Innovative Procurement Approach for Satellites Constellations on Institutional Market

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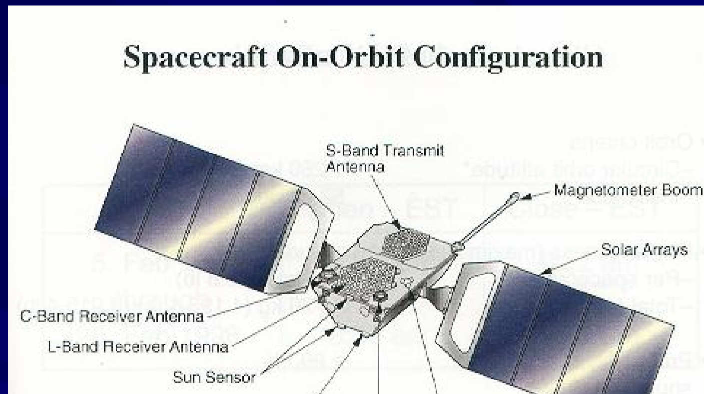
Why Innovative approach required on Institutional Market?

- Setting up a satellite constellation is project:
  - Large (costly and lengthy)
  - Complex (global, system layer over multi satellites management)
  - Risky (size, technical performances, serial production)
- Strong difference in business focus between private and institutional market
- Constellations have characteristics compared to single satellite projects that may be further exploited:
  - A single satellite failure will normally cause smooth and limited degradation of the service
  - More flexible procurement schemes can be envisaged

Few examples from the Commercial Market

Globalstar



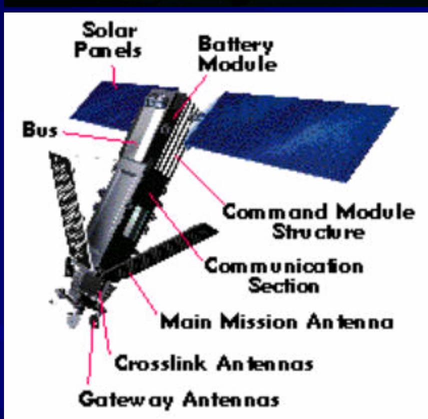
GLOBALSTAR		
Satellites		
Contractor	Space System/Loral	
Payload	S and L Band	
Platform	LS-400	
Dry Mass	400 kg	
Life time	7.5 years	
Constellation		
	48 satellites	
	8 orbital planes	
	4 spares in orbit	
	52 deg inclination	
	1410 km altitude	
Business		
Service	mobile satellite voice and data	
FCC filed	1995	
Initial Investment	1800 MUSD	
Company's history		
Globalstar LP	1991	
Globalstar LLC	2003	
Globalstar Inc.	2006	
Main adverse events		
Loss 12 satellites launch failure		1998
Bankruptcy		2002
fast degrading S Band amplifiers		2007

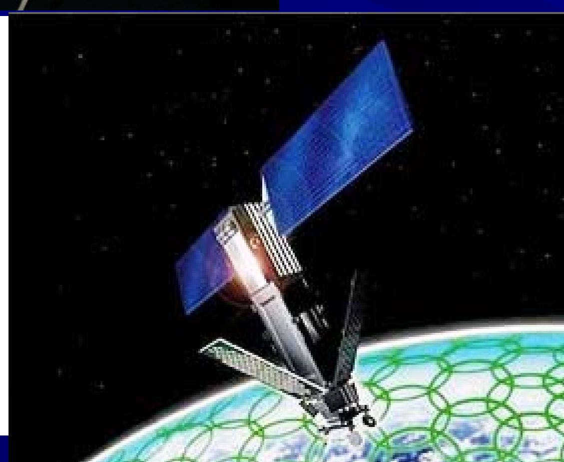
GLOBALSTAR NG	
Initial Investment	661 MUSD
Contractor	Thales Alenia Space
Contract Award	2007
scope	48 satellites
life time	15 years
In orbit delivery	2010 (expected)

