



SCOR Convergence Forum
30-31 October, 2006
Crowne Plaza Hotel Orlando- Airport USA

CONSTELLATION

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Contents



- ◆ **The NASA Human Space Flight Supply Chain**
- ◆ **Supply Chain Scope**
- ◆ **NASA Future Plans & Needs**
- ◆ **Defining a NASA Exploration Supply Chain for Understanding**
- ◆ **The Enterprise as we know it**
- ◆ **The Enterprise to be**
- ◆ **The NASA Supply Chain as we know it**
- ◆ **The NASA Supply Chain to be**
- ◆ **Simulation and SCOR**
- ◆ **SCC SCOR as an Efficient Approach for Managing and Understanding the Complexity in the NASA Exploration Supply Chain**



The NASA Human Space Flight Supply Chain... On Earth...



MAJOR SITES	NASA	RSRM	SSME	SRB	ET	Orbiter			
	Suppliers:	Boeing	USA	LM	HS	P&W Rocketdyne	ATK	Orbiter Suppliers	[ALL]

ATK Thiokol Propulsion
Brigham City, UT
Reusable Solid Rocket Motor

Edwards AFB, CA
Alternate Landing Site

Pratt & Whitney Rocketdyne
Canoga Park, CA
Space Shuttle Main Engines

White Sands Test Facility
Las Cruces, NM

Boeing
Houston, TX
Orbiter

Johnson Space Center
Houston, TX
Space Shuttle Program Office

United Space Alliance
Houston, TX
Space Operations

Lockheed Martin Michoud Assembly Facility
New Orleans, LA
External Tank

Stennis Space Center
Bay St. Louis, MS
SSME Test

Marshall Space Flight Center
Huntsville, AL
Space Shuttle Projects Office

NASA Headquarters
Washington, DC
Office of Space Flight

Kennedy Space Center, FL
Launch & Landing

United Space Alliance
Kennedy Space Center, FL
Launch, Landing, Logistics and SRB

Pratt & Whitney Rocketdyne
West Palm Beach, FL
Alternate Turbopumps



PRINT

DATA IS FOR INFORMATIONAL USE ONLY AND ACCURATE TO THE BEST OF OUR KNOWLEDGE AS OF 05/18/2006

Courtesy of: <http://www.frassanito2.com/SSPO/suppliers/>

The NASA Exploration Supply Chain, SCOR, Simulation & Analysis



The NASA Human Space Flight Supply Chain... Extending to Space...



10. MOE

MOE

- Crew Surface Days (CSD)
 - 0 [man-day]
- Expl. Mass Delivered (EMD)
 - 0 [kg]
- Exploration Capability (EC)
 - 0 [man-d-kg]
- Up-Mass Capa. Util. (UCU)
 - 0.931 [n.d.]
- Total Launch Mass (TLM)
 - 2928 [MT]
- Rel. Scenario Cost (RSC)
 - 1.18 [n.d.]
- Tot. Scenario Risk (TSR)
 - 0.004 [n.d.]
- Rel. Expl. Capability (REC)
 - 0.00 [n.d.]

5. Process

Transportation from Node 1001 to Node 1501
Element(s): 1 2 3 4 5 6 7 8

6. Date

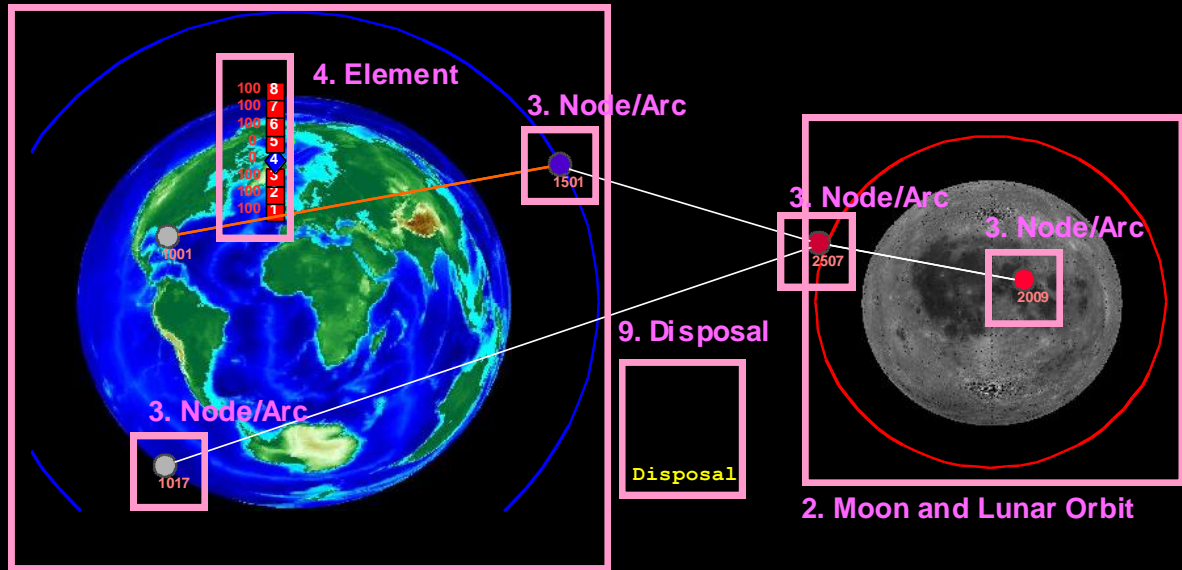
Date: 07-Dec-1972
Day 3

7. Node Information

Node	Name	Position
1001	NASA KSC	29N 81W
1017	Pacific Ocean	18S 166W
2009	Apollo 17 Landin	20N 31E
1501	LEO Parking Orbi	P 296 A 296 I 29
2507	LLO inclined	P 112 A 112 I 20

8. Element Information

EL#	EL Name	TRA	ACT	DIS	CRW
1	S-IC	X	X		
2	S-II	X	X		
3	S-IVB	X	X		
4	SLA	X			
5	CM	X			3
6	SM	X			
7	LM DS	X			
8	LM AS	X			

