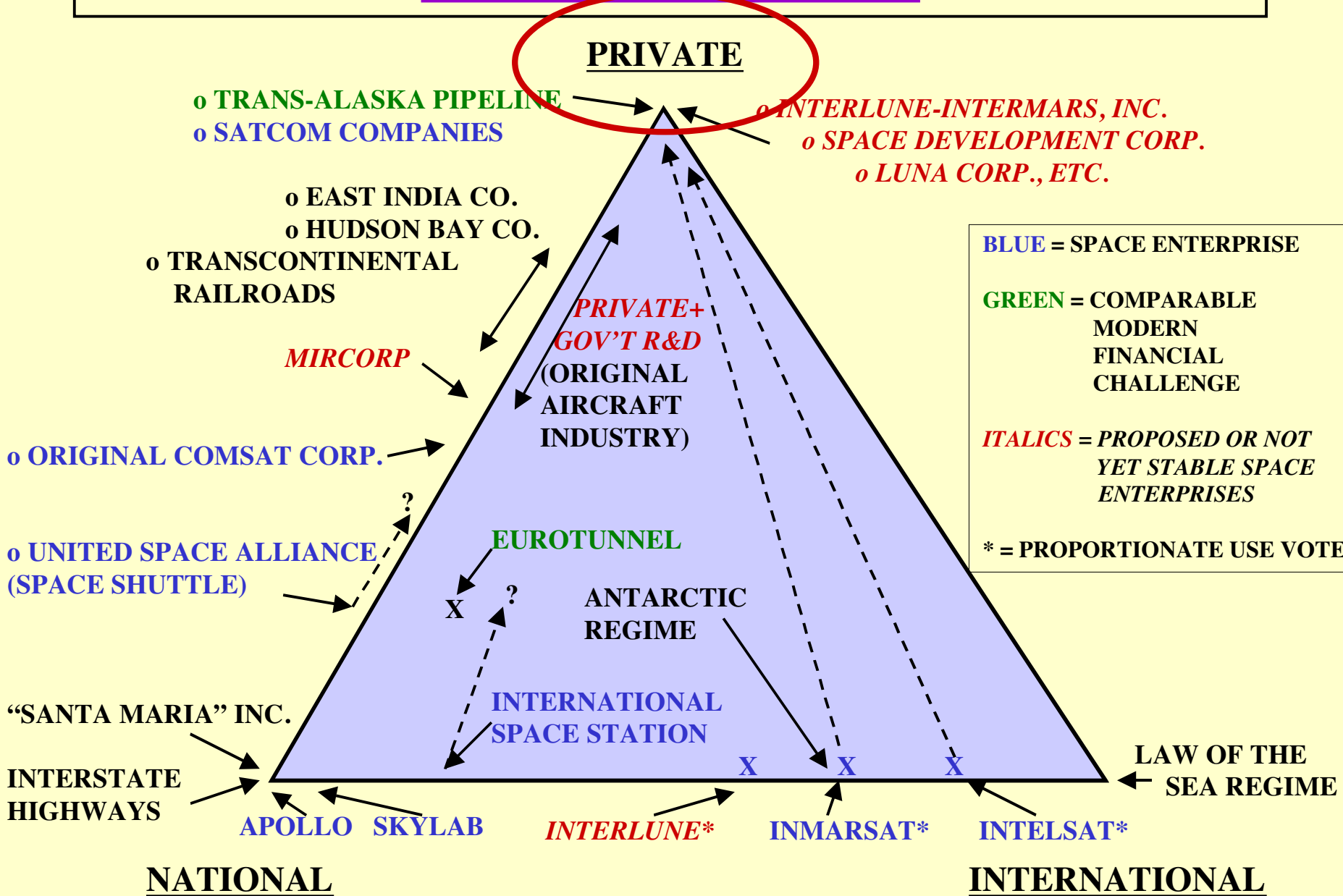
- **WORLD COMMUNITY CAN BRING  
MATTER TO THE WORLD COURT  
AND/OR ENFORCE SANCTIONS**

