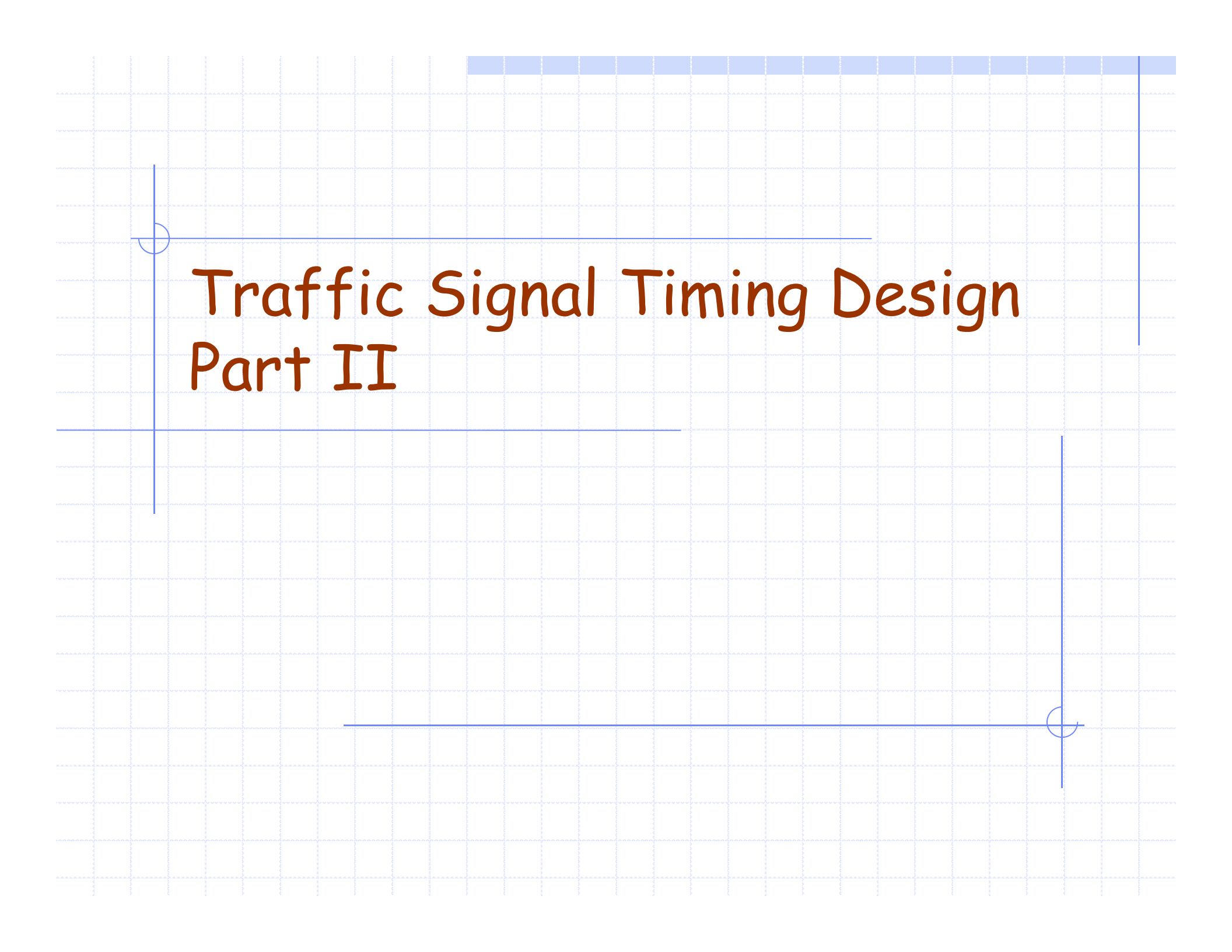
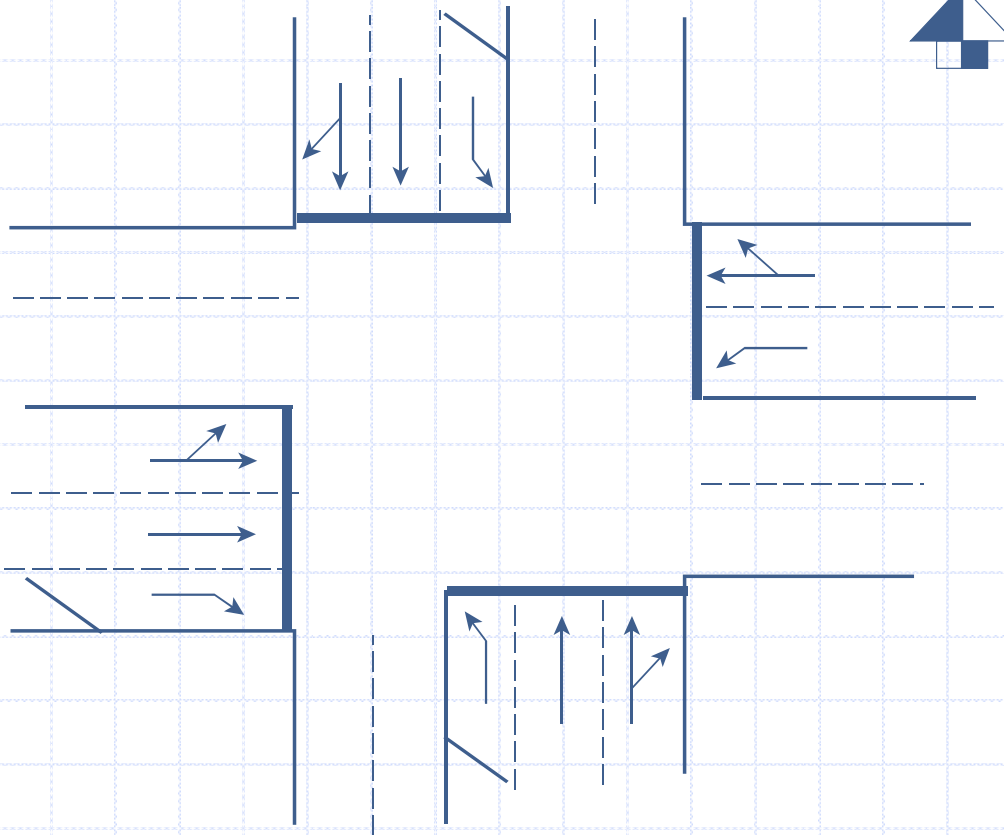




Traffic Signal Timing Design Part II



Reality!



**No single lane
all through traffic**



What to do?

- ◆ **Distribute volume among lanes to**
 - **Identify lane utilization**
 - **Determine need for lane adjustment**
 - **Estimate critical lane volumes**
- ◆ **Lane volume allocation**



Lane Volume Allocation Rules

- ◆ All turning movements are placed in exclusive left or right turn lanes, if present

100
400
200

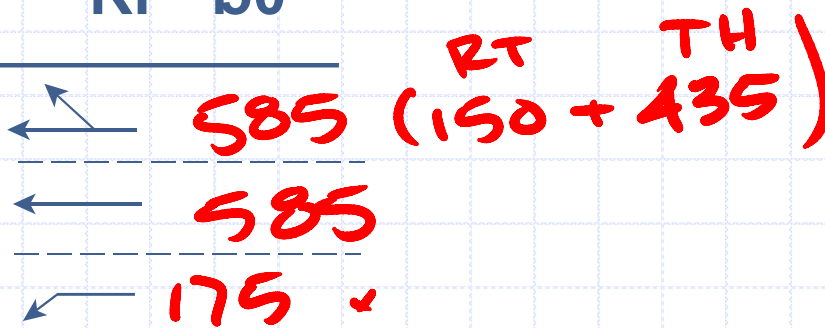
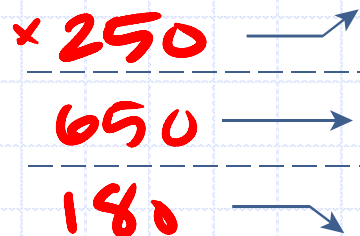
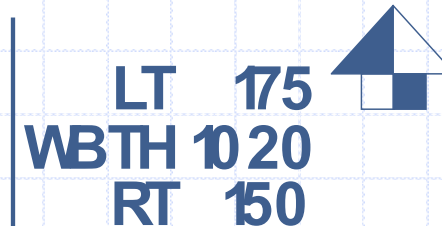
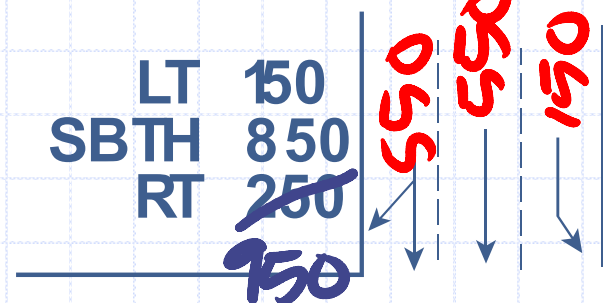
◆ Through traffic is distributed evenly among through lanes