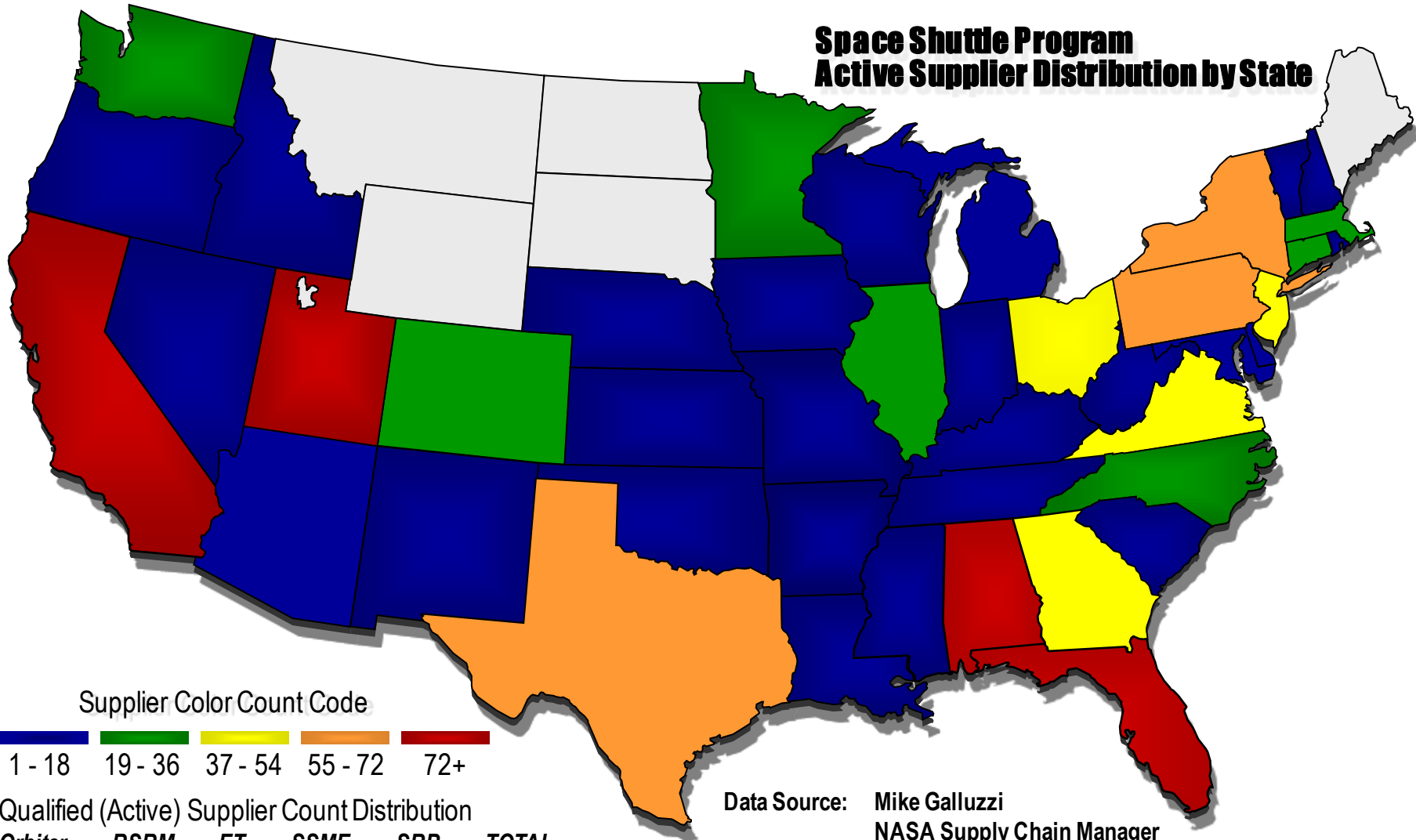


Courtesy of: <http://spacelogistics.mit.edu/about.htm>



A Supply Chain of over 1500 Suppliers...

Space Shuttle Program Active Supplier Distribution by State



Qualified (Active) Supplier Count Distribution

<u>Orbiter</u>	<u>RSRM</u>	<u>ET</u>	<u>SSME</u>	<u>SRB</u>	<u>TOTAL</u>
812	395	68	147	119	1,541

Data Source: Mike Galluzzi
 NASA Supply Chain Manager
 Strategic Sustainment Office

As of: 12/04



A Space Shuttle Operation Flowing:

- ◆ ~\$1B per year in material purchases as items, flight and ground element hardware, projects and tangible goods
- ◆ + ~\$3B per year in information as services, labor and intangibles
- ◆ ...in a low volume market with set demand for the transportation product of about 5 launches per year...
- ◆ ...with flight and ground technology that is usually custom, developing and not mature by commercial standards, and also low volume...
- ◆ ...incurring variance in all parts and processes, due to low volumes...
- ◆ ...while morphing into a new product line simultaneous with on-going operations...
- ◆ ...fulfilling as payload and ultimate “deliver-able” the parts and the in-space construction of an International Space Station in Low-Earth Orbit.





Amidst flawed tracking systems for following the money...



Follow *the money*



(...if you can)

- ◆ In May of 2004, the Government Accounting Office sent a Report to the Subcommittee on Space and Aeronautics, Committee on Science, House of Representatives
 - “NASA’s lack of Disciplined Cost-estimating Processes Undermines NASA’s Ability to Effectively Manage its Programs”.
- ◆ Numerous other similar critiques have surfaced over the decades...



Supply Chain Scope...two extremes...

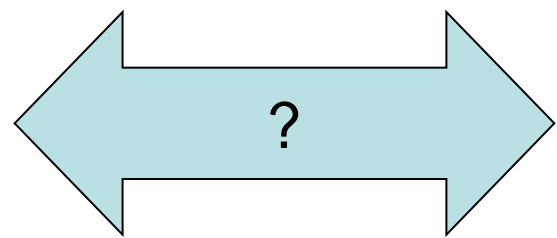
We are here

The combination of art and science that goes into improving the way your company **finds** the raw components it needs to make a product or service, **manufactures** that product or service and **delivers** it to customers. Plan, make, source, deliver, return.



Logistics is improved by good supply chain management

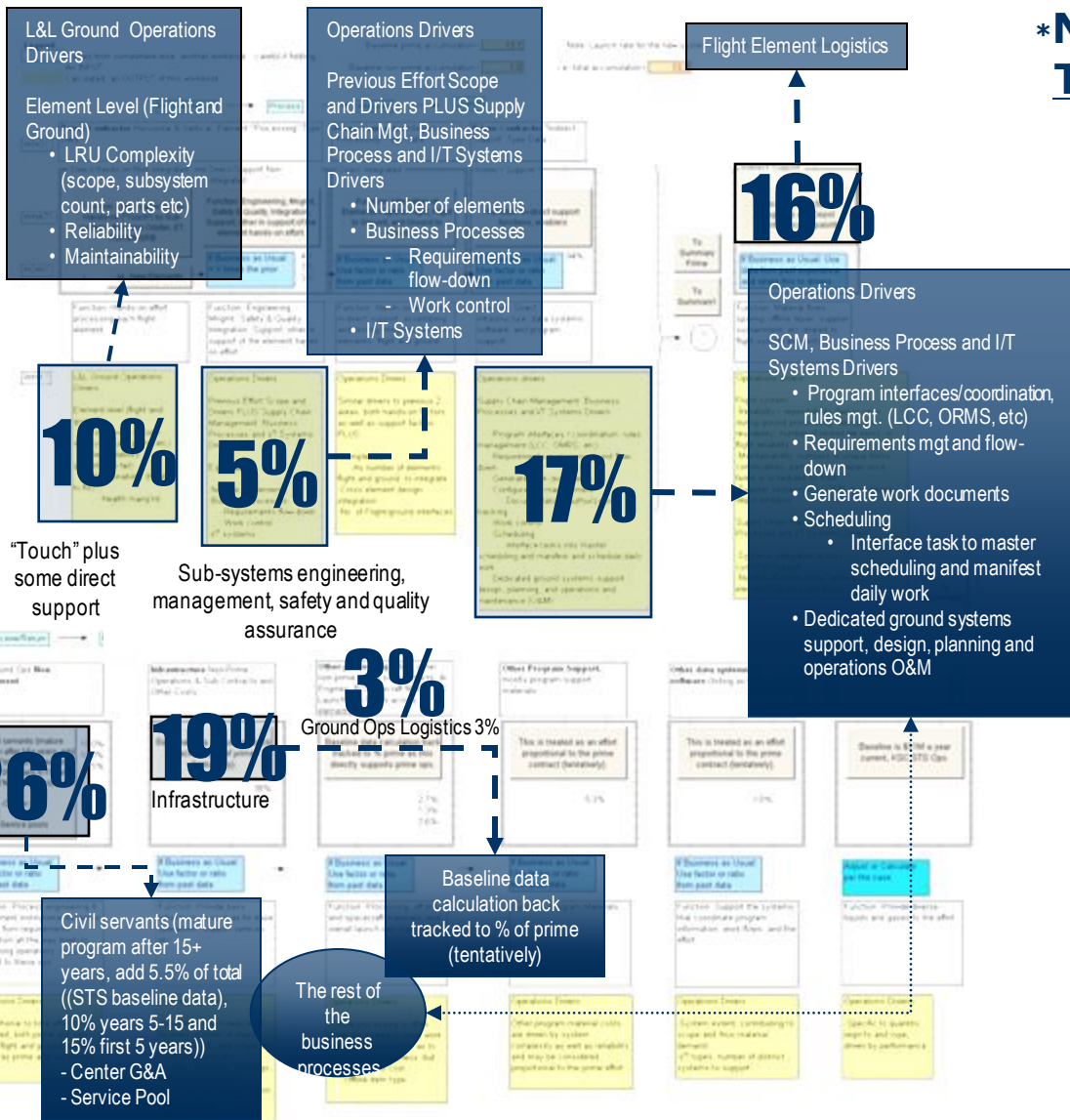
SCM as “deliver” only part of an organization





