



Impact of Scope Changes on Schedule Growth

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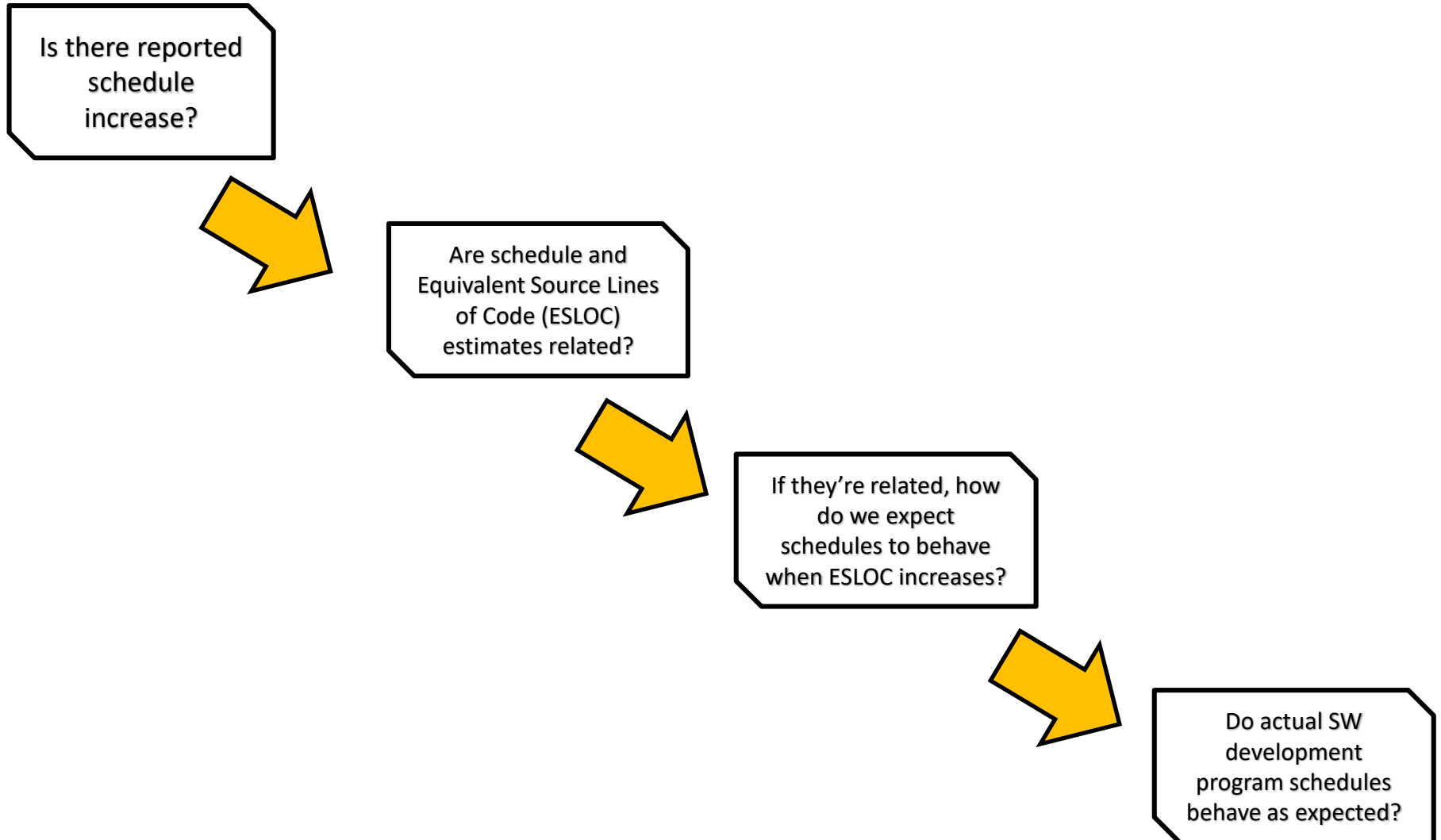
The Leader in Warfare Systems Development and Integration



