Software Development Project Management

Software Development Process?

1) Announce availability.
2) Order the T-shirts for the Development team.
3) Write the code.
4) Write the manual.
5) Hire a Product Manager.
6) Spec the software (Writing the specs after the code helps to ensure that the software meets the specifications).
7) Ship.
8) Test (the customers are a big help here).
9) Identify bugs as potential enhancements.
10) Announce the upgrade program.

Cynical Views or Reality?

- Projects progress quickly until they are 90% complete. Then they remain at 90% complete forever.
- When things are going well, something will go wrong. When things just can't get worse, they will. When things appear to be going better, you have overlooked something.
- If project content is allowed to change freely, the rate of change will exceed the rate of progress.
- Project teams detest progress reporting because it manifests their lack of progress.

Project Management Terms
(not universal)

- **Tasks**: Small units of work
- **Activities**: Major work units
- **Milestones**: When activities are completed
- **Functions**: Pervasive, on-going management activities

Tasks: Small units of work

- **Smallest** unit of management accountability
  - Atomic unit of planning and tracking
  - Finite duration, need resources, produce tangible result (documents, code)
- Specification of a task: Work package
  - Name, description of work to be done
  - **Preconditions** for starting, **duration**, required **resources**
  - Work product to be produced, acceptance criteria for it
  - Risk involved
- Completion criteria
  - Includes the acceptance criteria for the work products (deliverables) produced by the task.

Activities: Major Units of Work

- Culminates in major project ***milestone***:
  - Internal checkpoint should not be externally visible
  - Scheduled event used to measure progress
- Milestone often produces baseline:
  - formally reviewed work product
  - under change control (change requires formal procedures)
- Activities may be grouped into larger activities:
  - Establishes hierarchical structure for project (phase, step, ...)
  - Allows separation of concerns
  - Precedence relations often exist among activities (PERT Chart)

Examples of Activities

- Major Activities:
  - Planning
  - Requirements Elicitation
  - Requirements Analysis
  - System Design
  - Object Design
  - Implementation
  - System Testing
  - Delivery
- Activities during requirements analysis:
  - Refine scenarios
  - Define Use Case model
  - Define object model
  - Define dynamic model
  - Design User Interface

Project "Functions"

- Examples:
  - Project management
  - Configuration Management
  - Documentation
  - Quality Control (Verification and validation)
  - Training

- Project Functions in the IEEE 1058 standard are called ***Integral processes*** in the IEEE 1074 standard.

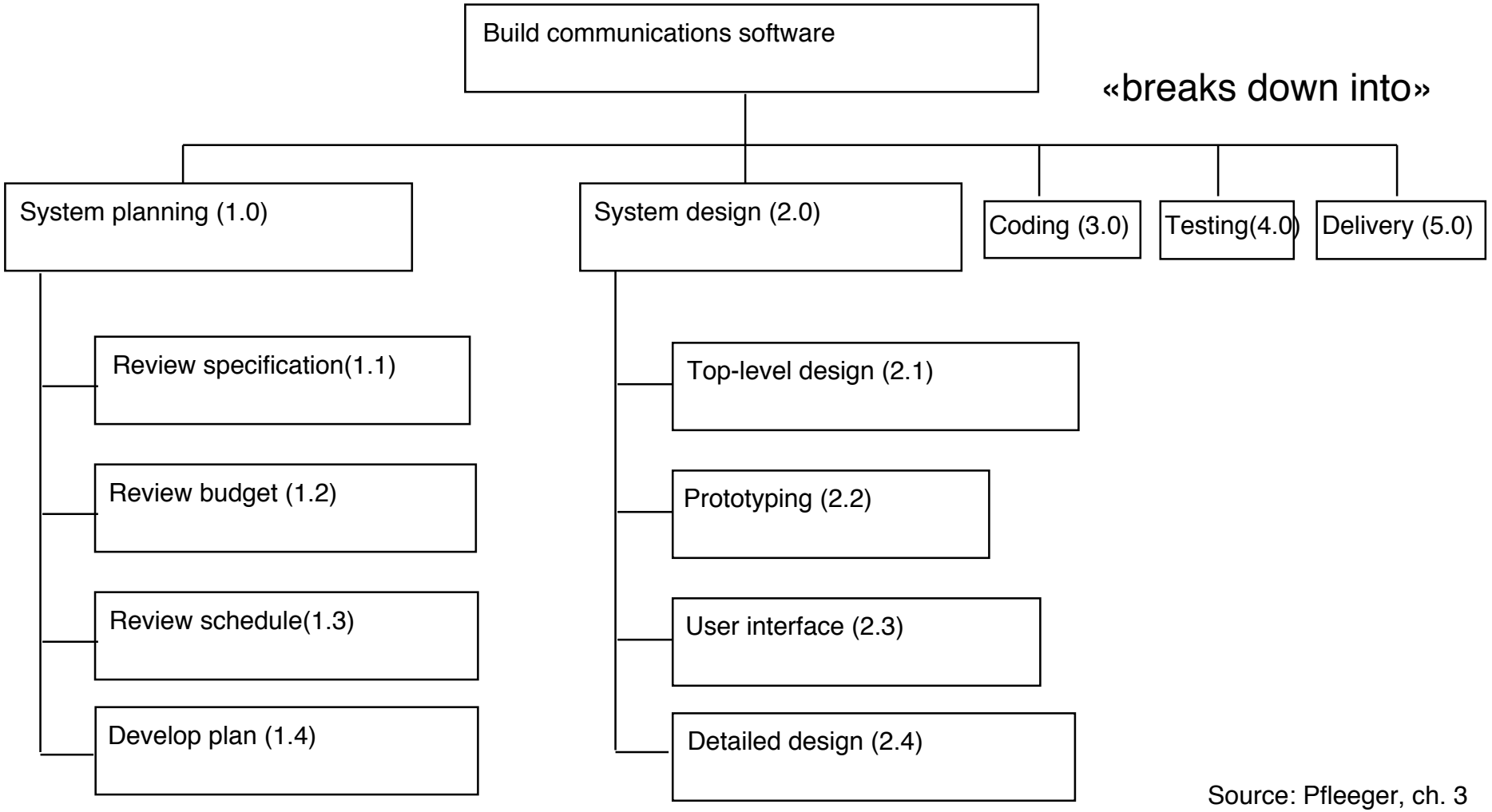
Organizational Diagrams

- **Work breakdown structure (WBS)**: Shows **hierarchy** of work products
- **PERT chart**: Shows the **order** in which activities must be done (a partial order)
- **Gantt Chart or Schedule**: Shows scheduling of work products as a function of time

Creating Work Packages

- Work Breakdown Structure (WBS)
  - Break up project into **activities** (phases, steps) and **tasks**.
  - *The work breakdown structure does **not** show the interdependence of the tasks*

Work Breakdown Structure (WBS) Diagram



Source: Pfleeger, ch. 3

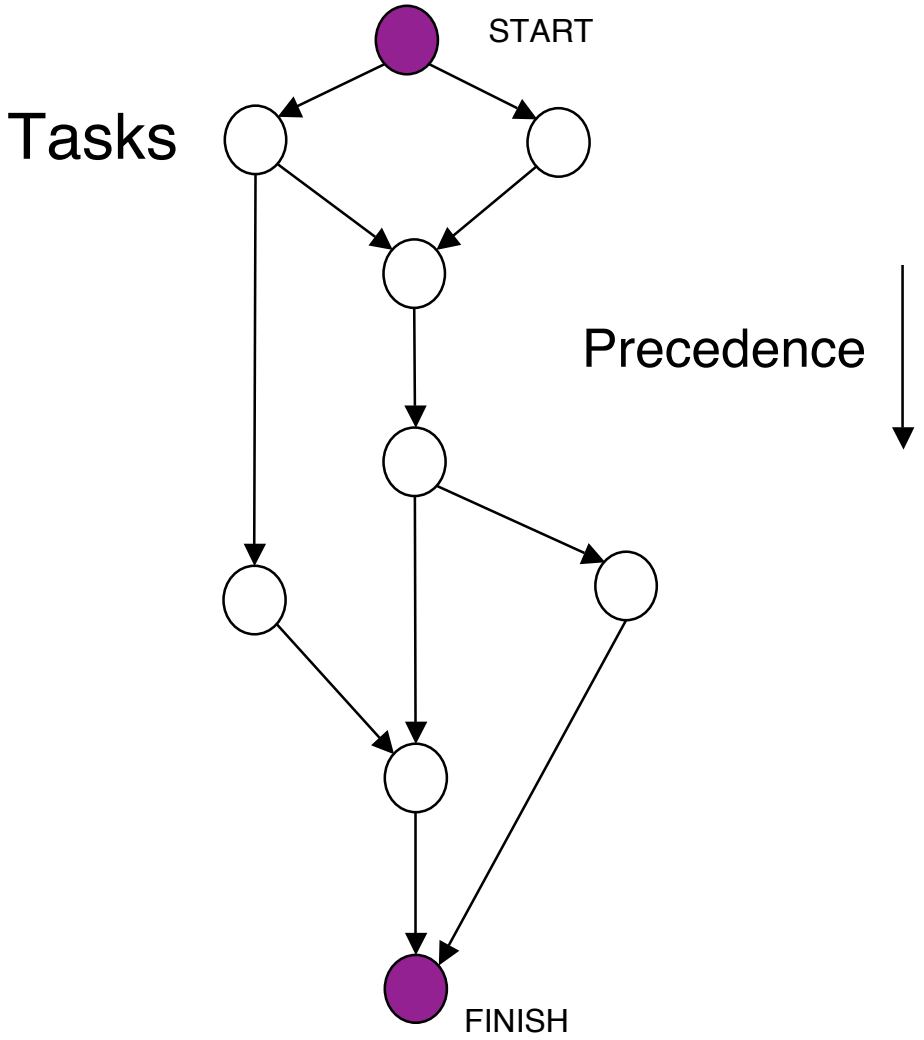
WBS Tradeoffs

- Work breakdown structure influences cost and schedule
- Determination of work breakdown structure may be **incremental** and iterative

PERT Chart

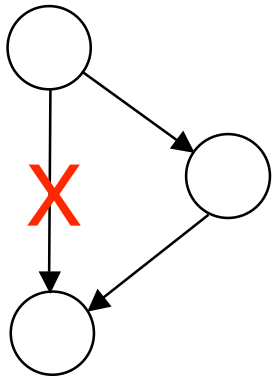
- "Program Evaluation and Review Technique"
- U.S. Navy, 1957

PERT chart
(Similar to UML Activity Diagram)



To Build a PERT chart

- List all the tasks.
- For each tasks:
  - List the tasks that must (immediately) precede that task
  - Remove *implied* dependencies (called the "**transitive reduction**" of the graph)



Tasks in Building a House: What are likely required orders?

