MnDOT Project Management Office Presents:

Collaborative Scheduling using the CPM Method

Presenter: Jonathan McNatty, PSP
Senior Schedule Consultant
DRMcNatty & Associates, Inc.

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- Lines will be muted during the webinar
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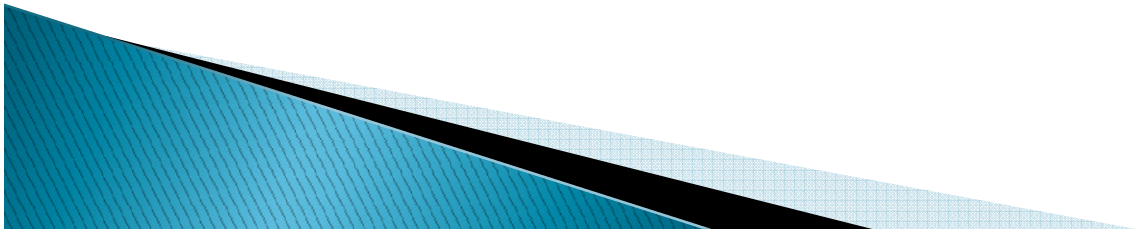

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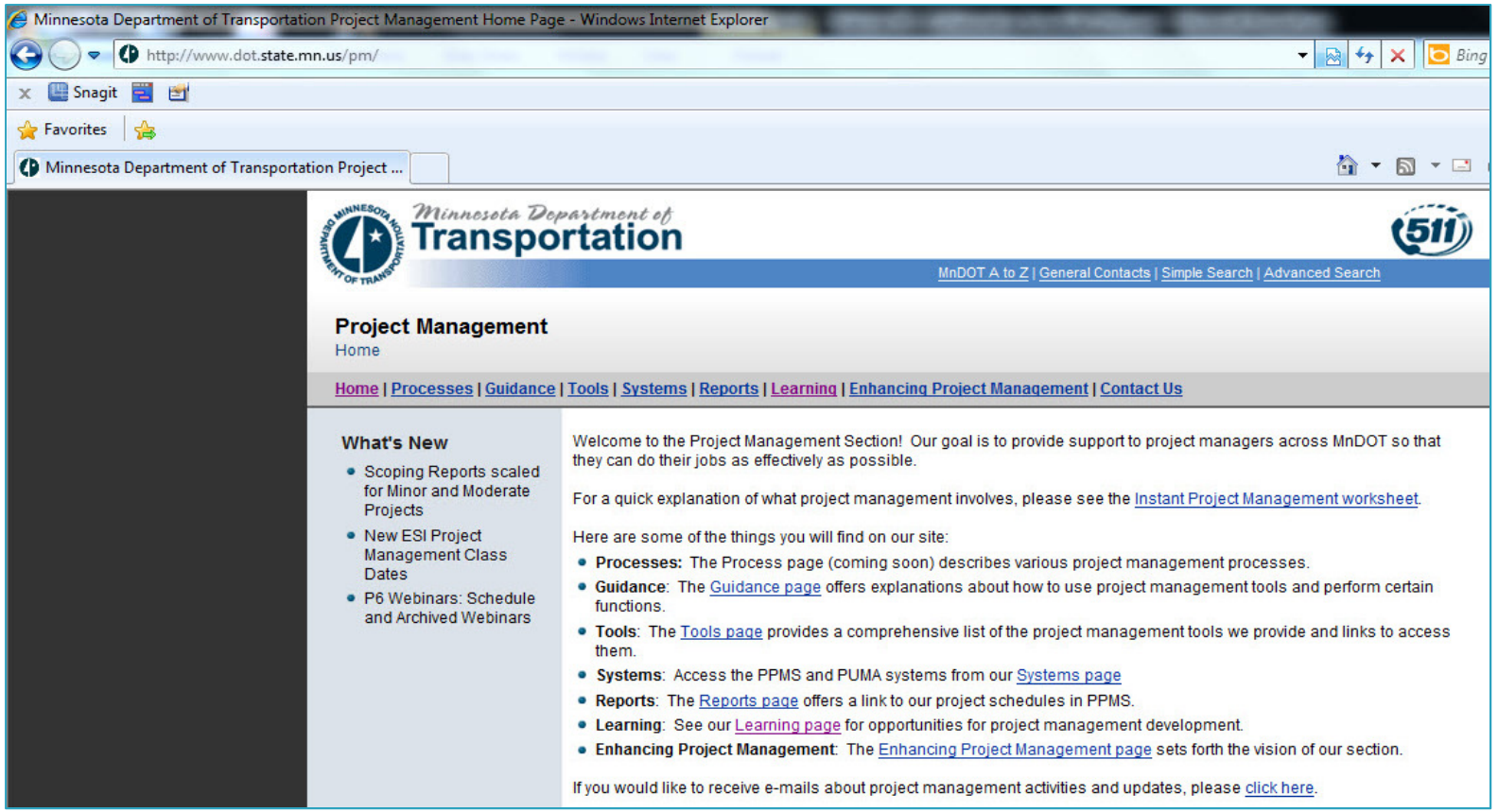

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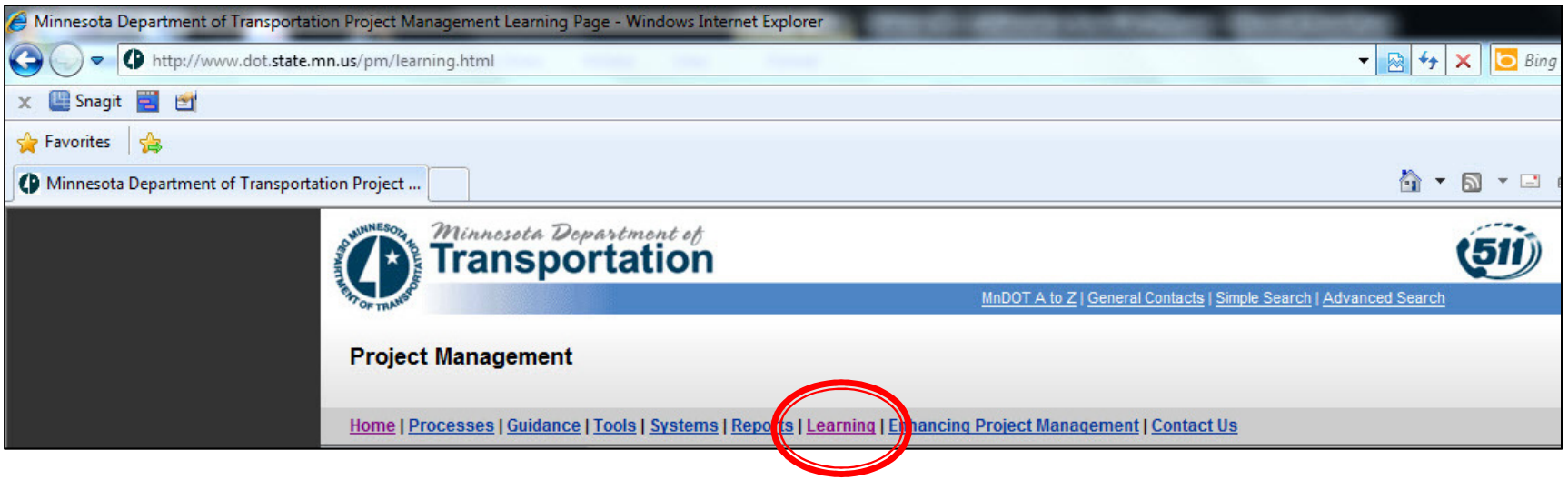

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MnDOT Webinars

Primavera P6 Webinars: Each webinar will start at 1:00 p.m. and last 1/2 hour. Click the links below to register for a session. After each webinar, a recording will be made available from this page.

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The Future of MnDOT Project Controls	March [illegible], 2013	View Project Controls Presentation (13:51 wmv 17 MB)
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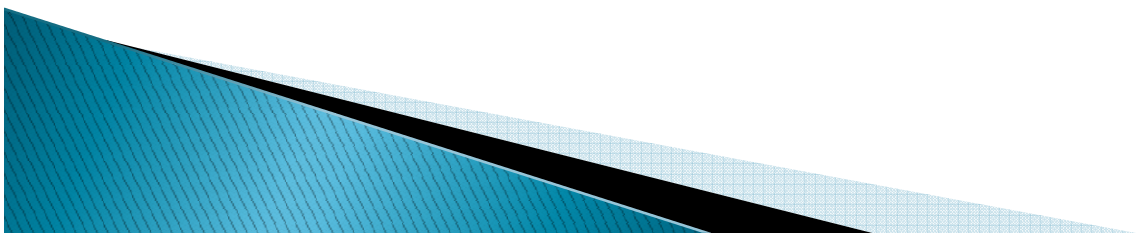
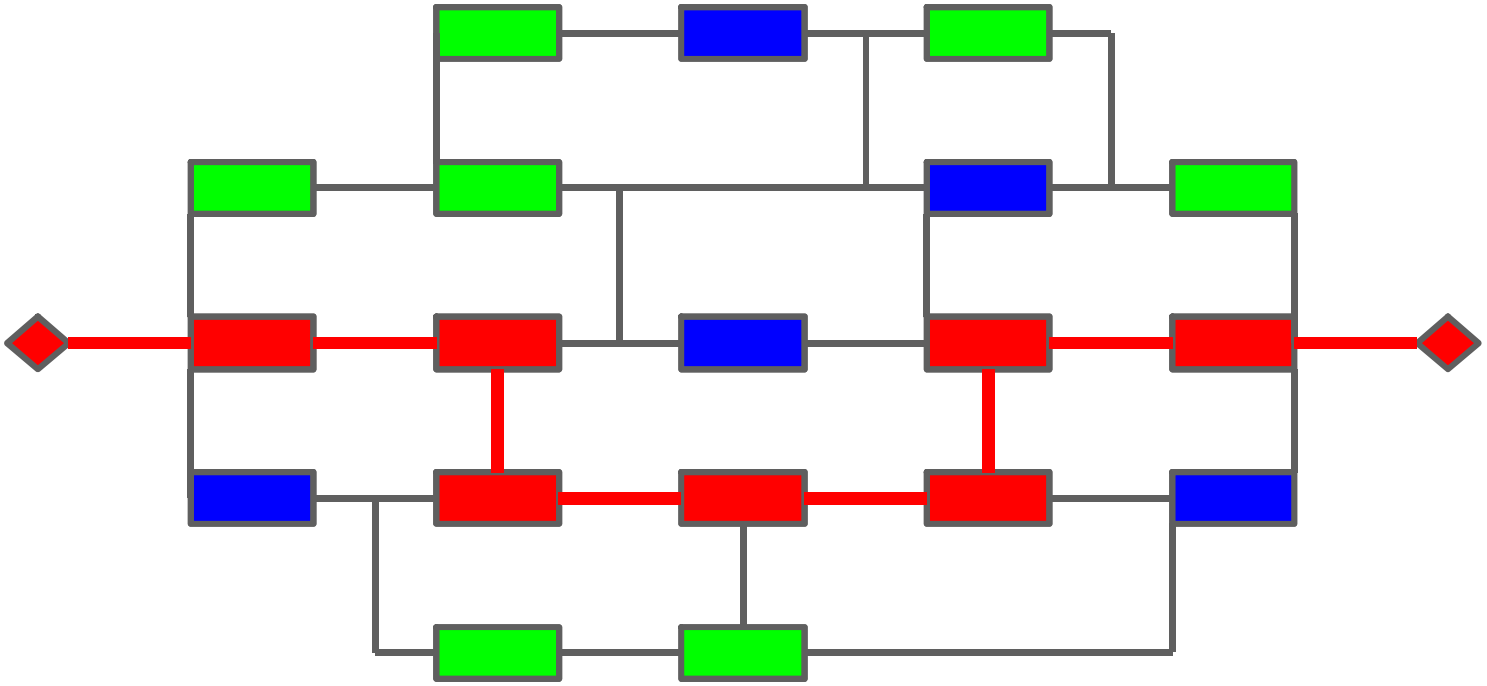
Introduction to Webinar

Get a basic understanding of Critical Path Method (CPM) Scheduling. CPM uses activity durations and relationships between activities to calculate schedule dates.



What is CPM Scheduling?



CPM – Critical Path Method

- The Critical Path Method (CPM) scheduling technique is utilized to calculate project schedules. CPM uses activity durations and relationships between activities to calculate schedule dates.

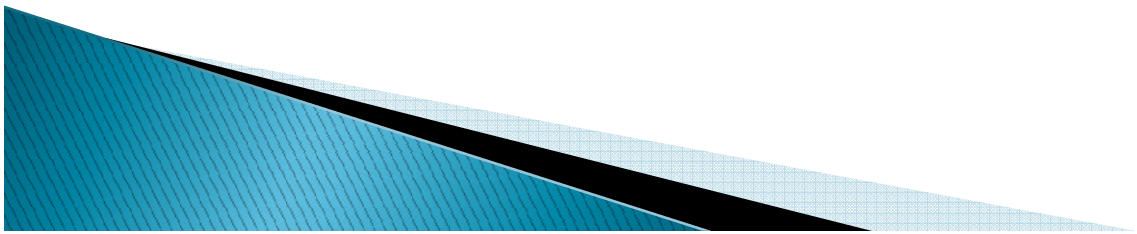
- The critical path is the series of activities that determines a project's completion date.

