

---

# Space Communications Architecture

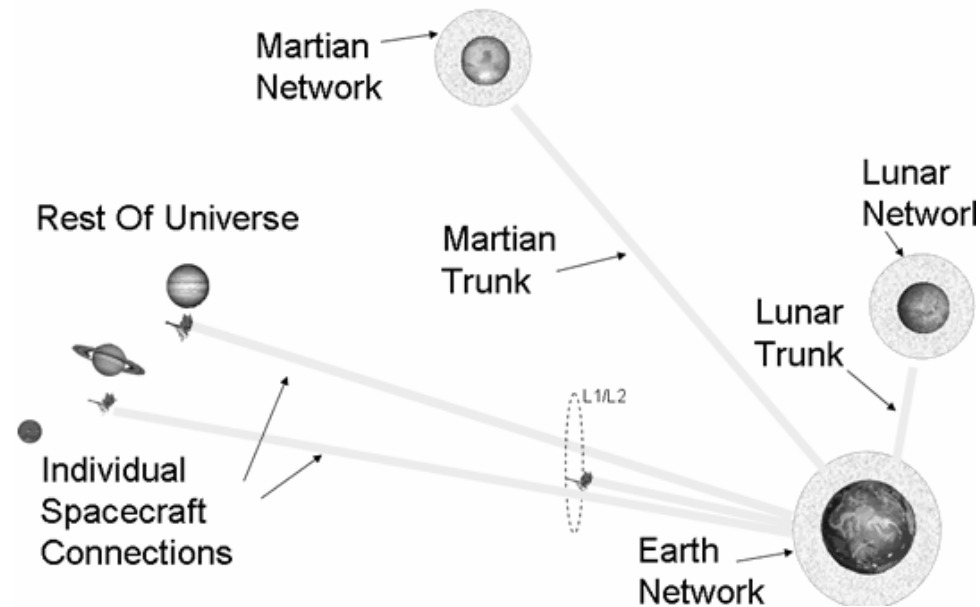
## Application Portfolio

Jennifer Underwood  
5 December 2005

# The System

---

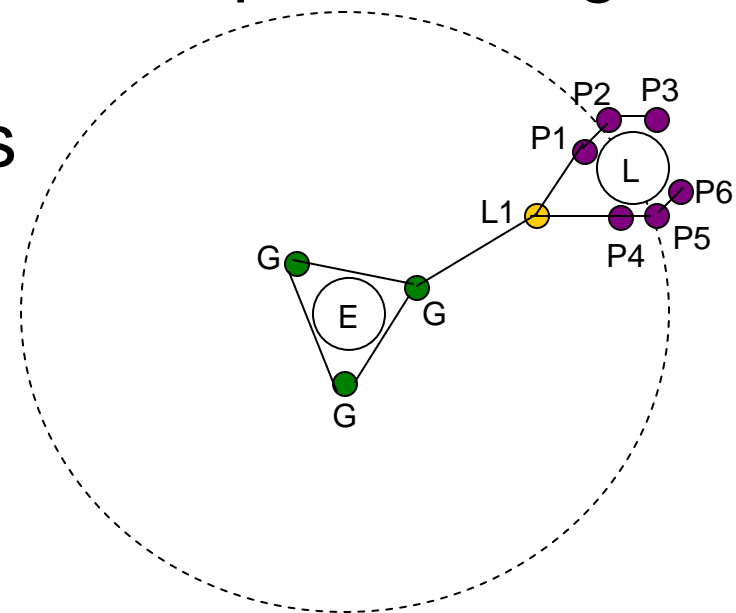
- Infrastructure to support the NASA Space Communications Architecture Vision.