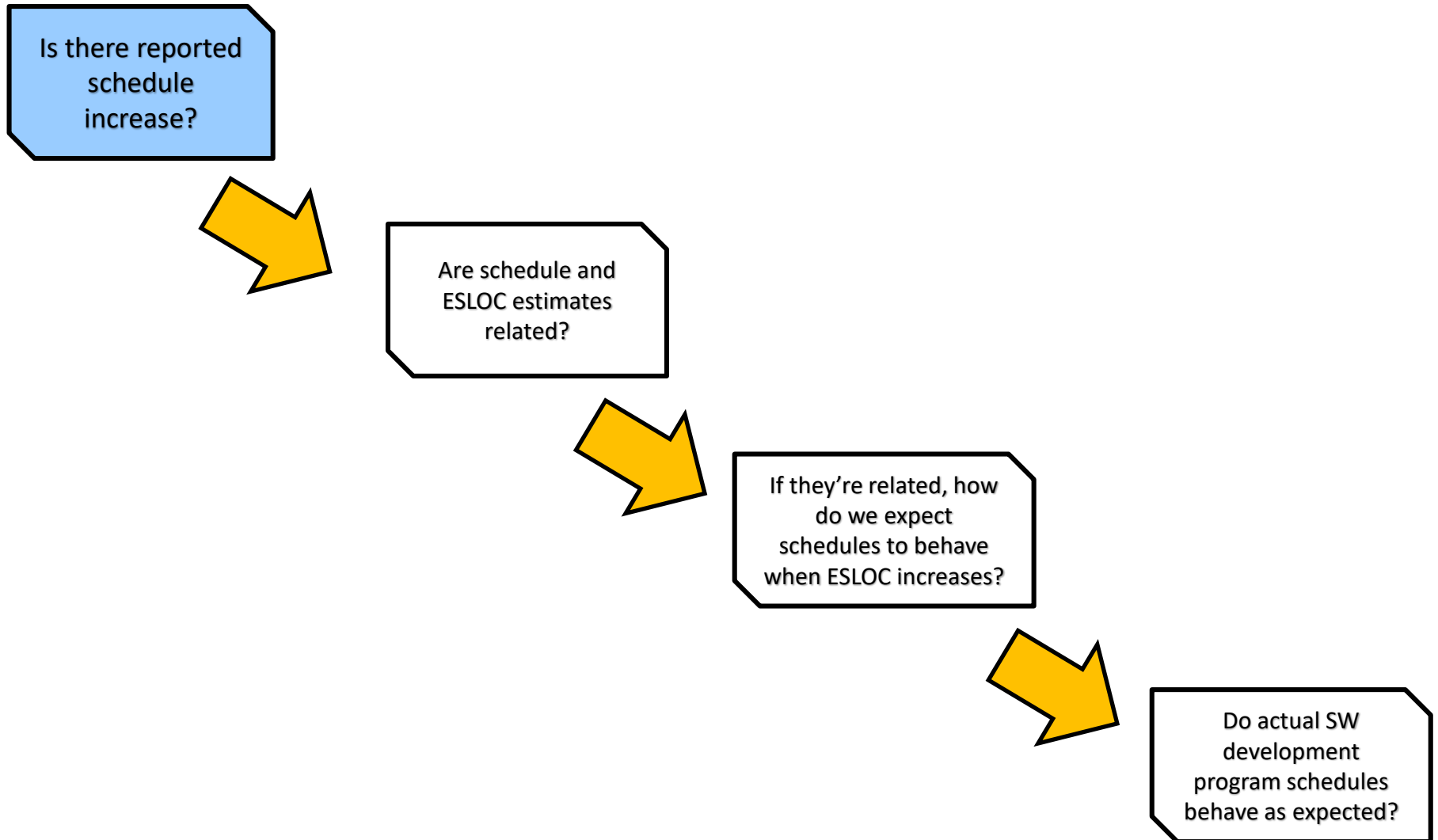
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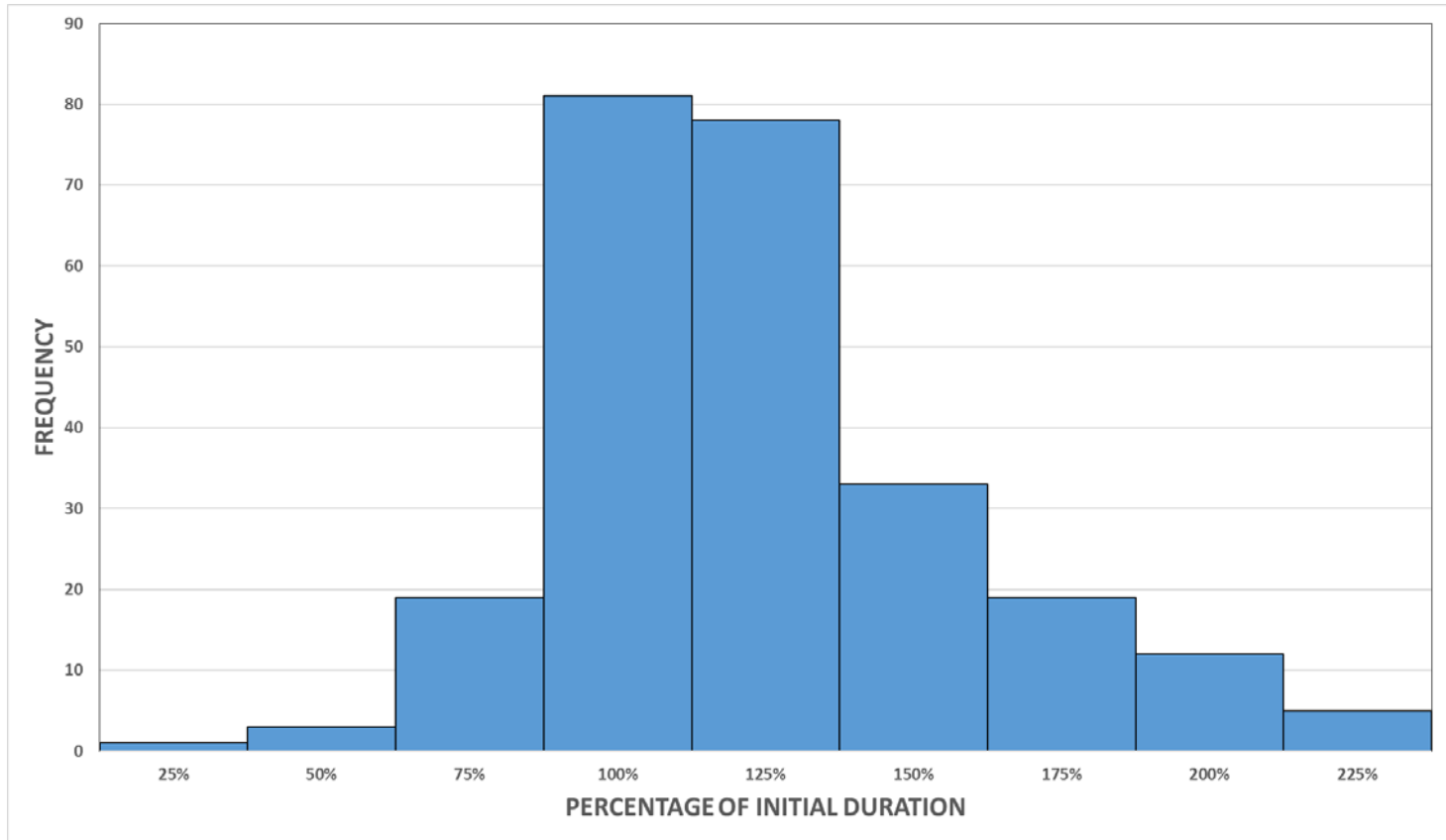
Agenda



Agenda



Schedule Growth in Software Programs

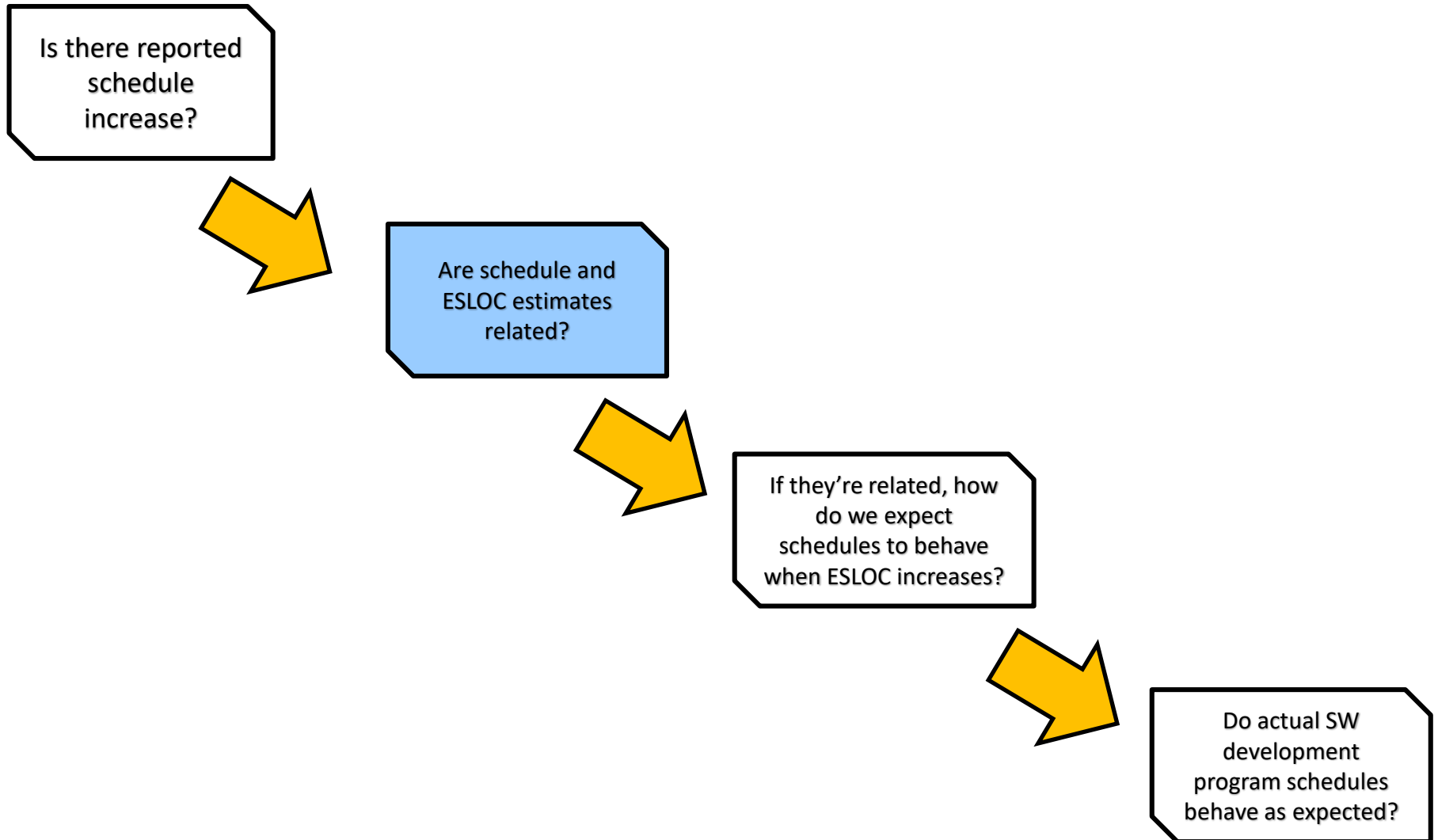


- Calculated growth using initial and final reported schedule months
- Method captures total growth including any growth owing to scope increases

Source:: SRDR Data Compilation Pairs, dated 16 NOV 2018

The SRDR data shows schedule growth happens more often than not.