- The duration of the activities on the critical path controls the duration of the entire project. A delay to any of these activities will delay the Finish date of the entire project.

- Critical activities are typically defined by “Total Float” or “Longest Path” in Primavera P6.

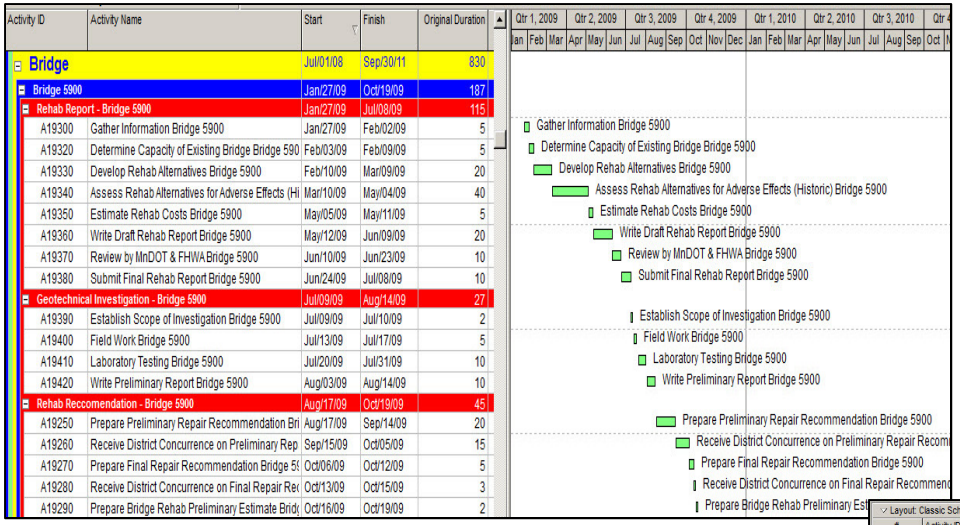
What Purpose do CPM Schedules Serve?

- Track Progress over Time
- Identify Interfaces among Functional Groups
- Communicate the Schedule Plan to Project Stakeholders
- Management tool to evaluate Risk
- Analyze Resource Utilization
- Forecast Completion (Dates/Resources/Costs)



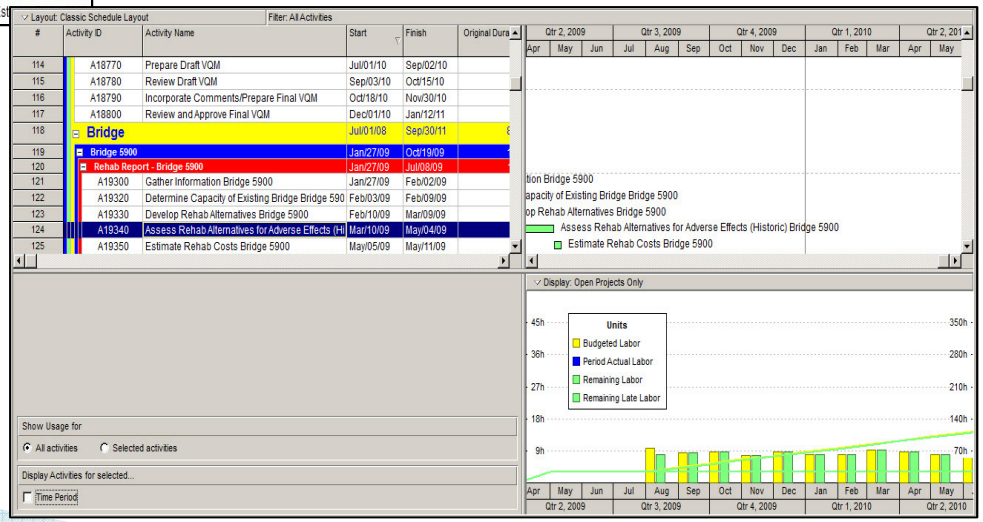
CPM Components

Activity Network



Activity ID	Activity Name	Start	Finish	Original Duration
Bridge		Jul/01/08	Sep/30/11	830
Bridge 5900		Jan/27/09	Oct/19/09	187
Rehab Report - Bridge 5900		Jan/27/09	Jul/08/09	115
A19300	Gather Information Bridge 5900	Jan/27/09	Feb/02/09	5
A19320	Determine Capacity of Existing Bridge Bridge 590	Feb/03/09	Feb/09/09	5
A19330	Develop Rehab Alternatives Bridge 5900	Feb/10/09	Mar/09/09	20
A19340	Assess Rehab Alternatives for Adverse Effects (Hi	Mar/10/09	May/04/09	40
A19350	Estimate Rehab Costs Bridge 5900	May/05/09	May/11/09	5
A19360	Write Draft Rehab Report Bridge 5900	May/12/09	Jun/09/09	20
A19370	Review by MnDOT & FHWA Bridge 5900	Jun/10/09	Jun/23/09	10
A19380	Submit Final Rehab Report Bridge 5900	Jun/24/09	Jul/08/09	10
Geotechnical Investigation - Bridge 5900		Jul/09/09	Aug/14/09	27
A19390	Establish Scope of Investigation Bridge 5900	Jul/09/09	Jul/10/09	2
A19400	Field Work Bridge 5900	Jul/13/09	Jul/17/09	5
A19410	Laboratory Testing Bridge 5900	Jul/20/09	Jul/31/09	10
A19420	Write Preliminary Report Bridge 5900	Aug/03/09	Aug/14/09	10
Rehab Reccomendation - Bridge 5900		Aug/17/09	Oct/19/09	45
A19250	Prepare Preliminary Repair Recommendation Bri	Aug/17/09	Sep/14/09	20
A19260	Receive District Concurrence on Preliminary Rep	Sep/15/09	Oct/05/09	15
A19270	Prepare Final Repair Recommendation Bridge 5	Oct/06/09	Oct/12/09	5
A19280	Receive District Concurrence on Final Repair Re	Oct/13/09	Oct/15/09	3
A19290	Prepare Bridge Rehab Preliminary Estimate Brid	Oct/16/09	Oct/19/09	2

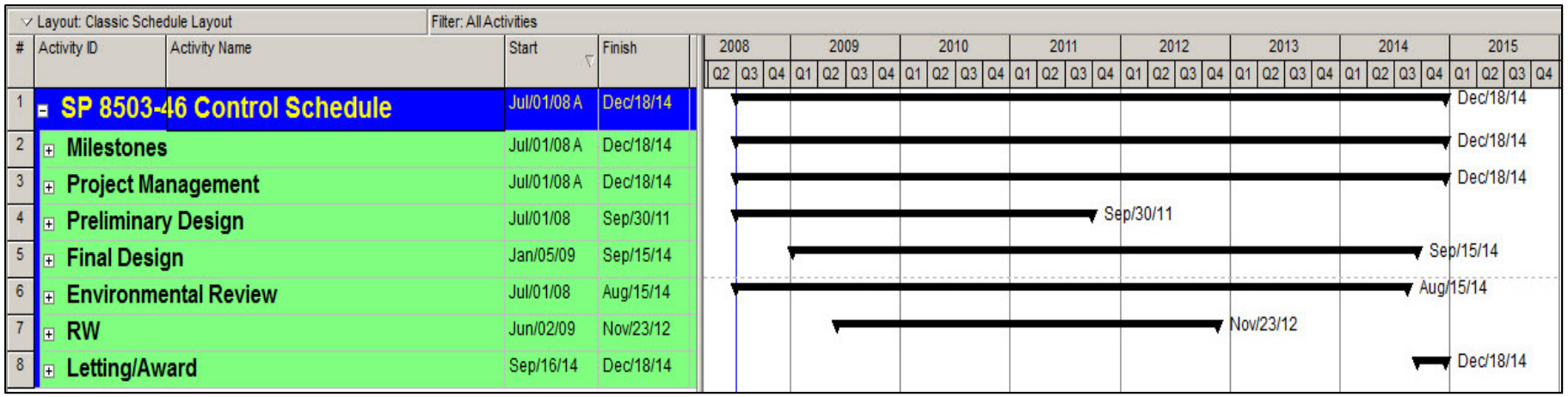
Resource Profile



#	Activity ID	Activity Name	Start	Finish	Original Dura
114	A18770	Prepare Draft VQM	Jul/01/10	Sep/02/10	
115	A18780	Review Draft VQM	Sep/03/10	Oct/15/10	
116	A18790	Incorporate Comments/Prepare Final VQM	Oct/18/10	Nov/30/10	
117	A18800	Review and Approve Final VQM	Dec/01/10	Jan/12/11	
118	Bridge		Jul/01/08	Sep/30/11	
119	Bridge 5900		Jan/27/09	Oct/19/09	
120	Rehab Report - Bridge 5900		Jan/27/09	Jul/08/09	
121	A19300	Gather Information Bridge 5900	Jan/27/09	Feb/02/09	
122	A19320	Determine Capacity of Existing Bridge Bridge 590	Feb/03/09	Feb/09/09	
123	A19330	Develop Rehab Alternatives Bridge 5900	Feb/10/09	Mar/09/09	
124	A19340	Assess Rehab Alternatives for Adverse Effects (Hi	Mar/10/09	May/04/09	
125	A19350	Estimate Rehab Costs Bridge 5900	May/05/09	May/11/09	