Perspective, Kennedy Space Center Shuttle Ops

USA SFOC



*Numbers reflect a % of Total Processing Costs

- Non-procurement -CS, sustaining, procure, finance** 26%
- Prime in-direct, business processes, I/T** 17%
- Flight logistics (Orbiter)** 16%
- Infrastructure** 16%
- Touch, plus support, business process, I/T** 10%
- Prime support** 5%
- Ground Ops Logistics** 3%
- 93%**

*All values under review for function, amount, uncertainty, and drivers

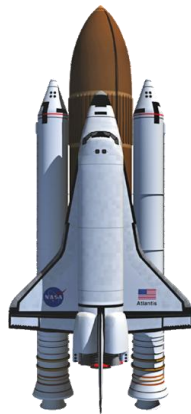


NASA Future Plans & Needs



◆ Flight Systems

- From one launch, to a two launch solution
- From Low-Earth orbit only operations to Lunar and Planetary capability



Space Shuttle



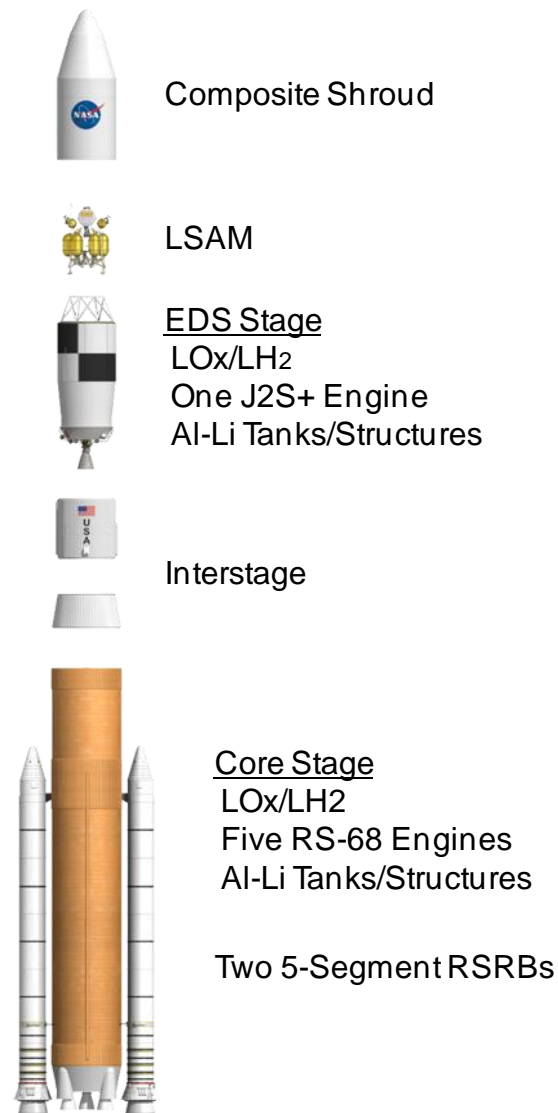
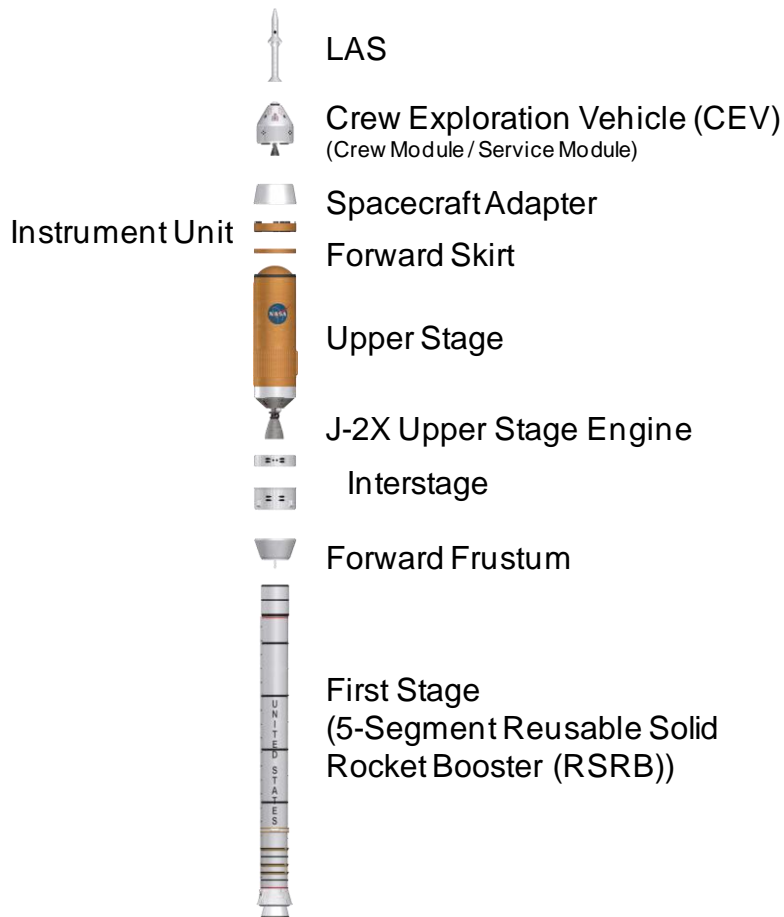
Crew Launch Vehicle
Ares I



Cargo Launch Vehicle
Ares V



Constellation Launch Vehicle Elements



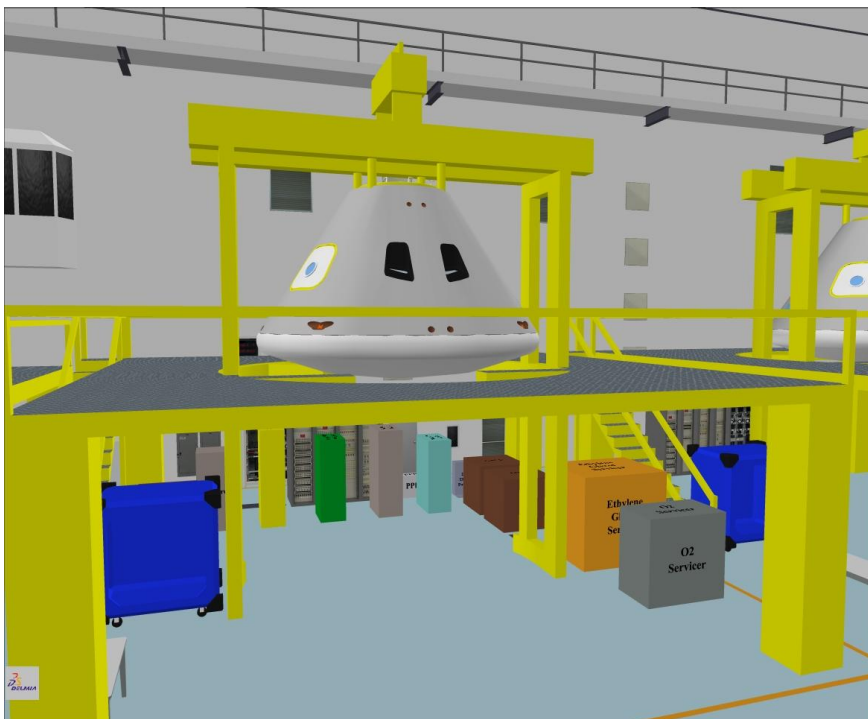
Ares I Crew Launch Vehicle

Ares V Cargo Launch Vehicle



◆ Ground Systems

- Migrating from reusable systems being processed to receipt of more expendable elements...





