Urban Street Symposium
May 2017

Interchange and Grade-Separated Intersection Designs that Promote Arterial Progression

Joe Hummer, State Traffic Management Engineer,
Mobility and Safety Division

Designing for Progression

- Many corridors have poor signal progression
  - Too many phases
  - Signals are spaced poorly
- Underlying reason is that nobody designed for progression
- Many intersections were sited and signals were installed individually, with little or no regard for surrounding signals
- Particularly with signals installed as part of a traffic impact analysis
- Arterial progression is in many cases is the exclusive duty of signal timing professionals
  - Engineers and technicians who enter the picture long after planners and designers
  - Try to make the best of the combination of signals and phasing they are handed.

We Do Not Have to Settle for This

- There are designs that promote two-way or four-way progression
- Four basic phases to three or two basic phases
- Half signals which only affect one through direction of the arterial
  - Full signals have narrow spacing limits
  - Half signals spacing does not matter

Objective

- Show intersection, grade-separated intersection, and interchange designs that promote good two-way or four-way progression
- Many of these designs have other benefits
- Will concentrate on progression
  - Some of these designs have been used for years
  - Some have only been installed in a few places
  - Some have only been published
  - One is being published for the first time
- Hopefully if planners and engineers know that there are designs available they will begin to use them

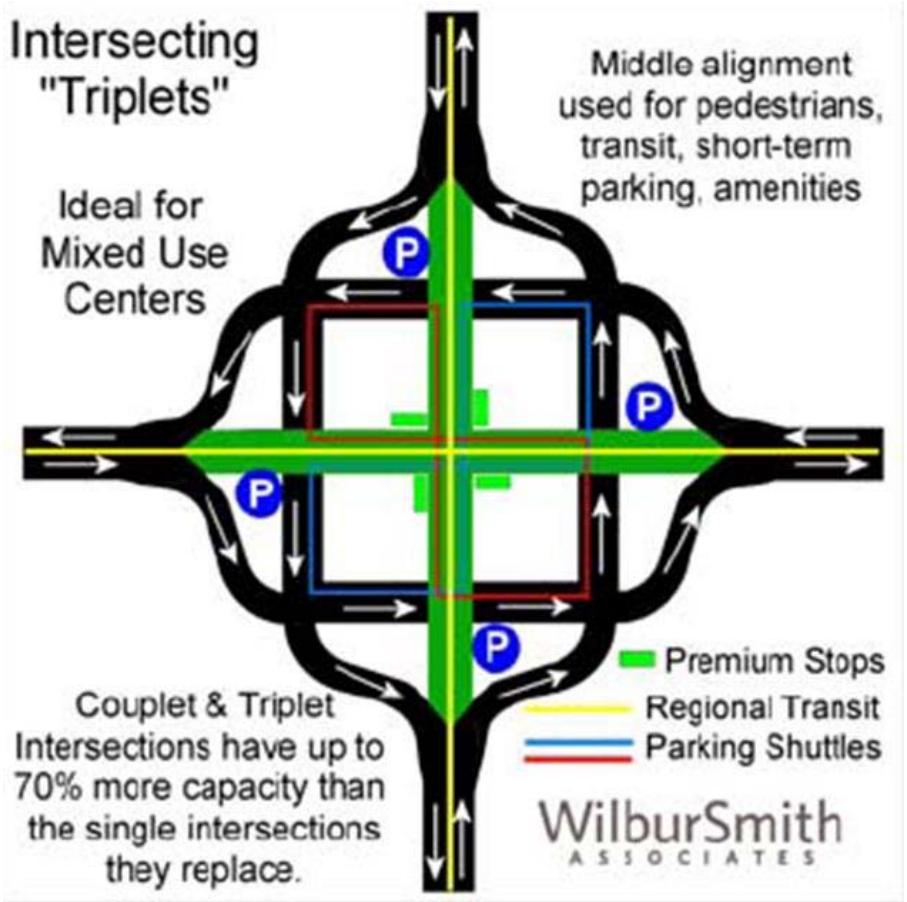
First Check if Full Signal is Spaced Well

- No sense converting if well spaced
- Can use classic equation for two signals:
- For 40% efficiency:

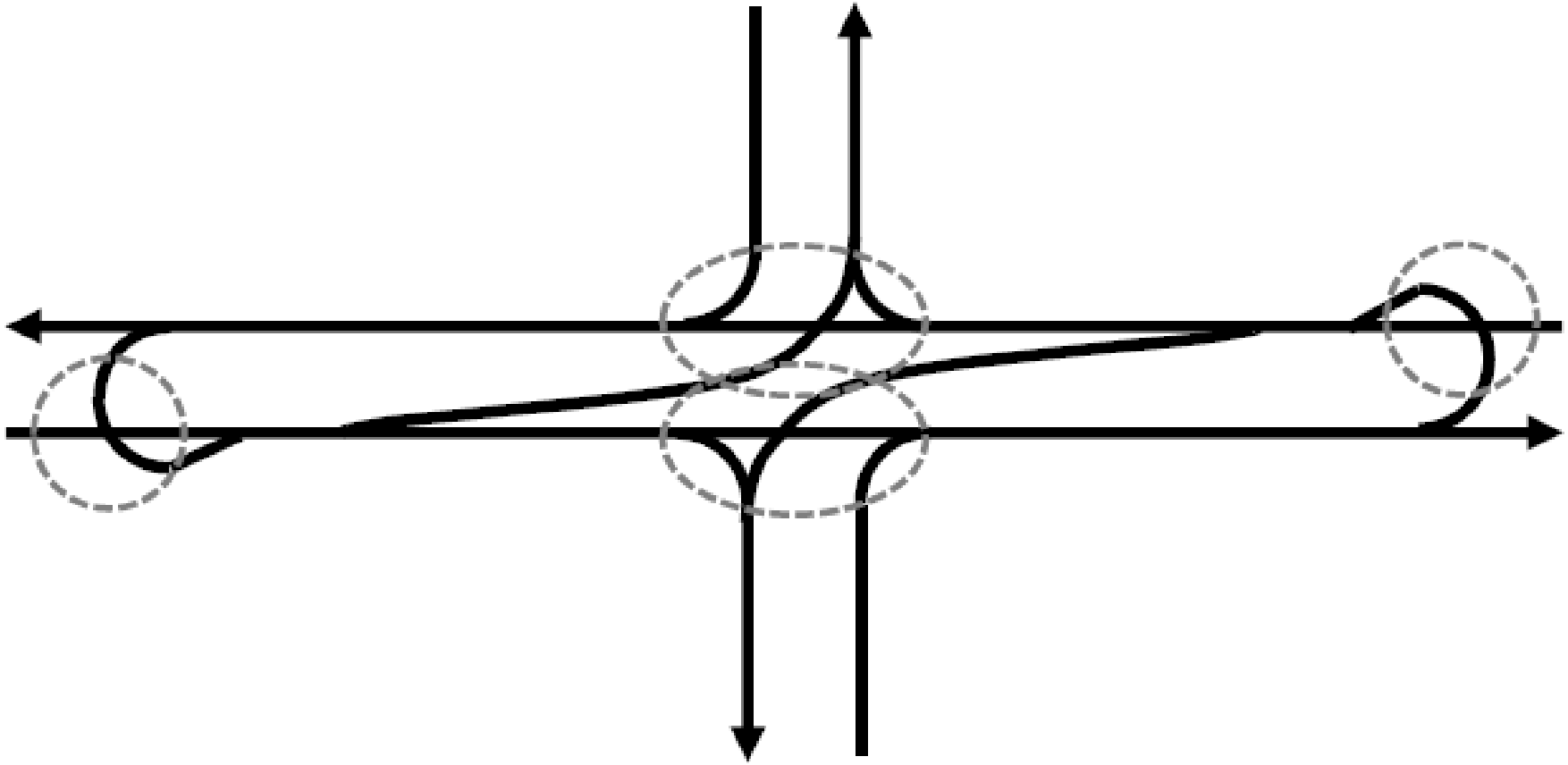
Speed, mph	Cycle, sec	Simultaneous sweet spot, ft	Alternate sweet spot, ft
25	80	0 – 290	1170 – 1760
30	80	0 – 350	1410 – 2100
35	80	0 – 410	1640 – 2460
35	150	0 – 770	3080 – 4620
45	150	0 - 990	3960 - 5940

Intersections

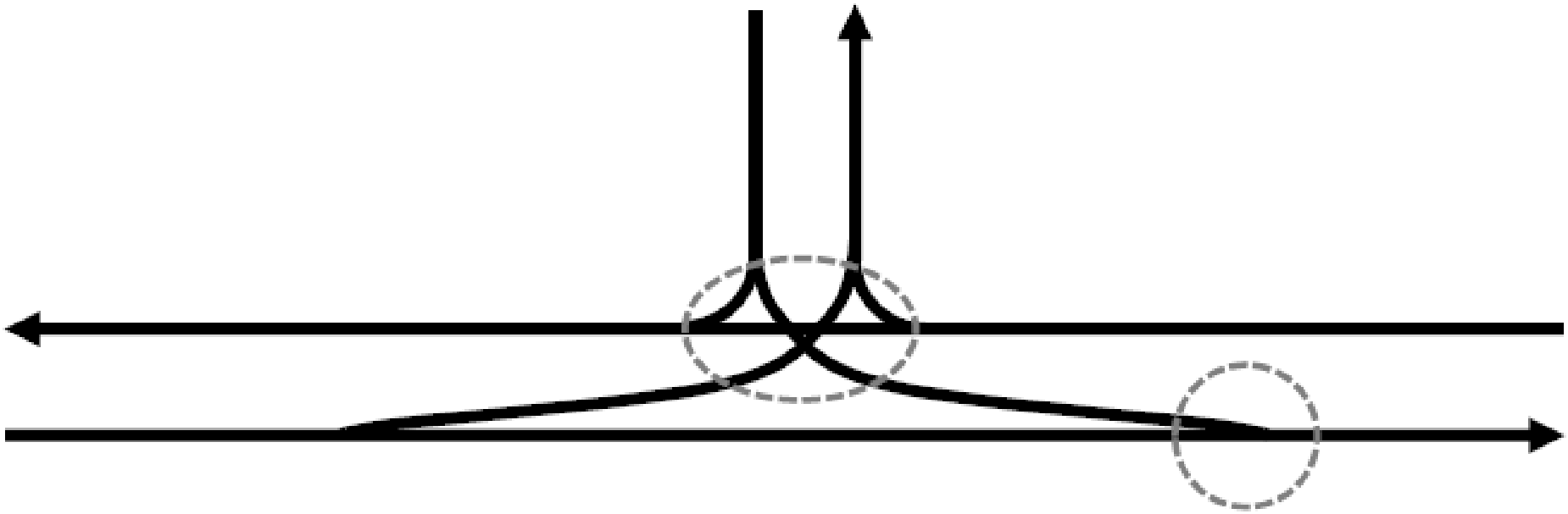
- No known at-grade design that provides potential for four-way progression
- Two designs that provide two-way potential
  - Superstreet, aka synchronized street, RCUT, j-turn, reduced conflict intersection
  - Continuous green T
- Designs that reduce phases
- Designs that mimic one-way pairs
  - Split intersection
  - Town center