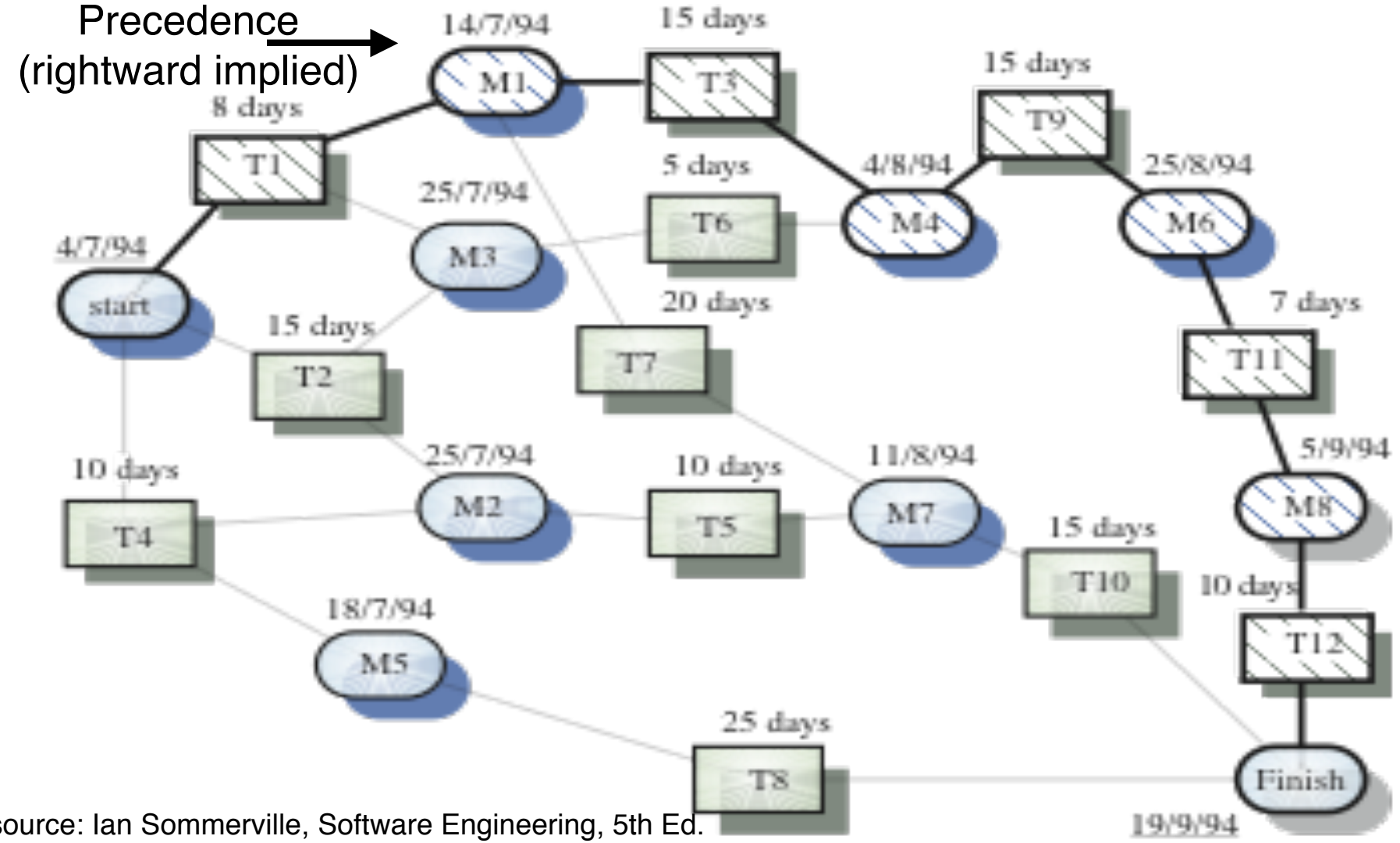
- Install roofing
- Install interior electrical
- Buy materials
- Excavate
- Build outside wall
- Install interior plumbing
- Install exterior siding
- Paint interior
- Install flooring
- Lay foundation
- Obtain permits
- Install exterior electrical
- Install exterior doors and fixtures
- Paint exterior
- Survey land
- Install interior doors and fixtures
- Install wallboard
- Install exterior plumbing

Task durations and dependencies

Task	Duration (days)	Dependencies
T1	8	
T2	15	
T3	15	T1
T4	10	
T5	10	T2, T4
T6	5	T1, T2
T7	20	T1
T8	25	T4
T9	15	T3, T6
T10	15	T5, T7
T11	7	T9
T12	10	T11

source: Sommerville, Software Engineering, 5th Ed.

Task network with Milestones (ovals)



source: Ian Sommerville, Software Engineering, 5th Ed.

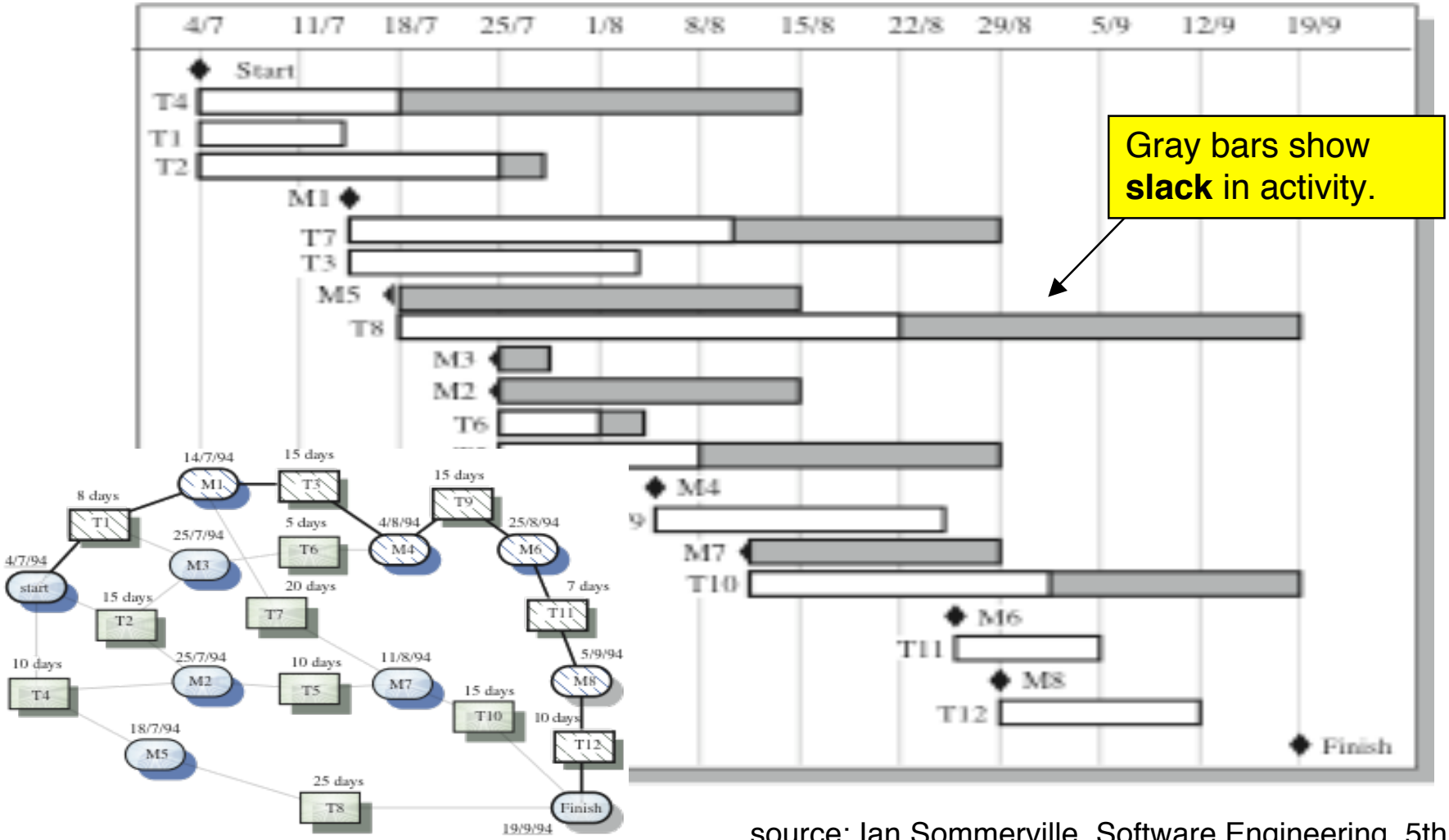
Determine from PERT Chart

- For each task:
  - Earliest start time (from forward pass)
  - Latest start time (from backward pass)
  - Slack (or float)
- For project
  - Minimum completion time
  - Critical path (from ESTs & LSTs)

PERT -> Gantt

- As we saw, PERT enforces certain **precedence constraints.**
- Other kinds of constraints:
  - **Staff assignment** (task -> person) and loading constrains number of activities that can go on concurrently.
  - **Resource availability** further constrains time at which various activities can happen.
- The **Gantt chart** (or schedule) shows a **particular** scheduling of the tasks, subject to all of the constraints.

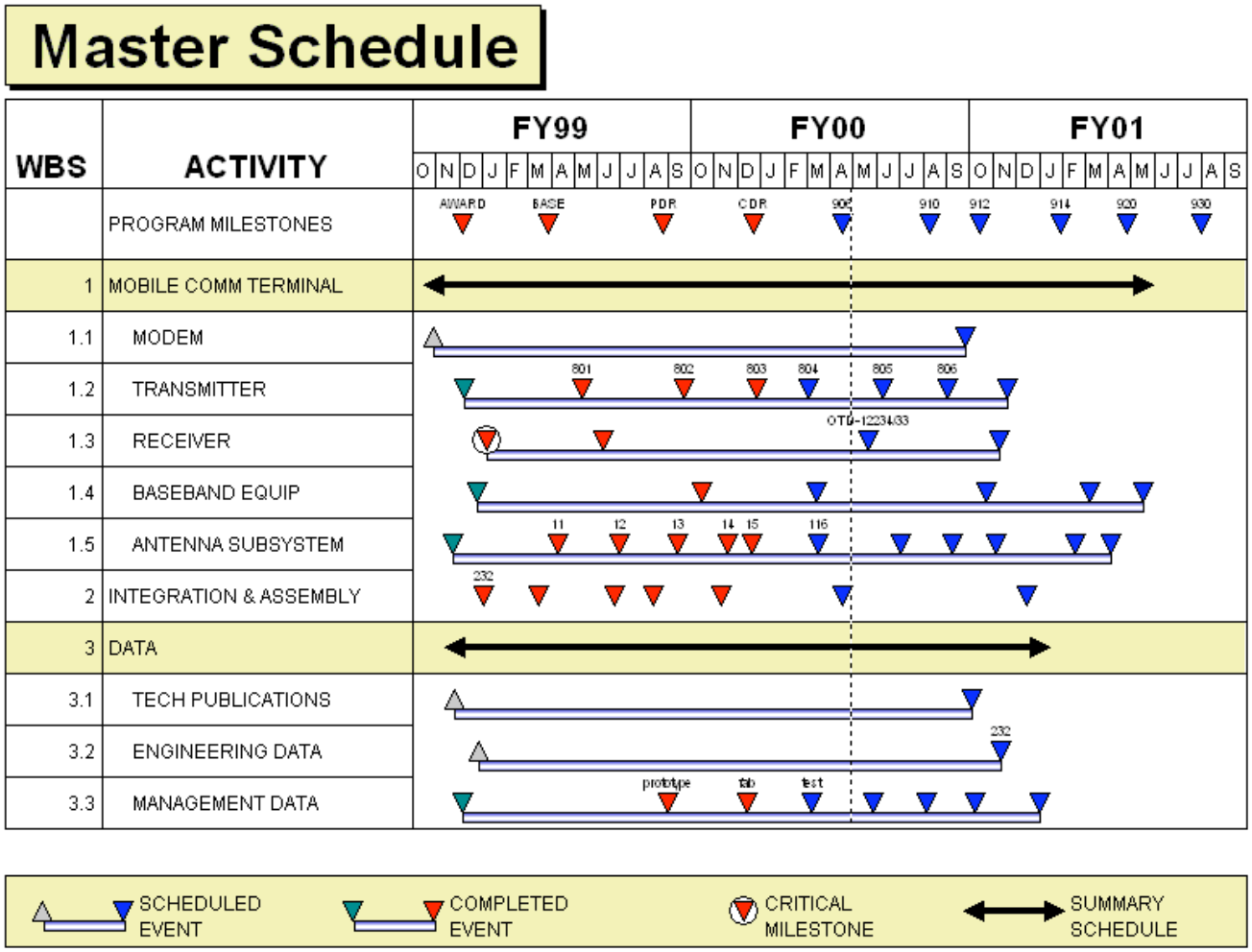
Gantt Chart from PERT (inset)
(Timeline chart, Timing chart, Schedule)



source: Ian Sommerville, Software Engineering, 5th Ed.

