

The ESA Project Office Cost Model

ICEAA – 2014 – Denver CO

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- Rationale
- Space Segment PO cost model approach;
- Model Concepts and levels:
 - System level activities;
 - Sub-system level engineering;
 - Industrial Set Up and Sub-Contractors;
- Model graphic interface;
- Future development
- Q & A

Project office is a significant slice of a spacecraft industrial cost
(Typical > 20%)

Its weight increases further considering actual Cost at Completion
(schedule delays affect mainly the PO)



Importance of estimating the Project Office cost.

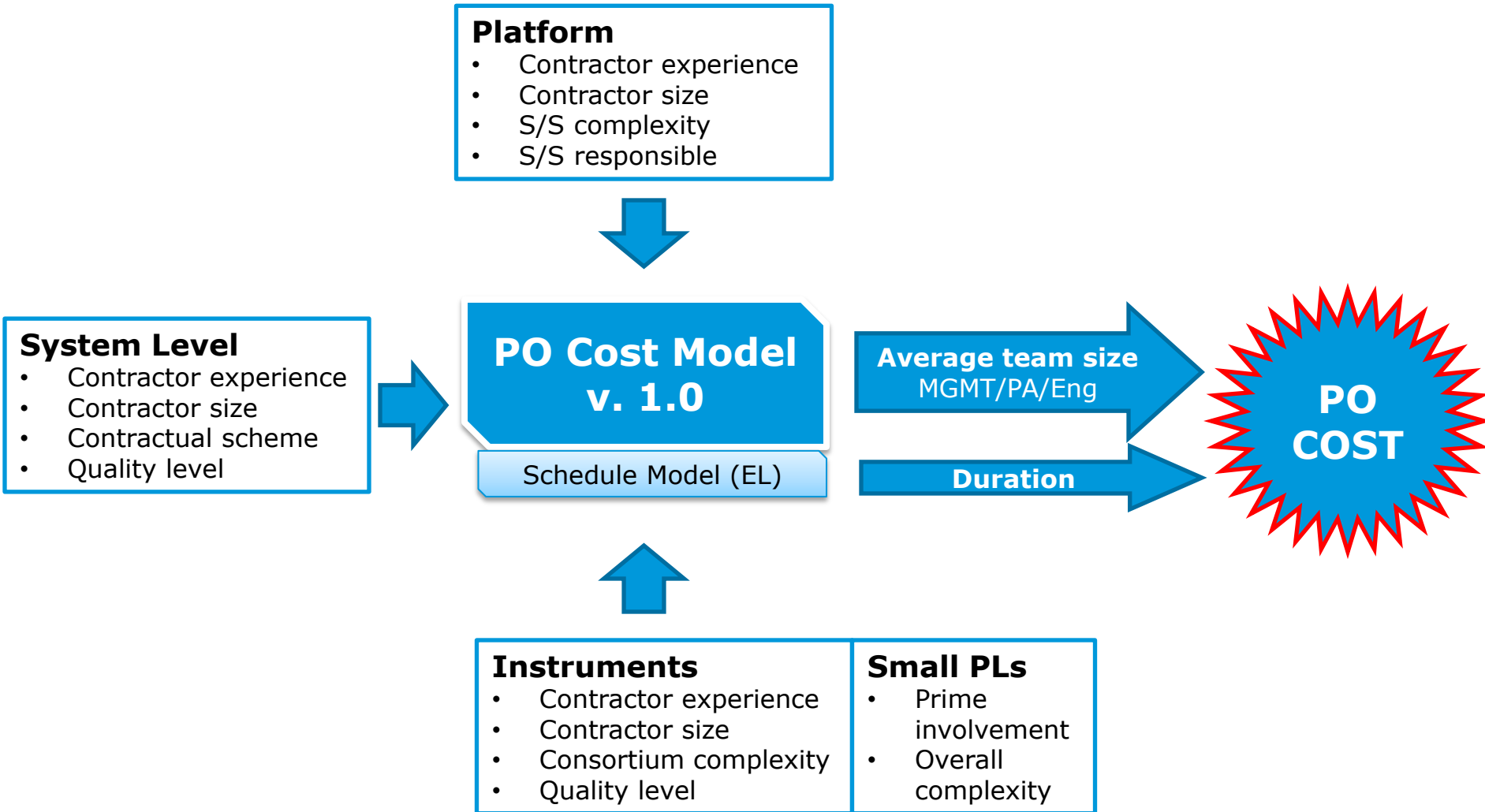
Models previously used were based on cost-to-cost relations at system
level