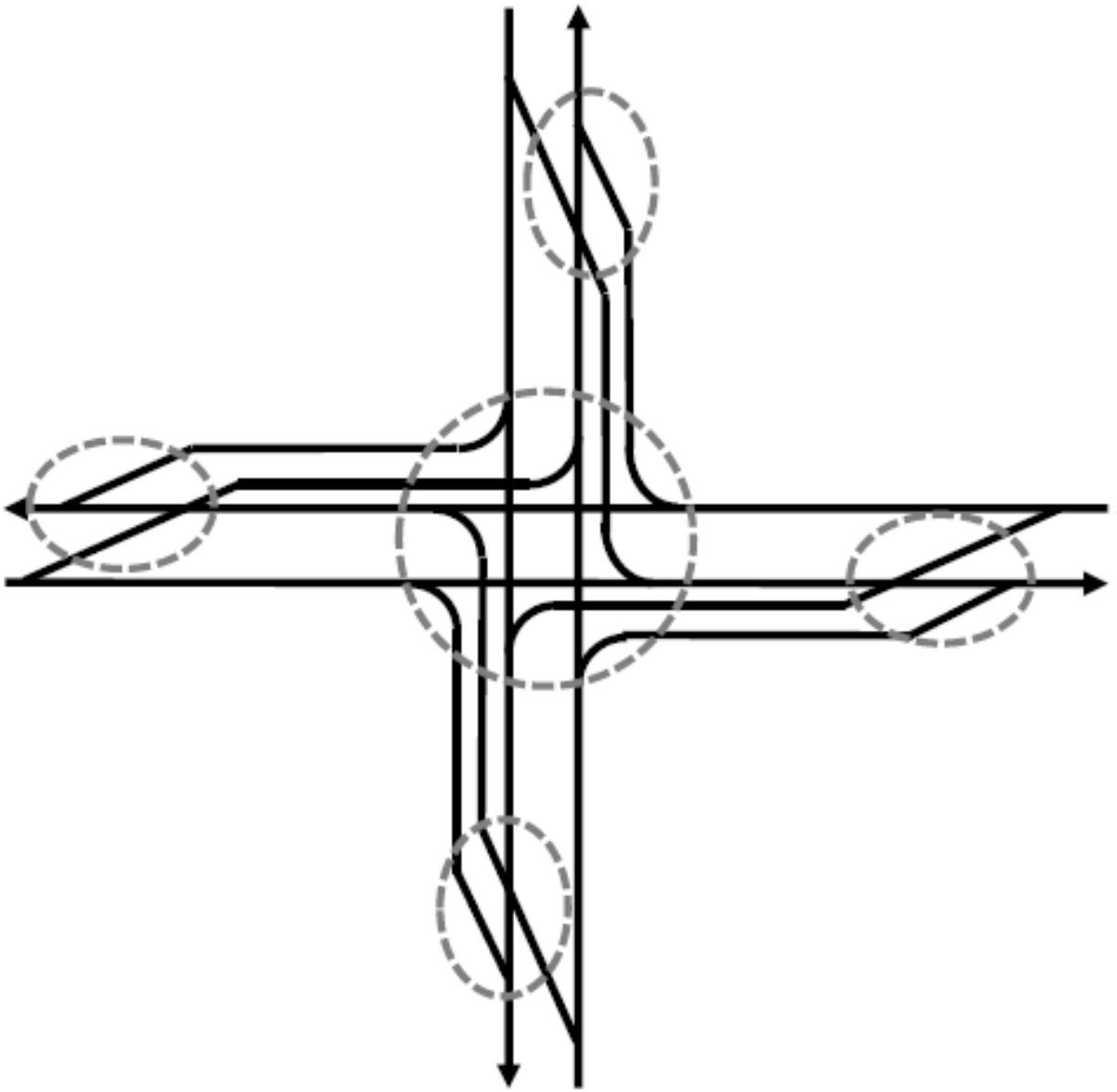
Superstreet



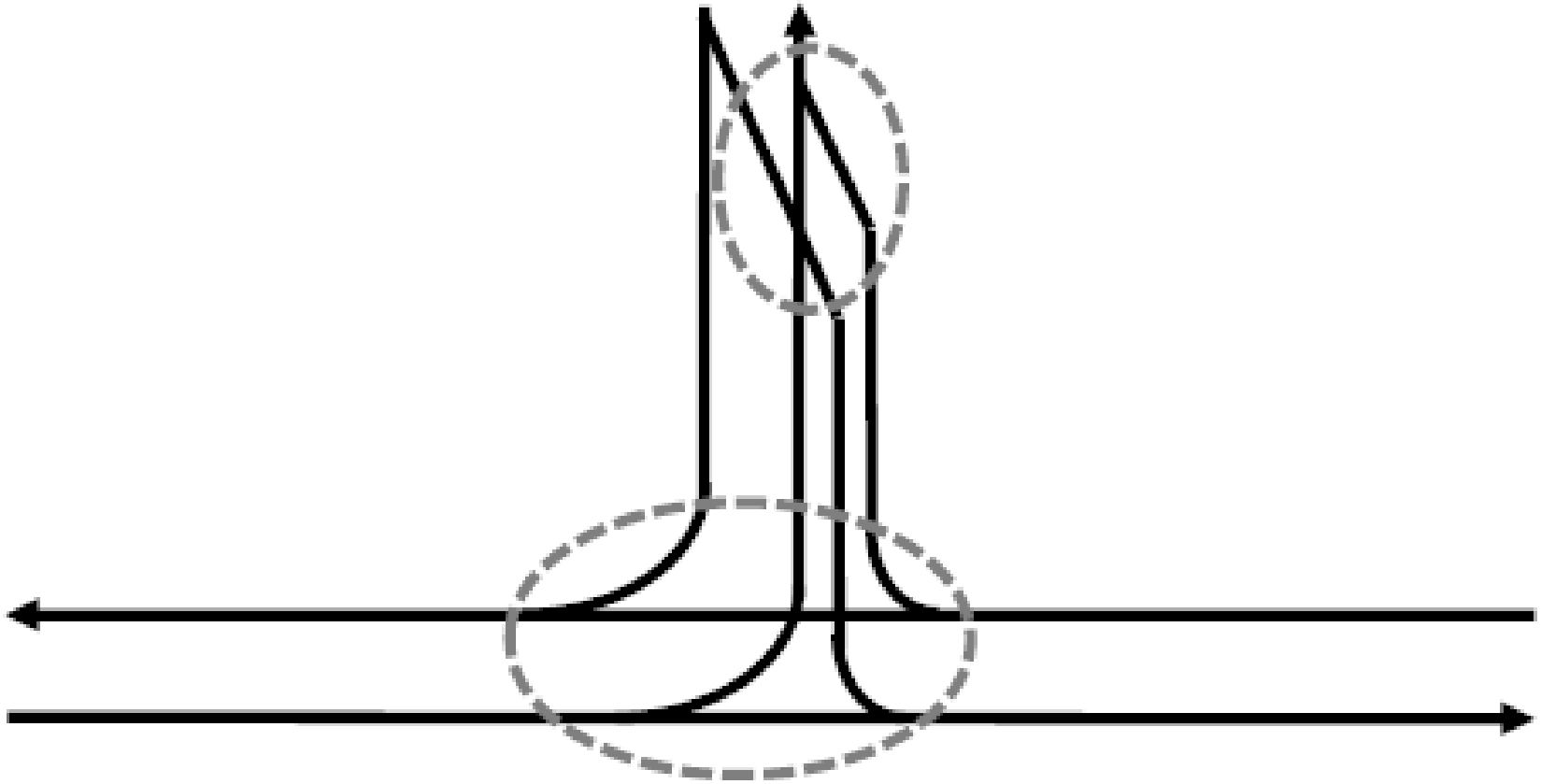
Continuous Green T



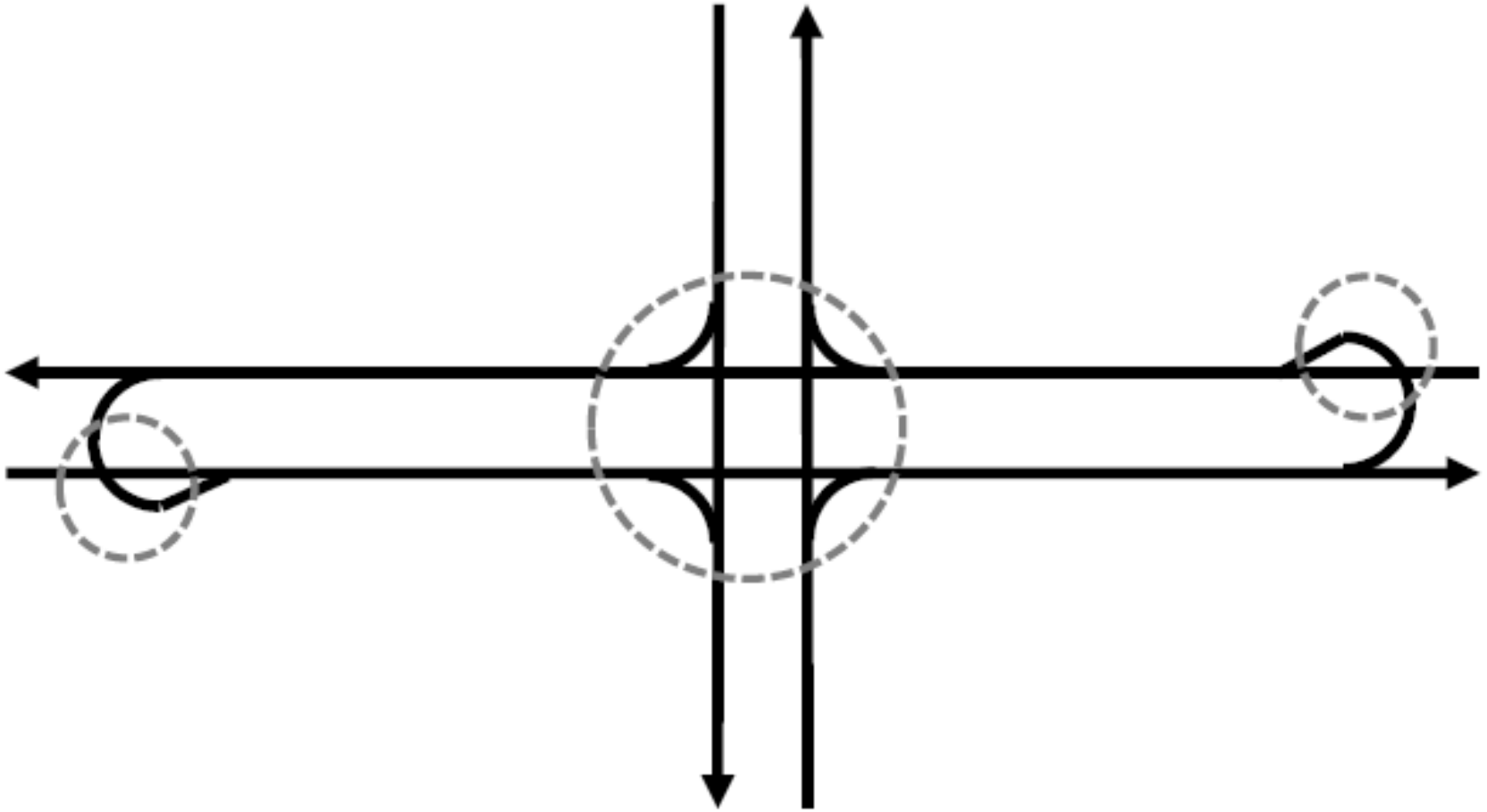
CFI—Four Phases to Three or Two



Three-Legged CFI



Median U-Turn—Four Phases to Two



Grade Separated Intersection

- Intersections with at least one bridge
- Neither intersecting route is a freeway
  - Both streets can have signals, progression
- We have at least 150 of these in NC
  - More on the way

