



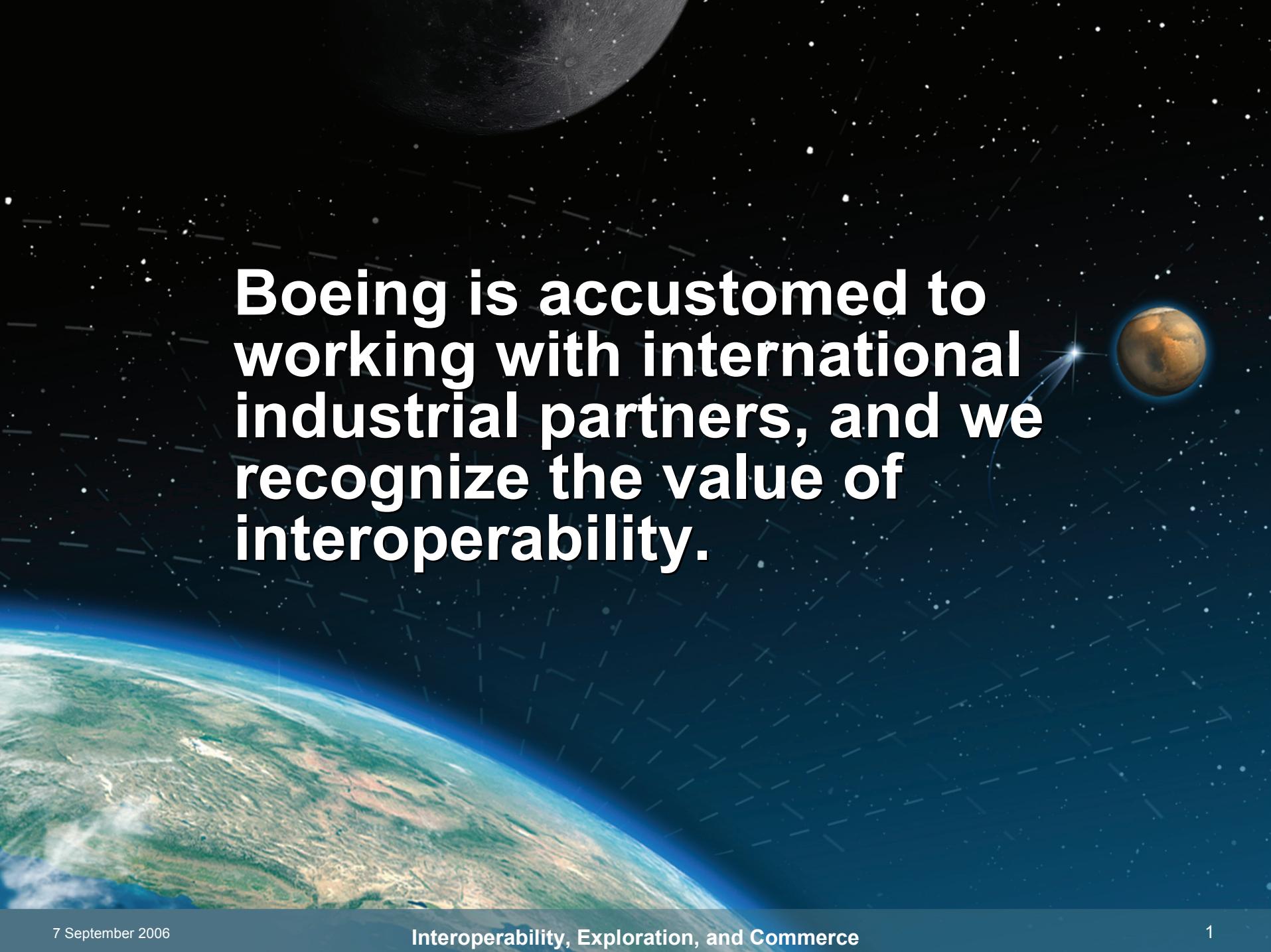
Network & Space Systems
Space Exploration

Interoperability, Exploration, and Commerce

Expanding Industry's Scope

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The Boeing Company

Interoperability & Space Exploration
7 September 2006



Boeing is accustomed to working with international industrial partners, and we recognize the value of interoperability.