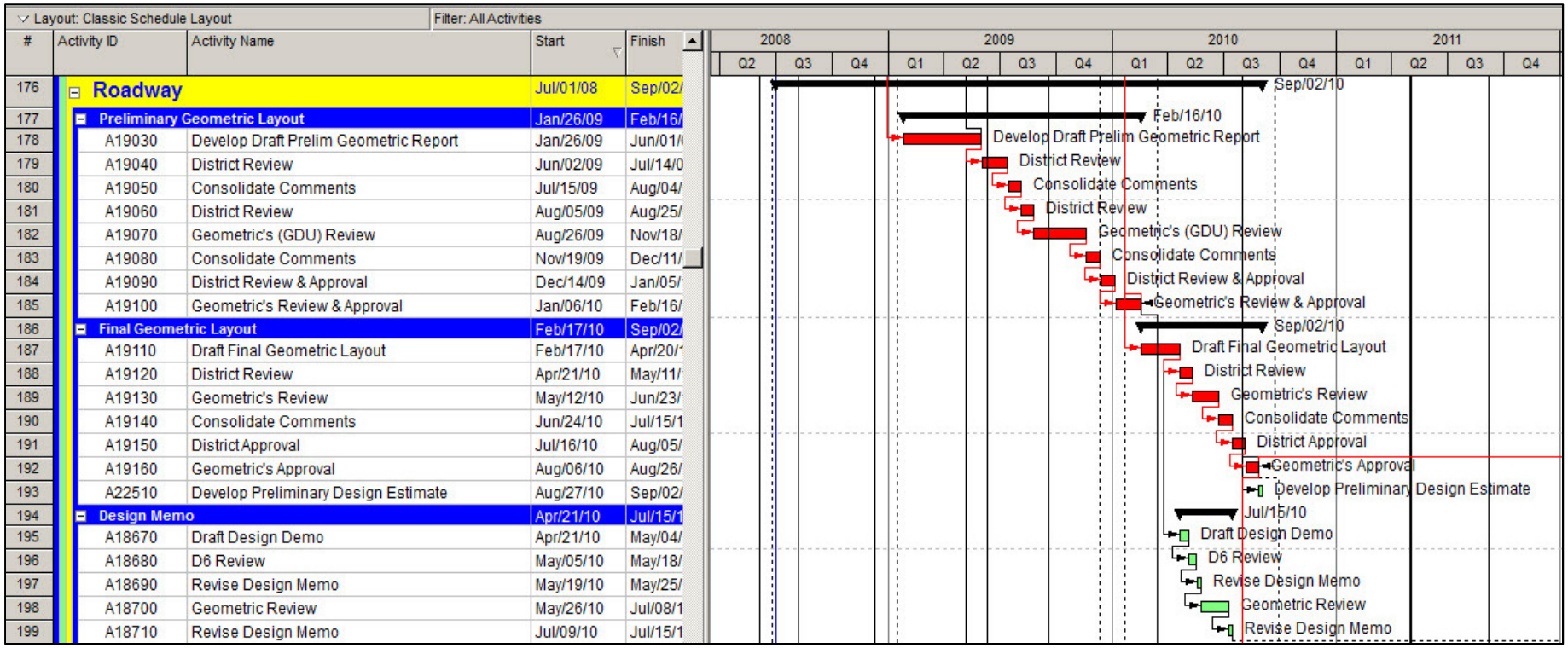
Types of Schedules

- SUMMARY SCHEDULE
  - Provides Rolled-Up View



Types of Schedules

- DETAILED SCEHDULE
  - Shows Activities/Relationships/Sequence of Work



Layout: Classic Schedule Layout | Filter: All Activities

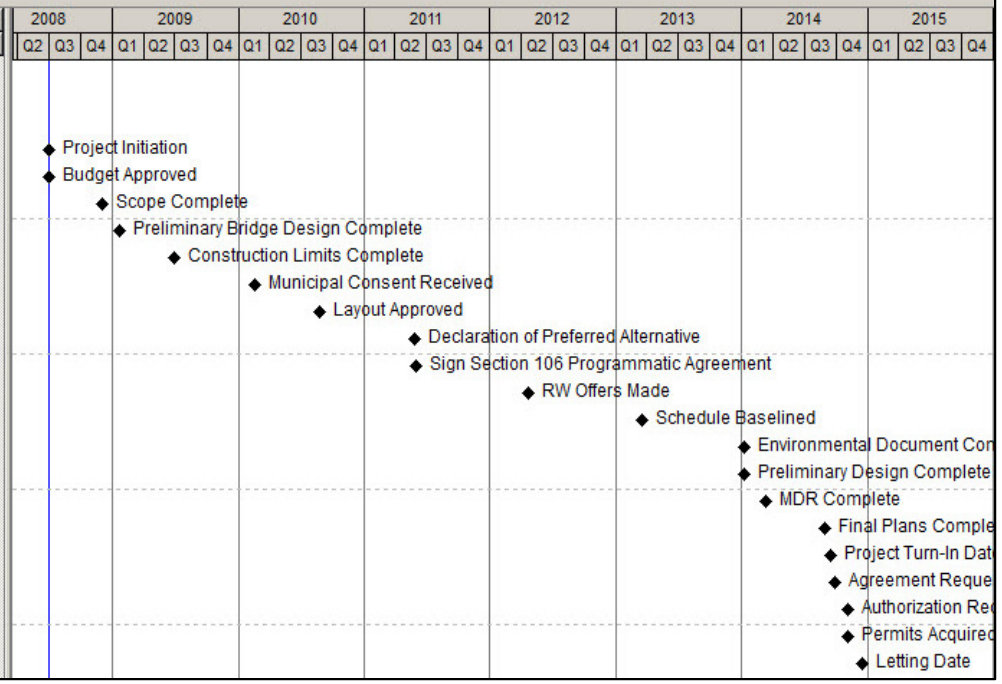
#	Activity ID	Activity Name	Start	Finish
176		**Roadway**	Jul/01/08	Sep/02/
177		**Preliminary Geometric Layout**	Jan/26/09	Feb/16/
178	A19030	Develop Draft Prelim Geometric Report	Jan/26/09	Jun/01/
179	A19040	District Review	Jun/02/09	Jul/14/0
180	A19050	Consolidate Comments	Jul/15/09	Aug/04/
181	A19060	District Review	Aug/05/09	Aug/25/
182	A19070	Geometric's (GDU) Review	Aug/26/09	Nov/18/
183	A19080	Consolidate Comments	Nov/19/09	Dec/11/
184	A19090	District Review & Approval	Dec/14/09	Jan/05/
185	A19100	Geometric's Review & Approval	Jan/06/10	Feb/16/
186		**Final Geometric Layout**	Feb/17/10	Sep/02/
187	A19110	Draft Final Geometric Layout	Feb/17/10	Apr/20/1
188	A19120	District Review	Apr/21/10	May/11/
189	A19130	Geometric's Review	May/12/10	Jun/23/
190	A19140	Consolidate Comments	Jun/24/10	Jul/15/1
191	A19150	District Approval	Jul/16/10	Aug/05/
192	A19160	Geometric's Approval	Aug/06/10	Aug/26/
193	A22510	Develop Preliminary Design Estimate	Aug/27/10	Sep/02/
194		**Design Memo**	Apr/21/10	Jul/15/1
195	A18670	Draft Design Demo	Apr/21/10	May/04/
196	A18680	D6 Review	May/05/10	May/18/
197	A18690	Revise Design Memo	May/19/10	May/25/
198	A18700	Geometric Review	May/26/10	Jul/08/1
199	A18710	Revise Design Memo	Jul/09/10	Jul/15/1

Types of Schedules

- MILESTONE SCHEDULE
  - KPI – Key Project Indicators

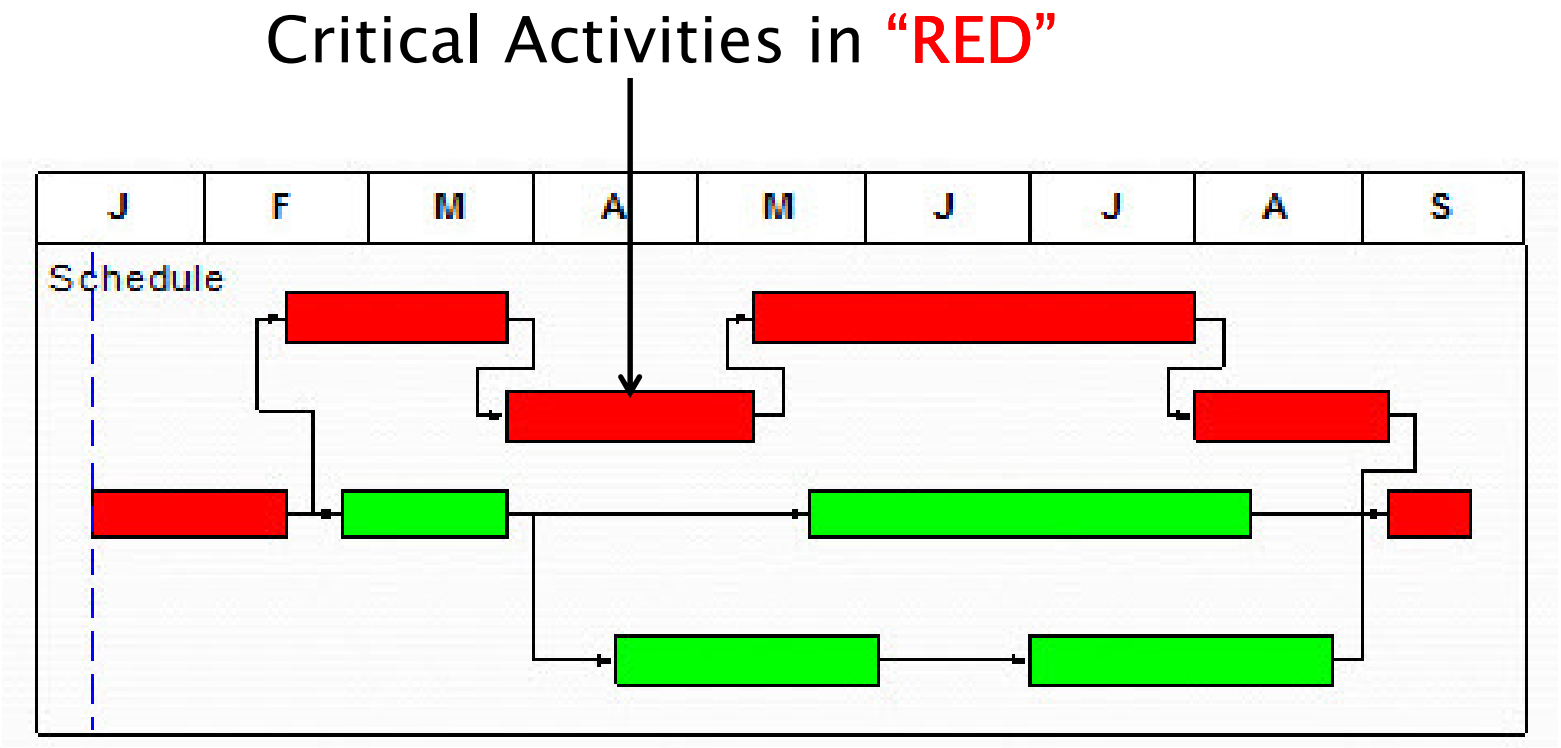
Layout: Classic Schedule Layout | Filter: All Activities

#	Activity ID	Activity Name	Start	Finish
1		SP 8503-46 Control Schedule	Jul/01/08 A	Dec/18/14
2		Milestones	Jul/01/08 A	Dec/18/14
3	MS_1000	Project Initiation	Jul/01/08 A	
4	MS_1020	Budget Approved		Jul/01/08
5	MS_1010	Scope Complete		Dec/01/08 A
6	MS_1040	Preliminary Bridge Design Complete		Jan/20/09
7	MS_1050	Construction Limits Complete		Jun/29/09
8	MS_1060	Municipal Consent Received		Feb/16/10
9	MS_1070	Layout Approved		Aug/26/10
10	MS_1793	Declaration of Preferred Alternative		May/27/11
11	MS_2122	Sign Section 106 Programmatic Agreement	May/30/11	
12	MS_1080	RW Offers Made		Apr/19/12
13	MS_1030	Schedule Baselined		Mar/18/13*
14	MS_1090	Environmental Document Complete		Jan/06/14
15	MS_1796	Preliminary Design Complete		Jan/06/14
16	MS_1100	MDR Complete		Mar/12/14
17	MS_1110	Final Plans Complete		Aug/29/14
18	MS_1120	Project Turn-In Date		Sep/15/14
19	MS_1130	Agreement Request Submitted		Sep/29/14
20	MS_1140	Authorization Received		Nov/03/14
21	MS_1150	Permits Acquired		Nov/03/14
22	MS_1160	Letting Date		Dec/18/14



CPM Schedule Activities

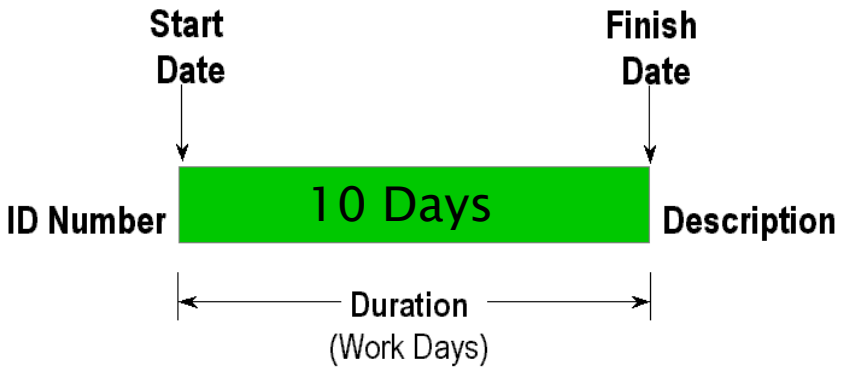
- The Critical Path activities will display Red in the CPM Network



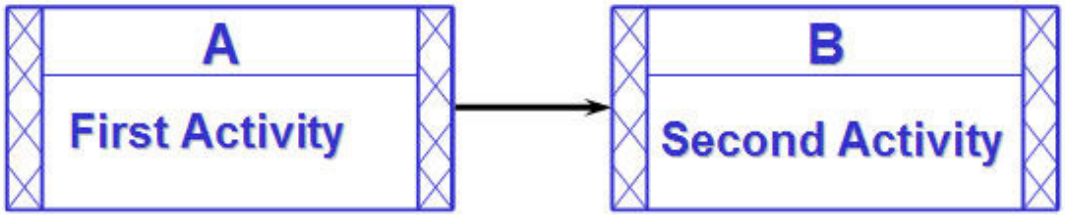
How Do Activities Become Critical!

- CPM uses activity durations and relationships between activities to calculate schedule dates.