Sources:
www.spaceantech.com

Wikipedia

Iridium



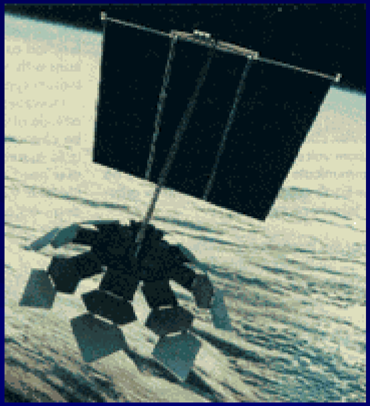


Source: Wikipedia

IRIDIUM		
Satellites		
Contractor	Lockheed Martin	
Payload	L Band	
ILS	Ka band	
Platform	LM-700	
Dry Mass	689	kg
Life time	5 to 8	years
Constellation		
	66	satellites
	6	orbital planes
	6	spares in orbit
	86.4	deg inclination
	781	km altitude
Business		
Service	global voice and paging	
FCC filed	2001	
service started	N/A	
Initial Investment	3400	MUSD
Company's history		
Teledesic LLC		
Main adverse events		
Loss 3 first satellites Delta 2 failure January		1997
Wrong injection of 1/5 satellite in July		1997
Bankruptcy		1999

IRIDIUM NEXT		
Satellites		
Contractor	Competition result in 2010	
Payload	L Band	
ILS	Ka band	
Host Payload	TBD	
Platform	?	
Dry Mass	?	kg
Life time	?	years

Teledesic (Cancelled)

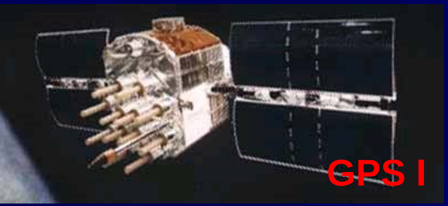


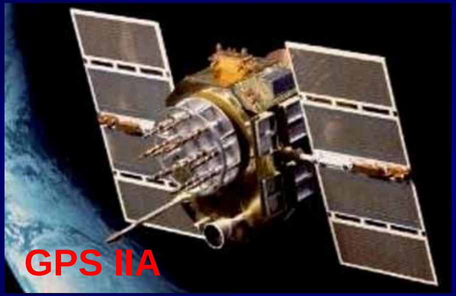
TELEDESIC		
Satellites		
Contractor	Boeing	
Payload	Ka Band	
ILS	Ka Band or optical	
Platform		
Dry Mass	?	kg
Life time	10	years
Constellation		
	840	satellites (initial)
	288	satellites (scaled-down)
	21	orbital planes (initial)
	12	orbital planes (scaled-down)
	3	spares in orbit (scaled-down
	98.2	deg inclination
	700	km altitude (initial)
	1400	km altitude (scaled-down)
Business		
Service	broadband internet	
FCC filed	1997	
Initial Investment	9000	MUSD
Company's history		
Teledesic LLC		
Main adverse events		
Project interruption 1st October		2002

Sources: Wikipedia

Two examples from the Institutional Market

GPS/NAVSTAR





Block	Launch Period	Satellite launches				Currently in orbit and healthy
		Suc-cess	Fail-ure	In prep-aration	Plan-ned	
I	1978–1985	10	1	0	0	0
II	1989–1990	9	0	0	0	0
IIA	1990–1997	19	0	0	0	11 of the 19 launched
IIR	1997–2004	12	1	0	0	12 of the 13 launched
IIR-M	2005–2009	8	0	0	0	7 of the 8 launched
IIF	2010–2011	0	0	10	0	0
IIIA	2014–?	0	0	0	12	0
IIIB		0	0	0	8	0
IIIC		0	0	0	16	0
Total		58	2	10	36	30

(Last update: 29 December 2009)