◆ Right turns are equivalent to through movements, if no right turn lanes exist

- ◆ Shared left and through lane requires special procedure

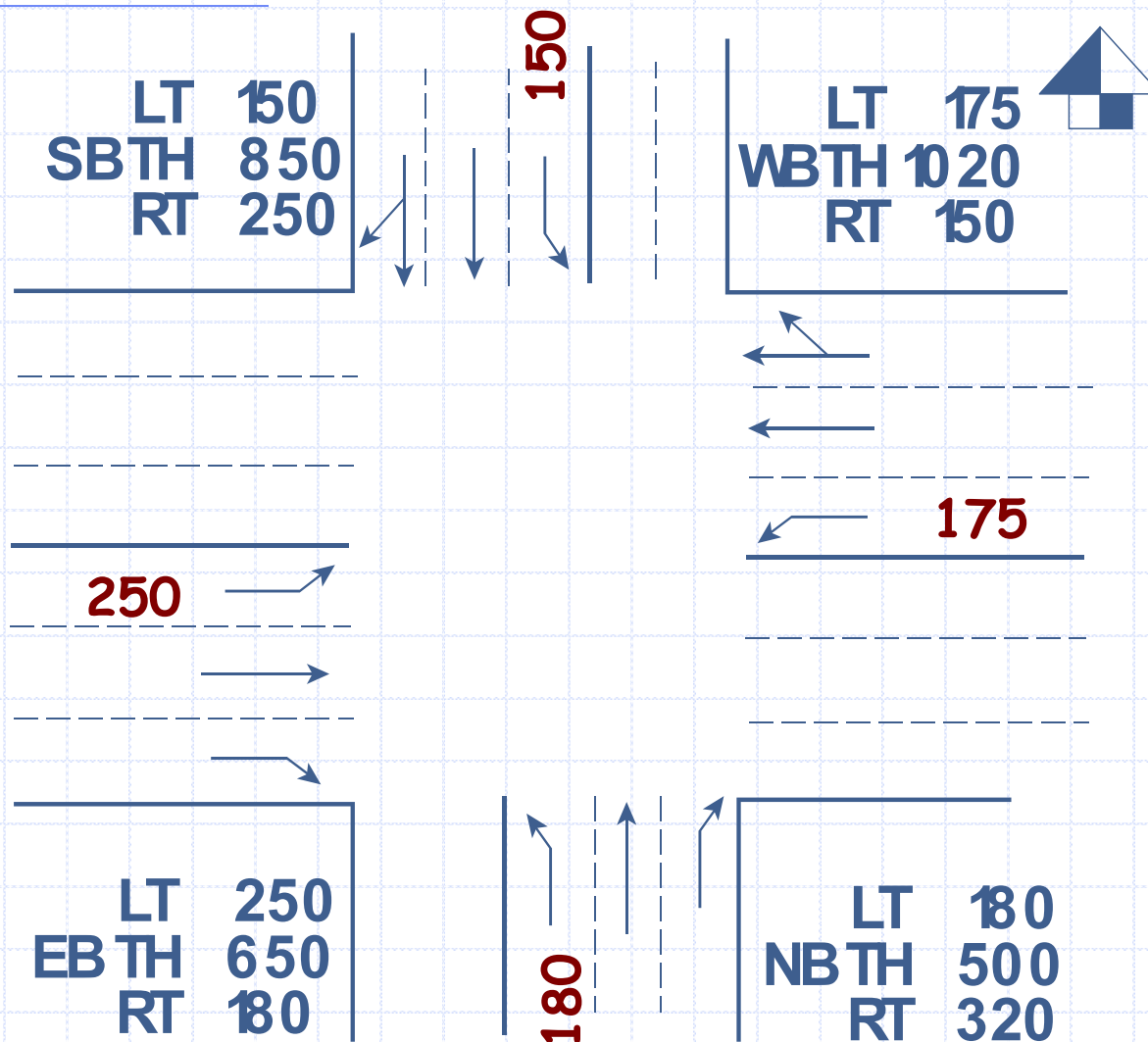


Lane Allocation Example 1





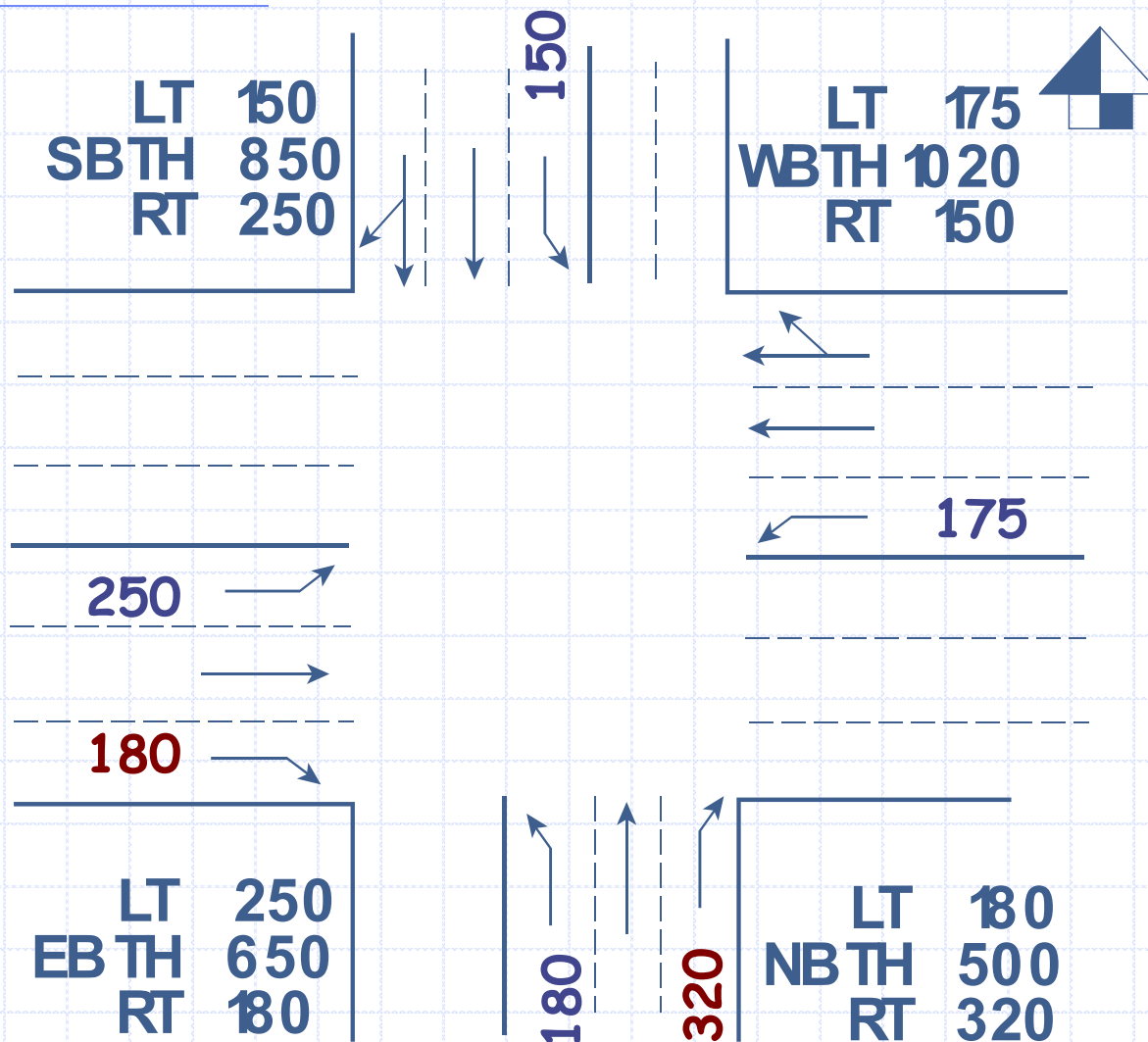
Lane Allocation Example 1



Left turns in
exclusive turn lane

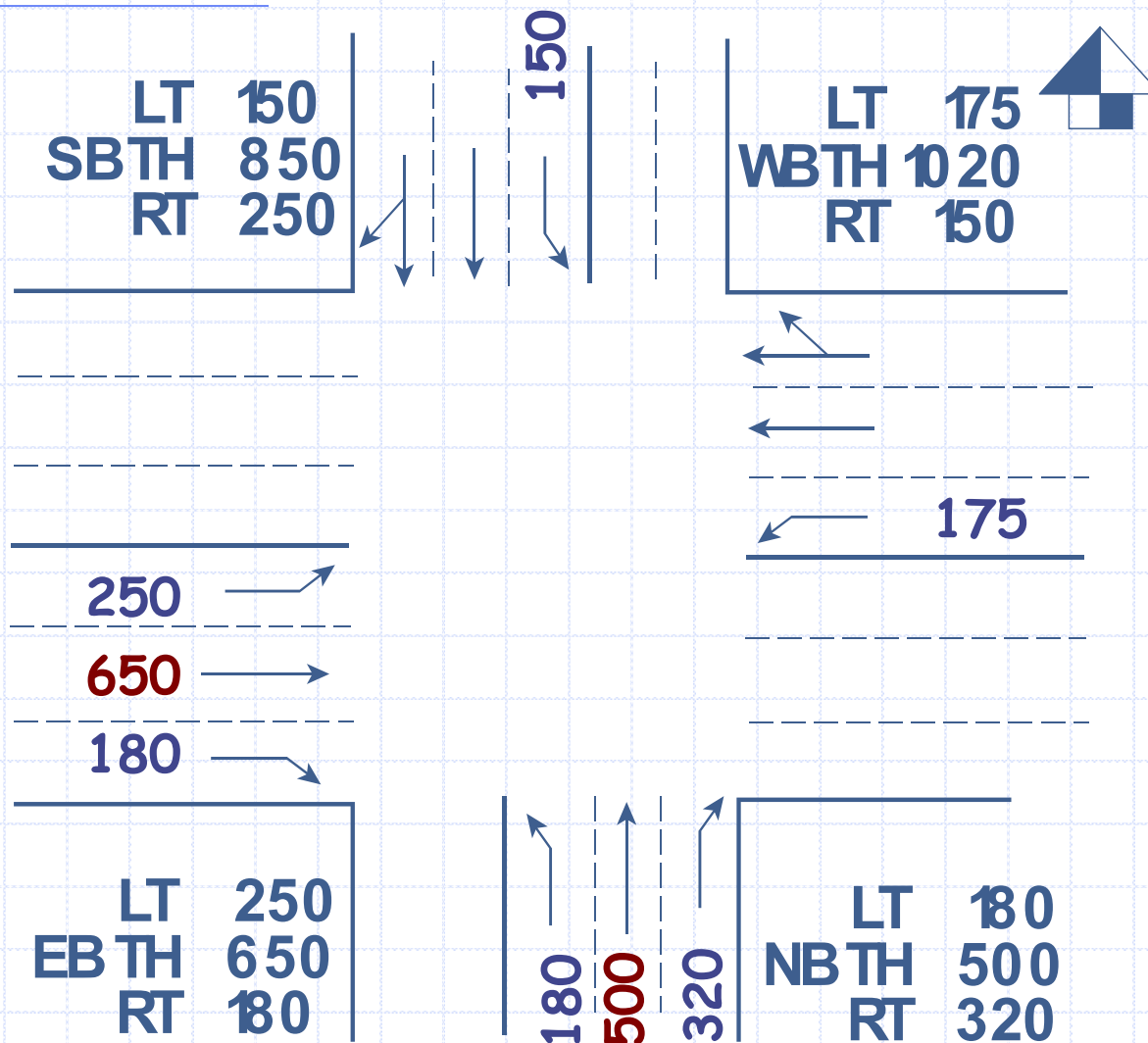


Lane Allocation Example 1





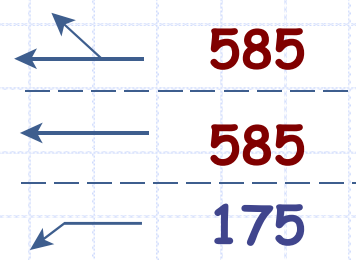
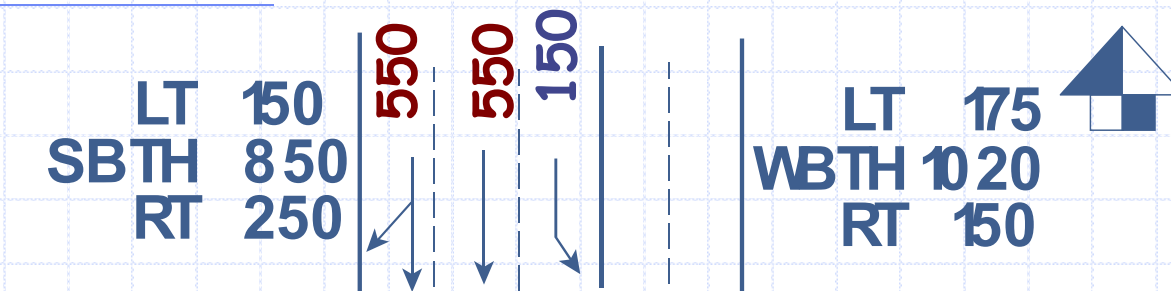
Lane Allocation Example 1