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Simplified Software Development Cost Model

ESLOC

SW Growth

Productivity Rate

Labor Rate

Design, Code, Test and Integration (DCTI)

$$\left[\frac{ESLOC \times (1 + SW \text{ Growth Rate})}{Productivity} \right] \times Labor \text{ Rate}$$



Cost Model

Simplified Software Development IMS Model

ESLOC

SW Growth

Productivity
Rate

Person
Months*

Design, Code, Test and Integration (DCTI)

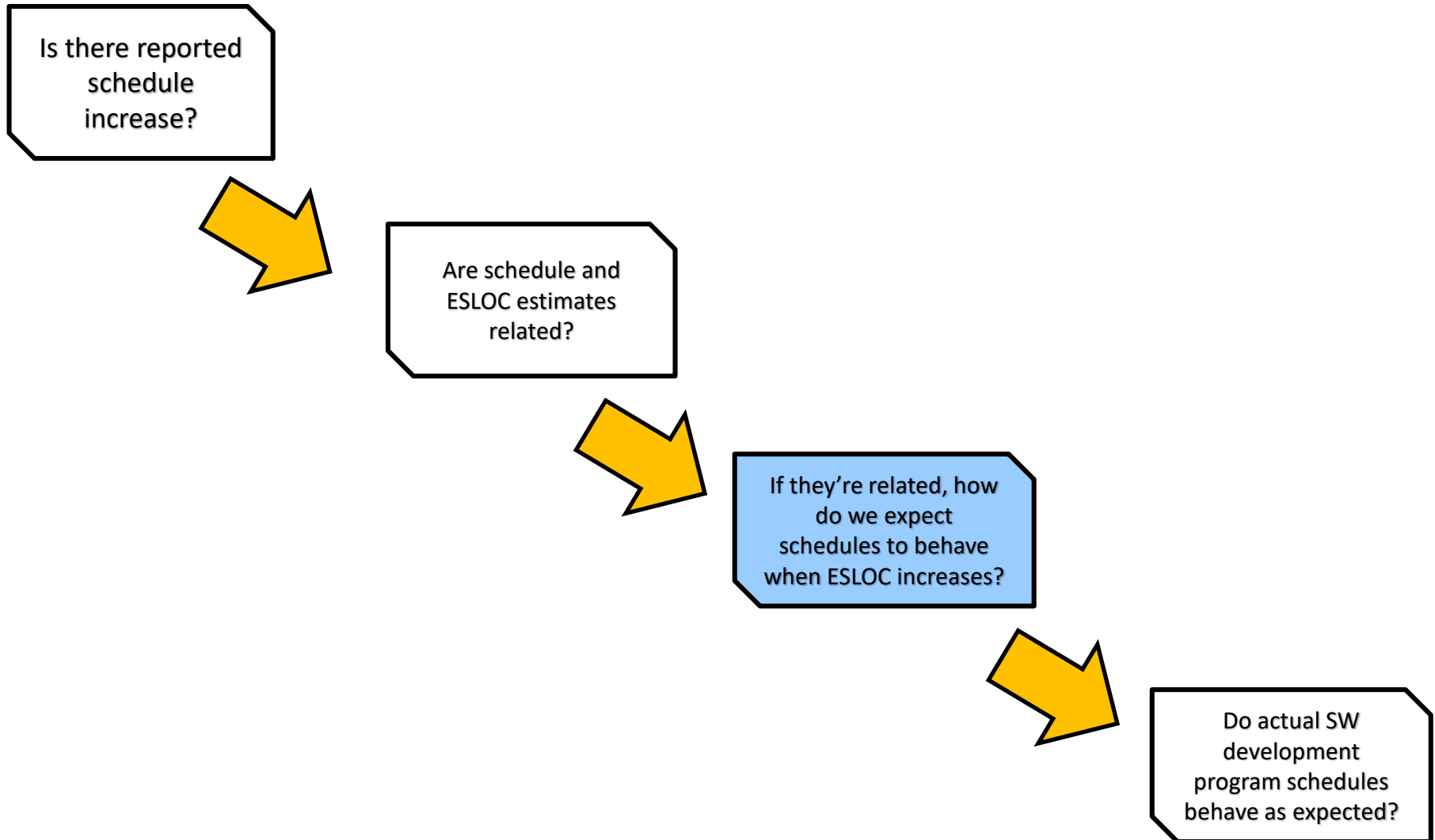
$$\left[\frac{ESLOC \times (1 + SW\ Growth\ Rate)}{Productivity} \right] \times \frac{1}{Person\ Months}$$



Integrated Master Schedule (IMS)

*Person Months =
Full Time Equivalents
(FTEs) x hours per
month

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DCTI Schedule Calculations

Example

❑ Current Schedule Input:

- 100K initial ESLOC
- 15 people at 156 hours per month
- 1.2 ESLOC/hour

❑ Calculate the time required to complete the effort with no SW growth

$$ESLOC * \frac{(1 + SW \text{ Growth Rate})}{Productivity} = \text{Total Hours} \approx 83,333 \text{ hours}$$

$$ESLOC * \frac{(1 + SW \text{ Growth Rate})}{Productivity} * \frac{1}{Person \text{ Months}} = \text{Man Months} \approx 35 \text{ months}$$

- This results in **35 months** of labor.

❑ Calculate the time required to complete the effort with SW growth

- Assume 28% SW growth

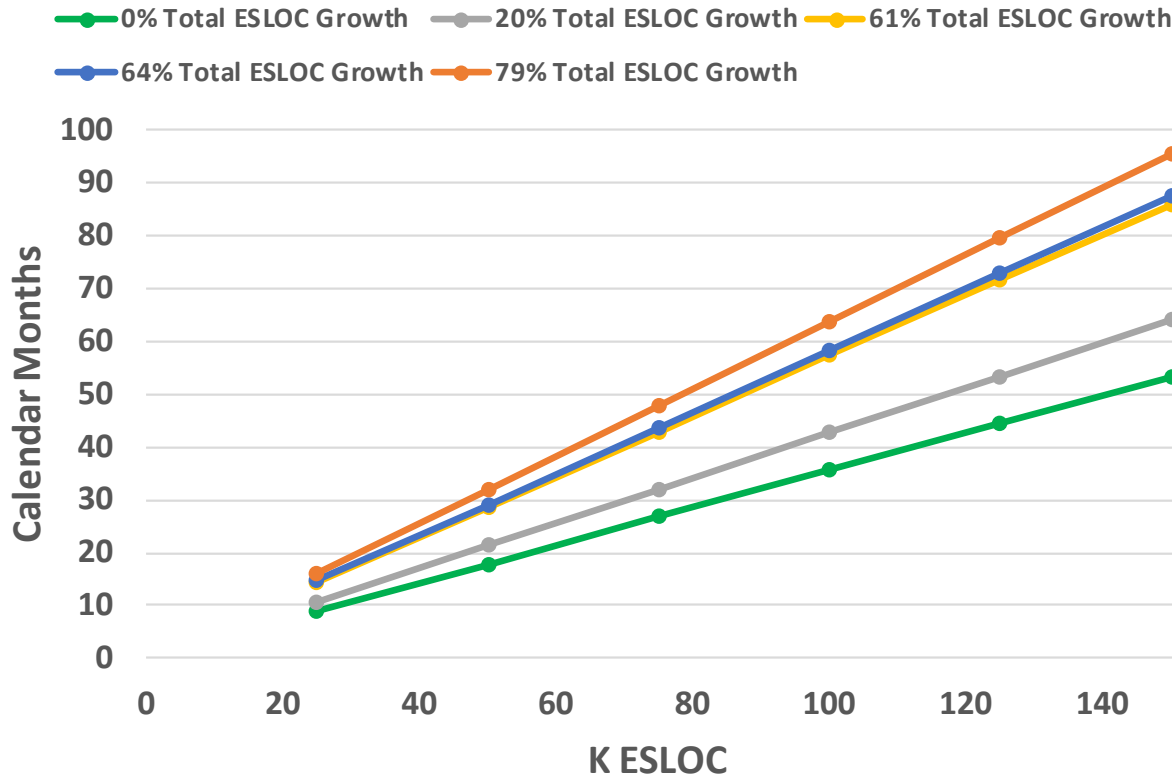
$$ESLOC * \frac{(1 + SW \text{ Growth Rate})}{Productivity} = \text{Total Hours} \approx 106,667 \text{ hours}$$

