Collaborative Requirements Scoring:
An Innovative Approach for Sizing Software Projects

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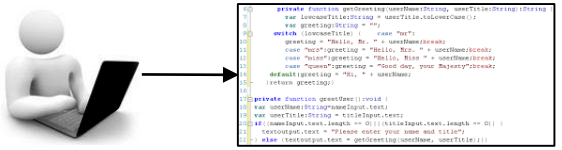
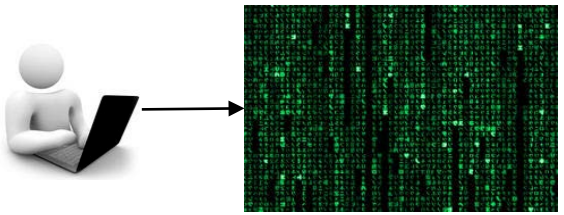
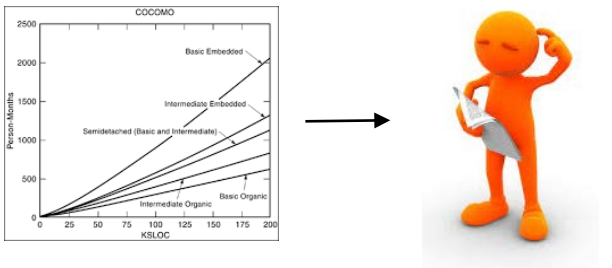
Existing software cost estimating techniques present various challenges, particularly when applying to modern systems with limited analogs and custom application requirements

- Estimating size using physical/functional measures is often non-intuitive to program engineers, particularly when estimating newer, lower-level requirements
- Accounting for non/cross-functional and/or derived requirements can be challenging
- Explaining to PMs how estimates are derived based on physical/functional sizing can be difficult
- Estimates are typically difficult to break out at lower levels of detail, hindering trade space analysis
- When estimates are wrong, hard to diagnose why







Traditional methods work well for many programs, but not all; some could use an alternative approach based on current software practices

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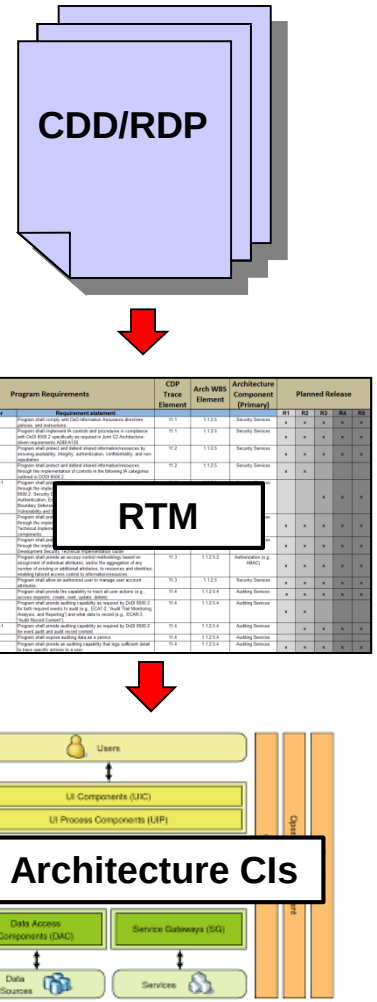
Step 1: Identify Appropriate Requirements to Size

Identifying appropriate requirements source and level of detail is essential to any sizing estimate

- Foundation would be functional/architectural requirements in program requirements document (e.g. Capability Definition Document (**CDD**) or Requirements Definition Package (**RDP**))
  - If **non-functional/cross-functional requirements** (architectural, usability, reliability, etc) are not captured in requirements document, they **can be identified and estimated during the sizing process**
- Requirements from CDDs or RDPs are often captured in a Requirements Traceability Matrix (**RTM**)
- Ideally, RTM would be used to map functional requirements to **components** in the intended **architecture**
  - Much more intuitive for SW engineers to estimate building components in an architecture

Ideal Requirements Flow



Best Practices for Requirements Identification

- Get agreement from estimate stakeholders (program manager, cost analyst, engineers) what requirements will be estimated and at what level
  - Need to identify the level of detail in requirements that fit time allocated to sizing and the appropriate units of measure (points, person-days, person-months)
- If documented requirements are all functional, work with engineers to identify non/cross-functional requirements/constraints before estimating session
- Identify trade space requirements up-front to inform later CAIV analysis
- Get Excel formats of requirements lists or matrices to help in building estimating template