- **EITHER ACTION WOULD HAVE  
SERIOUS IMPACT ON OFFENDING  
ENTITY'S ABILITY TO MAINTAIN  
ITS SPACE OPERATIONS**

- **SAFETY OF PERSONNEL**
- **ACCESS TO CAPITAL**
- **ACCESS TO MARKETS**

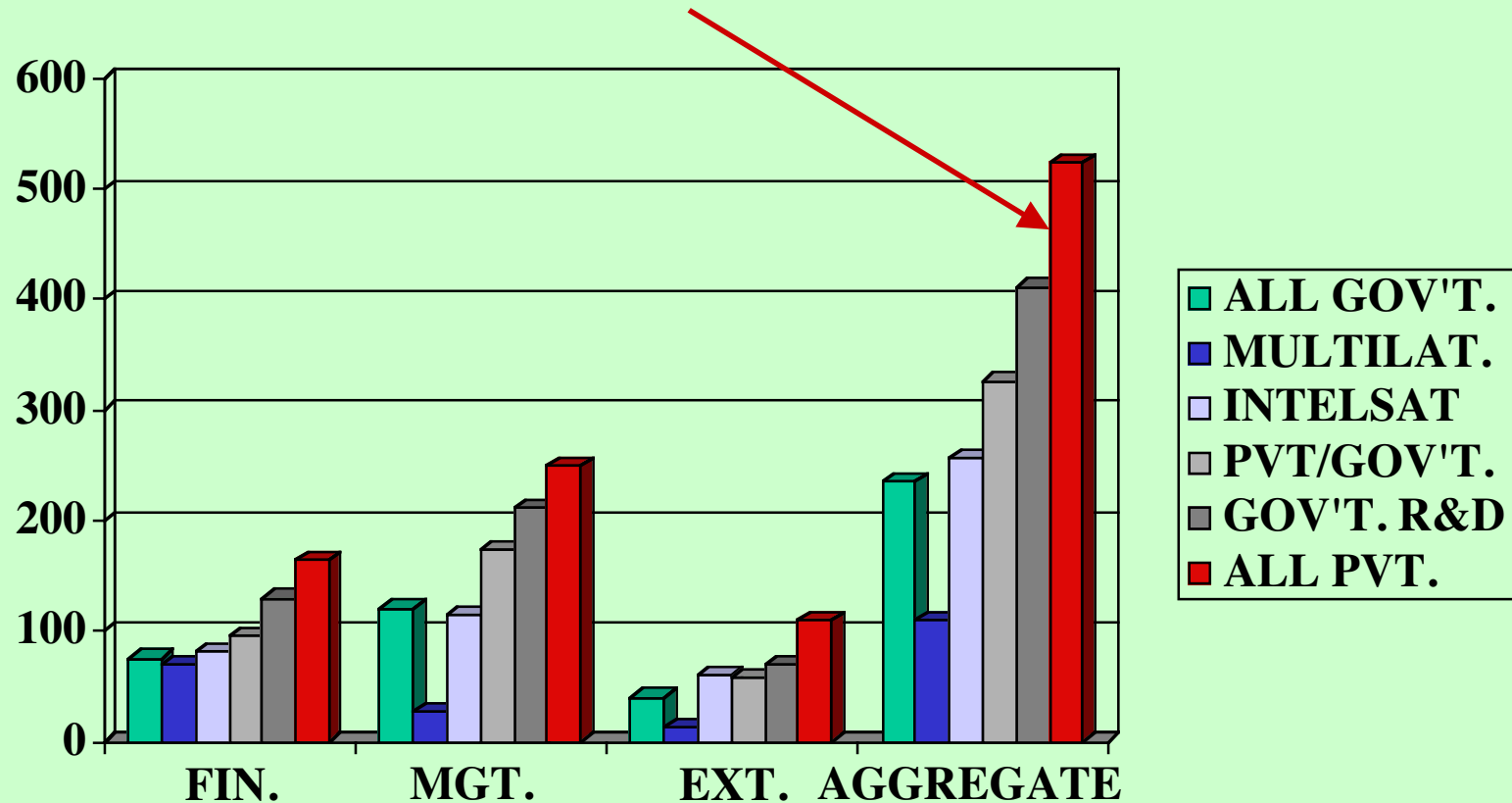


# ‘PURE’ MANAGEMENT CONTROL COMPONENTS: LARGE ENTERPRISES



# SEMI-QUANTITATIVE EVALUATION OF MANAGEMENT APPROACHES

## HOW WOULD AN ALL PRIVATE APPROACH WORK?



# FEASIBILITY OF AN “ALL PRIVATE” LUNAR RESOURCE INITIATIVE

- **PROF. HOWARD THOMPSON’S ANALYSIS FOR 1999 NEEP533**
  - PRIVATE INITIATIVE FOR LUNAR HE-3 MINING ONLY WON’T FLY
  - FAVORABLE RETURN ON INVESTMENT (ROI ~25%) ONLY IF GOVERNMENT A PARTNER TO FUND NECESSARY R&D AND INVESTORS WAIT 15 YEARS FOR RETURN ON INVESTMENT
    - GOVERNMENT BRIDGES GAPS IN TECHNOLOGY, START-UP FINANCING, AND INITIAL ROI FOR INVESTORS
    - GOVERNMENT GETS FREE VOLATILES AND USE OF LUNAR BASE
- **ALTERNATIVE APPROACH**
  - BRIDGE TECHNOLOGY, FINANCING, AND ROI GAPS WITH NEARER TERM BUSINESSES
    - BASE ON SPIN-OFF OF FUSION RELATED TECHNOLOGIES
      - ISOTOPE PRODUCTION AT POINT-OF-USE - ONE WATT OF FUSION POWER
      - USE OF PROTONS AND NEUTRONS: TRANSMUTATION AND ANALYSIS - KILOWATTS
