Real Options for the Satellite Fleet of a Commercial Remote Sensing Company

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AERO ASTRO

Motivation

GeoEye Commercial Remote Sensing Company

- Serves a wide variety of customers
- Works in a small, dynamic market
- Faces uncertainty in demand and regulation
- Is limited in ability to change satellite design after launch
- Uses two primary types of satellites

Image Source: www.geoeye.com

GeoEye's Customer Base

Customer	Main Application	Satellite(s)	Nominal % of Demand
U.S. Military	High Spatial Res Color Photos	IKONOS/GeoEye-1	40
International	High Spatial Res Color Photos	IKONOS/GeoEye-1	46
Other US Gov't	Scientific Imagery at low spatial res	OrbView-2	5
Microsoft/Yahoo!/Google, etc	High Spatial Res Color Photos	IKONOS/GeoEye-1	3
Commercial Fishing	Scientific Imagery at low spatial res	OrbView-2	3
Other	High Spatial Res Color Photos	IKONOS/GeoEye-1	3

Demand and Regulatory Uncertainty

Year	*2006*	*2005*	*2004*	*2003*	*2002*
Revenue ($M)	151	41	31	9	16
Expenses ($M)	82	38	34	11	10
Profit ($M)	68	2	-2	-1	5

Regulatory Scenario	Consequence for Commercial Remote Sensing Industry
Favorable federal policy	Increase in demand
War or defense crisis	Increase in demand
Negative government policy	Decrease in demand
Change in NASA Landsat Data Continuity Mission	Potential Increase in demand

GeoEye's Satellite Design Options

Categories	Design Variables
Instruments	•Number of instruments •Types of instruments •Spatial resolution (meters) •Spectral resolution (nanometers of wavelength)
Orbit	•Orbit altitude •Revisit time
Mission	•Mission design lifetime

Alternative Satellite Designs

Design Variables	Category A	Category B	Hybrid
Number of Instruments	2	1	2
Type(s) of Instruments	Panchromatic and Mulitspectral Sensors	Panchromatic	Panchromatic and Mulitspectral Sensors
Spatial Resolution	1 meter (high spatial resolution)	1 kilometer (low spatial resolution)	1 meter and 1 kilometer
Orbit Altitude	650 kilometers (low altitude)	705 kilometers (high altitude)	capable of either 684 or 705 km
Revisit Time	Every 3 Days (infrequent)	Daily (frequent)	capable of daily or every 3 days
Mission Design Lifetime	10	10	10
Cost per observation hour	$10,000	$8000	$8000 when acting as B, $10,000 when acting as A
Cost of Satellite	$500 Million	$350 Million	$550 Million

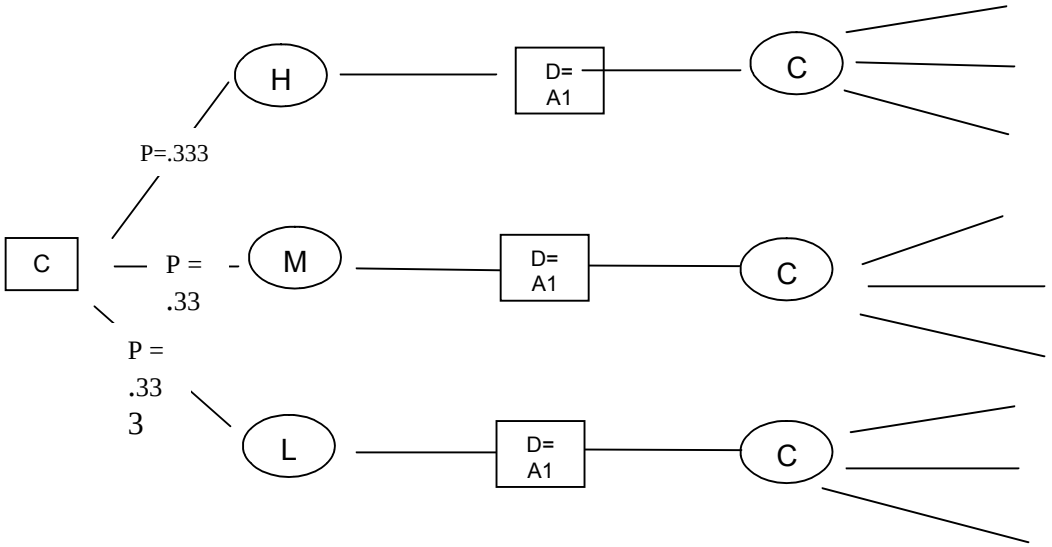
Alternative Fleet Designs

Architecture	Strategy	# Satellites	Cost Schedule, paid by GeoEye
1 (Fixed)	Launch 2 A sats and one B sat at year zero	3	Pay $500M for each A sat and $350M for B sat. Total is $1350M
2 (Delay)	Launch 1 A sat and 1 B sat at year 0. At year 5 decide whether to launch additional A sat or no sat.	2 or 3	Pay $850M in year 0 and possibly pay $500M in year 5
3 (Flex)	Launch 2 A sat and 1 hybrid sat in B format. Decide whether to change hybrid to A at year 5.	3	Pay $1550M in year 0