with complexity correction factors



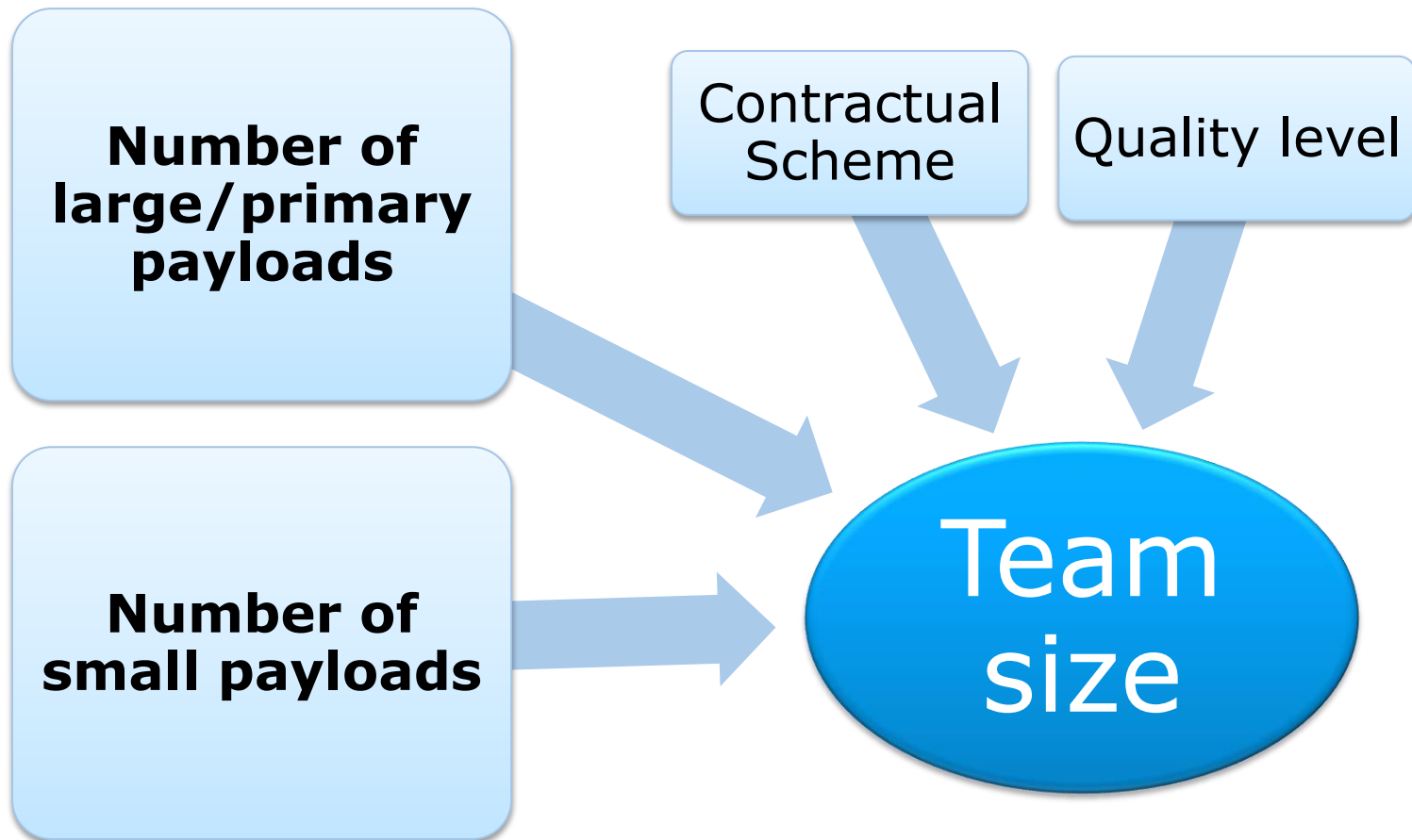
**Need of a more detailed parametric model to define a reference
manpower allocation to compare with industrial proposal**

