PRICE True Program Success™

A CASE STUDY AND ASSESSMENT OF A COTS UPGRADE FOR A SATELLITE GROUND SYSTEM

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True COTS Solution : Case study

- **Introduction**
- **True COTS Solution**
  - Why we need it
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- **Case Study Description**
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  - True COTS Solution
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- **Wrap Up**

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Introduction

- **The integration of Commercial Off the Shelf Software is often misunderstood and underestimated**
- **Estimators and project planners continue to struggle with estimation of COTS projects**
- **PRICE True S introduced in 2004 with a comprehensive solution for estimating all of the activities associated with COTS Implementations**
- **Command and Control COTS Integration project with actual data available**
- **Opportunity to exercise COTS Solution in True S**

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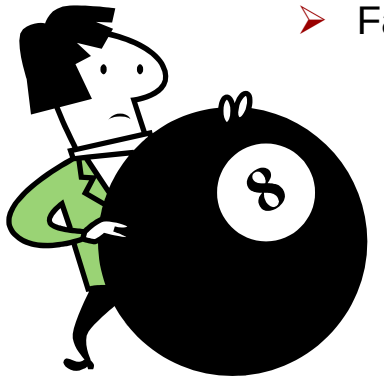
True COTS Solution : Why we need it

- **COTS solutions can save time and money in the development and life-cycle phases of a software product**
- **The implementation of COTS Intensive or COTS Based Software deployments are often underestimated**
  - Perception that COTS Integrations are plug and play exercises
  - Failure to account for all activities associated with successful COTS integrations
  - Failure to remain flexible in requirements
  - Failure to ask the right questions about a COTS based integration



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COTS Solution : Solution Details

- **Comprehensive Coverage of COTS related activities**
  - Analyze software requirements
  - Identify, evaluate and select COTS components
  - Purchase/Lease/License the COTS Components
  - Tailor COTS software
  - Design, code and test glue code and modifications
  - System level integration and test
  - Evaluate and integrate upgrades
  - Fix bugs

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COTS Solutions : Solution Details

- **Ask the right questions**
  - Software Size in sensible terms
    - Functional Size
    - Function Points
    - SLOC
    - POPs
  - Glue code description
  - Tailoring scope and complexity
  - Evaluation scope and complexity
  - Vendor and product characteristics
  - Integration team familiarity with COTS integrations
  - Upgrade information

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Case Study : Background

- COTS upgrade for a legacy satellite ground system
- Introduced new distributed client server-based architecture
- Maximized the use of COTS products
- This release of the system consisted primarily of the COTS upgrades
- Small amount of added functionality included as part of this release

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COTS Upgrade Development Environment

- **Difficulties with the COTS software created a cascading effect on the schedule**
  - Resources from next release being pulled onto this version to fix problems
  - System did not stabilize from COTS upgrade which impacted follow on build
- **Insufficient coordination between the multiple development organizations and COTS vendors**
  - Complex contractor, subcontractor, vendor relationships
  - Misunderstandings between contractors and COTS vendors with respect to COTS functionality expected
- **Limited visibility into the evolution of the NDI code**
- **Non standard requirements and software configuration management**

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Case Study Details

- **7 Existing home grown components**
  - Legacy Baseline = 618.6K
  - Deletions and Modifications for Glue Code and new functionality – New Baseline = 658.6K
- **One NDI (not developed internally) component**
  - Legacy Baseline = 860K
  - Deletions for functionality replaced by COTS – New Baseline = 590K
- **7 COTS Components ranging from midsize to very large**
  - Sun Solaris Operating System
  - COTS C2 Product (this replaced the deleted NDI functionality)
  - Oracle
  - Satellite Tool Kit
  - Tivoli Product (communication)
  - Veritas Product (network mgmt)
  - Gensym Product (network mgmt)

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Case Study Details

- **Complexities**
  - Integration team capability => above average
  - External Integration Complexity => High or very high
  - Project constraints => some constraints
- **Project data**
  - Project start date => Jan 2001
  - Project duration => 34 months
  - Project effort => 170K hours
  - Project cost => $22M