Activities

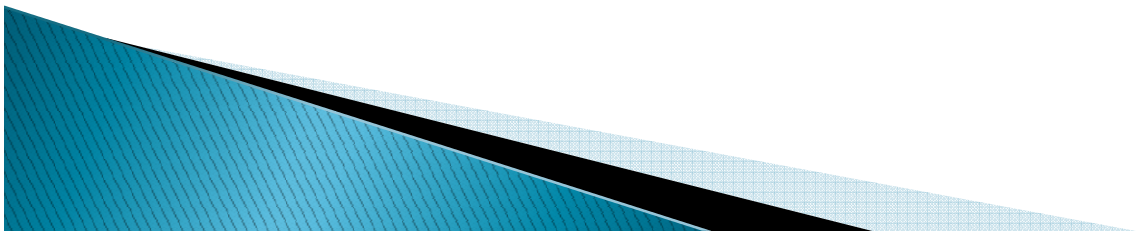


Activity Relationships



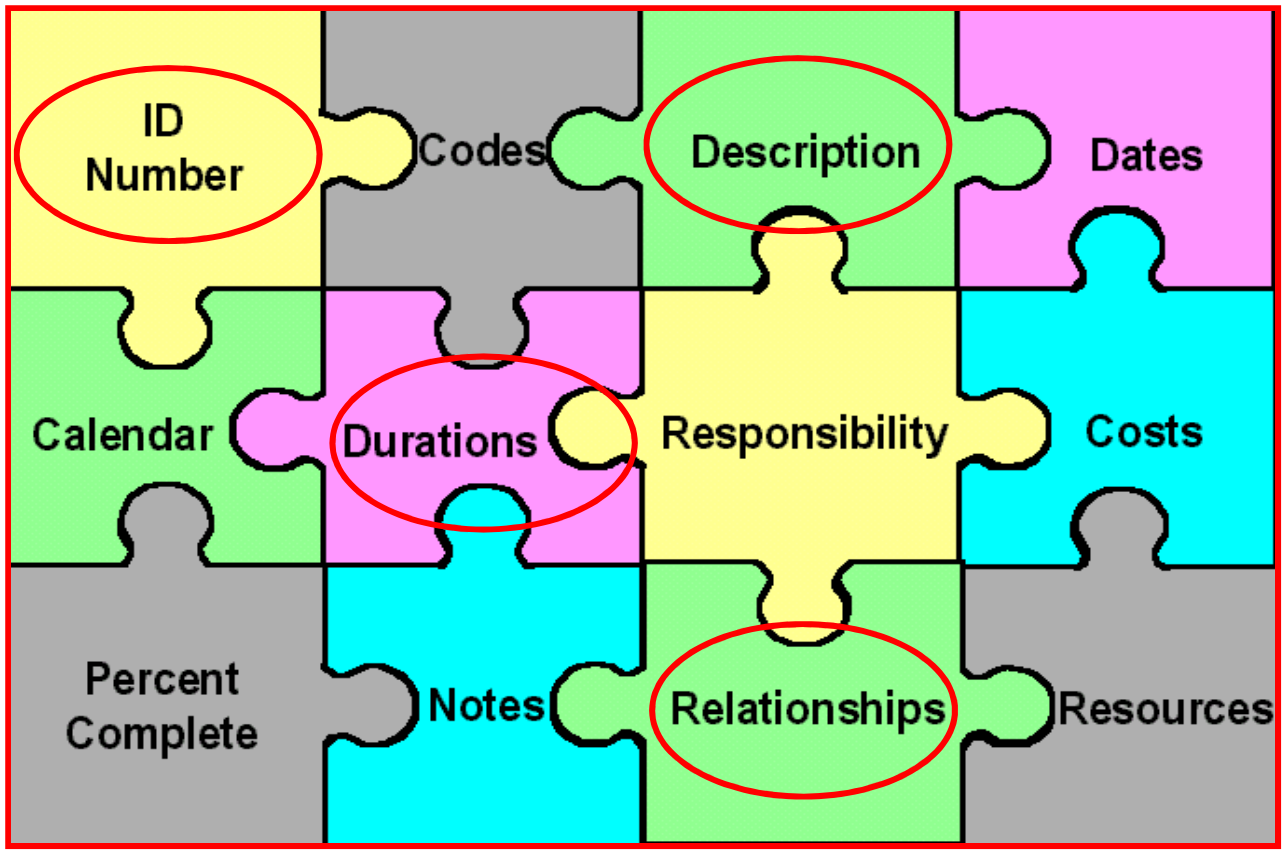
What do Schedule Activities Represent

- Fundamental Work Element in a Project
- Most detailed work unit tracked in a project schedule
- Contains all information about the work to be performed
- Also know as a task, item, event, or work package



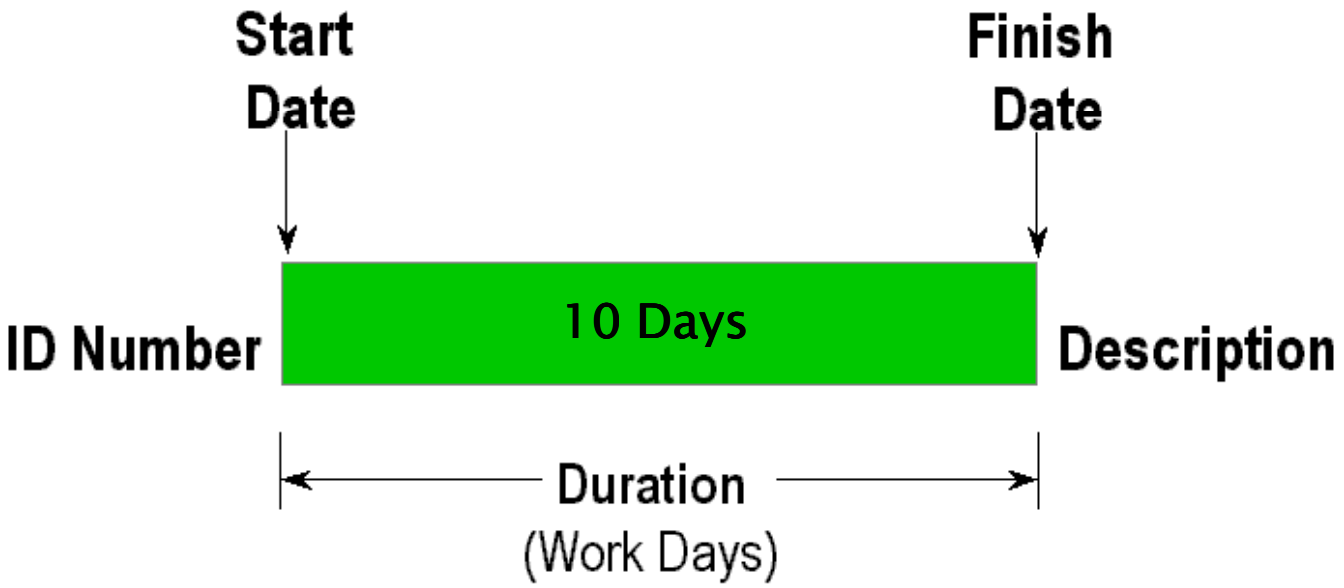
Activity Components

- Minimum Requirements for an Activity



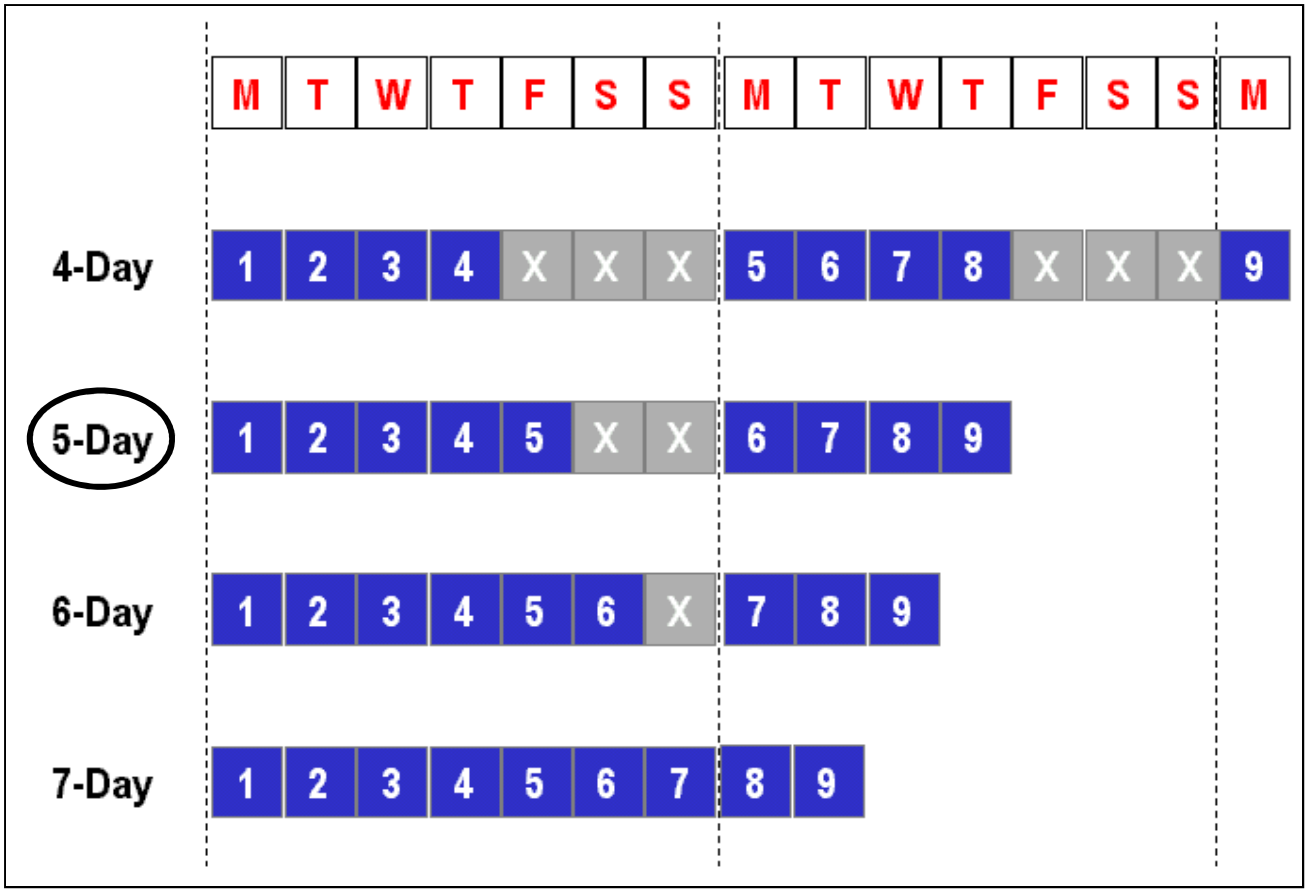
Activity Components

- Activities have unique information
- Activities can be part of Filters & Layouts for Reporting



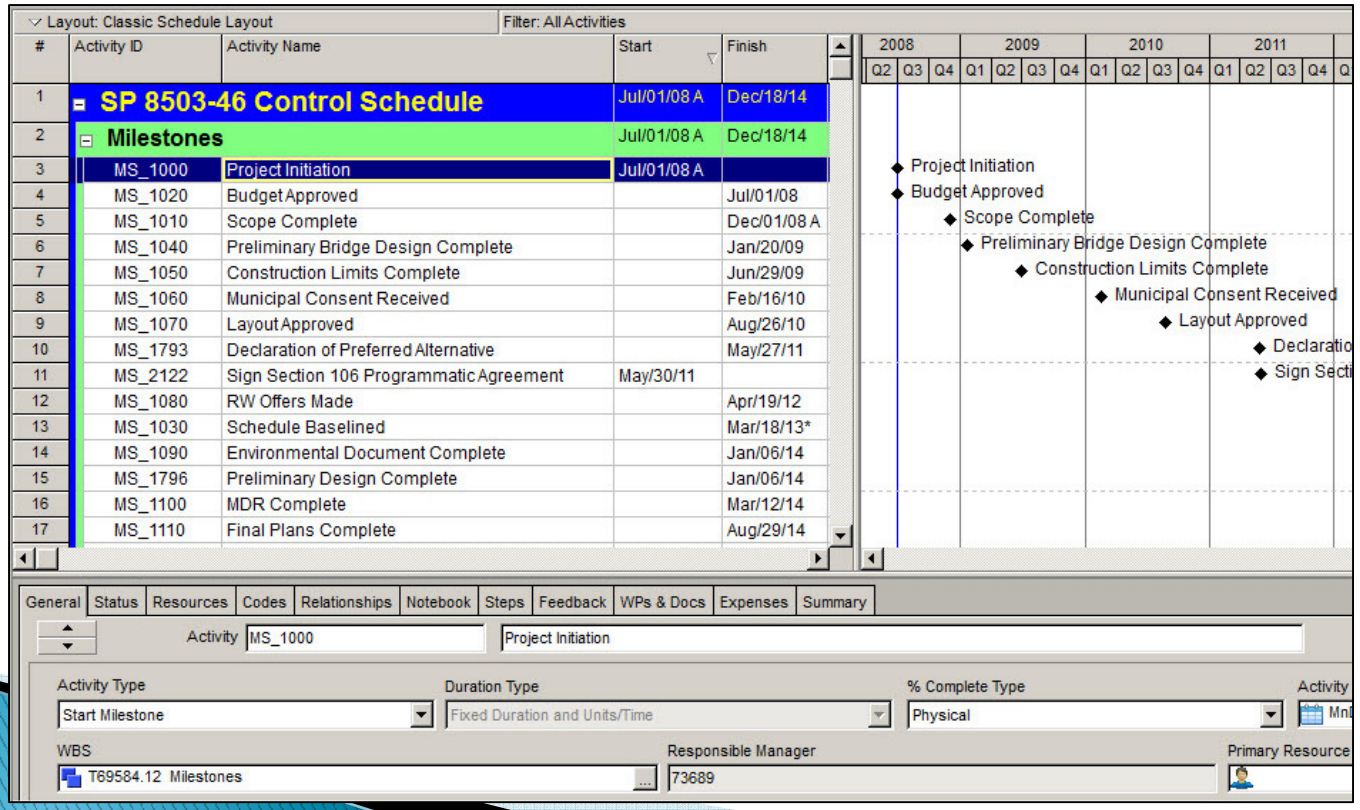
Activities & Calendars

- Each Activity is assigned to a specific Calendar (Dates)



