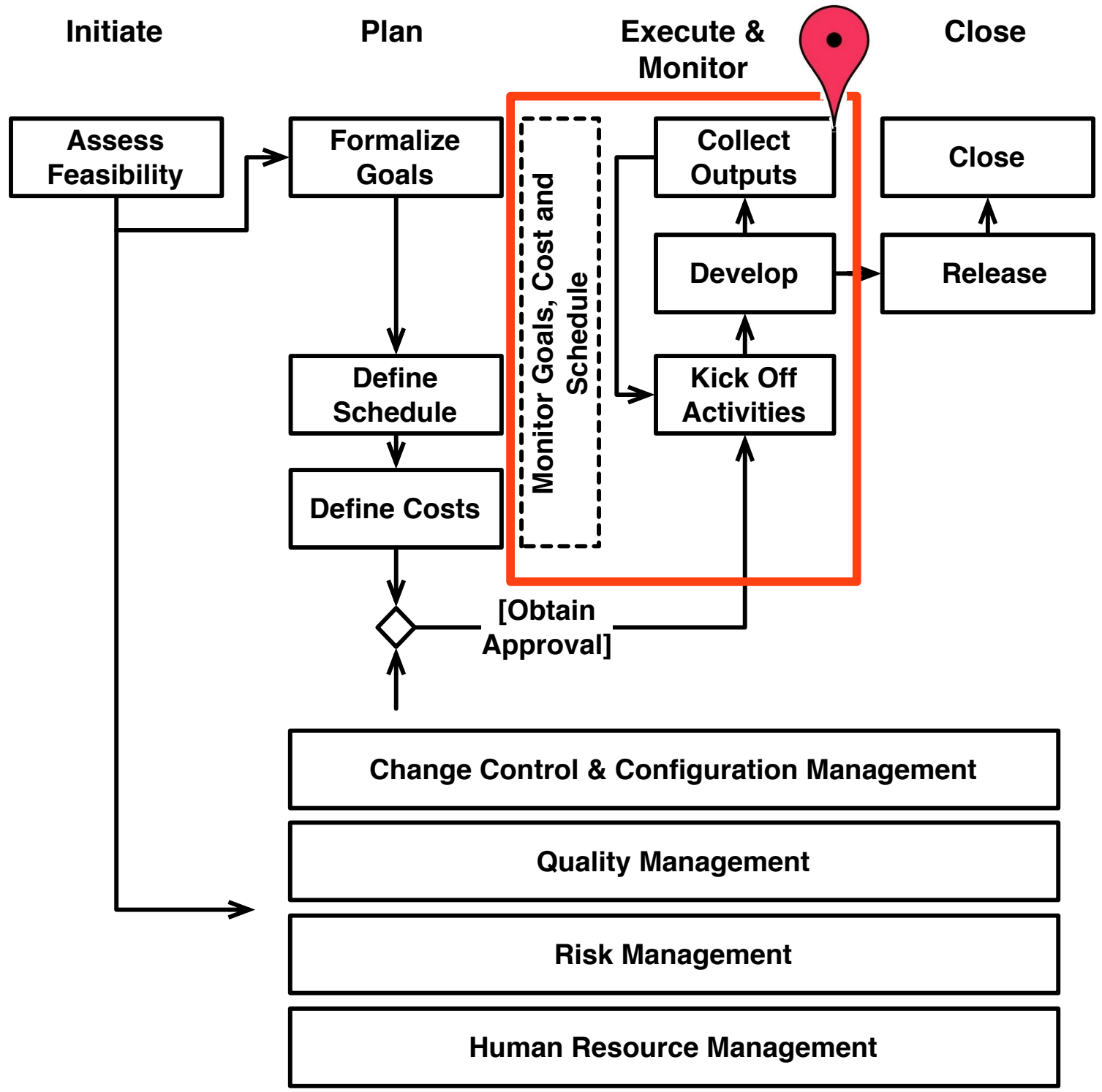# Project Execution, Monitoring, and Control

Goals of the Unit

- Plans have little value if not executed and, during execution, monitored and updated to reflect the current situation

- This unit introduces:
  - The activities to put a plan into practice
  - The techniques for monitoring and controlling your plans (progress and costs against schedule and budget)
  - Earned Value Analysis, a technique which allows the project manager to monitor a project in an integrated way

Initiate

Plan

Execute & Monitor

Close

Assess Feasibility

Formalize Goals

Monitor Goals, Cost and Schedule

Collect Outputs

Close

Define Schedule

Develop

Release

Define Costs

Kick Off Activities

[Obtain Approval]

Change Control & Configuration Management

Quality Management

Risk Management

Human Resource Management

Project Execution

Project Execution

- Project execution is where work is performed

- There are three main management activities:
    - Kicking activities off
    - Collecting the output of activities
    - Collecting information about the project health

Kicking Activities Off

- Goal:
  - Ensure there is a formal start for a significant portion of a project
  - Ensure the team is aligned on the goals and modalities of the activities being started

- The main mean is a kick-off meeting

- In general, any communication mean can be used (but it risks being less effective than a kick-off meeting)

- Choose an adequate level of granularity

Collecting the Output of Activities

- Goal:
  - Systematic collection of project outputs (deliverables)
  - Occasion to assess the lesson learned

- For software projects the main mean to collect project outputs is a repository + tagging/versioning

- A meeting to assess the lesson learned can also be used to "formalize" the collection of outputs

Collecting Information about the Project Status

- Goal:
  - Systematic collection of data to assess the project status

- It can be performed on a regular basis (in which case the frequency has to be chosen according tot he project size)

- It can be performed on a need basis (for exceptional events, e.g., risks)