A Real-life Gantt Chart

(source: http://www.kidasa.com/information/examples/aerospace/aerospace2.html)



Henry L. Gantt (1861-1919)

(http://accel-team.com/scientific/scientific_04.html)

- well-known pioneer in the early days of scientific management
- remembered for his humanizing influence on management, emphasizing the conditions that have favorable psychological effects on the worker
- "The Gantt chart for which he will be remembered, is a visual display chart used for scheduling, which is based on time, rather than quantity, volume or weight."

Critical Path

- A "critical path" on a PERT chart is one in which the **sum of durations** of the tasks on the path equals the **shortest** overall project-completion time.
- The critical path is shaded on the preceding diagram.
- PERT is also called CPM (Critical Path Method)

What is the Critical Path in Building your House, given the number of days required as shown?

- Install roofing (4)
- Install interior electrical (2)
- Buy materials (5)
- Excavate (7)
- Build outside wall (5)
- Install interior plumbing(4)
- Install exterior siding (3)
- Paint interior (2)
- Install flooring (2)
- Lay foundation (2)
- Obtain permits (24)
- Install exterior electrical (3)
- Install exterior doors and fixtures (2)
- Paint exterior (1)
- Survey land (1)
- Install interior doors and fixtures (2)
- Install wallboard (2)
- Install exterior plumbing (1)

Exercise

- List as many ways you can for **shortening** the critical path in a set of tasks.

Staff Loading & Resources

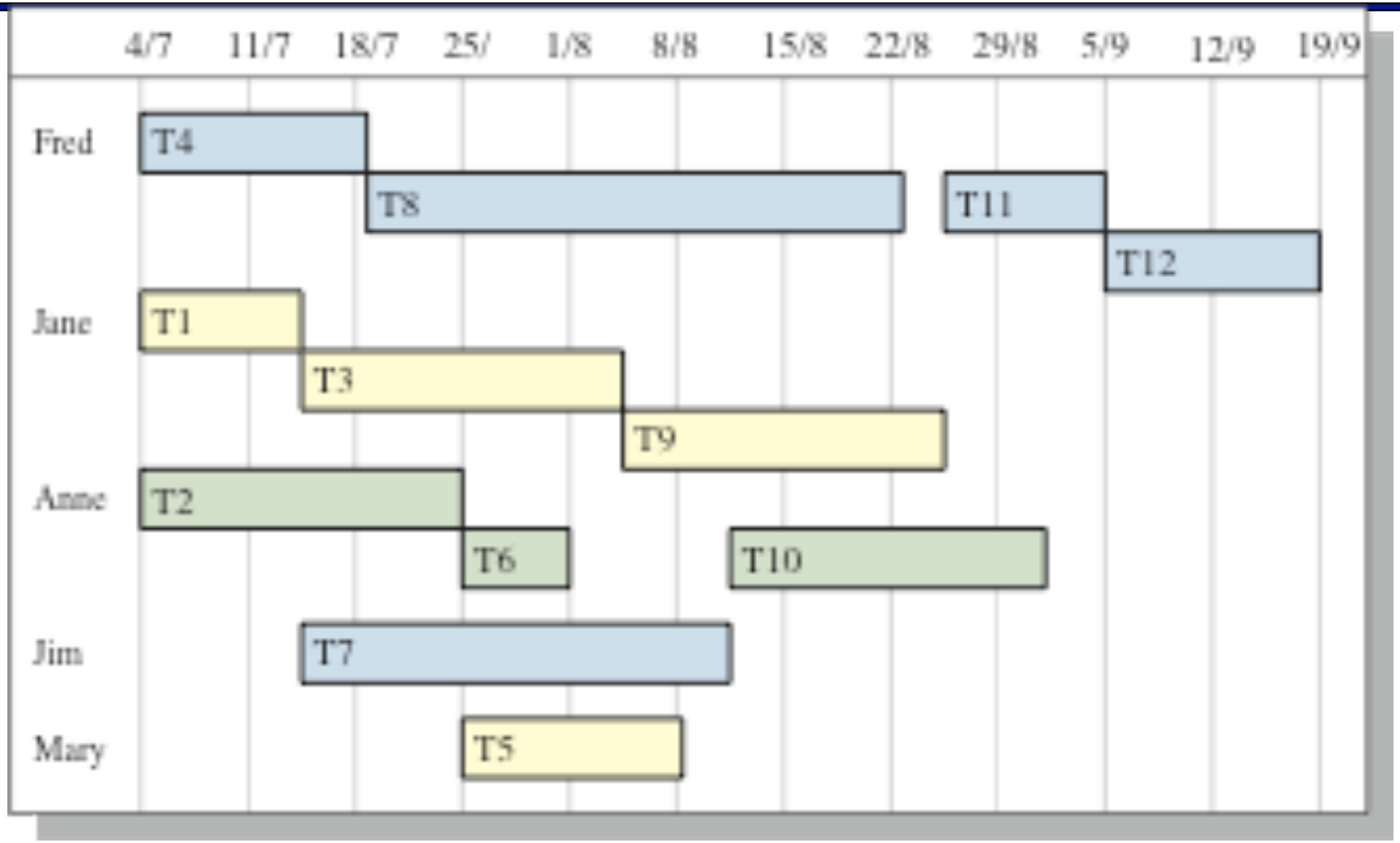
- Staff loading and resource constraints are two aspects of scheduling not represented directly on PERT charts.

- Generally they have the effect of providing added sequencing, and therefore lengthening overall project time.

Staff Loading & Resources

- Staff loading refers to:
  - Some tasks can be assigned only to certain staff members, based on specialized skills.
  - A given staff member can only do so much at a time.
  - Staff members differ in their productivity on a given task.

Staff loading



source: Sommerville, Software Engineering, 5th Ed.

Staff Loading & Resource Constraints

- Resource constraints refers to certain resources being needed for certain tasks, but being limited in the number of tasks they can support concurrently.

- Resources include:
  - Machines, workstations, storage units
  - Rooms, offices

Exercise

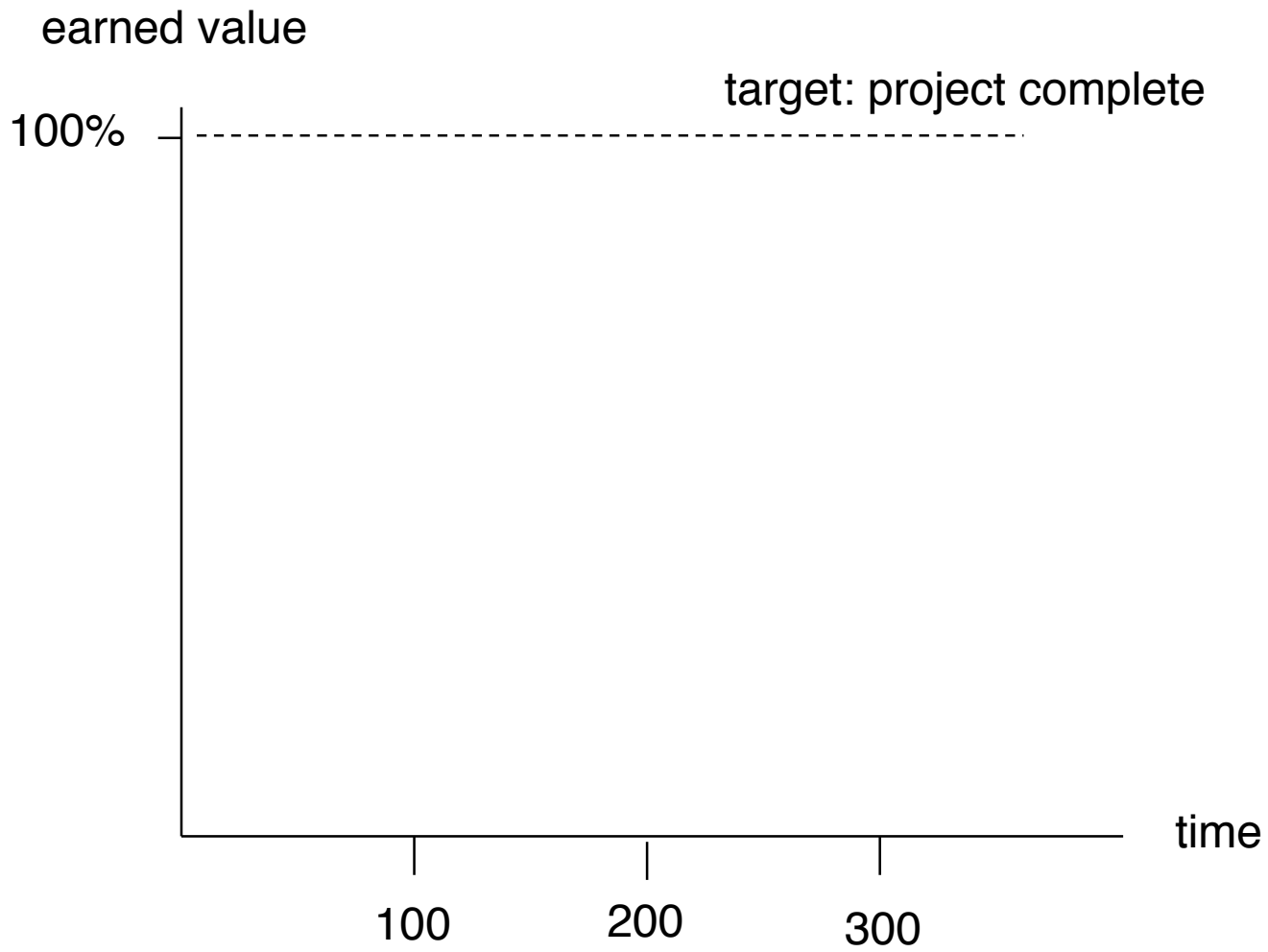
- How Do Constraints Differ from Precedence Relationships?