Our Exploration Supply Chain Definition



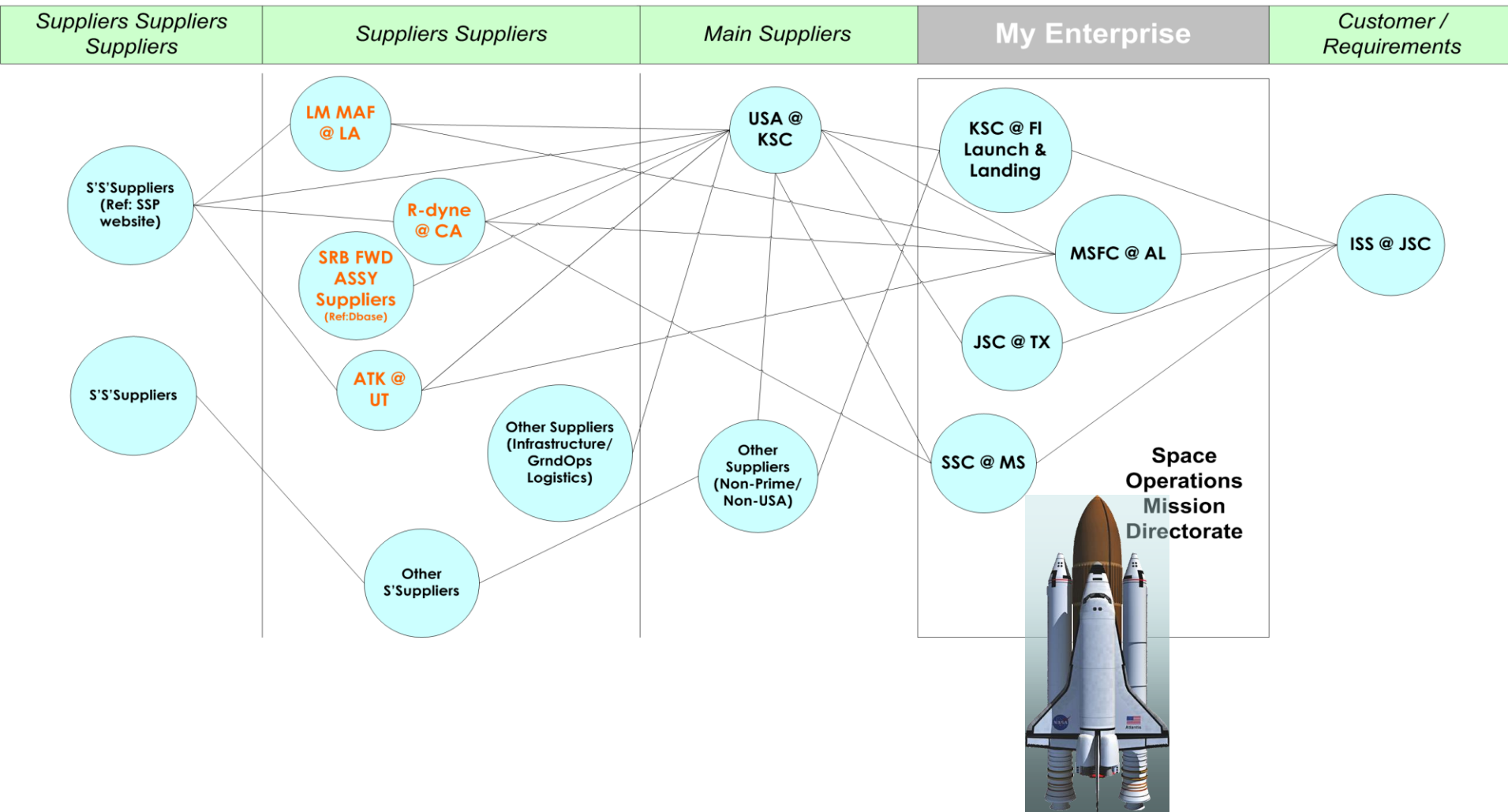
◆ We define an Exploration Supply Chain as:

The integration of NASA centers, facilities, third party enterprises, orbital entities, space locations, and space carriers that network/partner together to plan, execute, and enable an Exploration mission that will deliver an Exploration product (crew, supplies, data, information, knowledge, and physical samples) and to provide the after delivery support, services, and returns that may be requested by the customer.



The NASA Human Space Flight Space Transportation Supply Chain "As-is" viewed as an Enterprise Level Network

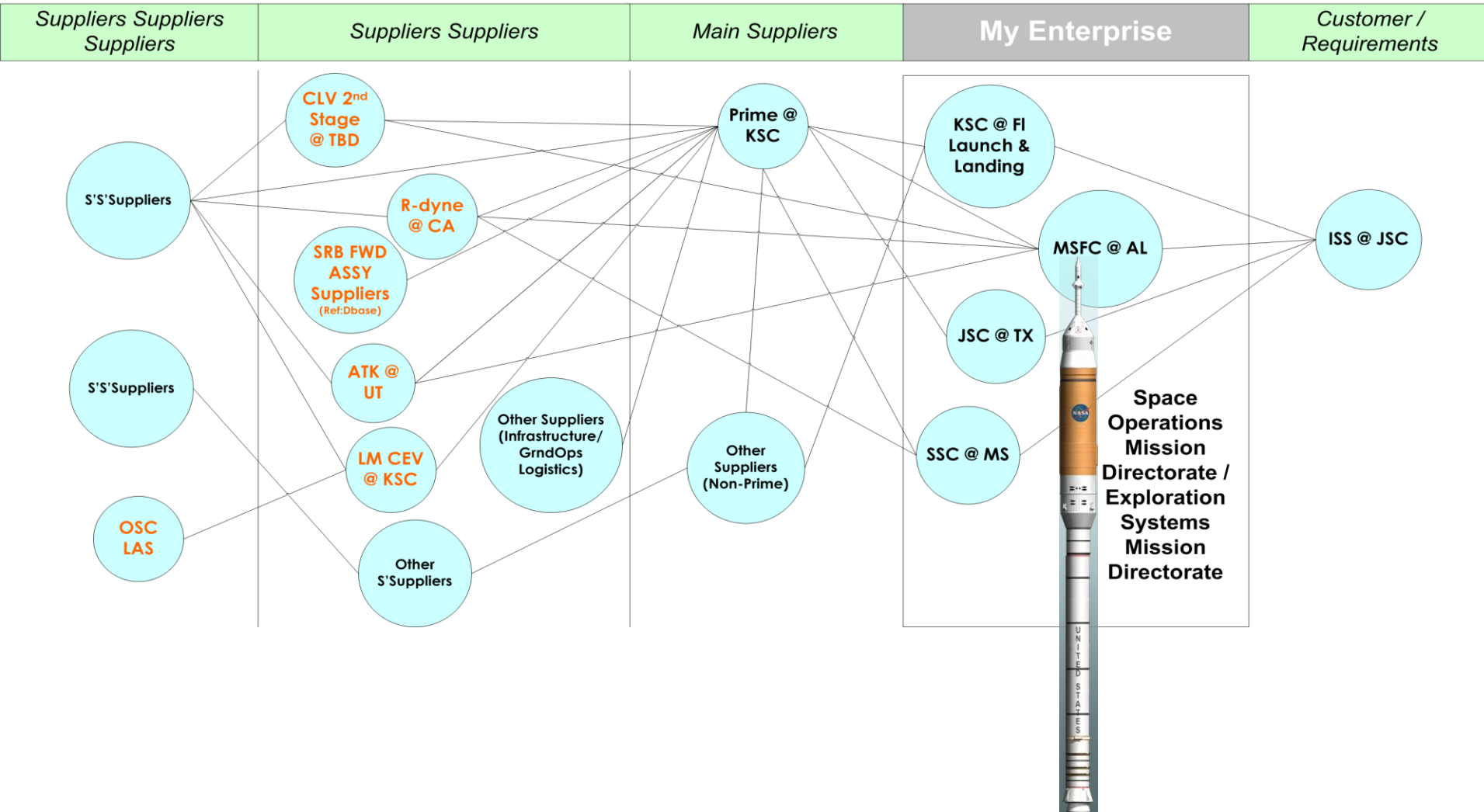
The Space Operations Supply Chain "As-is" Space Shuttle as a Relationship Network of Enterprises – These exchange Materials or Information