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Scoring sessions require upfront planning and coordination to be successful

- Identifying appropriate participants is key
  - "Scorers": Software engineering SMEs that will be providing estimates
    - A panel of four or five is ideal; minimum of three
    - Should be a mix of SMEs; at least a couple with experience in systems similar to the one being estimated, but independent SMEs add value, as well
  - Facilitator(s): Person who runs the meeting, records scores and assumptions, facilitates discussions, takes care of admin items
    - Ideally, two people – can be a lot for one person to handle
  - Other support SMEs: People knowledgeable about the program that can help scorers better understand requirements and constraints
    - Requirements analysts, test engineers, cyber experts, past users of similar system
- Coordinate schedules for participants and facilities early

Developing scoring materials and thinking through scoring process in advance will help the actual session go more smoothly

- Develop scoring template based on requirements to be estimated

		Round 1									Round 2			
		Scorer 1			Scorer 2			Scorer 3			1	2	3	
Req #	Req. Description	Exp.	Low	High	Exp.	Low	High	Exp.	Low	High				Comments
1.1.1	The system shall enable the user to . . .													
1.1.2	The system shall enable the user to . . .													
1.2.1	The system shall enable the user to . . .													
1.2.2	The system shall enable the user to . . .													
1.2.3	The system shall enable the user to . . .													
2.1.1	The system shall enable the user to . . .													
2.1.2	The system shall enable the user to . . .													
2.1.3	The system shall enable the user to . . .													
X.X.X	The system shall enable the user to . . .													

- Coordinate systems or materials needed to conduct scoring; session requires scorers to provide estimates anonymously and simultaneously
  - Decision analysis system, like Expert Choice
  - Agile Planning Poker app
  - Real-time collaboration tools, like Google Docs or Real Time Board
  - Screen sharing, like WebEx or Defense Collaboration Services (DCS)
  - White boards

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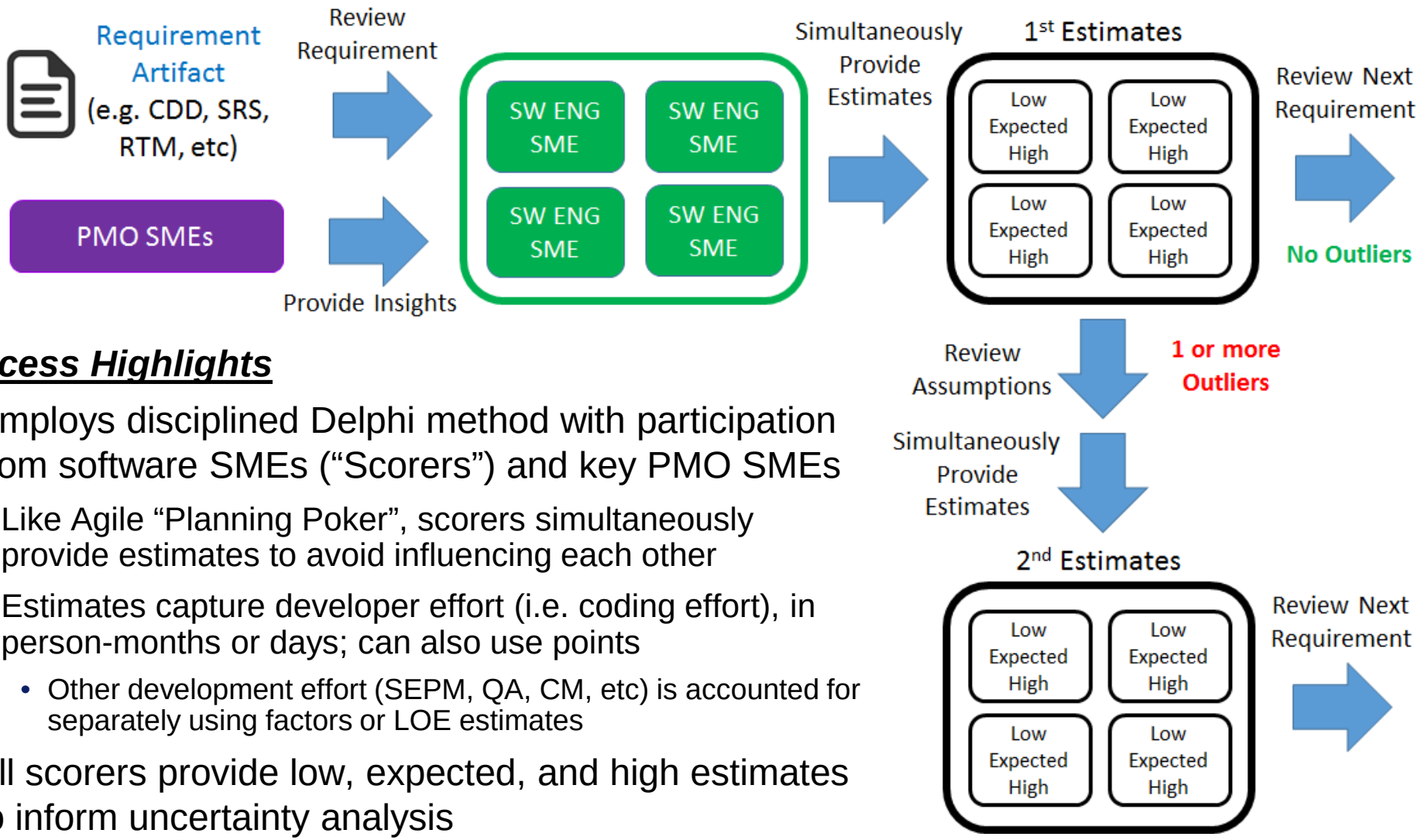
Scoring process helps objectify subjective inputs and documents assumptions for each estimate