PO Cost Model Approach at a glance

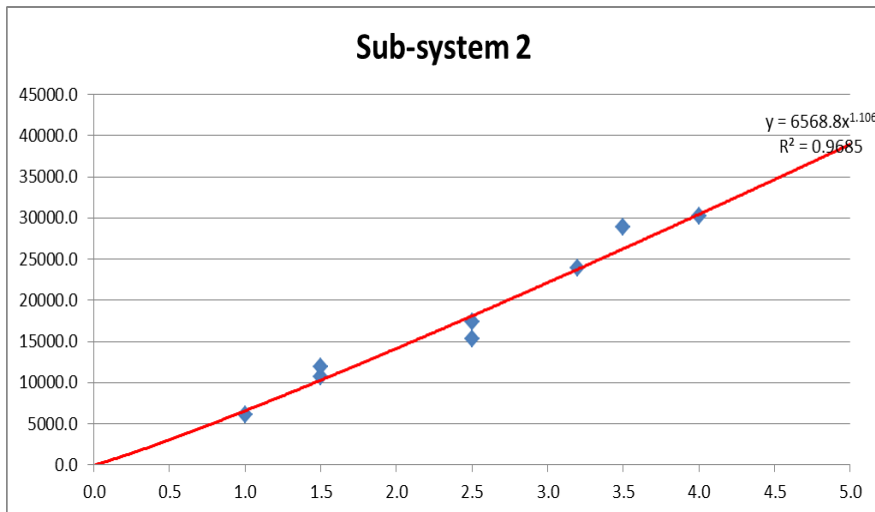
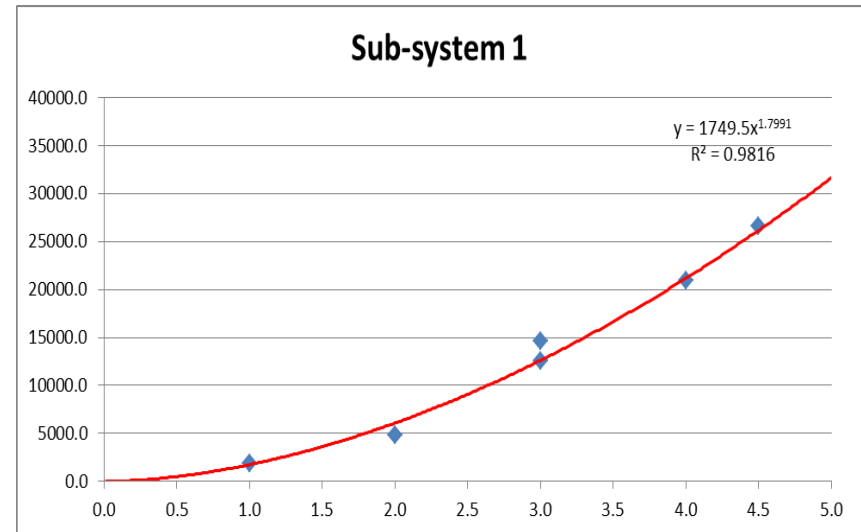


System Activities Concept

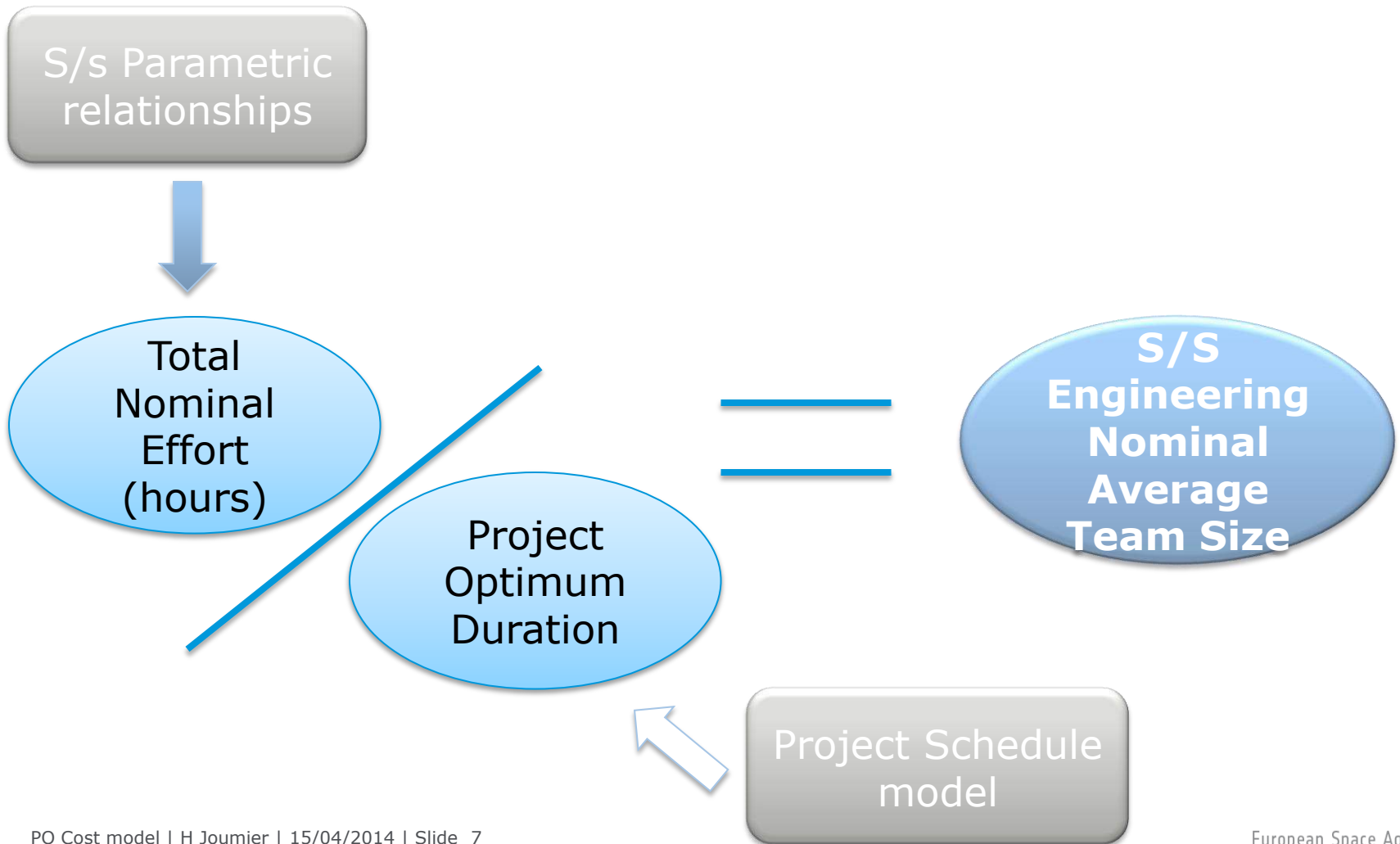
What influences team size?