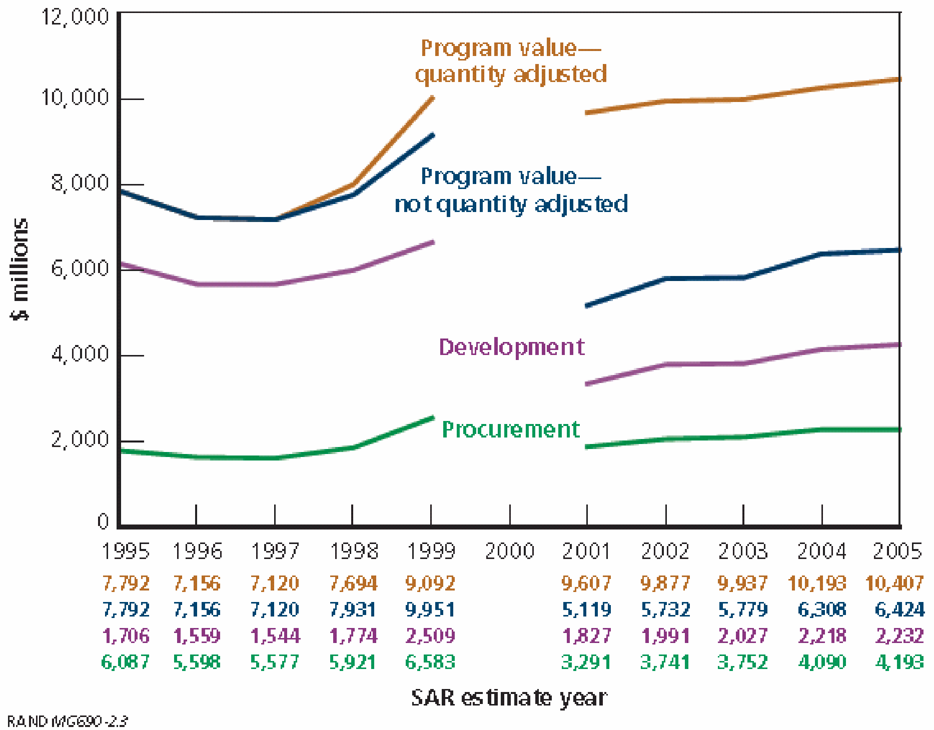
PRN 01 from Block IIR-M is unhealthy
PRN 25 from Block IIA is unhealthy
See the GPS almanac. For a more complete list, see *list of GPS satellite launches*

	Block 1	Block II	Block IIA	Block IIR	Block IIR-M	Block IIF	Block IIIA
	Rockwell	Rockwell	Rockwell	LM	LM	Boeing	LM
Nb Sat	12	9	19	12	8	12	12
Weight(kg)	450	840	840	1080	2032	1545	TBD