- Quantitative data can be collected based on the monitoring means

- Qualitative data (e.g., team morale, "feeling" about the status or difficulty of a given task) must also be collected
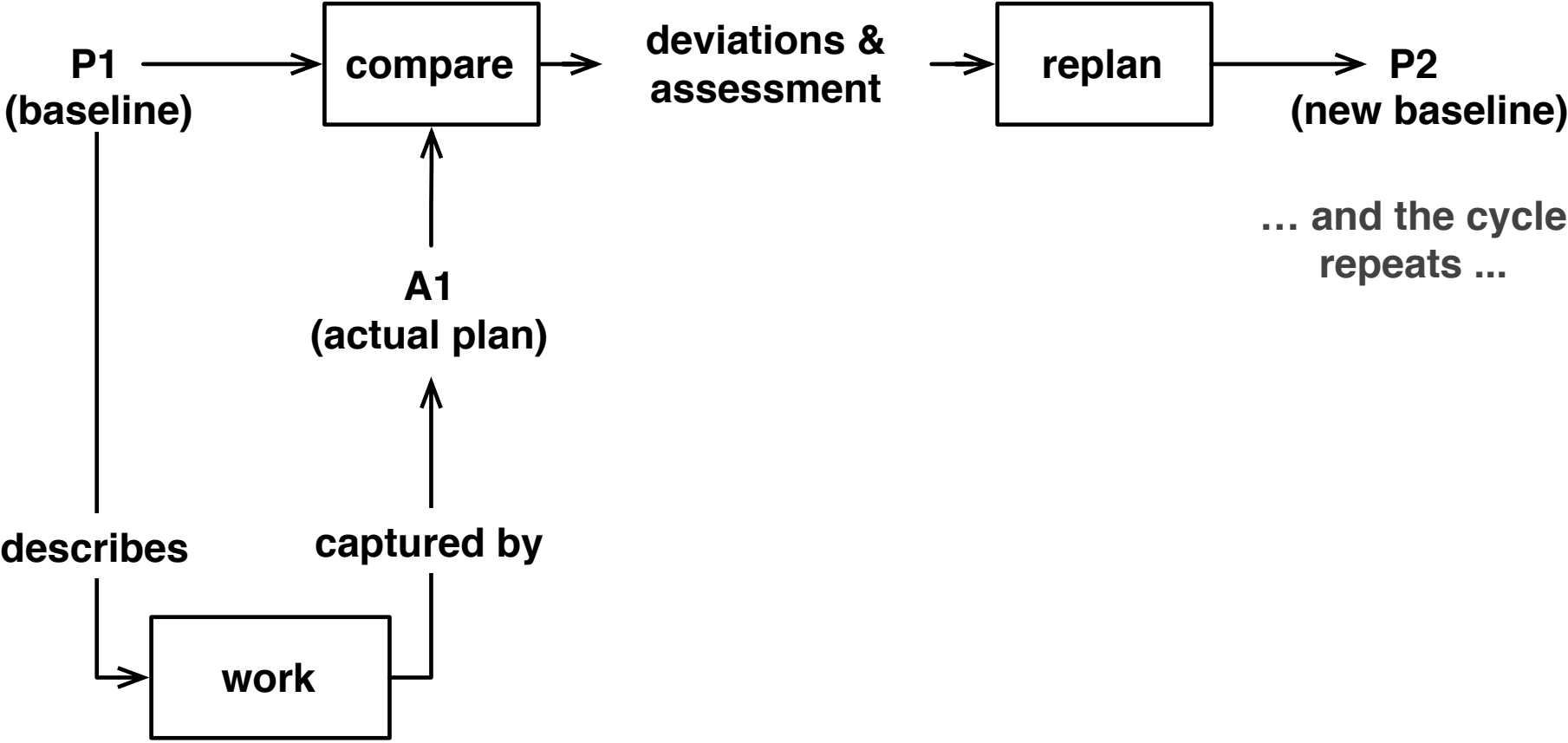
Project Monitoring and Control

Introduction

- Goals:
  - **For the project:** assessing project status (scope, time, cost, quality, ...), analyzing deviations, and taking corrective actions, if necessary
  - **For the organization:** collecting data helps building a better and more accurate plans for future projects

- Process (on a regular basis):
  - **Collect.** Get the data about the current status of your project.
  - **Measure and Compare.** Compare with baseline plan, highlight any deviation, make a projection based on current data.
  - **Assess and Re-plan.** Decide whether corrective actions are necessary. If so, plan, document, and take the corrective actions.

Monitoring and controlling cycle

Plan

Monitoring

Actual World

P1
(baseline)

compare

deviations &
assessment

replan

P2
(new baseline)

A1
(actual plan)

describes

captured by

work

… and the cycle
repeats …

Approaches

- Focus:
  - Here we focus on schedule, costs, and progress

- Non-integrated approach:
  - Monitor schedule: understand whether we are late or early
  - Monitor costs: understand whether we over or under budget
  - Simple, but partial views

- Integrated approach:
  - Earned Value Analysis: measure schedule, costs, and progress together
  - More complex, but a more comprehensive view

Monitoring Schedule

Basic Concepts

- Baseline (planned values):
  - A snapshot of the plan at a given time (plan at t1, plan at t2, …)
  - Many baselines can be taken