      - MODULAR POWER UNITS FOR MOBILE APPLICATIONS - >BREAK-EVEN (Q>1)
      - MODULAR AND CENTRAL STATION POWER PLANTS - LUNAR HE-3 REQUIRED
- **GETTING STARTED REQUIRES FINANCING OF START-UP DEVELOPMENT OF ISOTOPE PRODUCTION BUSINESS**

# ISOTOPE PRODUCTION START-UP DEVELOPMENT

- **TECHNOLOGY**

- RESEARCH PLAN
- IMPLEMENT AS RAPIDLY AS FINANCING PERMITS
- IDENTIFY AND PATENT “IP”

- **FINANCING**

- BUSINESS PLAN
- SEARCH FOR FUNDING SOURCE
- ESTABLISH MANAGEMENT TEAM

# I. TYPES OF FINANCING

- **PRE-PAID CONTRACTS (REVENUES)**
- **GRANTS**
  - **GOVERNMENT OR PRIVATE**
- **DEBT**
  - **BANK OR PRIVATE**
- **EQUITY**
  - **PUBLIC**
    - **INITIAL PUBLIC OFFERING**
    - **SECONDARY PUBLIC OFFERING**
  - **PRIVATE**
- **CONVERTIBLE DEBT**



# PRE-PAID CONTRACTS

- **PROS**

- NO REPAYMENT REQUIREMENTS (GENERALLY)
- NO DILUTION OF FOUNDERS EQUITY
- EXTREMELY FLEXIBLE TERMS

- **CONS**

- GENERALLY HARD TO GET
- SUBJECT TO COMPETITION AND PERFORMANCE MILESTONES

- **NOT LIKELY FOR START-UP DEVELOPMENT**

- POSSIBLE ONCE MANUFACTURING PROTOTYPE IS DEMONSTRATED

# GRANTS

- **PROS**

- NO REPAYMENT REQUIREMENTS (GENERALLY)
- NO DILUTION OF FOUNDERS EQUITY
- EXTREMELY FLEXIBLE TERMS
- MANY OPTIONS FOR USE

