Clearly Communicating Your IGCE To Decision Makers

THE ART OF THE OUTBRIEF

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So, What's The Status of Your IGCE ?

This Is How We IGCE Roll

- Slog long, tedious hours as professional cost estimators
- Research, gather info, pluck data, pour over SOWs
- Determine the cost drivers, factors and inflation
- Create the cost model, run the numbers, arrive at budget point estimates, test sensitivity limits
- Ta-da! The IGCE is now hot'n ready!

Just prepare the document. Call it a day, right?

Nope.
It's Time for the **OUTBRIEF**

"Hi, this is Senior Management. We'd like to see your results!

Don't focus so much on the itty-bitty cost intricacies.

Just the biggie hard-hitting facts and data, please.

And we have short attention spans, so… 10 slides or less.

Can you do tomorrow?"

*The **Wrong** Reaction Is…*

Why is

The **OUTBRIEF**

So Darn Important?

NASA says…

- "Because cost estimation is an inexact science based on historical experiences and subjective judgments, it is vital that the cost estimator prepare a **solid presentation package** that provides the context and rationale for the estimate in a way that is **clearly understood** and accepted by the customer and other stakeholders." **(NASA Cost Estimating Handbook v4.0 Appendix H, pp. H2-H3)**

The Navy says…

- "Use of **meaningful, thoughtfully-prepared visual displays is important** in communicating the results of detailed cost analyses to stakeholders. Briefing slides should reveal the basis and results of analysis, induce the viewer to focus on substance and decision space, and should avoid any distortions in either data or analysis."

(Navy's October 2010 Cost Estimating Guide, p.51)

Other Sources to Find Prep Tips

- DoD 5000.4-M Cost Analysis Guidance and Procedures dating to Dec 1992
- DoD Independent Government Cost Estimate Handbook for Services Acquisition (Feb 2018 update)
- Army Cost Analysis Manual (May 2002)
- Navy's Cost Estimating Documentation Policy (Sep 2012) and Cost Estimating Guide (Oct 2010)
- Marine Corps Cost Analysis Guidebook (Mar 2016)

Yeah, great, but I hate reg reading.

How about a real-life example?

- **Yes, that's a good idea.**
- **How about a sanitized one? No worries, I used lots of Lysol.**
- **… and I changed names, numbers, data, all kinds of stuff…**
- **… in an effort to protect, well, uh, protect the innocent, guilty, whomever & whatever it is that might need protecting.**
- **But you'll get the idea, I promise!**

The following OUTBRIEF flow/presentation style works nicely for my program office leadership; But it may need *tweaking* for yours

Today's Date

OUTBRIEF

on the

Radar & Fire Control System X1

Independent Government Cost Estimate

Mr. Crunchin Numeros

Cost Estimator, Whirlybird Program Office

Background

- CHALLENGE:
  - **Current Radar & Fire Control System (RFCS) is facing obsolescence compounded by ongoing hardware and software quality issues.**
  - **OEM is dissolving; advance buys & spares will be exhausted by 2024; no alternate supplier/manufacturer available.**
  - **Future fleet readiness is at risk, and Whirlybirds are vulnerable.**

- PROPOSED OPTION:
  - **Radar/Fire Control System X1**
    - **Pursue a Modified Non-Developmental Item (NDI) with New Software & Open System Architecture**

Bottomline Up Front

Cost Estimate: RFCS-X1 48-mo Mod, Write S/W, Test, 100 Prototypes (w/out TDY & Gov't Costs)

RFCS-X1 48-mo IGCE		FY19	FY20	FY21	FY22	FY23	Subtotal TY$
S/W SLOC		$ 8.840	$ 21.253	$ 0.697	$ 0.641	$ 0.286	$31.717
Test Scripts		$ 2.232	$ 16.331	$ 2.382	$ 1.271	$ 0.046	$22.262
Eng drawings		$ -	$ 0.456	$ -	$ 0.846	$ -	$1.302
Tech Data		$ 1.521	$ 4.716	$ 0.847	$ 0.780	$ 1.070	$8.933
S/W licenses		$ 3.694	$ 0.273	$ 0.278	$ 0.284	$ 0.289	$4.817
CDRLs		$ 0.745	$ 0.910	$ 0.771	$ 0.882	$ 0.670	$3.977
TDY							$0.000
Prototypes, Mat'ls, Rpr		$ -	$ -	$ 10.809	$ 19.574	$ 8.038	$38.421
Mat'l Mgmt	10%	$ -	$ -	$ 1.081	$ 1.957	$ 0.804	$3.842
SEPM	42.3%	$ 4.367	$ 15.096	$ 1.514	$ 0.974	$ 0.130	$22.081
G&A	15%	$ 3.210	$ 8.855	$ 2.757	$ 4.081	$ 1.700	$20.603
Profit	10%	$ 2.461	$ 6.789	$ 2.114	$ 3.129	$ 1.303	$15.795
GRAND TOTAL (BudgetYr$'s)		**$ 27.068**	**$ 74.678**	**$ 23.250**	**$ 34.419**	**$ 14.335**	**$ 173.750**