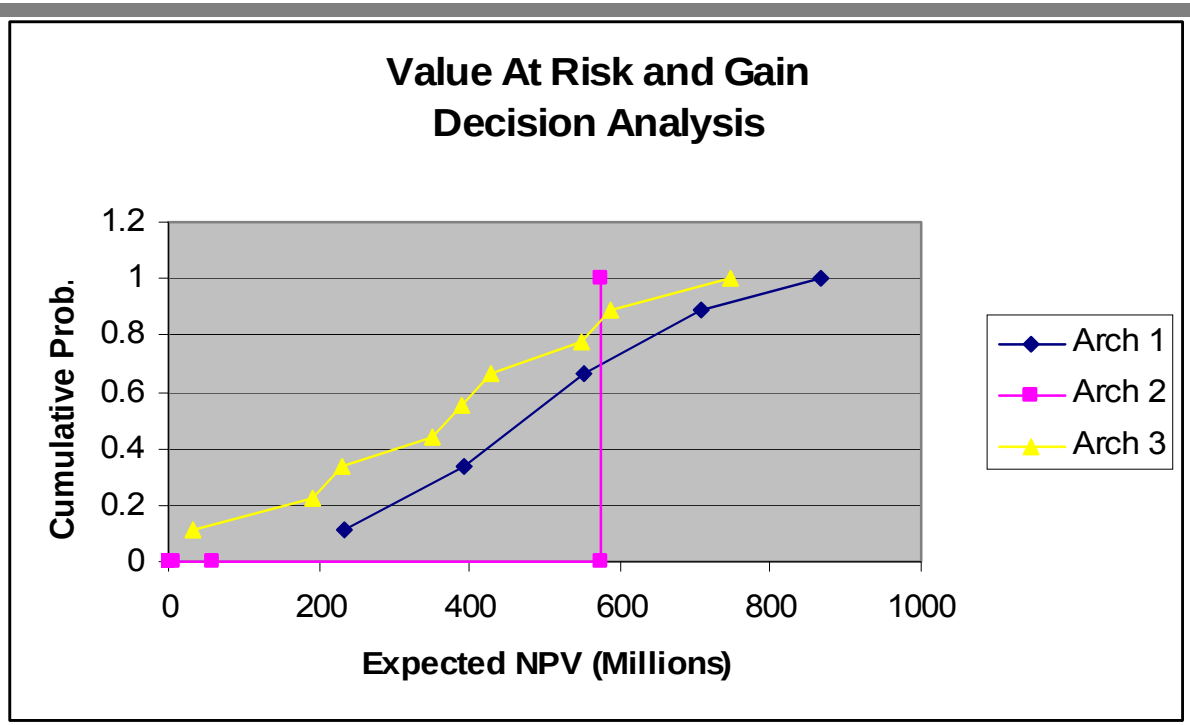
Decision Analysis: Assumptions

- Demand could take values of High, Medium and Low
- Probability of each demand level = 1/3
- 2 stage analysis; each stage = 5 years
- Satellite capacity = 24 hours/day for 330 days per year
- Price per hour (A) = $10,000; (B) = $8000

Notional drawing of the section of the decision tree for ARCH 1 (Fixed)



Decision Analysis Results



Architecture	E[NPV] ($M)	Max NPV ($M)	Min NPV ($M)	CAPEX ($M)
1 (Fixed)	**$812**	**$868**	$234	-1350
2 (Delay)	$576	$576	**$576**	**-850**
3 (Flex)	$390	$747	$34	-1550

Lattice Analysis Assumptions

- Modeling Demand
  - Starting Value = $150 Million
  - Growth Rate (v) = 4%
  - Standard Deviation (σ) = 10%
  - Probability of Upside Growth, P, = .7
  - Upside Factor, u, = 1.105
  - Downside Factor, d, = .904
- Modeling Cost
  - CAPEX = $1.15 B
  - OPEX = $10 M/year/satellite
  - Fleet Maintenance = $100 M

p	0.7	$0.5 + 0.5\,(v/\sigma)\,(\Delta t)^{0.5}$
u	1.105	$e\,\exp[\,(\sigma)\,(\Delta t)^{0.5}]$
d	0.904	1/u

Lattice Analysis Results

Reduce Fleet	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
WITH OPTIONS		**NO**	**NO**	**NO**	**NO**	**NO**
(check next year)			**NO**	**NO**	**NO**	**NO**
				NO	**NO**	**NO**
					NO	YES
						YES

Value of option =	0.9721	Billion	NPV with option
-	0.9732	Billion	NPV w/o option
	0.0011	Billion	

Conclusions

- Decision Analysis appeared to favor fixed architecture
- Limitations of Decision Analysis Results
  - A risk averse manager may prefer Delay Architecture (2); no risk
  - Decision Analysis is not good for modeling demand growth in hours, better for modeling regulatory changes
  - 5 year delay in Architecture 2 was arbitrary and could be better chosen by management
  - Analysis should be reconsidered with better estimates for cost of flexible architecture
- Lattice Method showed potential economic benefit for option to reduce fleet size
- Consider using Discounted Cash Flow analysis with simulation to consider how GeoEye can respond to changes in make up of customer base
- There is much potential for benefits from real options in satellite fleet design