Source: wikipedia

GPS Cost growth

A Ten-Year Look at SAR Cost Estimates for GPS Development and Procurement

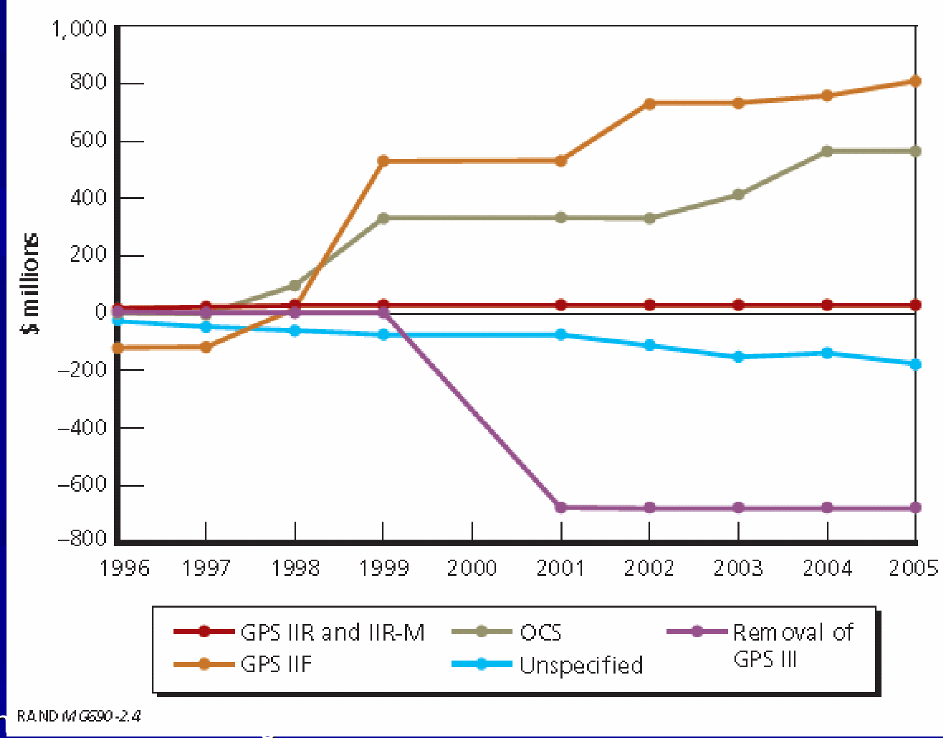


Extracts from Rand MG690

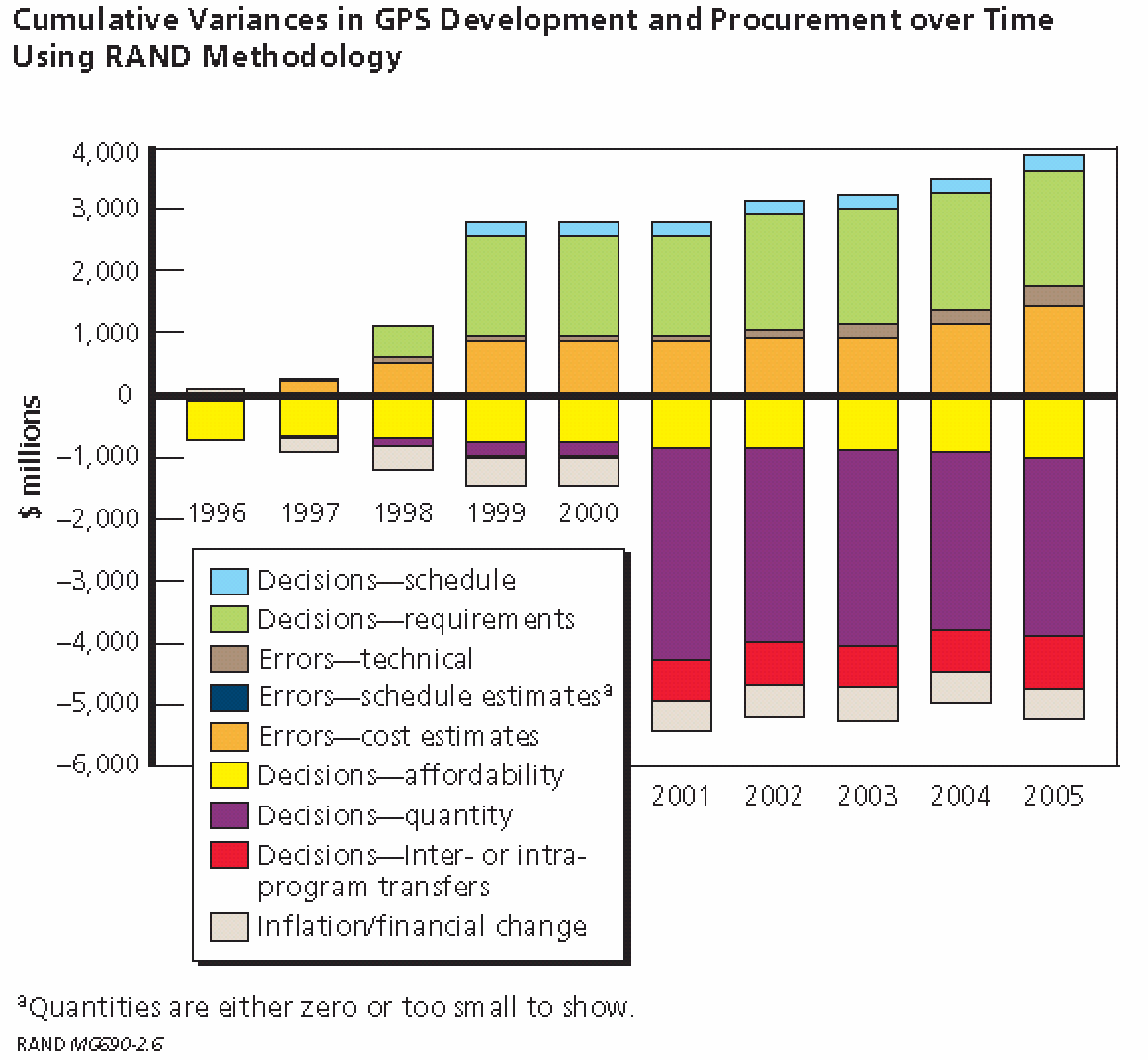
Improving the Cost Estimation of Space Systems