- **Approx $175M necessary to get the RFCS-X1 ready for LRIP and Full Rate Production**
- **Roughly $225K per RFCS-X1 (A+B kit) during Dev/Mod/Test/Prototype phase**

Life-Cycle Cost Estimate RFCS-X1 vs. Current RFCS

Cost Estimates (w/Gov't costs, but w/o TDY costs)		Budget Yr $M
4-yr Phase of Mod, Test, Prototype		$ 173.8
Testing (Govt & Ktr costs)		$ 46.8
RadarFireCntrlSys-X1 Production		$ 463.9
O&M (RadarFireCntrlSys-X1)		$ 380.8
O&M (S/W Refreshes both sys, Trng, Legacy Proc/Repairs/Cut-In)		$ 313.6
Other Costs: Material Mgt, SEPM, G&A, Profit		$ 650.6
Total RadarFireCntrlSys-X1 Life Cycle Cost (w/out TDY)	To FY40	**$ 2,029.4**

Current RFCS projected Life Cycle Cost Est to FY40

$2,200.0M

- **Some savings advantage exists for RFCS-X1 across life-cycle**

Estimate $150K per RFCS-X1 (A+B kit) during production phase (current RFCS cost = $175K/ea)

Facts from the SME's

- **Currently ~$195M identified & available in the Program Office's budget**

Potential Funds	FY19	FY20	FY21	FY22	FY23	Total
Approp: APA	$30.0	$75.0	$30.0	$40.0	$20.0	$195.0

- **Current Radar & Fire Control System hardware obsolescence projections:**
  - **Worst Case – FY2022 // Most Likely – FY2024 // Best Case – FY2026**
- **HW Quality: ~ 20% of current RFCS's received have had failures.**
- **SW Quality: Delayed upgrades are a direct result of software quality issues.**
- **SW Maintx: Limited options for fixes/updates; legacy Ada language is burdensome.**
- **SW Architecture: Closed architecture is not portable and significantly limits agility in introducing/updating capabilities; limits use of 3rd party applications.**
- **Systems Engineering: Lack of modern System Engineering (i.e. MBSE) processes increase time to field new capabilities.**
- **SW Update implications: Cost increases.**

Hardware Comparo -- Pros and Cons

		RFCS-X1	Current RFCS
Aspect	HW	New RFCS model X1	Current RFCS
Hybrid HW/SW	DO-254 compli?	YES	NO
Current HW/SW	New A-kit req'd?	YES	NO
H/W	Pro's	- Addresses obsolescence, current standards to include safety & quality - Facilitates transition to Open Architecture (COTS) - Promotes competition - H/W portability (at LRU, SRU) - Potential H/W upgrade (processor, memory) - US Gov't controls interfaces	- Familiarity, simplest
	Con's	- Retrofit costs - Logistics impacts -Req'ts for Full Rate Production contract (impacts to production line) - PM required to handle some Config Mgmt & LSI roles	- Past performance - Expensive O&M tail - Obsolescence issues - Retains proprietary interfaces - Only defers new H/W until Yr24 (best case) - Still have old RFCS w/bit, flip, leakage issues; no Gov't influence on design