$$ESLOC * \frac{(1 + SW \text{ Growth Rate})}{Productivity} * \frac{1}{Person \text{ Months}} = \text{Man Months} \approx 46 \text{ months}$$

- This results in **46 months** of labor!

Impact of Total ESLOC Growth on Schedule Estimates

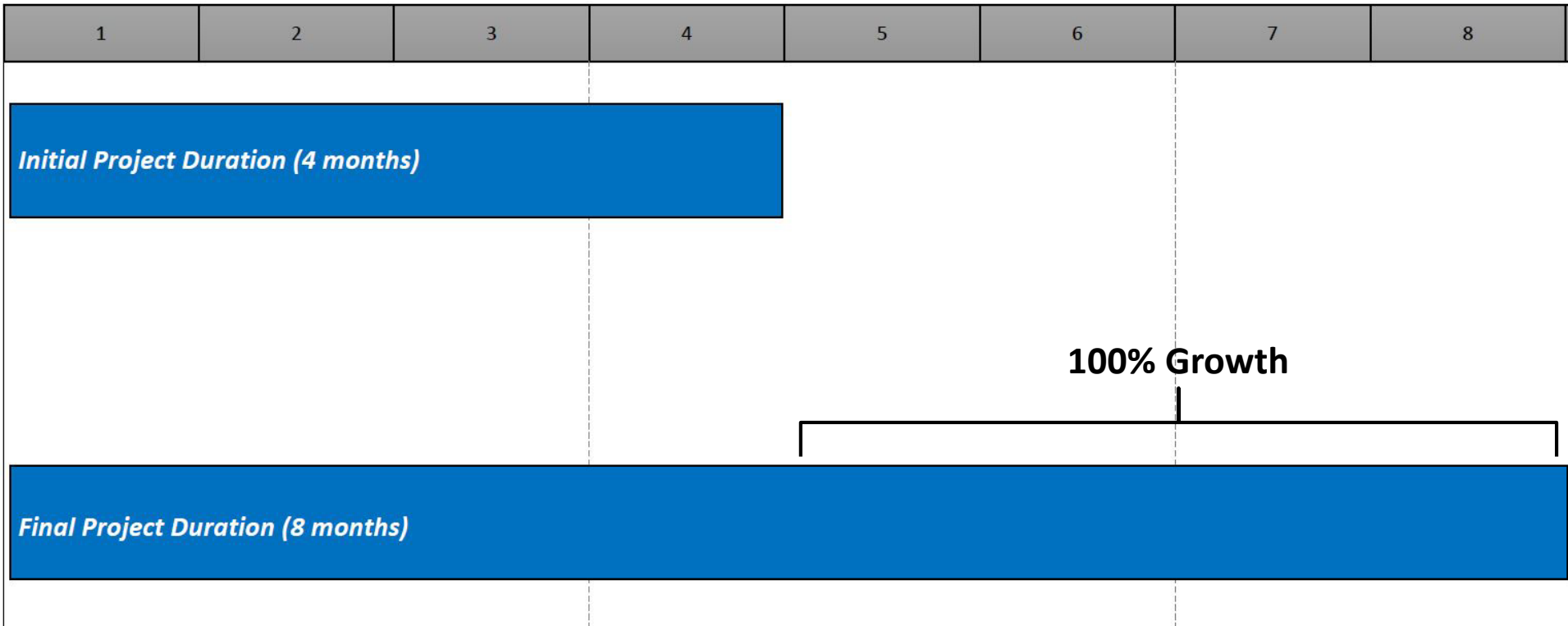
SW Development Schedule Estimate



- Constants:
 - Productivity
 - Person months
- Variables:
 - ESLOC
 - SW Growth factor
- Total ESLOC growth percentages taken from real-world examples

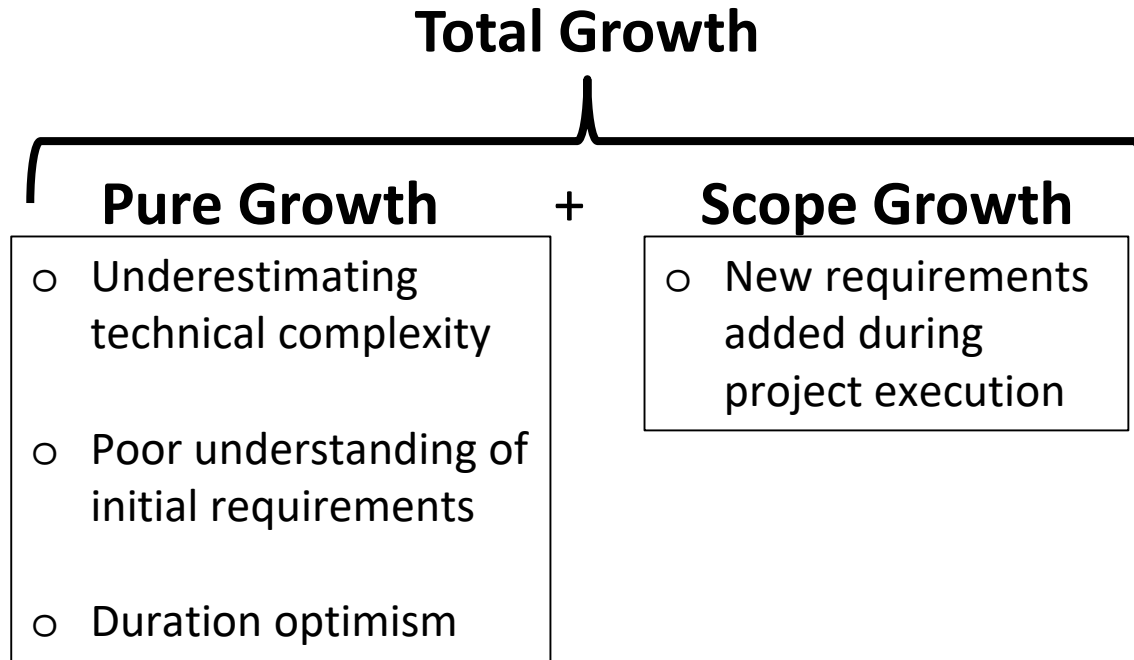
Can we divide the total schedule growth into pure and scope growth?