# Current Design

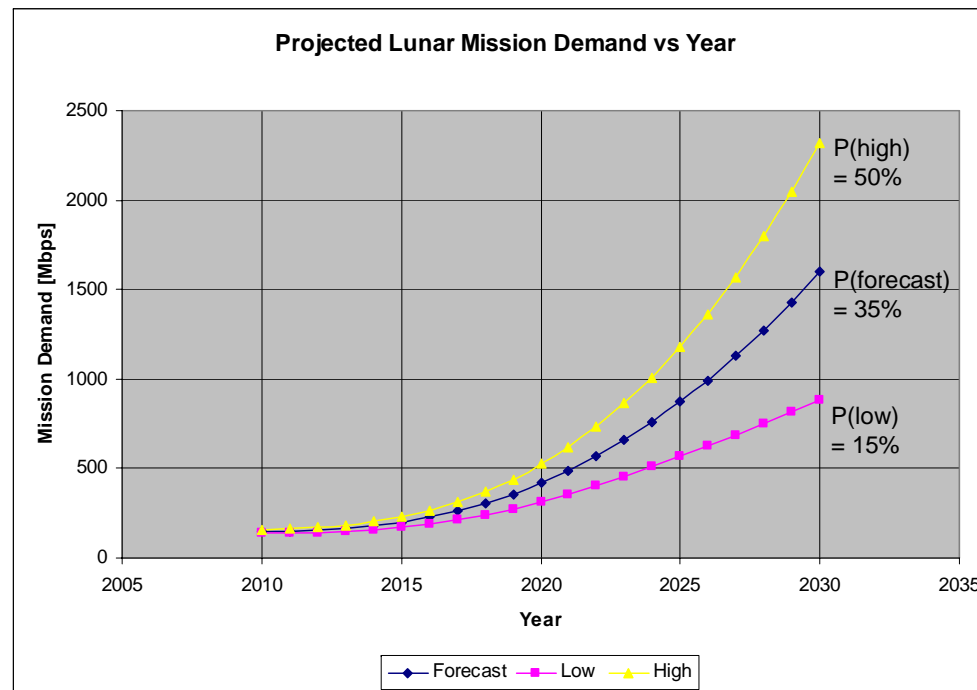
---

- Space assets in orbit about the moon (P1-P6) and at L1.
- 3 Geostationary satellites (G) provide connectivity to Earth – assumed pre-existing and not included in analysis.
- Uses distributed platforms to enable expansion of link capacity at each location.



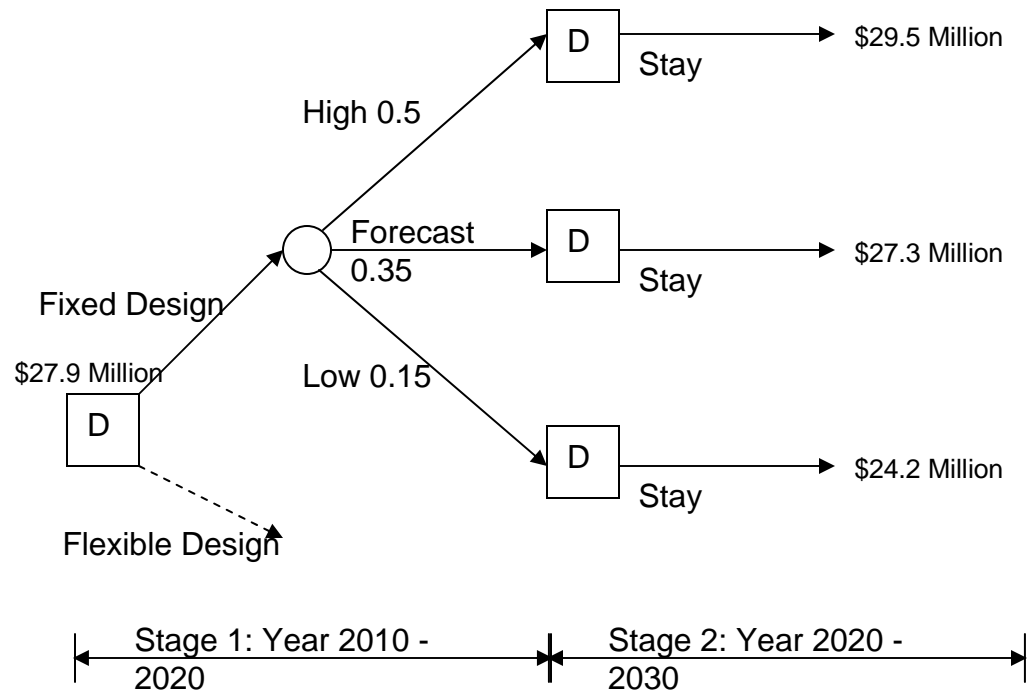
# Future Operational Decisions

- Salient uncertainty is mission demand.
- Can expand link capacity by launching additional space assets.