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Estimation Assumptions

- **Software and System Requirements Analysis set low**
  - Existing functionality being replaced
  - Enterprise like components such as OS require less analysis than embedded components
- **Documentation costs set low**
  - Existing functionality being replaced
- **Other overhead costs reduced for allocation to prime**
  - Project management
  - Quality Assurance
  - Configuration Management
  - Plan and Oversee

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Estimation Assumptions

- **Modeled Existing Components as Software Components with New Code for glue code and new functionality and Deleted Code for Deleted Functionality**
- **Modeled NDI Component as a COTS component**
- **Modeled COTS Products as COTS Components – using Functional Size Generator to determine size**

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Estimation Assumptions

- **Integration and Test costs require adjustment for several reasons**
  - Existing components have already been successfully integrated
  - Enterprise type components have large functional size with a relatively limited percentage that requires integration
  - Operational software components integrate differently with each other than with the mission software components

- **In order to accomplish reasonable integration and test values constructed sub-assemblies to represent:**
  - Operational Software (software required to get the other components working together – more enterprise type software) – low integration
  - C2 Software – large NDI Component (low integration complexity) with C2 COTS component (high integration complexity)
  - Mission Software – existing homegrown components (average integration complexity) with mission specific COTS component high integration complexity
  - Spread integration and test activity equally between the system and the three sub-assemblies

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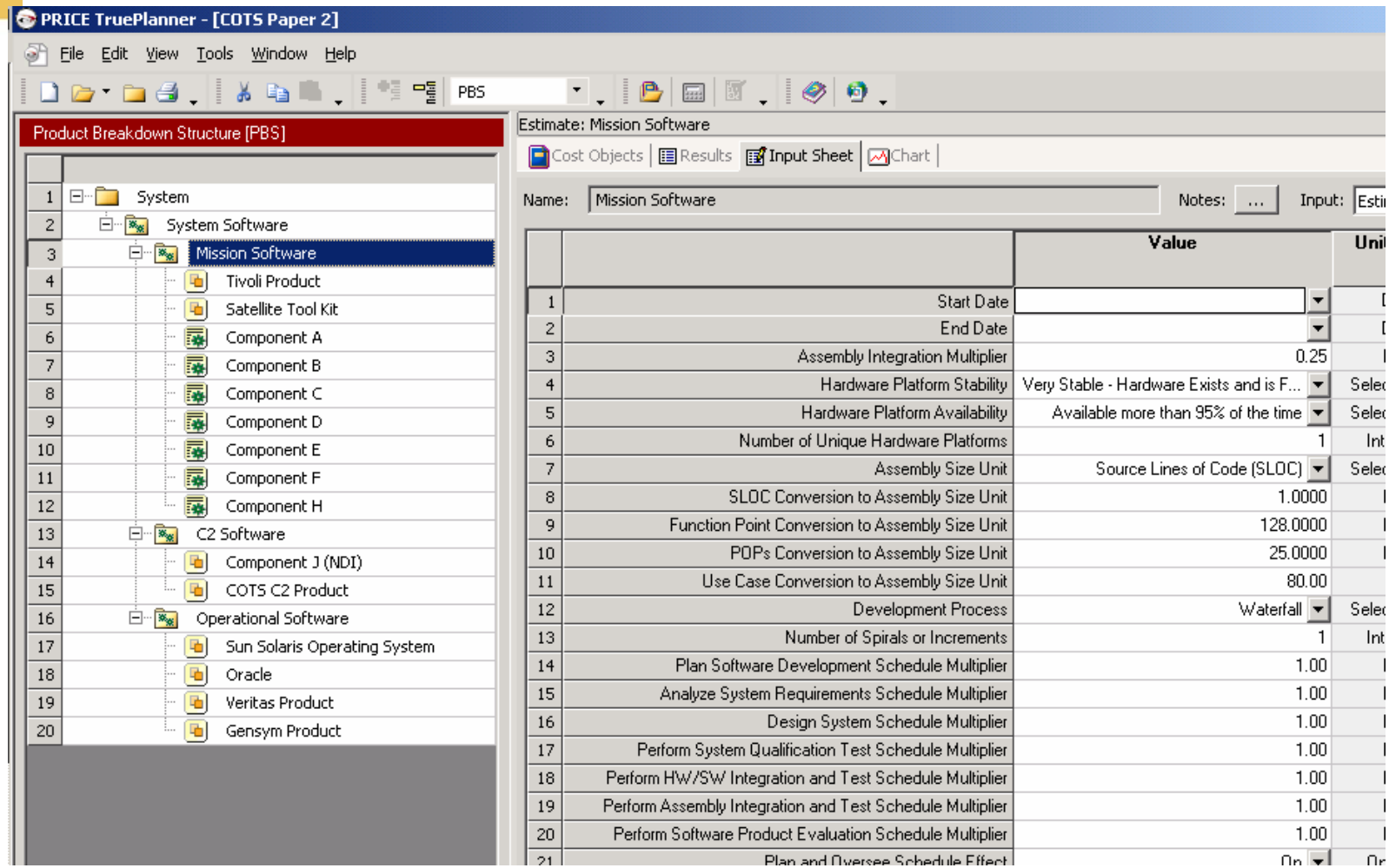
Product Breakdown Structure