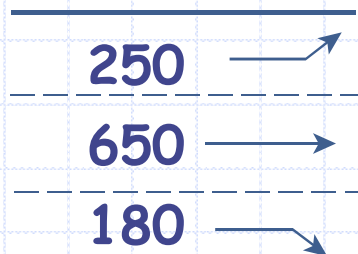
Through in single through only lanes



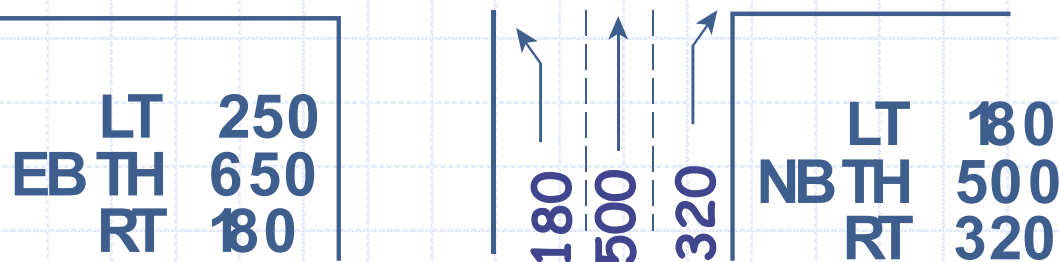
Lane Allocation Example 1



Through and right in shared lanes

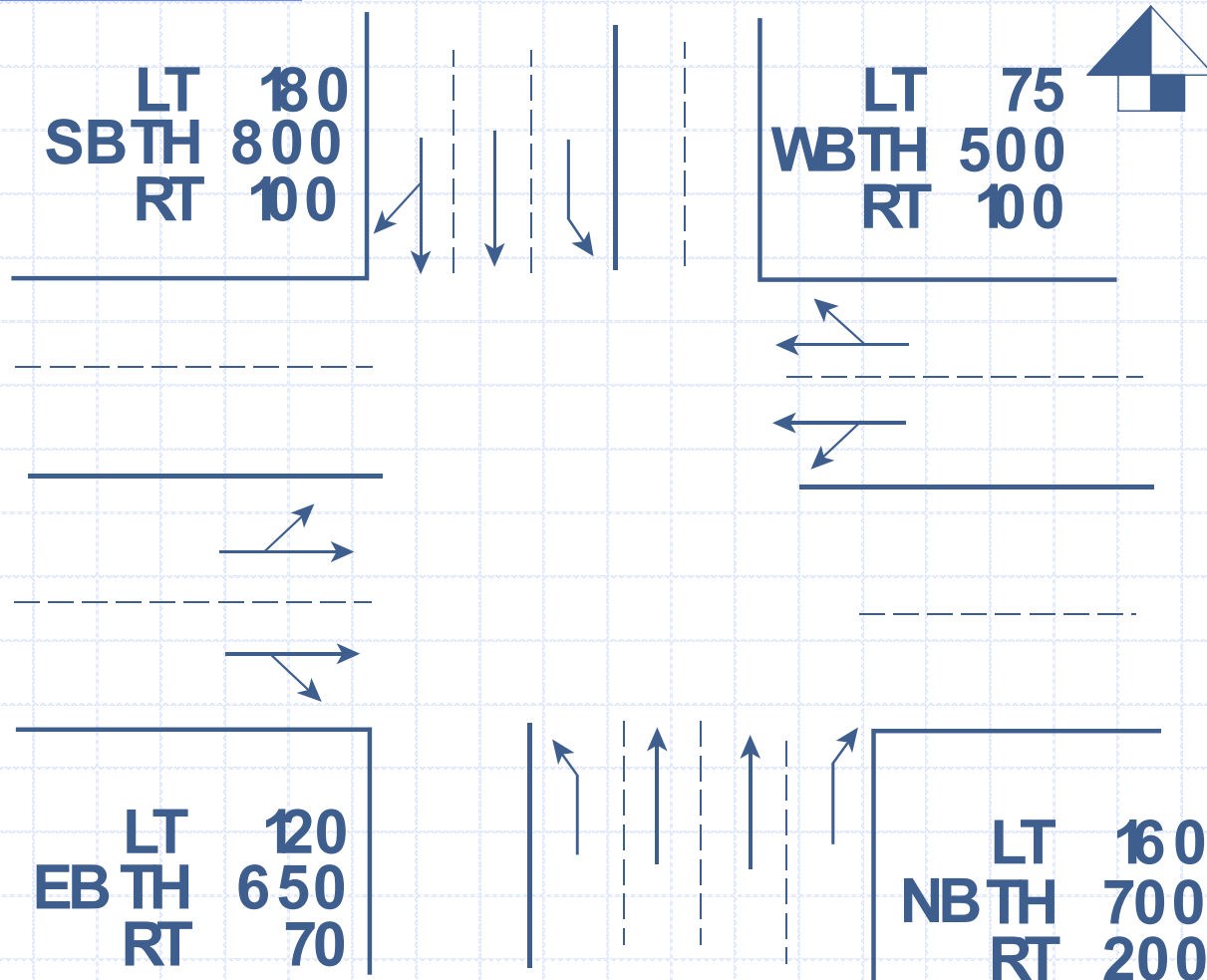


$$\begin{aligned}
 \text{WB} & (1020+150)/2 = 585 \\
 \text{SB} & (850+250)/2 = 550
 \end{aligned}$$



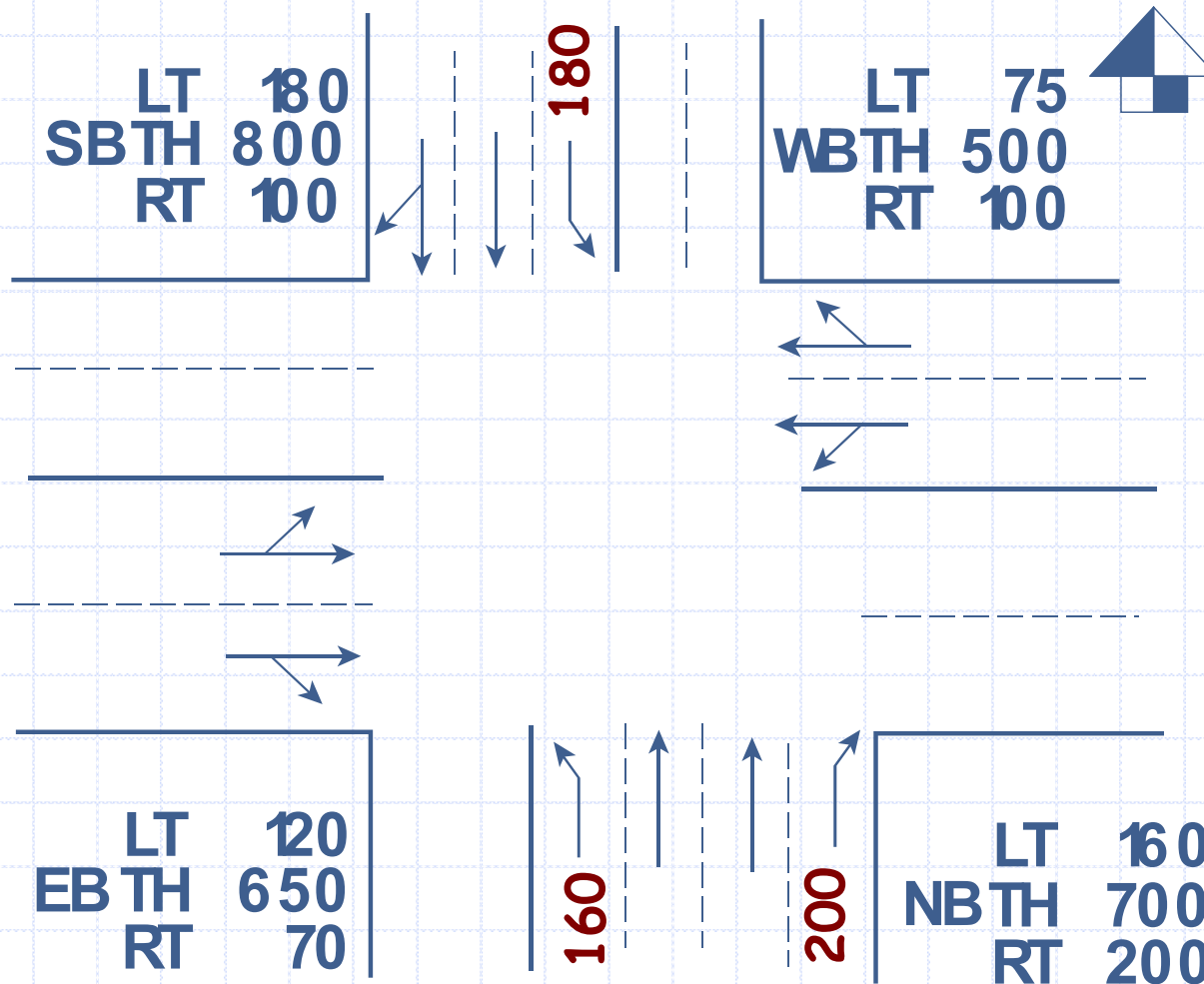


Lane Allocation Example 2





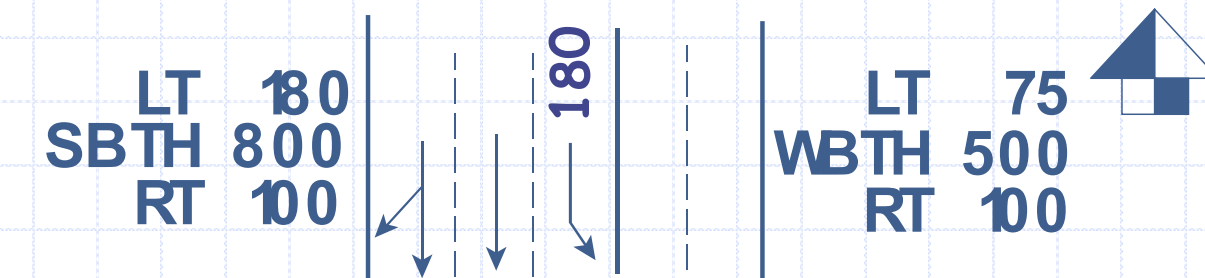
Lane Allocation Example 2



Left & right turns
exclusive turn lane

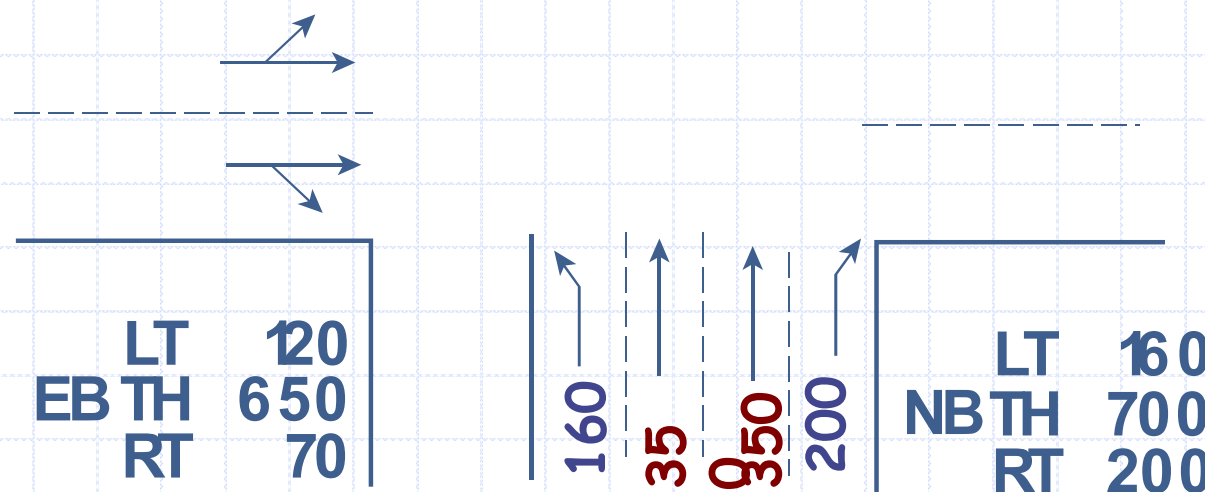


Lane Allocation Example 2



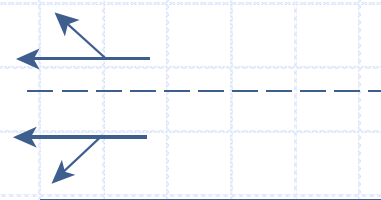
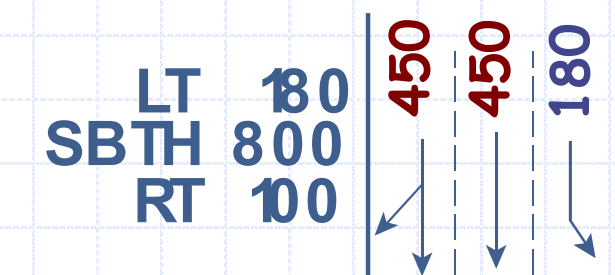
Through in
through only lanes

$$\text{NB } 700/2 = 350$$



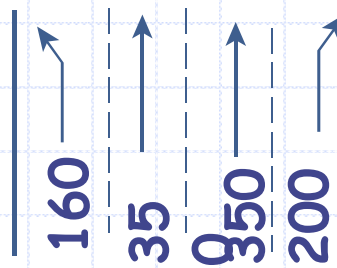
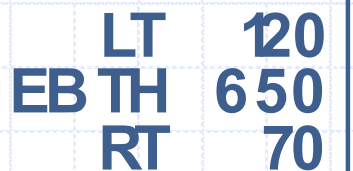
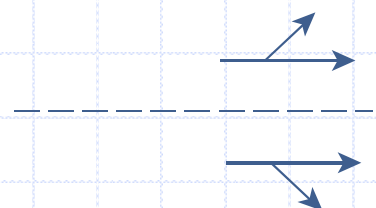