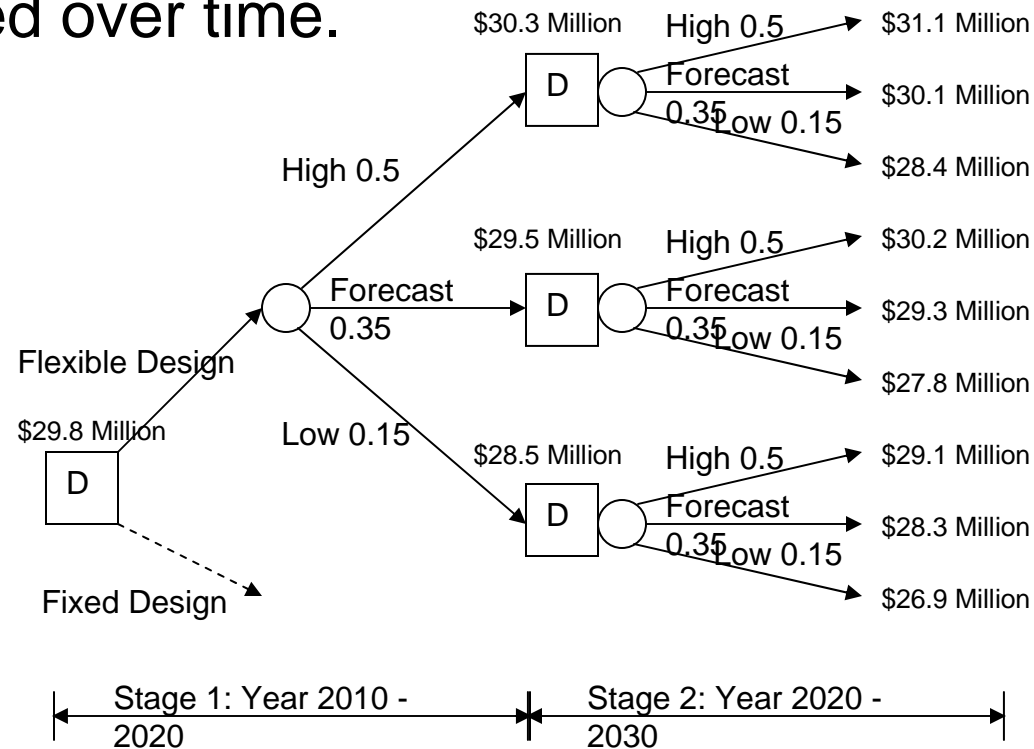
# 2-Stage Decision Analysis: Fixed

- The NPV values are for the discounted costs of the system based on the required antenna diameter sizes to provide the required communication capacity.



# 2-Stage Decision Analysis: Flexible

- The flexible design has the space assets in the same locations as in the fixed design, but the capacity can be expanded over time.



# 2-Stage Decision Analysis Results

---

- Fixed: \$27.9 Million
- Flexible: \$29.8 Million
- Fixed design costs less.

Recommendation: Fixed design if all you can do is adjust the capacity for this system over 2 periods.

# Lattice Analysis

- Option is to launch a secondary spacecraft in each slot to boost the link capacity as needed.

Expected Value of the System Value Recognizing Uncertainty using the Probability Weighted Net Value

	0	1	2	3	4	5	6
	0	91	47	15	9	27	41
		41	54	49	34	13	10
			11	22	29	30	23
				3	8	13	18
					1	2	5
						0	1
							0
E [Value]	0	132	114	92	66	37	2
							442

= Cost Function(x)  
 \* Probability(x) =  
 188.00 \* 0.06

# Decision Analysis with Lattice

- Exercising the option during period 4 appears to increase the net “value” of the system by a significant amount

Expected Value of the System with Option Exercised

WITH OPTIONS	0	1	2	3	4	5
(check next year)	629	556	370	230	149	143
		863	653	478	349	284
			820	594	390	216
				754	532	328
					618	396
						437

$$=594*p+754*(1-p) + \text{Cost}$$

$$\text{Function}(x) =$$

$$594*0.7622 +$$

$$754*0.2378 + 188 = 820$$

Value of the Option to Boost Capacity

<b>Value of option =</b>	629
-	442
	<b>187</b>

# Design Recommendation

---

- Fixed design with option to expand the link capacity during the fourth period.
- Future analysis should consider impact of expanding the system by asset location rather than capacity.

# Assumptions

---

- Models are very simplistic and ignore many important aspects of the system.
- Considering location over capacity likely to be more interesting and meaningful.
- Portfolio provides an example of how to apply approach to the SCA.