- Actual Values
  - Actual status of the schedule
  - Actual start, actual end, actual effort/actual progress

planned start   **planned end**

actual start   **actual end**
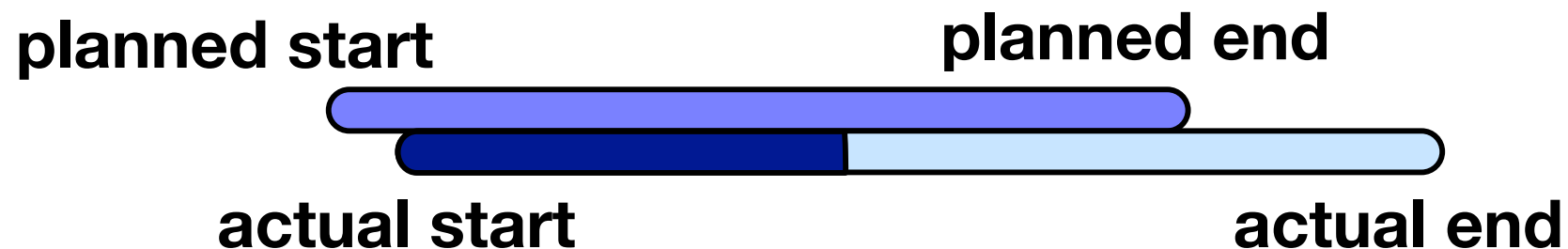
The Process

1. Build the plan

2. Save a baseline

3. On a regular basis, assess the plan:

   1. Actual start and end of an activity

   2. Actual effort spent on the activity

   3. Technical progress (**may be difficult to assess**)

4. Re-plan:

   1. Estimate effort and duration to end

   2. Technique 1: efficiency with which actual effort has been expressed w.r.t. planned effort

   3. Technique 2: efficiency with which technical progress is expressed w.r.t. planned progress

   4. Share the new plan, and GOTO 2

Collecting Effort Data

- Depending on the level of formality... people may be required to provide data about effort spent on activities

- Usually best on a weekly basis

- Need to reference activities of the plan

- It will contain "noise"

John Doe	W1	W2	W3	W4
Requirements M1	30		6	
Requirements M2		30	6	
Meeting	2	2	6	2
Research	4	4	4	4
Indirect activities				2

Monitoring Costs

Cost control, the simple approach

- The budget table defines your baseline

- Actual costs define your current status

- It can be split over years (or reporting periods)

CBS Item	Budgeted	Actual	Status	New Budget
Hardware	€10,000.00	€5,000.00	€5,000.00	€5,000.00
Software	€4,000.00	€2,000.00	€2,000.00	€2,000.00
Travel	€5,000.00	€6,000.00	**-€1,000.00**	**€1,000.00**
Project Bfr	€3,000.00		€3,000.00	**€1,000.00**
Total	€22,000.00	€13,000.00	€9,000.00	€9,000.00

Overruns drawn from other funds (e.g. project buffer, a different CES item) or from other projects

Remarks

- **Advantages:**

  – Relatively simple (however, delays between commitment of expenditures and cash flow)

  – For various CES items probably the best way of monitoring (e.g. hardware, software, ...)

- **Disadvantages:**

  – Not sufficient to have an idea on the overall status of the project (will we make it with the remaining money?)
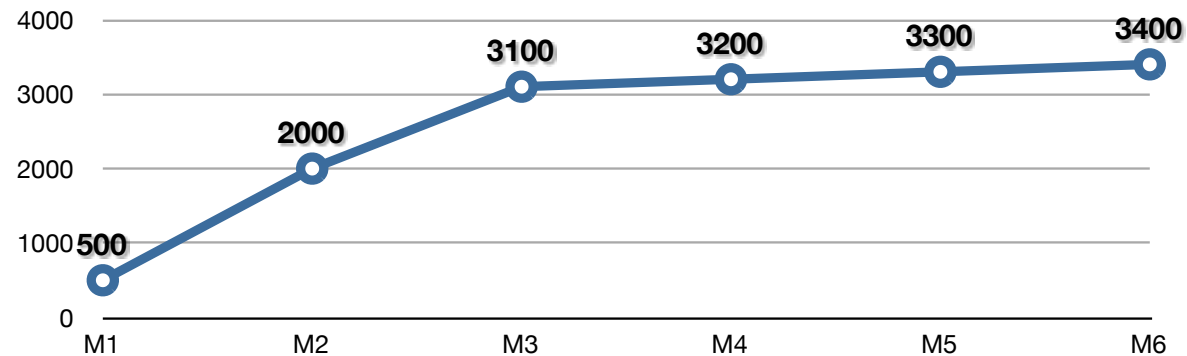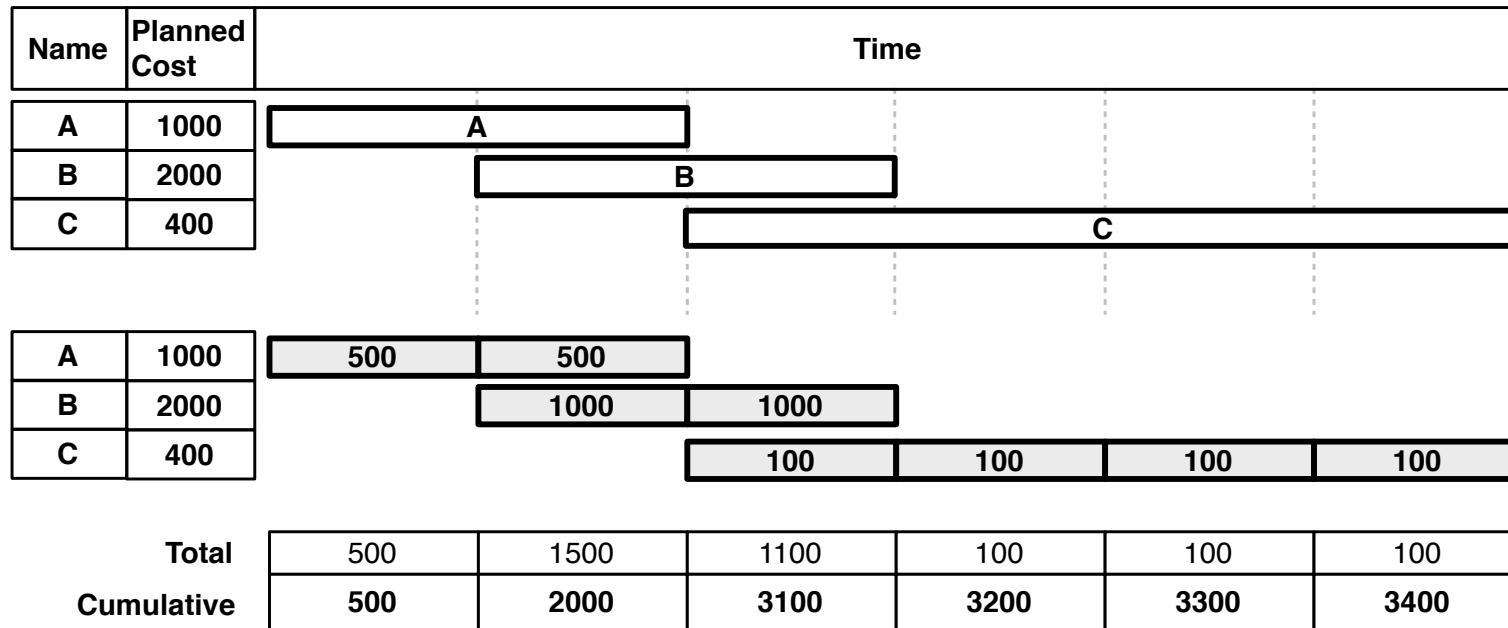
Earned Value Analysis