- Progression friendly designs use half signals
- Four-direction progression is possible

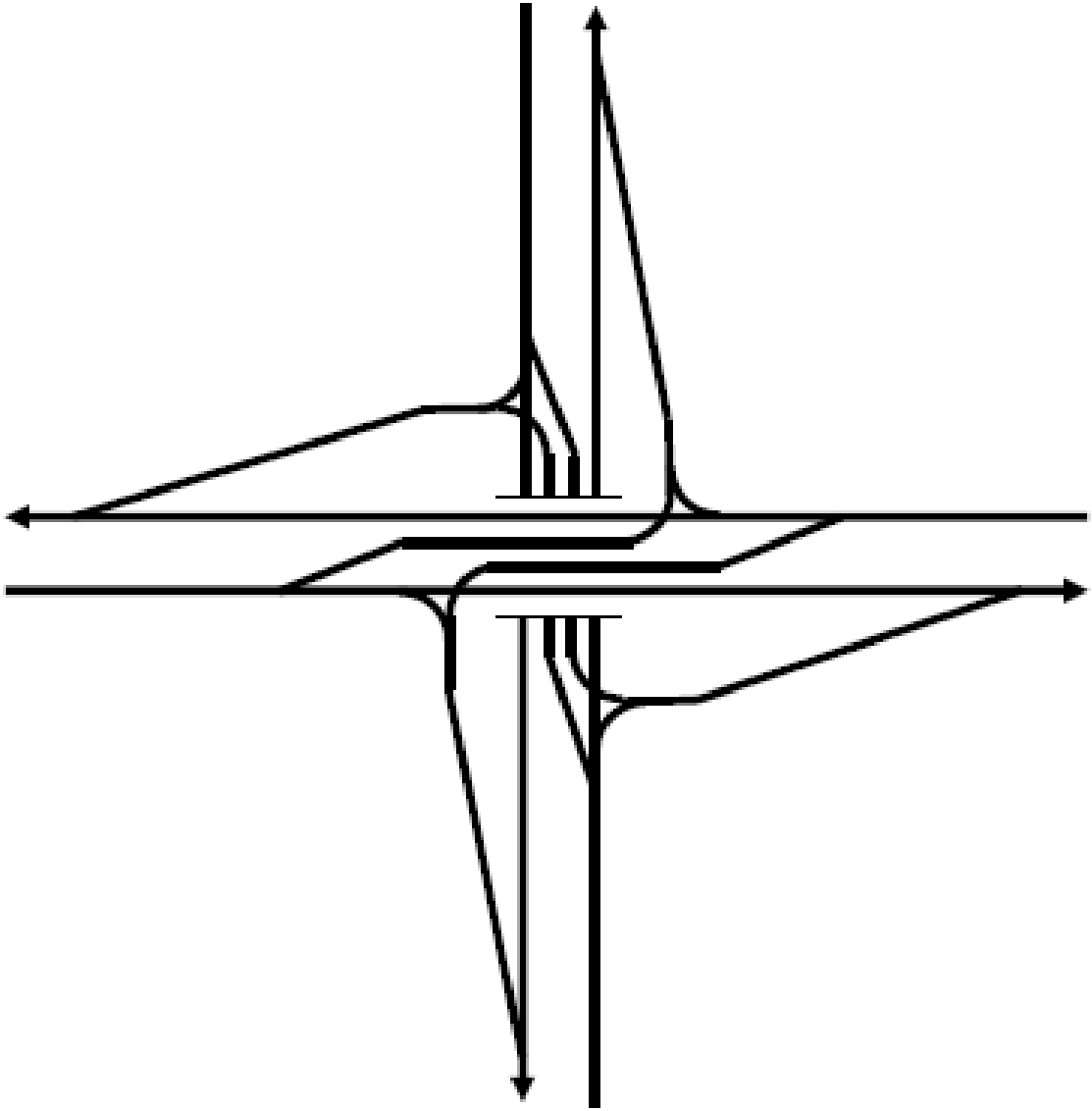
Most of NC's Grade Separated Intersections are Interchange Designs with Poor Progression Potential