The NASA Human Space Flight Space Transportation Supply Chain "To-be" viewed as an Enterprise Level Network

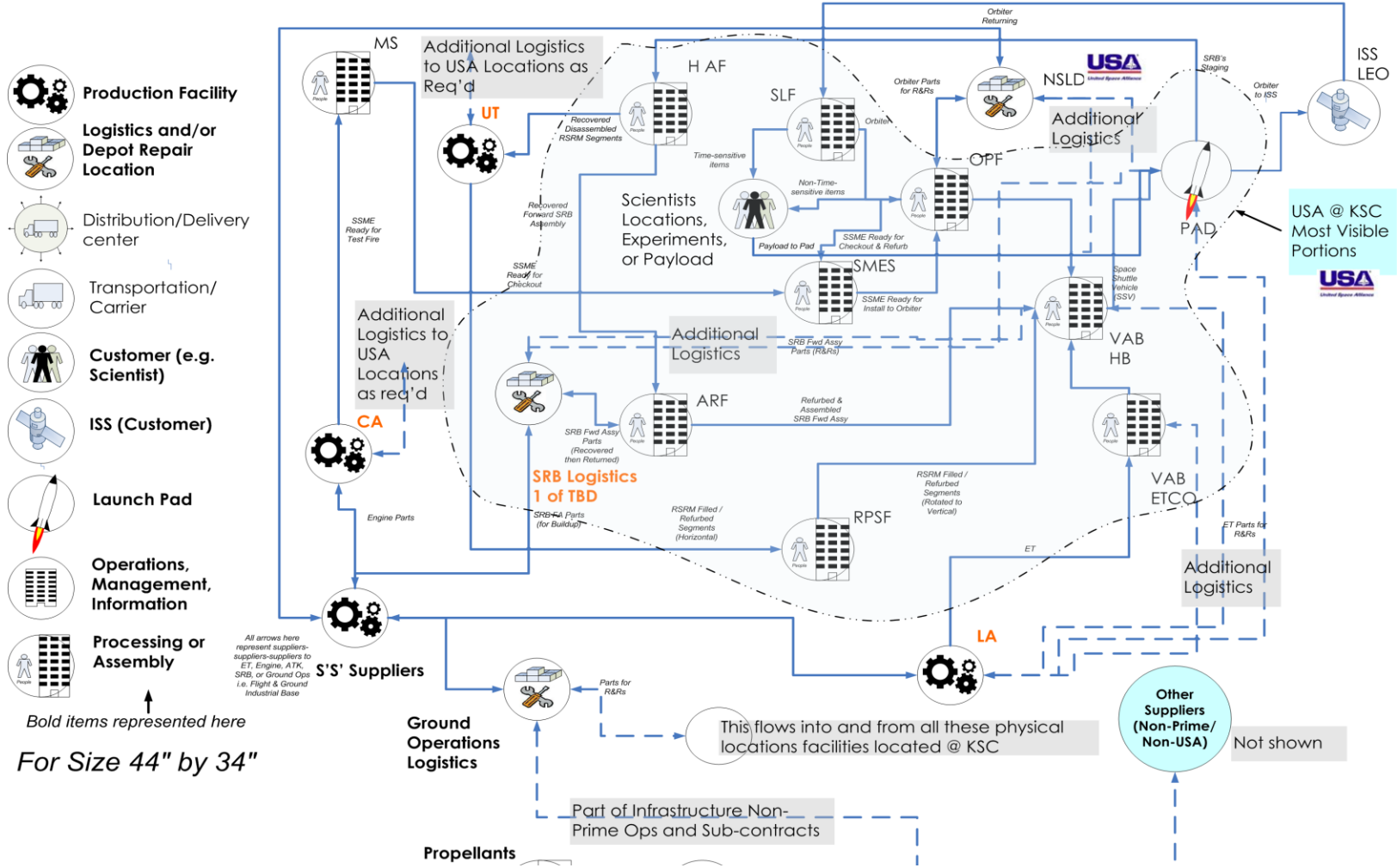
The Space Operations Supply Chain "To-be" Orion / Ares I as a Relationship Network of Enterprises – These exchange Materials or Information





The NASA Human Space Flight Space Transportation Supply Chain "As-is" viewed as an Functional Units...

