Understanding the Effects of Multiple Task Calendars on a Schedule's Critical Path

Presented by:
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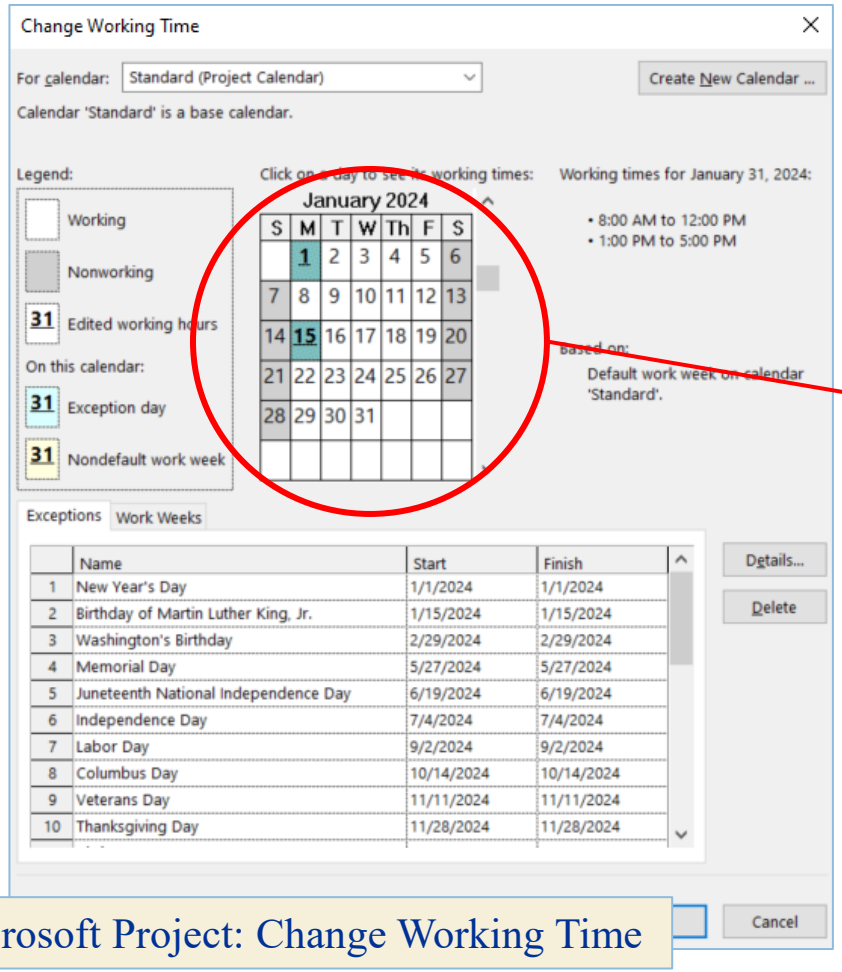
24 April 2024

Introduction

- Why?
- Basics of multiple calendars
- How it affects:
  - Float calculations
  - Schedule performance
  - Critical path identification
- Management strategies

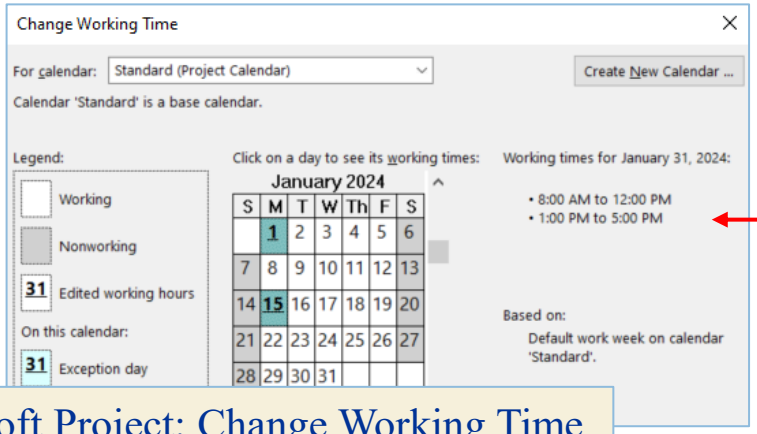
Review: Working Calendar Basics



Microsoft Project: Change Working Time

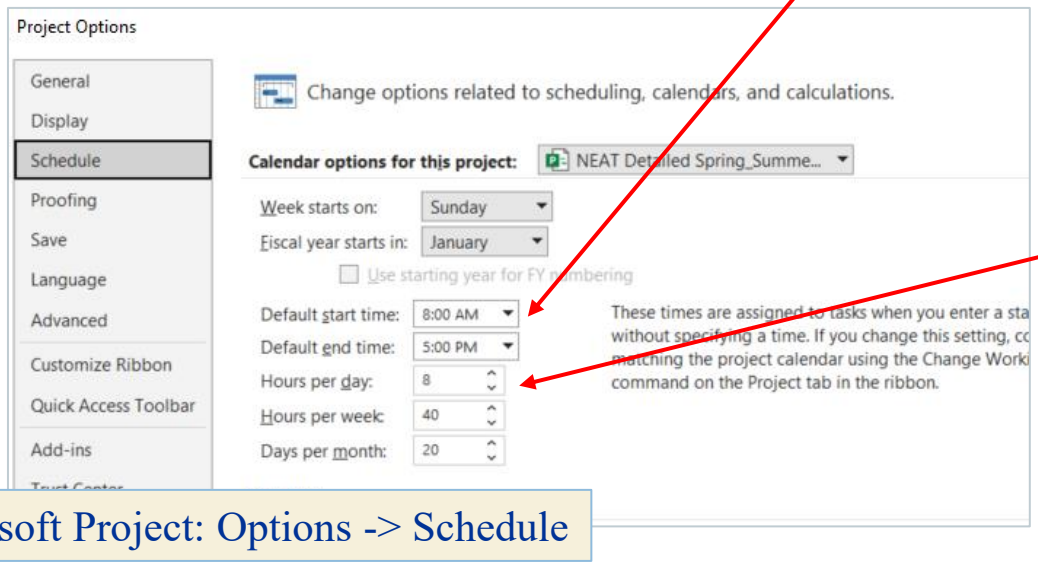
- Tasks are assigned a task calendar with working and non-working days
- Tasks will only be scheduled only on working days and will skip over nonworking and exception days

Review: Working Calendar Basics



Microsoft Project: Change Working Time

Default times for the working day are from 8:00am to 5:00pm

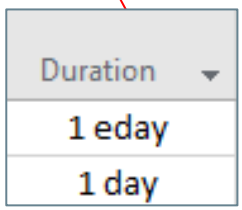


Microsoft Project: Options -> Schedule

Duration settings:
Day = 8 hours
Week = 40 hours
Month = 20 days

Types of Work Calendars

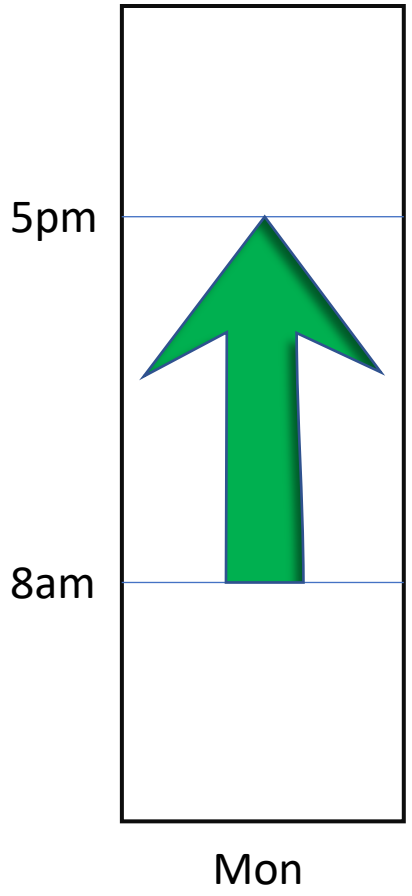
- Standard Calendar (8 hr/day, 5-day week)
- Double-shifts
- Flex schedules
  - 10 hr/day, 4-day week
  - 9 hr/day, 8 hours or off on alternating Fridays
- 24 hours, 7 days per week
- **edays**



"Elapsed Days":
- represents 24 hours of elapsed time
- ignores project calendars