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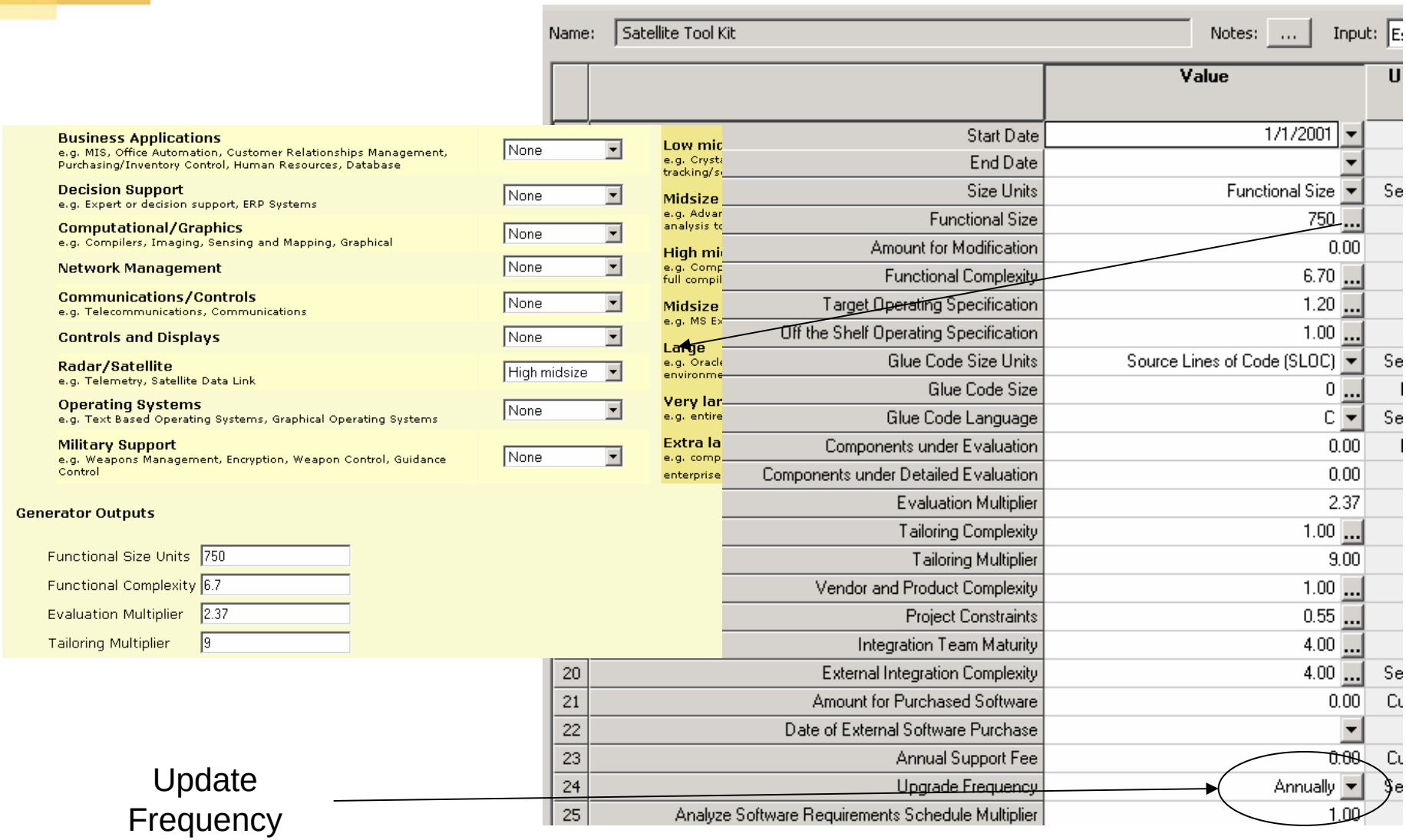