Available at: www.rand.org/pubs/

Cumulative Development Cost Variance, by Program Segment over Time



GPS Cost growth



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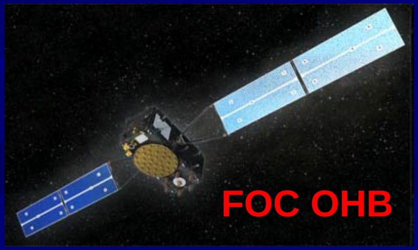
GALILEO



Constellation		
30	satellites	TBC
3	orbital planes	
3	spares in orbit	
56	deg inclination	
23222	km altitude	

	GIOVE-A	GIOVE-B	IOV	FOC 1st batch	FOC rem.
Nb Sat	1	1	4	14	TBD
Weight (kg)	602	525	640	TBD	TBD
Contractor	SSTL	ESNI	Astrium	OHB/SSTL	TBD
Life time	2 years	2 years	12 years	12 years	TBD
Launched	2005	2008	2011?	2012-13?	TBD

Source: http://space.skyrocket.de

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Galileo cost and schedule growth

GALILEO COST ESTIMATES

	Original cost estimate in million euro (COM(2000)750)	Updated cost estimate in million euro (COM(2007)261 and ESA documents)
Definition phase	80	80
Development and validation phase	1 100	2 100
Deployment	2 150	3 400
Total	3 330 (of which 1 800 million to be borne by the public)*	5 580 (all to be borne by the public sector)**

* Annual operating costs, including constellation replacement, were estimated at 220 million euro.

** Availability payments (fixed part) for operating cost, maintenance and replenishment debt interest until 2030 are estimated at 5 300 million euro.

Special Report No 7/2009 - Management of the Galileo programme's development and validation phase

- Galileo Operational Phase was originally foreseen for 2008
- The report mention a foreseen date 2013

Extracts from the European Court of Auditors 2007

Available at: www.eca.europa.eu

Dealing with difficulties

- Inherent complexity of constellations
  - All constellations encountered major problems
    - Development
    - Deployment
    - Operational service
  - Serial production
    - Late occurrence of Equipment generic failure
    - due to inappropriate material and unsettled processes to be avoided (e.g. Globalstar Solar Arrays). Late event means direct impact on critical path.
  - Several multiple launches required.
    - This creates a high risk on launch failure with potential severe cost and schedule drift before reaching full operational capability. Globalstar lost 14 satellites)
  - Serial production has a strong appeal for equipment suppliers in a market dominated by single of a kind projects.
    - Price Dumping, excessive risk taking, bankruptcy risk

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The Institutional Market case

- The development of the infrastructure can hardly be amortized in a business plan but profitable Users applications can be developed once the system in place and maintained
  - Global positioning system
  - Search and Rescue
- Development contractors do not have strong interest to reach constellation operational stage
  - The business is in the development
  - Single contractor procurement is prone to significant schedule delays and cost growth

The trade-off elements

- Single offer vs. open competition
- Development cost
- Schedule
- Learning curve factor

Learning curve factor effect

- Commercial market
  - Minimise capital expenditure
  - Reach operational stage the soonest
  - Industry will get organised to benefit from full learning effect
- Institutional Market
  - Learning curve factor is part of the negotiation
  - Monopoly situations usually leads to high values for negotiated learning factor

Dual Production Lines

- Principle
  - Place two independent contracts instead of one up to final delivery of the whole constellation in orbit
  - Place orders per batches
- Pros
  - Reinstate competition all along the procurement cycle including during production
    - Better containment of cost and schedule
  - Limit technical and programmatic risks
    - Mitigate generic equipment level technical risks
    - Avoid single point failure on single integration line
- Cons
  - 2 developments to pay for. The larger the constellation is, the more marginal becomes the non recurring costs.
- Questions?
  - How many satellites in the constellation before the Dual Production becomes the cost effective solution?