Step 3: Execute Scoring Session



Process Highlights

- Employs disciplined Delphi method with participation from software SMEs ("Scorers") and key PMO SMEs
  - Like Agile "Planning Poker", scorers simultaneously provide estimates to avoid influencing each other
  - Estimates capture developer effort (i.e. coding effort), in person-months or days; can also use points
    - Other development effort (SEPM, QA, CM, etc) is accounted for separately using factors or LOE estimates
- All scorers provide low, expected, and high estimates to inform uncertainty analysis

Best Practices for Executing Scoring Session

- Baseline all participants upfront on ground rules and assumptions
  - Ensure everyone is operating off of the same overarching technical assumptions
  - Agree on the scope of estimates to be provided; typically, developer effort from design to code unit test
  - Discussion before scores should be limited to technical assumptions only
    - No value statements -> “This is easy, should be minimal effort”
  - Second round is needed when one or more outlier scores
- Ensure everyone is clear on time constraints to stay on schedule
  - Calculate benchmark requirements to measure progress against time plan
- Capture all assumptions for each requirement in scoring spreadsheet; capture any other thoughts on white boards or smartboards & take pictures
- Use white board to capture “parking lot” items; could inform additional items to score, like cross-functional or derived requirements

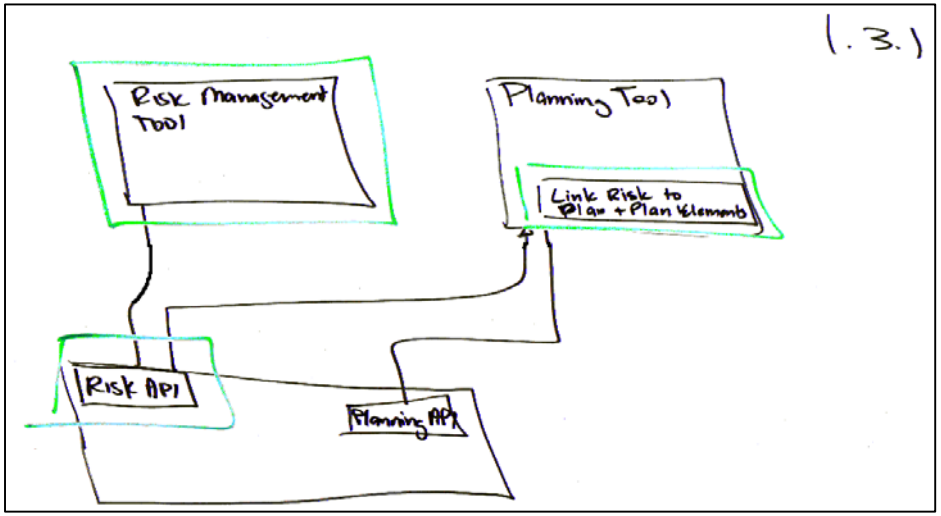
Step 3: Execute Scoring Session

Outputs of a successful scoring session

- Fully populated scoring template with all scores and documentation comments

