



The NASA Software Cost Model Task: Formalizing analogy based cost estimation

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Background

Cost Analysis Division

Jet Propulsion Laboratory

West Virginia University

- ★ *The NASA Software CER Development Task is funded by the Cost Analysis Division to develop a software cost model that*
 - ★ *Can be used in the early lifecycle*
 - ★ *Can be used effectively by non-software specialists*
 - ★ *Uses data from NASA in-house built and funded software “projects”*
 - ★ *CADRe but also other Center level data sources*
 - ★ *Supplement to current modeling and bottom up methods not a replacement*
 - ★ *Can be documented as a paper model*
 - ★ *Acceptable for use with both the cost and software communities*



★ NASA Robotic SC Flight Software Cost Model V 1.0

- ★ *Analysis completed March 2015*
- ★ *Results documented in*
 - ★ *Hihn, J. et. al., NASA Software Cost Estimation Model: An Analogy Based Estimation Method, International Cost Estimation and Analysis Association Workshop Proceedings, Forthcoming June 2105. (Copies available)*
- ★ *Excel-based tool to be unveiled at the 2015 NASA Cost Symposium being held at ARC in August 2015*
- ★ *Released through the NASA CAD ONCE portal*

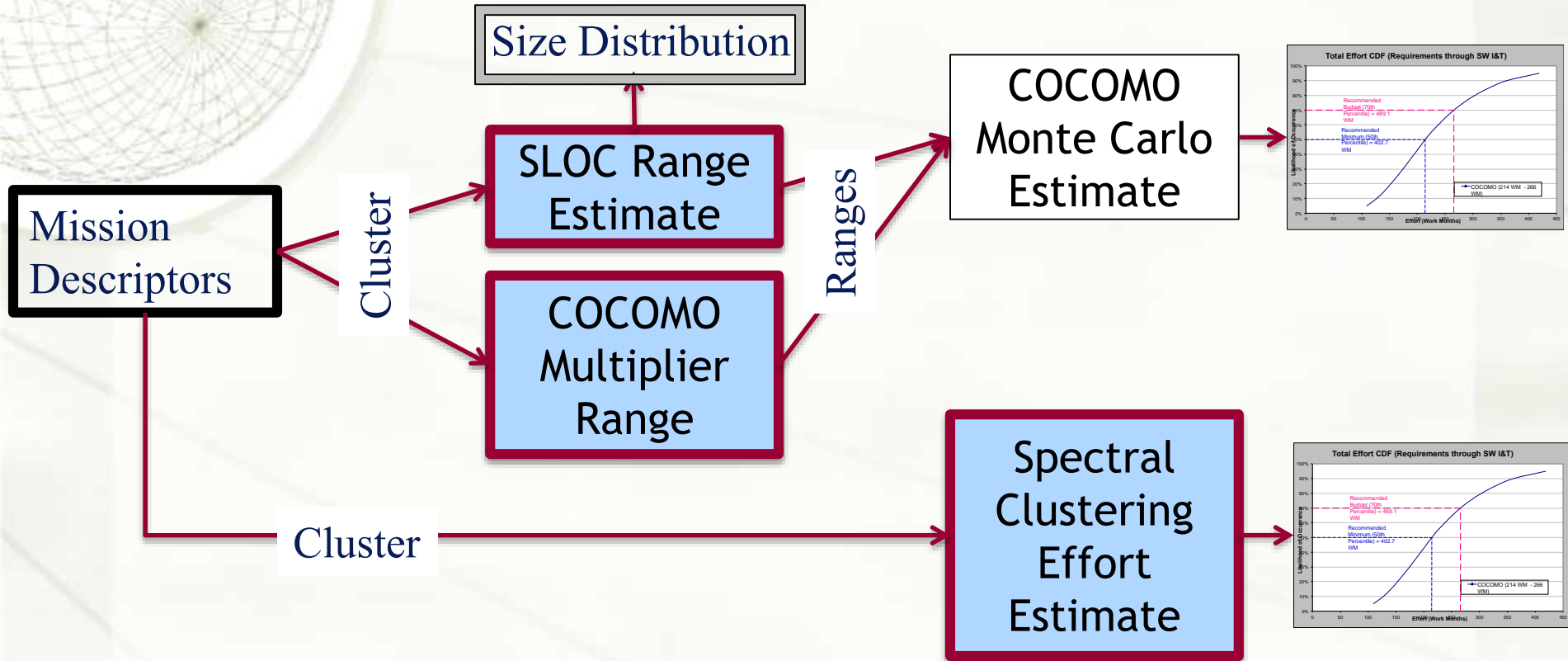


NASA Robotic Spacecraft FSW Cost Model