Tracking How Well are We Doing

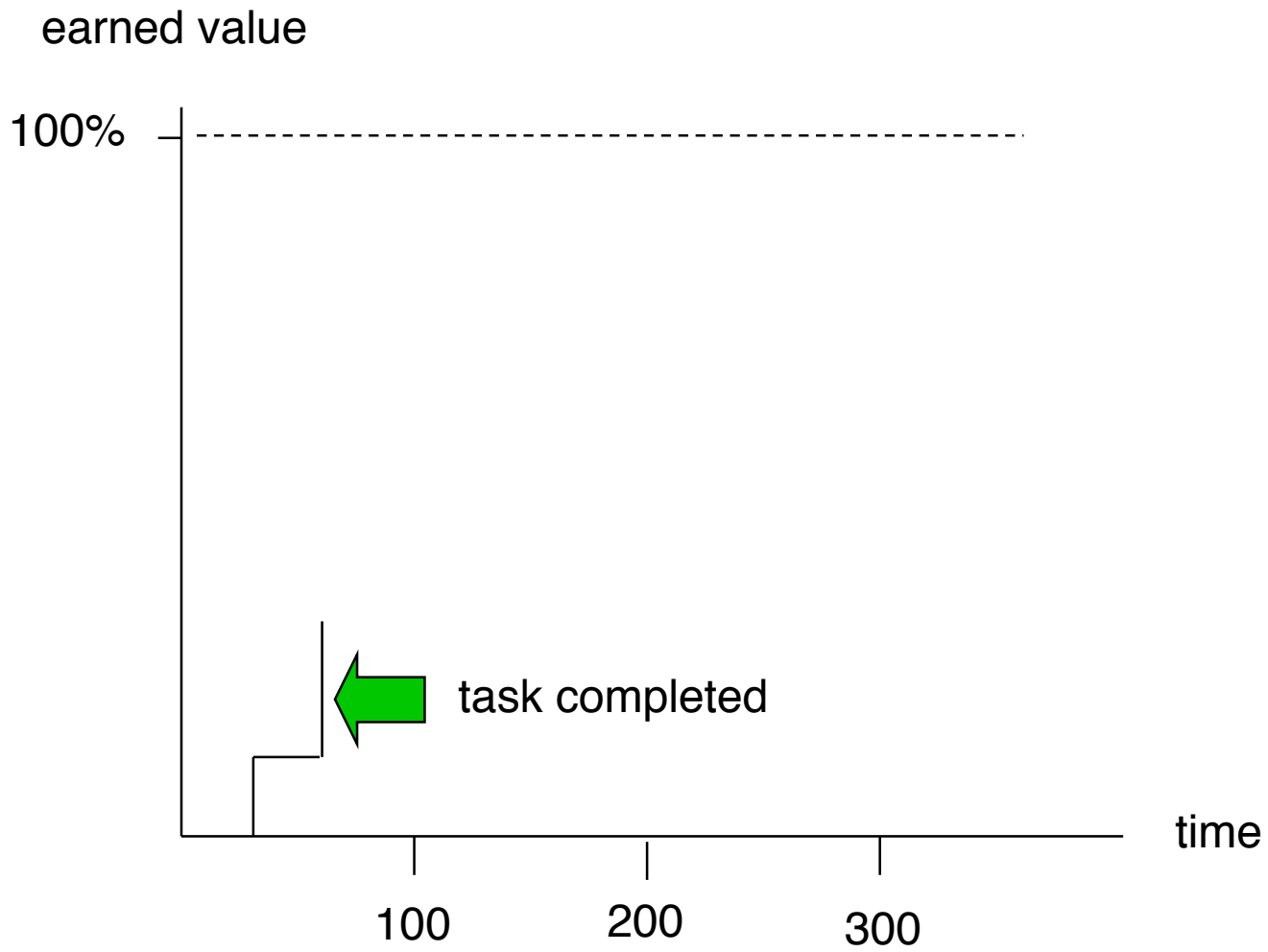
Earned-Value Tracking Method/Chart

- One way to track how close to "done" the project is:
  - As key parts of a product are **completed**, the product "earns value".
  - Express earned value in % of total value or $ (= % x budgeted amount for task)
  - Some variations allow **partial credit**, others don't.