Software Comparo -- Pros and Cons

		RFCS-X1	Current RFCS
	SW	New SW	Keep HW/SW with OEM
Obsolescence	DO-178 compli?	YES	NO
Worst – 2022	Model Based Sys Engrg?	YES	NO
Most Likely - 2024	FACE compli?	YES	NO
Best - 2026	Cost Share ?	YES	NO
S/W	Pro's	- Minimizes H/W obsolescence impacts - S/W updates (shorter release cycles), addresses current S/W quality concerns - SW architecture flexibility to meet DO-178, MBSE/FACE & safety standards - Permits full DO-178C, ARINC 653 and FACE conformance - Reduced SW lifecycle costs - Aligns with Army's Open Architecture vision - Enables unlimited SW data rights - Meets DOD Better Buying Power initiative via competitive bid - Retain US Govt data rights on newly developed SW - Promotes, allows future competition	- Familiarity, simplest
	Con's	- Risk associated with introduction of MBSE and FCE - Developing SW for 10% of code for which there are no data rights	- Past performance - Expensive - Does not match Future Modernization Roadmap - Vendor dependency

RFCS-X1 Details

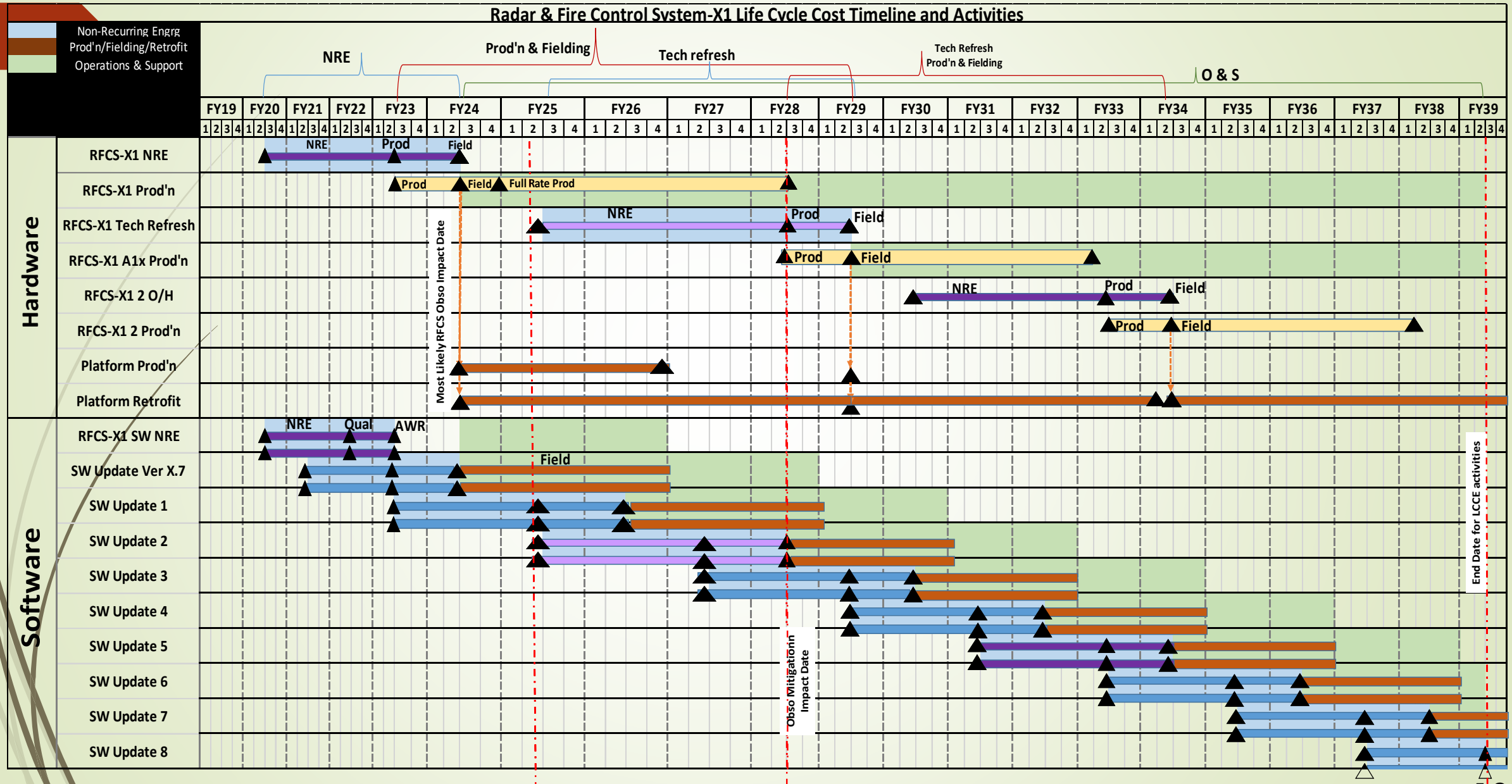
48-mo CPIF contract - HW/SW Build & Mod, Produce & Test Prototypes

