

Project Estimation

Realistic estimation

- ❑ set **expectations** about the time & cost needed to complete the project.
- ❑ expectation of whom?
stakeholders, team, organization management.
- ❑ **expectations** should be **realistic**
- ❑ if expectations are **not** realistic from the beginning, then stakeholders will not **trust** the team or the project manager.

What to Estimate?

Product size

Effort

Schedule

Quality (defects)

Cost

Prerequisites

- ❑ Vision
- ❑ Scope
- ❑ Requirements

These do not need to be formal. Estimation can be done before requirements are written.

Approaches

Top-Down:

Function Point Analysis - count "function points" from user's point of view.

<http://alvinalexander.com/FunctionPoints>

Use-Case Points - weighted effort based on use cases

User story effort

Bottom-Up:

Break-down to tasks, estimate task time

Wide-band Delphi

Other Ways

- **By Analogy** - using a similar project you have done.
 - need the sizes of parts from that project
- **Count Features:**
 - # screens and dialogs,
 - # database tables,
 - # reports,
 - # use cases.

Estimating Size

- Size estimate is used to estimate effort
 1. Write down the products you will produce
 - ◆ include documents, too
 2. Create a conceptual design
 3. Break design down into smaller parts
 4. Estimate size of each part

Common Ways

- ❑ **By Analogy** - using a similar project you have done.
 - need the sizes of parts from that project
- ❑ **Count Features**: # screens and dialogs, # database tables, # reports, # use cases.

Presenting Your Estimate

Your estimate **must** always include:

1. assumptions
2. methods used
3. data and other values you used
4. the calculations
5. be expressed as a **range**, not a single **number**.

Elements of a Sound Estimate

To generate a sound estimate, you need:

- ❑ **work breakdown structure** (WBS), or a list of tasks that will produce the product
- ❑ **effort estimate** for each task
- ❑ list of **assumptions** which were used for making the estimate
- ❑ **discussion & consensus** among the team that the estimate is accurate (at least, reasonable)

Write Down Assumptions

- ❑ Team makes *assumptions* about the work to be done in order to deal with incomplete information
- ❑ Assumptions about decisions to be made
- ❑ Assumptions must be written down!
 1. so everyone knows the basis for estimates
 2. if assumption is wrong, estimate can be revised
 3. they are frequently overlooked – and cause error

Checklist to Find Assumptions (1)

- ❑ are there project goals known to team but not written in documentation?
- ❑ are any concepts or terms that need to be identified?
- ❑ are there standards that must be complied with?
 - will it be expensive to comply?
- ❑ how is the dev't of this project different from previous projects?
- ❑ are there architecture or technology assumptions?

Checklist to Find Assumptions (2)

- ❑ What changes could occur in the organization that could cause estimates to be inaccurate?
- ❑ Are there issues that the team disagrees on that will affect this project?
 - e.g., disagree on implementation (write ourself or use open-source components)

Discuss the Assumptions!

- Discussion is the best way to identify hidden assumptions or missing tasks

Update Vision & Scope

- ❑ Does the list of assumptions affect scope or vision?
- ❑ Update them!

Wideband Delphi

Wideband Delphi is a process for reaching a consensus estimate of project effort

- Wideband Delphi is a *repeatable* process because it consists of a straightforward sequence of steps

Wideband Delphi Roles

Estimation Team: PM chooses an estimation team that include reps from all project areas (managers, developers, architect, QA, writers, etc).

- every team member should have stake in plan
- should understand Delphi Process

Moderator: someone who understands Delphi Process *but has no stake in the results*

Observers: selected stakeholders or users.

- encourages trust in the estimation process
- sense of ownership in the results

Entry Criteria

1. **Vision** and **Scope** documents have been agreed on by stakeholders
2. Kick-off meeting has been scheduled
3. Estimation meeting is scheduled (1-2 hrs)
4. Moderator chosen (*not* the Project Manager)
5. Agreement on the goal of the estimation session

Wideband Delphi Steps

Step 1: Choose the team

- PM selects estimation team and a moderator.
- team consists of 3 - 7 project team members.
- moderator should be familiar with Delphi process, but should **not have a stake in the outcome**
- PM should **not** be the moderator (he should be part of the estimation team)

Wideband Delphi Steps

Step 2: Kickoff Meeting

- each member has read the vision and scope document and any other documentation, and is familiar with the project needs.
- brainstorm and write down assumptions
- brainstorm to generate a WBS with 10-20 tasks
- team decides on a unit of estimation (man-hours, days, pages, ...)