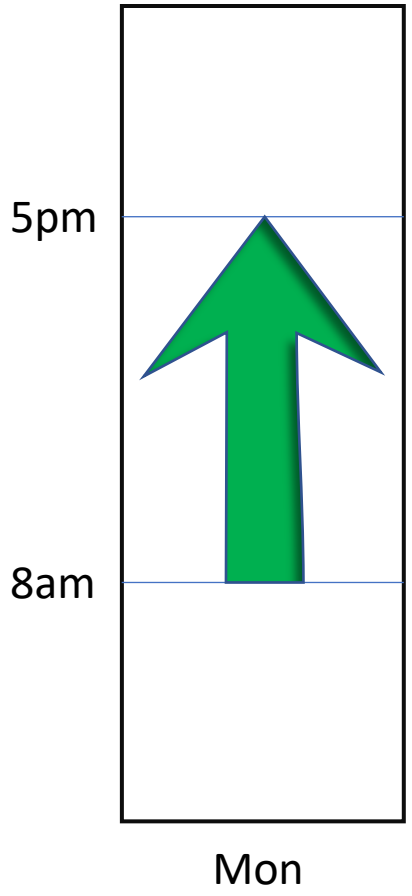
Comparison: Standard vs. edays

Task Calendar	Dur	Start	Finish
Standard	1 day	Mon 8:00 AM	Mon 5:00 PM

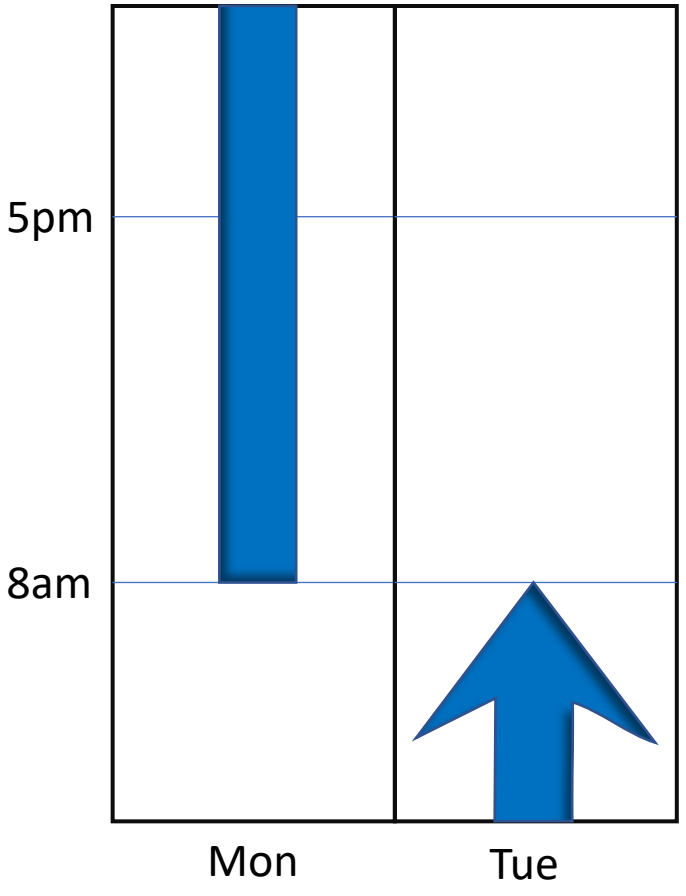


Comparison: Standard vs. edays

Task Calendar	Dur	Start	Finish
Standard	1 day	Mon 8:00 AM	Mon 5:00 PM

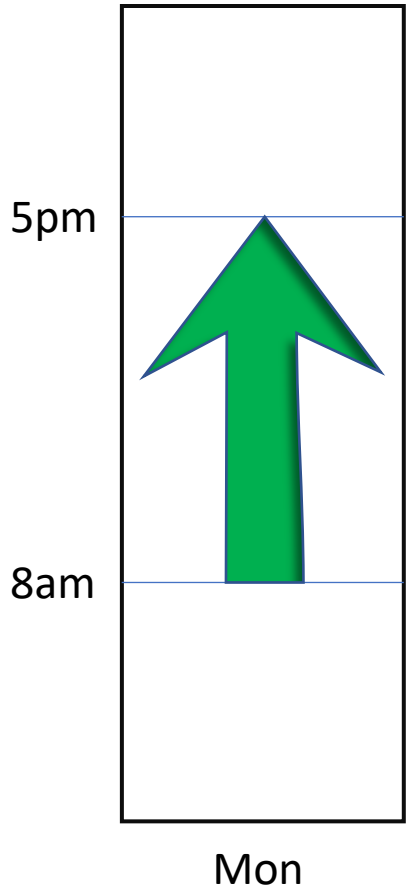


Task Calendar	Dur	Start	Finish
None	1 eday	Mon 8:00 AM	Tue 8:00 AM



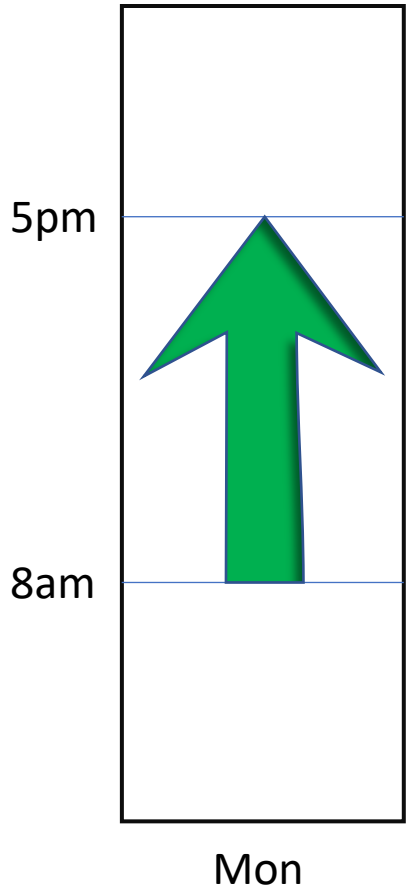
Comparison: Standard vs. 24/7

Task Calendar	Dur	Start	Finish
Standard	1 day	Mon 8:00 AM	Mon 5:00 PM

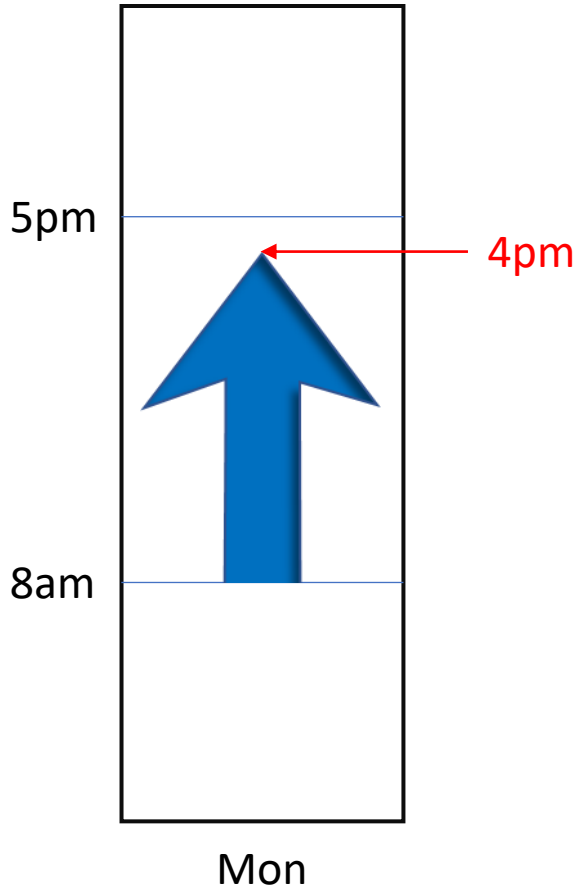


Comparison: Standard vs. 24/7

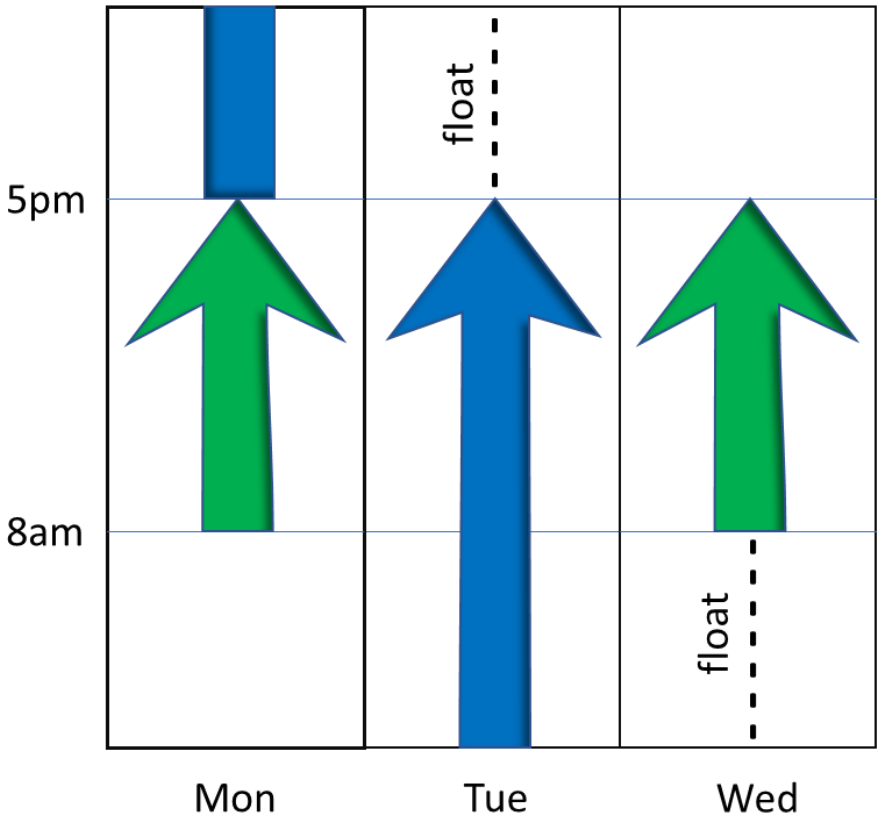
Task Calendar	Dur	Start	Finish
Standard	1 day	Mon 8:00 AM	Mon 5:00 PM



Task Calendar	Dur	Start	Finish
24 Hours	1 day	Mon 8:00 AM	Mon 4:00 PM



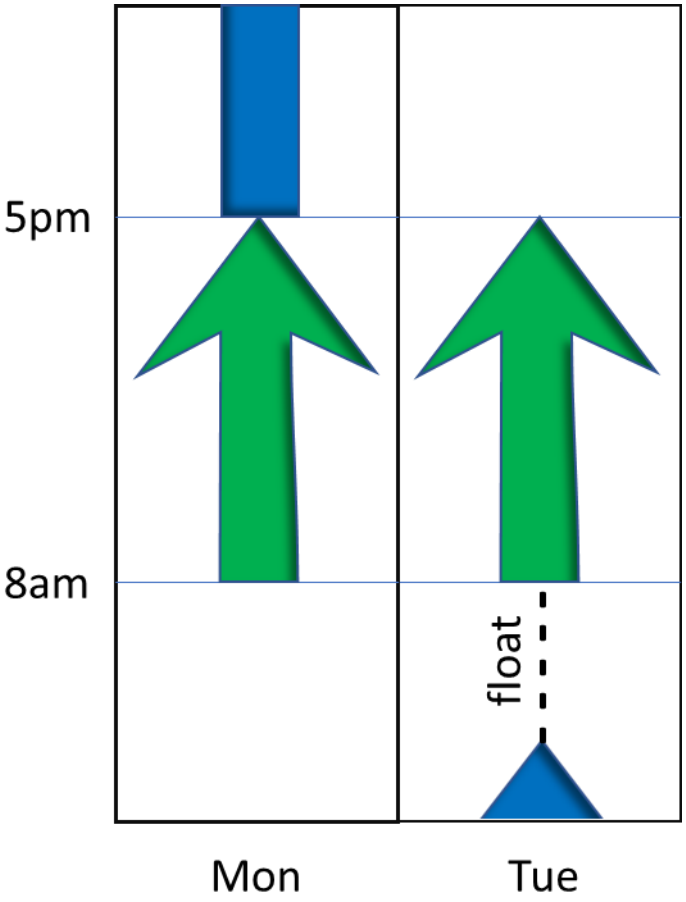
Fractional Float: days ⇨ edays



Task Calendar	Dur	Total Slack	Start	Finish
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM
None	1 eday	0.63 edays	Mon 5:00 PM	Tue 5:00 PM
Standard	1 day	0 days	Wed 8:00 AM	Wed 5:00 PM

5pm to 8am = 15 hours of float
15 hours/24 hours = .625

Fractional Float: days ⇨ 24/7



Task Calendar	Dur	Total Slack	Start	Finish
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM
24 Hours	1 day	0.88 days	Mon 5:00 PM	Tue 1:00 AM
Standard	1 day	0 days	Tue 8:00 AM	Tue 5:00 PM

1am to 8am = 7 hours of float
7 hours/8 hours = .875