Parclo A at Dawson/McDowell and Western/ML King

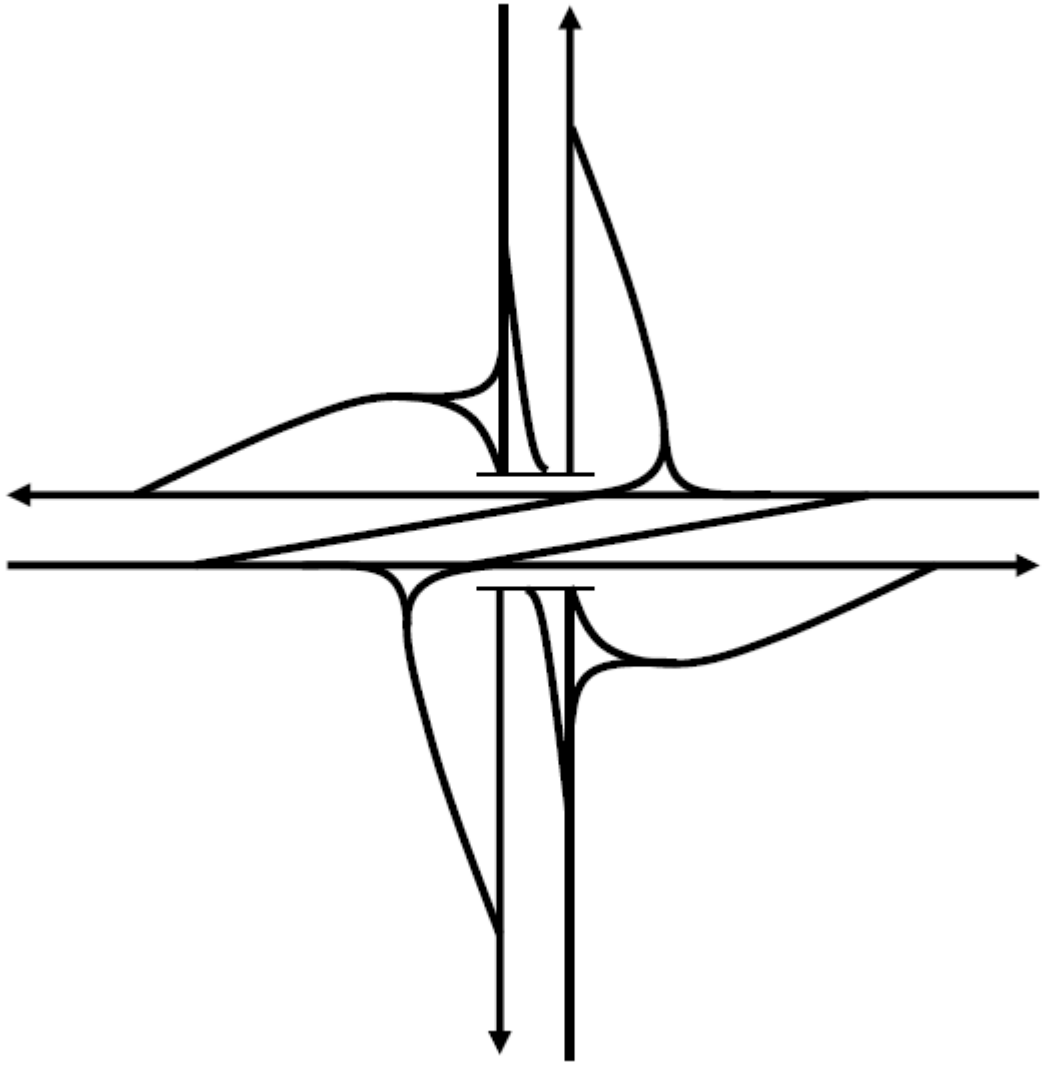
Two full signals at poor spacing

Drivers feel like they are on a freeway

Contraflow Left Turns on Both Roadways

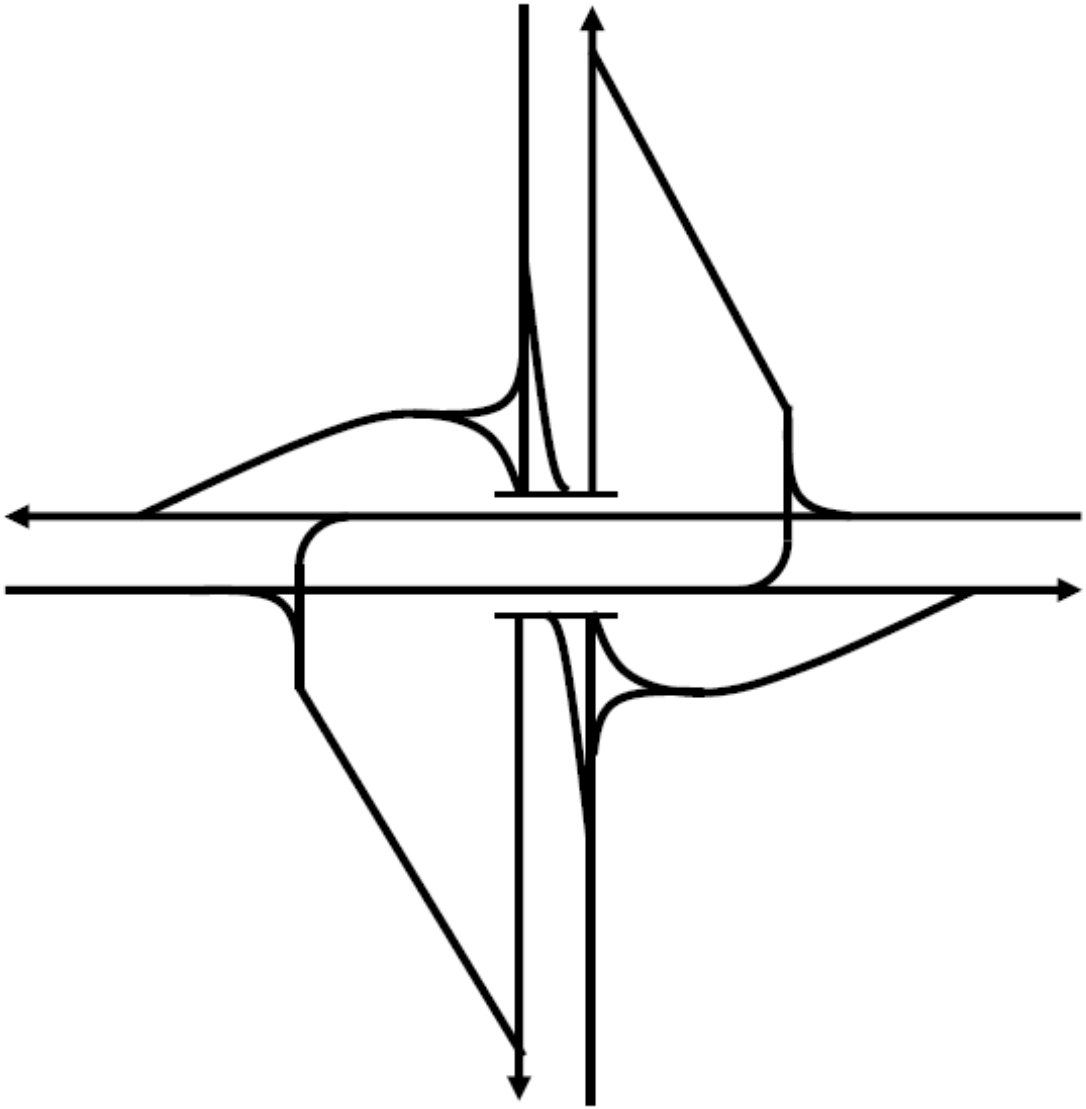


Single-Point Left Turn on Both Arterials

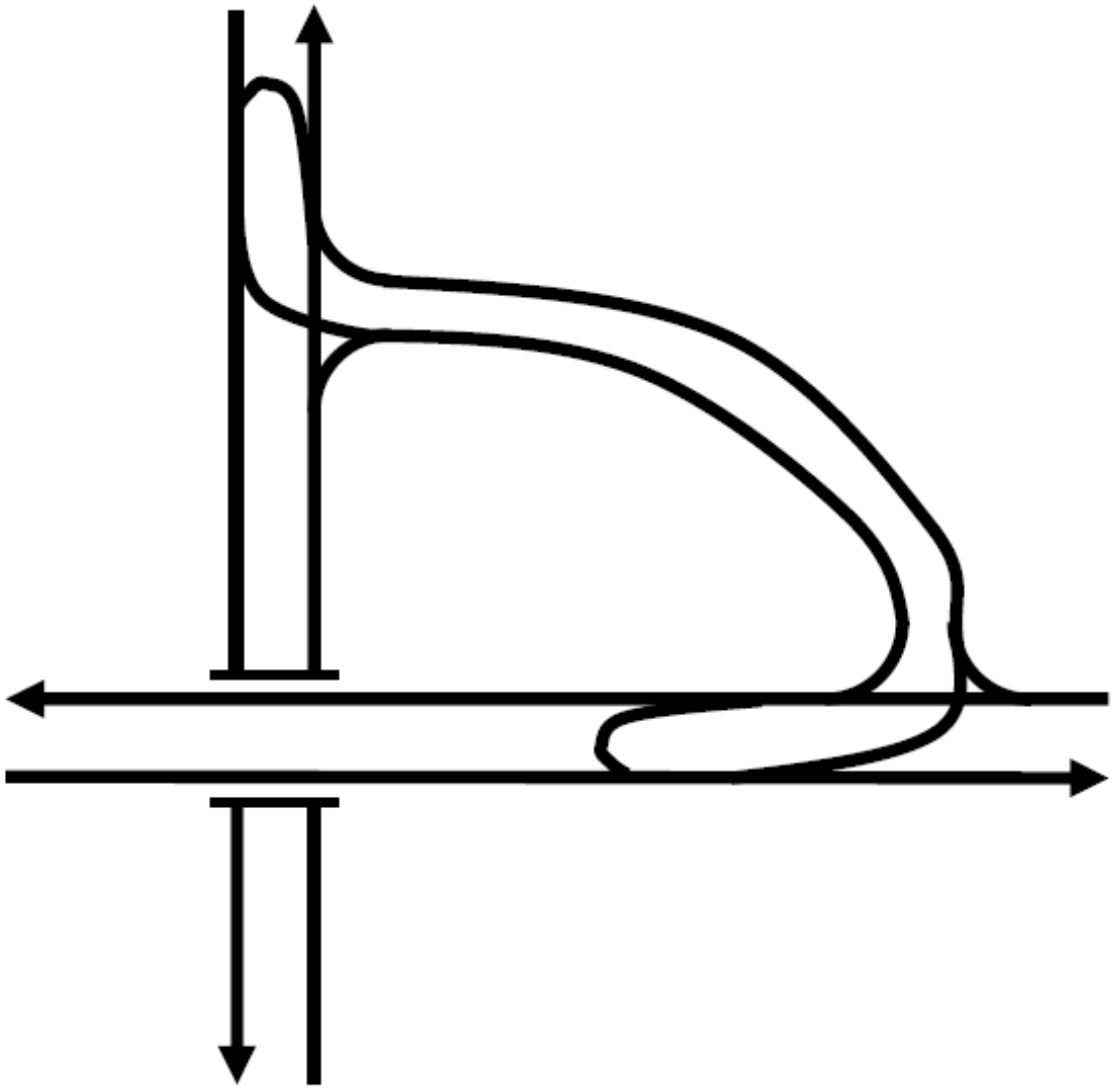


- Called two-level signalized intersection
- Likely patented in US and elsewhere

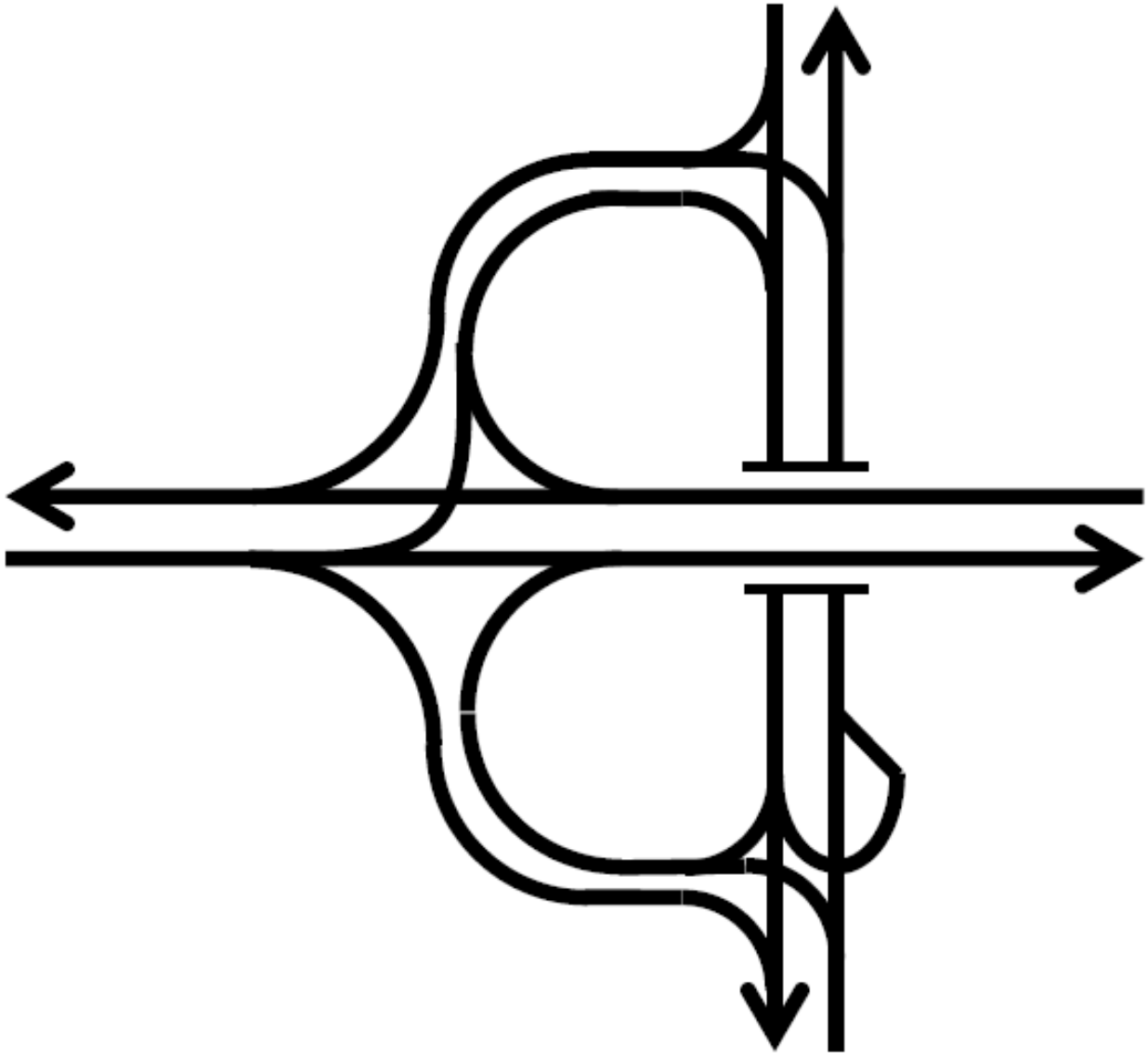
Diamond Left Turns on One Roadway and Single-Point Left Turns on the Other Roadway