Earned Value Analysis

- **Earned Value Analysis** provides an integrated view of the project by measuring **planned effort (costs), actual progress (earned value), and effort (actual costs)** in terms of **monetary values**

- Measuring plan, work, and progress with the same unit makes them comparable

- Useful because:

  – Progress becomes comparable with effort

  – Budget and actual costs are put in context (being under budget is not necessarily good, if the technical progress is even lower)

Assumptions and Definitions

- Assumptions:

  - **Manpower = Cost:** plotting effort or cost is equivalent

  - Corollary: **Actual manpower = Actual Cost**

  - **Progress = Money**

- Definitions:

  - **Planned Value:** the cumulative costs planned for the project. Also called: **Budgeted Costs of Work Scheduled**

  - **Actual Costs:** the cumulative costs actually incurred into. Also called: **Actual Costs of Work Performed**

  - **Earned Value:** the actual progress, expressed as the quantity of planned value which has generated results

Planned Cost Computation

Name	Planned Cost	Time
A	1000	A
B	2000	B
C	400	C

Name	Planned Cost					
A	1000	500	500			
B	2000		1000	1000		
C	400			100	100	100	100

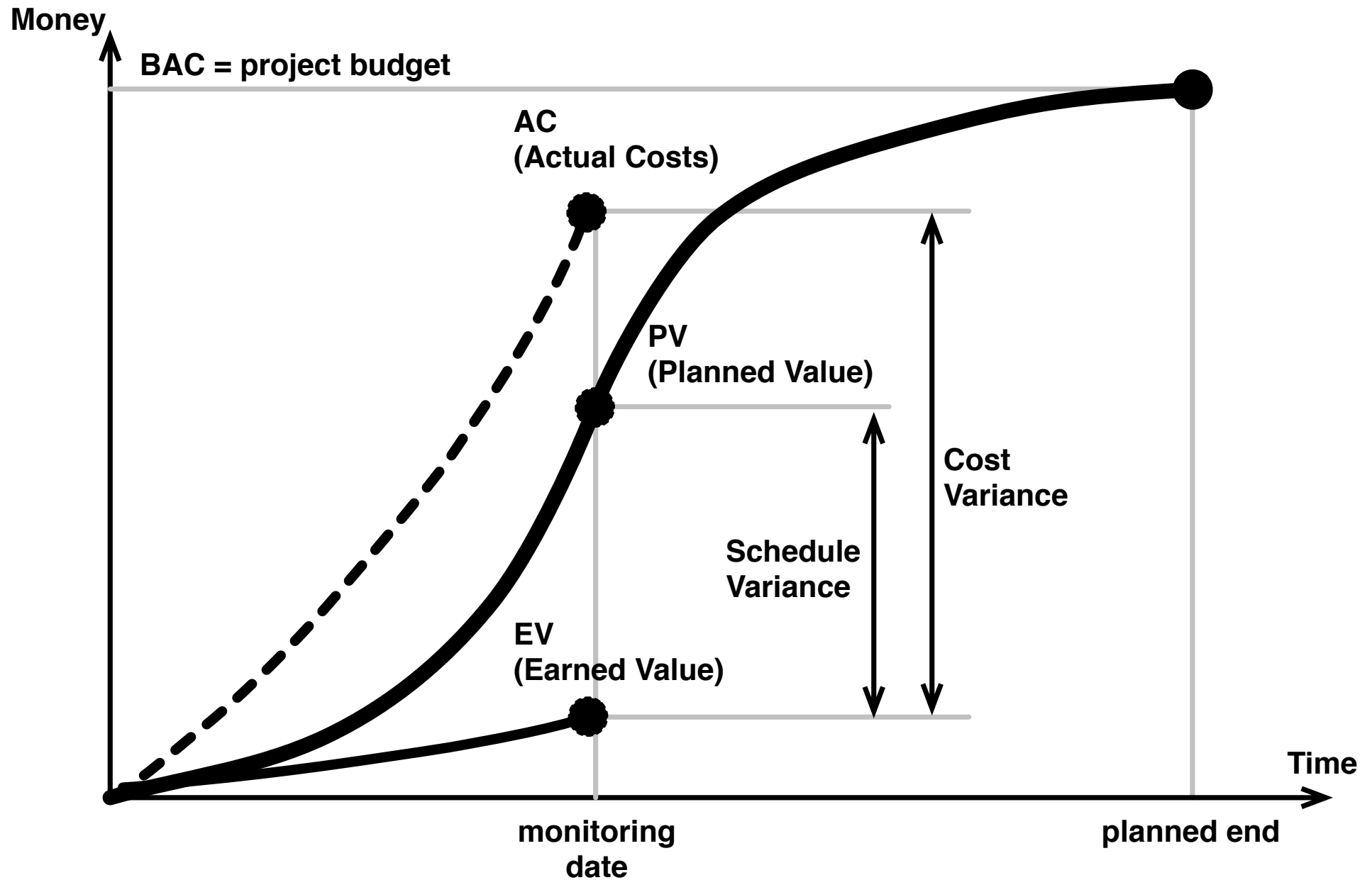|						
Total	500	1500	1100	100	100	100
Cumulative	500	2000	3100	3200	3300	3400