Summary: Common Fractional Float

standard ⇒ edays: 0.63, 1.63, 2.63 (edays)

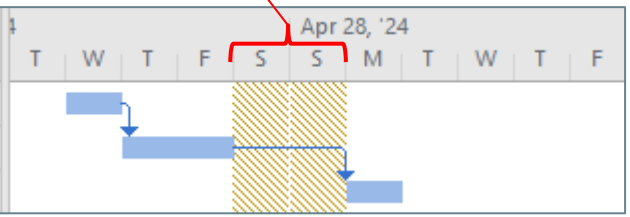
standard ⇒ 24/7: 0.88, 1.88, . . ., 6.88 (days)

24/7 ⇒ standard: 0.13, 1.13, 2.13 (days)

Schedule Jumps

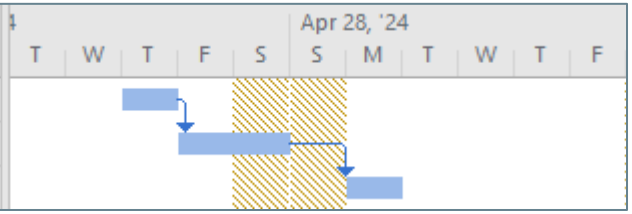
Non-working time

Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	2 days	Wed 8:00 AM	Wed 5:00 PM
None	2 edays	2.63 edays	Wed 5:00 PM	Fri 5:00 PM
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM



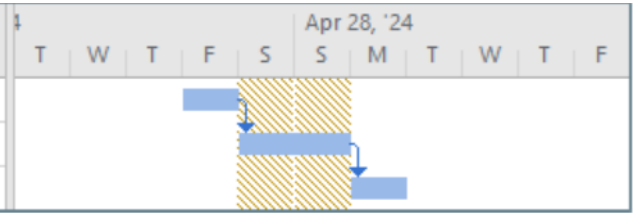
1-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	1 day	Thu 8:00 AM	Thu 5:00 PM
None	2 edays	1.63 edays	Thu 5:00 PM	Sat 5:00 PM
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM



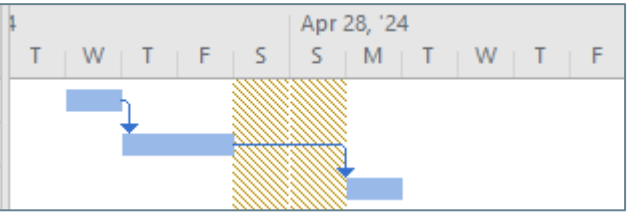
2-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	0 days	Fri 8:00 AM	Fri 5:00 PM
None	2 edays	0.63 edays	Fri 5:00 PM	Sun 5:00 PM
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM



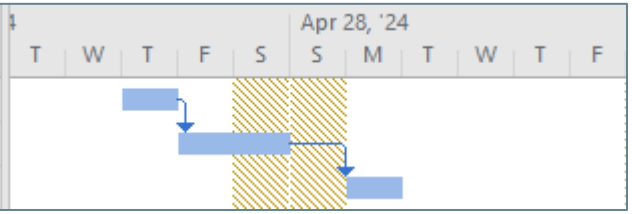
Schedule Jumps

Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	2 days	Wed 8:00 AM	Wed 5:00 PM
None	2 edays	2.63 edays	Wed 5:00 PM	Fri 5:00 PM
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM



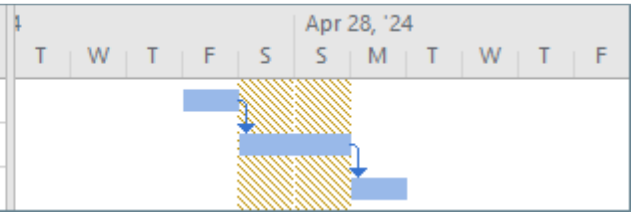
1-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	1 day	Thu 8:00 AM	Thu 5:00 PM
None	2 edays	1.63 edays	Thu 5:00 PM	Sat 5:00 PM
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM



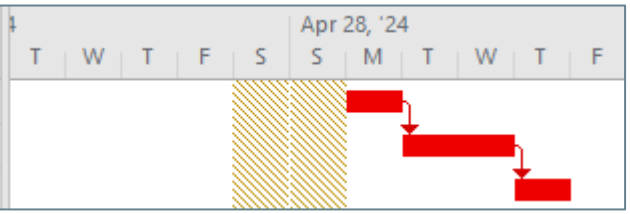
2-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	0 days	Fri 8:00 AM	Fri 5:00 PM
None	2 edays	0.63 edays	Fri 5:00 PM	Sun 5:00 PM
Standard	1 day	0 days	Mon 8:00 AM	Mon 5:00 PM

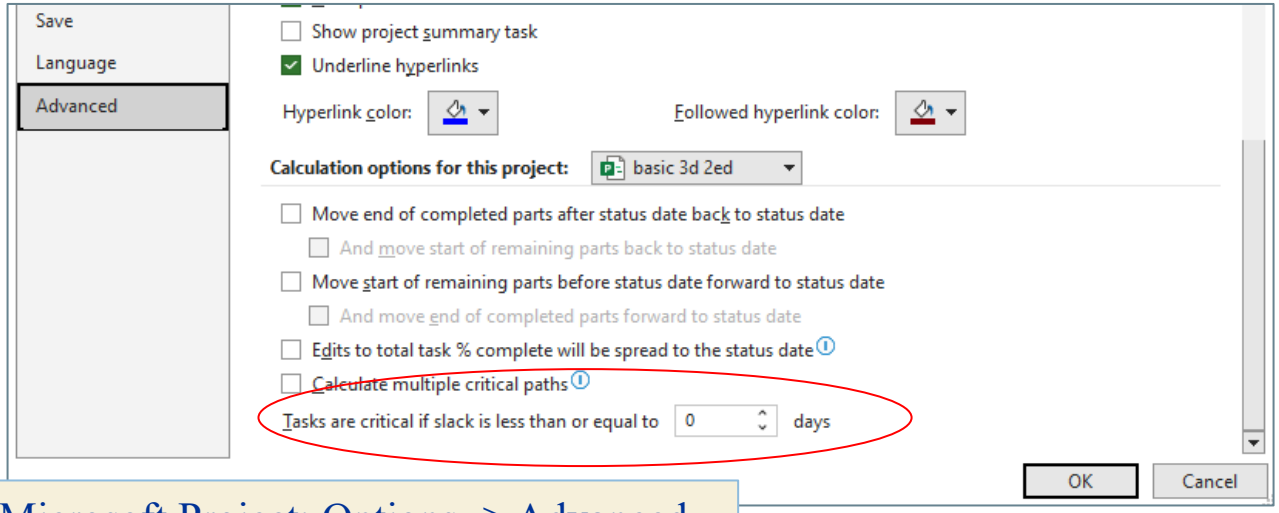


3-day slip

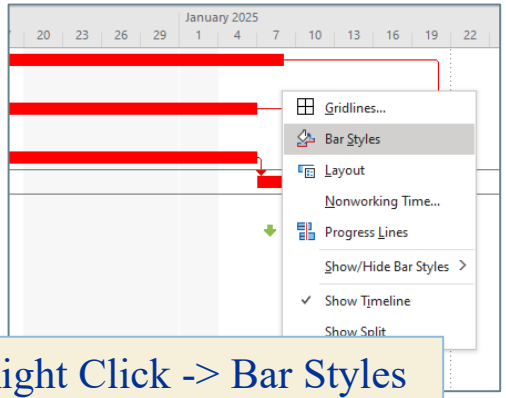
Task Calendar	Dur	Total Float	Start	Finish
Standard	1 day	-1 day	Mon 8:00 AM	Mon 5:00 PM
None	2 edays	-2.38 edays	Mon 5:00 PM	Wed 5:00 PM
Standard	1 day	-3 days	Thu 8:00 AM	Thu 5:00 PM



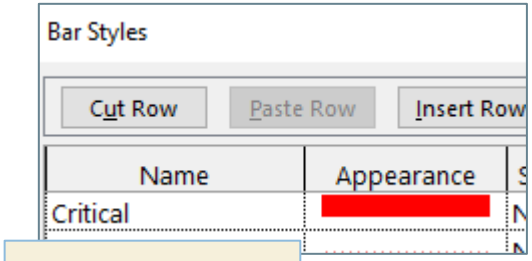
MS Project: Highlight Critical Tasks



Microsoft Project: Options -> Advanced



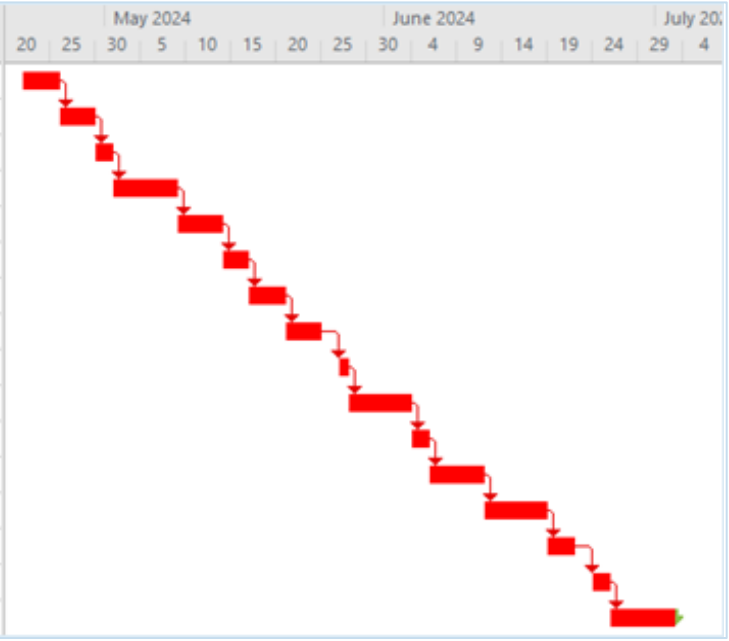
Right Click -> Bar Styles



Name: Critical

Identifying the Critical Path

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	0 days	4/22/2024	4/25/2024
Standard	2 days	0 days	4/26/2024	4/29/2024
Standard	2 days	0 days	4/30/2024	5/1/2024
Standard	5 days	0 days	5/2/2024	5/8/2024
Standard	3 days	0 days	5/9/2024	5/13/2024
Standard	3 days	0 days	5/14/2024	5/16/2024
Standard	2 days	0 days	5/17/2024	5/20/2024
Standard	4 days	0 days	5/21/2024	5/24/2024
Standard	1 day	0 days	5/27/2024	5/27/2024
Standard	5 days	0 days	5/28/2024	6/3/2024
Standard	2 days	0 days	6/4/2024	6/5/2024
Standard	4 days	0 days	6/6/2024	6/11/2024
Standard	5 days	0 days	6/12/2024	6/18/2024
Standard	3 days	0 days	6/19/2024	6/21/2024
Standard	2 days	0 days	6/24/2024	6/25/2024
Standard	5 days	0 days	6/26/2024	7/2/2024

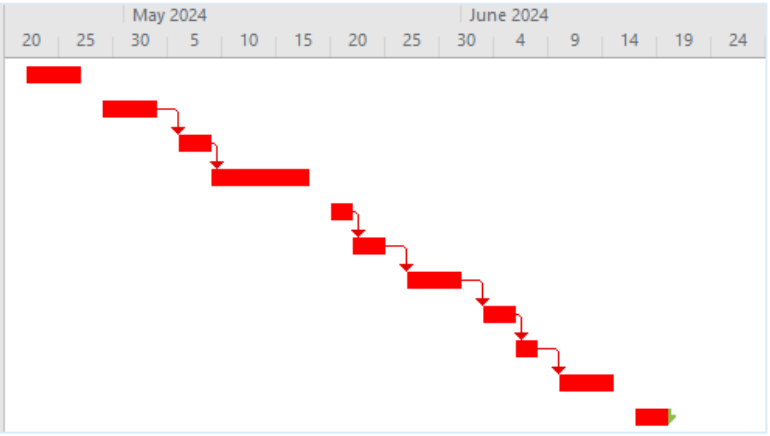


The Ideal Critical Path:

- Longest path with least amount of float
- Clean, well-linked waterfall
- Single shared total float value