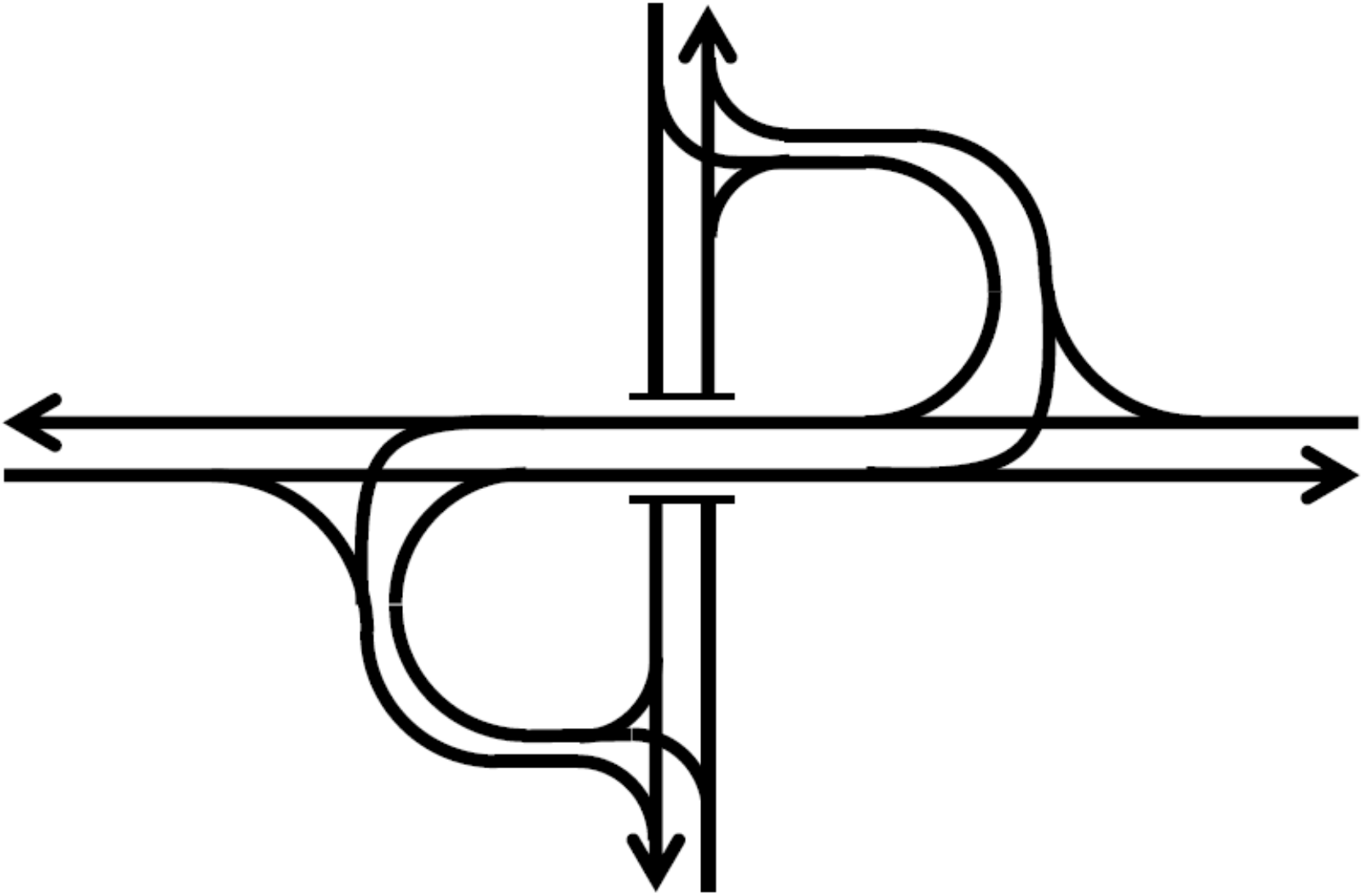
One Loop Design



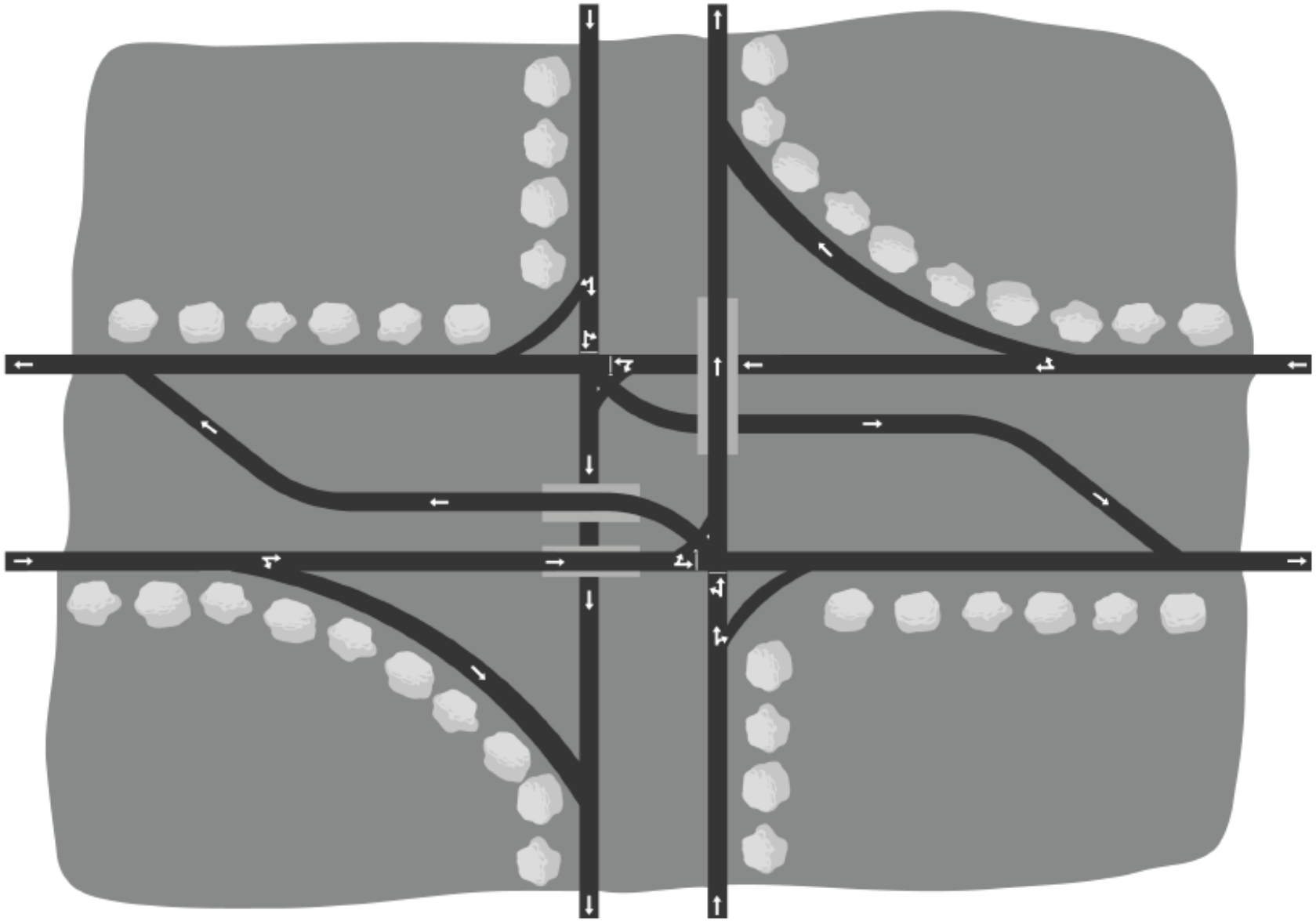
Two Loop Design—Rescuing a Parclo AB



Two Loops in Diagonal Quadrants

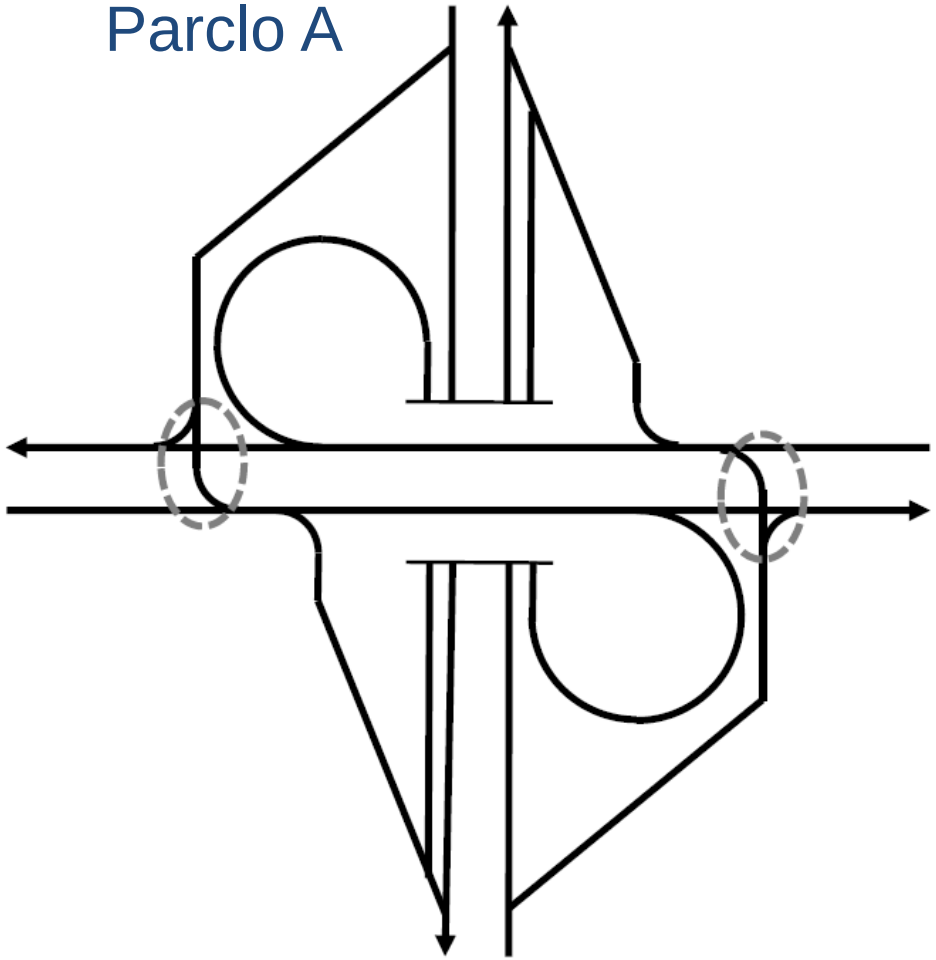


Echelon Interchange

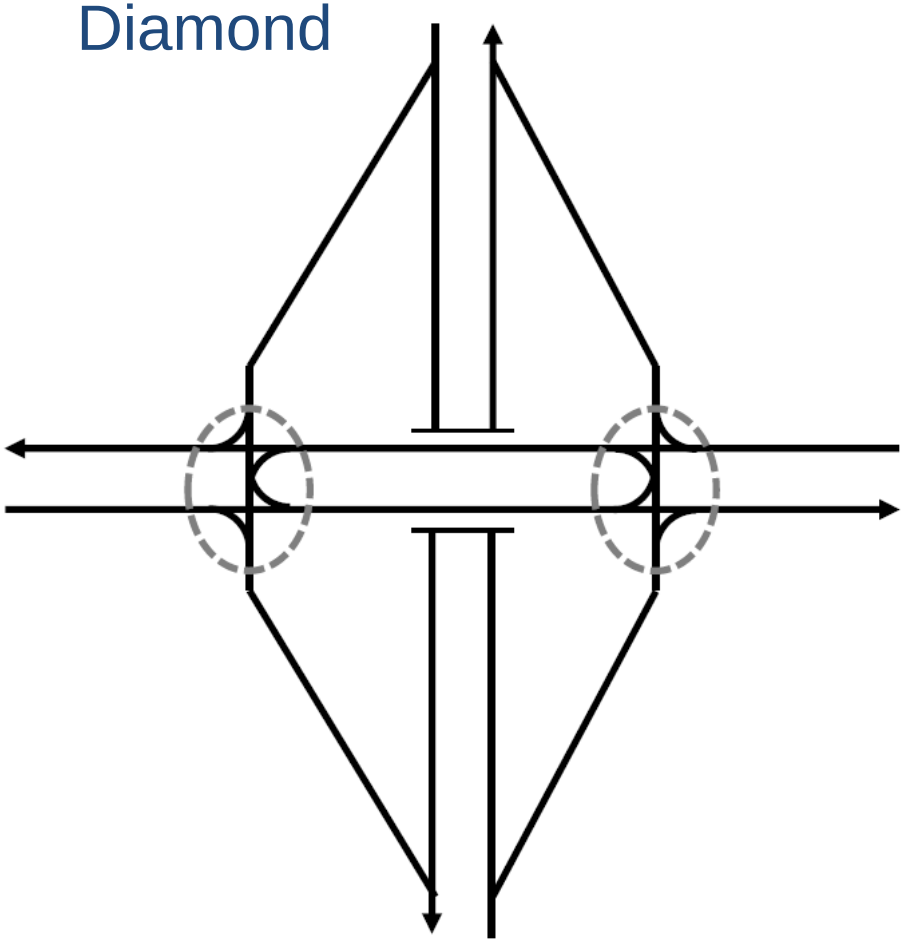