Organising batches

- Batches to be placed according to Constellation configuration.
  - Number of orbital planes
  - Number of satellites per orbital plane
  - Possibly optimizing number of satellites per launcher
  - Each batch is open to competition
  - Smoother and more flexible than GPS procurement per block, although GPS already beneficiate from multiple suppliers market condition.

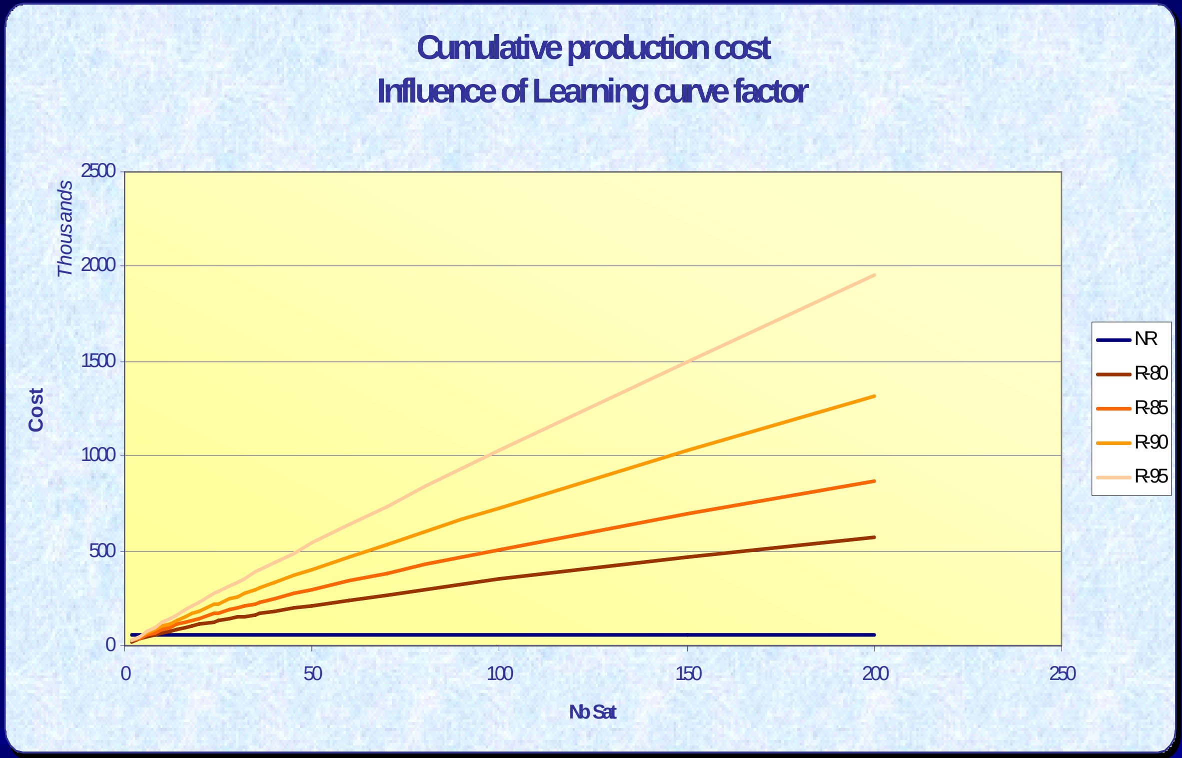
Risk mitigation effect

- Satellite Integration is on critical path
- Major global disruption of Integration plant will have significant on cost/schedule containment. This could be due to
  – Natural disaster such as Earthquakes
  – Strikes
  – Sabotage/Terrorism
  – Etc…
- Fully Independent Integration plants will efficiently mitigate the risk