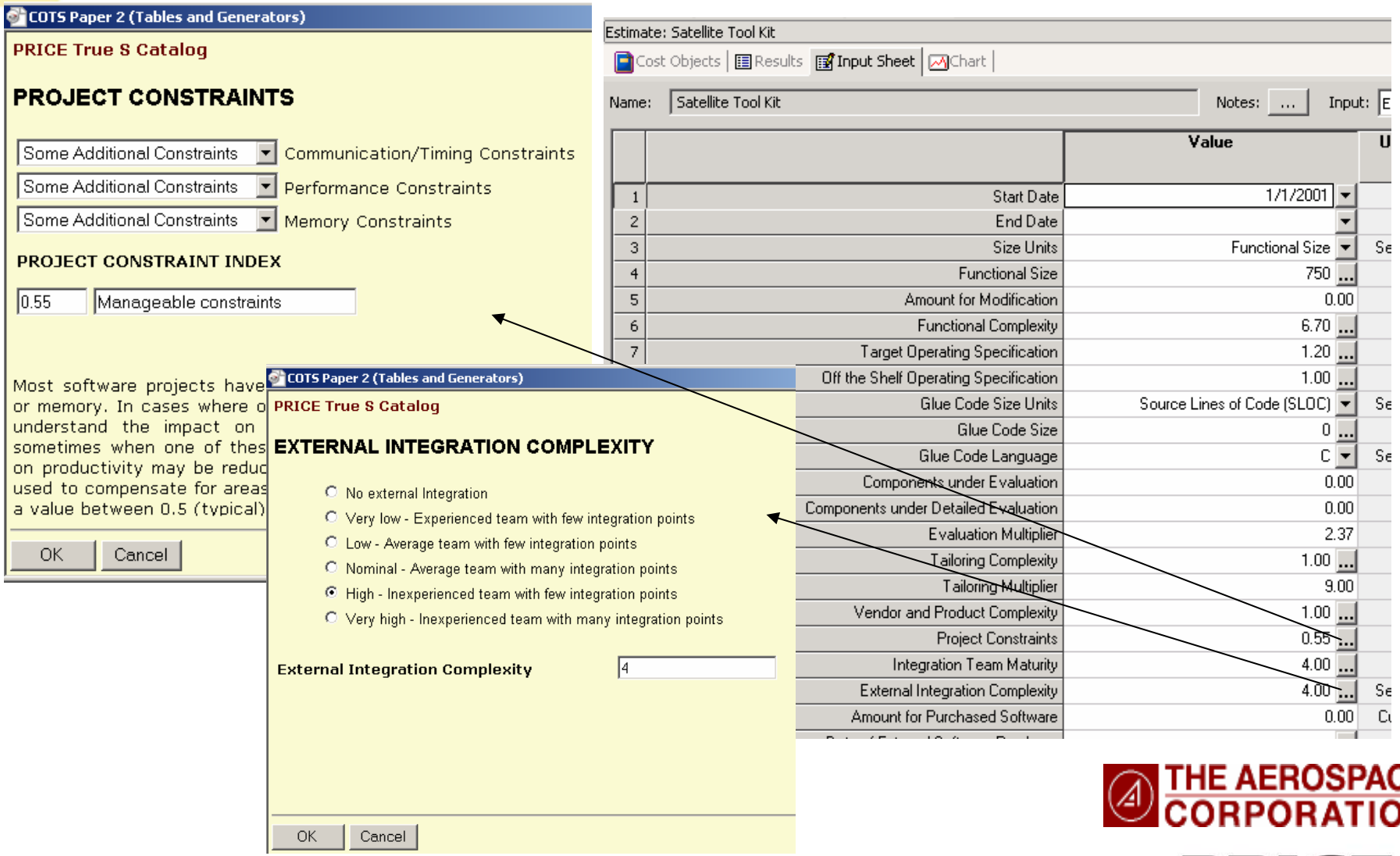
Typical COTS Input Set