Individual Preparation

Step 3: Individual Preparation

- each member generates his own initial estimates for all tasks in the WBS
 - identify subtasks may help clarify an estimate
- for each task, the team member writes:
 1. estimate of effort required to complete task
 2. any assumptions needed to make the estimate
- write down any new tasks the were missed during brainstorming session

Wideband Delphi Steps

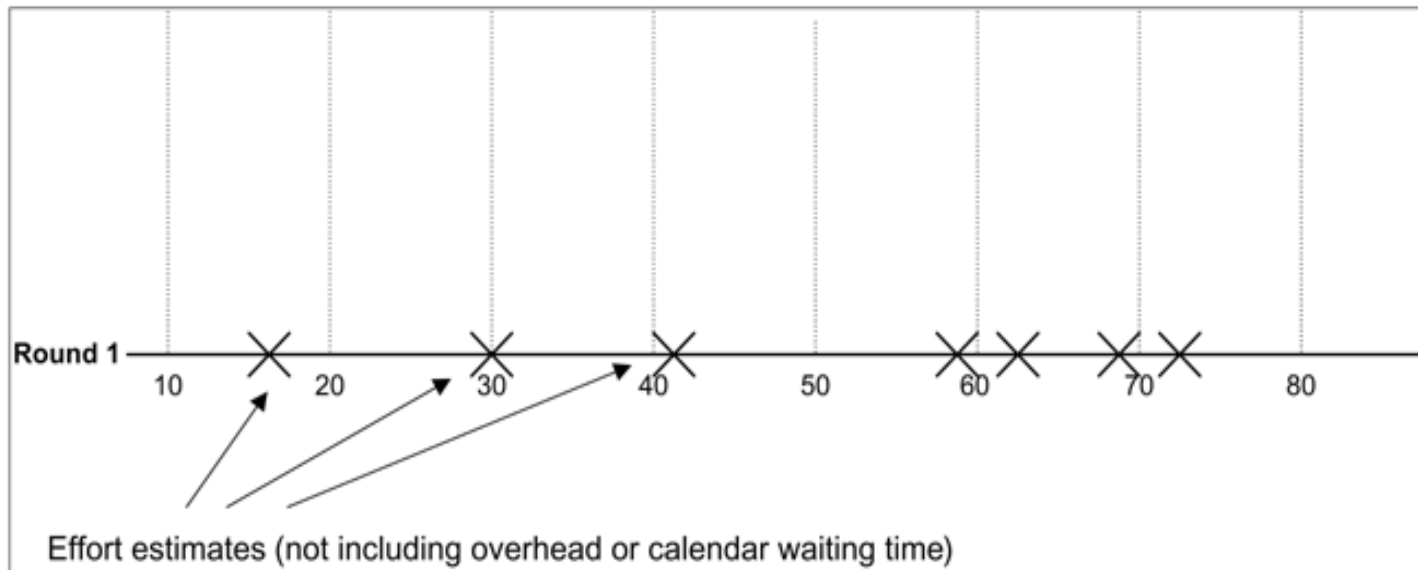
Step 4: Estimation Session

- Each team member fills out an estimation form which contains his estimate for each task
- give the form to the moderator
- rest of the estimation session consists of rounds where each estimation team member revises her estimates based on group discussion.
 - Individual estimate(s) are not disclosed

Wideband Delphi Estimation

Step 4: Estimation Session (2)

- moderator collects the estimation forms and plots the sum of the effort from each form on a line:



Wideband Delphi Estimation

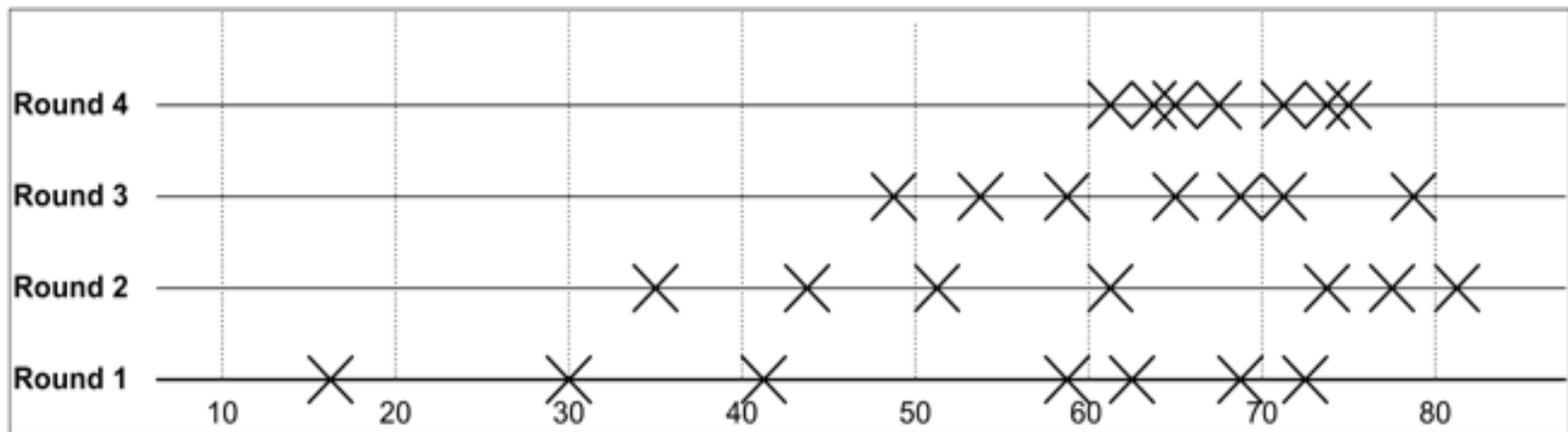
Step 4: Estimation Session (3)

- team resolves any issues or disagreements that are brought up.
- individual estimate times are not discussed. Disagreements are usually about the tasks themselves.
- Disagreements are often resolved by adding assumptions.

Wideband Delphi Estimation

Step 4: Estimation Session (4)

- team members each revise their individual estimates and gives them to moderator.
- The moderator updates the plot with the new total



Wideband Delphi Estimation

Step 4: Estimation Session (loop)

- moderator leads the team through several rounds of estimates to gain consensus on estimates.

Exit Criteria

- The estimation session continues until the estimates converge or the team is unwilling to revise estimates.
- Process also ends if time limit (2 hours) has elapsed.

Wideband Delphi Results

Step 5: Assemble Tasks

- PM collects the estimates from the team members and compiles the final task list, estimates, and assumptions.

Step 6: Review Results

- PM reviews the final task list with the estimation team

Alternative Paths

1. In Step 1, if team determines that not enough information is known about the project, then process ends.
The PM must document the missing info, typically by modifying the Vision, Scope, or Requirements.
2. In Step 1 or 2, if team determines some issues need to be resolved before estimates can be made, they agree on a plan to resolve issues and process ends.