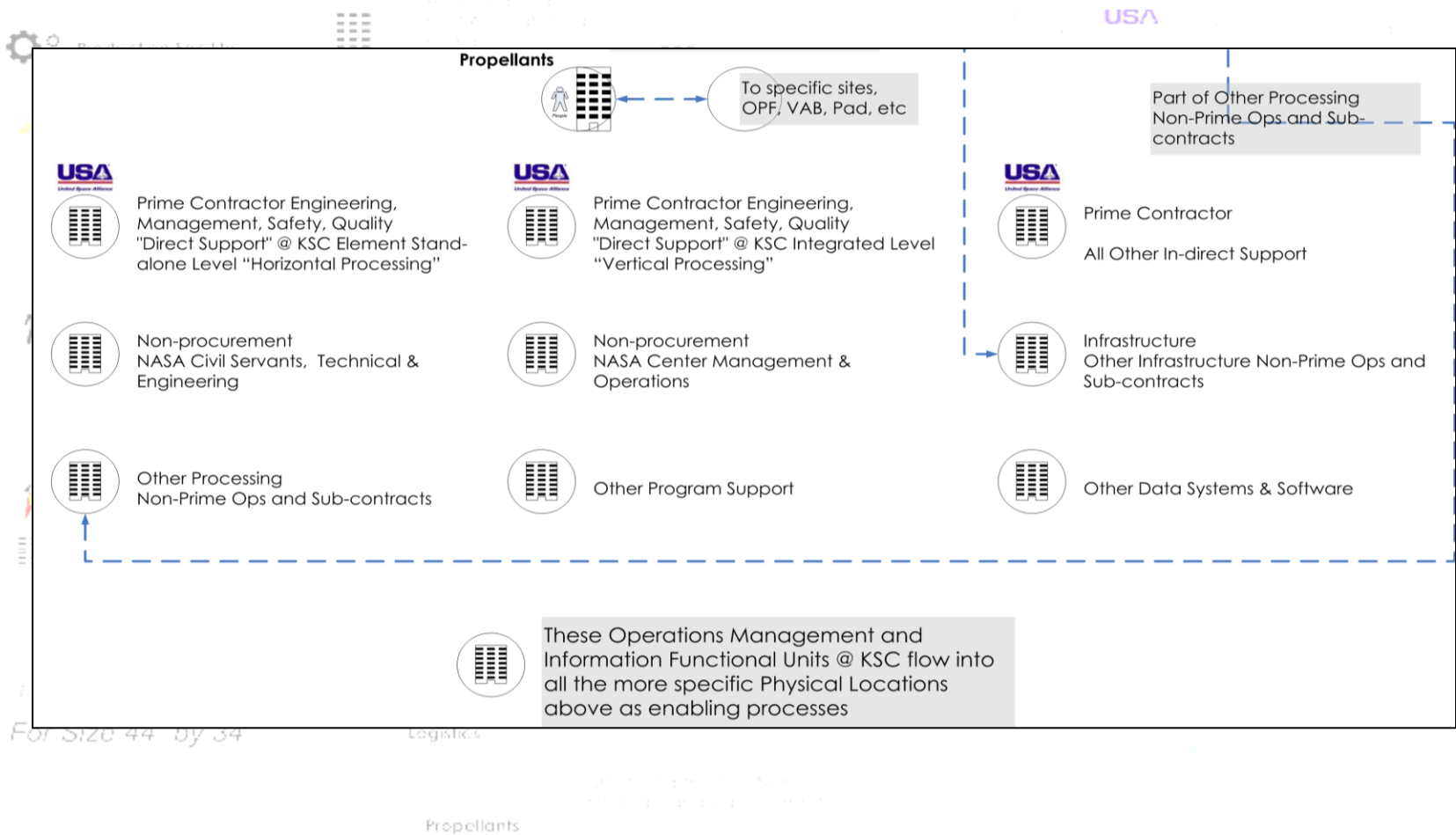
The Space Operations Supply Chain "As-is" Space Shuttle as Physical Locations of Major Enterprise Physical Functional Units – Each of these belongs to an Enterprise





The NASA Human Space Flight Space Transportation Supply Chain "As-is" viewed as an Functional Units...and Resources

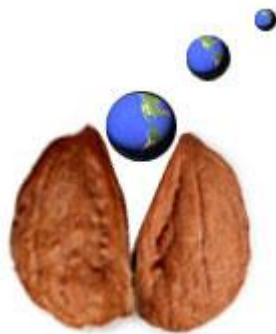
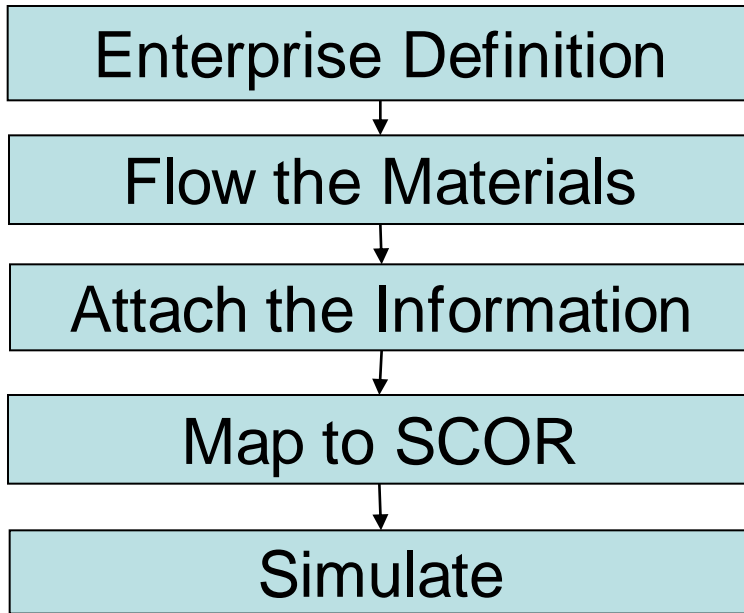
The Space Operations Supply Chain "As-is" Space Shuttle as Physical Locations of Major Enterprise Physical Functional Units – Each of these belongs to an Enterprise





Simulation and SCOR - E₂O Supply Chain Sim

http://science.ksc.nasa.gov/shuttle/nexgen/supply_chain_main.htm



Capture the knowledge
Represent the data
Estimate the “to-be”



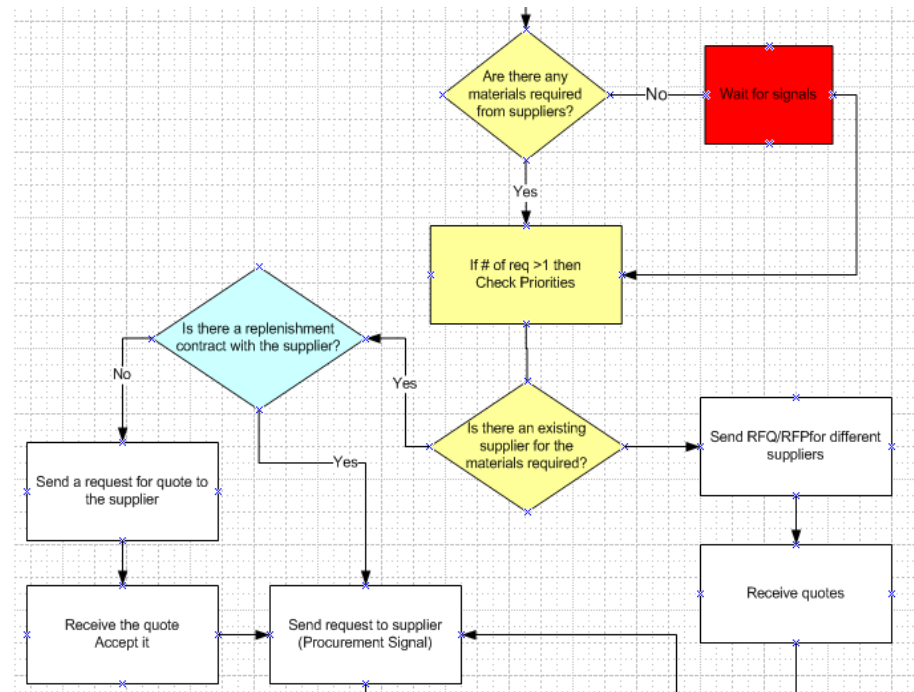
The Exploration Earth-to-Orbit Supply Chain Simulation project –

- NASA KSC
 - Edgar Zapata, PI
 - Mike Galluzzi, Shuttle SC Manager
- Productivity Apex Inc. of Orlando FL.
 - Sam Fayez, Ph.D
 - Mansooreh Mollaghasemi Ph.D



- ◆ Capability to analyze different, advanced operating scenarios and new initiatives:

- ◆ New designs & architectures
- ◆ Practices
e.g. VMI / VOI,
RFID, e-Shop
Floor,
commonality,
modularity, etc.