Lane Allocation Example 2



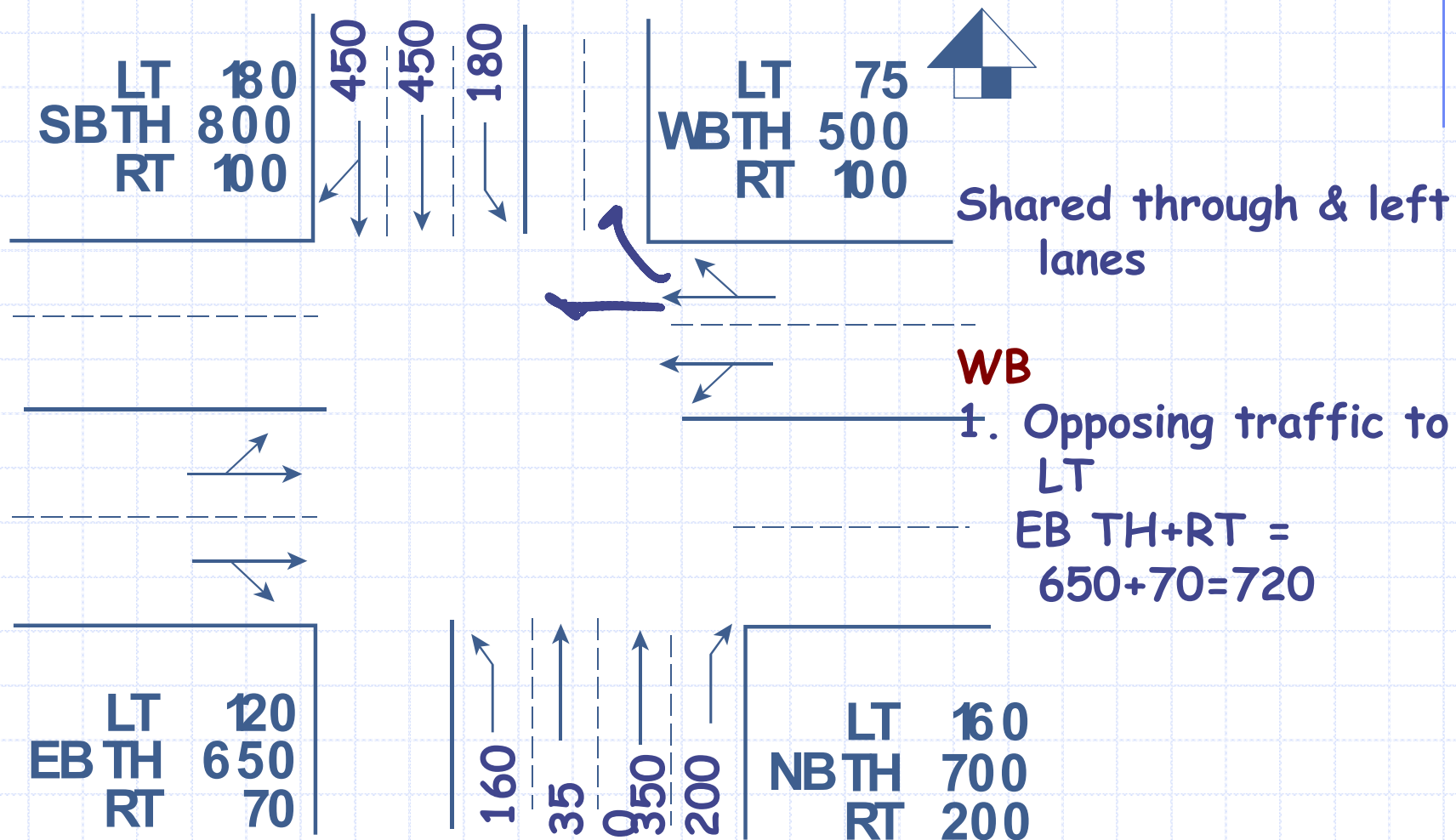
Through in shared
through & right lanes

$$SB \quad (800+100)/2 = 4$$





Lane Allocation Example 2



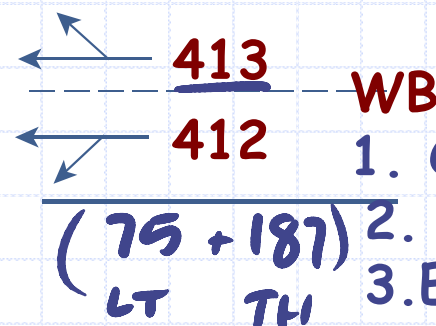
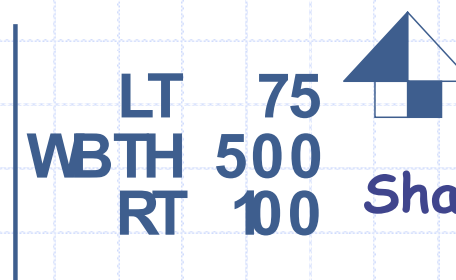
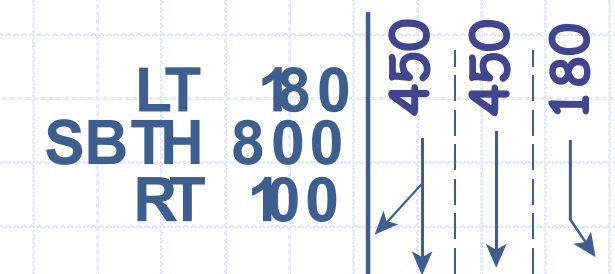
Through Vehicle Equivalents for Left Turns



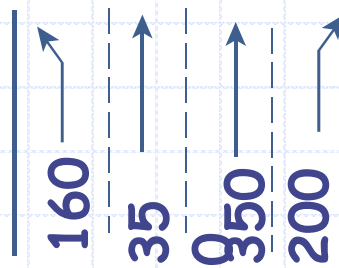
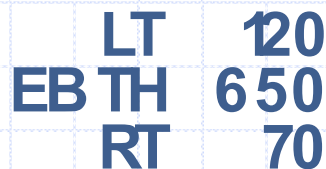
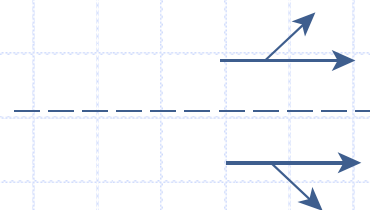
Opposing Volume Through+Right (vph)	Through Vehicle Equivalents
0-199	1.1
200-599	2.0
600-799	3.0
800-999	4.0
>1000	5.0



Lane Allocation Example 2

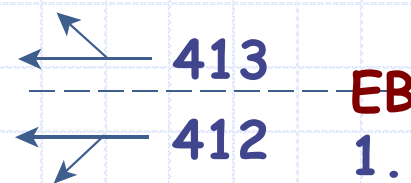
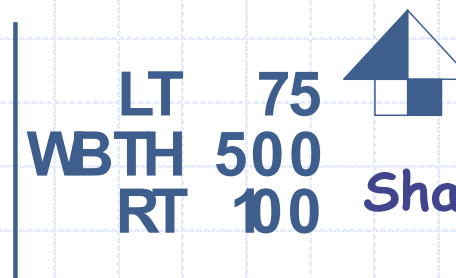
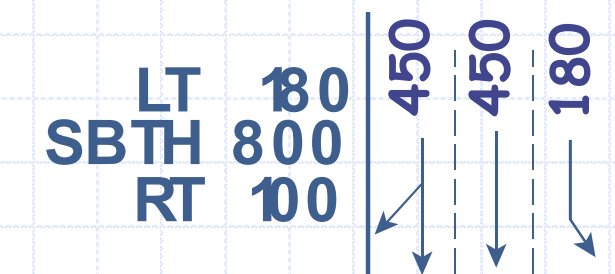


- Opposing traffic to
- LT = 3 TH
- EBTH equivalent TH
- Per lane $825/2 = 412$





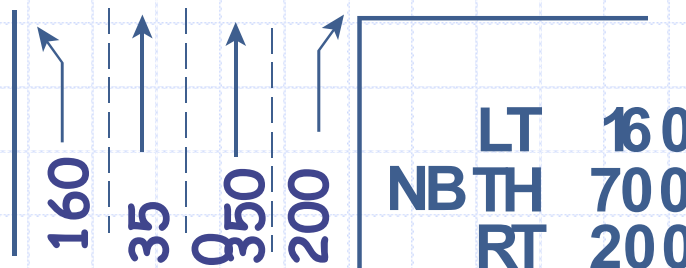
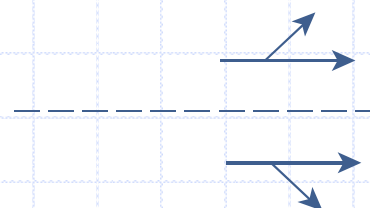
Lane Allocation Example 2



1. Opposing traffic to
LT

WB

$$TH + RT = 500 + 100 = 600$$



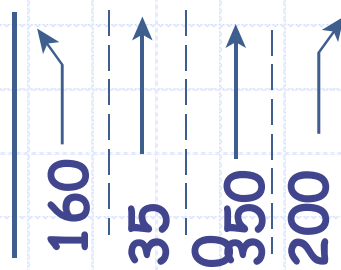
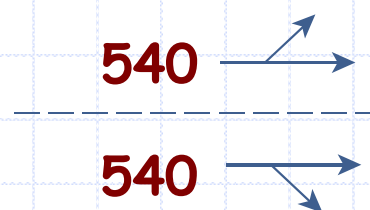
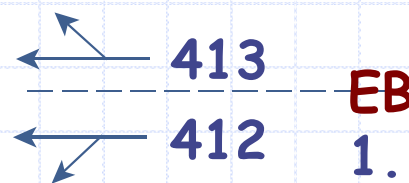
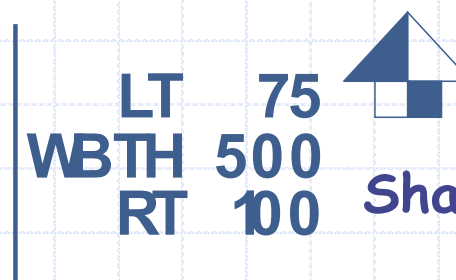
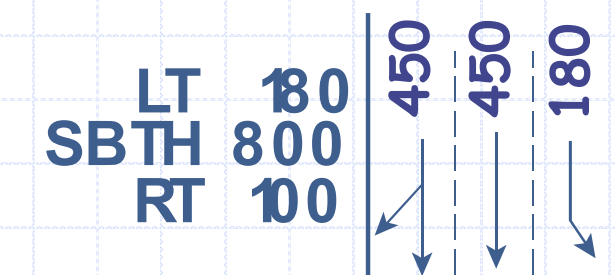
Through Vehicle Equivalents for Left Turns



Opposing Volume Through+Right (vph)	Through Vehicle Equivalents
0-199	1.1
200-599	2.0
600-799	3.0
800-999	4.0
>1000	5.0



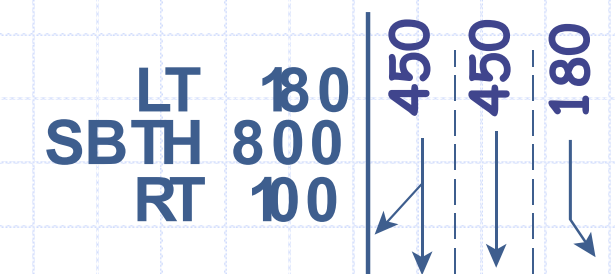
Lane Allocation Example 2



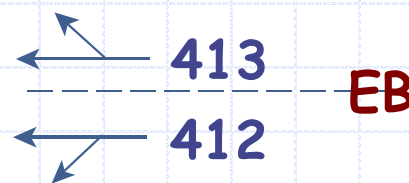
1. Opposing traffic to
2. $LT = 3 \text{ TH}$
3. Total equivalent TH
 $WBTH + 3(RT) = 500 + 300 = 800$
4. Per lane $1080/2 = 54$



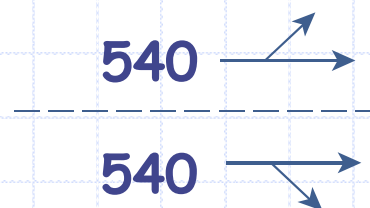
Lane Allocation Example 2



How many TH in shared lane?