- **CONS**

- GRANT MAY NOT BE FOR WHAT YOU ULTIMATELY WANT TO DO
- SUBJECT TO PERFORMANCE MILESTONES
- OFTEN SUBJECT TO STRICT REPORTING REQUIREMENTS

- **NOT LIKELY FOR START-UP DEVELOPMENT**

- SBIRS ARE POSSIBLE



# DEBT

- **PROS**

- LIMITED UPSIDE PAYMENTS
- EASY TO FIND (AS OPPOSED TO “GET”) AND UNDERSTAND
- WELL-ESTABLISHED INDUSTRY
- MAY BE NO VALUATION NEGOTIATION

- **CONS**

- ALMOST IMPOSSIBLE TO GET FOR PRE-REVENUE COMPANIES
  - PERSONAL GUARANTEE BASED ON INDIVIDUAL NET WORTH
- COVENANTS MAY SERIOUSLY LIMIT MANAGEMENT FLEXIBILITY
- SENIOR POSITION IN REPAYMENTS WHEN IN TROUBLE
- NOT TIED TO YOUR REVENUE STREAMS
  - MAY BE TIED TO YOUR RECEIVABLES, INVENTORY, ETC.

- **NOT LIKELY FOR START-UP DEVELOPMENT**

- FRIENDS, FAMILY AND FOOLS (FFF) MIGHT STEP UP

# PRIVATE EQUITY

## • PROS

- NO REPAYMENT UNTIL EXIT
  - I.E., IPO OR SALE OF COMPANY
- ALIGNMENT OF INTERESTS
- POSSIBLE TO GET FOR EARLY STAGE FIRMS
- MAY ATTRACH STRATEGIC PARTNER(S)

## • CONS

- DILUTION OF FOUNDERS EQUITY
- EXIT MAY BE REQUIRED AT SOME POINT
  - PARTICULARLY FOR VENTURE CAPITAL
- SHARED OWNERSHIP STRUCTURE
  - MAY HAVE MORE MANAGEMENT “HEP” THAN YOU WANT
- VALUATION NEGOTIATION

## • POSSIBLE FOR START-UP DEVELOPMENT

- “ANGEL” OR MINI-ANGEL / NOT VENTURE CAPITAL
  - VENTURE CAPITAL IS LOOKING FOR EXIT IN 3-5 YEARS

# PUBLIC EQUITY

- **PROS**

- LIQUIDITY FOR INVESTORS AND (TO A LESSER DEGREE) OTHER SHAREHOLDERS
- LONG-TERM BUSINESS VIABILITY
  - PROVIDED THERE IS GOOD MANAGEMENT AND A VIABLE BUSINESS PLAN

- **CONS**

- NORMALLY NOT AVAILABLE TO EARLY STAGE FIRMS
- NORMALLY REQUIRES 3 YEARS TRACK RECORD IN THE MARKET
  - E-COMMERCE WAS THE RECENT EXCEPTION
- EXPENSIVE TO ACCESS
- VERY STRINGENT FEDERAL REPORTING REQUIREMENTS

- **NOT AVAILABLE TO START-UP DEVELOPMENT**

# CONVERTIBLE DEBT

(DEBT WITH CONVERSION TO STOCK AT AGREED STOCK PRICE)

## • PROS

- LIMITED UP-FRONT VALUATION DISCUSSION
- CAN SERVE AS AN EFFECTIVE BRIDGE INSTRUMENT WHEN EQUITY MARKET LIMITED
- FAST
- ACCESSIBLE TO COMPANIES AT MANY STAGES