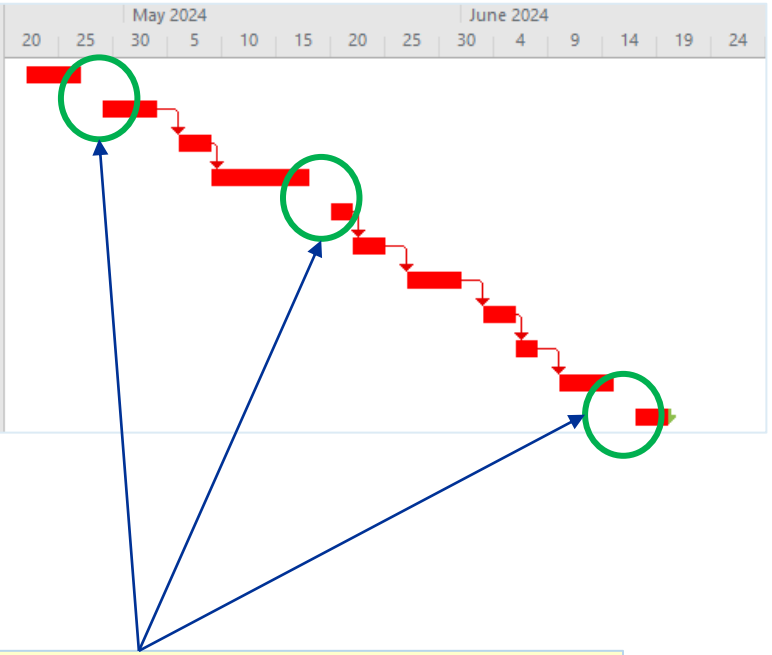
Identifying the Critical Path

Task Calendar	Dur	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



Identifying the Critical Path

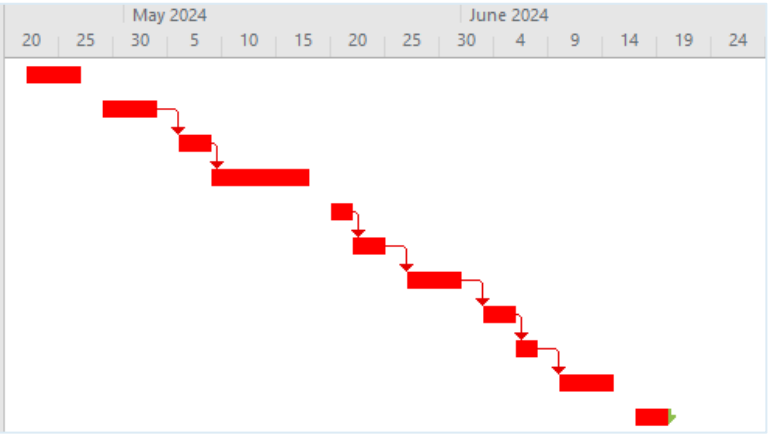
Task Calendar	Dur	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



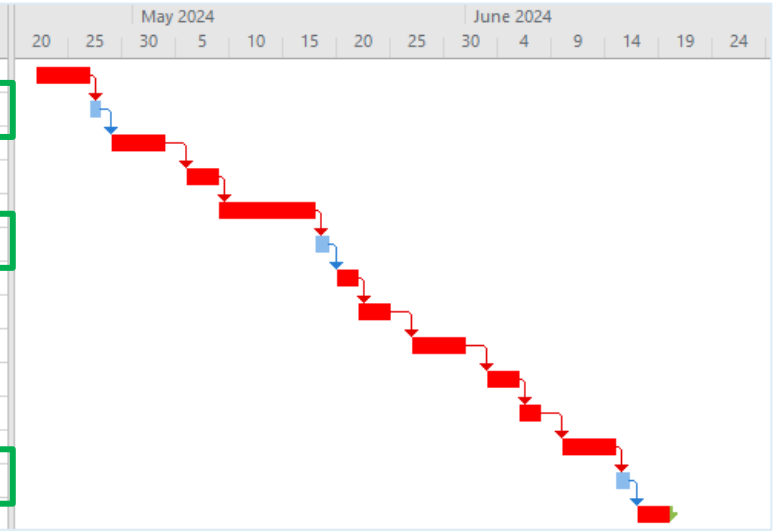
Gaps in the constrained critical path

Identifying the Critical Path

Task Calendar	Dur	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
Standard	3 days	0 days	6/17/2024	6/19/2024

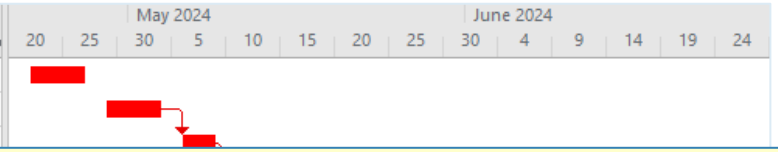


Task Calendar	Dur	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	3 days	4.88 days	4/26/2024	4/27/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
24 Hours	5 days	2.88 days	5/17/2024	5/19/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
24 Hours	5 days	2.88 days	6/14/2024	6/16/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



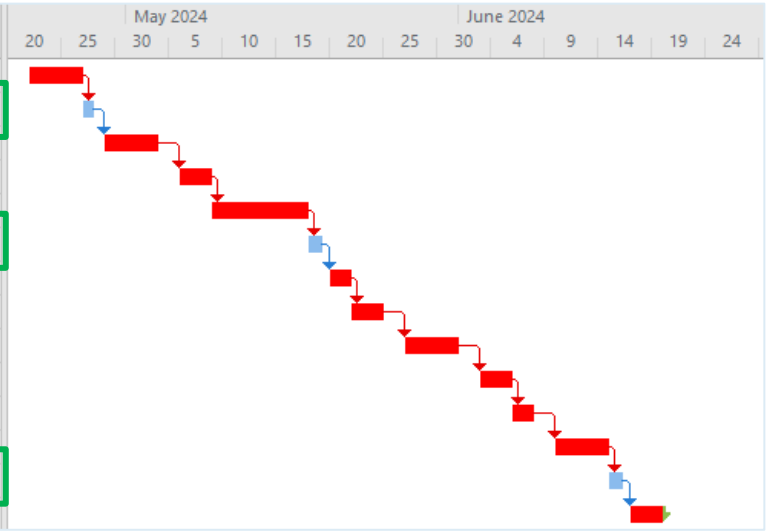
Identifying the Critical Path

Task Calendar	Dur	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/
Standard	2 days	0 days	5/20/2024	5/21/
Standard	3 days	0 days	5/22/2024	5/24/
Standard	5 days	0 days	5/27/2024	5/31/
Standard	3 days	0 days	6/3/2024	6/5/
Standard	2 days	0 days	6/6/2024	6/7/
Standard	5 days	0 days	6/10/2024	6/14/
Standard	3 days	0 days	6/17/2024	6/19/



> "The threshold for total float criticality may need to be raised to capture the entire critical path, which in turn complicates the tracking of near-critical paths."
>
> *– GAO Schedule Assessment Guide (GAO-16-89G)*

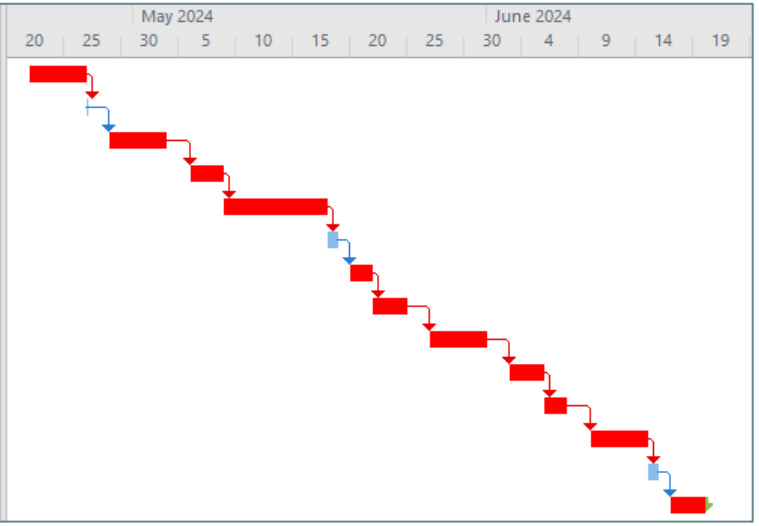
Task Calendar	Dur	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	3 days	4.88 days	4/26/2024	4/27/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
24 Hours	5 days	2.88 days	5/17/2024	5/19/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
24 Hours	5 days	2.88 days	6/14/2024	6/16/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