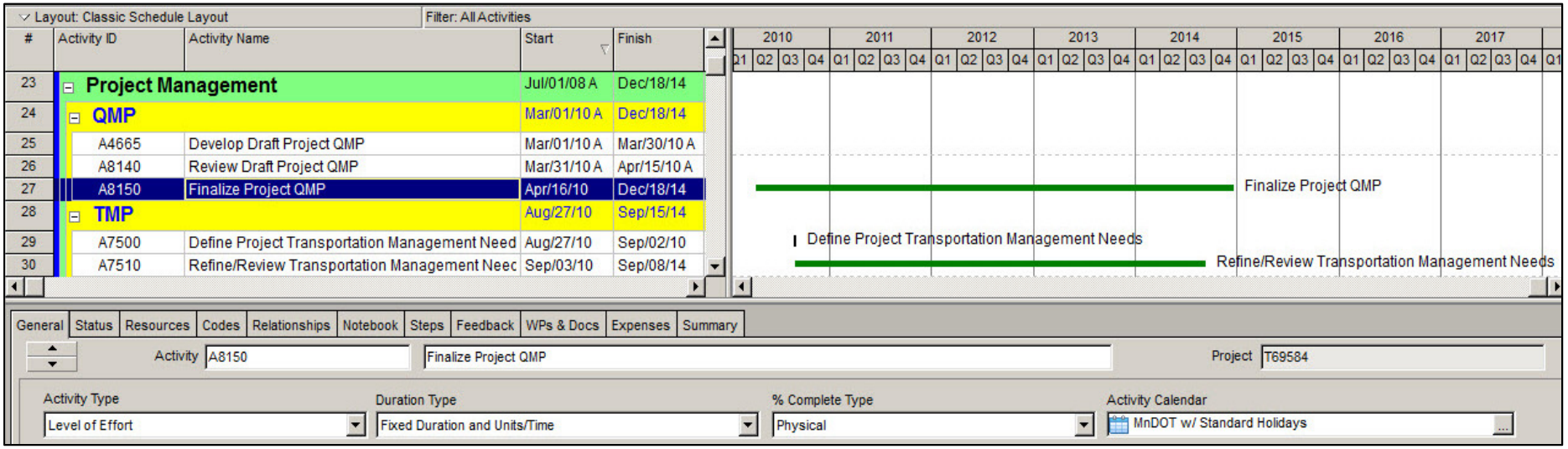
Activity Types

- The Activity Type controls how an Activity's Durations is Calculated ("Remember the Calendars")
  - Milestones – Point in Time



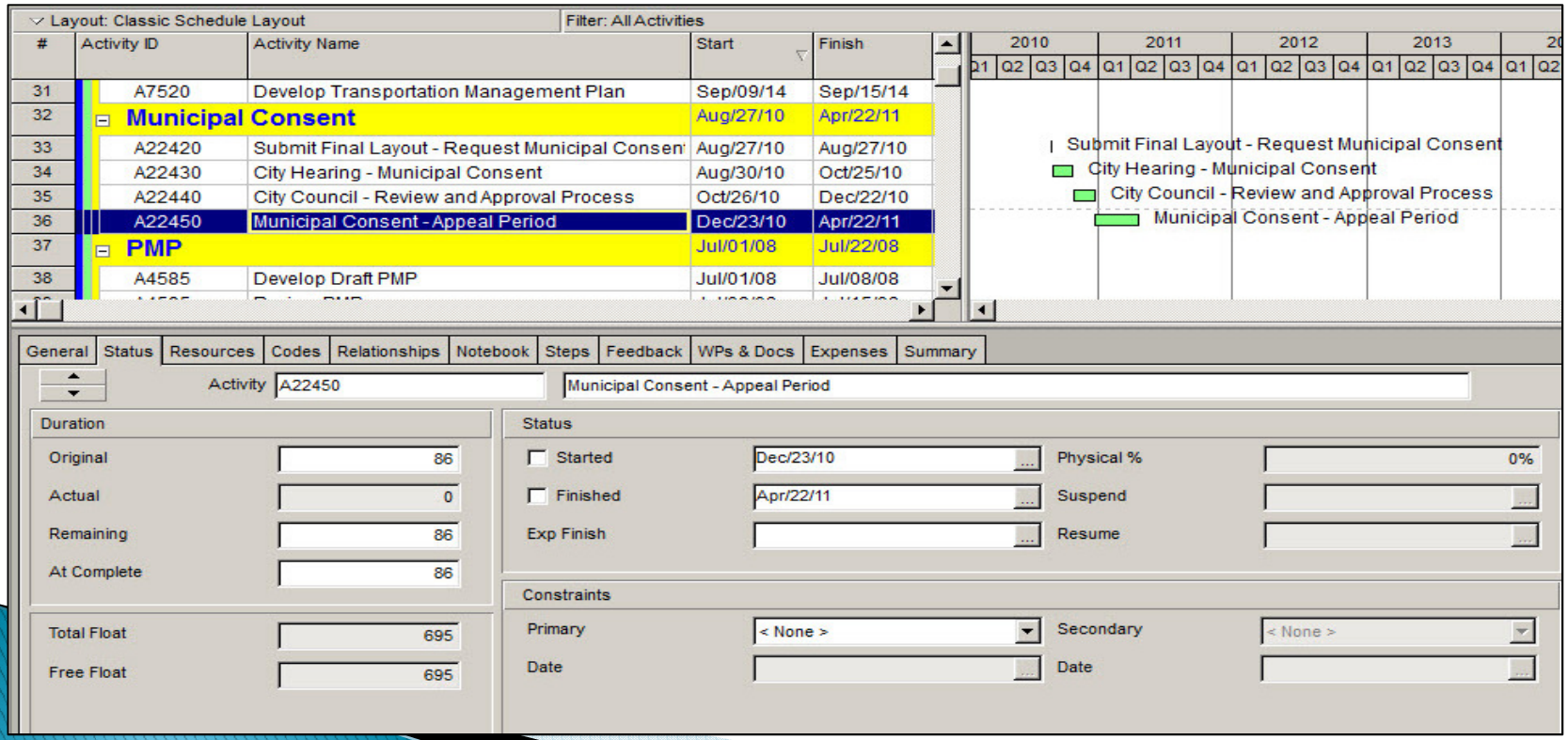
Activity Types

- The Activity Type controls how an Activity's Durations is Calculated ("Remember the Calendars")
  - Level of Effort (Summary Level)



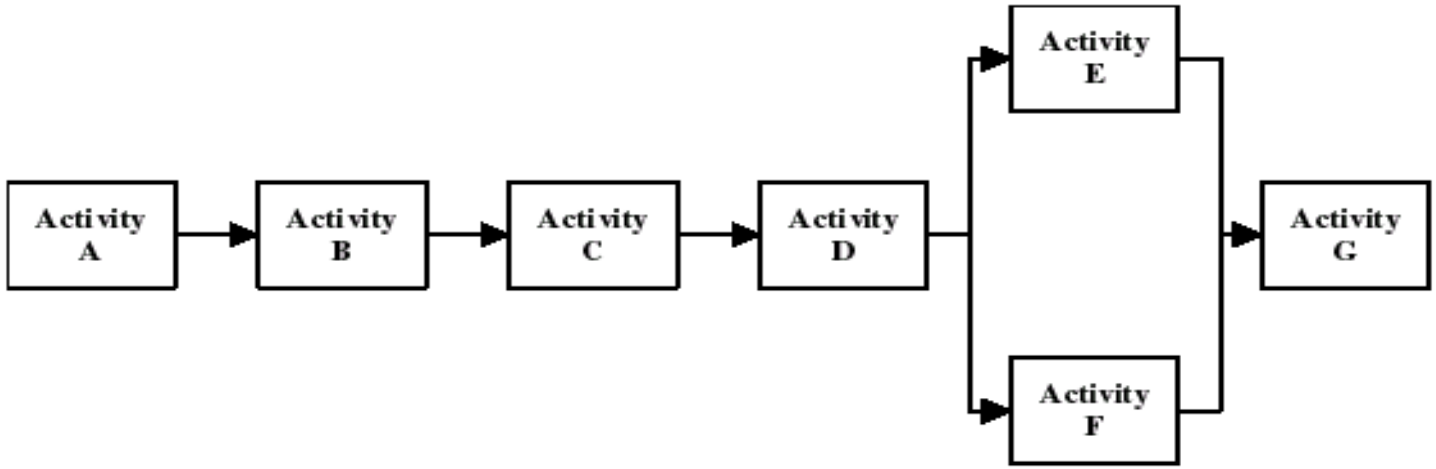
Activity Types

- The Activity Type controls how an Activity's Durations is Calculated ("Remember the Calendars")
  - Task – Item of Work



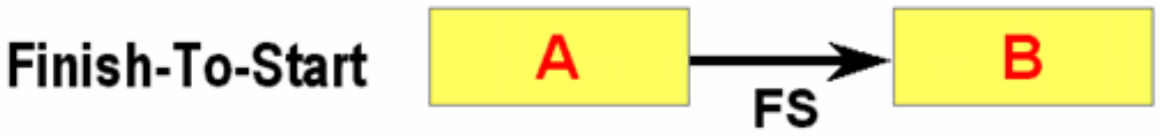
Activity Relationships

- Establish Precedence
  - Predecessor – Controls the Start or Finish of another Activity
  - Successor – Depends on the Start or Finish of another Activity

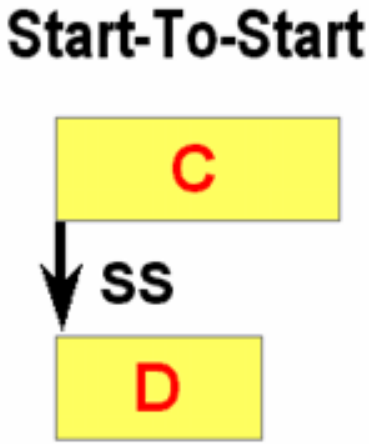


Activity Relationship Types

- Logical Relationship Types



When A Finishes, B can Start



When C Starts, D can Start

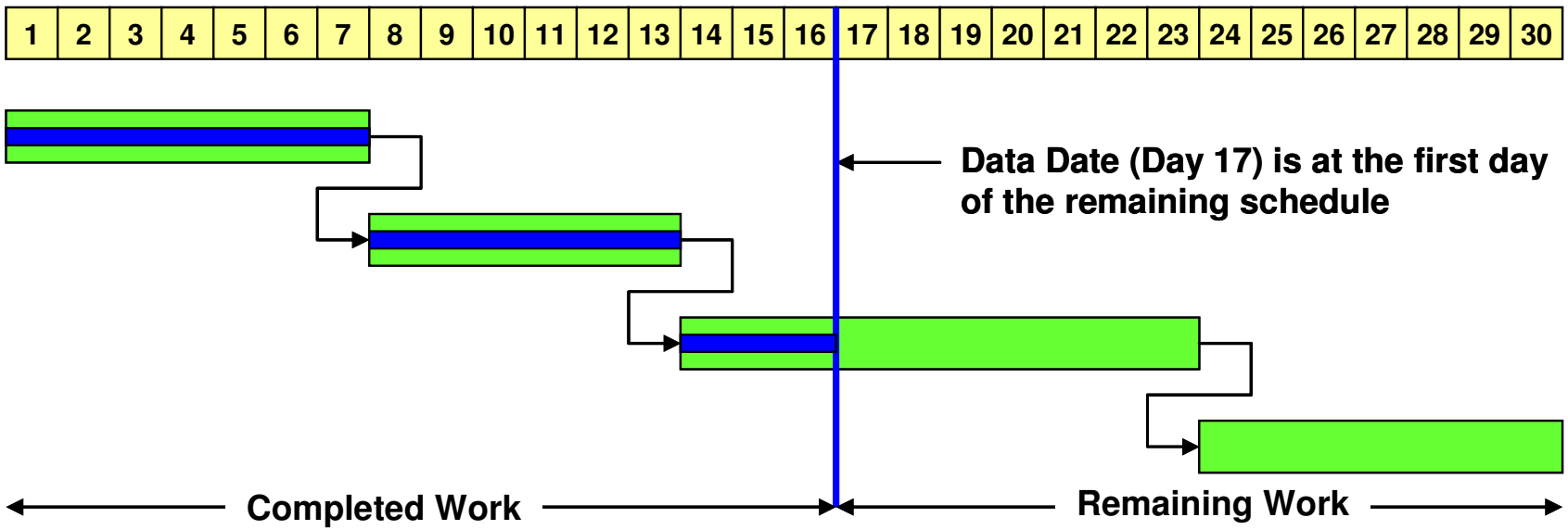
Activity Relationship Types

- Logical Relationship Types cont.