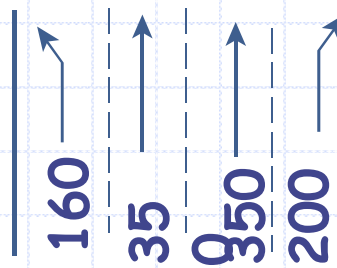


$$540 - 3(120) = 180 \text{ vph}$$



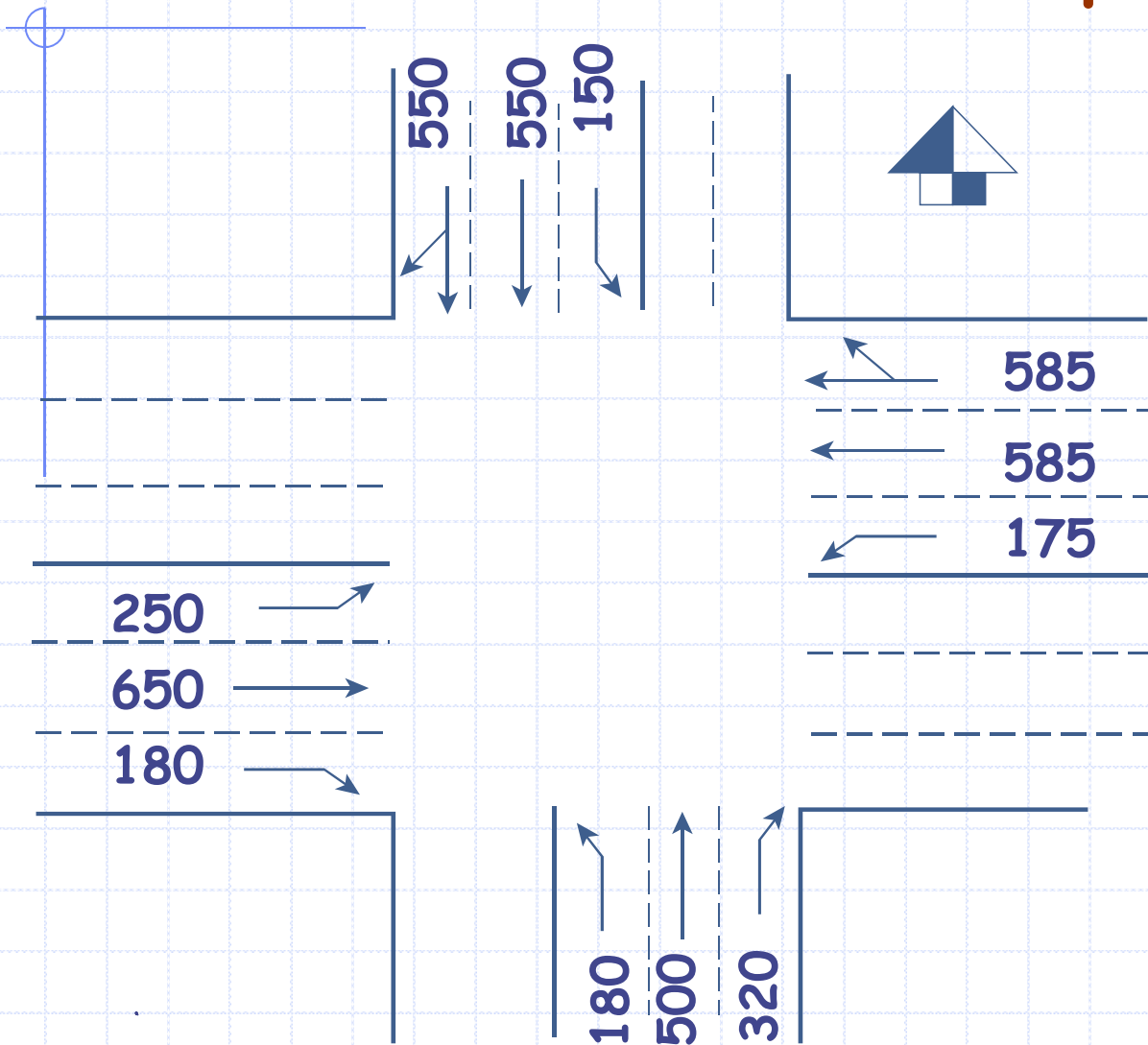
WB

$$412 - 3(75) = 187 \text{ vph}$$



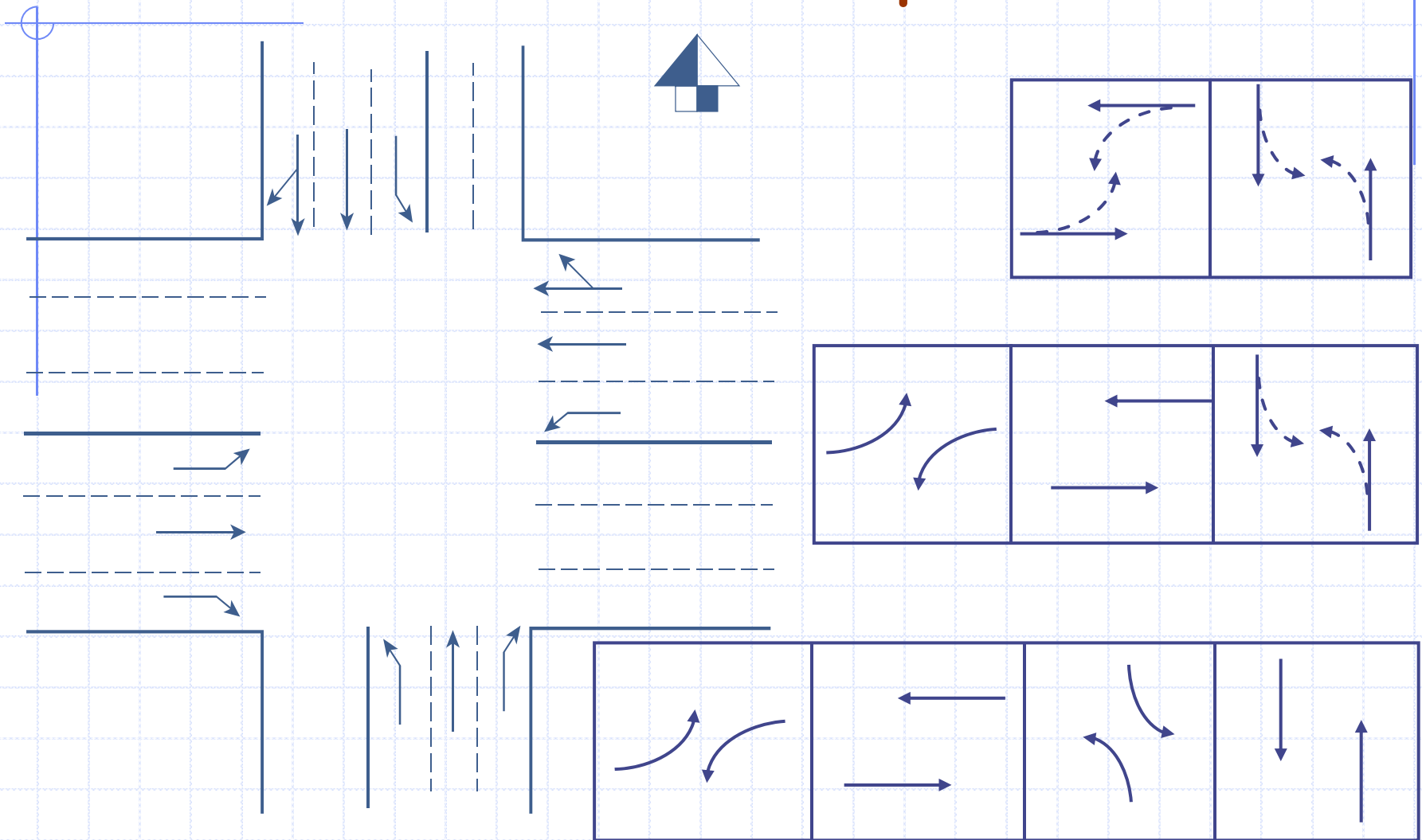


Phase Plans for Example 1



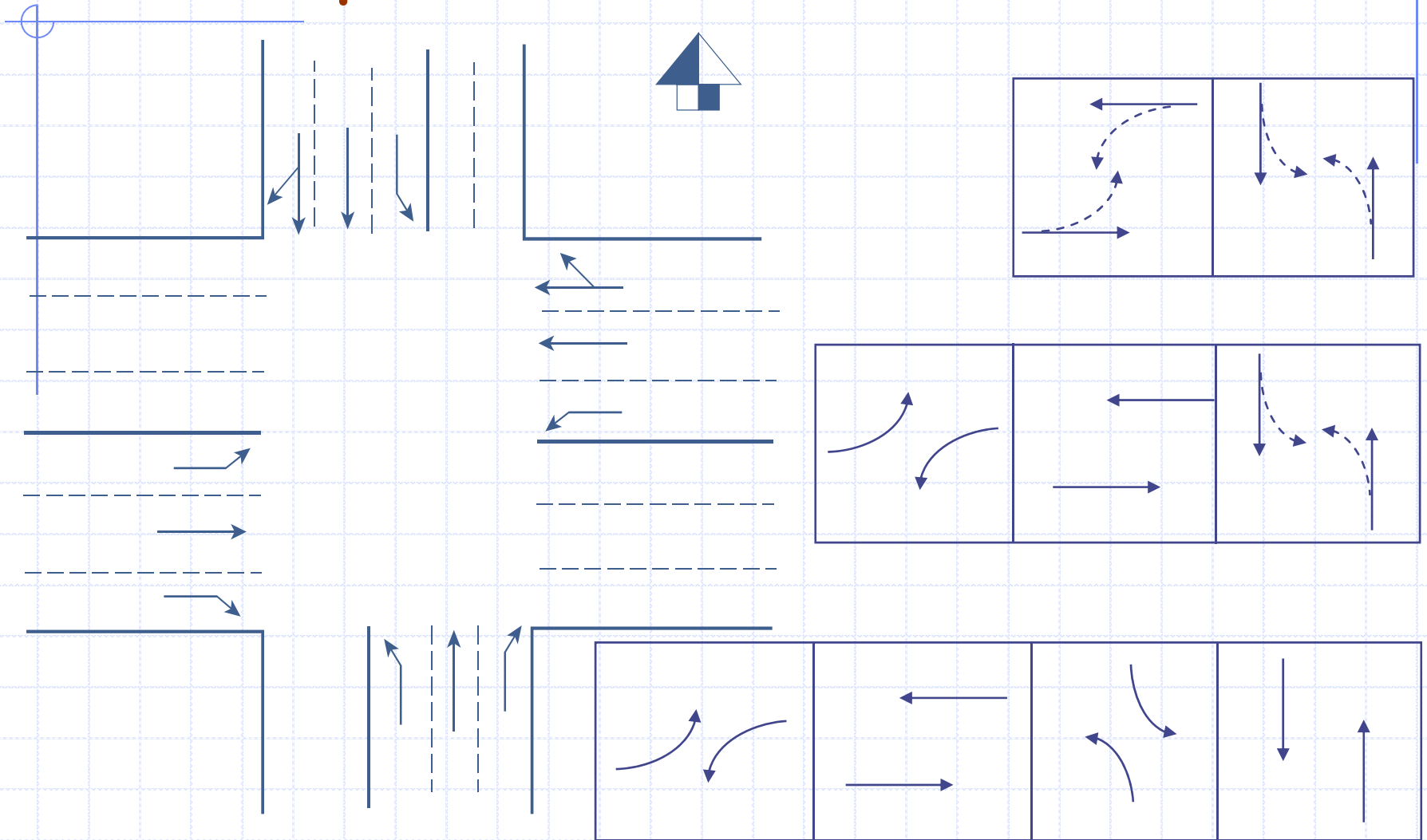
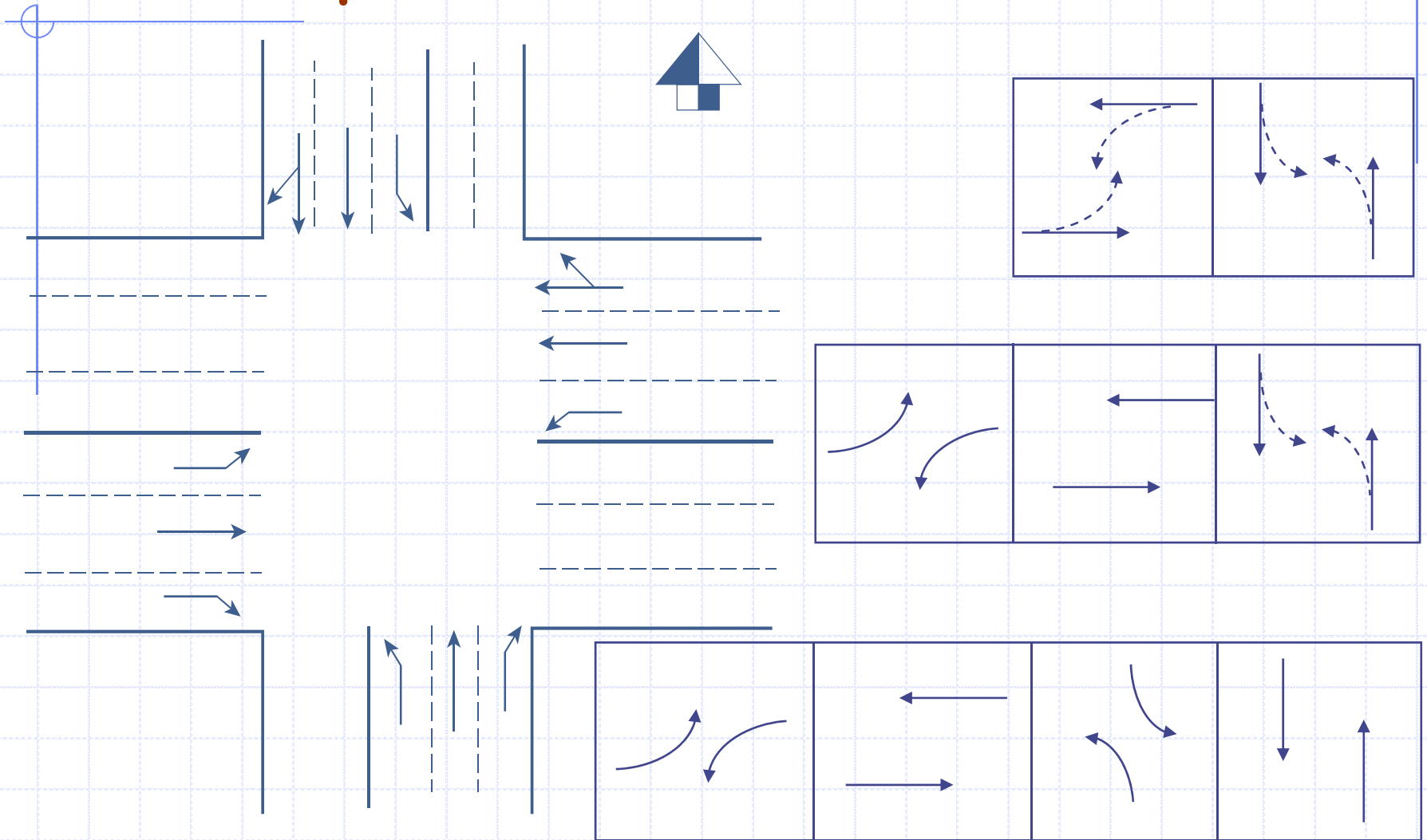


Phase Plans for Example 1





Which plan do we use?



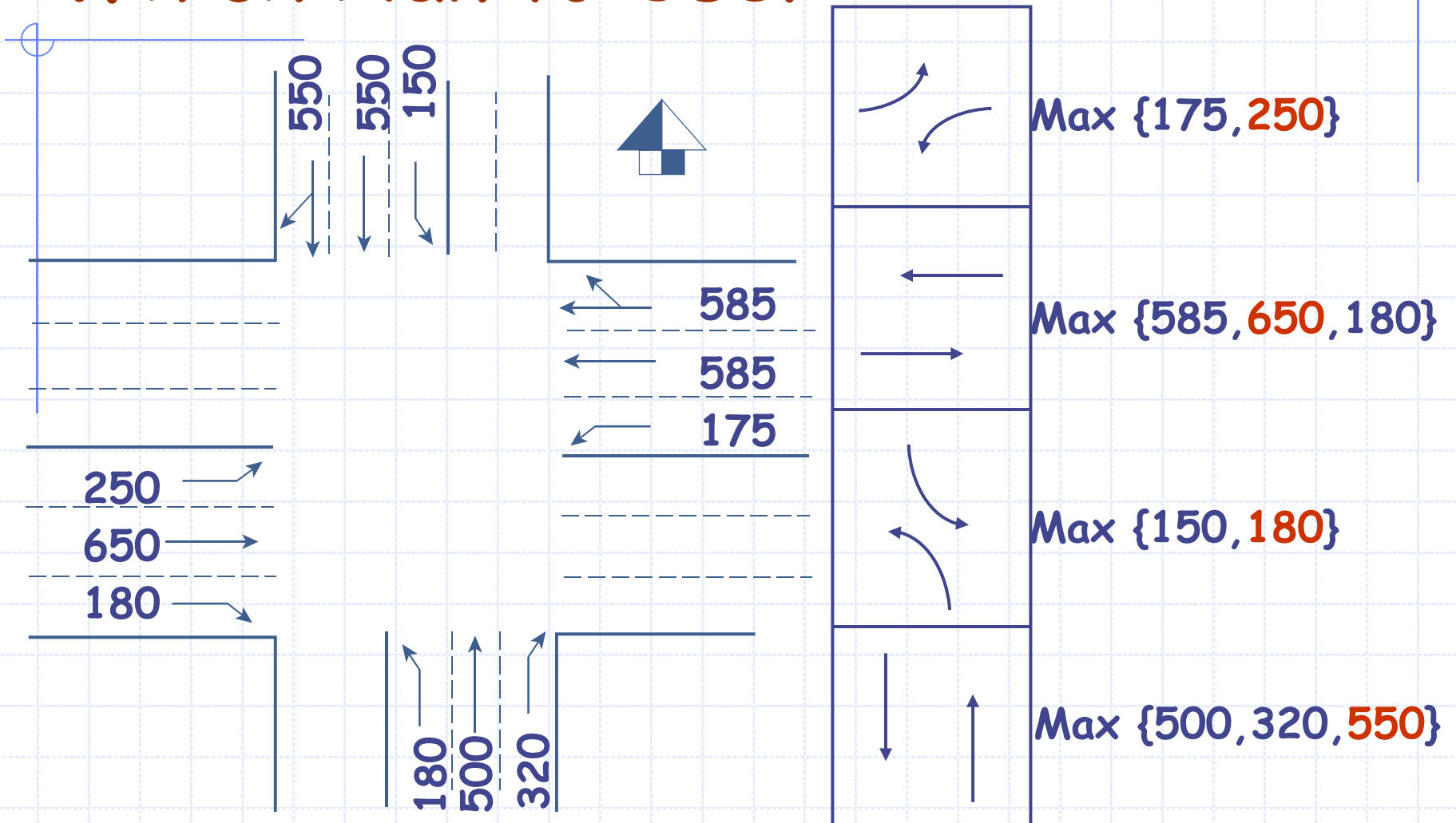


Critical Movement