Sea Launch

Expanding Industry's Scope

- Launch of commercial satellites from a mobile sea-based platform, positioned on the equator in the Pacific Ocean
- The Boeing Company (U.S., 40%), RSC Energia (Russia, 25%), Aker ASA (Norway, 20%) and SDO Yuzhnoye / PO Yuzhmash (Ukraine, 15%)



Sea Launch sends JCSAT-9 into orbit, 12 April 2006

Photo: Sea Launch

Mitsubishi Heavy Industries

Expanding Industry's Scope

- **International Space Station**
 - Boeing: JEM development assistance, especially in procuring ISS common parts
 - ISS Partner Dialogue: international cooperation dialogue promoted by Boeing, as NASA's ISS Prime Contractor
- **H-IIA & Delta IV**
 - Boeing manufacture of second stage LOX tank for H-IIA
 - MHI manufacture of second stage LH2 tank for Delta IV
- **Backup Agreement:**
 - Alliance among Sea Launch's Zenit-3SL, MHI's H-IIA and Arianespace's Ariane V
- **MB-XX Propulsion System**
 - Collaborating since 1999 with Boeing Rocketdyne Propulsion & Power (now Pratt & Whitney Rocketdyne) on high performance, highly reliable upper stage engine with multiple restart capability



Japanese Kibo Module
©JAXA



H-IIA 2nd stage
LOX Tank

Delta IV 2nd stage
LH2 Tank

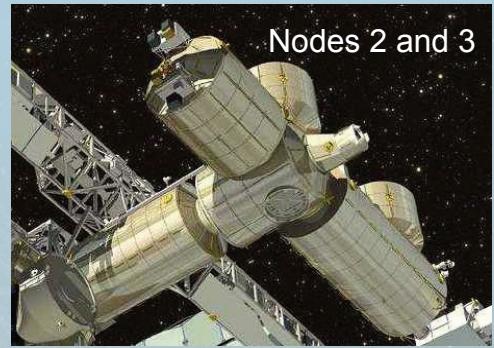


MB-XX Demonstrator
Hot Fire

Alcatel Alenia Space Italia

Expanding Industry's Scope

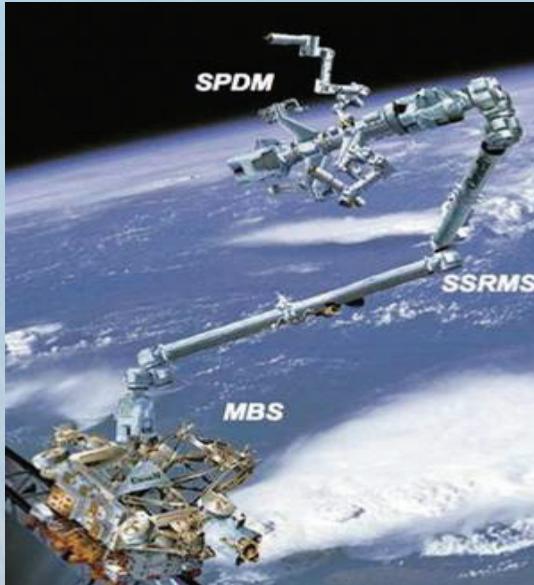
- ISS Nodes 2 and 3, and Columbus Lab
 - Boeing has provided AAS-I with ISS common hardware
- ISS Multi-Purpose Logistics Modules (MPLM)
 - AAS-I supports Boeing as prime contractor for Checkout, Assembly, and Payload Processing Services (CAPPS) contract (i.e., testing, processing, and management of Space Shuttle and expendable launch vehicle payloads)
 - AAS-I provides Boeing with engineering support for both MPLM ground processing at NASA KSC and flight operations in MER at NASA JSC
- Orion (CEV)
 - Collaborated with Northrop Grumman / Boeing team on phase 1 activities, as well as concept definition and trade analysis
 - Supported team in pursuit of design, development, and production contract award
 - Responsible for planning design, development, and production of pressurized structure of Crew Module