- Primary cost drivers:
  - Approximately 550,000 S/W lines of code, 90% auto-generated via model-based engineering
  - Running over 3,000 test scripts (a Safety of Flight issue)
  - Prototype quantities (test articles) = 100 A- & 100 B-kits

Full-Rate Production, Retrofit and O&M phases

- Costs driven by production quantities (fleet plus spares), anticipated unit failure and repair rates, and refresh cycle frequency
  - Assumes spares required at 20% of fleet
  - Assumes Mean Time Between Repair of 1,500 hours for both RFCS-X1 and current RFCS
  - Assumes average Retrofit pace of 125 a/c per year, requiring 10hrs labor ea + TDY (approx. $5,000 total retrofit cost per a/c, not including actual RFCS-X1 unit cost)
  - Continue procuring/maintaining/refreshing current RFCS during 3-yr cut-in to RFCS-X1

Forecasted RFCS-X1 Timeline



Recommendation: Pursue RFCS-X1

RFCS-X1 48-mo IGCE		Subtotal TY$
S/W SLOC		$31.717
Test Scripts		$22.262
Eng drawings		$1.302
Tech Data		$8.933
S/W licenses		$4.817
CDRLs		$3.977
TDY	*Note: No TDY costs included*	$0.000
Prototypes, Mat'ls, Rpr		$38.421
Mat'l Mgmt	10%	$3.842
SEPM	42.3%	$22.081
G&A	15%	$20.603
Profit	10%	$15.795
GRAND TOTAL (BudgetYr$'s)		**$ 173.750**

- **Solves current Radar & Fire Control System obsolescence issues**
- **Addresses HW/SW quality**
- **Transitions to an Open System Architecture**
- **Provides portability and agility**
- **Gives greater ability to compete future capability enhancements and updates**
- **Gov't owns Tech Data Pkg and SW data rights and controls interfaces**
- **Program Office has identified sufficient funding**
- **Sensitivity analyses = +/- $20M potential deviation**

OUTBRIEF Backup

- Need to have the details back here.
- One or more of the senior leaders WILL want to see it and flip through it.

Key Cost Estimate Inputs & Drivers

Software Lines of Code

	Initial Build		S/W Refreshes (ea)	
New SLOC		**400,000**		**22,000**
Manual New	50,000		2,000	
Autocode	350,000		20,000	
Ported SLOC		**100,000**		**3,000**
Reused SLOC		**50,000**		**0**
TOTAL SLOC		***550,000***		***25,000***

Test Scripts

	Initial Build	S/W Refreshes (ea)
New Manual	200	20
New Autocode	2,000	100
Modified	600	50
Ported	200	20
Total Test Scripts	3000	190

Technical Data

	# of new	# of revised
Func'l Description Documents (FDDs)	1	40
Maint Operational Checks (MOCs)	1	40
Fault Isolation Procedures (FIPs)	40	300

Engineering Drawings

	FY19	FY20	FY21	FY22	FY23	FY24	TOTALS
Mech/Structural Dwgs	0	7	0	12	0	8	27
Electrical Drawings	0	3	0	6	0	8	17

Prototype Qty/Schedule

	FY19	FY20	FY21	FY22	FY23	TOTAL
A-kit delivery quantity	*0*	*10*	*30*	*30*	*30*	*100*
B-kit delivery quantity	*0*	*10*	*30*	*30*	*30*	*100*

Contract type: 48-month Cost-Plus Incentive Fee

Key **Software** Cost Est Relationships

		RFCS-X1 - initial build		Convert to ESLOC	Est ESLOC
72.7%	New Sloc		400,000		
	Manual New	50,000		100%	50,000.0
	Autocode	350,000		31.97%	111,895.0
18.2%	Ported		100,000	15.40%	15,400.0
9.1%	Reused		50,000	6.72%	3,360.0
	Total SLOC	RadarFireCntrlSys-X1	550,000	Tot Est ESLOC	180,655.0
				Hrs / ESLOC	0.8151
				Est Base SW hrs (SWEngr)	**147,251.6**

Hrs/ESLOC is an average of hrs/ESLOC for like-kind systems extracted from BIGARMY's Form 1921 database