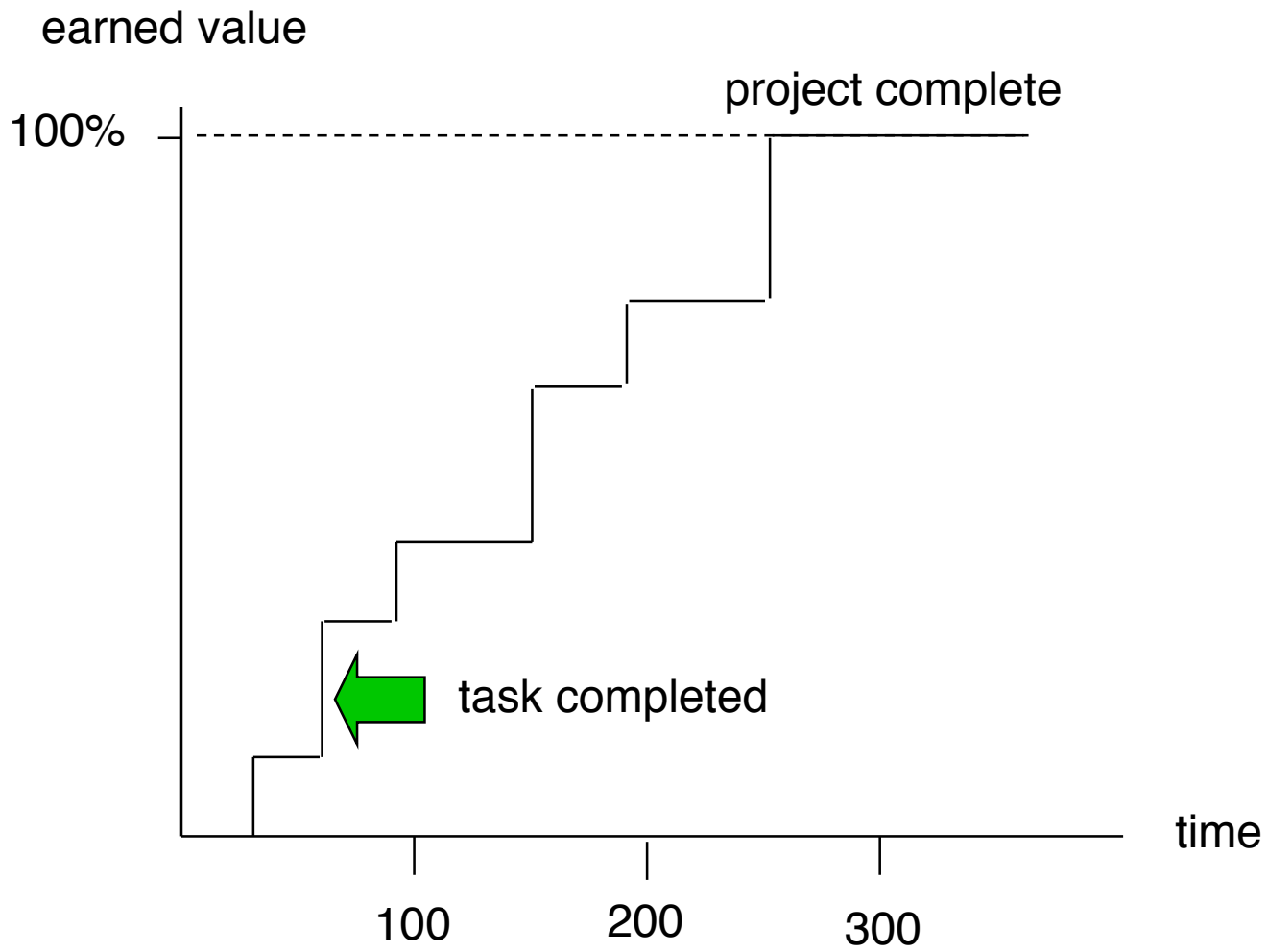
Earned Value vs. Time



Earned Value vs. Time



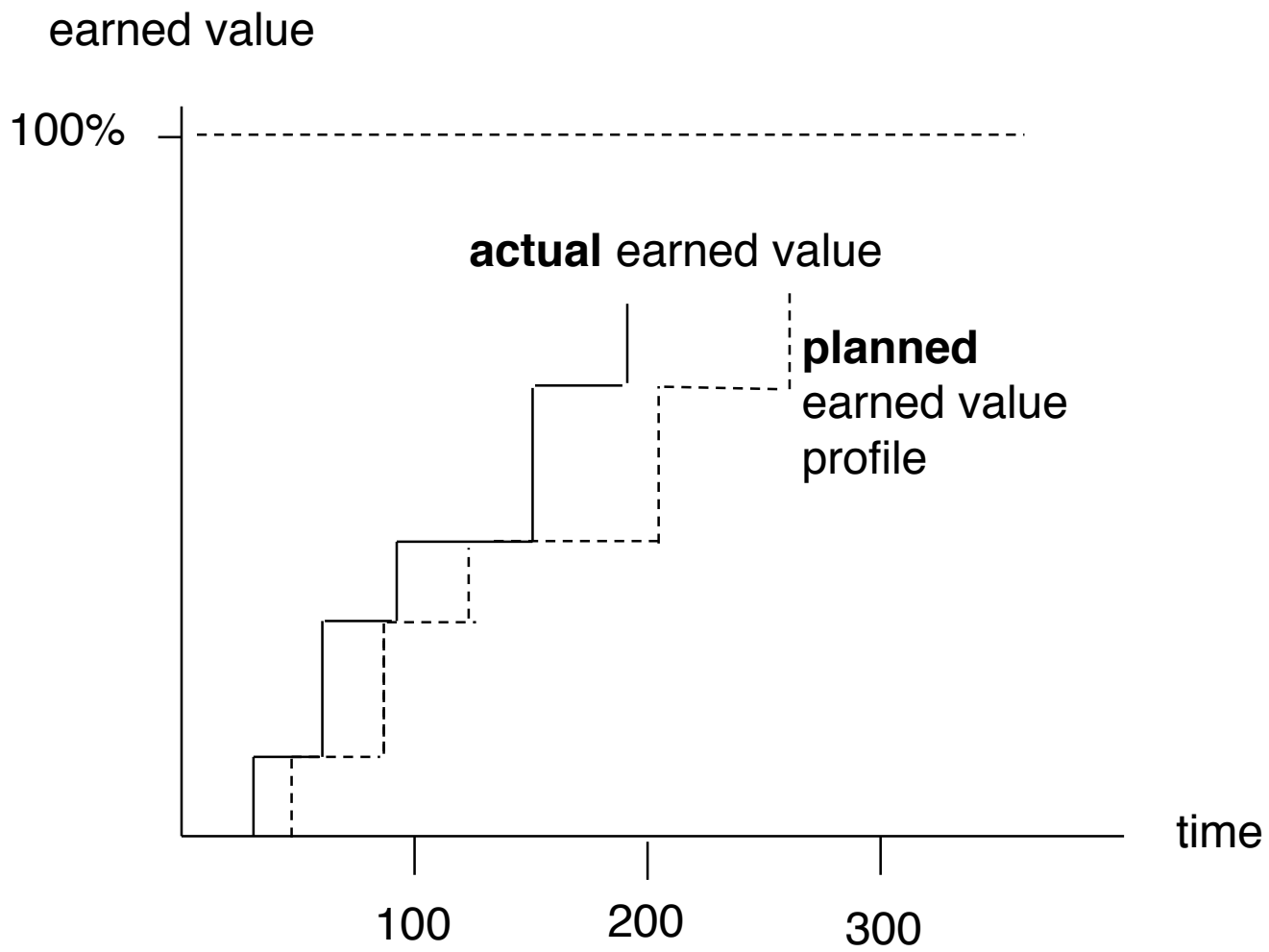
Earned Value vs. Time



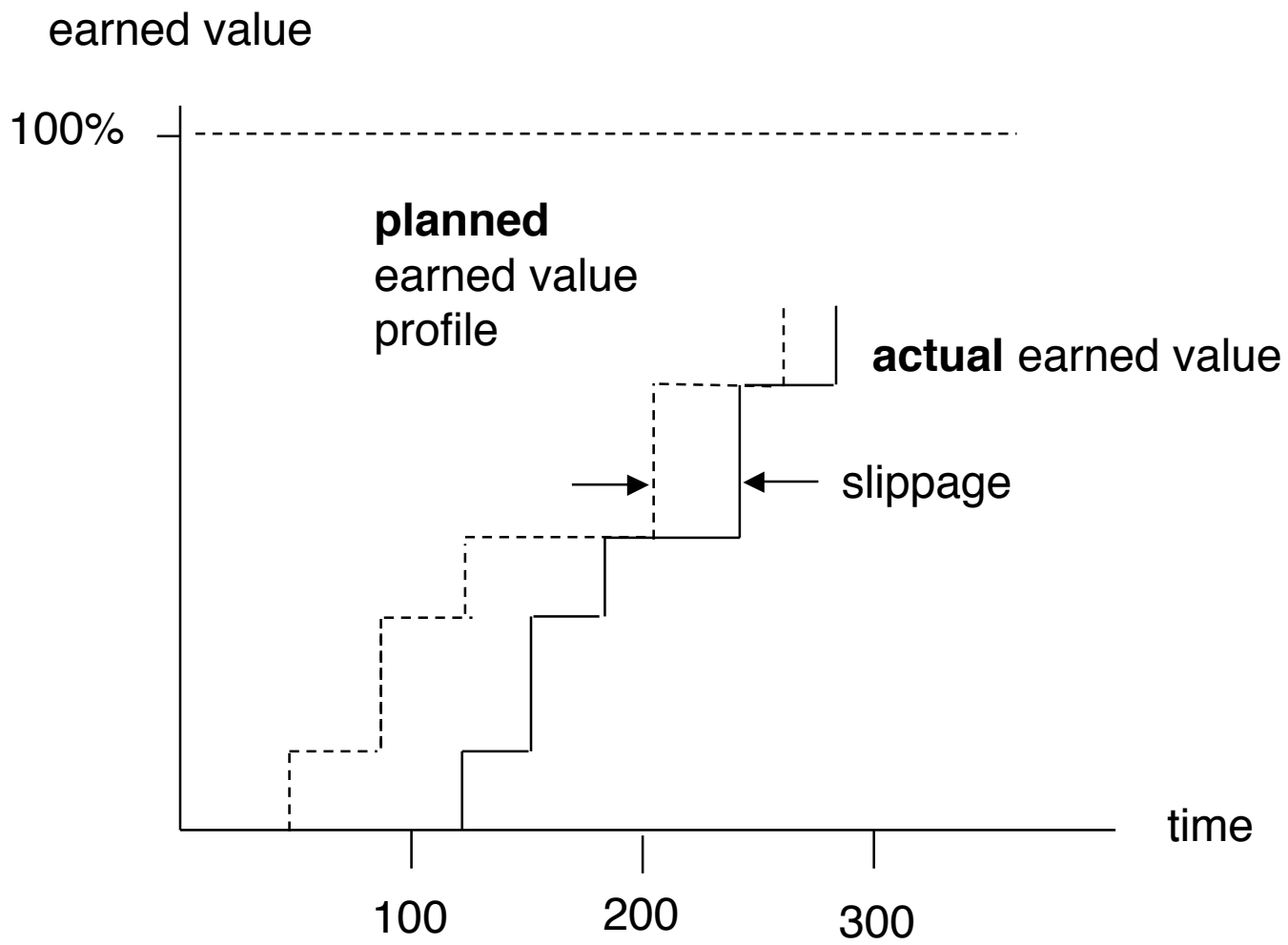
Use of Earned Value Diagram

- Based on project Gantt chart, create a profile **plan** of earned value
- Track **actual** earned value against plan
- Use **discrepancies** to make projections about delivery dates, cost, etc.

Project Ahead of Schedule

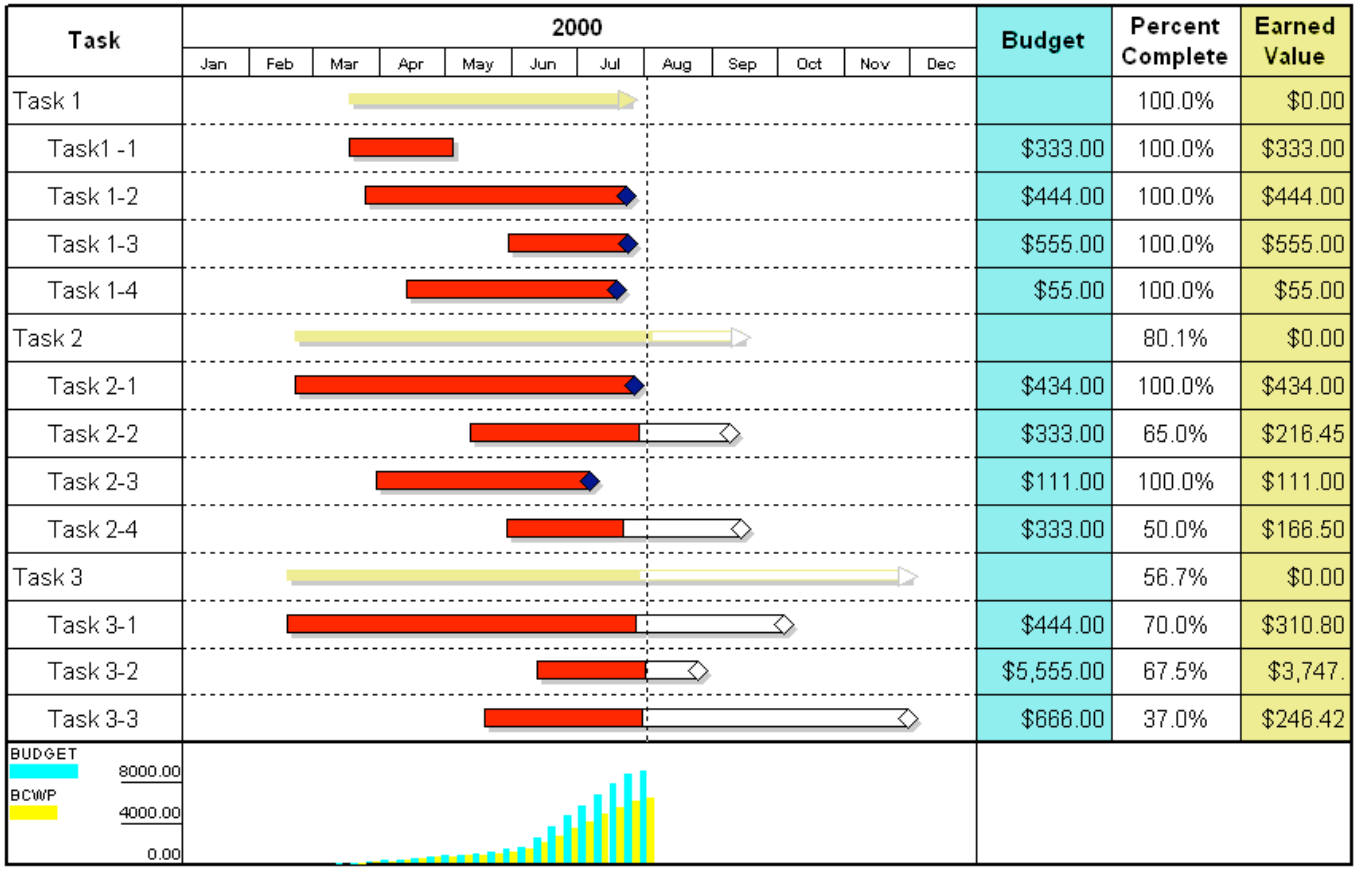


Project Behind Schedule



Earned Value with **sub-tasks** in $ (% x budget)

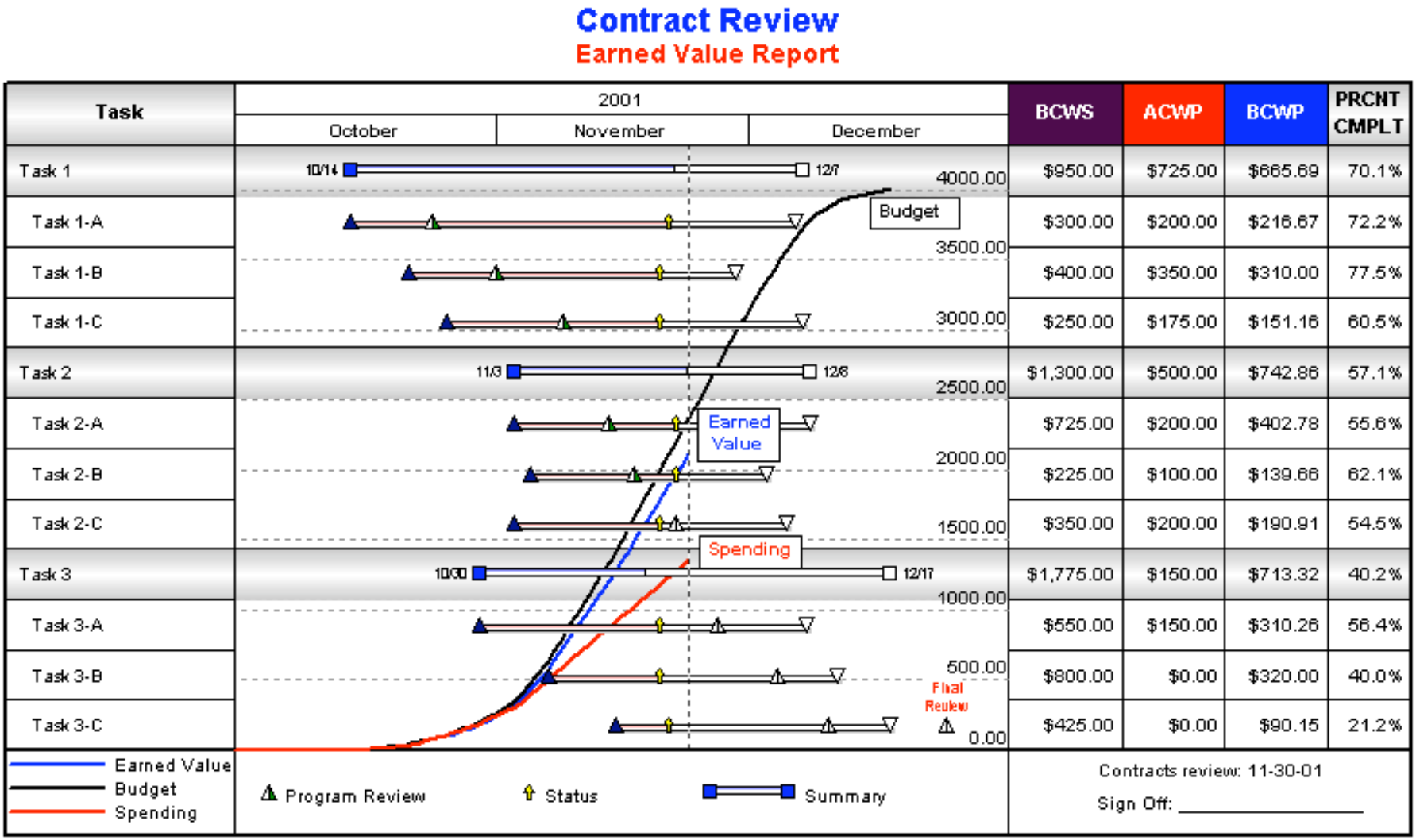
Earned Value Calculation Example



Task	Budget	Percent Complete	Earned Value
Task 1		100.0%	$0.00
Task1 -1	$333.00	100.0%	$333.00
Task 1-2	$444.00	100.0%	$444.00
Task 1-3	$555.00	100.0%	$555.00
Task 1-4	$55.00	100.0%	$55.00
Task 2		80.1%	$0.00
Task 2-1	$434.00	100.0%	$434.00
Task 2-2	$333.00	65.0%	$216.45
Task 2-3	$111.00	100.0%	$111.00
Task 2-4	$333.00	50.0%	$166.50
Task 3		56.7%	$0.00
Task 3-1	$444.00	70.0%	$310.80
Task 3-2	$5,555.00	67.5%	$3,747.
Task 3-3	$666.00	37.0%	$246.42

Example Gantt Chart with Earned Value Overlay

(source: http://www.kidasa.com/information/solutions/evalue/index.html)