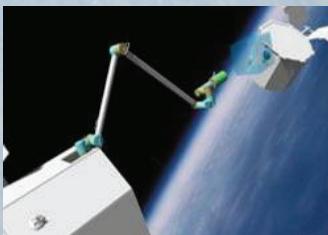
MacDonald Dettwiler & Associates

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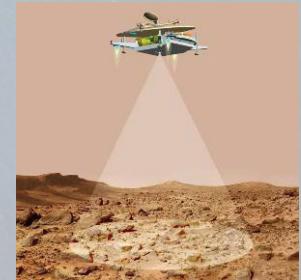
- **Shuttle**
 - Remote Manipulator System (SRMS or 'Canadarm')
 - Inspection Boom Assembly (IBA) developed for Space Shuttle return to flight
- **ISS Mobile Servicing System (MSS)**
- **Orbital Express (OE) Manipulator Arm Assembly (MAA)**
- **Precision Landing and Hazard Avoidance Technology Demonstration (PL&HA)**



Three Part ISS Mobile Robotic System



On-Orbit satellite servicing operations



Conceptual design for autonomous planetary lander



Our experience suggests that exploration interoperability could involve numerous dimensions.

Standardized Interfaces

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- Pressure vessels (any functional volume pressurized for human habitation: landers, habitats, rovers, logistics modules, etc.)
- Electrical outlets and plugs
- Liquid connectors for each type (e.g., water)
- Gas connectors for each type (e.g., oxygen)
- Data (e.g., Ethernet cables, RF/WiFi)
- Airlock control panels
- Spacesuit connections with habitat life support and environment control systems (servicing, recharging, umbilical operations)
- Robotic manipulating mechanisms (robot to system interfaces)

Interchangeable Assemblies & Components

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▪ Assemblies:

- Life support
- Power (management, generation, & storage)
- Waste management
- Thermal management
- Crew interface panel (e.g., command & control station)
- Airlocks
- Command & data handling systems

▪ Components:

- Microprocessors
- Valves
- Tanks
- Filters
- Keyboards
- Software
- Fans
- Computers
- Pumps
- Batteries
- Solar arrays
- Circuit boards
- Antennas