		Round 1									Round 2			
		Scorer 1			Scorer 2			Scorer 3			1	2	3	
Req #	Req. Description	Exp.	Low	High	Exp.	Low	High	Exp.	Low	High				Comments
1.1.1	The system shall enable the user to . . .	8	6	10	8	6	10	6	4	8				Need to build API and widget XYZ
1.1.2	The system shall enable the user to . . .	6	4	8	8	6	10	6	4	8				Need to edit data handling APIs
1.2.1	The system shall enable the user to . . .	4	3	5	1	1	1	5	4	7				Need to build presentation widget
1.2.2	The system shall enable the user to . . .	7	5	9	6	4	8	10	7	13				Need to integtrate XYZ COTS tool
1.2.3	The system shall enable the user to . . .	7	5	9	10	7	13	4	3	5				Need to implement XYZ interface
2.1.1	The system shall enable the user to . . .	2	1	3	4	3	5	1	1	1				Need to implement XYZ function in data layer
2.1.2	The system shall enable the user to . . .													Effort included in estimate above
2.1.3	The system shall enable the user to . . .	3	2	4	1	1	1	3	2	4				Need to build presentation widget
[illegible]	[illegible]	[illegible]												
[illegible]	[illegible]	[illegible]												
[illegible]	[illegible]	[illegible]												
[illegible]	[illegible]	[illegible]												
[illegible]	[illegible]	[illegible]												
X.X.X	The system shall enable the user to . . .	2	1	3	7	5	9	9	6	12				Need to build API and widget XYZ

- Additional information captured in the room during the session, such as sketches or assumptions on a white board or smart board captures



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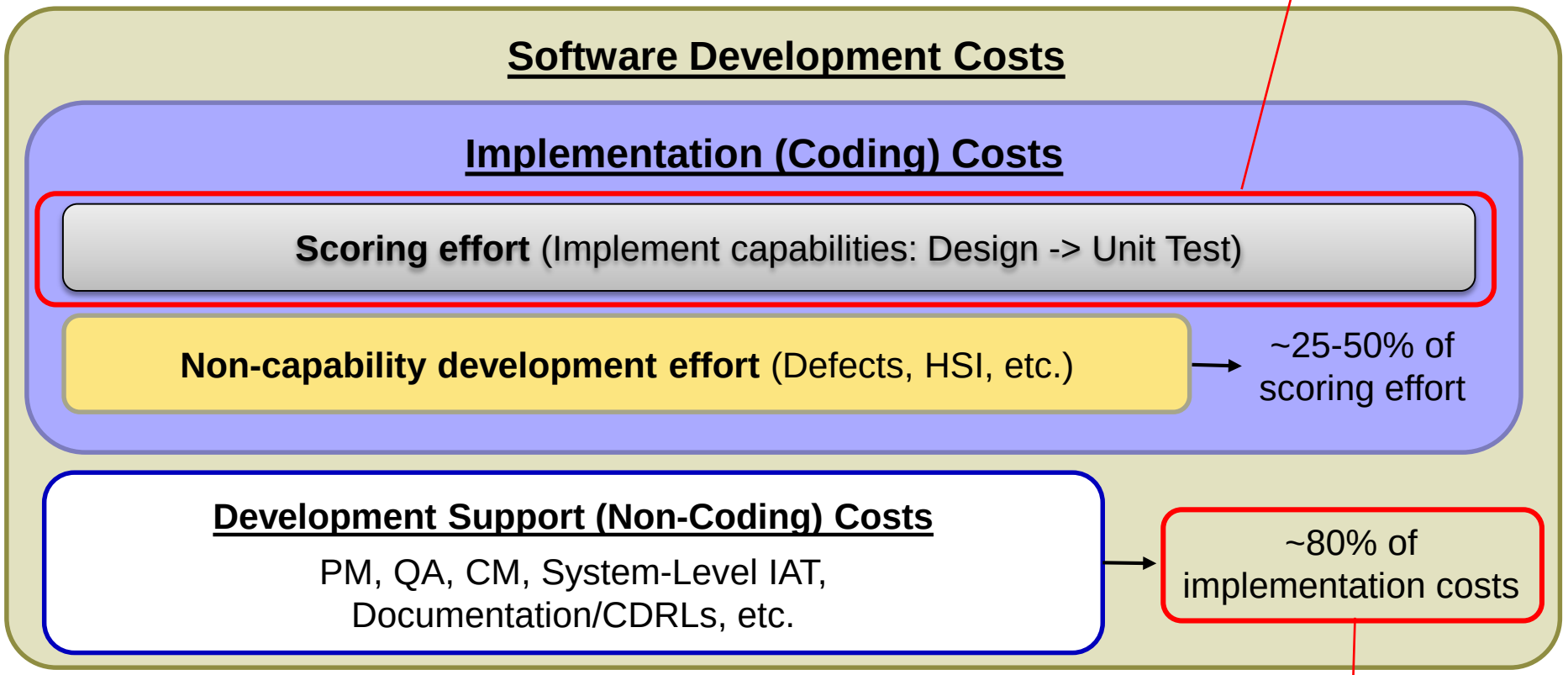
Other costs must be added to the scoring outputs to derive full software development cost estimate