Schedule Growth Example



Direct comparison of final to initial project duration includes ALL sources of growth if not adjusted

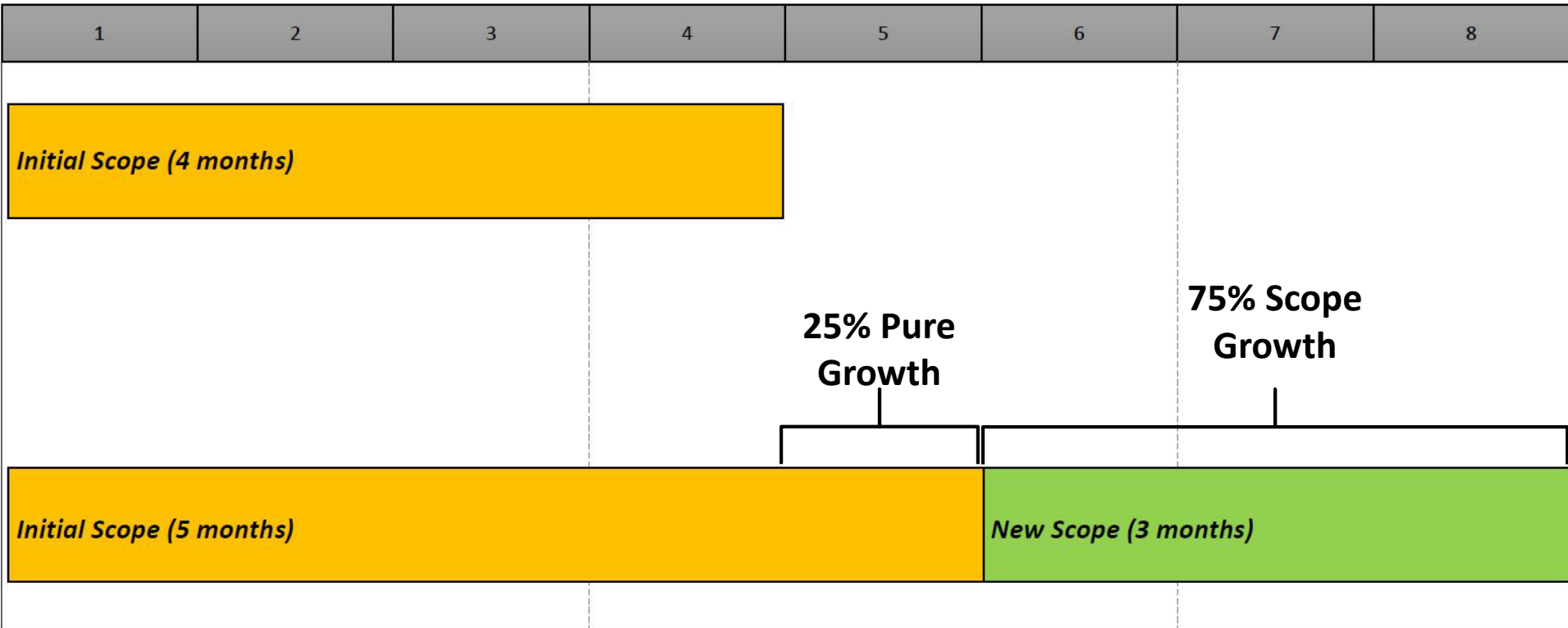
Definition of Pure Schedule Growth



- Based on recent studies, there is at least some pure growth in SW development programs. Therefore we want to consider the pure growth's impact on a schedule.

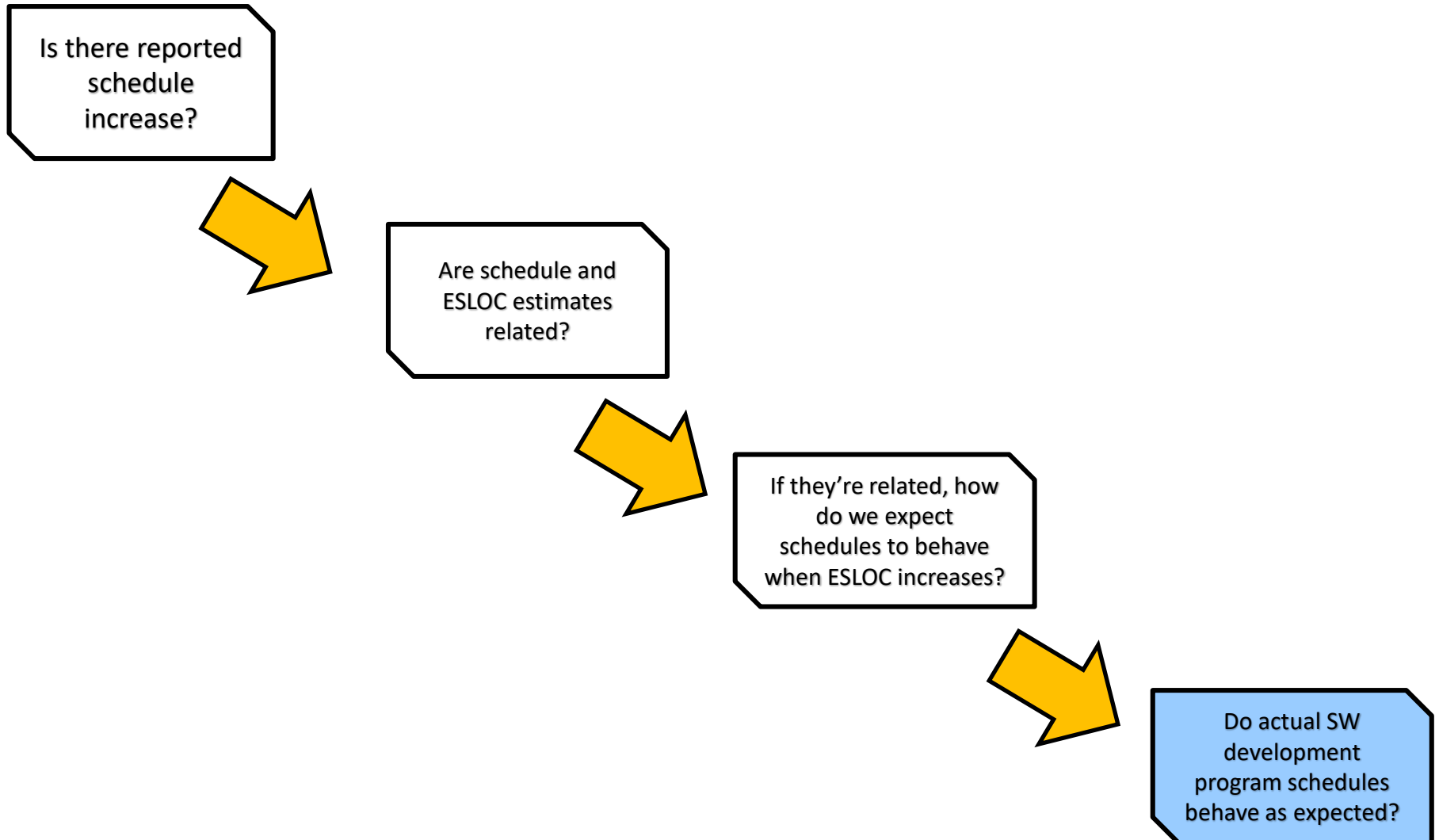
Completely unrelated scope additions should be estimated separately and adjusted for in historical data.