Other Estimation Methods

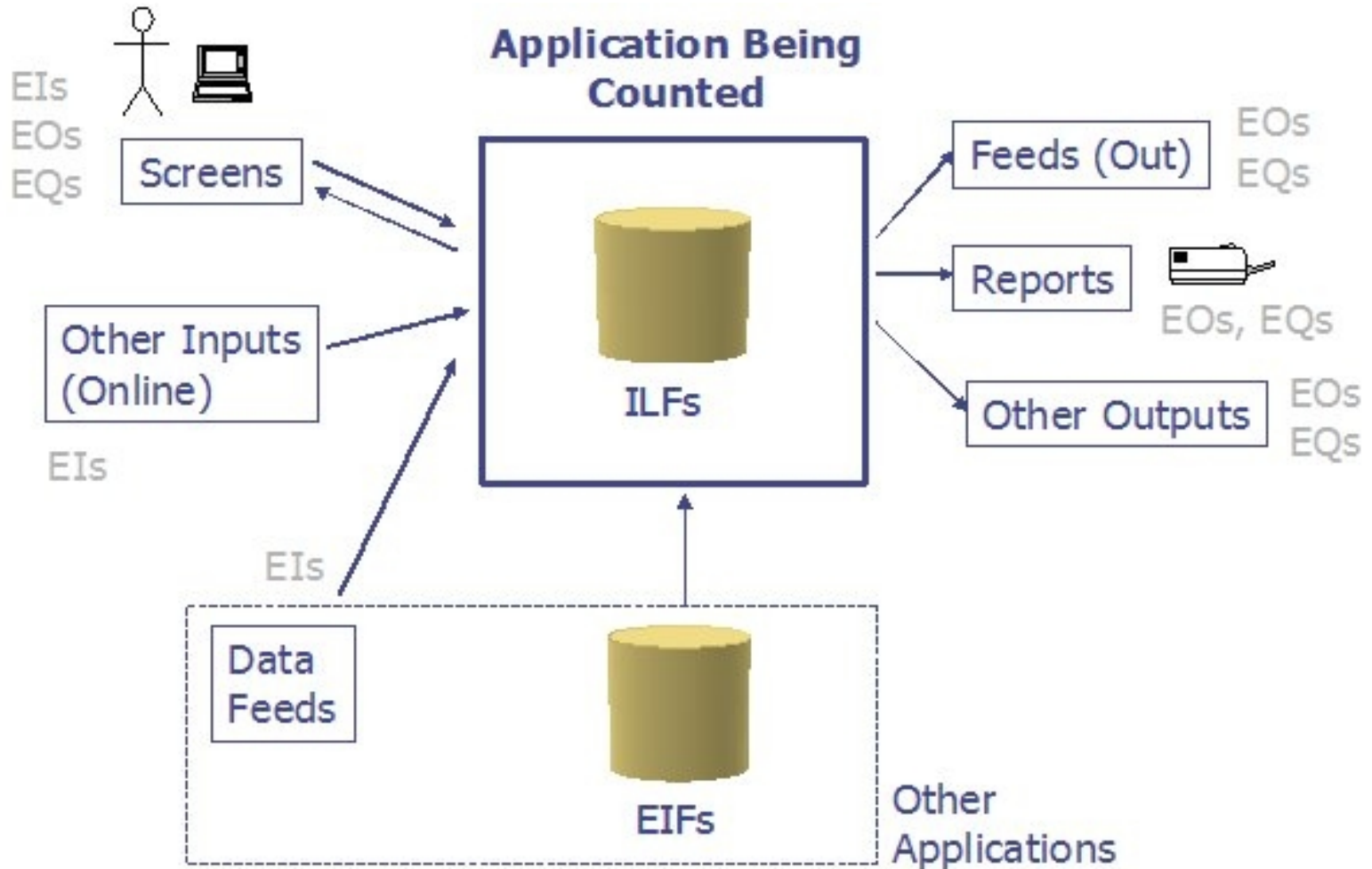
PROBE: Proxy Based Estimating

- ❑ PROBE is based on the assumption that building a component similar to one previously built will require about the same effort
- ❑ Each team member use a database to maintain a history of the effort they have put into their past projects (component by component)
- ❑ A formula based on linear regression is used to calculate the estimate for each task from this history.

Constructive Cost Model

- ❑ In COCOMO, projects are summarized using a set of variables that are input for a model.
- ❑ Estimates are based on the results of a large number of projects across the industry.
- ❑ The output of the model is a set of size and effort estimates that can be developed into a project schedule.
- ❑ Sommerville (S.E. 9) describes COCOMO II in section 23.5. He includes details of how to apply it.

Function Point Analysis



Kinds of Function Points

1) Data

Internal Logic File (ILF)

External Logic File (ELF)

2) Transaction

External Inputs (EI)

External Outputs (EO)

External Queries (EQ)

3) **General System Characteristics** - most detailed and important category

Counting FPs

See:

<http://www.codeproject.com/Articles/8151/Using-function-point-to-quote-a-software>

<http://alvinalexander.com/FunctionPoints/node12.shtml>

Use Case Points

- ❑ Project effort is based on a weighted sum of use cases.
- ❑ This method used at Infosys and described in the book *Software Project Management in Practice*.