Earned Value Computation

- Rule 1.
  - Earned value should be determined by examining products

- Rule 2.
  - **50/50 Rule** (50% of Planned Value at start and 50% at end)
  - **20/80 Rule** (20% at start and 80% at end)
  - **0/100 Rule** (0% at start and 100% at end)

Earned Value Analysis

Some Interesting Points and Metrics

- BAC = Budget at Completion

- SV: Schedule Variance (BCWP-BCWS)
  - A comparison of amount of work performed during a given period of time to what was scheduled to be performed.
  - A negative variance means the project is behind schedule

- CV: Cost Variance (BCWP-ACWP)
  - A comparison of the budgeted cost of work performed with actual cost.
  - A negative variance means the project is over budget.

Cost Performance Index (CPI)

$$CPI_t = \frac{EV_t}{AC_t}$$

\mbox{\em CPI}_t = \frac{\mbox{\em EV}_t}{\mbox{\em AC}_t}

- CPI (Cost Performance Index) compare performed to actual costs

- How much are we getting for each euro we spend?

CPI > 1	Project is efficient
CPI < 1	Project is inefficient

Schedule Performance Index (SPI)

$$SPI_t = \frac{EV_t}{PV_t}$$

- SPI (Schedule Performance Index) compares work performed to work planned

- How fast does the project progress w.r.t. how fast we expected it to be?

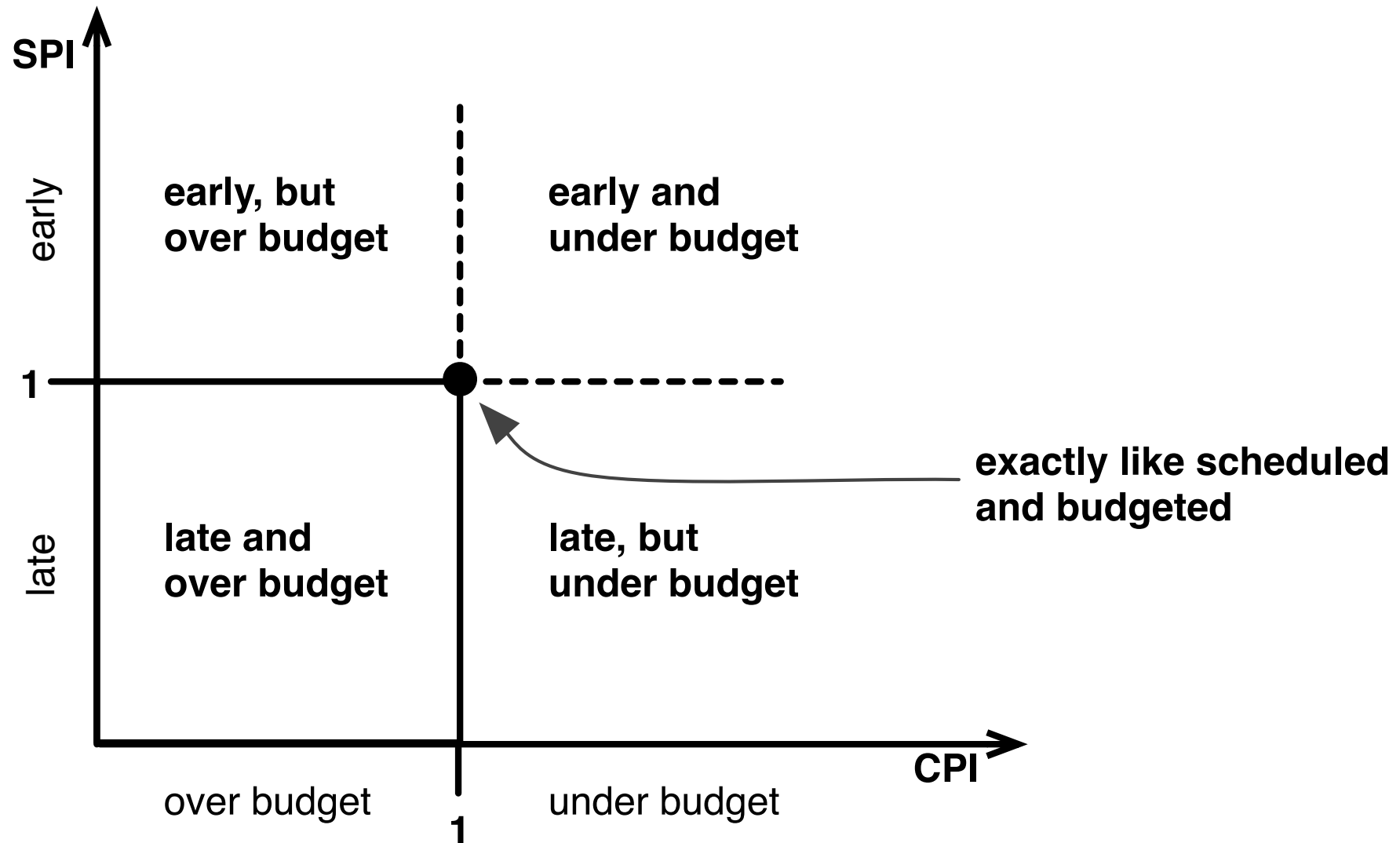| SPI > 1	Project is ahead of schedule
SPI < 1	Project is behind schedule