Service Interchanges
Common Designs with Poor Progression Potential

Parclo A

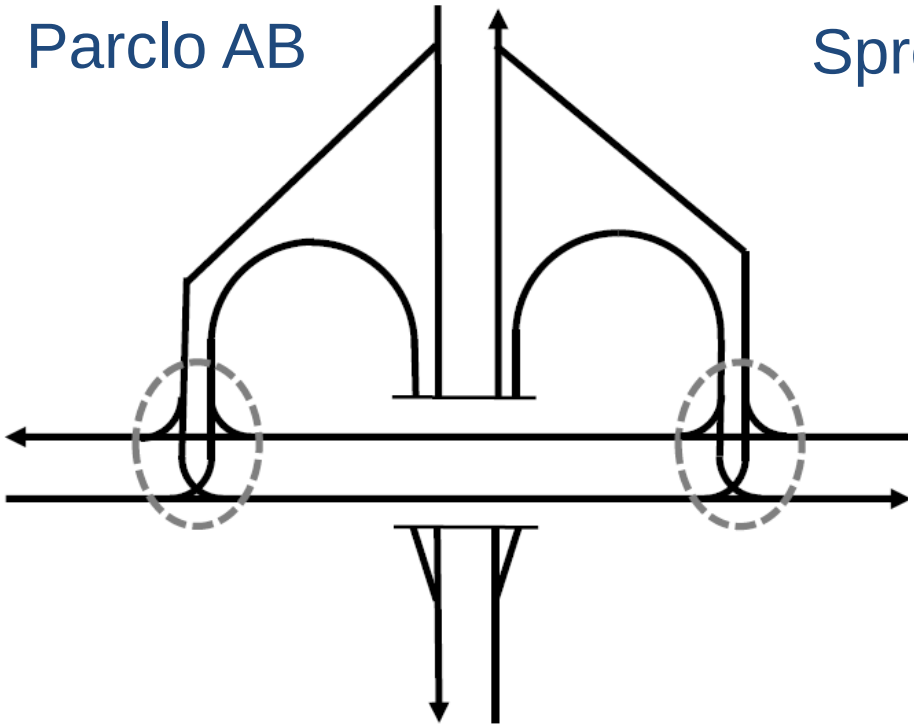


Diamond

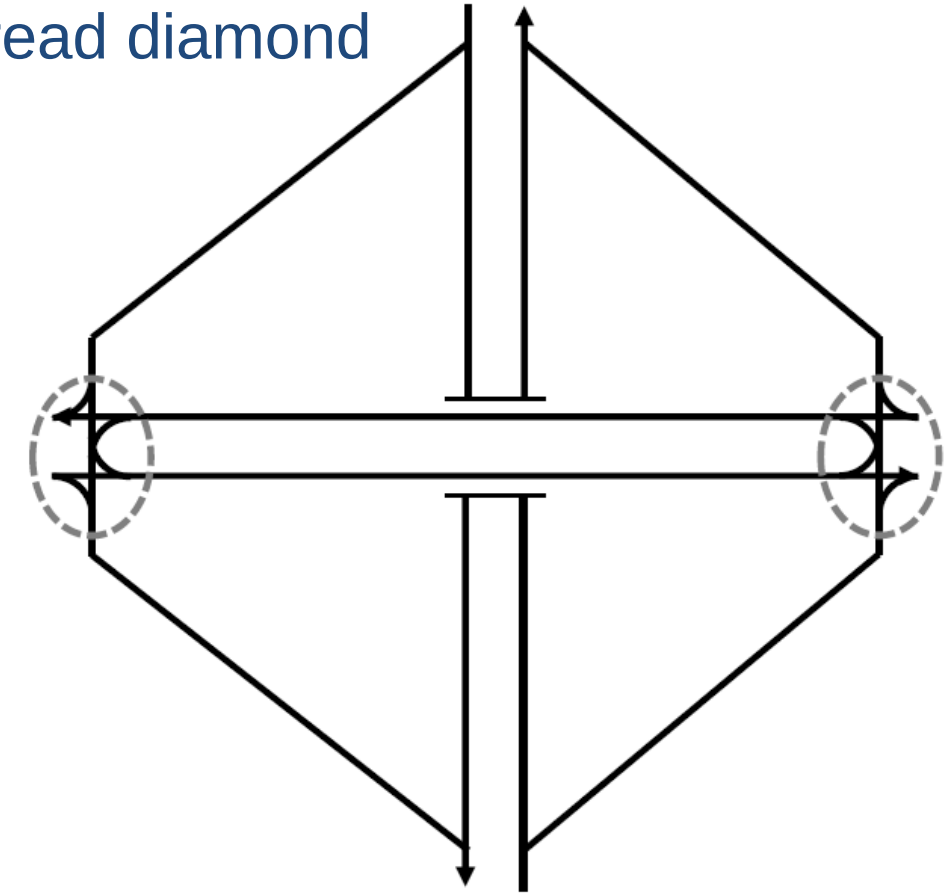


More Common Designs with Poor Progression Potential

Parclo AB

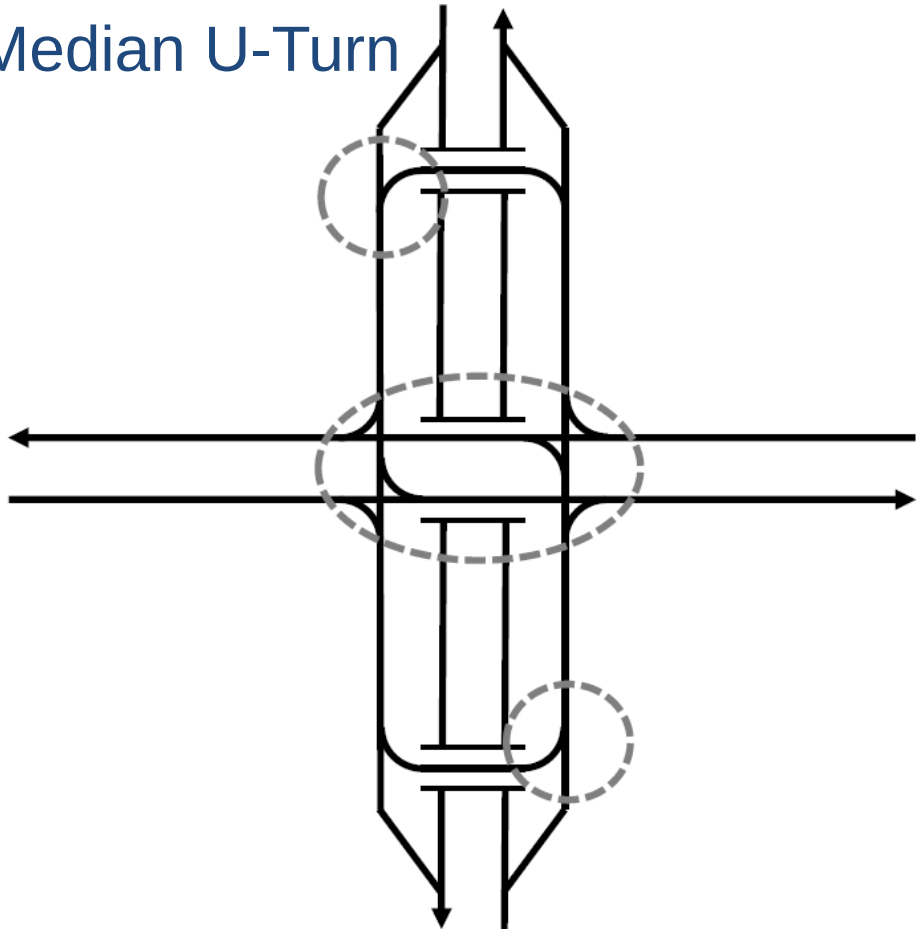