UCP 1 – weighted use cases

- Weight each use case as shown in the table:

Use Case Type	Description	Weight
Simple	1-3 transactions	5
Medium	4-7 transaction	10
Complex	>7 transactions	15

A *transaction* is a group of atomic activities that are either performed entirely or not at all.

Example: POS in Java

- See <http://se.cpe.ku.ac.th/trac/firstpos> for Vision, Assumptions, and preliminary analysis documents.
- $UUCP = 5 + 10 + 5 + 5 + 5 + 15 = 45$

Use Case	Trans.	Weight
Process Sale	3	5
Process Refund	4	10
Cashier Login	2	5
Search for Item	2	5

UCP 2 – UUCP and TCF

UUCP (unadjusted use case points) = sum of use case weights.

Next adjust this in view of project complexity.

T-Factor = Technical complexity Factor

1. For each complexity factor, assign 0 – 5 for relevance to this project (0=irrelevant, 5=essential)
2. Compute TFactor for project as follows:

$$\text{TFactor} = \text{sum}(\text{factor_weight} * \text{factor_relevance})$$

Tech. Complexity Factor (TCF)

Distributed system	2	Easy to change	1
Response or throughput are objectives	1	Concurrent	1
End-use efficiency	1	Has special security features	1
Complex Internal Processing	1	Provides direct access for 3 rd parties	1
Code must be reusable	1	Special User training facilities required	1
Easy to install	0.5		
Portable	2		

TCF Example – POS in java

Distributed system	2	5	10
Response or throughput are objectives	1	4	4
End-use efficiency	1	0	0
Complex Internal Processing	1	3	3
Code must be reusable	1	0	0
Easy to install	0.5	0	0
Portable	2	5	10
Easy to change	1	0	0
Concurrent	1	0	0
Has special security features	1	0	0
Provides direct access for 3 rd parties	1	5	5
Special User training facilities required	1	0	0
Total TFactor for FirstPOS			29

TCF

- The Technical Complexity Factor is computed as:

$$\text{TCF} = 0.6 + 0.01 * \text{TFactor}$$

- FirstPOS Example:

$$\text{TCF} = 0.6 + 0.01 * 29 = 0.89$$

Environmental Factor

For each environmental factor, assign a rating of 0 – 5.

0 = none (no experience), 3 = average, 5 = high (expert)

Factor	Weight
Familiar with Internet Process	1.5
Application Experience (0=none, 5=expert)	0.5
Object-oriented Experience (0=none)	1.0
Lead Analyst Capability	0.5

FirstPOS Example

Factor	Weight	Rating
Familiar with Internet Process	1.5	4
Application Experience	0.5	1
Object-oriented Experience	1.0	3
Lead Analyst Capability	0.5	3
Motivation	1	3
Stable Requirements	2	2

Compute EF from EFactor

- The Environmental Factor (EF) is:

$$EF = 1.4 - 0.03 * EFactor$$

- FirstPOS Example:

$$EFactor = 13$$

$$EF = 1.4 - 0.03 * 13 = 1.01$$

Adjusted Use Case Points

- The total adjust Use Case Points (UCP) is:

$$UCP = UUCP * TCF * EF$$

FirstPOS Example

- $EF = 1.4 - 0.03 * 13 = 1.01$
- $TCF = 0.89$
- $UCP = UUCP * TCF * EF = 45 * 0.89 * 1.01 = 40$

Computing Effort

- For "average" project, 20 person-hours per UCP
- Review the TCF and EF. Count how many factors were < 3 and how many were > 3 . If there are many factors with relevance < 3 , then use 28 person-hours per UCP.

FirstPOS Example

- Effort = $40 * 20$ person-hours = 800 person-hours
- In business, actual time spent on projects (for full-time) is typically ≤ 6 hours/day.
 - The rest of time is overhead or unproductive activity
- Since we have part-timers, estimate 15 hours/week.
 $800 / 15 = 53$ person-weeks
- Using "square-root" heuristic, we need about 7 people for 8 weeks.