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Data Items

Data Item	Number of Projects
Total development effort in work months	28
Logical Lines of Code (LOC)	
o Delivered LOC	36
o Equivalent LOC	36
o Inherited LOC (Reused plus Modified re-used lines)	36
o Reused LOC (0-10% modified)	36
COCOMO model inputs (See Appendix A for the parameter definitions) translated from CADRE which has SEER model inputs because the SEER data items are very sparse in CADRe	19
System parameters (See Appendix B parameter definitions)	
o Mission type (deep-space, earth-moon, rover-lander, observatory)	39
o Multiple element (probe, etc.)	39
o Number of instruments	39
o Number of deployables	39
o Flight Computer Redundancy (Dual Warm, Dual Cold, Single String)	39
o Software Reuse (Low, Medium, High)	36
o Software Size (Small, Medium, Large, Very Large)	36



Data Sources

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- ✦ Where the data came from
 - ✦ NASA CADRe (When it exists and is usable)
 - ✦ Cost Analysis Data Requirements archived in ONCE database
 - ✦ NASA 93 - Historical NASA data originally collected for ISS (1985-1990) and extended for NASA IV&V (2004-2007)
 - ✦ Contributed Center level data
 - ✦ NASA software inventory
 - ✦ Project websites and other sources for system level information if not available in CADRe