		RFCS-X1 - SW refresh		Convert to ESLOC	Est ESLOC
	New Sloc		22,000		
	Manual New	2,000		100%	2,000.0
	Autocode	20,000		31.97%	6,394.0
	Ported		3,000	15.40%	462.0
	Reused		0	6.72%	0.0
	Total SLOC	RadarFireCntrlSys-X1 refr	25,000	Tot Est ESLOC	8,856.0
				Hrs/ESLOC*	0.8151
				Est Base SW hrs (SWEngr)	**7,218.5**

** Hrs/ESLOC is an avg of hrs/ESLOC for like-kind systems extracted from BIGARMY's SRDR database*

Plus:

- SW Engineering Environment Support
- General SW Engineering/Support
- SW Baseline Verification Tests & Full Qualification Tests
- SW Regression Tests in Avionics & System Integration Labs
- Weapons/Inhibits/Limits/Interruptions Tests

Key **Test Scripts** Cost Est Relationships

Avionic/System Integration Lab Test Scripts

		# new manual	# new autocode	# modified	# ported			
test scripts	Test Scripts	200	2,000	600	200		Spt hrs %	1.00%
	Hrs / script	40.0	40.0	40.0	40.0	Total SWEngr hrs		**1,200.0** EEEngr hrs
3000		8,000	80,000	24,000	8,000	**120,000**		

SME input from Mr Suftwear

Calculation for Test Script Hours:

Analogous Pgm XT data:
39,000 hours spent doing test scripts (per CDRL data)
975 test scripts in Project XT SVCP
40.0 hrs /test script

SW Refresh RadarFireCntrlSys-X1

CER	# new manual	# new autocode	# modified	# ported			
Test Scripts	20	100	50	20		Spt hrs %	1.00%
Hrs / script	40.0	40.0	40.0	40.0	Total SWEngr hrs		**76.0** EEEngr hrs
	800	4,000	2,000	800	**7,600**		

Plus:

- General SW/Script Engineering Support

Key **Drawings** Cost Est Relationships

Mech / Structural Drawings: Air Vehicle/Airframe Design and Support to Design Release			FY20	FY22	FY24	
- Development Complexity Design			7	12	8	
Development Airframe	hrs/dwg	200	1,400.0	2,400.0	1,600.0	MeStruxEngr
	Hrs1	Hrs2				
Support hrs/dwg	25	30	spread a % to drawings			
Production Complexity Drwgs						
Development Configuration	hrs/dwg	100	700.0	1,200.0	800.0	MeStruxEngr
	Hrs1	Hrs2				
Support hrs/dwg	10	20	spread a % to drawings			
Summary of Hrs by LaborCat						
		MeStruxEngr	**2,100.0**	**3,600.0**	**2,400.0**	MeStruxEngr
		PrDataMgt	**21.0**	**36.0**	**24.0**	PrDataMgt
		FltEngr	**21.0**	**36.0**	**24.0**	FltEngr
		MfgEngr	**21.0**	**36.0**	**24.0**	MfgEngr
		SysEngr	**14.0**	**24.0**	**16.0**	SysEngr

Electrical Drawings: Elec Design and Support to Design Release			FY20	FY22	FY24	
- Development Complexity Design			3	6	8	
Development Complexity Drwgs						
Development Electrical	hrs/dwg	100	300.0	600.0	800.0	EEEngr
	Hrs1	Hrs2				
Support hrs/dwg	30	20	spread a % to drawings			
Summary of Hrs by LaborCat						
		EEEngr	**300.0**	**600.0**	**800.0**	EEEngr
		PrDataMgt	**3.0**	**6.0**	**8.0**	PrDataMgt
		MeStruxEngr	**3.0**	**6.0**	**8.0**	MeStruxEngr
		FltEngr	**3.0**	**6.0**	**8.0**	FltEngr
		MfgEngr	**3.0**	**6.0**	**8.0**	MfgEngr
		SysEngr	**3.0**	**6.0**	**8.0**	SysEngr

Plus:

- General Engineering/Design Support

Key **Sys Eng/Pgm Mgmt** Cost Est Relationships

Systems Engineering and Program Management

Sys Engrg involves Test Mgt, Airworthiness, HW Qual, Sys Integ/Modif/Upgrd, V&V, Test/Eval Support, Test Facilities