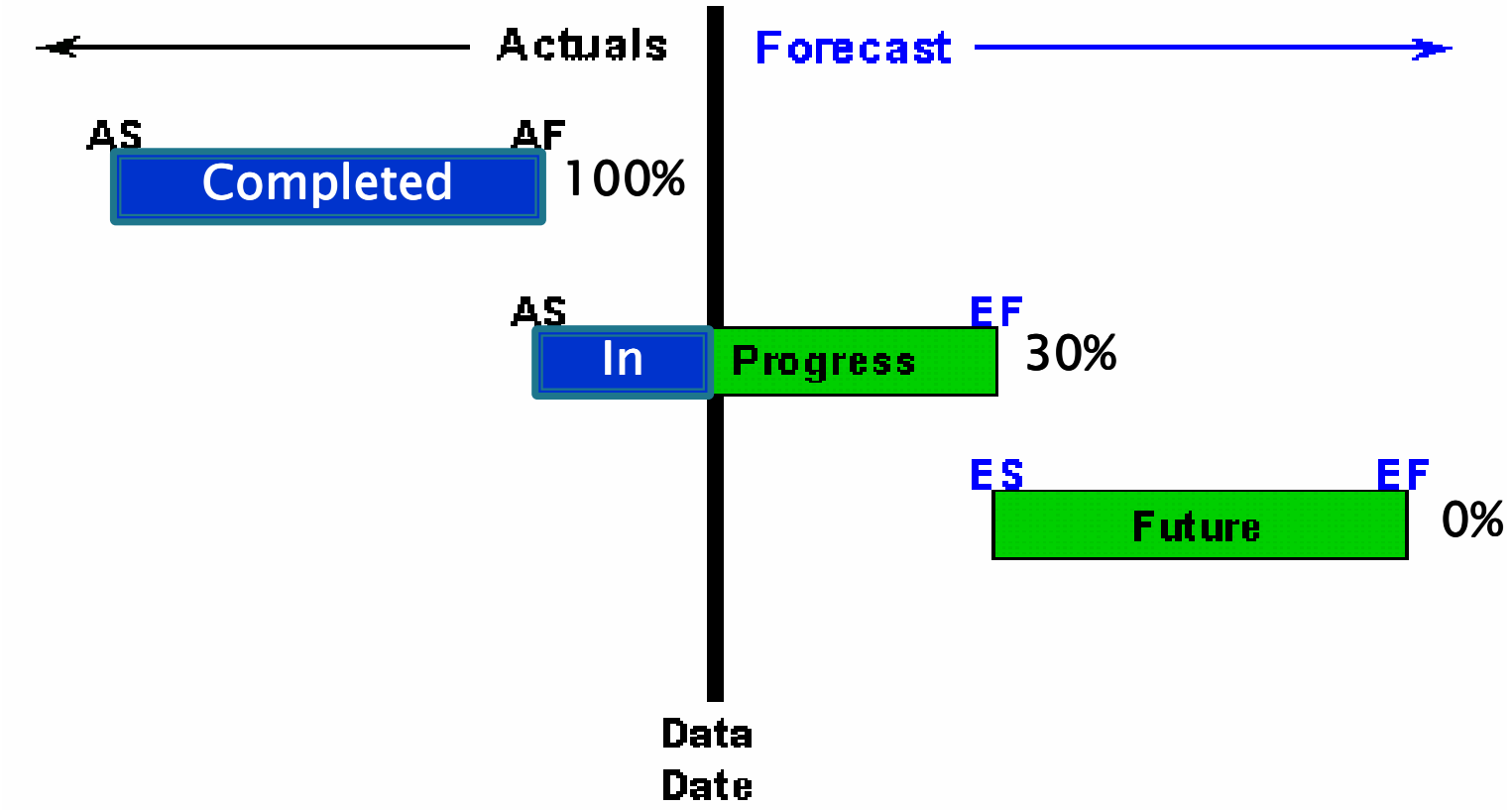
When E Finishes, F is Allowed to Finish

CPM Schedule Calculations

- Data Date – “Time Now” the data date is the date up to which actual progress is reported and the date from which future work is scheduled



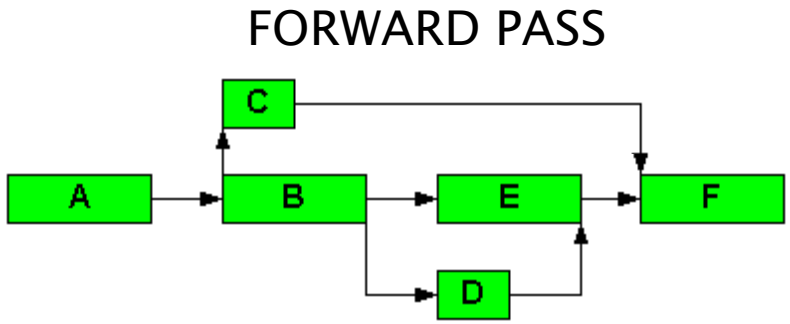
Updating Progress in Schedule



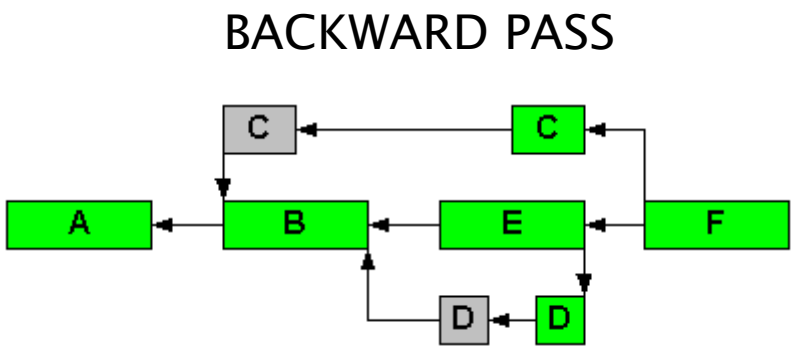
Calculating the Schedule Dates

- CPM Calculations determine the Start & Finish dates

- Forward Pass
  - Calculates the Activities Early Dates



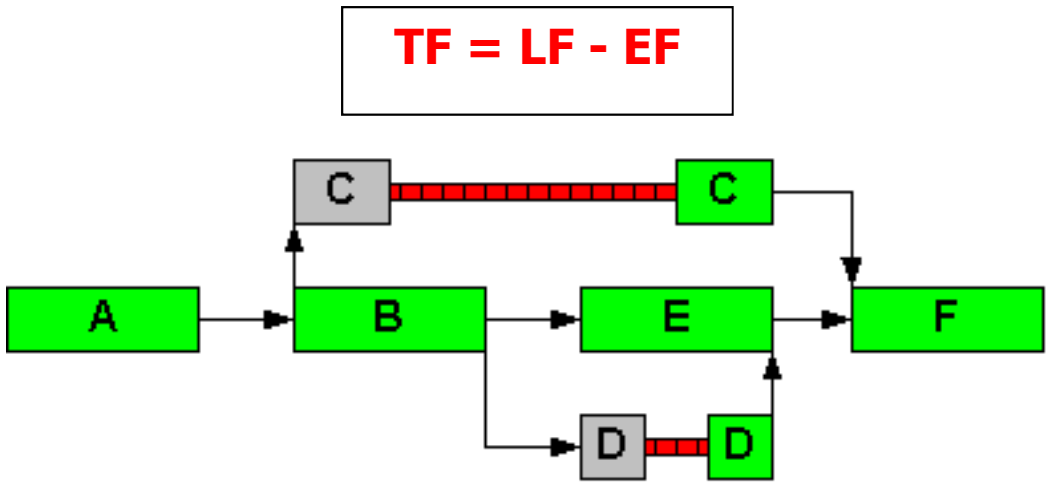
- Backward Pass
  - Calculates the Activities Late Dates



Float in the Schedule

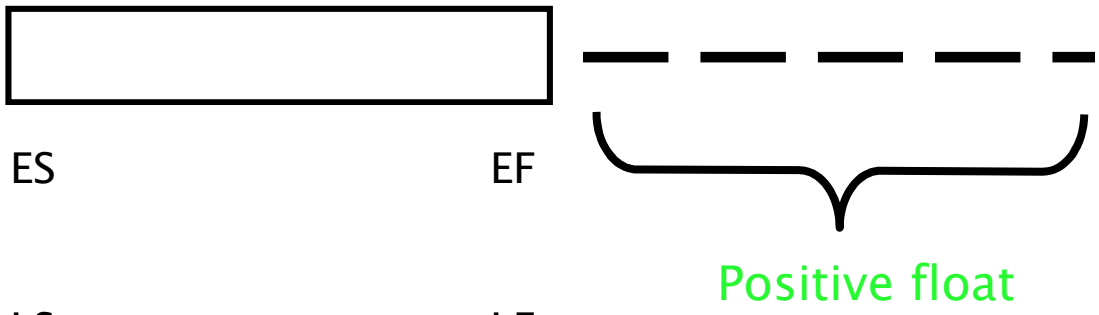
- Calculated by Subtracting the Early Finish Date from the Late Finish Date

- Represents the amount of time “days” an activity can slip before it impacts other activities and the end of the project

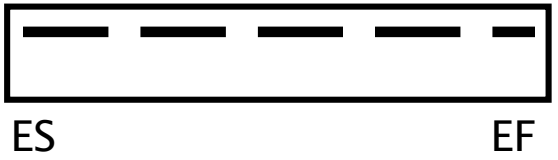


Total Float

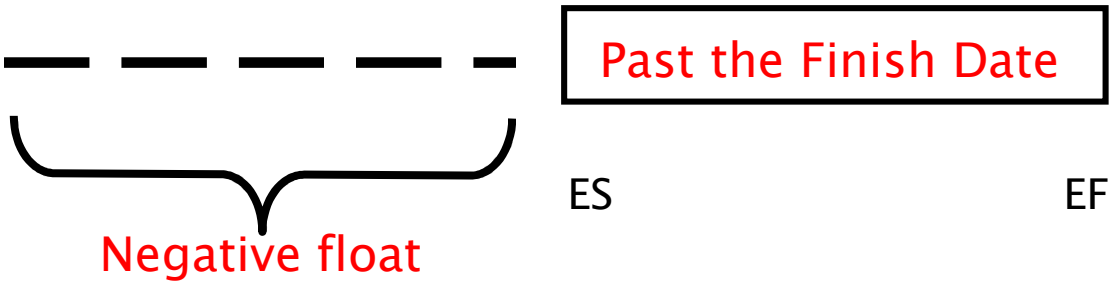
Positive float



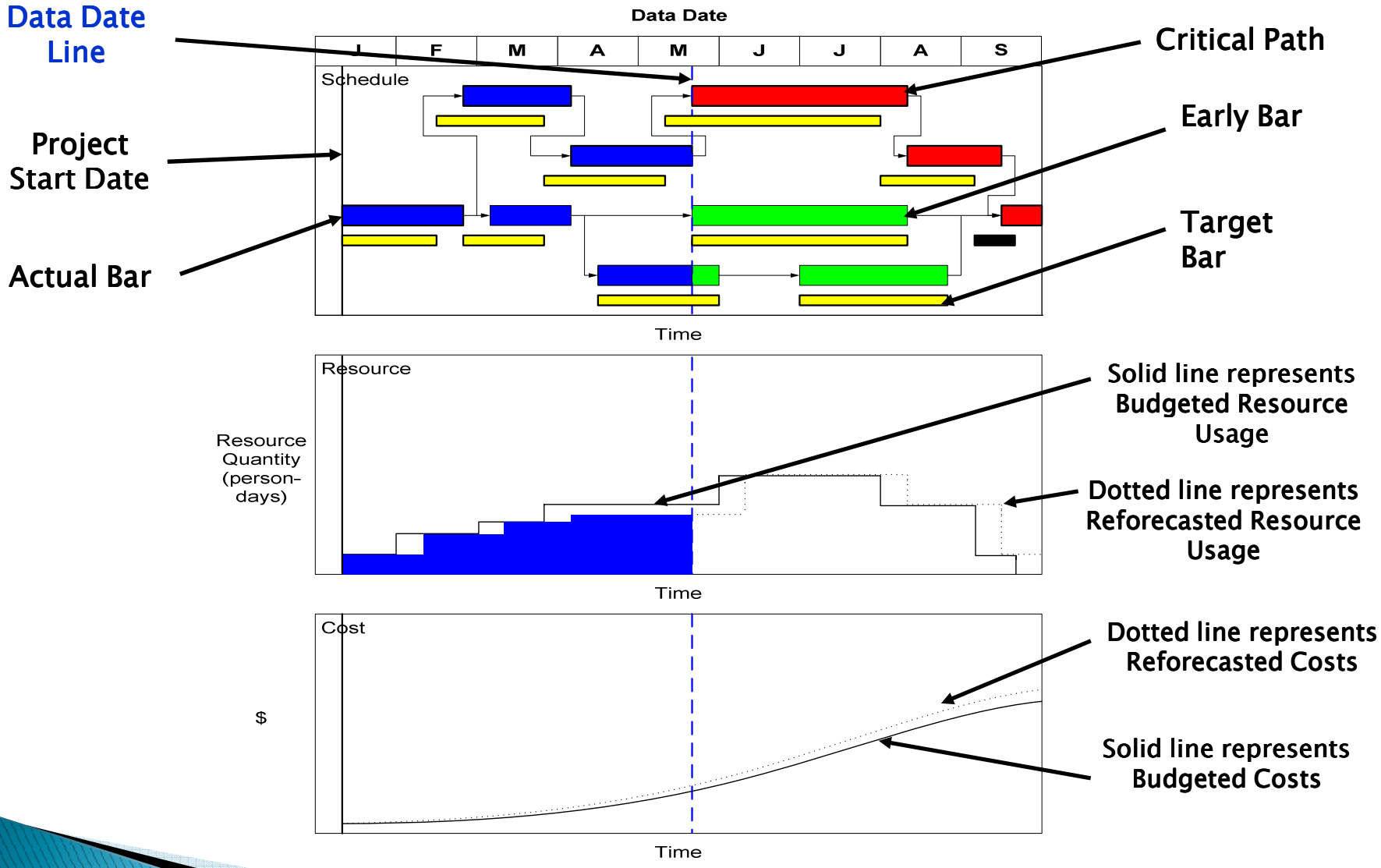
Zero float (critical)



Negative Float (extremely critical)