Cost Schedule Index (CSI)

$$CSI_t \quad = \quad CPI_t * SPI_t$$

$$CSI_t = \frac{EV_t}{AC_t} * \frac{EV_t}{PV_t}$$

- CSI: Cost Schedule Index (CSI=CPI x SPI)

- The further CSI is from 1.0, the less likely project recovery becomes

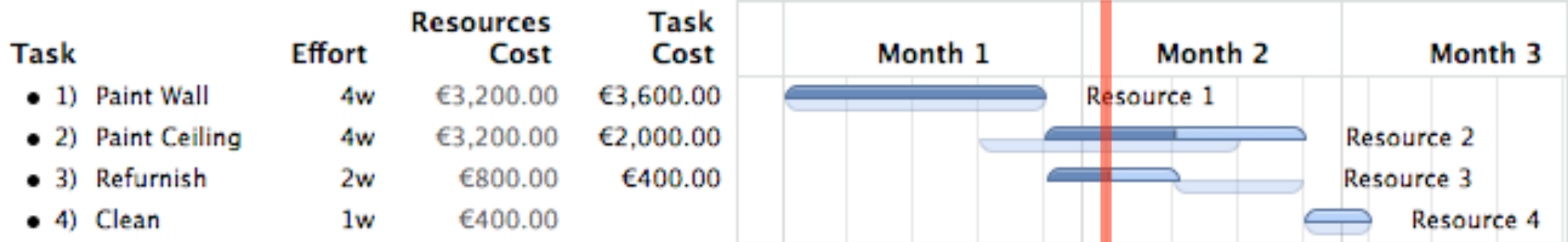# Measuring SPI and CPI

SPI

early

early, but
over budget

early and
under budget

1 ●

exactly like scheduled
and budgeted

late

late and
over budget

late, but
under budget

over budget

under budget

1

CPI

Earned Value Analysis: Example

Example

Task	Effort	Resources Cost	Task Cost	Month 1	Month 2	Month 3
● 1) Paint Wall	4w	€3,200.00	€3,600.00	Resource 1		
● 2) Paint Ceiling	4w	€3,200.00	€2,000.00		Resource 2	
● 3) Refurnish	2w	€800.00	€400.00		Resource 3	
● 4) Clean	1w	€400.00				Resource 4

- Remarks:
  - Lower part = baseline; upper part: actual & progress

- Questions:
  - Are we late?
  - Are we over budget?

Example

| Task	Effort	Resources Cost	Task Cost
• 1) Paint Wall	4w	€3,200.00	€3,600.00
• 2) Paint Ceiling	4w	€3,200.00	€2,000.00
• 3) Refurnish	2w	€800.00	€400.00
• 4) Clean	1w	€400.00	

- Activity 1: as scheduled (time)

- Activity 2: started late; ahead of schedule

- Activity 3: started earlier; progress same as time elapsed

- Activity 4: not started yet

Example: BCWS (Planned Value)

Task	Effort	Resources Cost	Task Cost
• 1) Paint Wall	4w	€3,200.00	€3,600.00
• 2) Paint Ceiling	4w	€3,200.00	€2,000.00
• 3) Refurnish	2w	€800.00	€400.00
• 4) Clean	1w	€400.00	