Pgm Mgmt involves Data Mgmt, Integrated Product Spt, Change Mgmt, Security, Cost Reporting, Risk Mgt, Integrated Master Planning/Schedule

Used several programs as data points -- for prime mission product, sys engrg and pgm mgmt -- and take average:

Program		PMP	Sys Engrg	Pgm Mgmt	
Program A1	EAC	$47,000,000	$16,000,000	$8,000,000	Per Final 1921 Report
	percentage of PMP		34.0%	17.0%	
Program B2	EAC $M	$1,500,000.0	$172,000.0	$200,000.0	Per Final 1921 Report
	percentage of PMP		11.5%	13.3%	
Program C3	EAC hours	661,000.0	107,000.0	286,000.0	Per Final 1921 Report
	percentage of PMP		16.2%	43.3%	
Program D4	EAC $M	$292,000.0	$61,000.0	$74,000.0	Final Report 1921
	percentage of PMP		20.9%	25.3%	
Program E5	EAC $M	$234,000.0	$73,000.0	$60,000.0	Milestone C Report 1921
	percentage of PMP		31.2%	25.6%	
Program F6	EAC $M	$83,000.0	$13,000.0	$17,000.0	Lot 1 Final 1921
	percentage of PMP		15.7%	20.5%	
Program G7	EAC $M	$47,000.0	$9,000.0	$11,000.0	Country X 1921 Final Report
	percentage of PMP		19.1%	23.4%	
Program H8	EAC $M	$8,400.0	$1,000.0	$2,000.0	Final 1921 accepted
	percentage of PMP		11.9%	23.8%	
Program I9	EAC $M	$40,000.0	$5,200.0	$6,000.0	Lot 1 Production CYXX, Form 1921
	percentage of PMP		13.0%	15.0%	

	AVERAGE	
Sys Eng	19.3%	
Pgm Mgmt	23.0%	42.3%

- SEPM % is applied against sum of Prime Mission Product hours

Key **CDRL** Cost Est Relationships

	FY19	FY20	FY21	FY22	FY23
Total CDRL Submits	**452**	**538**	**442**	**492**	**364**
Submits less 1-time Submits	424	505	415	461	341
x recurring hrs/submittal (CER CDRL), Labor code PrDataMgt	4	4	4	4	4
Recurring Hrs	1696.0	2020.0	1660.0	1844.0	1364.0
Spread of 1-time CDRL initial prep hrs (analyst est)	19.8%	23.5%	19.3%	21.5%	15.9%
NRE hrs after spread	2,678.8	3,188.5	2,619.5	2,915.9	2,157.3
RE + NRE CDRL Hrs (PrDataMgt)	**4,374.8**	**5,208.5**	**4,279.5**	**4,759.9**	**3,521.3**

- Over 100 CDRLs identified in RFCS-X1 Statement of Work

Total Manhours (by Cost Item & Labor Cat)

RadarFireCntrlSys-X1 EST MANHOURS	FY19 Jun19-Sep19	FY20	FY21	FY22	FY23
S/W SLOC	**52,348.0**	**122,565.2**	**3,892.8**	**3,472.8**	**1,516.7**
Test Scripts	**13,218.0**	**94,189.2**	**13,332.0**	**6,908.4**	**242.4**
Eng drawings	**0.0**	**2,613.0**	**0.0**	**4,573.8**	**0.0**
Tech Data	**8,987.3**	**27,148.1**	**4,724.2**	**4,228.2**	**5,664.8**
CDRLs	**4,374.8**	**5,208.5**	**4,279.5**	**4,759.9**	**3,521.3**
Prototypes, Mat'ls, Repair	**0.0**	**0.0**	**9,180.0**	**3,060.0**	**1,026.4**
SEPM	**27,181.1**	**91,500.4**	**8,908.4**	**5,562.5**	**725.6**
Grand Total Hrs	106,109.1	343,224.4	44,317.0	32,565.6	12,697.2
					538,913.3