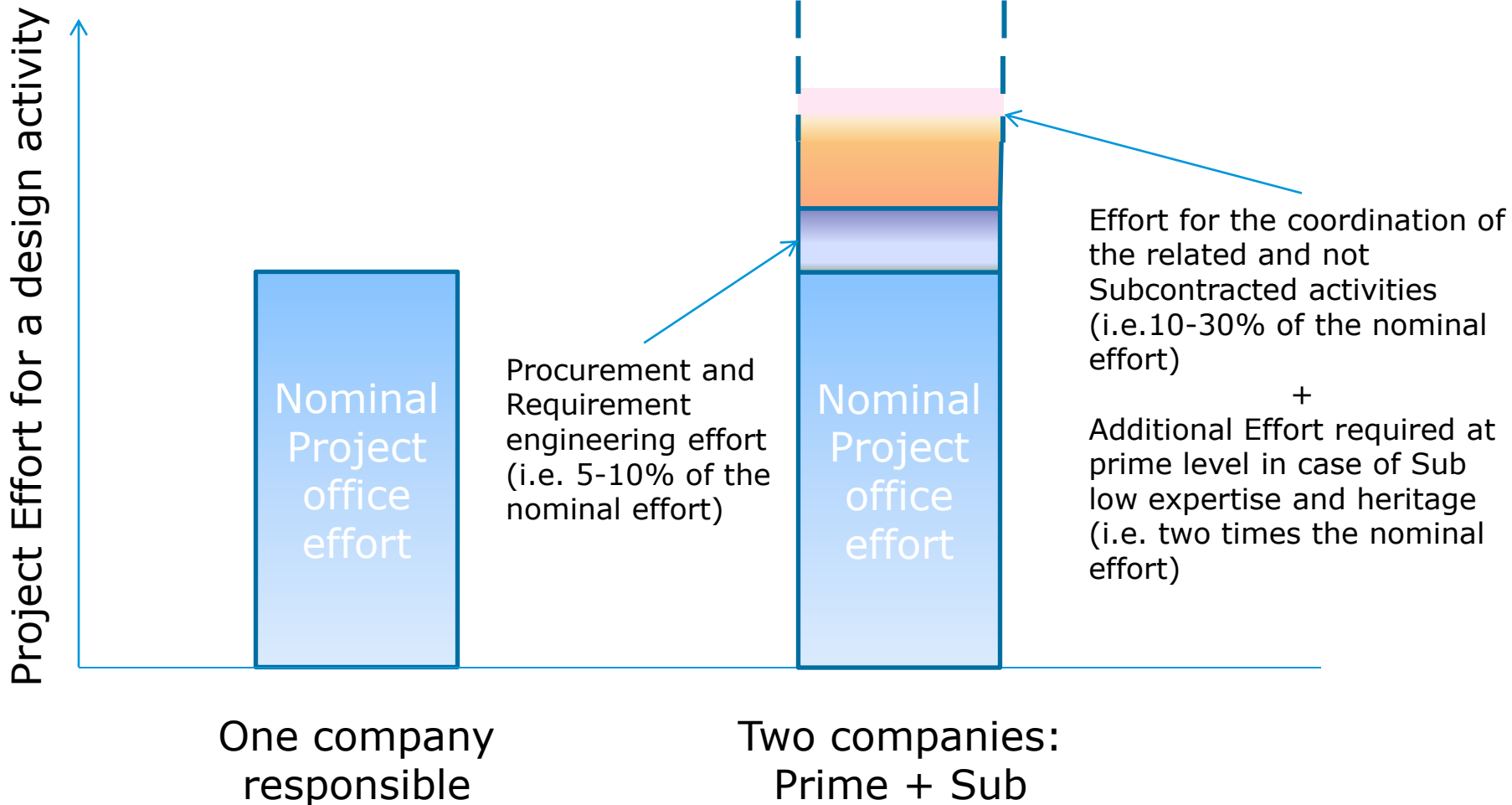
The S/S engineering team sizes should be based on the total effort required by the design (hours) spread over the available S/S time span