Schedule Growth Example (cont'd)



- Being able to separate schedule growth up into pure and scope growth gives a truer picture of the actual growth of initial project scope

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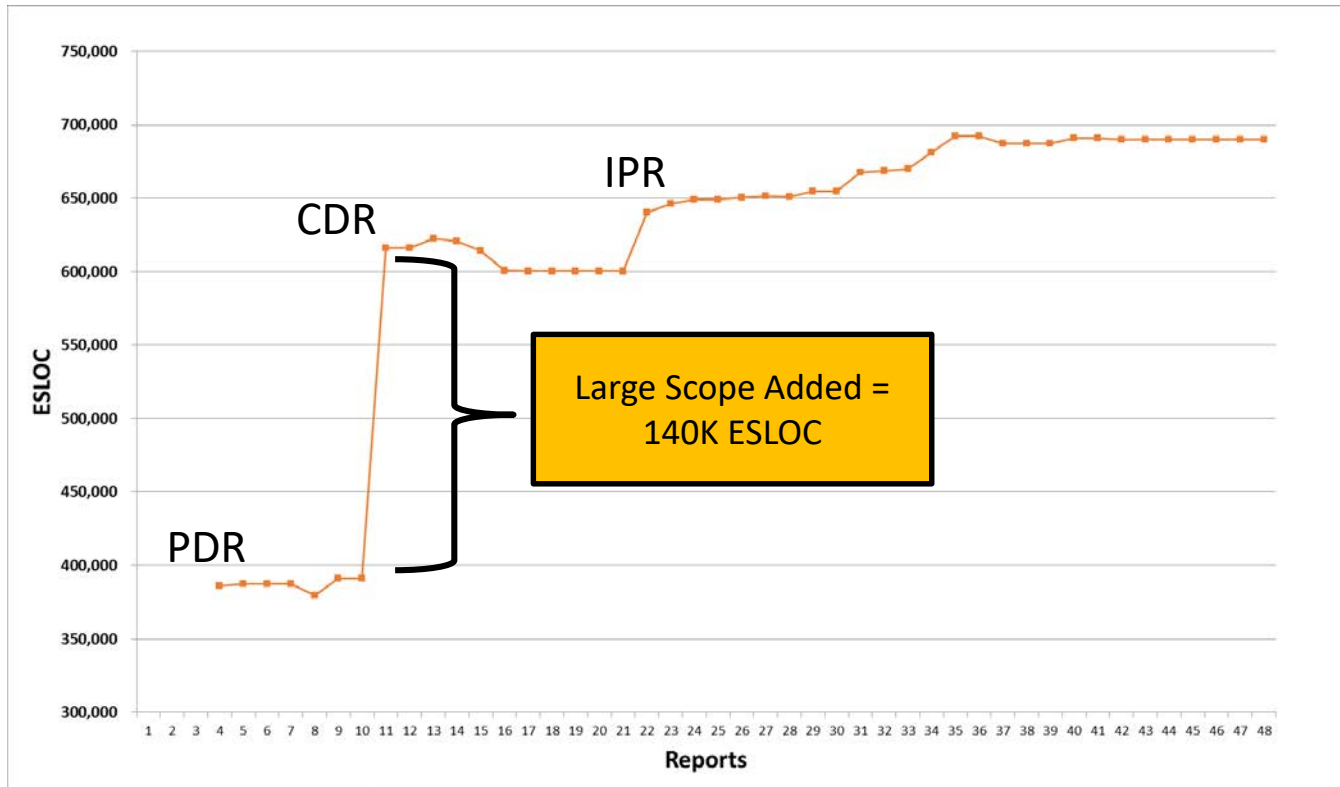




Examples of Pure vs Total Growth

- ❑ **Three large DoD software programs were selected based on relevance and for availability of data**
- ❑ **Scope changes were determined using data outside available SRDRs, which included**
 - Monthly or quarterly ESLOC reports
 - Systems Engineering Technical Review briefs
 - Program schedules
 - Software metric reports
 - Identified and interviewed subject matter experts when possible to validate interpretations of data

Pure vs Total Growth Program 1 (cont'd)

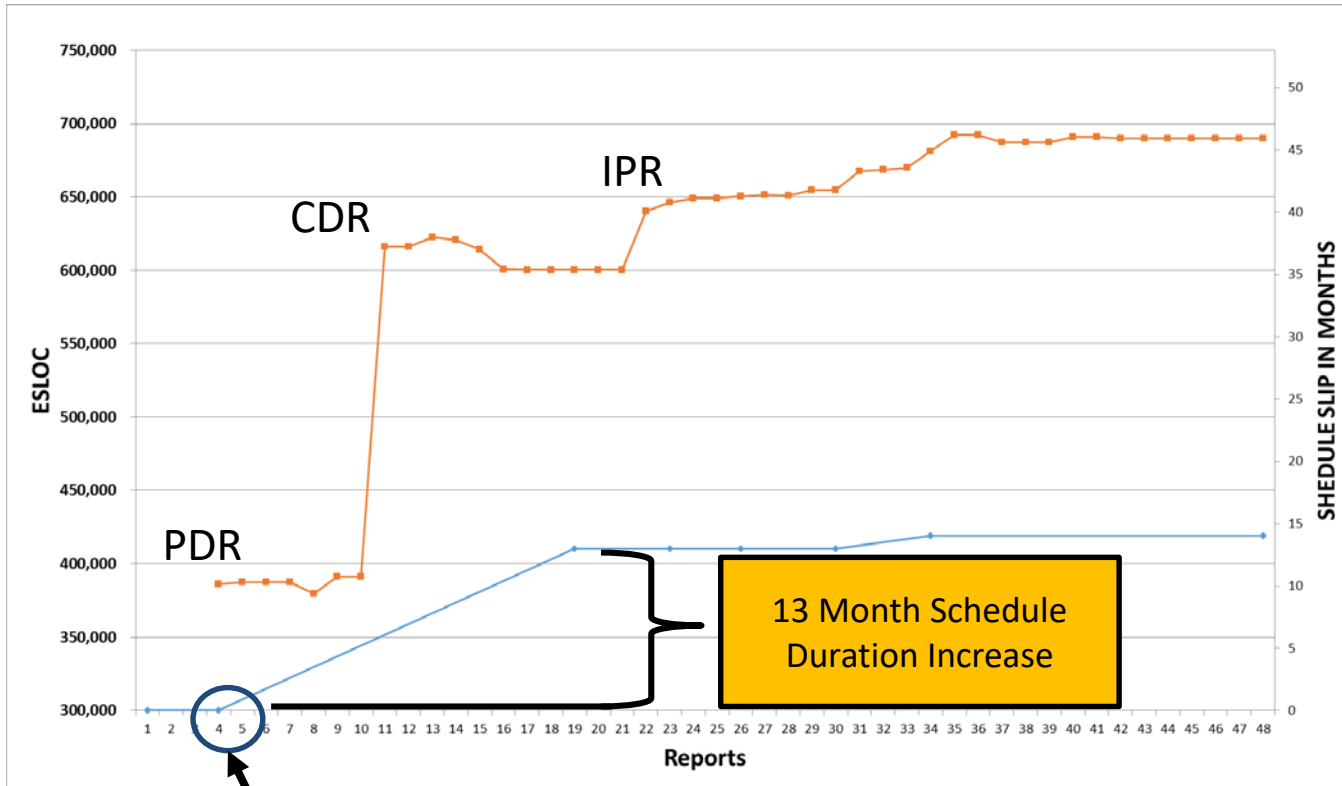


Program Description

- Real time
- Command and Control
- Combat Management System (CMS) upgrade
- Software program: ~5000K DSLOC

Software	
Pure Growth	28%
Scope Growth	51%
Total Growth	79%

Pure vs Total Growth Program 1 (cont'd)