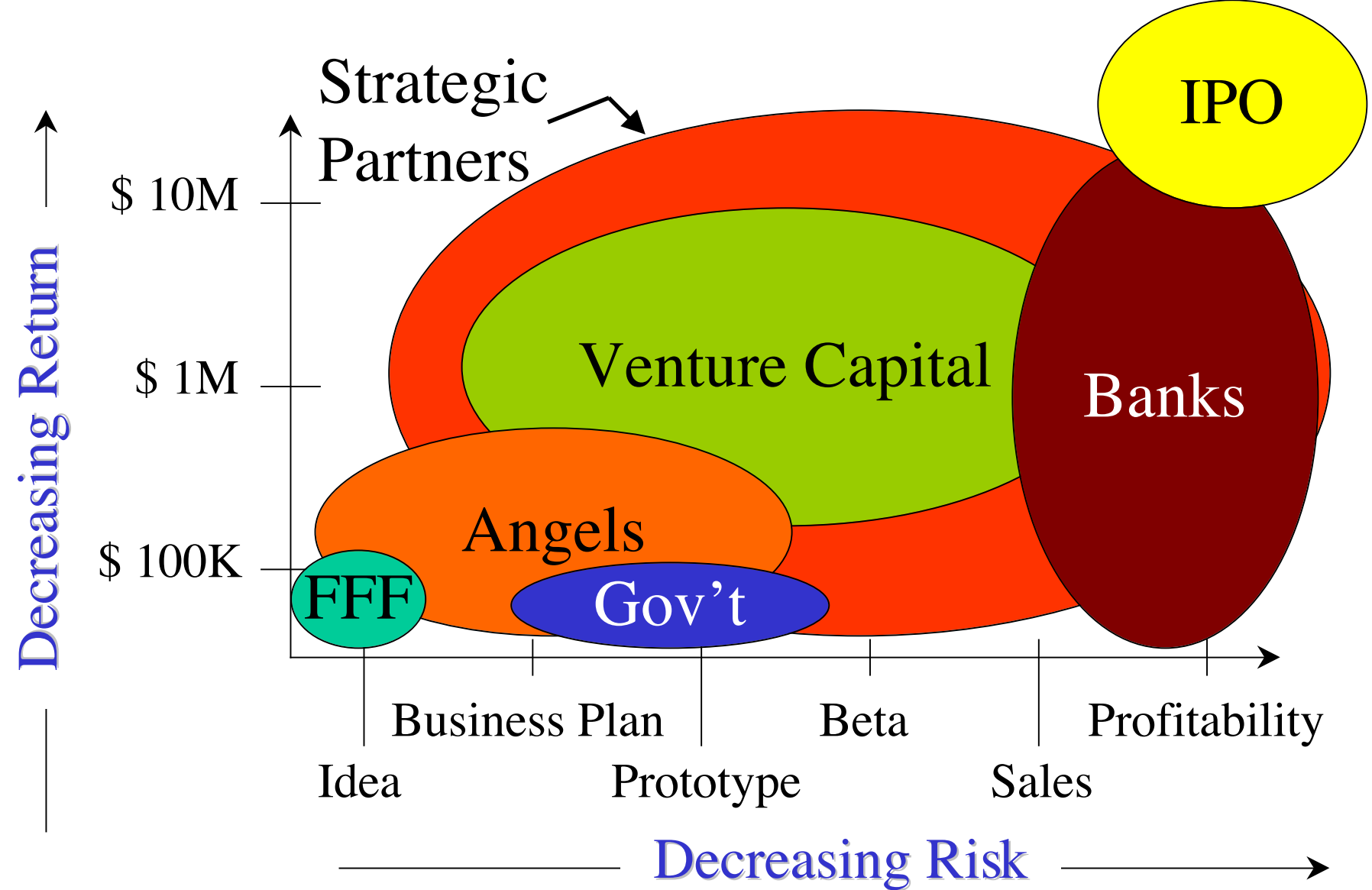
## • CONS

- ALMOST ALWAYS HAS “WARRANT COVERAGE”
  - CAN BE MARKET OVERHANG ON STOCK PRICE
- DECISION TO CONVERT LIES WITH INVESTORS
  - COMPANY CAN INFLUENCE THE DECISION SOMETIMES
- INTERST PAYMENTS AFFECT CASH FLOW
- WOULD REQUIRE A FUTURE ACCESS TO CAPITAL TO FORCE CONVERSION