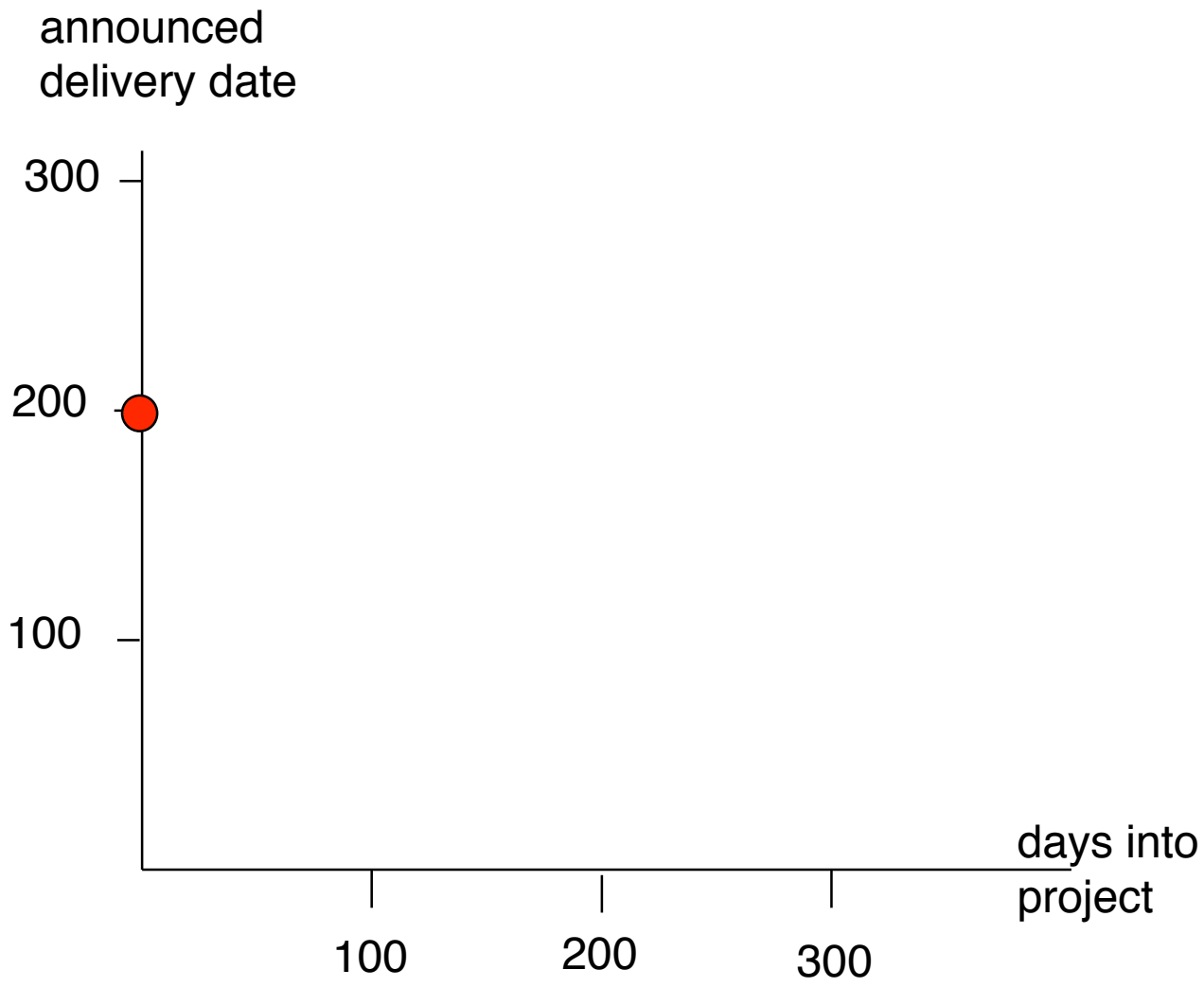


Implication of Slippage

- Slippage in earned value may imply slippage in delivery date,

  especially if the slipped task is on the critical path.

Slip Chart
(Dwayne Phillips)