- ◆ Basic assumption:
 - All movements and approaches have the same saturation flow rate
- ◆ The lane movement with the highest volume to saturation flow ratio
- ◆ LT protected
 - The highest lane volume per phase
- ◆ LT permitted
 - The highest sum of TH or RT single lane and opposing LT



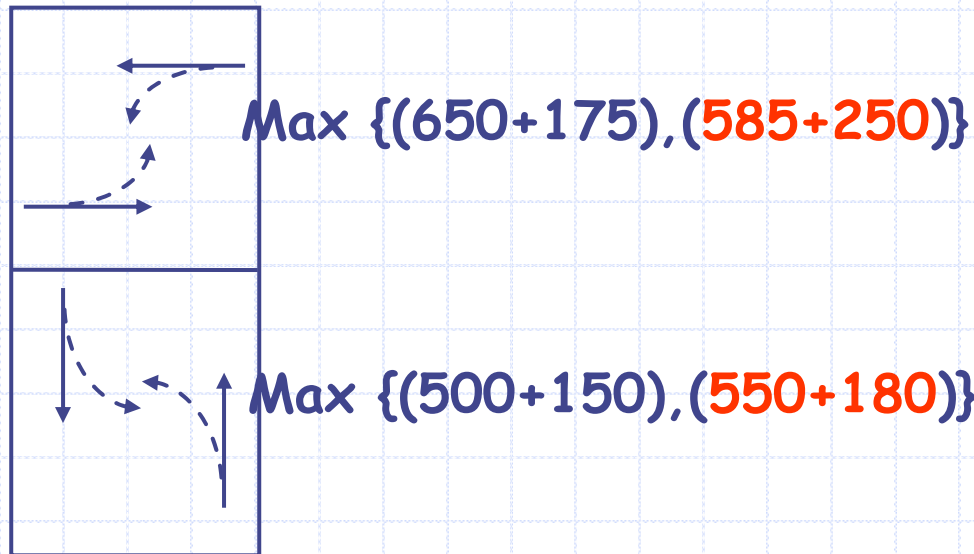
Which Plan to Use?



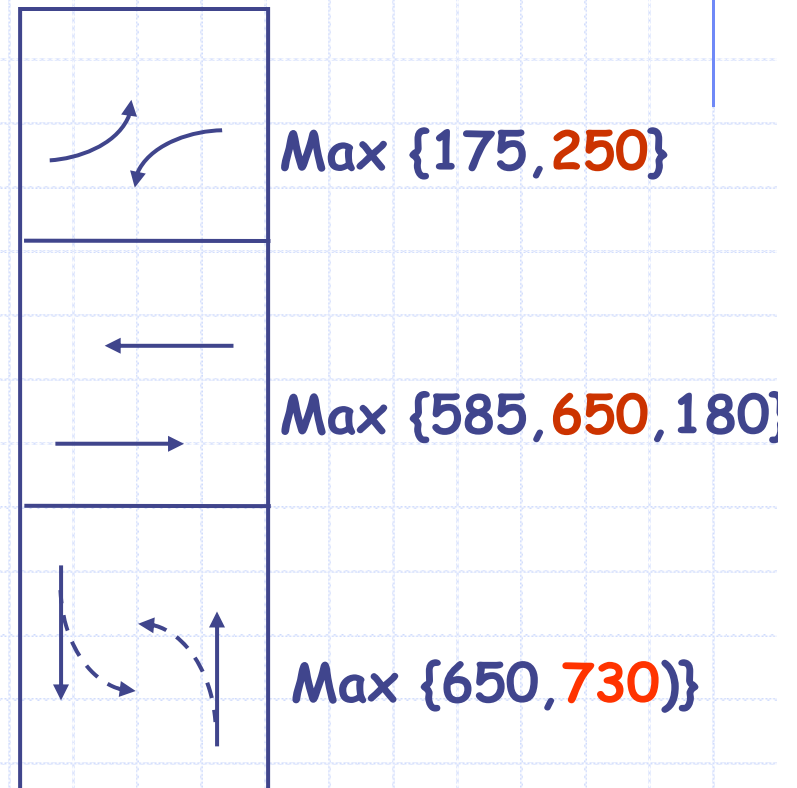
$$\Sigma_{cv} = 250 + 650 + 180 + 550 = 1630$$