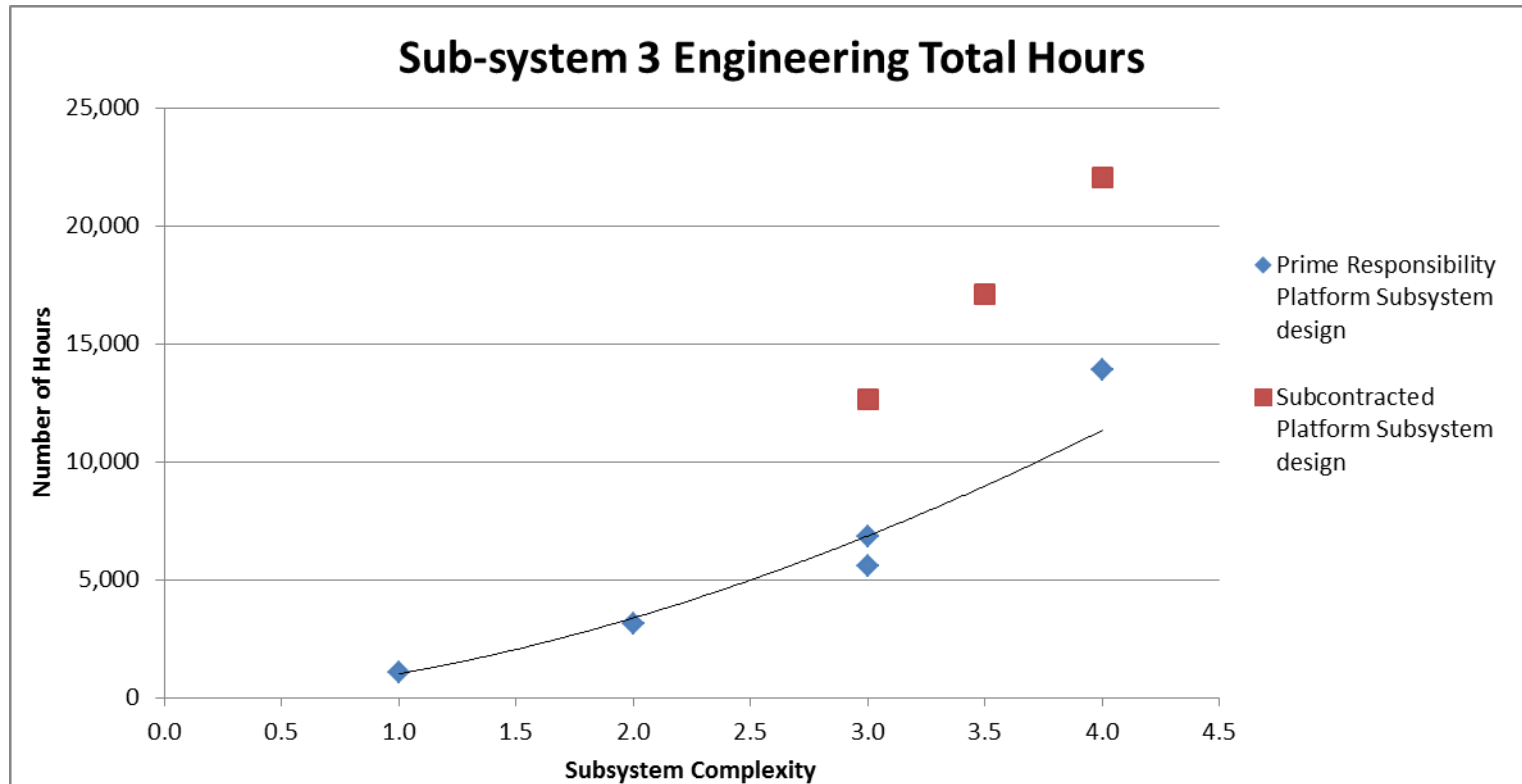
This data allowed to establish parametric relationships for each S/S between the total hours for the detailed design of the S/S and its Complexity