Estimated based on scoring session outputs; provides foundation for the rest of the SW development estimate



Can be estimated using a factor like this or using a LOE build-up

Ranges provided during scoring analysis provide solid inputs for robust uncertainty analysis

- Ranges provided by multiple scorers provide many possibilities for uncertainty bounds
  - Average of Expected
  - Min of Low, Max of High
  - Average of High as Expected
- Uncertainty can be applied at whatever level in requirements desired

		Round 1									Round 2		
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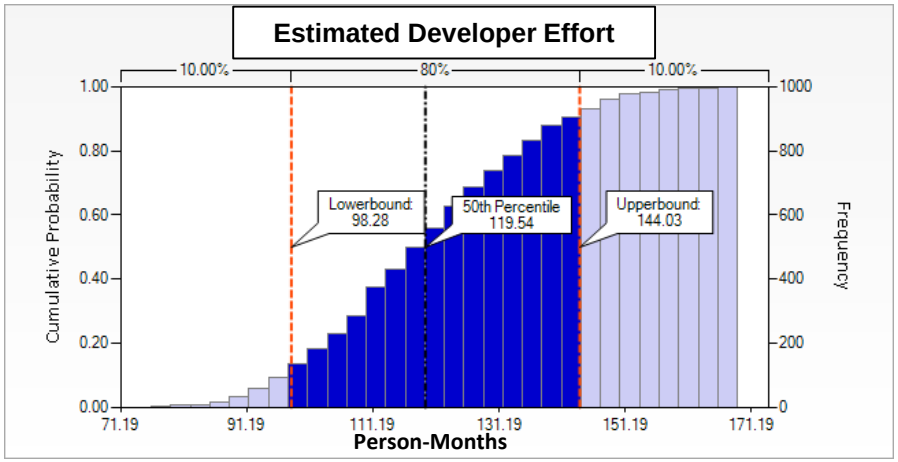
1.1.1	The system shall enable the user to . . .	8	6	10	8	6	10	6	4	8			
1.1.2	The system shall enable the user to . . .	6	4	8	8	6	10	6	4	8			
1.2.1	The system shall enable the user to . . .	4	3	5	1	1	1	5	4	7			
1.2.2	The system shall enable the user to . . .	7	5	9	6	4	8	10	7	13			
1.2.3	The system shall enable the user to . . .	7	5	9	10	7	13	4	3	5			
2.1.1	The system shall enable the user to . . .	2	1	3	4	3	5	1	1	1			
2.1.2	The system shall enable the user to . . .												
2.1.3	The system shall enable the user to . . .	3	2	4	1	1	1	3	2	4			
X.X.X	The system shall enable the user to . . .	2	1	3	7	5	9	9	6	12			



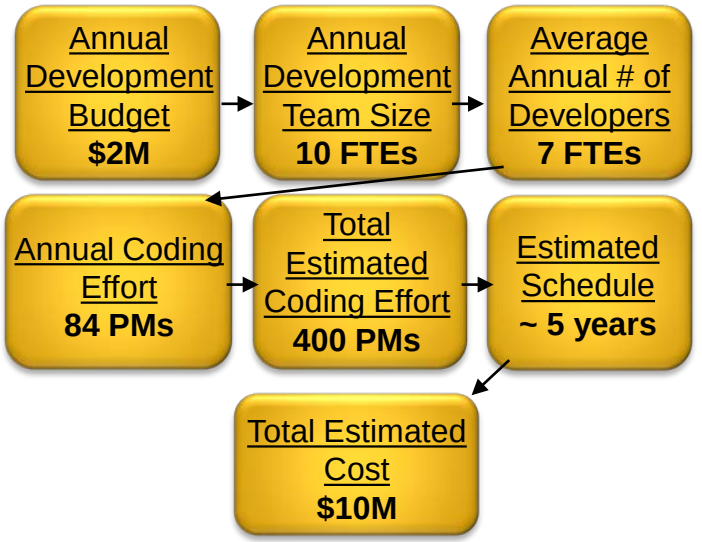
Uncertainty analysis is a pivotal step to bound cost and schedule estimates