## • NOT AVAILABLE TO START-UP DEVELOPMENT

# II. SOURCES OF FINANCING

- **AVAILABLE TO START-UP DEVELOPMENT**
  - **UNSOPHISTICATED INVESTORS (A.K.A. THE 3F'S)**
  - **MINI-ANGELS**
  - **ANGELS**
- **AVAILABLE AFTER START-UP DEVELOPMENT**
  - **VENTURE CAPITALISTS**
  - **STATE OR FEDERAL GOVERNMENT**
  - **STRATEGIC PARTNERS**
- **AVAILABLE AFTER TRACK RECORD ESTABLISHED**
  - **PUBLIC EQUITY MARKETS (THE MAGIC IPO)**
  - **COMMERCIAL BANKS**



**FINANCING RETURN ON INVESTMENT VS. RISK**

# UNSOPHISTICATED INVESTORS (3F'S)

- **PROS**

- EASY TO ACCESS
- OFTEN ATTRACTIVE VALUATION OR TERMS
- EXTREMELY FLEXIBLE TERMS (DEBT, EQUITY OR BOTH)

- **CONS**

- USUALLY ONLY AVAILABLE FOR SEED OR PRE-SEED ROUND
- VALUE-ADD TO THE BUSINESS UNCERTAIN (ROLE IN CO.)
- CAN BE HARD ON PERSONAL RELATIONSHIPS

- **MAY BE AVAILABLE FOR START-UP DEVELOPMENT**

# ANGELS/MINI-ANGELS

- **PROS**

- ABLE TO DECIDE QUICKLY
- HIGHER LEVEL OF SOPHISTICATION THAN 3F'S
- POSSIBILITY OF VALUE-ADD BEYOND JUST MONEY

- **CONS**

- HARD TO FIND (USUALLY)
- TYPICALLY ONLY INTERESTED IN INVESTING IN THEIR LOCAL GEOGRAPHIC AREA
- USUALLY HAVE PARTICULAR INVESTMENT CRITERIA
- HAVE TO WATCH FOR CON-ARTISTS

- **MAY BE AVAILABLE FOR START-UP DEVELOPMENT**



# VENTURE CAPITALISTS

- **PROS**

- VALUE-ADD BEYOND MONEY (MANAGEMENT, CONTACTS, FINANCE LEADS)
- ADDED CREDITABILITY WITH BUSINESS COMMUNITY
- POTENTIAL FOR SYNDICATES AND FOLLOW-ON FUNDING
- REQUIRE STRONG MANAGEMENT TEAM IN PLACE

- **CONS**

- STRINGENT INVESTMENT CRITERIA
- VALUATION USUALLY VERY TOUGH
- SLOWER TO ACT THAN ANGELS OR 3F'S
- EXIT EXPECTED (AND USUALLY REQUIRED) WITHIN 3-5 YEARS

- **MAY BE AVAILABLE TO START-UP DEVELOPMENT**

- WITH SUCCESSFUL MANUFACTURING PROTOTYPE

# STATE OR FEDERAL GOVERNMENT

- **PROS**

- NO DILUTION OF EQUITY
- MANY DIFFERENT SOURCES (SBIR, STTR, CRADA, COMPETITIVE BID)

- **CONS**

- STRINGENT REPORTING REQUIREMENTS
- TERMS MAY NOT MATCH COMPANY GOALS
- INTELLECTUAL PROPERTY OWNERSHIP QUESTIONS
- HIGHLY POLITICAL PROCESS

- **DIFFICULT FOR START-UP DEVELOPMENT**

- TAKES TIME, SOME CASH AND POSSIBLY SOME POLITICAL CONNECTIONS

# STRATEGIC PARTNERS

- **PROS**

- MANY DIFFERENT OPTIONS (EARLY, LATE, EQUITY, DEBT)
- OFTEN ATTRACTIVE VALUATION OR TERMS
- CAN SERVE AS BOTH A FINANCING SOURCE AND AN EXIT
- NON-CASH BENEFITS (MANUFACTURING, MARKETING, SALES, DISTRIBUTION, PROCUREMENT)