Sub Contractors Effect



Subsystem Subcontracted example



POCoMo (Project Office Cost Model)

v 2.0

12/11/2013
 Developed by G. Cilani / P. Martino, ESA TEC-SYC

	Project		Date	
	Estimator		Issue	
			Revision	

Payload instruments total Mass	500	kg	
Payload Module Mass excl. Instruments (Optional)	0	kg	
Total Payload Mass	500	kg	
In orbit lifetime	0	years	

Domain	<input type="radio"/> Science <input checked="" type="radio"/> Earth Observation <input type="radio"/> Telecom <input type="radio"/> Technology demonstration			
Orbit Type	<input type="radio"/> GEO <input checked="" type="radio"/> Non-GEO Earth Orbit <input type="radio"/> L-points or Sun orbit <input type="radio"/> Interplanetary			
Payload	Nr. of Large Instruments / Primary payloads: <input style="width: 40px; text-align: center;" type="text" value="1"/>	Nr. of SMALL instruments: <input style="width: 40px; text-align: center;" type="text" value="0"/>		
Prime contractor size	<input type="radio"/> Large <input type="radio"/> Medium <input checked="" type="radio"/> Small			
Contractual scheme	<input type="radio"/> TRADITIONAL (Prime responsible for Platform or Instrument, no PO layer at system level) <input type="radio"/> HEAVY (Presence of co-primers, PO layer at system level) <input checked="" type="radio"/> LIGHT (Prime responsible for the whole project, few small subcontractors)			
Quality Level	<input type="radio"/> Operational <input checked="" type="radio"/> Standard / Pre-operational <input type="radio"/> Low cost / Technology demonstration			
Prime experience	<input checked="" type="radio"/> High <input type="radio"/> Medium <input type="radio"/> Low			
Satellite Models	<input checked="" type="checkbox"/> SM <input type="checkbox"/> STM <input type="checkbox"/> EM <input checked="" type="checkbox"/> PFM			

Estimated Total Satellite Dry Mass (PF+PL) [kg]	796	800	<input checked="" type="checkbox"/> Override
	calculated	override	
Estimated phase C/D duration [months]	45		<input type="checkbox"/> Override
	calculated	override	
Estimated phase D duration [months]	27		<input type="checkbox"/> Override
	calculated	override	

1. The user is driven through elementary choices covering the Project Office main cost drivers and modifiers such as:
 - a. Domain, Orbit type
 - b. Payload mass & characteristics
 - c. Industrial team structure and experience
 - d. Quality level and HW matrix