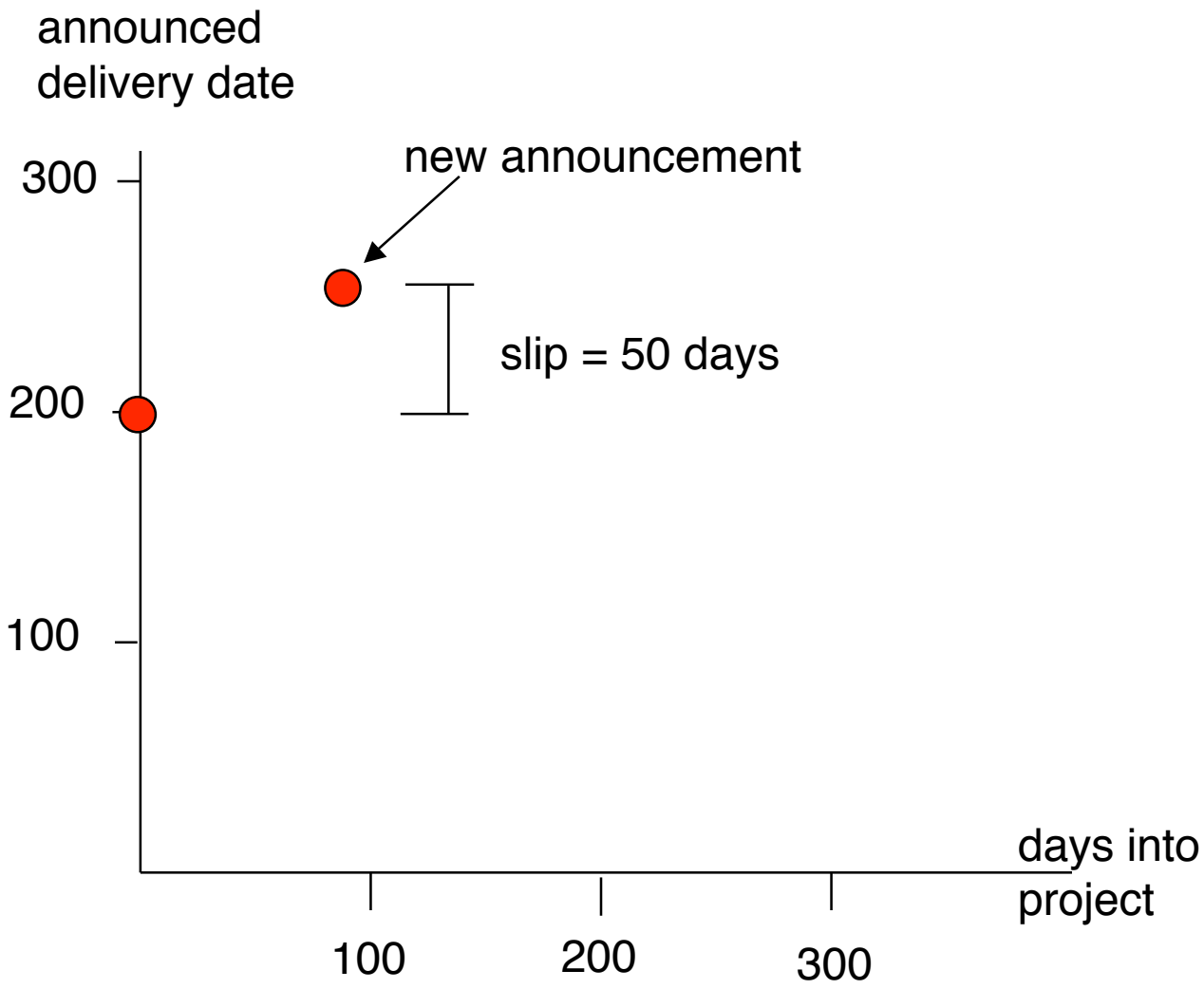
Slip Chart

slip = delivery date

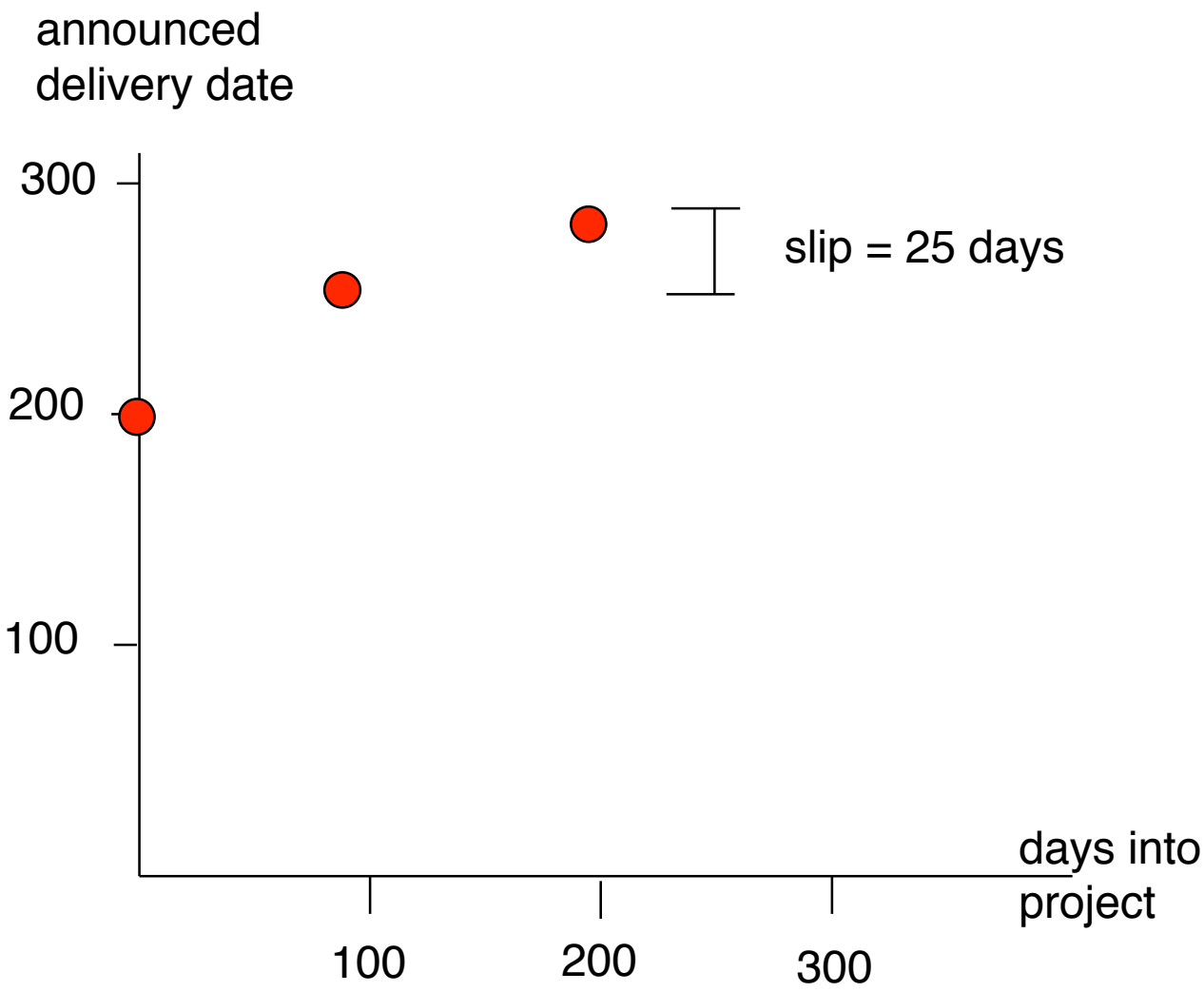
minus

previously announced

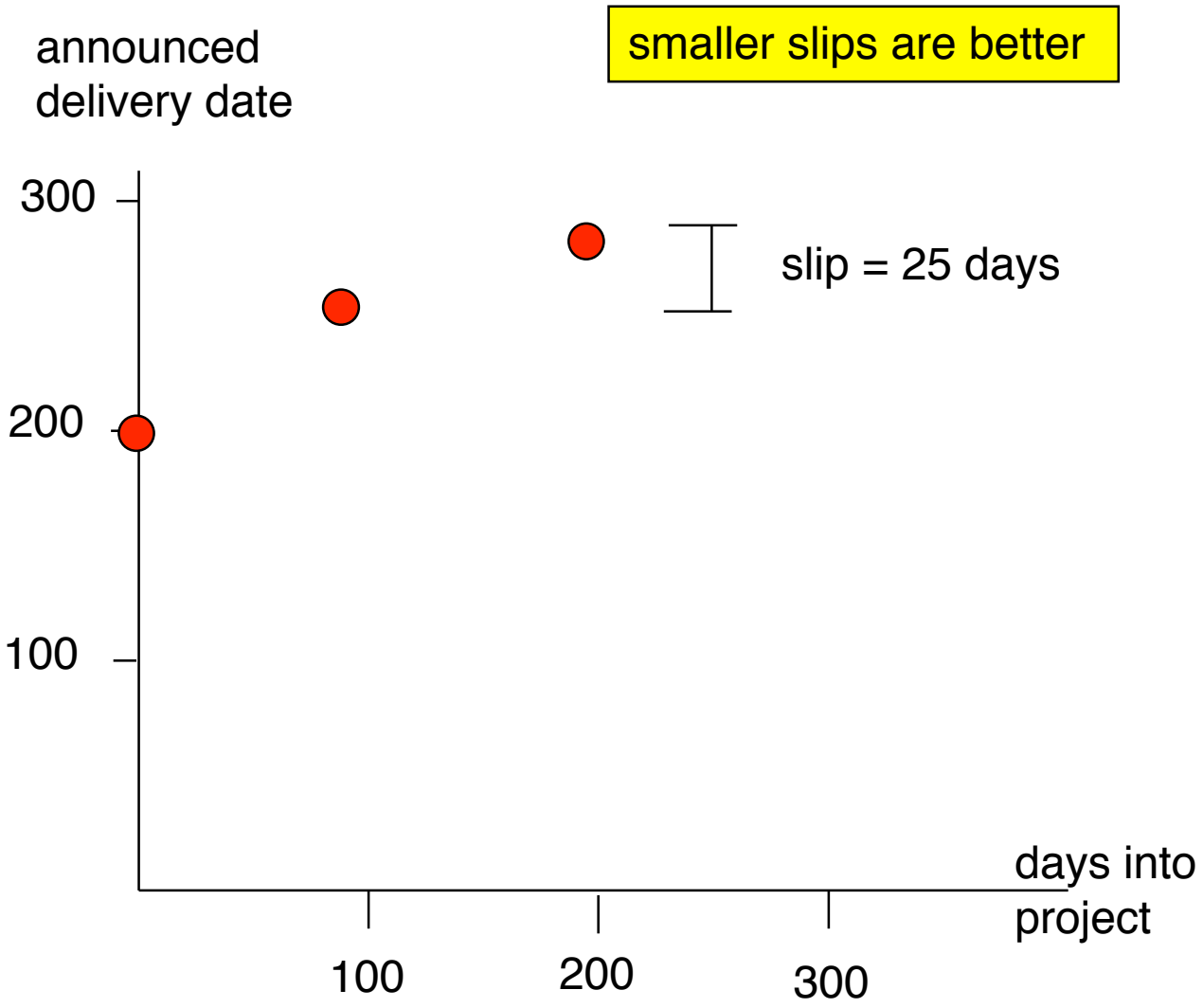
delivery date



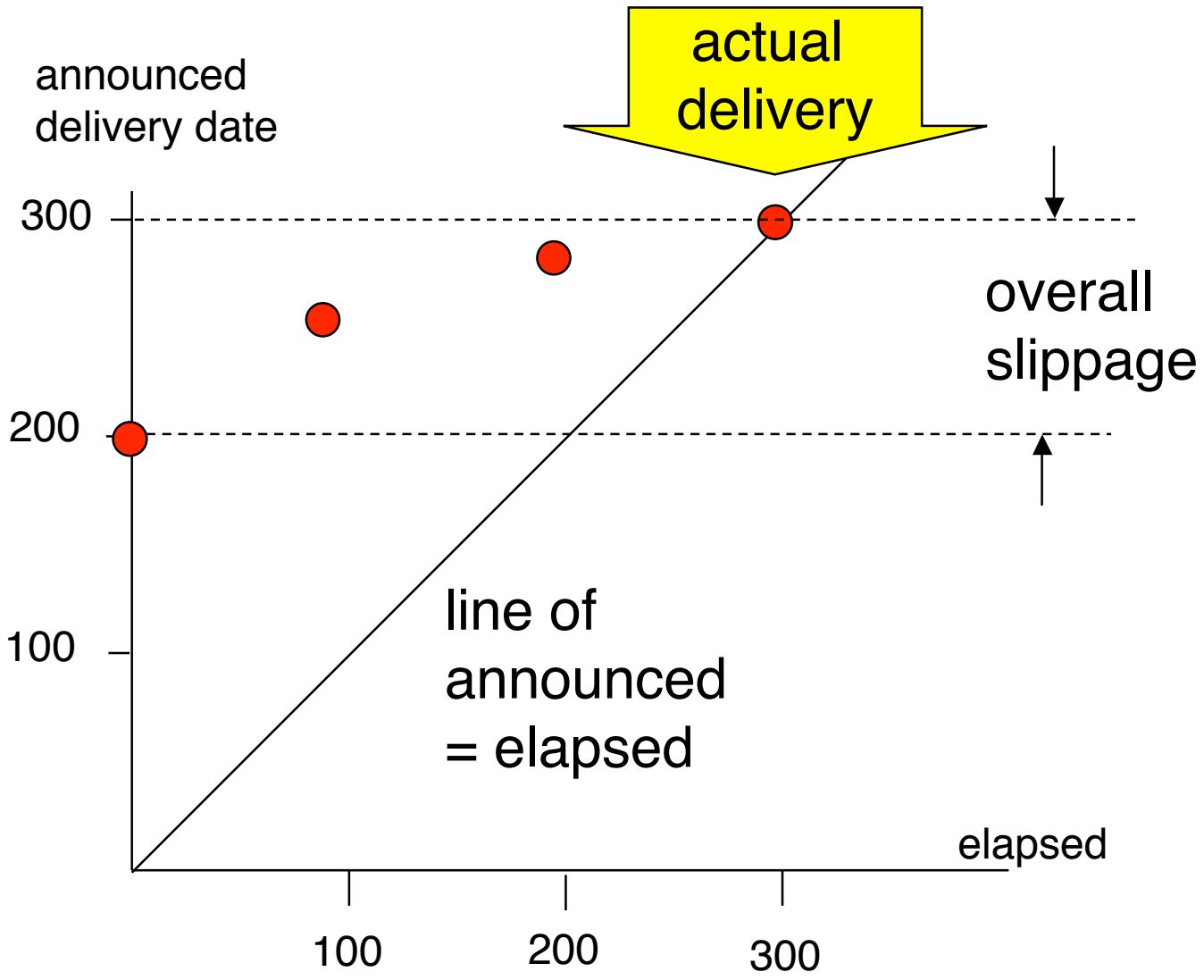
Slip Chart


announced
delivery date
300
200
100
slip = 25 days
days into
project
100
200
300

Slip Chart


announced
delivery date
smaller slips are better
300
200
100
slip = 25 days
days into
project
100
200
300

Slip Chart

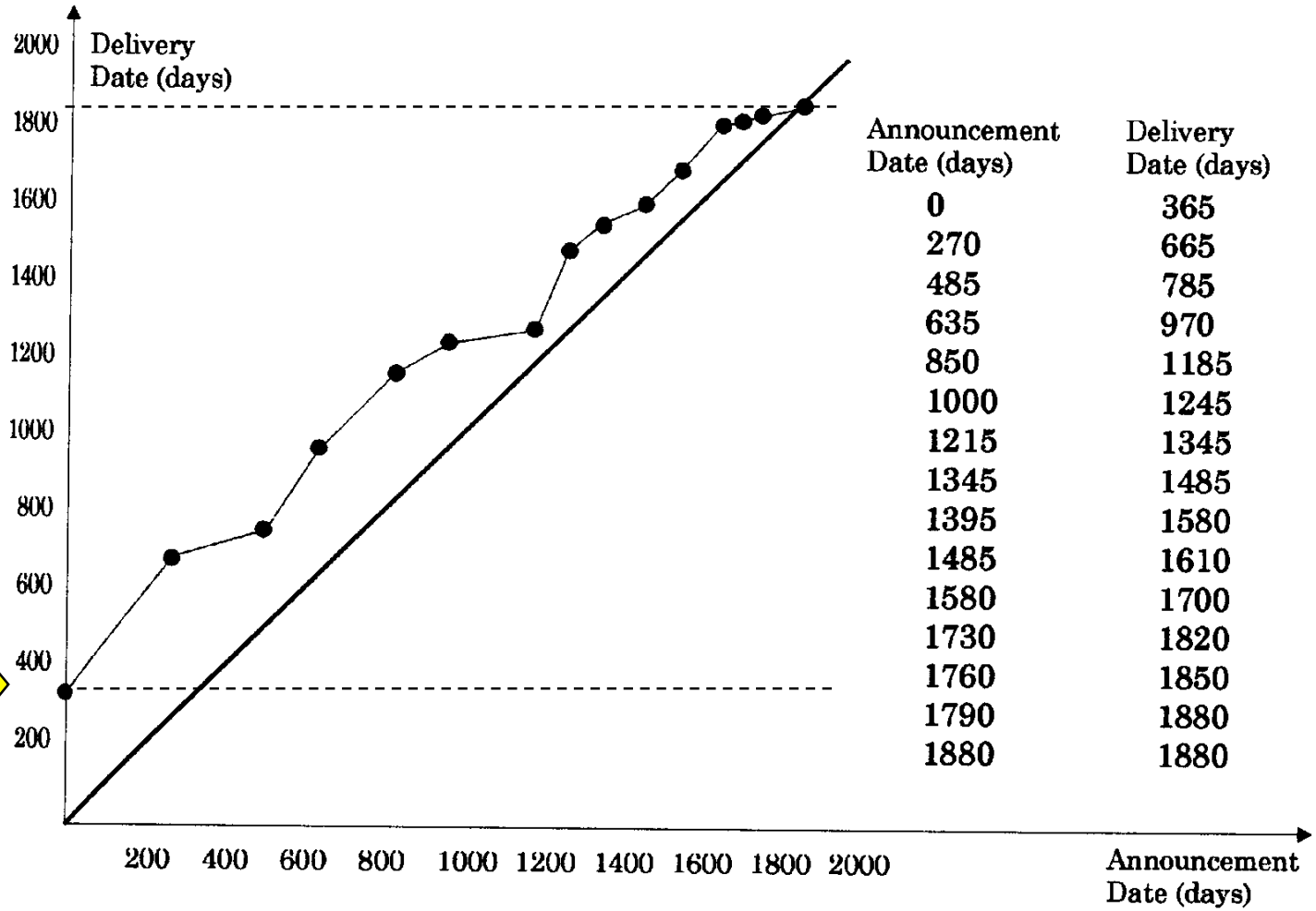

actual
delivery
announced
delivery date
300
200
100
overall
slippage
line of
announced
= elapsed
elapsed
100
200
300

Word for Windows 1.0 Slip

actual

1880
365
= 515%
net slip

original



Announcement Date (days)	Delivery Date (days)
0	365
270	665
485	785
635	970
850	1185
1000	1245
1215	1345
1345	1485
1395	1580
1485	1610
1580	1700
1730	1820
1760	1850
1790	1880
1880	1880

source: Dwayne Phillips, The software project manager's handbook, IEEE, 1998.