Update Frequency

Typical COTS Input Set



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Results – Labor Hours

Labor Requirement Profile: System

Cost Objects | Results | Input Sheet | Chart

System Total Labor Requirements = 179,291.21 Hours View: Labor Requiremer

Units: Hours Timescale: Monthly

	Labor Requirement Profile : System - [System] Labor Requirements in Hours	Total	12/1/2000	1/1/2001	2/1
1	System Software	**21,304.57**	452.40	345.87	
2	Mission Software	**65,104.96**	5,039.46	1,999.79	
3	Tivoli Product	**484.98**		80.69	
4	Satellite Tool Kit	**848.87**		88.58	
5	Component A	**9.87**		2.53	
6	Component B	**2,292.97**		310.95	
7	Component C	**2,488.21**		341.29	
8	Component D	**17,637.92**		709.15	
9	Component E	**611.46**		133.53	
10	Component F	**3,461.29**		295.66	
11	Component H	**12,015.22**		612.87	
12	C2 Software	**35,199.13**	1,968.49	1,500.71	
13	Component J (NDI)	**4,827.17**		937.78	
14	COTS C2 Product	**637.71**		110.96	
15	Operational Software	**8,356.61**	644.59	326.87	
16	Sun Solaris Operating System	**2,049.37**		392.87	
17	Oracle	**650.54**		61.36	
18	Veritas Product	**655.17**		46.04	
19	Gensym Product	**655.17**		46.04	
20	**Total**	**179,291.21**	**8,104.94**	**8,343.55**	**1**

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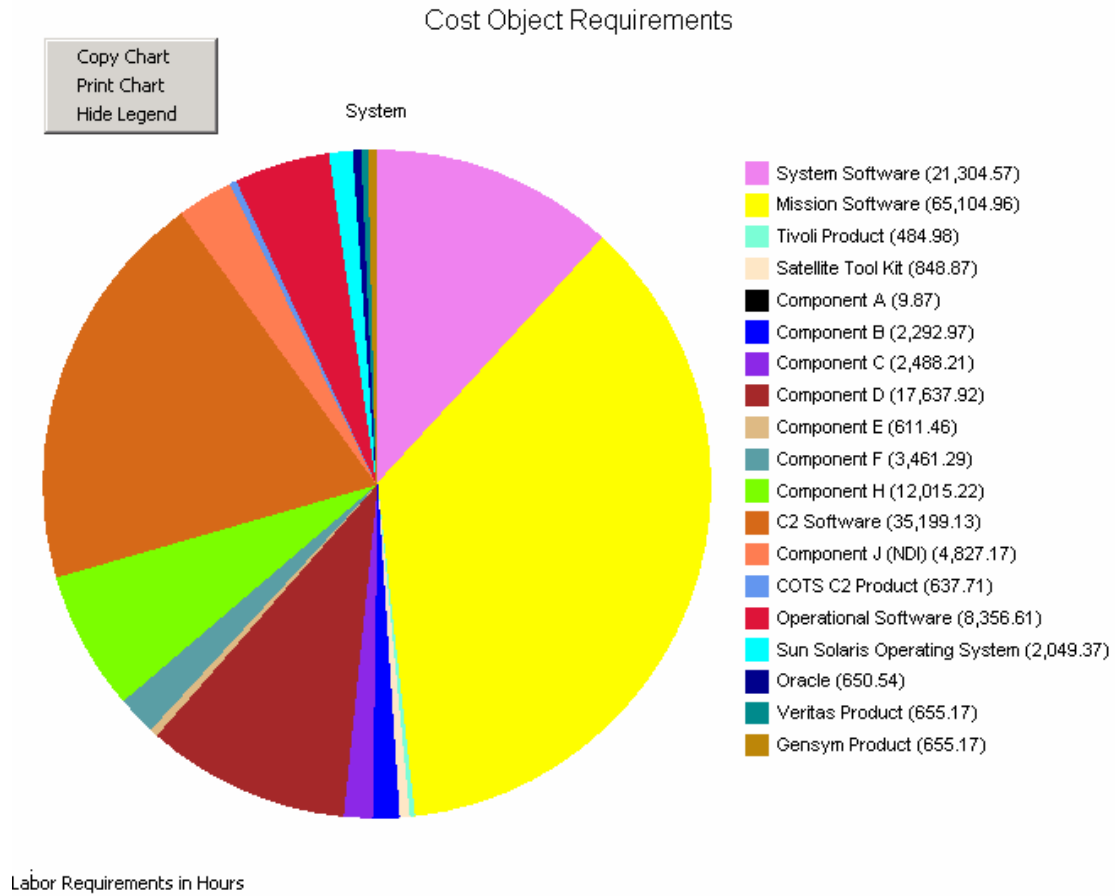
Results Labor Hours Per PBS Element