- **CONS**

- HARD TO DEVELOP CONTACT WITH RIGHT PARTNER
- POTENTIAL FOR EXPLOITATION (BIG CO./SMALL CO.)
- CAN LIMIT RELATIONSHIPS WITH COMPETITIVE FIRMS
- BOARD MEMBERSHIP MAY CREATE CONFLICTS

- **MAY BE POSSIBLE FOR START-UP DEVELOPMENT**

- MAKE A NEW MARKET FOR THE PARTNER

# PUBLIC EQUITY MARKETS

- **PROS**

- SERVES AS AN EXIT STRATEGY AS WELL AS FINANCING
- MAJOR “BRANDING” EVENT
- EASIER TO GET FOLLOW-ON FUNDING (DEBT & EQUITY)

- **CONS**

- DEPENDS UPON AN “IPO WINDOW”
- MANY SEC REPORTING REQUIREMENTS
- AUDITED FINANCIAL STATEMENTS REQUIRED
- EXTREMELY EXPENSIVE

- **NOT AVAILABLE FOR START-UP DEVELOPMENT**

# COMMERCIAL BANKS

- **PROS**

- LIMITED COST (INTEREST RATE + FEES)
- LONG-TERM RELATIONSHIP (NO EXIT)
  - PROVIDED YOU DO NOT GET INTO FINANCIAL TROUBLE

- **CONS**

- MUST HAVE ASSETS TO ACCESS (REVENUES, RECEIVABLES, HARD ASSETS)
- AUDITED FINANCIAL STATEMENTS PROBABLY REQUIRED
- TYPICALLY REQUIRE COVENANTS OR GUARANTEES

- **NOT AVAILABLE FOR START-UP DEVELOPMENT**

- EXCEPT WITH PERSONAL GUARANTEES AGAINST HARD ASSETS

# COMMERCIAL PRECEDENTS IN SPACE



- **GEOSYNCHRONOUS COMMUNICATION SATELLITES AND SATELLITE COMMUNICATIONS SERVICES (MANY EXAMPLES WITH MORE APPEARING EVERY YEAR)**
- **LOW EARTH ORBIT COMMUNICATION AND REMOTE SENSING SATELLITE CONSTELLATIONS**
  - **IRIDIUM, ODESSEY, GEODESIC, ORBCOMM, ICO, ETC.**
  - **EARTHWATCH, ORBIMAGE, SPOTIMAGE, LOCKHEED/MARTIN, ETC.**
    - **LOTS OF INVESTMENT**
    - **NO CLEAR SUCCESSES**
    - **MISSED WINDOW OF OPPORTUNITY RELATIVE TO CELLULAR**
    - **DUST HASN'T SETTLED**
- **LAUNCH SERVICES (GOVERNMENT AN ESSENTIAL CUSTOMER IN ALL CASES SO FAR)**
  - **ORBITAL SCIENCES' TRANSFER ORBIT STAGE, PEGASUS, AND TAURUS**
  - **BOEING/MCDONNELL DOUGLAS DELTA AND ATLAS (SORT OF) FAMILIES**
  - **ARIANE (SORT OF)**

# ARE THERE PRECEDENTS FOR "REALLY BIG" PRIVATE SPACE INITIATIVES

- **SIMILAR SCALE, LARGELY PRIVATE INVESTMENT PROJECTS:**
  - **TRANSALASKA PIPELINE - 1977 - \$8B (~\$20B NOW)**
  - **ENGLAND TO FRANCE "CHUNNEL" - 1995 - \$15B**
  - **TRANSCONTINENTAL RAILROADS - LATE 1800'S**
  - **U.S. SURFACE COMMUNICATIONS INFRASTRUCTURE - MID 1900'S**
  - **AIR TRANSPORTATION SYSTEM - MID-LATE 1900'S**
  - **SATELLITE COMMUNICATIONS INVESTMENTS - LATE 1900'S**
- **MOST OF THESE PROVIDED NEAR-TERM RETURNS ON INVESTMENT AS WELL AS INTERNAL CASH FLOWS THAT SUPPORTED EXPANSION.**
- **ALL, TO A GREATER OR LESSER DEGREE, HAD GOVERNMENT AS A PARTNER**
- **NOW MUST ALSO MEET NATIONAL AND INTERNATIONAL REGULATORY REQUIREMENTS**
  - **LAUNCH LICENSES (DOT)**
  - **COMMUNICATION FREQUENCY ALLOCATIONS (FCC AND ITU)**
  - **ENVIRONMENTAL IMPACT (EPA AND INTERNATIONAL PRECEDENT)**
  - **OUTER SPACE TREATY OBLIGATIONS (DEPT. OF STATE)**
  - **OTHER TREATY OBLIGATIONS (?)**