Paint Wall	800	800	800	800					
Paint Ceiling				800	800	800	800		
Refurnish						400	400		
Clean									400
Budgeted Cost of Work Scheduled (BCWS)	800	1600	2400	4000	4800	5600	6800	7200	7600
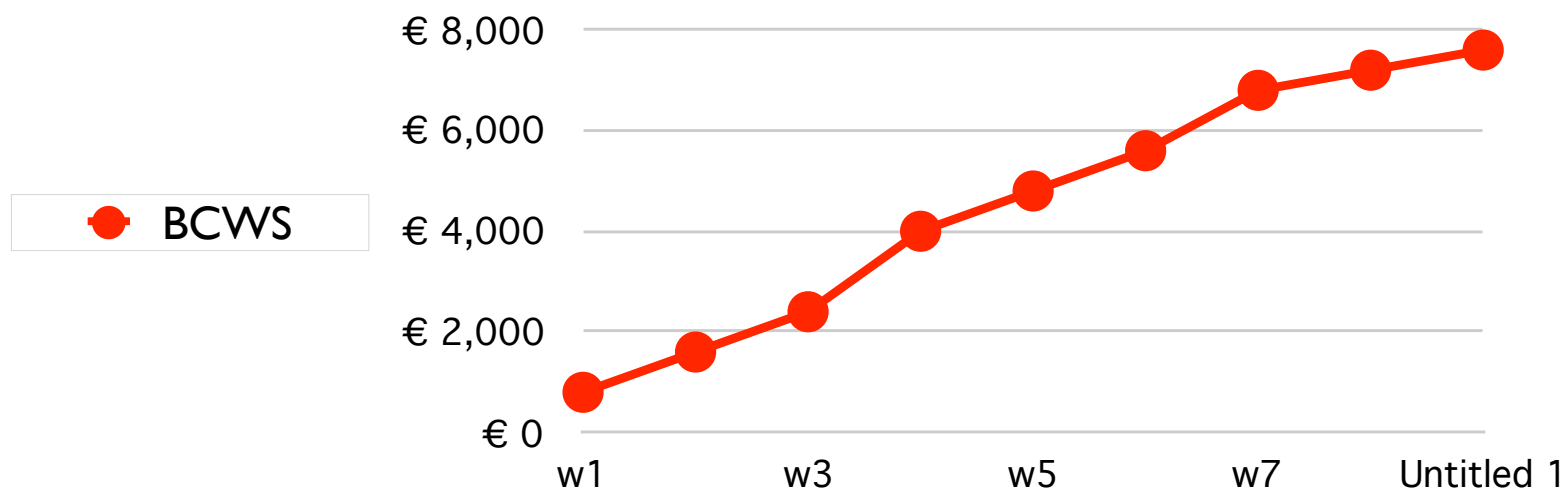
Example: BCWP (Earned Value)
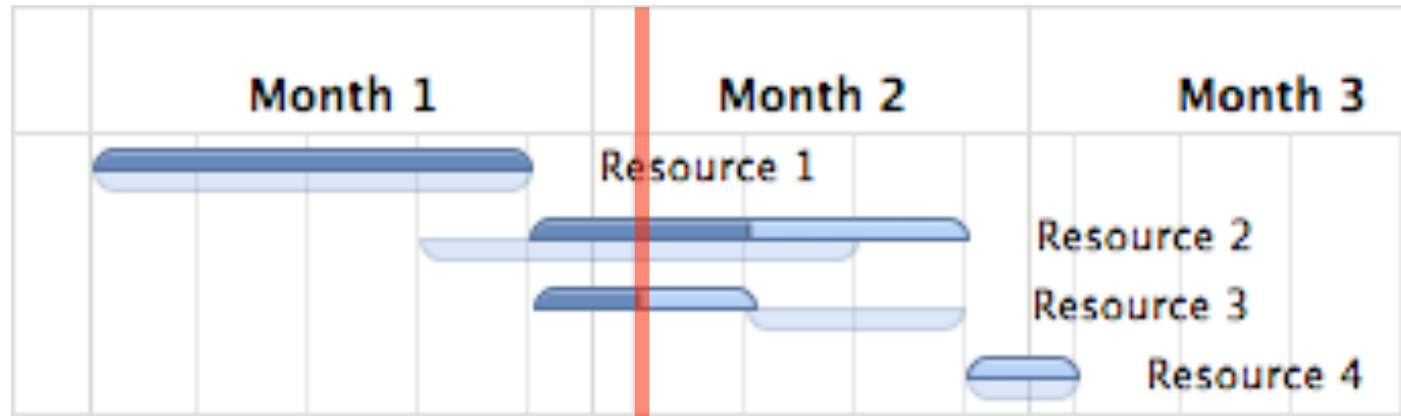
|	Month 1			Month 2			Month 3	
Paint Wall	1600			1600				
Paint Ceiling				0	1600			
Refurnish					400			
Clean								
Budgeted Cost of Work Scheduled (BCWS)	1600	1600	1600	3200	5200			
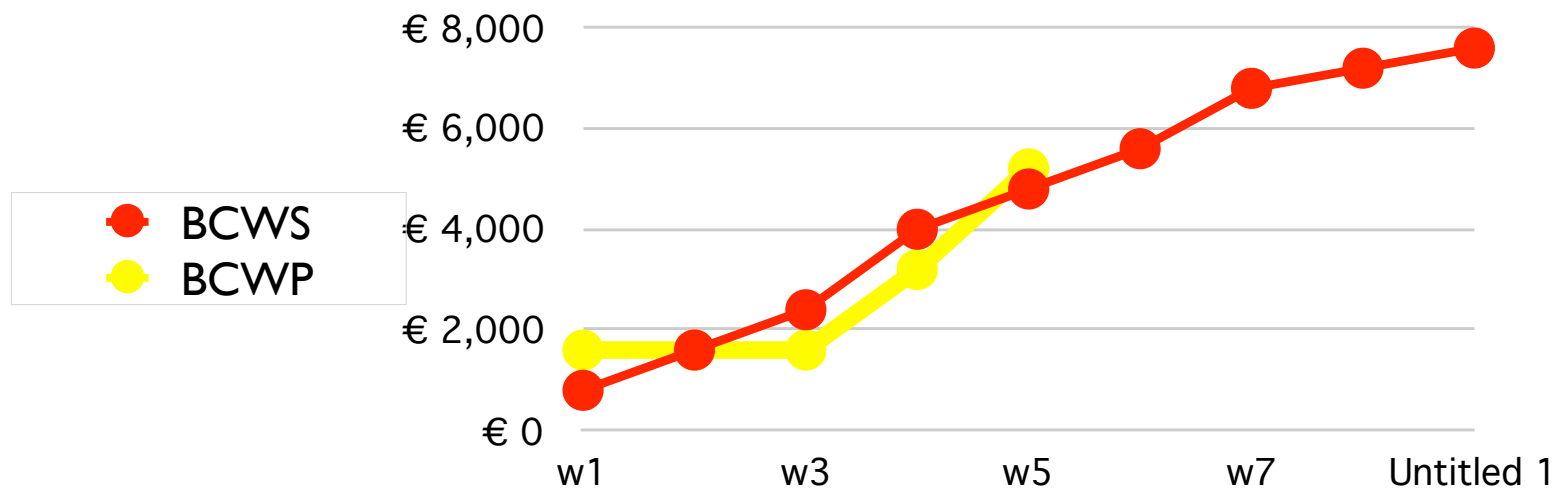
Comments

- Ahead of schedule on week 1 because of the noise of the 50%-50% rule (analogously the delay on w2 and w3)

- w4: we are behind schedule (activity 2 did not start as expected)

- w5: we are again ahead of schedule, because of activity 3.