Institutional Market - Simulation case

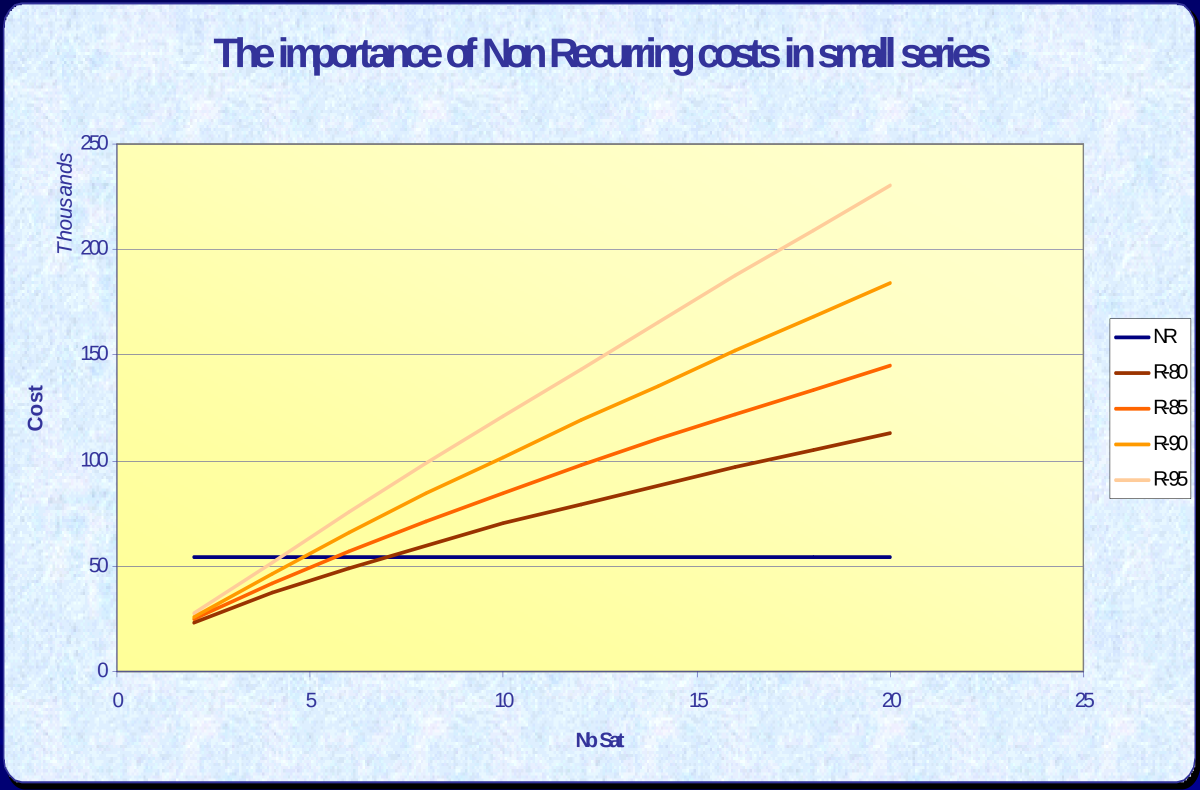
- Comparing two solutions
  - Single procurement
    - Once awarded many changes expected on non recurring activities with inflation impact on recurring costs
    - Negotiated learning curve factor expected not better than 95%
    - High cost and schedule growth
  - Two parallel contracts for dual production lines.
    - “Race” conditions attract focus on the recurring production i.e. where the big money is. Contractor is expected to work according to optimised industrialisation process so the Learning curve factor is expected to be in the range of 85%