Possible Interoperability Benefits

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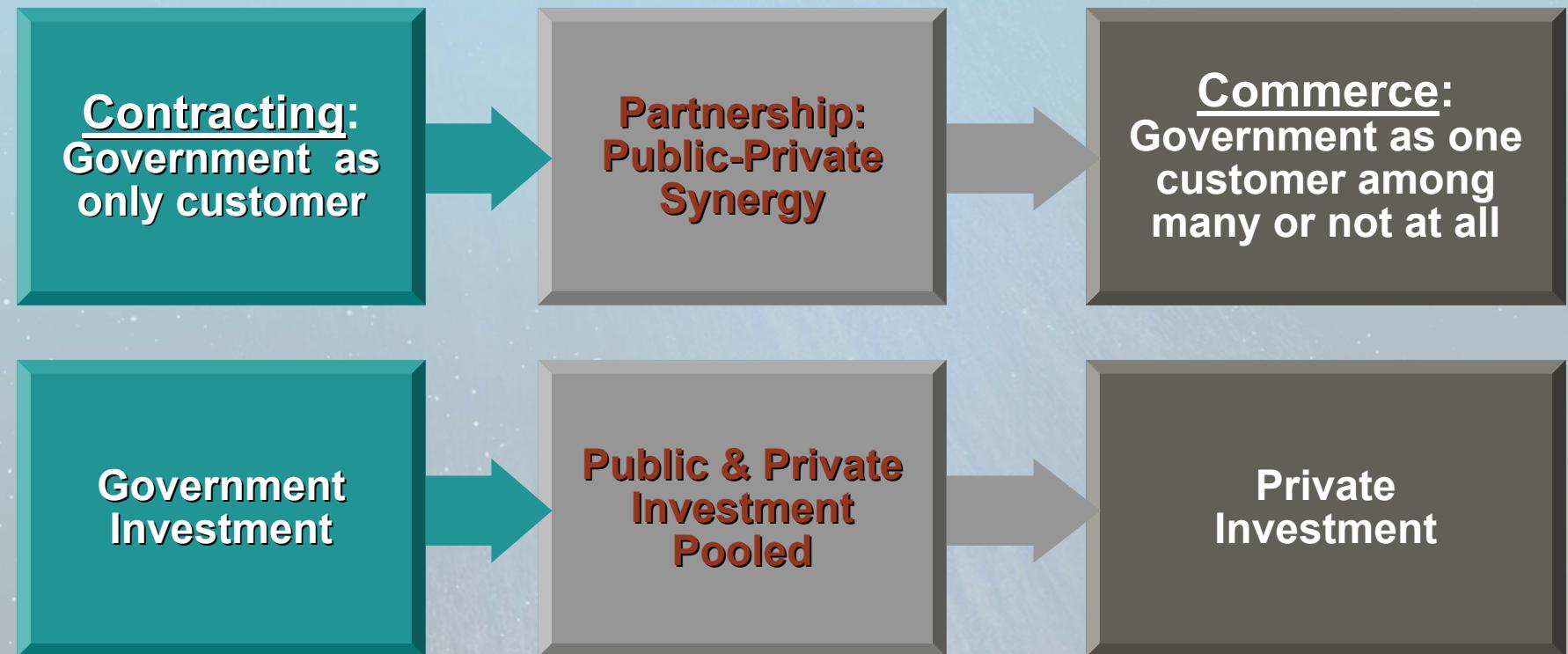
- **Reduced Cost**
 - Shared infrastructure & consumables
 - Increased competition in commercial markets
 - Decreased logistics overhead (i.e., fewer unique parts)
 - Enhanced reuse & reconfigurability (e.g., lander converted to propellant depot)
- **Increased Supply**
 - Larger customer base
- **Enhanced Safety**
 - Rescue
 - Repair
- **Expanded Investment**
 - Attractiveness of lower risk and larger markets



We recognize the importance of interoperability to *commerce*—a key to affordable and sustainable exploration.