- Since the 50%-50% rule only counts start and end of activities, the fact that progress in activity 2 is better than expected is not taken into account in the EVA graph

Example: ACWP (Actual Costs)

Task Cost	Month 1				Month 2			Month 3	
€3,600.00					Resource 1				
€2,000.00							Resource 2		
€400.00							Resource 3		
								Resource 4	
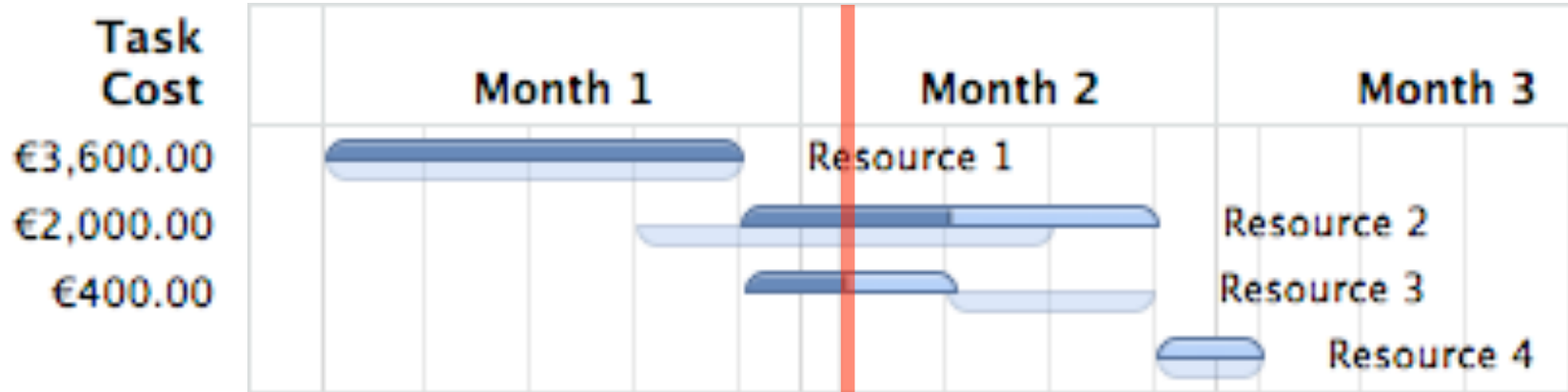
Paint Wall	900	900	900	900	
Paint Ceiling				0	2000
Refurnish					400
Clean					
Actual Cost of Work Performed (ACWP)	900	1800	2700	3600	6000

Legend:
- BCWS (red)
- BCWP (yellow)
- ACWP (green)
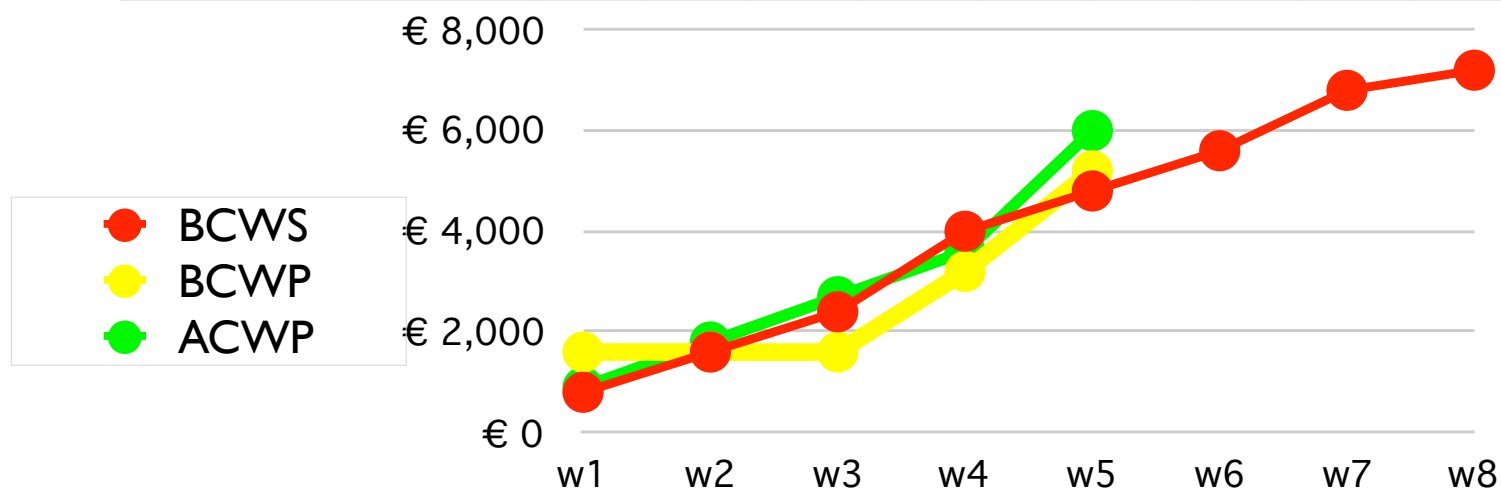
Recap

Paint Wall	€800.00	€800.00	€800.00	€800.00	
Paint Ceiling				€800.00	€800.00
Refurnish					
Clean					
Budgeted Cost of Work Scheduled (BCWS)	€800	€1,600	€2,400	€4,000	€4,800
Budgeted Cost of Work Performed (BCWP)	€1,600	€1,600	€1,600	€3,200	€5,200
Actual Cost of Work Performed (ACWS)	€900	€1,800	€2,700	€3,600	€6,000
CPI (BCWP/ACWP)	178%	89%	59%	89%	87%
SPI (BCWP/BCWS)	200%	100%	67%	80%	108%
Cost Variance	€700	-€200	-€1,100	-€400	-€800
Schedule Variance	€800	€0	-€800	-€800	€400

Comments

- Various noise due to the 50%-50% rule (e.g. w1)

- Data shows that we are now a bit over budget, but early in schedule (last column).

- However:

  – Actual costs efficiency is due to the 50%-50% rule on activity 2 (we accrued 1600) ... the data will get more accurate when we finish activity 2 (expenditure will likely be 4000 euros and BCWS 3200)