# LAUNCH COSTS

**“LONGEST FINANCIAL POLE IN A LARGE TENT FULL OF LONG POLES”**

- **PROF. THOMPSON'S 1999 ANALYSIS**
  - **NEED LAUNCH COST TO THE MOON OF ~\$2000/KG OR LESS FOR COMMERCIAL LUNAR <sup>3</sup>HE MINING TO BE ATTRACTIVE**
  - **MAY BE ABLE TO TOLERATE \$3000-4000/KG FOR A LUNAR VOLATILE RESOURCES AND <sup>3</sup>HE FUSION COMBINED INITIATIVE**
    - **IN THE BALLPARK OF WHAT DR. GRIFFIN CONCLUDED MIGHT BE POSSIBLE FOR A HLLV OR A HIGH USE RLV.**
- **APOLLO SATURN V COSTS**
  - **~\$64 BILLION (2000 DOLLARS) TOTAL FOR RESEARCH, DEVELOPMENT, MANUFACTURING, AND OPERATIONS INCLUDING THE COST OF CAPITAL MAXIMUM PAYLOAD 48,000KG ON A LUNAR TRAJECTORY**
  - **AT THE TIME OF APOLLO 17, THIS WORKS OUT TO A MISSION COST OF ~3 BILLION PER LAUNCH**
    - **OR ~ \$70,000/KG**
    - **AS THIS NUMBER INCLUDES ITEMS THAT WOULD BE ALLOCATED TO OTHER COST CENTERS, IT IS A MAXIMUM HEAVY LIFT LAUNCH COST FOR THE 1970'S AND PROBABLY ANY FUTURE RETURN TO THE MOON**
- **CAN WE DO BETTER THAN \$70,000/KG?**





# LAUNCH COSTS

## “SATURN VI”

- **LONG TERM PRODUCTION COMMITMENT.**
- **DOUBLE THE PAYLOAD CAPABILITY.**
- **PREVIOUS APOLLO, TITAN, AND SHUTTLE EXPERIENCE PERMITS DESIGN TO BE FOCUSED AND FINALIZED AT AN EARLY STAGE WITH LITTLE OR NO UNCERTAINTIES OR PARALLEL DESIGNS.**
- **DESIGN TO MINIMUM COST WITH NEW, PROVEN TECHNOLOGIES THAT CAN ENHANCE CAPABILITIES AS WELL AS LOWER COST (E.G., COMPUTERS, GUIDANCE AND CONTROL SYSTEMS, COMPOSITE MATERIALS, ETC.).**
- **NEW, PROVEN MANUFACTURING AND TEST TECHNOLOGIES CAN SPEED PRODUCTION RATES (ROBOTICS, JUST-IN-TIME INVENTORY MANAGEMENT, BUILT-IN DIAGNOSTICS, MODULAR DESIGN, END TO END TESTING, ETC.).**
- **UNDERUSED OR SURPLUS GOVERNMENT FACILITIES MAY BE AVAILABLE FOR REFURBISHMENT AND ENHANCEMENT AT LESS THAN REPLACEMENT COST.**
- **NEW GENERATION OF TALENTED, HIGHLY MOTIVATED YOUNG ENGINEERS AND WORKERS CAN BE ATTRACTED TO THE ENTERPRISE.**