2. The model estimates the dry mass of the platform that provides an extensive parameter when needed.

3. The model performs an initial parametric estimate of the schedule duration to derive team sizes from man-hours

Platform complexity



Platform contractor		<input checked="" type="radio"/> Prime responsibility <input type="radio"/> Large <input type="radio"/> Medium <input type="radio"/> Small
Platform contractor experience		<input type="radio"/> High <input checked="" type="radio"/> Medium <input type="radio"/> Low
		Complexity
		Calculated Manual
AOCS		3
S/S Responsible	<input checked="" type="radio"/> Prime Contractor <input type="radio"/> Dedicated Subcontractor <input type="radio"/> No S/S	
Subsystem status	<input type="radio"/> Off the Shelf <input type="radio"/> Minorly Modified <input checked="" type="radio"/> Majorly Modified <input type="radio"/> Newly Developed	
Pointing accuracy	<input type="radio"/> Very low, simple system, low stability <input type="radio"/> Low: >= 1 arcminute <input checked="" type="radio"/> Medium: > 8 arcsec, < 1 arcminute <input type="radio"/> Fine Pointing, High: <= 8 arc sec <input type="radio"/> Extreme: <= 1 arcsec	
Propulsion		2
S/S Responsible	<input type="radio"/> Prime Contractor <input checked="" type="radio"/> Dedicated Subcontractor <input type="radio"/> No S/S Check "PF SubCO" sheet	
Subsystem status	<input type="radio"/> Off the Shelf <input checked="" type="radio"/> Minorly Modified (new feed system) <input type="radio"/> Majorly Modified (new feed system + new tanks) <input type="radio"/> Newly Developed	
Propulsion type	<input type="radio"/> Cold Gas <input checked="" type="radio"/> Mono Prop, blowdown <input type="radio"/> Mono Prop, Pressurized <input type="radio"/> Bipropellant <input type="radio"/> Elec. Propulsion <input type="radio"/> Elec. Propulsion incorporating additional Cold Gas thrusters	
EPS (Power)		3
S/S Responsible	<input checked="" type="radio"/> Prime Contractor <input type="radio"/> Dedicated Subcontractor <input type="radio"/> No S/S	
Subsystem status	<input type="radio"/> Off the Shelf <input checked="" type="radio"/> Modified <input type="radio"/> Newly Developed	
Power S/S requirements	<input type="radio"/> Simple: fixed solar array panels with standard cells <input checked="" type="radio"/> Medium: standard deployable solar arrays with standard cells <input type="radio"/> Complex: deployable solar arrays with special materials and cells (for high temperature and/or high radiation environments)	
Communications		3
S/S Responsible	<input type="radio"/> Prime Contractor <input checked="" type="radio"/> Dedicated Subcontractor <input type="radio"/> No S/S Check "PF SubCO" sheet	
Subsystem status	<input type="radio"/> Off the Shelf <input checked="" type="radio"/> Modified <input type="radio"/> Newly Developed	
Data rate	<input type="radio"/> Low: tens of kbps <input checked="" type="radio"/> Medium: hundreds of kbps <input type="radio"/> High: in the order of Mbps	
Antenna type	<input type="radio"/> Low Gain <input checked="" type="radio"/> Low Gain + Medium/High Gain	

Subsystem status inputs refer to the subsystems as a whole, not to the individual equipment units. A subsystem is only **"Off the Shelf"** if the equipment and subsystem design is completely recurrent. If all equipment is recurrent but the design/layout is new, the subsystem is **"Modified"**.

Complexity ranges from 0 to 5:
0: None, sub-system not included
1: Simple, off-the-shelf subsystem
3: Standard, modified subsystem
5: State of the art, all equipment and subsystem design newly developed

- Platform contractor is characterized
 - Contractor size
 - Contractor experience
- Sub-systems "profiling" determines a complexity factor for each the S/S Project Office sizing (expressed in man-hours)
 - Performance parameters
 - Development status
- Make-or-Buy decision is made on each of the sub-systems.
 - Contractors of Procured Sub-systems are further qualified (see next page)

Sub Contractors



Platform Subcontractor



		Complexity
AOCS		3
Sub contractor size	<input checked="" type="radio"/> Large <input type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 20 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>
Propulsion		2
Sub contractor size	<input checked="" type="radio"/> Large <input type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 20 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>
EPS (Power)		3
Sub contractor size	<input type="radio"/> Large <input checked="" type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 45 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>
Communications		3
Sub contractor size	<input type="radio"/> Large <input checked="" type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 35 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>
DHS (Data Handling)		3
Sub contractor size	<input type="radio"/> Large <input checked="" type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 40 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>
Structure		3
Sub contractor size	<input type="radio"/> Large <input checked="" type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 25 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>
Thermal Control		3
Sub contractor size	<input type="radio"/> Large <input checked="" type="radio"/> Medium <input type="radio"/> Small	Manual Adjustment (Prime-Sub Overlap) 20 %
Subcontractor experience	<input checked="" type="radio"/> High Expertise <input type="radio"/> Medium Expertise <input type="radio"/> Low Expertise	<input type="text" value=""/>

SubContractor Experience and Manual adjustment:

The Prime-Sub Overlap percentage represent the additional effort, in terms of hours, required at Prime and Sub level for the subcontracting of a Subsystem design. It is intended in term of percentage of the nominal engineering effort required.

The Prime-Sub Overlap percentage centre value, related to the subcontractor high expertise, is based on historical data and it is different between the subsystems.

The manual adjustment cursor allow to modify this value basing on the user knowledge.

In absence of additional information the user is advised to select "high expertise" and the companies size in accordance with the expected rates.