Spread diamond

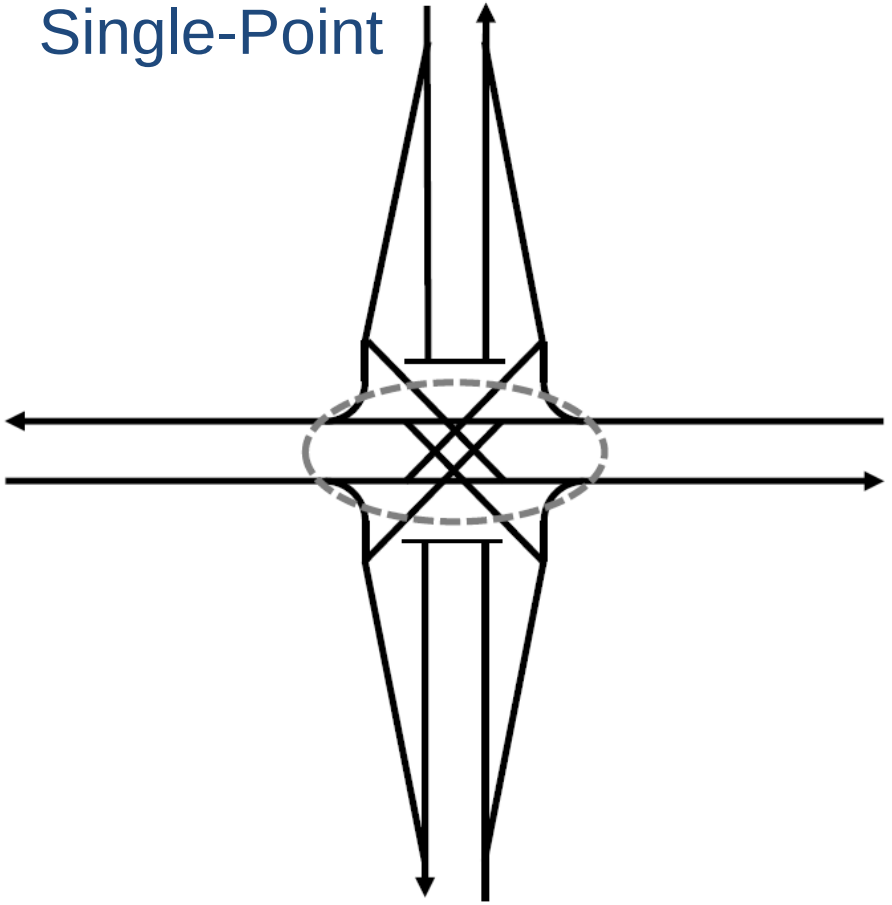


Common Designs with Moderate Progression Potential

Median U-Turn



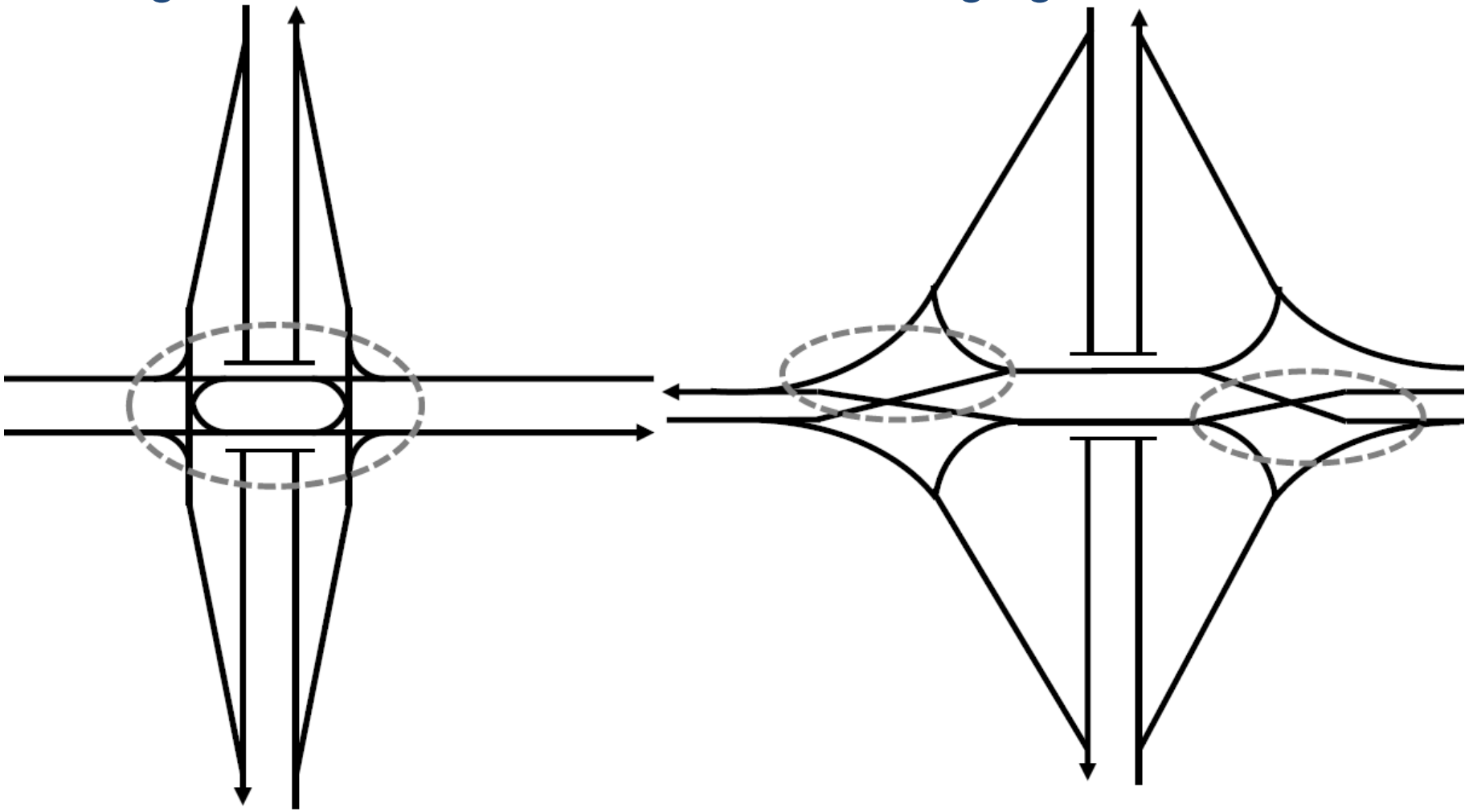
Single-Point



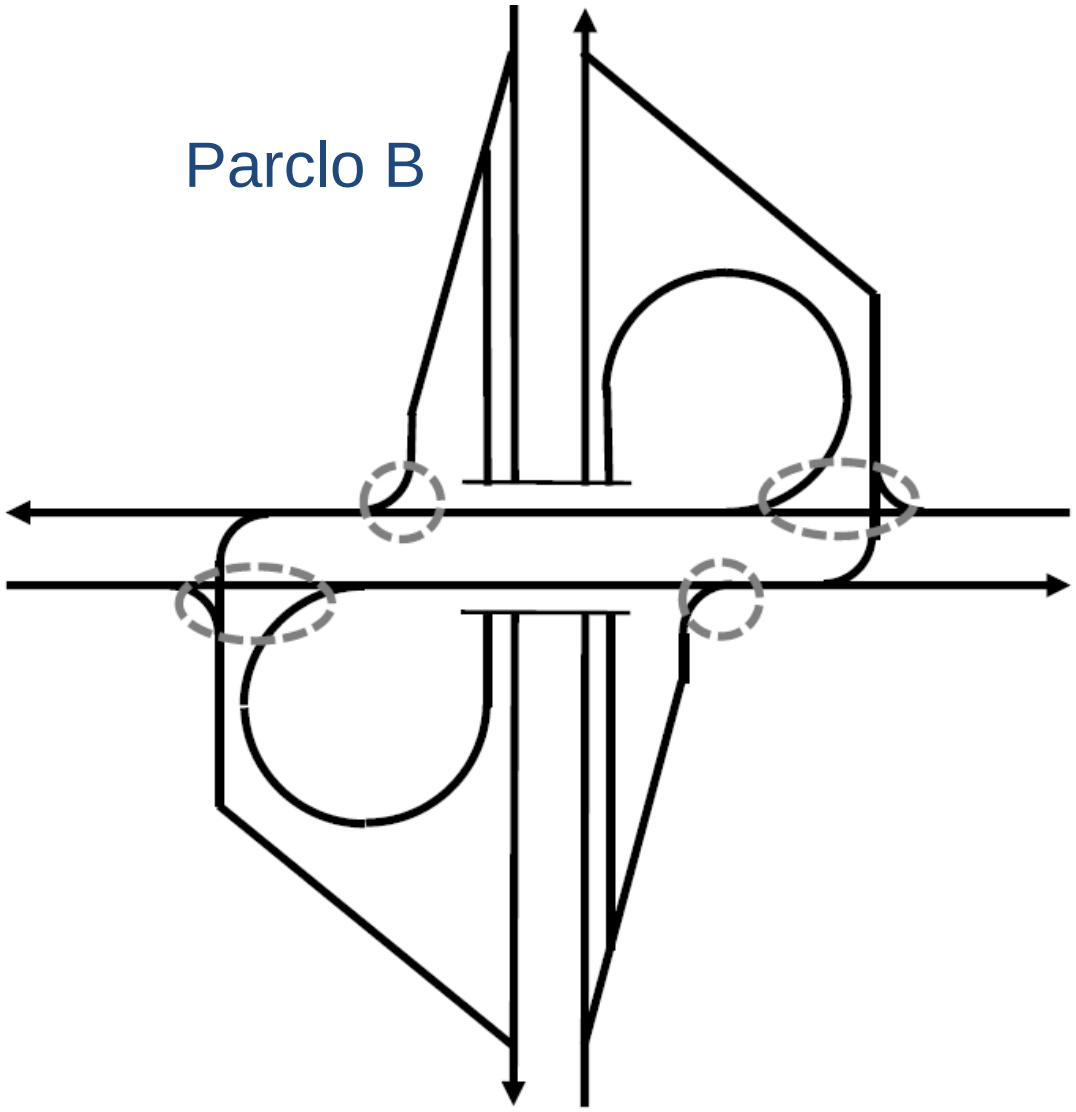
More Common Designs with Moderate Progression Potential