FirstPOS Example (Review)

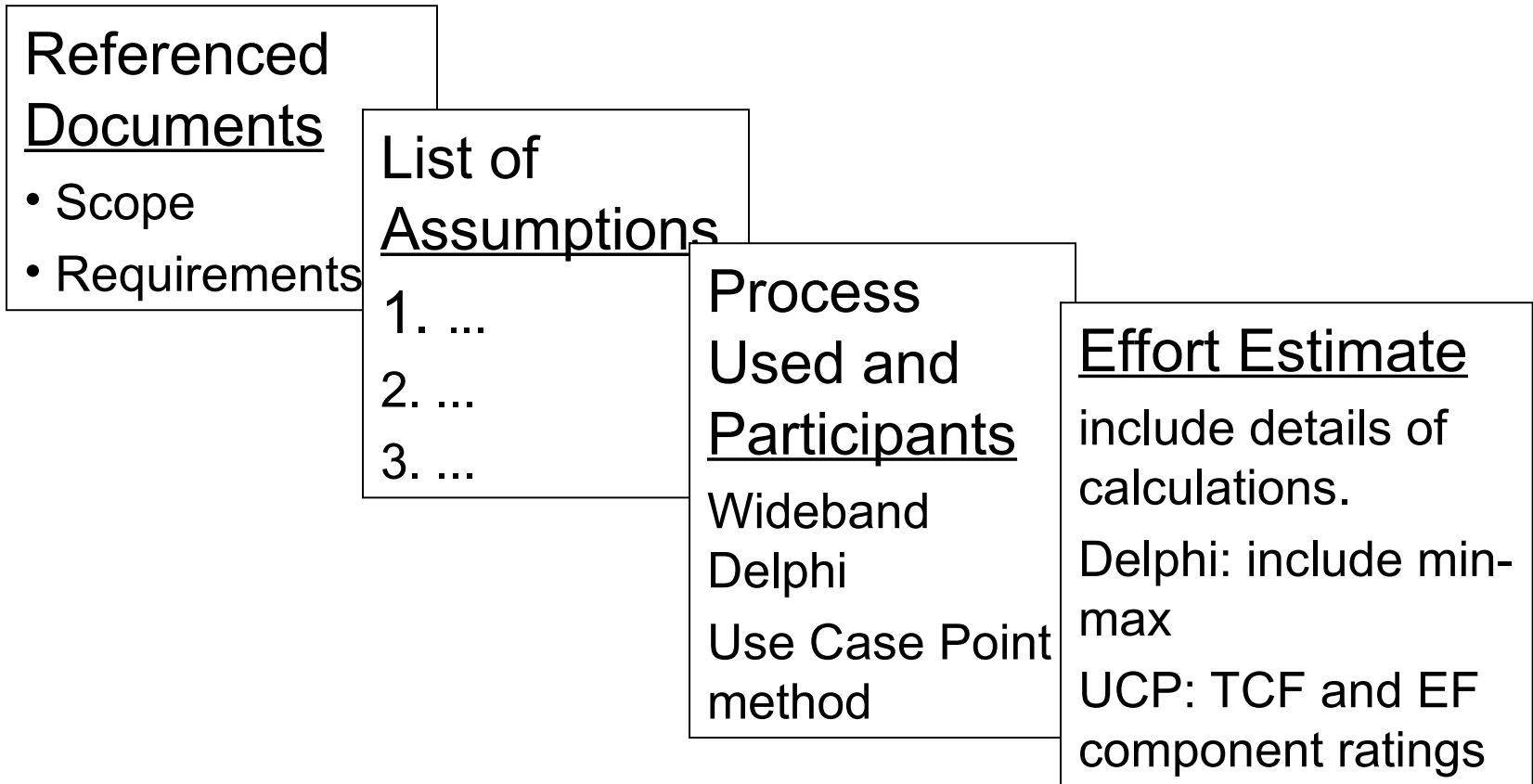
- Record the assumptions and conditions used to create this estimate!
 - Only 7 use cases (low). Did we miss something?
 - Project assumptions:
if they are wrong, will it increase complexity (TCF)?

Presenting Your Estimate

Your estimate **should** always include:

1. assumptions
2. methods used
3. data and other values you used
4. the calculations
5. **expressed as a range**, not a single number.

Estimation Deliverables



References

Software Project Estimation

Article from

<http://courses.cs.washington.edu/courses/cse403/07sp/assignments/estimationbasics.pdf>

Software Project Management in Practice, ch. 4.

Applied Software Project Management, ch. 3.