- ✦ Data from JPL and GSFC projects



NASA SW Cluster Estimation Prototype

Example Clusters

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COCOMO EM

Enter Data

Rovers

System Descriptors

\$StartYear	\$prec	\$flex	\$resl	\$team	\$pmat	\$rely	\$cplx	\$data	\$ruse	\$time	\$stor	\$pvol	\$acap	\$pcap	\$pcon	\$apex	\$ifex	\$tool	\$sced	\$site	\$locu	\$LogicalDeliverables	Language	MissionType	SecondaryType	Complexity	\$NumSimpleInstruments	\$NumMediumInstruments	\$NumInstr	FlightComputerRedundancy	\$NumSimpleDeployables	\$NoMediumDeployables	\$NoComplexDeployables	Inheritance	Effort
1997																							C	DeepSpace	None	Medium	1	2	3		10	0	2	LowtoNone	
2000	3	3	3	3	4	5	3	2	3	3	4	4	4	5	4	4	4	2	1	5	3		C	Rover	EDL	Medium	0	5	5	DualString-Warmbackup	10	0	1	LowtoNone	1735.4
1993	2	3	4	3	3	4	3	2	4	4	2	5	5	3	5	1	5	3	3	6	3		C	Rover	EDL	Simple	3	0	3	SingleString	10	0	1	LowtoNone	1080
2007	3	2	4	3	3	4	4	3	4	3	4	3	4	4	3	3	3	3	5	3		C	Rover	EDL	Complex	0	10	10	DualString-Warmbackup	0	1	1	LowtoNone	1705	
2000	3	3	4	4	3	4	4	3	3	4	4	3	4	5	4	5	2	4	3	3	6	3	C	Rover	EDL	Medium	2	5	7	DualString-Warmbackup	5	1	1	LowtoNone	1392.5
1998	4	3	3	4	4	4	3	2	3	3	2	3	3	3	5	3	4	2	3	6	3		C	DeepSpace	SampleReturn	Simple	2	1	3	DualString-Coldbackup	5	0	0	Veryhigh	637
2002	3	2	3	3	3	4	5	3	3	3	3	5	4	4	3	4	3	3	2	6	3		C/C++/Assembly	DeepSpace	None	Complex	0	7	7	DualString-Coldbackup	1	0	0	Medium	691
2005	3	2	2	3	4	4	4	3	2	3	3	?	?	?	?	?	?	?	?	3	5	3	C	Observatory	None	Simple	3	1	4	DualString-Coldbackup	1	0	0	Medium	446
1995	4	3	3	4	4	4	4	3	2	3	3	2	3	3	5	3	4	2	3	6	3		C	DeepSpace	SampleReturn	Medium	2	0	2	DualString-Coldbackup	3	0	0	Veryhigh	546
1997	4	3	3	3	4	4	4	3	2	3	3	2	3	3	3	5	3	4	2	3	5		C/Jovial	DeepSpace	None	Medium	2	1	3	DualString-Coldbackup	5	0	0	Veryhigh	336
2009	4	2	3	3	4	4	3	2	3	3	2	4	3	3	5	4	4	2	3	5	3		C	DeepSpace	None	Medium	?	8	8	DualString-Coldbackup	0	1	0	Medium	552
1997	4	3	3	3	4	4	3	2	3	3	2	3	3	3	5	3	4	2	3	5		C	DeepSpace	None	Medium	2	1	3	DualString-Coldbackup	3	0	0	Veryhigh	546	
1995	3	3	3	3	3	4	3	2	3	3	3	3	3	3	4	3	4	2	4	3		C	DeepSpace	None	Medium	2	0	2	SingleString	2	0	0	Medium	1042.8	
1998	3	3	3	2	3	4	5	3	2	3	3	3	3	3	3	4	3	4	5	3		C	Observatory	None	Medium	3	0	3	DualString-Coldbackup	0	2	0	Medium	2519	
2005	3	2	2	3	4	4	3	2	3	3	?	?	?	?	?	?	?	?	?	3	5	3	C	Earth/LunarOrbiter	None	Simple	1	0	1	SingleString	1	0	0	High	492
2007	4	2	2	3	4	3	3	4	5	3	4	3	4	3	3	3	3	3	3	3		C	DeepSpace	None	Medium	6	3	9	DualString-Coldbackup	1	0	0	High	320	
2007	3	2	2	3	3	4	3	3	3	3	2	4	3	3	3	3	3	3	3	3		C	Earth/LunarOrbiter	None	Simple	4	0	4	SingleString	1	0	0	High	329	
2010	4	2	4	3	4	4	3	2	3	3	4	2	?	?	?	?	?	?	?	5	3	3	C	Earth/LunarOrbiter	None	Simple	2	1	3	SingleString	1	1	1	Medium	789
2006	3	2	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		C	Earth/LunarOrbiter	None	Medium	3	0	3	SingleString	1	0	0	Medium	640.5

Deep Space

Earth/Moon



★ **NASA Instrument Software Cost Model**

- ★ *Data is being collected and cleaned from multiple sources (started April, 2015)*
 - ★ *NICM database*
 - ★ *CADRe*
 - ★ *NASA 93*
- ★ *Currently working on improving the NICM software CER*
- ★ *Model V1 completed end of FY 16 (similar architecture to SC model)*

★ **NASA Experiment Software Cost Model**

- ★ *Collect experiment data in parallel with instrument sw data*
- ★ *Plan is for a prototype model in FY16*



Instrument FSW Cost Model Data

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SW Cost

SW Effort

Instrument Cost

Sensor Cost

Instrument Type

Destination

Remote vs Insitu

Thermal passive vs active

TRL for SS's

LOC?

???



Next steps

- ★ Need help defining appropriate “system” descriptors for Instruments and Experiments
- ★ When I call you please respond and possibly provide data
 - ★ CADRe data has many errors and needs correction
 - ★ Many instruments are not in CADRe
- ★ All data collected will be made available to NASA