Tight diamond

Diverging diamond

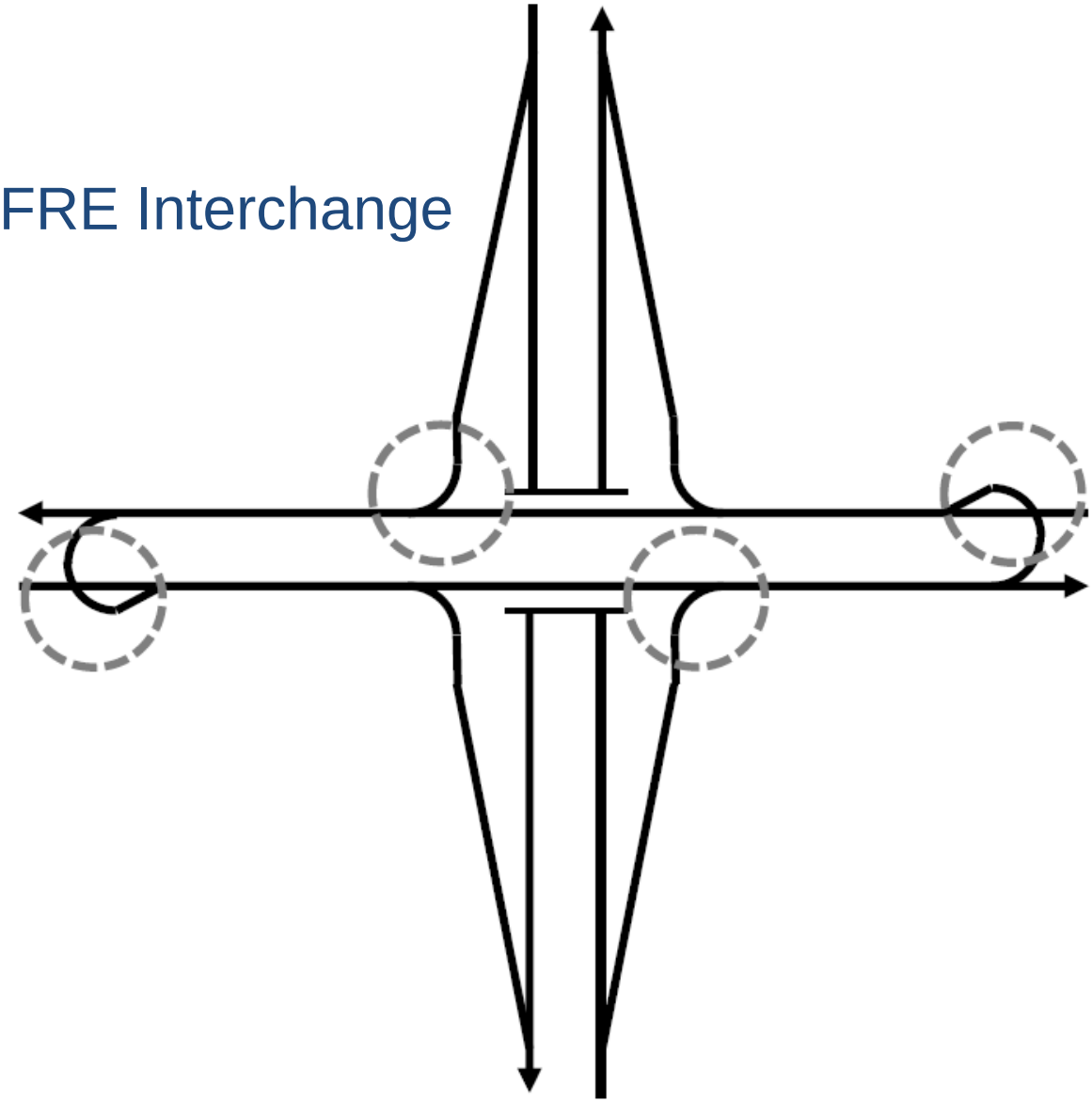


The Common Design with Excellent Progression Potential

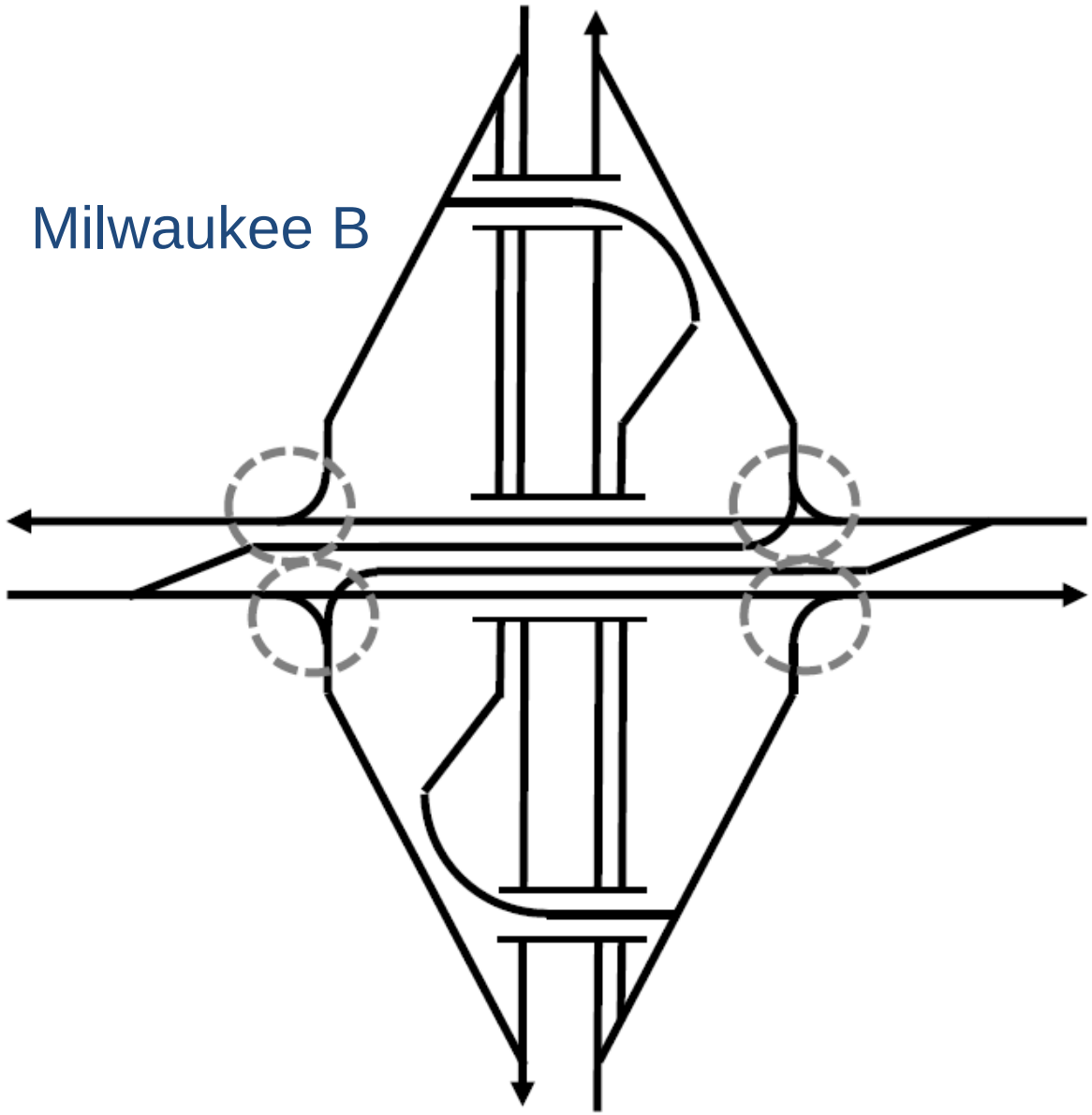


Published but Not Built Yet

FRE Interchange

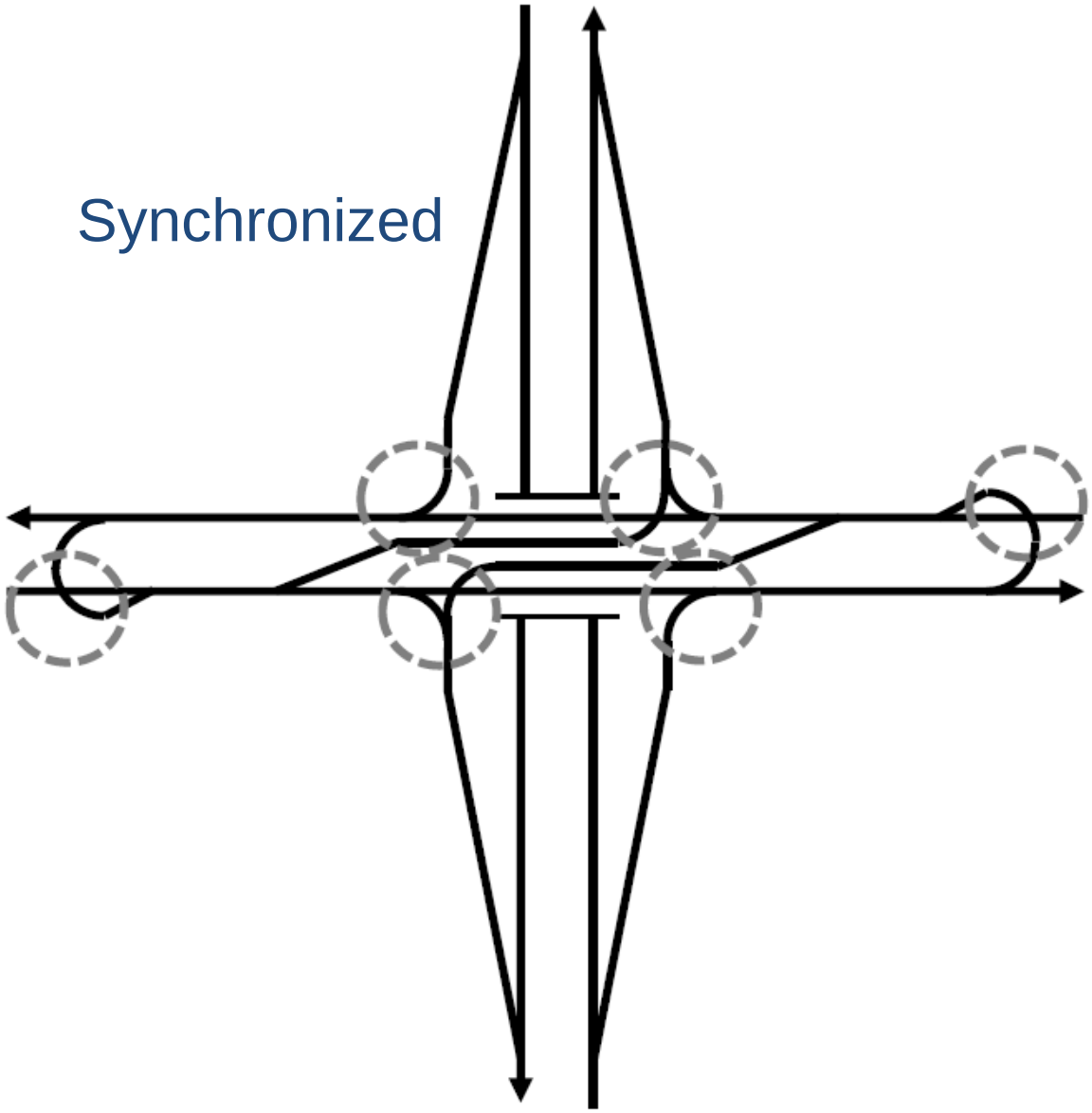


Also Published but Not Built Yet



Not Published Yet

Synchronized



Retrofits

- Room for far-side loops on right side?
  - Use parclo B
- Room for arterial u-turn crossovers?
  - Use FRE or synchronized
- Room for far-side loops that straddle freeway?
  - Use Milwaukee B
- Failing parclo AB?
  - Use superstreet and/or CFI features at one or both signals
- Progression friendly on half an interchange is much better than nothing

Conclusions

- When full signals are spaced poorly along an arterial, two-way progression is not possible
- In this common situation, we should design for progression when we can
- Designs exist for intersections, grade-separated intersections, and interchanges
- Designs that reduce phases and go from full to half signals
- Don’t let the project scope creep, but…
- Do look on either side of project to consider progression and if it can be designed in

Future Research

- Research at Wayne State finishing soon on synchronized and Milwaukee B designs
- Research funded by NCDOT about to start on grade-separated intersections
- Parclo B field data!
- Field data from new designs
- Incorporate info in books and manuals and standards
- Consider progression formally as part of traffic impact analysis process

Thank You! *Joe Hummer, jehummer@ncdot.gov, 919-814-5040*