Uncertainty adjusted developer estimates can be used to build up total estimate using multiple methodologies

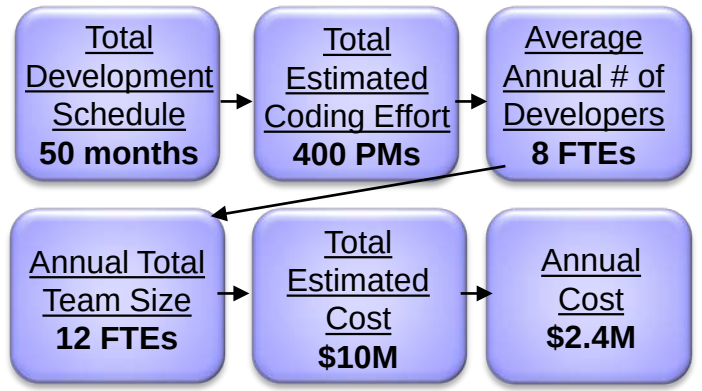
- Variable schedule/CAIV driven methodology based on annual budget constraints
  - Annual budget determines team size and number of developers
  - # of developers coupled with scoring session effort estimates determine total estimated schedule
  - Non-coding effort can be added along that schedule using factors or LOE
- Fixed schedule driven methodology based on schedule constraints
  - Targeted schedule determines how developer effort gets spread and required # of developers
  - Non-coding effort can be added using factors or LOE
  - Requires sanity check on required development team size for reasonableness

Examples

Variable Schedule / Fixed Annual Cost



Fixed Schedule / Variable Annual Cost



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Utilizing this process to estimate size of a software project has various benefits and a few challenges

Benefits
More intuitive scope sizing methodology
Sizing explicitly relates complexity to effort
Systematic scoring process
Scoring ranges inform robust uncertainty
Allows for trade-off analysis at requirement level

Challenges
Subjective sizing inputs; limited analogous data
New type of cost model required
Sizable effort/coordination to run scoring session

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		Scorer 1			Scorer 2			Scorer 3		
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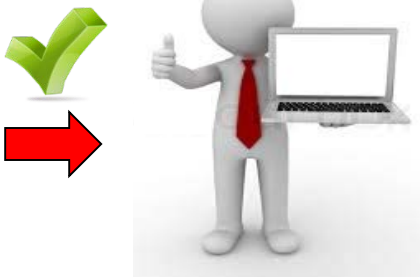
1.1.2	The system shall enable the user to	6	4	8	8	6	10	6	4	8
1.2.1	The system shall enable the user to …	4	3	5	1	1	1	5	4	7
1.2.2	The system shall enable the user to …	7	5	9	6	4	8	10	7	13
1.2.3	The system shall enable the user to …	7	5	9	10	7	13	4	3	5
2.1.1	The system shall enable the user to …	2	1	3	4	3	5	1	1	1
2.1.2	The system shall enable the user to									
2.1.3	The system shall enable the user to …	3	2	4	1	1	1	3	2	4
XXX	The system shall enable the user to	2	1	3	7	5	9	9	6	12



$$PM = A \cdot Size^{E} \cdot \prod_{i=1}^{n} EM_i$$

For many projects, the benefits outweigh the challenges, and challenges can be mitigated

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Collaborative requirements estimating is a viable new methodology for informing cost estimates for software projects

- While traditional methodologies are still viable for various types of software projects, this new methodology is viable for newer projects with limited analogs and new requirements
  - Scoring methodology is intuitive to software engineers and aligns with how software teams estimate, plan, and execute work
  - Disciplined scoring process attempts to add objectivity and documentation to subjective inputs
  - Scoring ranges enable detailed uncertainty analysis
  - Estimates at low requirement levels enable detailed scope trade-off analysis
  - Easy to explain to decision makers and diagnose estimating error

Questions?

For further information . . .

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