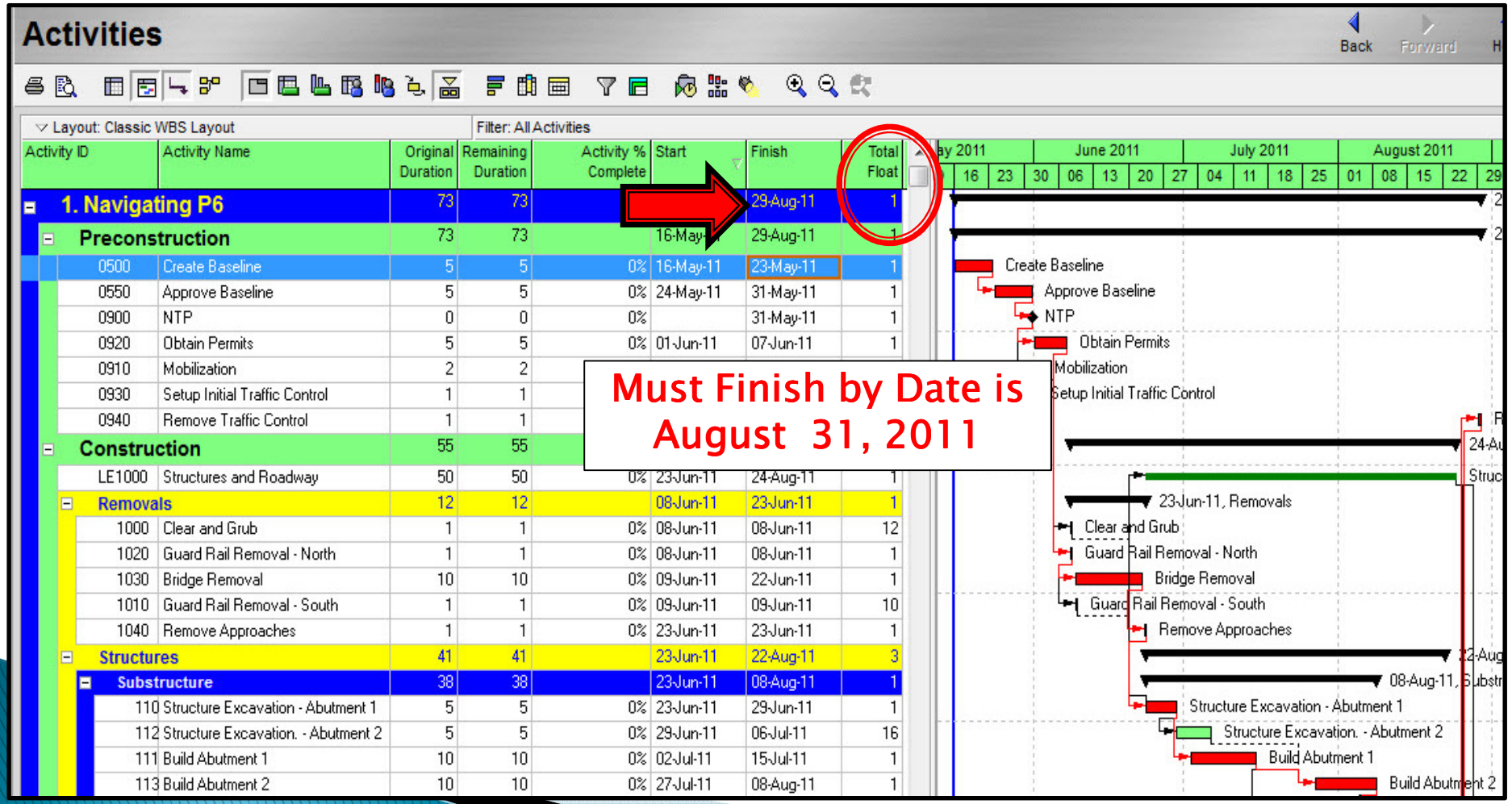


Navigating a CPM Schedule



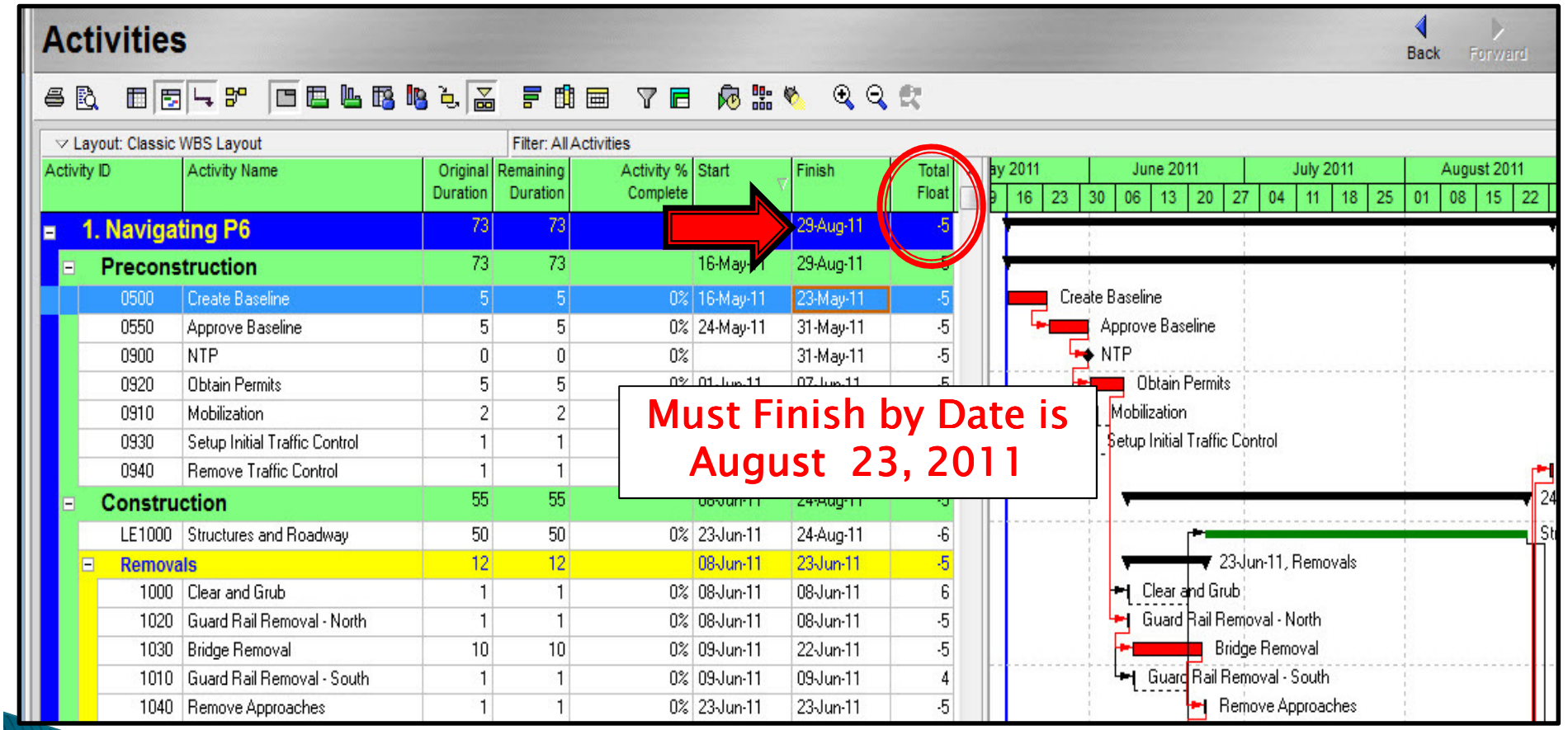
Positive Float Schedule

- Finish of Schedule is before the Must Finish Date of Project
- Use “Longest Path” in a Positive Float Schedule to see the Critical Path in Red



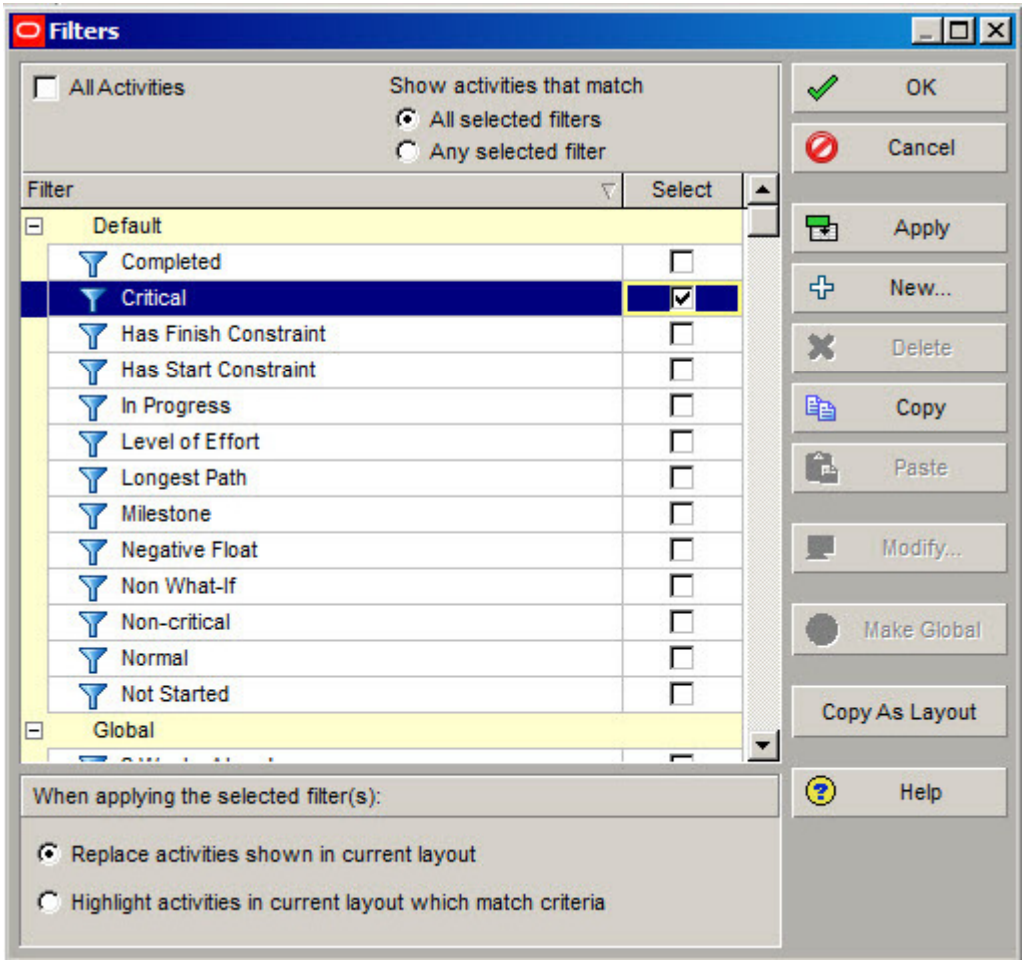
Negative Float Schedule

- Finish of Schedule is after the Must Finish Date of Project



Critical Path “Filter”

- Apply a “Filter” to show only the Critical Activities

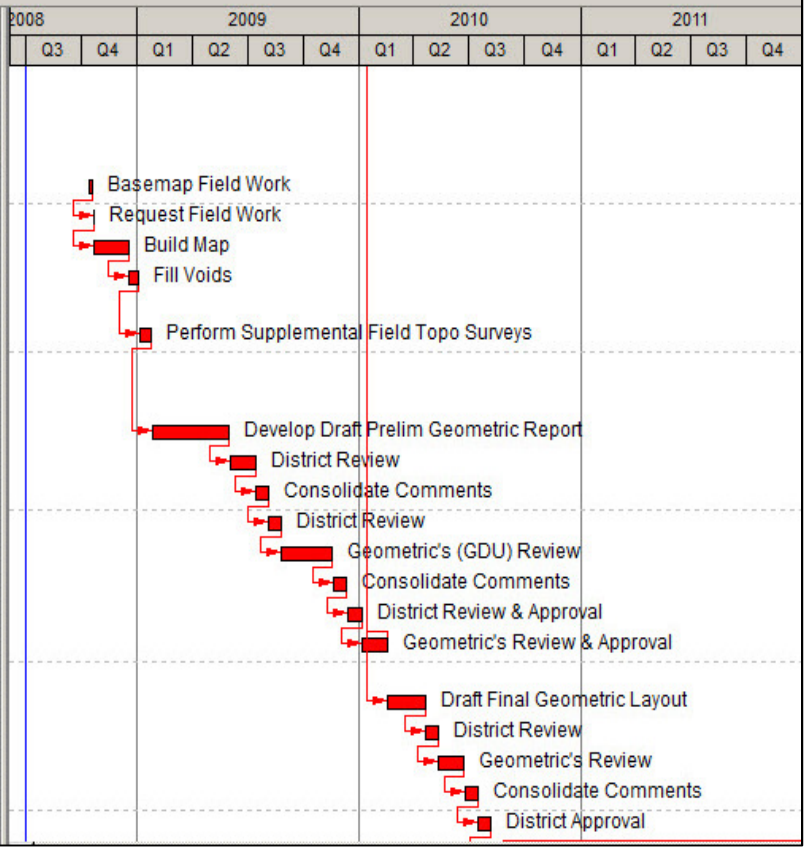


Critical Path "Filter"