Which plan do we use?



$$\Sigma_{cv} = 835+730=1565$$



$$\Sigma_{cv} = 250+650+730=1630$$

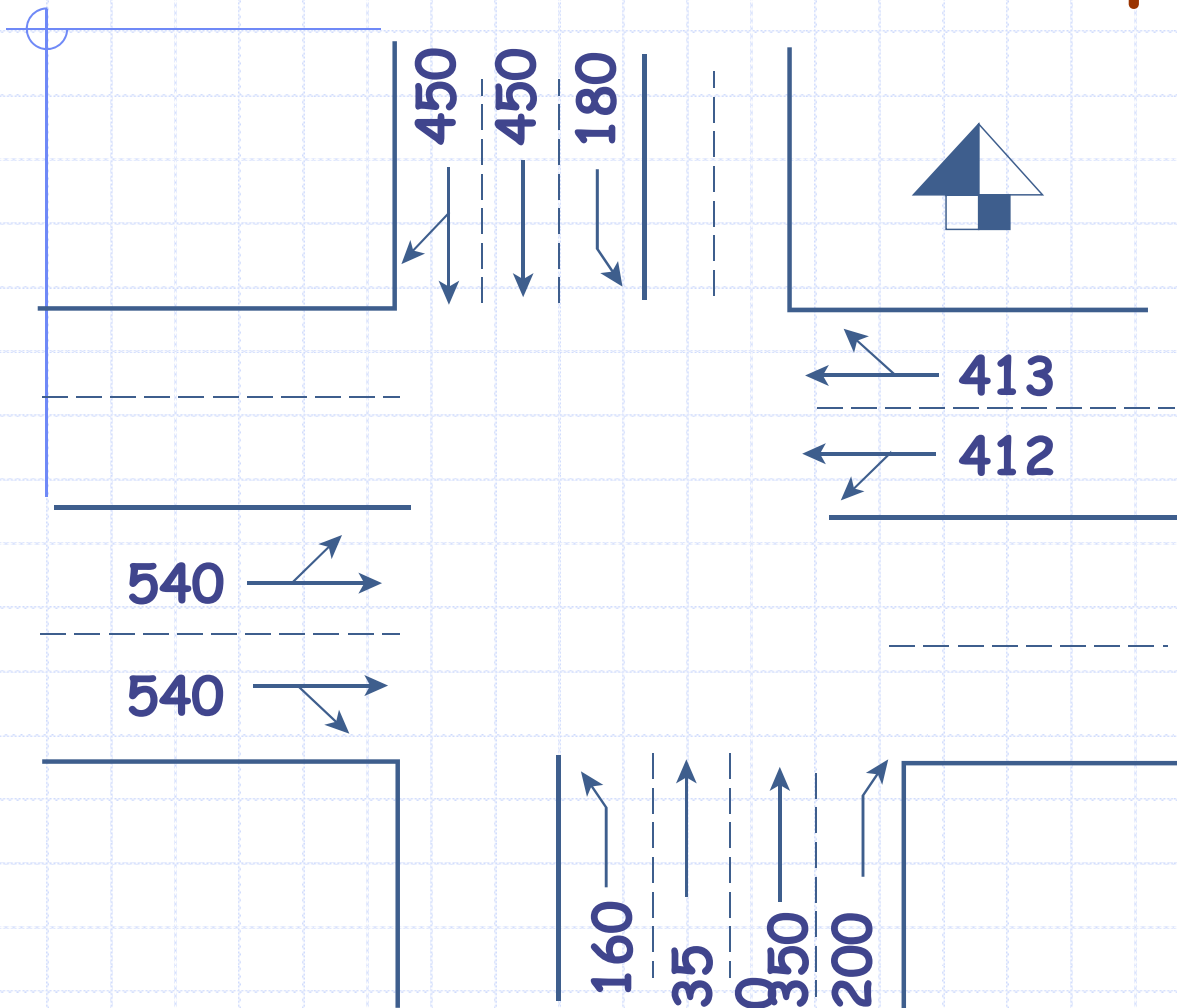


Which plan do we use?

- ◆ Maximum critical sum volume for capacity **1400 vph**
- ◆ All phase plans > 1400 vph
 - 2 phase: 1565
 - 3 phase: 1630
 - 4 phase: 1630
- ◆ Over capacity conditions, need to change lane assignment!