**Scope Increase
Decision Point**

Program Description

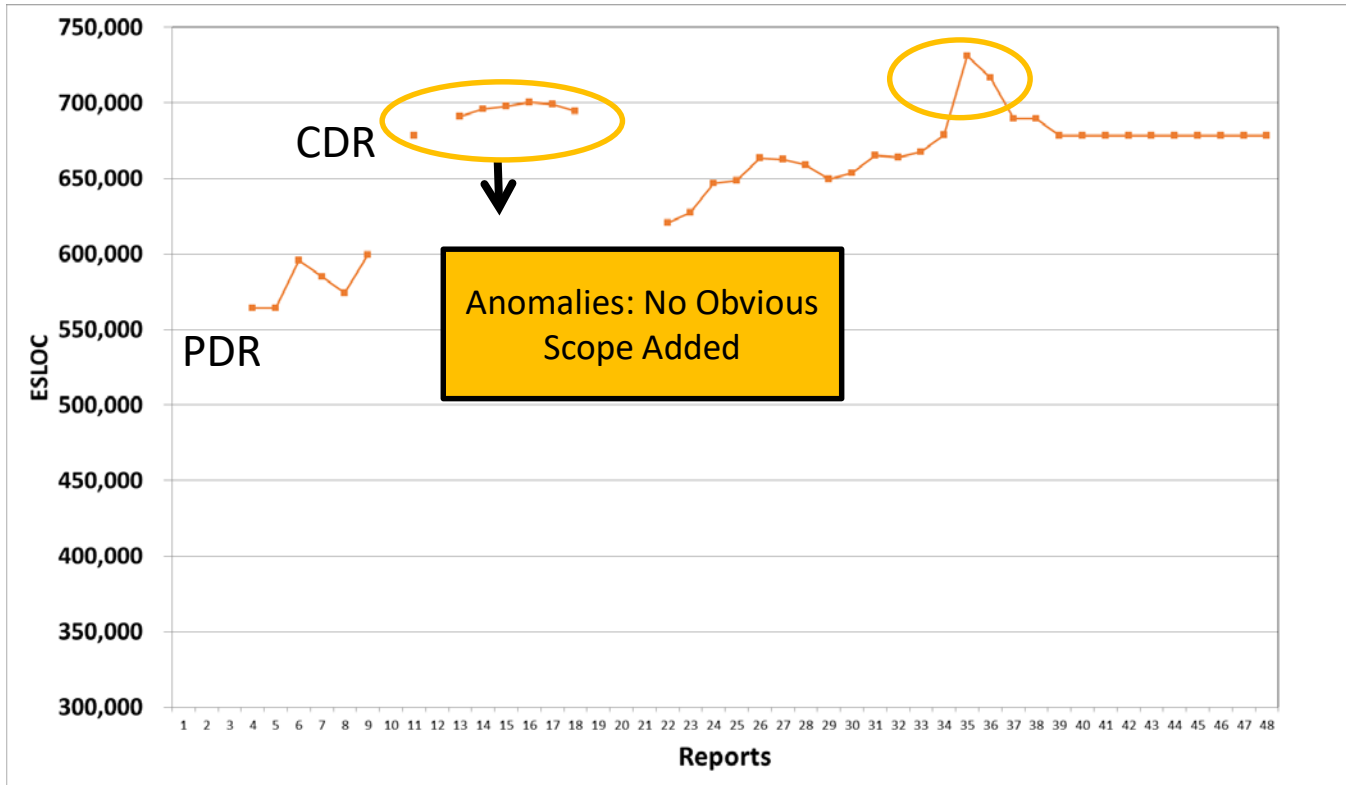
- Real time
- Command and Control
- Combat Management System (CMS) upgrade
- Software program: ~5000K DSLOC

Software	
Pure Growth	28%
Scope Growth	51%
Total Growth	79%

Schedule	
Pure Growth	2%
Scope Growth	25%
Total Growth	27%



Pure vs Total Growth Program 2 (cont'd)



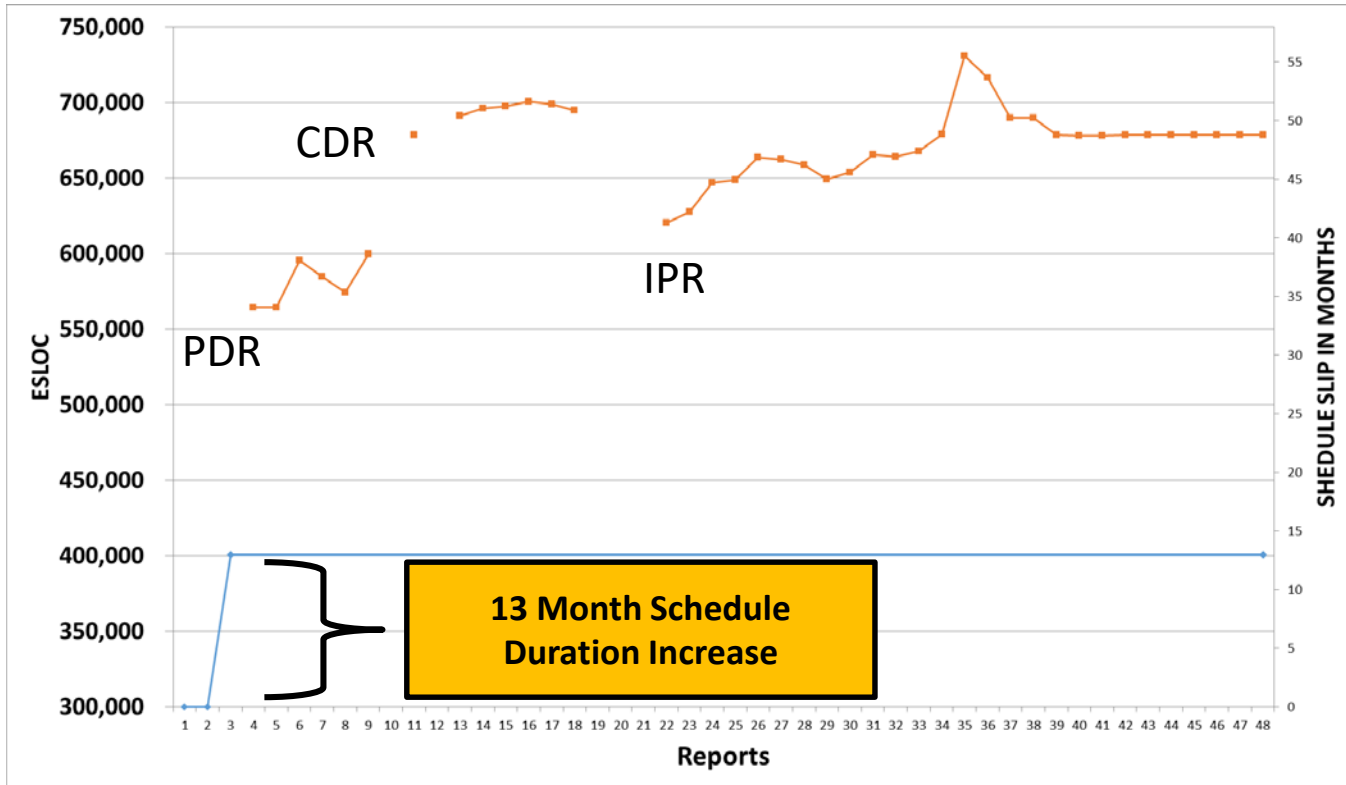
Program Description

- Real time
- Command and Control
- CMS upgrade
- Software program: ~4000K DSLOC

Software	
Pure Growth	20%
Scope Growth	0%
Total Growth	20%



Pure vs Total Growth Program 2 (cont'd)