The influence of the Learning Curve Factor



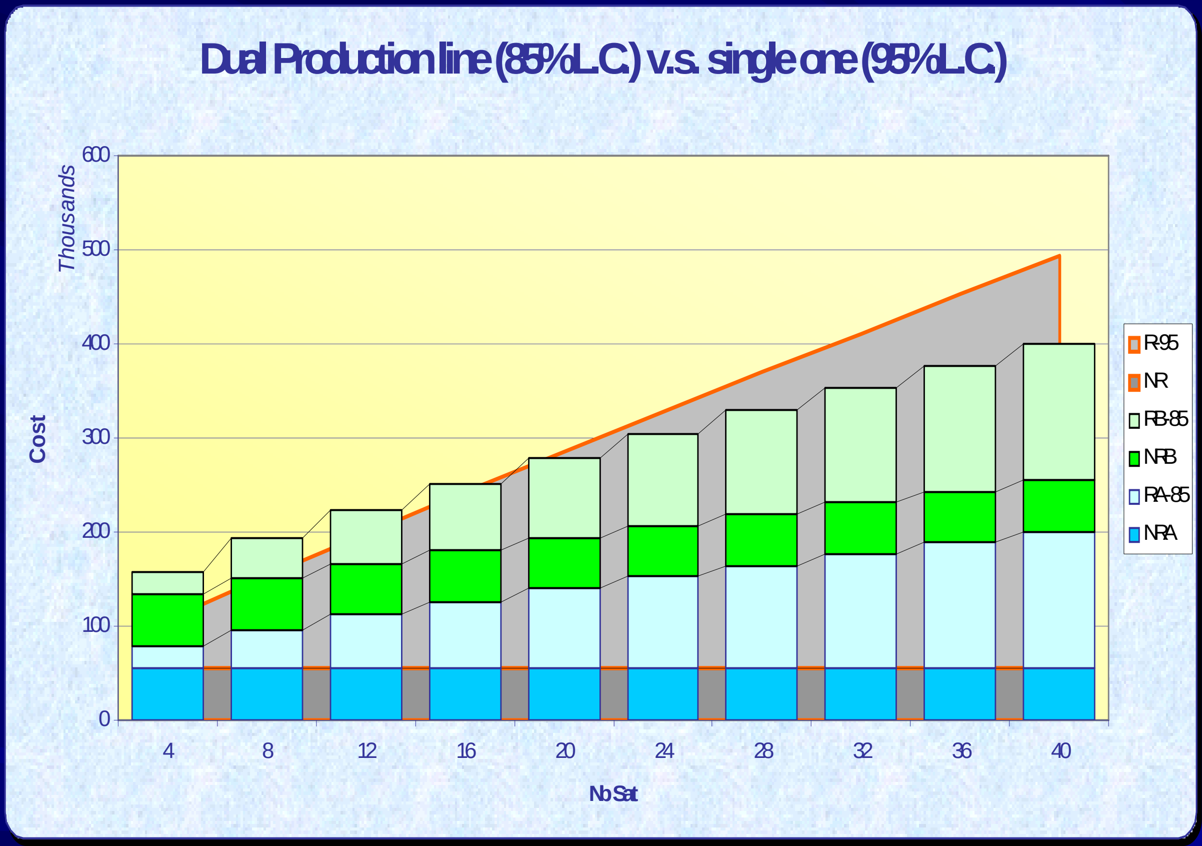
- Large constellation case
  - The non recurring costs become marginal. All the focus is on the recurring costs
  - Dual source production lines becomes the obvious choice
  - Learning curve factor becomes the most sensitive cost driving parameter. For a constellation of 200 satellites the cost almost quadruple when L.C. factor varies from 80% to 95%

The dilemma between non recurring and recurring costs



- The case of small constellations
  - The development cost is not neglect able
  - Need to study when dual sources production lines becomes attractive

The Trade-Off



- Comparison single v.s. double souces
  - The break even appears to be for 16 satellites
  - The schedule risk factor is not considered in this analysis nor the AIT risk. When doing so the breakeven is down to around 10 satellites

Conclusions

- Cost and schedule efficiency of constellation projects can be improved by setting up competitive production lines
- Overall procurement becomes cheaper in the case of dual procurement for constellations made of around 12 satellites and beyond.
  - Specific study is required when in the range 8 to 16 satellites. It depends on:
    - The magnitude of non recurring costs
      - Requirements stability
      - Inherent complexity
      - Heritage
    - Achievable learning rate factor