Identifying the Critical Path

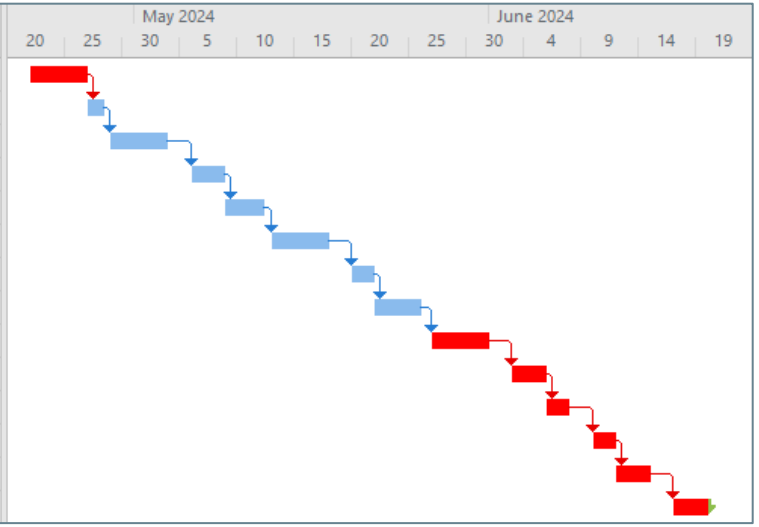
Path A

Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	1.5 days	6.38 days	4/26/2024	4/27/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
24 Hours	3 days	4.88 days	5/17/2024	5/18/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
24 Hours	3 days	4.88 days	6/14/2024	6/15/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



Path B

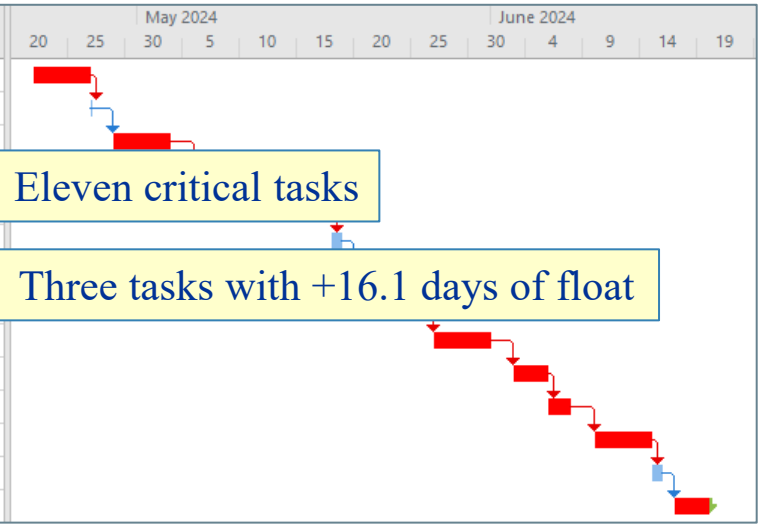
Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	5 days	6.88 days	4/26/2024	4/28/2024
Standard	5 days	1.88 days	4/29/2024	5/3/2024
Standard	3 days	1.88 days	5/6/2024	5/8/2024
24 Hours	11 days	5.88 days	5/8/2024	5/12/2024
Standard	5 days	1 day	5/13/2024	5/17/2024
Standard	2 days	1 day	5/20/2024	5/21/2024
24 Hours	12 days	4.88 days	5/21/2024	5/25/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	2 days	0 days	6/10/2024	6/11/2024
Standard	3 days	0 days	6/12/2024	6/14/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



Identifying the Critical Path

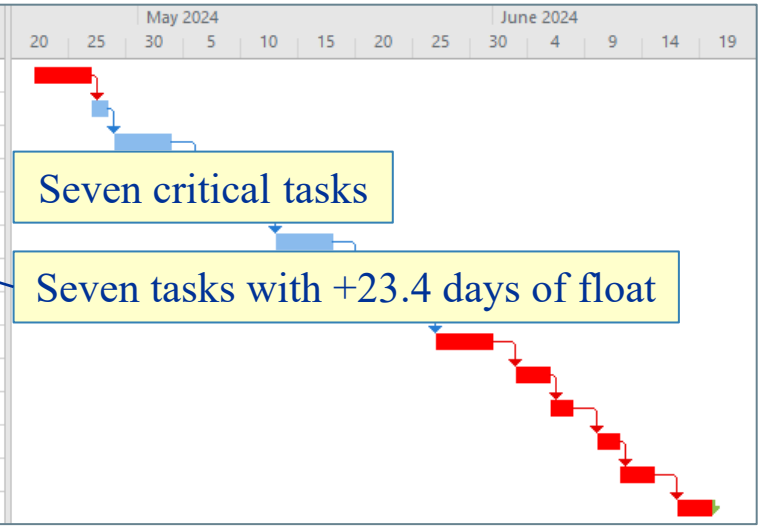
Path A

Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	1.5 days	6.38 days	4/26/2024	4/27/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
24 Hours	3 days	4.88 days	5/17/2024	5/18/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
24 Hours	3 days	4.88 days	6/14/2024	6/15/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



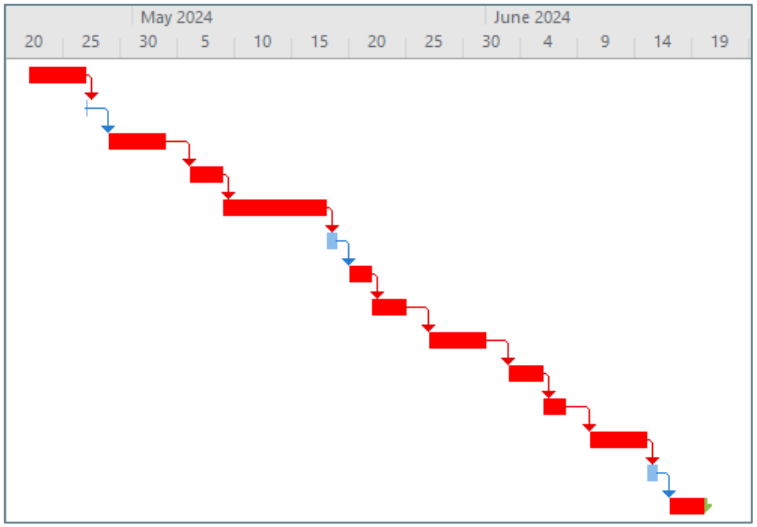
Path B

Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	5 days	6.88 days	4/26/2024	4/28/2024
Standard	5 days	1.88 days	4/29/2024	5/3/2024
Standard	3 days	1.88 days	5/6/2024	5/8/2024
24 Hours	11 days	5.88 days	5/8/2024	5/12/2024
Standard	5 days	1 day	5/13/2024	5/17/2024
Standard	2 days	1 day	5/20/2024	5/21/2024
24 Hours	12 days	4.88 days	5/21/2024	5/25/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	2 days	0 days	6/10/2024	6/11/2024
Standard	3 days	0 days	6/12/2024	6/14/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