	FY19 Jun19-Sep19	FY20	FY21	FY22	FY23
TOTAL Manhrs by Labor Category					
SWEngr	64,410.0	213,461.2	16,579.1	9,742.3	1,834.0
PrDataMgt	5,070.2	6,897.4	6,420.5	5,655.4	3,599.4
QEngrPlan	0.0	20.0	1,118.0	486.0	89.3
EEEngr	6,725.3	22,265.1	6,036.1	4,785.3	4,920.4
MeStruxEngr	0.0	2,208.2	0.0	3,786.3	0.0
FltEngr	0.0	24.0	0.0	42.0	44.6
MfgEngr	0.0	24.0	0.0	42.0	44.6
SysEngr	12,864.5	42,907.9	7,632.1	3,877.0	450.7
TestVerEngr	2,242.3	5,605.7	1,681.7	1,121.1	605.2
ProdnSpt	0.0	0.0	0.0	0.0	116.0
PgmSpt	14,796.9	49,811.2	4,849.6	3,028.1	395.0
Assmbly	0.0	0.0	0.0	0.0	270.0
EwireFabr	0.0	0.0	0.0	0.0	270.0
QualAssr	0.0	0.0	0.0	0.0	58.0
TOTAL HRS	106,109.1	343,224.4	44,317.0	32,565.6	12,697.2
					538,913.3

Forecasted RFCS-X1 Delivery Schedule

RFCS-X1 Expected Delivery Schedule		CY 24																								
		FY 24																								
	Customer	O	N	D	J	F	M	A	M	J	J	A	S	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	TOTALs
RFCS-X1 Prototype A-KIT	USG		25	25	25	25																					100
RFCS-X1 Prototype B-KIT	USG		25	25	25	25																					100
FRP RFCS-X1 A-kits	USG													200	200	200	200	200	200	200	200	200	200	200	200	200	2600
FRP RFCS-X1 B-kits	USG													200	200	200	200	200	200	200	200	200	200	200	200	200	2600
A-Kit Total Deliveries		0	25	25	25	25	0	0	0	0	0	0	0	200	200	200	200	200	200	200	200	200	200	200	200	200	2700
B-Kit Total Deliveries		0	25	25	25	25	0	0	0	0	0	0	0	200	200	200	200	200	200	200	200	200	200	200	200	200	2700

- 2,600 units necessary to retrofit fleet, cut into the production line, and meet spares/benchstock requirements

Sensitivity Analysis

- Varied the following cost drivers plus or minus 15%, alone and in combinations:
  - SLOC
  - Test Scripts
  - Engineering drawings
  - Quantity of prototypes
- Net effect: risk of +/- $20M variation on 48-mo IGCE

Other Relevant Backup Material

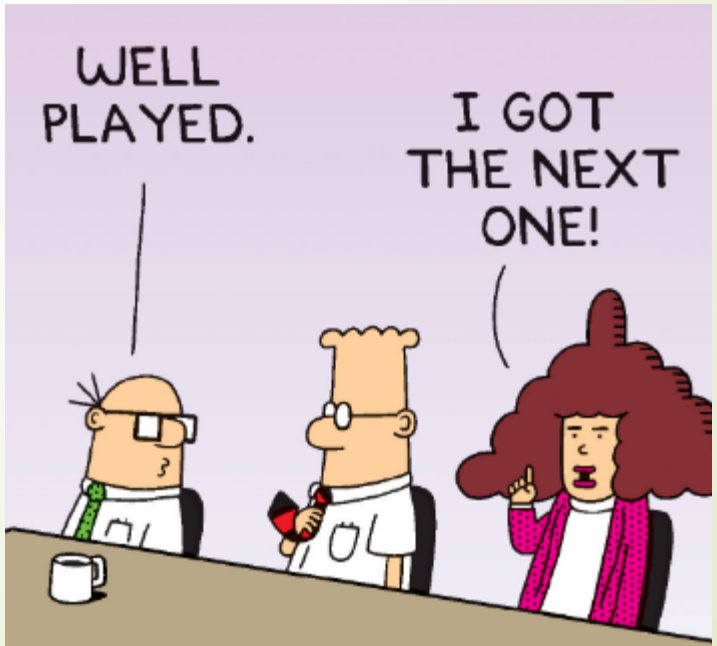
- Try to anticipate what leadership might ask about, and put it in backup
- Maybe historical data for the current system
- Maybe the next level detail on performance parameters for both current and new systems

But the Outbrief is NOT where you fully/completely document the IGCE.

So don't pack it full of boring inflation tables, labor rates, etc.

Parting Words

- **Tailor the OUTBRIEF to what your leadership wants**
- **Simple and straightforward, tell the story**
  - **Don't confuse audience & obfuscate results with data overload**
- **You can do this!**



Don't everyone shout at once…

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