S/S not Subcontracted

1. Greyed sub-system are directly handled by the Platform Prime contractor
2. Highlighted sub-systems are subcontracted with the following specifications:
 - a. Sub-contractor size
 - b. Sub-contractor experience
 - c. Adjustment on the degree of overlap between the Platform prime and the sub contractor

Major Instruments

Instrument #1



Name	Instrument #1		
Type	Optical	N of FPAs	1
Mass	10 without margin, 10-500 kg	design modularity	0%
Instrument contractor			
<input type="checkbox"/> Prime responsibility <input checked="" type="checkbox"/> Large <input type="checkbox"/> Medium <input type="checkbox"/> Small			
Engineering experience of the contractor			
Low	Small and unexperienced contractor that has never faced this technology		
Medium	Medium experienced contractor facing a new design / major modifications		
High	Experienced team that has already worked on similar relevant projects		
Very high	Very experienced team that minorly modifies an existing instrument / FM		
<input type="checkbox"/> Low <input type="checkbox"/> Medium <input checked="" type="checkbox"/> High <input type="checkbox"/> Veryhigh			
Instrument core team <small>Please indicate the n. of members per each category not including the Prime</small>			
Co-primos	0	Responsible for a major assembly of the instrument	
Major	0	Responsible for a subassembly or critical HW (e.g. Detectors)	
Minor	0	Responsible for major engineering support (e.g. Calibration support)	
Support	0	Responsible for minor studies (i.e. contracts below 500 k€)	
Instrument quality level			
<input type="checkbox"/> Operational <input checked="" type="checkbox"/> Standard / Pre-operational <input type="checkbox"/> Low cost / Technology/demonstration			
PO Optimisation Level <small>NB This is NOT automatically adapted choosing the contractor size</small>			
LSI	< IIII >	SME	0%

Estimated phase C/D duration [months] **48** calculated override

Estimated team size MGMT	2.0
Project Administration	1.1
Contracts and Subcos Adm.	0.0
Project Control	0.9
Procurement Mgmt	0.0
PA	0.2
Engineering	2.9
System, mechanical & thermal	2.9
Optical Engineering	0

1. Project Office related to Main Instruments is also estimated based on:
 - a. Instrument type, size, design repeat and modularity
 - b. Instrument contractor experience and size
 - c. Complexity of the Instrument Core Team
 - d. Instrument Quality level
2. The model estimate the Project Office man-hours
3. The model provides an initial estimate of the schedule duration to determine Team size as a function of the man-hours

Small instruments



Instrument #1		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	80
Overall complexity	Low (1)	<input type="text"/>	High (5)	4
Instrument #2		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	70
Overall complexity	Low (1)	<input type="text"/>	High (5)	2
Instrument #3		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	0
Overall complexity	Low (1)	<input type="text"/>	High (5)	3
Instrument #4		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	0
Overall complexity	Low (1)	<input type="text"/>	High (5)	3
Instrument #5		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	100
Overall complexity	Low (1)	<input type="text"/>	High (5)	3
Instrument #6		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	100
Overall complexity	Low (1)	<input type="text"/>	High (5)	3
Instrument #7		Name		
Prime involvement	CFI (0%)	<input type="text"/>	CPI (100%)	100
Overall complexity	Low (1)	<input type="text"/>	High (5)	3

Unused

1. The secondary payloads (expected to be small instruments) are also identified and taken into account to adjust the Prime contractor Project Office sizing. The main parameters considered are:
 - a. CFI : Company Furnished Instrument. The effort is limited to the I/F management and integration onto the Platform
 - b. CPI: Company Procured Instrument. The Prime contractor holds the full responsibility for the development and integration of the Instrument.
2. The level of Prime Contractor involvement
3. The complexity of each of the Instruments

Results screen



POCoMo Class 4 Results

Team Size	Rate [€/h]	Total Hours [h]	Total Cost [k€]	EC
<i>calculated override</i>	<i>calculated override</i>			2013

System Level

Resp	PRIME	Phase C/D duration	45 months	Delay [months]	
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Management	3	130	18,150	2360 k€
Project Administration	1.1			
Contracts	0.6			
Project Control	0.8			
Procurement Mgmt	0.5			
Product Assurance	1.5	115	9,040	1040 k€
Engineering	2	115	12,090	1390 k€
Total PO			39280	4790 k€
Satellite AI T	15.5	115	56,460	6500 k€
AI T Coordination	4.2		15410.0	
SW/STM AI T	2.3		8290.0	
EM AI T	1.8		6420.0	
PRM AI T	7.2		26340.0	

- Recurring Satellites and Constellations PO estimation capability;
- Class 5 model definition for very early design phases;
- Further develop AIT activities

Questions?