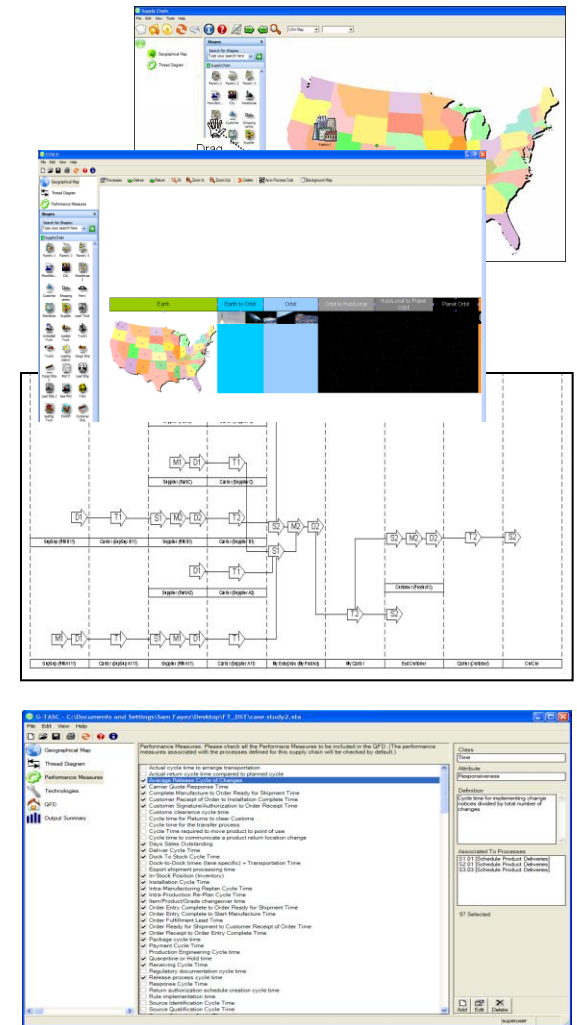




E₂O Supply Chain Sim The Interface



- Define a Supply Chain on a geographic and Space-time map.
- Automatically generate the process flow of the end-to-end Space Exploration Supply Chain
- Automatically generates the Key Performance Indicators relevant to the Supply Chain

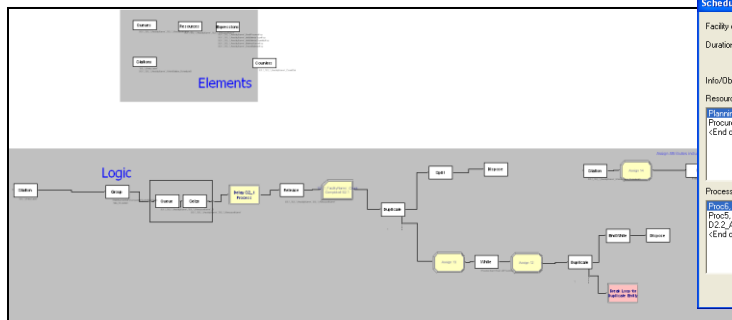




E₂O Supply Chain Sim The Simulation



- Simulation templates consistent with SCOR – Plan, Source, Make, Deliver, and Return
 - Automatically generate simulation models.



Schedule Product Deliveries

Facility or Object Name:

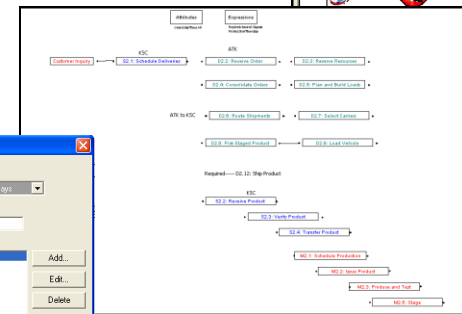
Duration: Units:

Info/Objects In: Info/Objects Out:

Resources	Objects Before
Planning Team 2.2	Mission Requirements
Procurement, Signal, Inv.	Procurement_Signal
Procurement, Signal, Inv.	Purchase_Order
Procurement, Signal, Inv.	Purchase_Order

Process After	Objects After
Procurement_Signal, Inv.	Procurement_Signal
D2.2 ATK, Purchase_Order, OI	Purchase_Order
D2.2 ATK, Purchase_Order, OI	Purchase_Order

OK Cancel Help





E₂O Supply Chain Sim Visualize the improvements...



Ability to model “what-ifs” that follow both time and money

Improvements by:

- Understanding the supply chain at a strategic level
- Design of the supply chain
- Application of best practices – quantified as to potential effects



● Classes ■ Slots ■ Forms ◆ Instances

CLASS BROWSER

For Project: ● NASA_SC61

Class Hierarchy

- :THING
- ▶ ○ :SYSTEM-CLASS
- ▼ ● MyNASA
 - ▶ ● On Earth
 - ▶ ● In Space
 - ▶ ● MyNASAx (hidden)
 - ▶ ● NASA_SupplyChains
 - ▶ ● NASA_SupplyChain_Materials
 - ▶ ● NASA_Functions
 - ▶ ● NASA_Processes
 - ▶ ● NASA_SupplyChain_Objects
 - ▶ ● NASA_SupplyChain_Information
 - ▶ ● NASA_SupplyChain_Information_Resources
 - ▶ ● NASA_SupplyChain_Performance_Measures
 - ▶ ● SupplyChain_Schemas
 - ▶ ● SupplyChain_Practices

▶ ● Time

▶ ● GEM-FLO

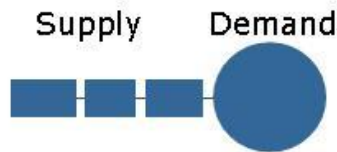
**The Complexity...it CAN be managed,
understood...and turned into useful knowledge**



How dynamic is the future state? Shaping demand rather than accepting it.

Present State

Linear, push manual practice



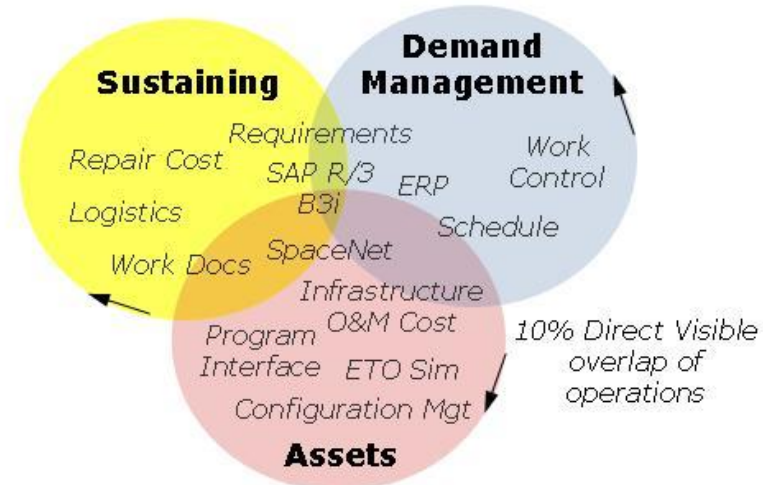
10% is what we see...results... and all that "other processing stuff" where the time and money is...**90%** what we don't see.