Slip vs. Lead

- slip = delivery date
  minus
  previously announced delivery date

- lead = previously announced delivery date
  minus
  date on which new delivery announced

Example of Lead

- lead = previously announced delivery date
  minus
  date on which new delivery announced

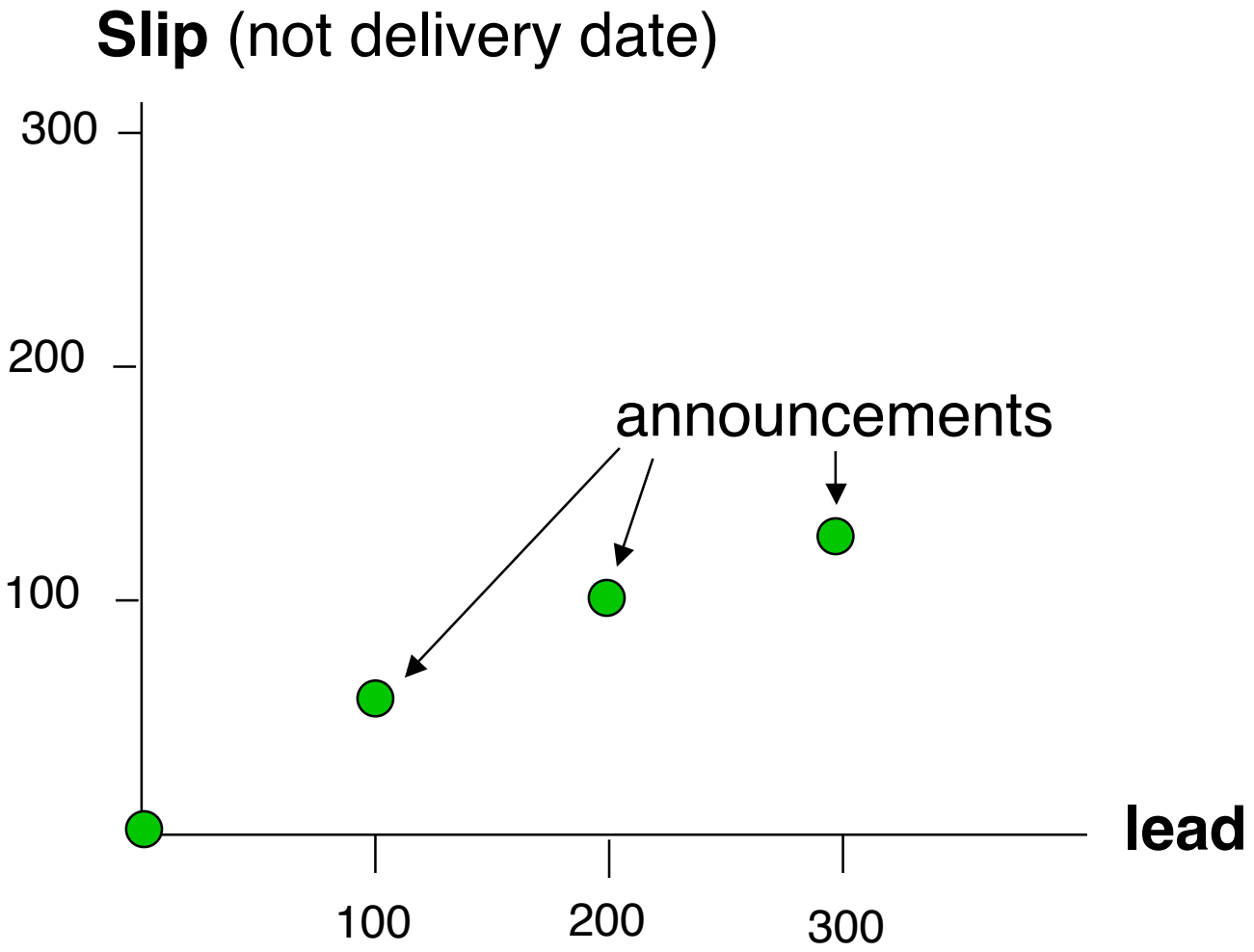
- Example:
  - Original delivery date = day **200**
  - On day **100** announce new delivery date:
    day 300: ***moderate* lead**

Example of Lead

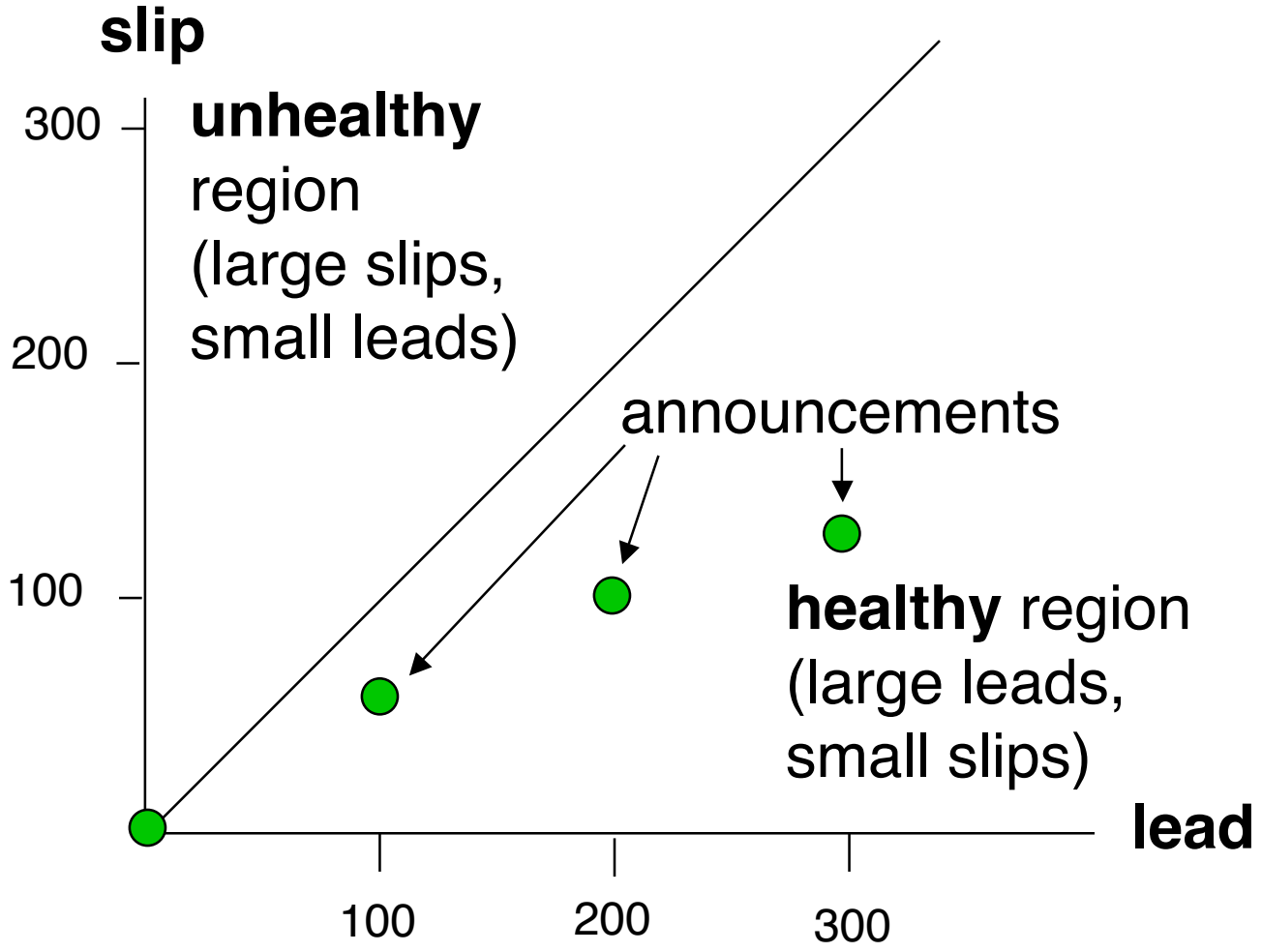
- lead = previously announced delivery date
  minus
  date on which new delivery announced

- Original delivery date = day **200**
- On day **195** announce new delivery date:
  day 300: very **small lead**
- **Small leads are bad** (but small slips are good)

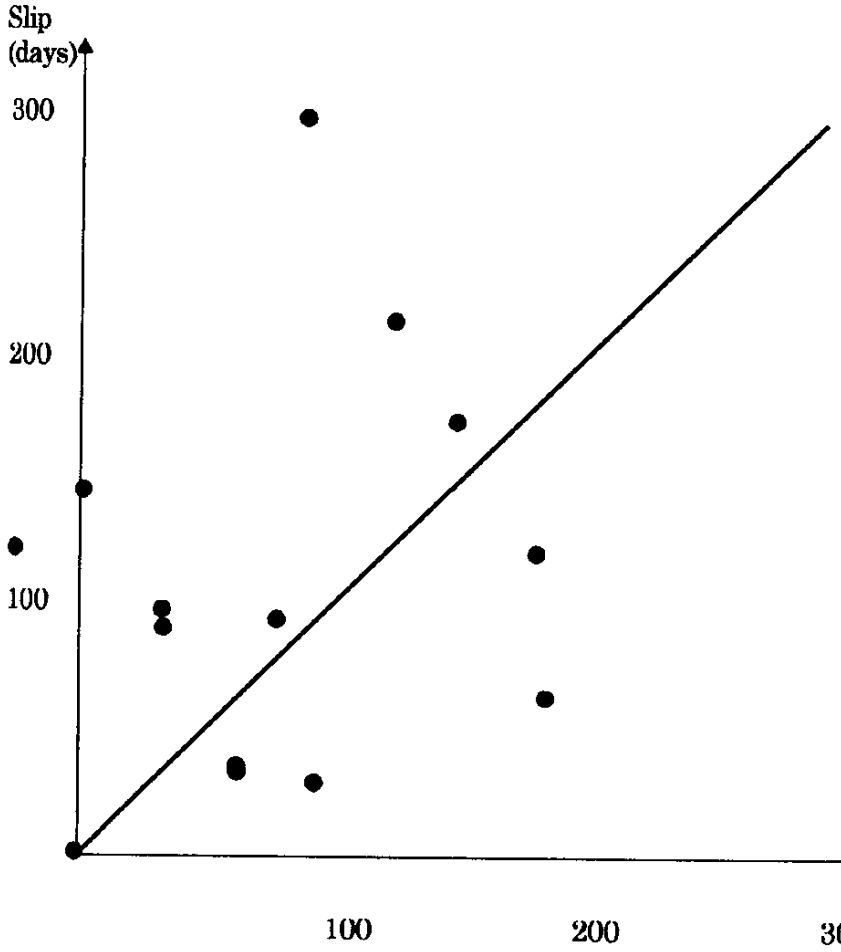
Slip-Lead Chart (plots slips vs. leads)



Slip-Lead Chart (plots slips vs. leads)



Word for Windows 1.0 Slip/Lead



Lead (days)	Slip (days)
95	300
180	120
150	185
120	215
185	60
30	100
0	140
70	95
95	30
30	90
-30	120
60	30
60	30
0	0

source: Dwayne Phillips, The software project manager's handbook, IEEE, 1998.