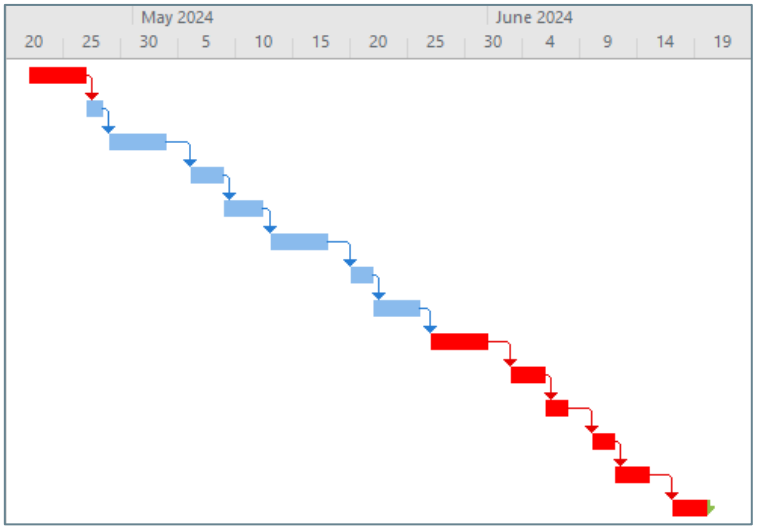
Identifying the Critical Path

Path A



Slip	Final Task Float
0d	**0d**
1d	-3d
2d	-4d
3d	**-5d**
4d	**-5d**

Path B

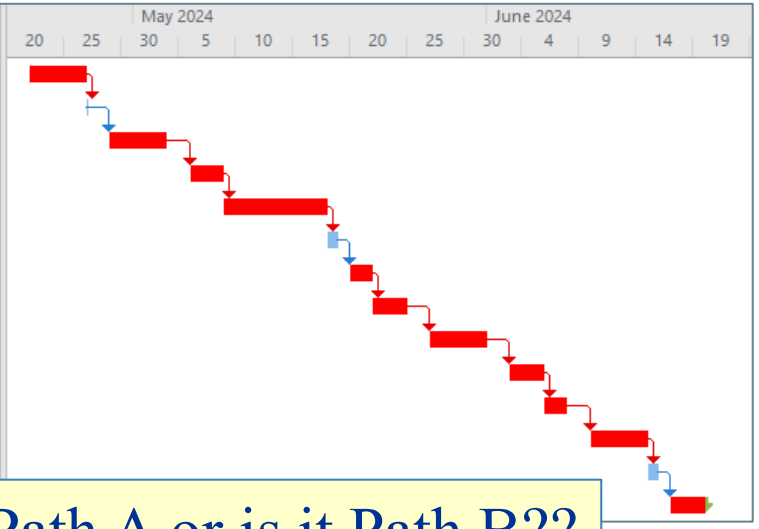


Slip	Final Task Float
0d	**0d**
1d	**-5d**
2d	**-5d**
3d	**-5d**
4d	**-5d**

Identifying the Critical Path

Path A

Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	1.5 days	6.38 days	4/26/2024	4/27/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
24 Hours	3 days	4.88 days	5/17/2024	5/18/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/2024	5/24/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	5 days	0 days	6/10/2024	6/14/2024
24 Hours	3 days	4.88 days	6/14/2024	6/15/2024
Standard				



Is the critical path Path A or is it Path B??

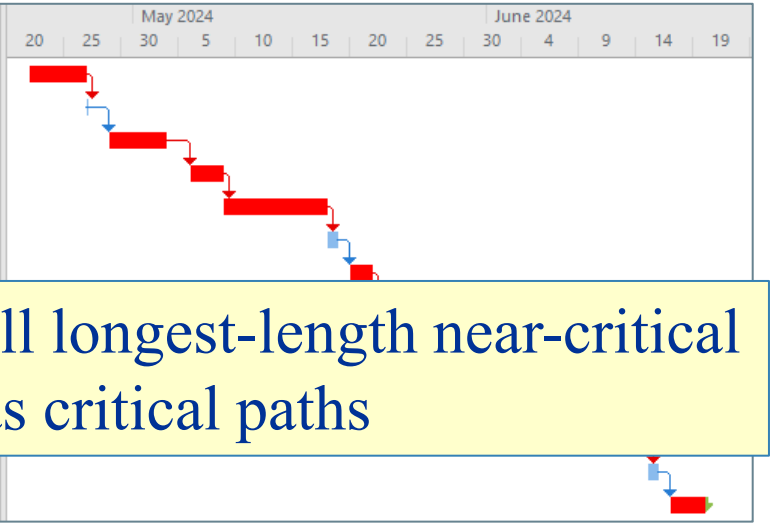
Path B

Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	5 days	6.88 days	4/26/2024	4/28/2024
Standard	5 days	1.88 days	4/29/2024	5/3/2024
Standard	3 days	1.88 days	5/6/2024	5/8/2024
24 Hours	11 days	5.88 days	5/8/2024	5/12/2024
Standard	5 days	1 day	5/13/2024	5/17/2024
Standard	2 days	1 day	5/20/2024	5/21/2024
24 Hours	12 days	4.88 days	5/21/2024	5/25/2024
Standard	5 days	0 days	5/27/2024	5/31/2024
Standard	3 days	0 days	6/3/2024	6/5/2024
Standard	2 days	0 days	6/6/2024	6/7/2024
Standard	2 days	0 days	6/10/2024	6/11/2024
Standard	3 days	0 days	6/12/2024	6/14/2024
Standard	3 days	0 days	6/17/2024	6/19/2024

Identifying the Critical Path

Path A

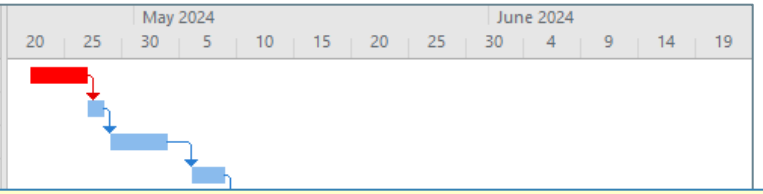
Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	1.5 days	6.38 days	4/26/2024	4/27/2024
Standard	5 days	0 days	4/29/2024	5/3/2024
Standard	3 days	0 days	5/6/2024	5/8/2024
Standard	7 days	0 days	5/9/2024	5/17/2024
24 Hours	3 days	4.88 days	5/17/2024	5/18/2024
Standard	2 days	0 days	5/20/2024	5/21/2024
Standard	3 days	0 days	5/22/	
Standard	5 days	0 days	5/27/	
Standard	3 days	0 days	6/3/	
Standard	2 days	0 days	6/6/	
Standard	5 days	0 days	6/10/	
24 Hours	3 days	4.88 days	6/14/2024	6/15/2024
Standard	3 days	0 days	6/17/2024	6/19/2024



Treat all longest-length near-critical paths as critical paths

Path B

Task Calendar	Duration	Total Float	Start	Finish
Standard	5 days	0 days	4/22/2024	4/26/2024
24 Hours	5 days	6.88 days	4/26/2024	4/28/2024
Standard	5 days	1.88 days	4/29/2024	5/3/2024
Standard	3 days	1.88 days	5/6/2024	5/8/2024
24 Hours	11 days	5.88 days	5/8/202	
Standard	5 days	1 day	5/13/202	
Standard	2 days	1 day	5/20/202	
24 Hours	12 days	4.88 days	5/21/202	
Standard	5 days	0 days	5/27/202	
Standard	3 days	0 days	6/3/202	
Standard	2 days	0 days	6/6/202	
Standard	2 days	0 days	6/10/202	
Standard	3 days	0 days	6/12/202	
Standard	3 days	0 days	6/17/202	

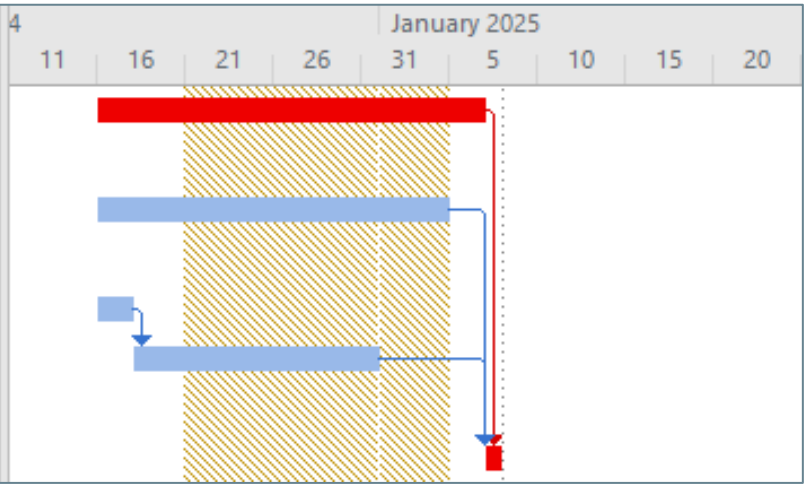


"Because the longest path makes no reference to total float, <the longest path> is the only guaranteed method of identifying the driving sequence of activities when using multiple calendars."