Accepting demand
New technology an exception
Deterministic optimization

Future State

Circular, self-renewing simulation model



Shaping demand
Embedded technology insertion
Probabilistic planning optimization



Also Using SCOR: ESATA “LLEGO”

http://science.ksc.nasa.gov/shuttle/nexgen/ESATA_main.htm

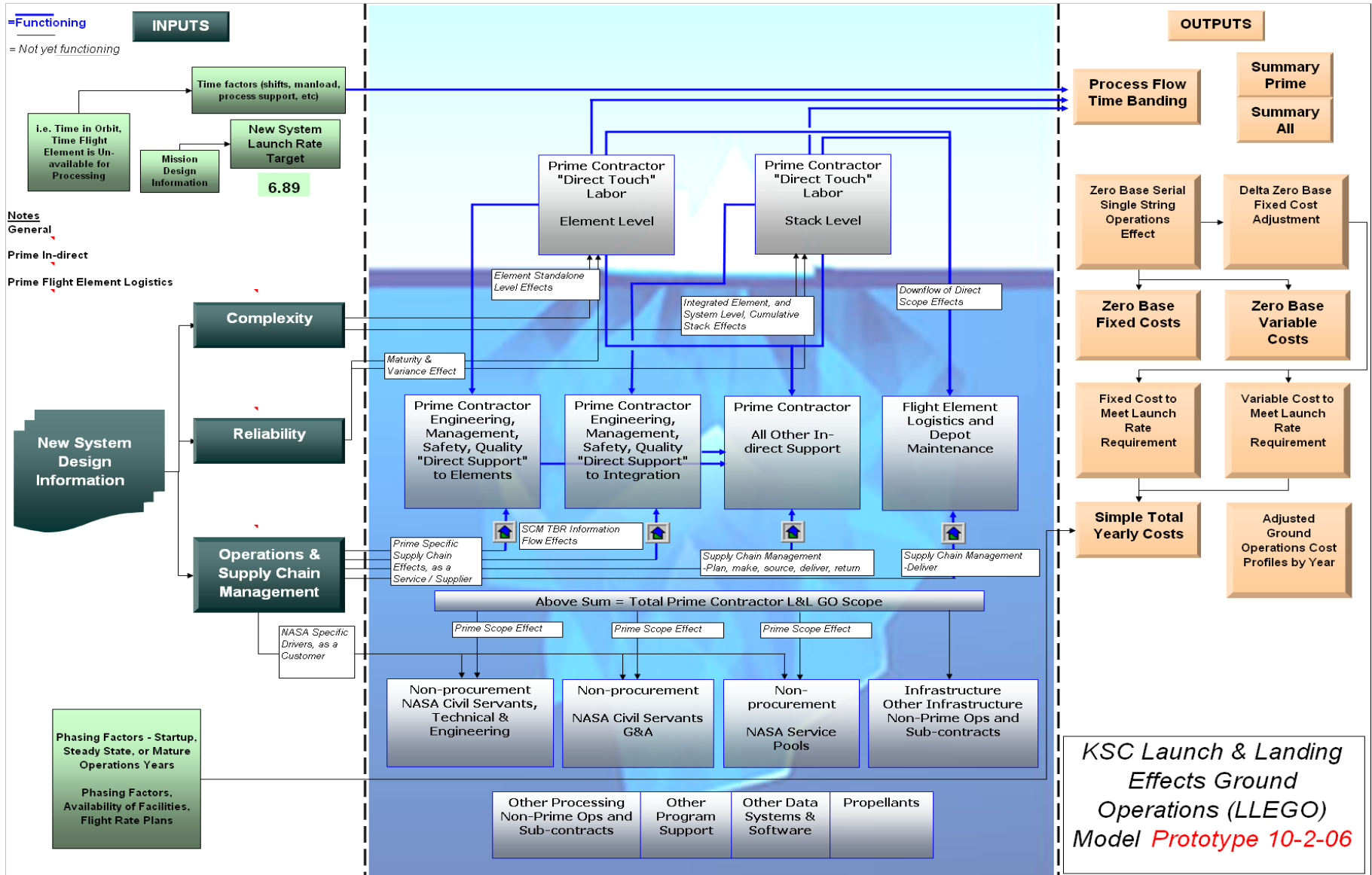


- ◆ Explorations Systems Analysis and Technology Assessment Project
 - This research and development project:
 - Will create a model that provides linkage between the what, how and why of Launch and Landing costs and flow times, reflecting on future affordability and responsiveness for space launch, specifically the Exploration architecture.
 - Locate the rudders
 - Communicate to key decision makers and stakeholders
 - Quantify
 - Model



ESATA & The Iceberg: Root Influences, \$ and Time

http://science.ksc.nasa.gov/shuttle/nexgen/ESATA_main.htm



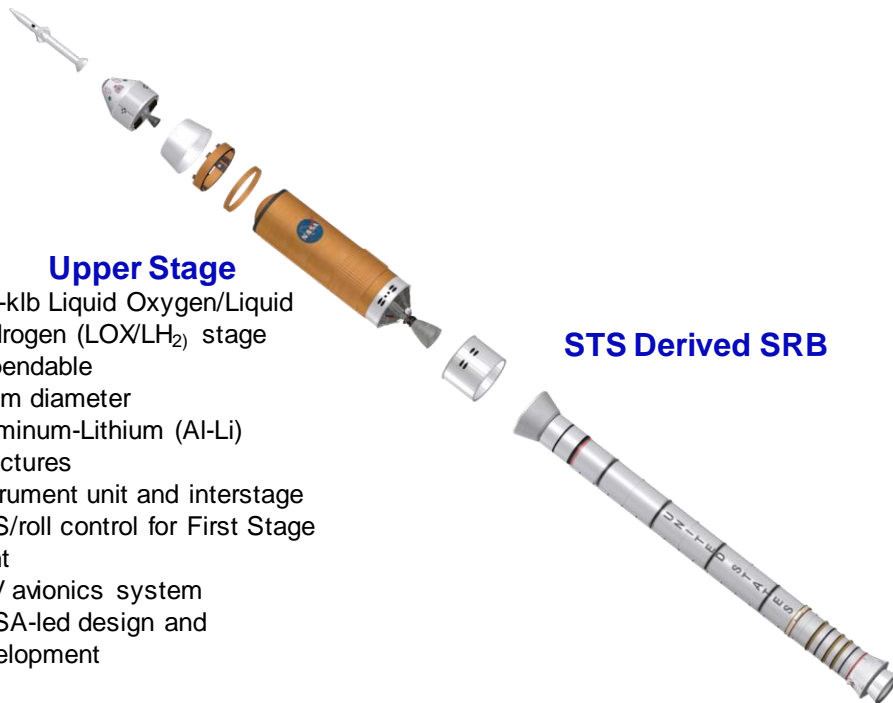


ESATA & The Iceberg: Root Influences, \$ and Time

http://science.ksc.nasa.gov/shuttle/nexgen/ESATA_main.htm



- ◆ **Complexity and reliability influence product outcomes such as cost, safety, responsiveness (time to process a launch) and growth potential.**
- ◆ **Strive to establish, understand and quantify design operability drivers and influence on the product outcomes**
- ◆ **Work with designers, collaborate early and often**



Upper Stage

- 280-klb Liquid Oxygen/Liquid Hydrogen (LOX/LH₂) stage
- Expendable
- 5.5-m diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- RCS/roll control for First Stage flight
- CLV avionics system
- NASA-led design and development

STS Derived SRB



CEV / Orion Crew Exploration Vehicle



Closing



- ◆ **Project “E₂O SC Sim” is currently go through November**
 - Project runs through June 2007.
- ◆ **Project “ESATA/ LLEGO” is go through August 2007**

- ◆ **Work to date has shown:**
 - SCC SCOR as an Efficient Approach for Managing and Understanding the Complexity in the NASA Exploration Supply Chain
 - Ability to connect knowledge based ontology approach to an automatically generated simulation via a graphic user interface
 - Program once, use many times!

- ◆ **A Supply Chain Perspective has already proven useful in just organizing data – what is flowing? Where? Why? What information is virtual? What are the enabling processes? The match to “resources” and NASA flow of product, even at low volume, is especially applicable.**



Backup