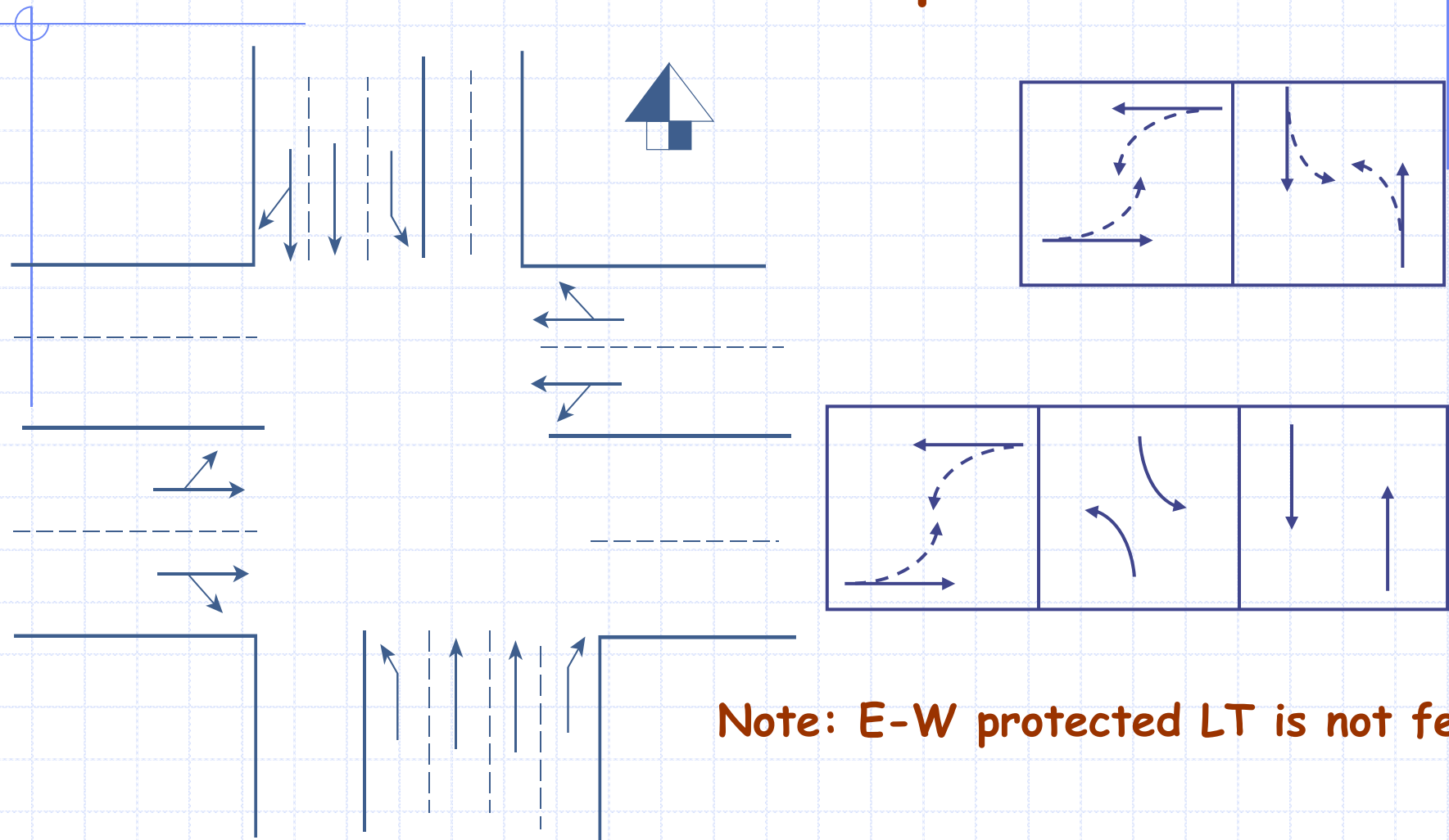


Phase Plans for Example 2





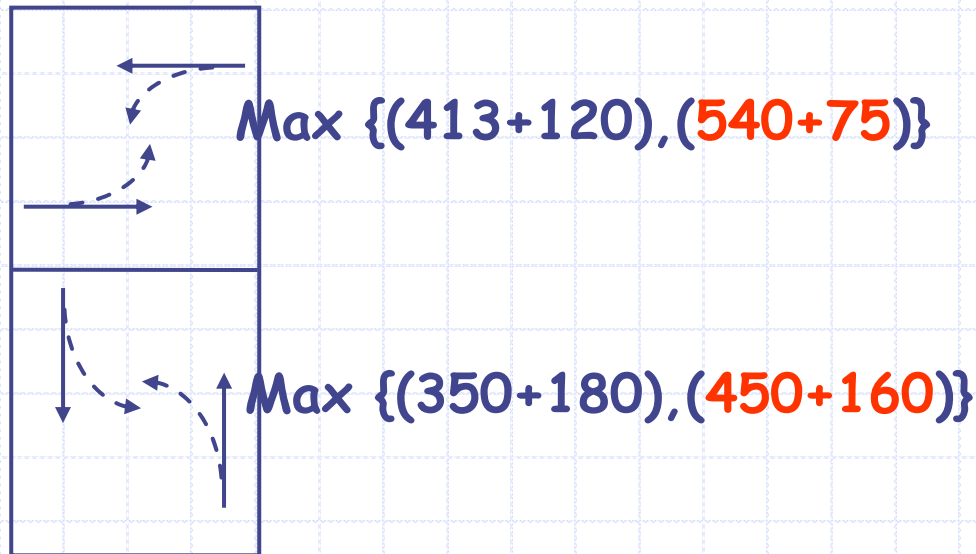
Phase Plans for Example 2



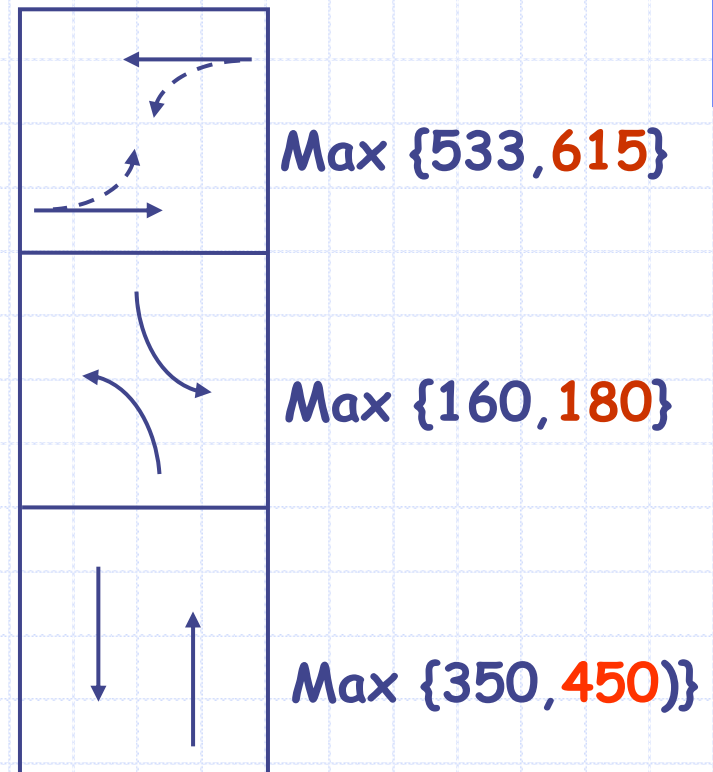
Note: E-W protected LT is not feasible



Phase Plans for Example 2



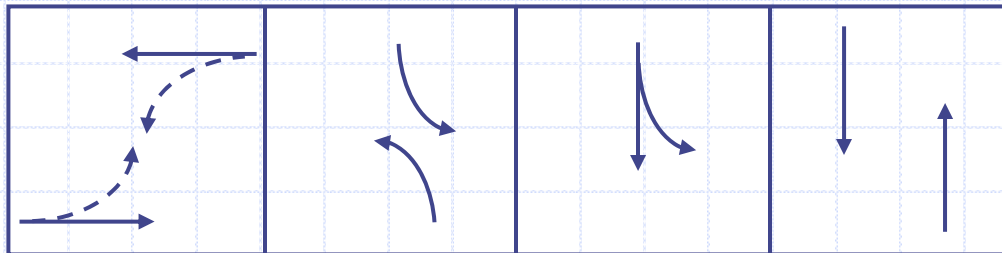
$$\Sigma_{cv} = 615+610=1225$$



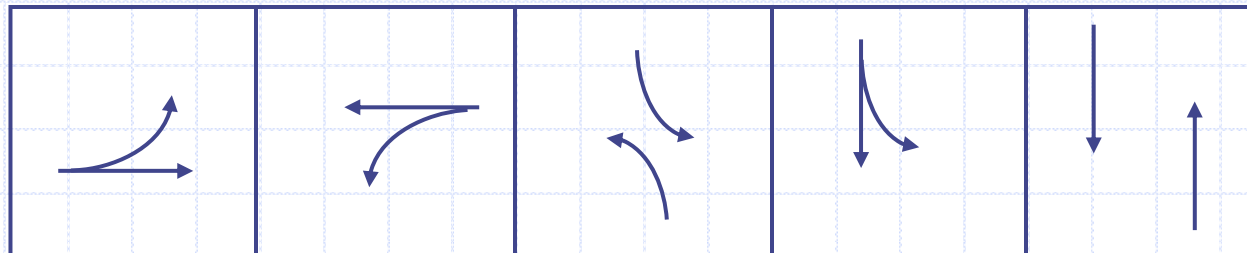
$$\Sigma_{cv} = 615+180+450=1245$$



More Phase Plans for Example 2



Overlapping Phases

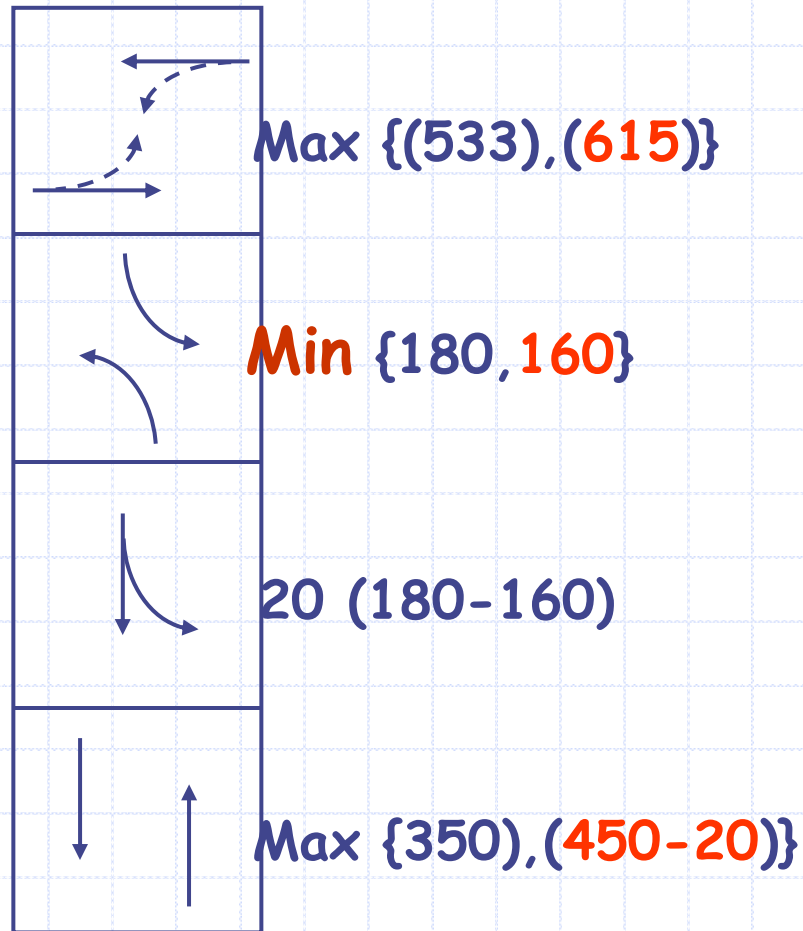


Note: LT are unopposed, i.e. protected

More phase plans can be developed

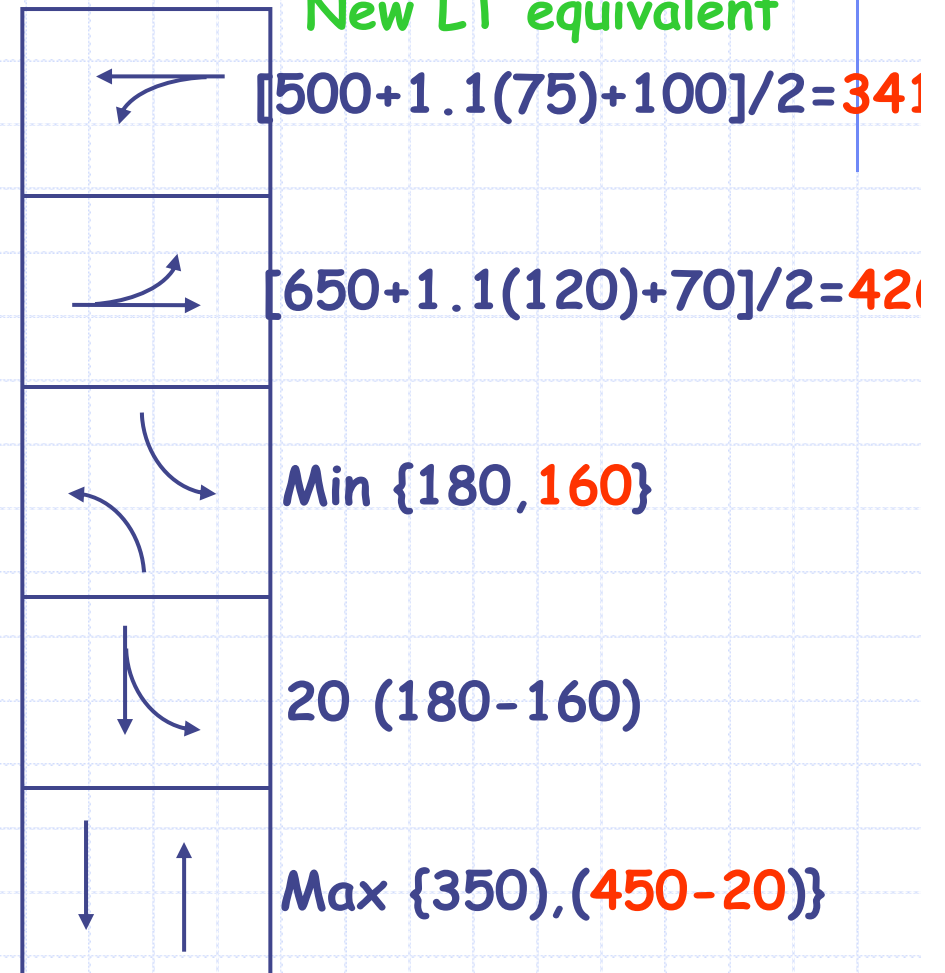


Phase Plans for Example 2



$$\Sigma_{cv} = 615 + 160 + 20 + 430 = 1225$$

New LT equivalent



$$\Sigma_{cv} = 341 + 426 + 160 + 20 + 430 = 1377$$

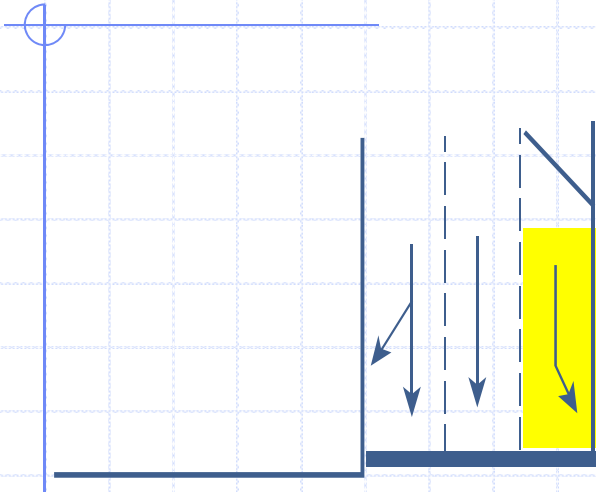


Critical Concepts to Note

- ◆ Shared LT+TH lanes
 - Use of left turn equivalents for lane volume allocation
- ◆ LT phase impact on critical lane volumes
- ◆ Overlapping phasing: **exception** to the “highest volume is critical” rule
- ◆ Every intersection is different in terms of which phase plan works best

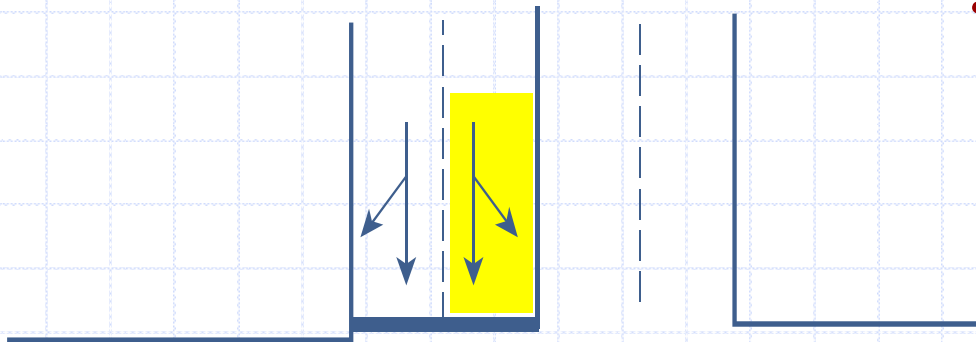


Left Turn Equivalents?



~~Yes~~ / No

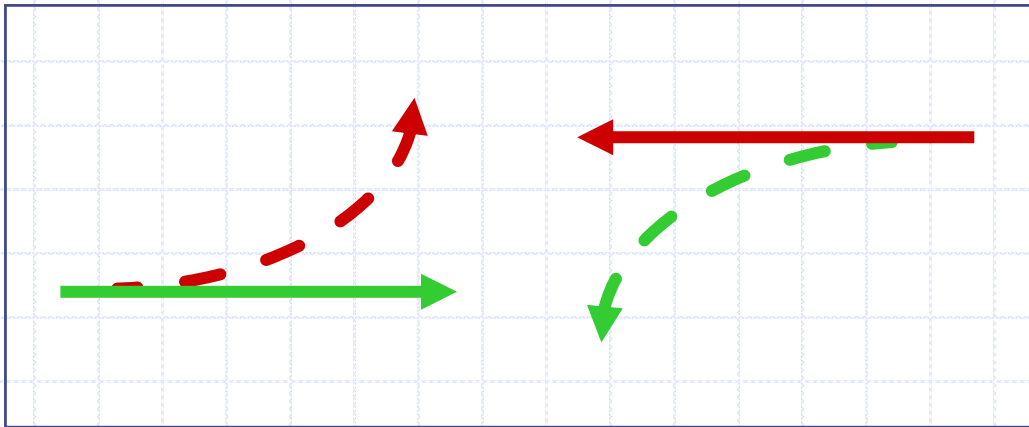
Phasing NO effect!!!



Yes / ~~No~~



Permitted Left Turns?



ALWAYS!!!

Left turn lane configuration NO effect!