Program Description

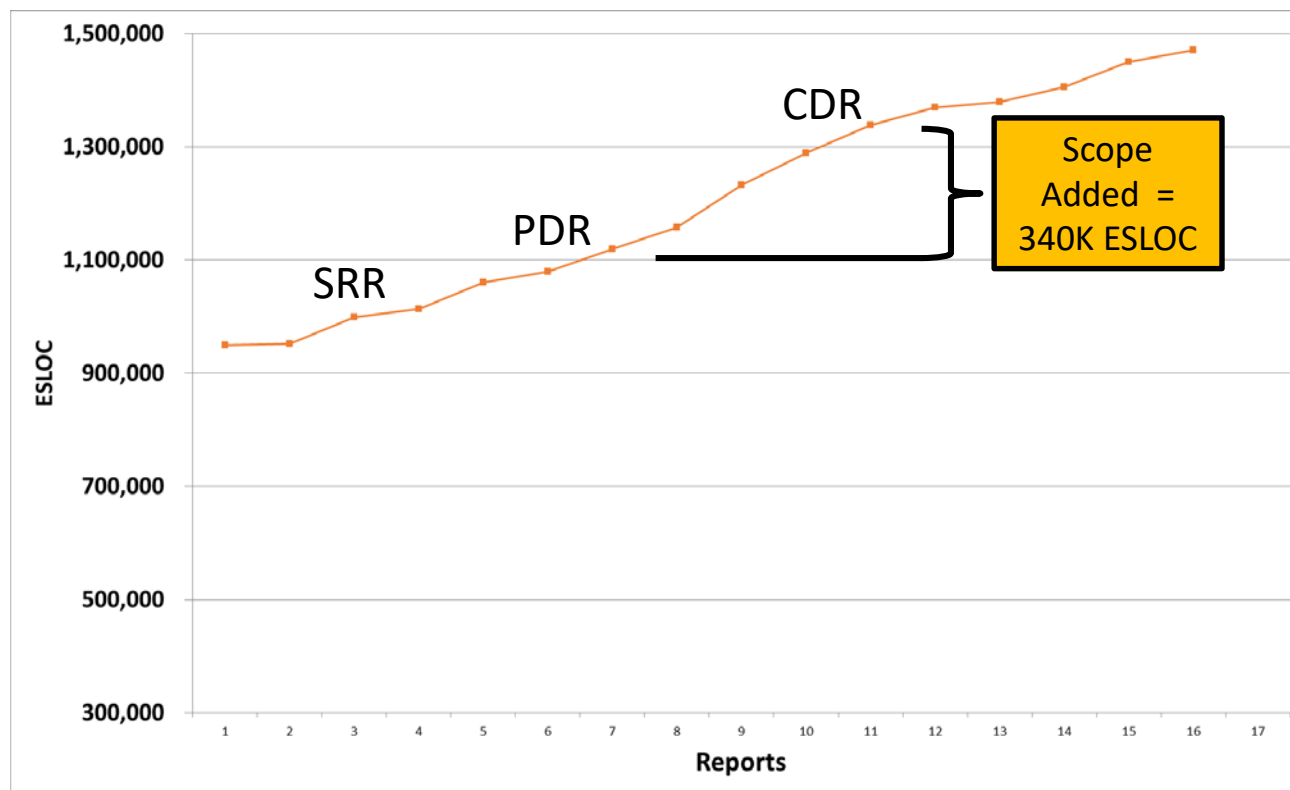
- Real time
- Command and Control
- CMS upgrade
- Software program: ~4000K DSLOC

Software	
Pure Growth	20%
Scope Growth	0%
Total Growth	20%

Schedule	
Pure Growth	N/A
Scope Growth	N/A
Total Growth	22%



Pure vs Total Growth Program 3

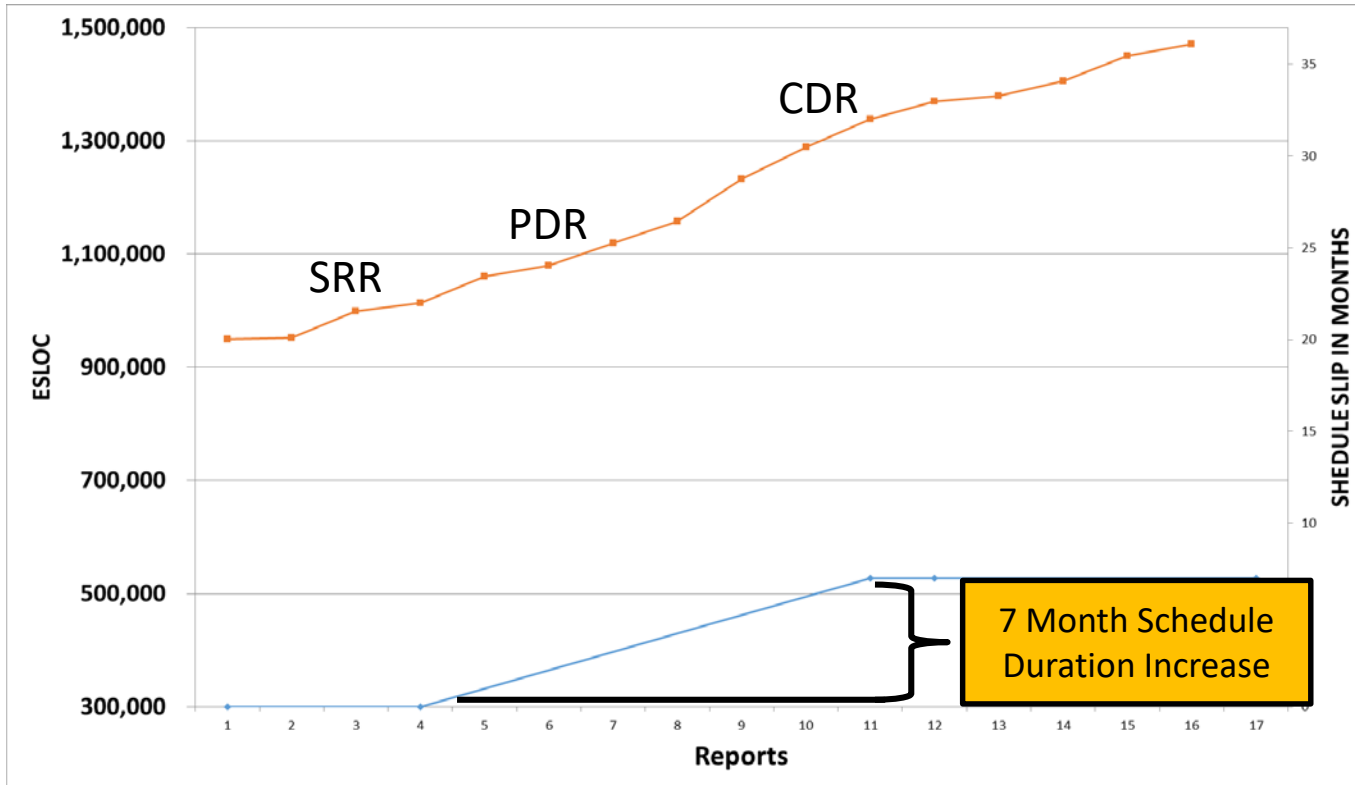


Program Description

- Real time
- Command and Control
- CMS upgrade
- Software program:
~4000K DSLOC

Software	
Pure Growth	24%
Scope Growth	37%
Total Growth	61%

Pure vs Total Growth Program 3 (cont'd)



Program Description

- Real time
- Command and Control
- CMS upgrade
- Software program:
~4000K DSLOC

Software	
Pure Growth	24%
Scope Growth	37%
Total Growth	61%

Schedule	
Pure Growth	N/A
Scope Growth	N/A
Total Growth	19%



Program Analysis Summary

- ❑ In cases where discernable scope was added, we observed a corresponding schedule increase**
- ❑ In cases where only pure software growth was observed, little corresponding schedule increase was observed**
- ❑ We did not have a large enough data set to identify a statistically significant correlation between ESLOC increases and schedule increases**

- ❑ We need a centralized IMS repository as well as more frequent documentation and collection at multiple points during the program life cycle**
- ❑ We have the tools to estimate schedule impacts due to software growth and should account for that growth in our estimates**
- ❑ Cost estimates should be used as a crosscheck to the IMS and vice versa.**



Questions, Answers, and Discussion

NSWCDD V11

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Thank You