Product Breakdown Structure [PBS]

1	System
2	System Software
3	Mission Software
4	Tivoli Product
5	Satellite Tool Kit
6	Component A
7	Component B
8	Component C
9	Component D
10	Component E
11	Component F
12	Component H
13	C2 Software
14	Component J (NDI)
15	COTS C2 Product
16	Operational Software
17	Sun Solaris Operating System
18	Oracle
19	Veritas Product
20	Gensym Product



Results – Costs in $

Cost Table: System Software

Cost Objects | Results | Input Sheet | Chart

System Software Cost = $22,551,438 View: Cost Table

	Cost Table : System Software - [Software Assembly] Currency in USD ($) (as spent)	Total	Programmer	System and Software Engineers
1	Perform Software Maintenance	**0**	0	0
2	Manage Project	**4,004,146**		746,128
3	Perform Configuration Management	**1,540,962**	39,694	26,447
4	Perform Joint Technical Reviews	**0**		0
5	Perform Quality Assurance	**1,498,228**	19,847	26,447
6	Plan and Oversee	**573,398**		494,452
7	Plan Software Development	**880,374**		363,685
8	Write Documentation	**765,867**	10,608	11,294
9	Analyze System Requirements	**23,159**		23,159
10	Design System	**72,114**	16,599	55,514
11	Analyze Software Requirements	**1,330,452**		1,330,452
12	Perform Assembly Integration and Test	**6,023,883**	757,740	2,381,382
13	Purchase External Software	**0**		
14	Evaluate and Select	**0**	0	0
15	Design Software	**2,990,406**	559,001	2,431,405
16	Tailor	**269,922**	186,678	83,243
17	Code and Unit Test	**924,425**	803,234	121,191
18	Perform Software Integration and Test	**461,413**	109,086	177,075
19	Perform Software Qualification Test	**571,701**	98,126	276,094
20	Perform HW/SW Integration and Test	**380,080**	112,474	120,248
21	Perform Software Product Evaluations	**0**		0
22	Perform System Qualification Test	**240,908**	59,370	130,840
23	**Total**	**22,551,438**	**2,772,458**	**8,799,057**

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Lessons Learned

- **Steps taken to improve overall integration of processes between the contractors**
- **Common software development configuration management system enabled team to more readily share source code baselines**
- **NDI should be reclassified as mission unique code and its evolution managed as such**
- **Evolution of COTS and NDI components need to follow robust systems engineering processes**
  - Especially in areas of requirements definition and risk management

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Lessons Learned

- **Be aware when important decisions are being driven by schedule considerations at the expense of technical considerations**
- **More systematic process for specifying requirements for each new version of COTS and NDI software**
  - Include provisions in development schedule for theses activities
- **Full appreciation of system and software engineering practices is required through the life cycle of COTS-based systems**

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Conclusion

- **Planning and budgeting for COTS upgrades present unique challenges to a project manager**
- **Use the COTS solution capabilities of PRICE True S**
  - Provides for comprehensive coverage of COTS related activities
  - Asks the right questions to get needed insight
  - Provides consistent and defendable estimates of costs
- **Make COTS-based systems tradeoffs and realign budgets for COTS realities**

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