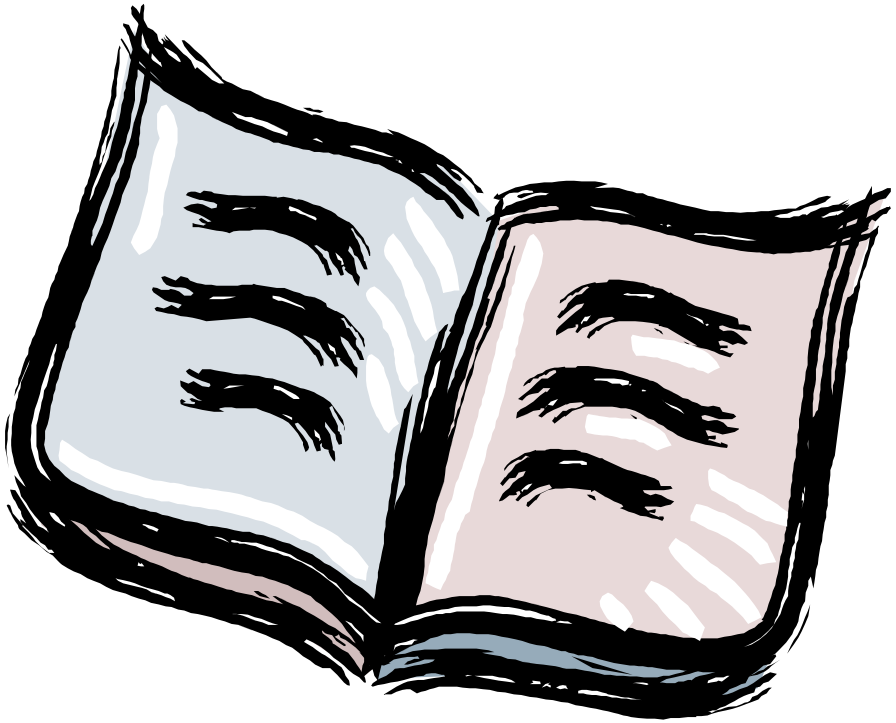
- These Activities have the lowest amount of Total Float

Layout: Classic Schedule Layout | Filter All: Critical

#	Activity ID	Activity Name	Start	Finish	Original
12		**Preliminary Design**	Oct/13/08	Aug/26/10	
13		**Surveys**	Oct/13/08	Jan/23/09	
14		**Photogrametric Basemap**	Oct/13/08	Jan/02/09	
15	A18810	Basemap Field Work	Oct/13/08*	Oct/17/08	
16	A18820	Request Field Work	Oct/20/08	Oct/20/08	
17	A18830	Build Map	Oct/21/08	Dec/17/08	
18	A18840	Fill Voids	Dec/18/08	Jan/02/09	
19		**Preliminary Field Surveys**	Jan/05/09	Jan/23/09	
20	A18970	Perform Supplemental Field Topo Surveys	Jan/05/09	Jan/23/09	
21		**Roadway**	Jan/26/09	Aug/26/10	
22		**Preliminary Geometric Layout**	Jan/26/09	Feb/16/10	
23	A19030	Develop Draft Prelim Geometric Report	Jan/26/09	Jun/01/09	
24	A19040	District Review	Jun/02/09	Jul/14/09	
25	A19050	Consolidate Comments	Jul/15/09	Aug/04/09	
26	A19060	District Review	Aug/05/09	Aug/25/09	
27	A19070	Geometric's (GDU) Review	Aug/26/09	Nov/18/09	
28	A19080	Consolidate Comments	Nov/19/09	Dec/11/09	
29	A19090	District Review & Approval	Dec/14/09	Jan/05/10	
30	A19100	Geometric's Review & Approval	Jan/06/10	Feb/16/10	
31		**Final Geometric Layout**	Feb/17/10	Aug/26/10	
32	A19110	Draft Final Geometric Layout	Feb/17/10	Apr/20/10	
33	A19120	District Review	Apr/21/10	May/11/10	
34	A19130	Geometric's Review	May/12/10	Jun/23/10	
35	A19140	Consolidate Comments	Jun/24/10	Jul/15/10	
36	A19150	District Approval	Jul/16/10	Aug/05/10	



Glossary of CPM Terms



Glossary of CPM Terms

Activity - An individual work task that is the basic component of a project.

Activity Codes - Values assigned to project activities to organize then into manageable groups for updating, analyzing, reporting, plotting, and summarizing.

Actual Cost - The cost incurred to date for a resource or activity.

Actual Dates - Start (AS) and Finish (AF) dates that you record for an activity that has progress or is complete.

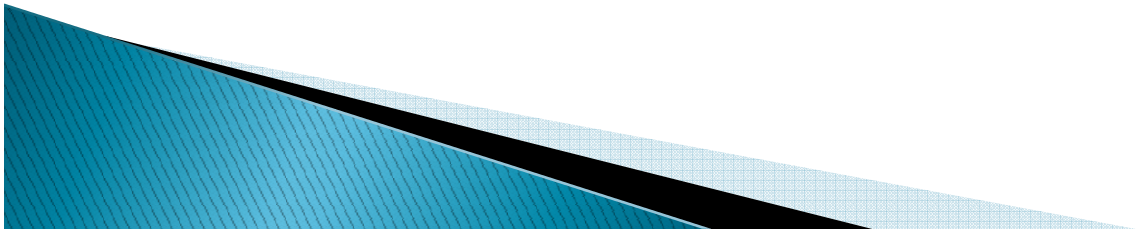
Actual Quantity - The amount of a resource used to date.

Backward Pass - The calculation of a network's late dates.

Bar Chart - The graphical display of activities according to time. Relationships between activities are not shown. A bar chart is also called a Gantt Chart.

Baseline Schedule -The original planned schedule for a project.

Budget - The estimate of the total units or costs required by a resource or cost account for an activity.



Glossary of CPM Terms

Calendar - The workdays and holidays defined for a project that determine when an activity can be scheduled.

Completion - The date on which a project is to be finished.

Constraint - A restriction imposed on the start or finish of an activity.

Critical Activity - An activity that has the least amount of total float.

Critical Path - The series of activities in a project that will take the longest to complete.

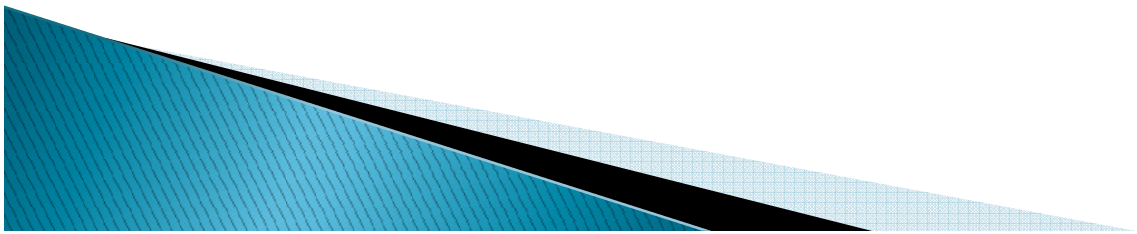
Critical Path Method (CPM) - The calculation of the earliest and latest start and finish dates of activities based on their duration and relationships to other activities.

Data Date - The date used as the starting point for schedule calculations.

Driving - A predecessor/successor relationship in which the predecessor

Relationship - Determines the successor's early dates.

Duration - The amount of time (in workdays) needed to complete an activity.



Glossary of CPM Terms

Early Start (ES) - The earliest date when an activity can begin after its predecessors have been completed.

Earned Value - The value of work performed rather than actual work performed.

Exception - A day when work must occur that was originally designated as a nonworkday.

Finish to Finish - A type of relationship in which a successor activity finish depends on its **(FF)** predecessor activity's finish.

Finish-to Start - A type of relationship in which a successor activity can begin only when its **(FS)** predecessor activity finishes.

Float - The amount of time that the start or finish of an activity can be delayed without affecting the project finish date.

Forward Pass - The calculation of the network's early dates.

Free Float - The amount of time that an activity's early start can be delayed without delaying the early start of a successor activity.

Lag - An offset or delay from an activity to its successor.

Late Finish (LF) - The latest date when an activity can start without delaying the project's completion.

Glossary of CPM Terms

Late Start (LS) - The latest date when an activity can start without delaying the project's completion.

Loop - Circular logic within a network.

Milestone - An activity that represents a significant point in time, that has no duration.

Negative Float - The total number of days that the start or finish of an activity exceeds the time allowed. Negative float indicates a delay in the schedule.

Negative Lag - An offset or lead time from an activity to its successor in which the successor's start date is earlier than the predecessor's start date.

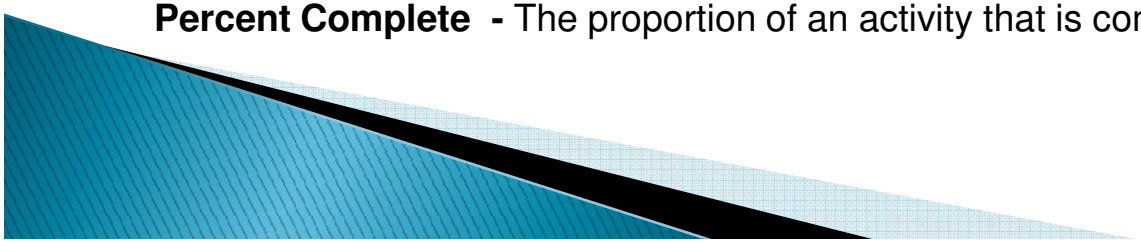
Network - The series of activities required to complete a project.

Nonworkperiod - A period of time when work may not occur.

Open End - An activity that has no successor or predecessor relationships to other activities in the network.

Out-of-Sequence Progress - Work completed for an activity before it is logically scheduled to occur.

Percent Complete - The proportion of an activity that is complete.



Glossary of CPM Terms

Performance Measurement - The comparison of the current plan to a target plan to assess whether it is progressing as intended.

Planning Unit - The increment of time used to schedule a project. The planning unit can be in hours, days, weeks, or months.

Predecessor - An activity that must logically occur before another activity.

Progress - The completion of work.

Resources - The people, materials, equipment or services required to complete a project.

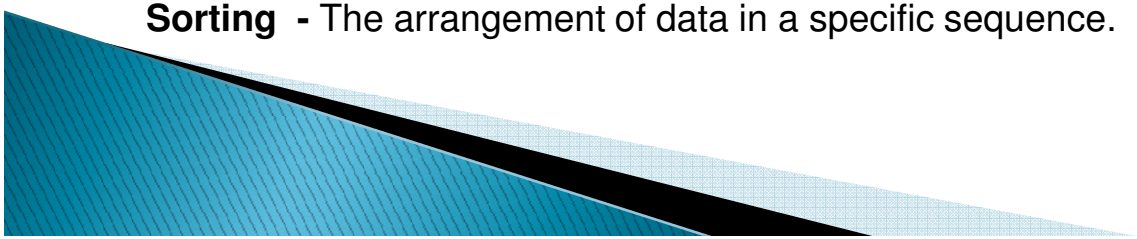
Schedule - A list of the activities needed to complete a project, along with their start and finish dates.

Schedule Calculation - The calculation of early and late dates for each activity in the project.

Slack - See Float**.**

Slippage - Lateness determined by measuring the target finish of an activity from its actual or current early finish.

Sorting - The arrangement of data in a specific sequence.



Glossary of CPM Terms

Start-to Start (SS) - A type of relationship in which a successor's start depends on the start of its predecessor.

Status - The process of updating a project by indicating progress at regular intervals.

Successor - An activity that must logically occur after another activity.

Target - A project plan that can be compared to the current schedule to measure progress.

Task - A unit of work. Also called an activity.

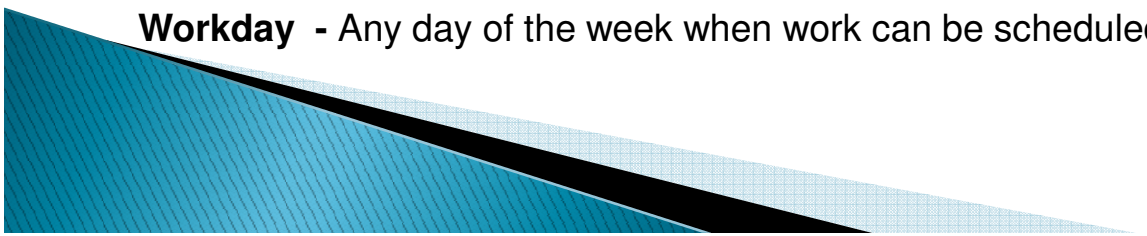
Total Float (TF) - The total number of days that the start or finish of an activity can be delayed without affecting the project finish date. Float can be negative,zero, or positive.

Updating - The process of recording progress in a project at regular intervals.

Variance - The difference between the current and target schedule dates.

Work Breakdown Structure (WBS) - The graphical depiction of the hierarchy of work needed to complete a project.

Workday - Any day of the week when work can be scheduled.



MnDOT Goals Going Forward

Projects in Construction Phase

- Contractor's Build Their Schedule in our Network 1/1/13
- Piloting Providing BIM Models and CTD Schedules to Contractors 3/1/13
- Select "Unit Rate" project- Resource and Cost Loaded 3/1/13
- Role and Resource Loaded of CE&I staff 6/1/14

MnDOT Goals Going Forward

Projects in Scoping and Design Phase

- "Active Projects" Role and Resource Loaded 6/30/13
- All planned projects Role loaded by June 30, 2014
- Taxpayer Transportation Accountability Act

Questions or Comments

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Next Webinar: Wednesday, April 03, 2013
Time: 1:00 p.m.
Topic: WBS – Work Breakdown Structure
Presenter: Jonathan McNatty
DRMcNatty & Associates, Inc.