– GAO Schedule Assessment Guide (GAO-16-89G)

Large Calendar Gaps

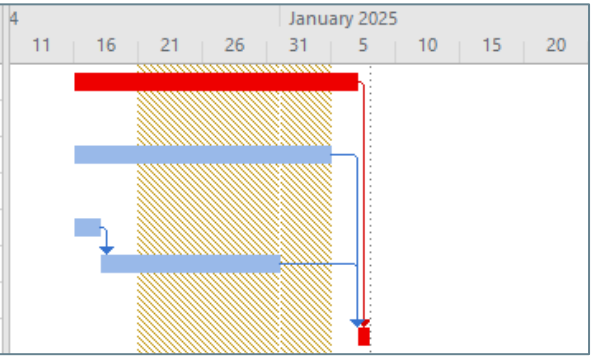
Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	0 days	12/16/2024	1/6/2025
None	20 edays	2 edays	12/16/2024	1/5/2025
Standard	2 days	1 day	12/16/2024	12/17/2024
None	14 edays	6.63 edays	12/17/2024	12/31/2024
Standard	1 day	0 days	1/7/2025	1/7/2025



- Schedule example of a long holiday break
  - First path: standard calendar
  - Second path: elapsed days only
  - Third path: standard calendar linked to elapsed days

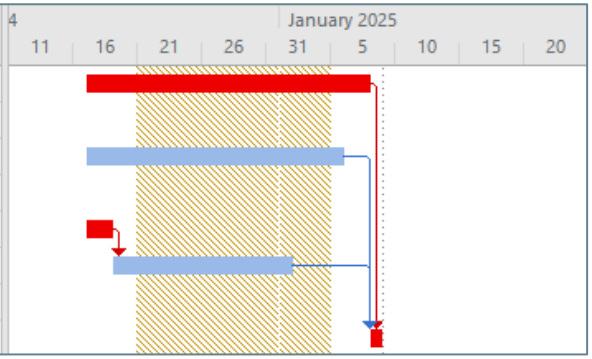
Large Calendar Gaps

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	0 days	12/16/2024	1/6/2025
None	20 edays	2 edays	12/16/2024	1/5/2025
Standard	2 days	1 day	12/16/2024	12/17/2024
None	14 edays	6.63 edays	12/17/2024	12/31/2024
Standard	1 day	0 days	1/7/2025	1/7/2025



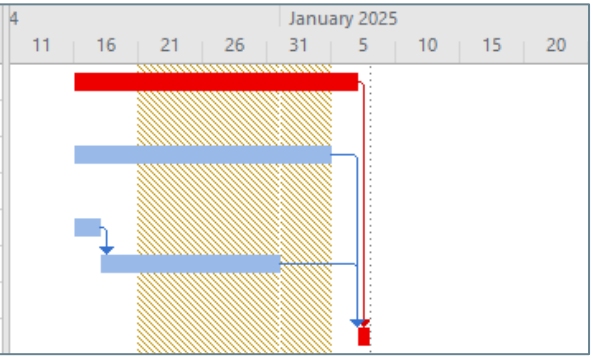
1-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	-1 day	12/17/2024	1/7/2025
None	20 edays	1 eday	12/17/2024	1/6/2025
Standard	2 days	0 days	12/17/2024	12/18/2024
None	14 edays	5.63 edays	12/18/2024	1/1/2025
Standard	1 day	-1 day	1/8/2025	1/8/2025



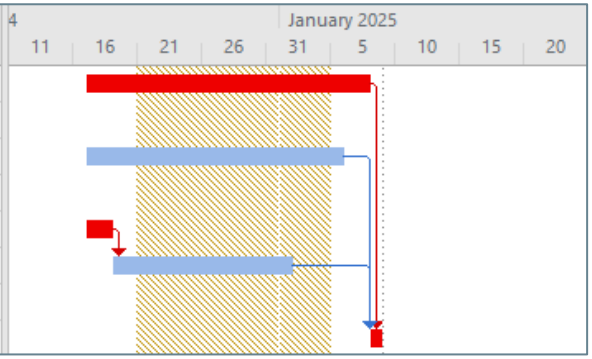
Large Calendar Gaps

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	0 days	12/16/2024	1/6/2025
None	20 edays	2 edays	12/16/2024	1/5/2025
Standard	2 days	1 day	12/16/2024	12/17/2024
None	14 edays	6.63 edays	12/17/2024	12/31/2024
Standard	1 day	0 days	1/7/2025	1/7/2025



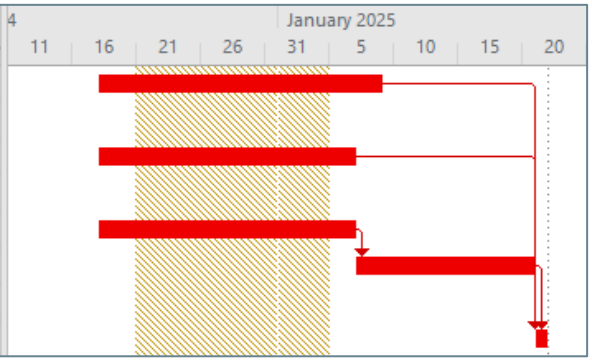
1-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	-1 day	12/17/2024	1/7/2025
None	20 edays	1 eday	12/17/2024	1/6/2025
Standard	2 days	0 days	12/17/2024	12/18/2024
None	14 edays	5.63 edays	12/18/2024	1/1/2025
Standard	1 day	-1 day	1/8/2025	1/8/2025



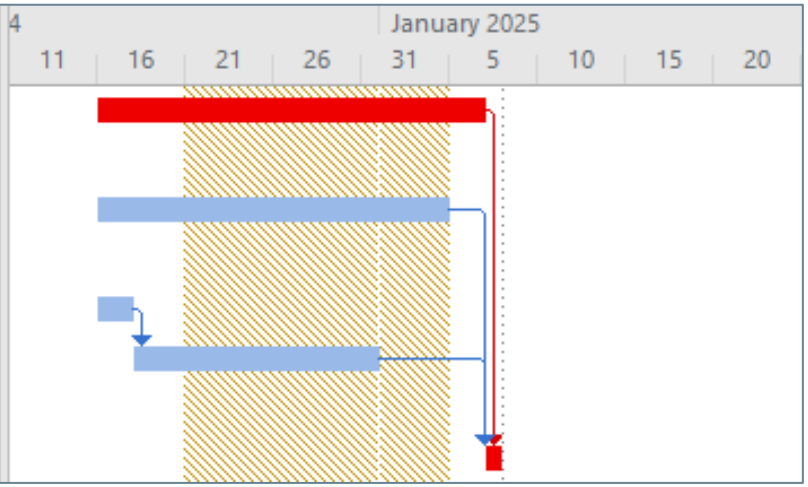
2-day slip

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	-2 days	12/18/2024	1/8/2025
None	20 edays	0 edays	12/18/2024	1/7/2025
Standard	2 days	-1 day	12/18/2024	1/6/2025
None	14 edays	-13.38 edays	1/6/2025	1/20/2025
Standard	1 day	-10 days	1/21/2025	1/21/2025



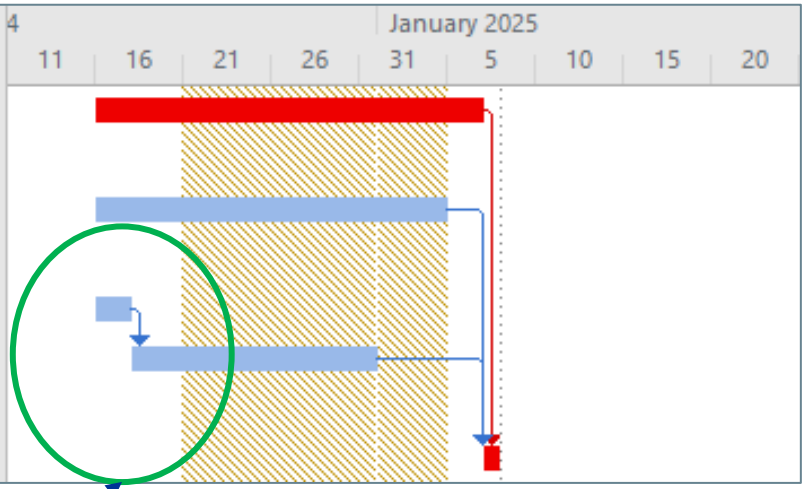
Large Calendar Gaps

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	0 days	12/16/2024	1/6/2025
None	20 edays	2 edays	12/16/2024	1/5/2025
Standard	2 days	1 day	12/16/2024	12/17/2024
None	14 edays	6.63 edays	12/17/2024	12/31/2024
Standard	1 day	0 days	1/7/2025	1/7/2025



Large Calendar Gaps

Task Calendar	Dur	Total Float	Start	Finish
Standard	4 days	0 days	12/16/2024	1/6/2025
None	20 edays	2 edays	12/16/2024	1/5/2025
Standard	2 days	1 day	12/16/2024	12/17/2024
None	14 edays	6.63 edays	12/17/2024	12/31/2024
Standard	1 day	0 days	1/7/2025	1/7/2025



- Monitor linked tasks of different calendars that are near large non-working periods
- Trust scheduling tool calculate impacts

Summary: Analysis w/Multiple Calendars

- Identify large periods of non-working time that is not shared by all calendars
- Monitor linked tasks that have different working calendars as they approach these large periods
- Treat longest-length near-critical paths as critical paths
- Trust the scheduling tool
  - Step through areas where many calendars converge because the tasks might move unintuitively
  - Sensitivity Analysis – measure the magnitude of possible performance scenarios
- Be cognizant of the calendars used in your project

Questions?

Contact:

Michael Vallely
james.m.vallely@nasa.gov