Why Commerce Matters

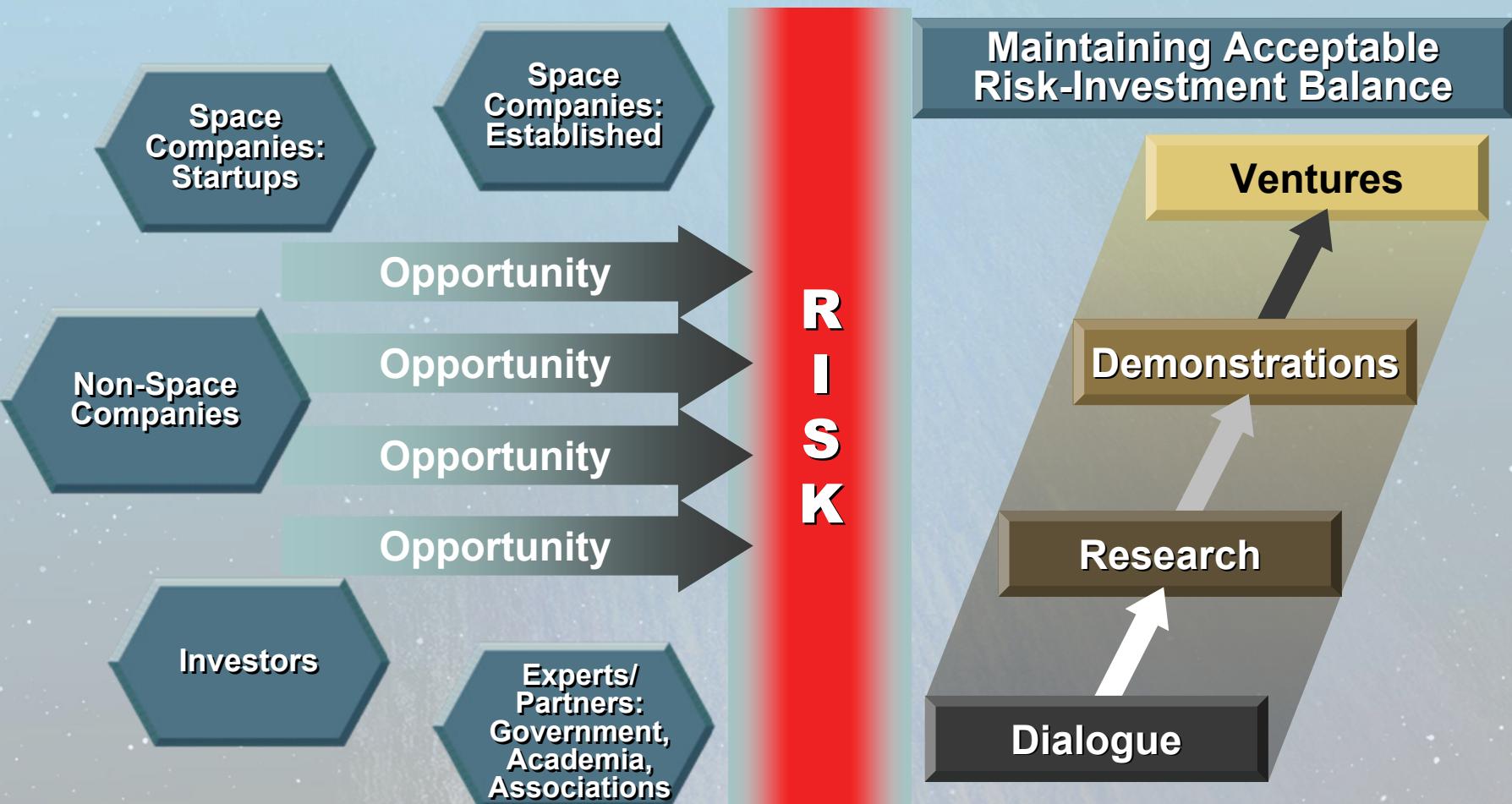
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Real commerce, with non-government customers, is the key to economic *growth*

Incremental Risk Management

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We are facilitating international commercial dialogue, relevant to interoperability.

Roundtable Series

Expanding Industry's Scope

www.lunarcommerceroundtable.com

▪ Roundtable 1

- Dallas, Texas – June 2005
- Broad survey of lunar-related opportunities

▪ Roundtable 2

- Houston, Texas – Oct. 2005
- Focus on lunar-related solar power, propellant, media, robotics

▪ Roundtable 3

- Las Vegas, NV – July 2006
- Shift focus to entire Earth-Moon economic system

Third Roundtable Sponsors



Honeywell

LOCKHEED MARTIN



 Lunar Transportation Systems^{Inc}

 Mitsubishi Corporation

NORTHROP GRUMMAN

Raytheon

Sectors & Interoperability

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- Solar Power
- Platforms
- Surface Facilities
- Services
- Information

Boeing Photo

Enablers & Interoperability

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Funding

Access to Space

Use of Space Resources

Legal/Regulatory Framework

Public/Private Sector Relationship

Risk Reduction & Interoperability

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- **Risks include:**
 - Market demand, residual value, funding availability, human factors, technical viability, legal-regulatory constraints, etc.
- **Risk reduction options include:**
 - **Industry:** Effective business planning, market research, team skill mix, etc.
 - **Government:** Advance purchase commitments, infrastructure investment, strategic planning, legal/regulatory frameworks, policy initiatives, as well as models for government-industry partnerships, etc.
- **Future roundtable options:**
 - Investor and public private partnership focus

Toward an Interoperable Future?

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- **Heritage:** Boeing is accustomed to working with international industrial partners, and we understand the value of interoperability.
- **Foresight:** Our experience suggests that exploration interoperability could involve numerous dimensions.
- **Adaptability:** We recognize the importance of interoperability to *commerce*—a key to affordable and sustainable exploration.
- **Inclusiveness:** We are facilitating international commercial dialogue, relevant to interoperability.