Flashing Yellow Arrows
Overcome Limitations of a
Yellow Trap Condition

Carl Baughman
Traffic/Transportation Engineer
City of Franklin, Tennessee
Agenda

- Basic facts about FYA
- Prior intersection condition
- Investigation into FYA
- Specifics of FYA design
- Conclusions
Basic FYA facts

- NCHRP research from 1995-2003 (concern of permissive Lt turn right-of-way)
- Report 493 identifies yellow trap benefits
- FHWA issues interim approval in 2006
- MUTCD adopts in 2009 (Lt & Rt arrows)
- FYA can be displayed with any other display
Intersection Condition

- Double-T offset intersection, mainline E-W (lefts on external approaches, positive treatment)
- All streets are three lanes wide
- RR crossing between the T intersections (gated crossing with overhead flashing red signals for single track)
- Trailing far-side greens required prot lts
Intersection Condition
PHASING DIAGRAM
(NORMAL OPERATION)

<table>
<thead>
<tr>
<th>φ1</th>
<th>φ2</th>
<th>φ3</th>
<th>φ4</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLC</td>
<td>OLC</td>
<td>NOT USED</td>
<td>NOT USED</td>
</tr>
<tr>
<td>OLB</td>
<td>OLD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(RAILROAD PREEMPTION)

<table>
<thead>
<tr>
<th>OLC</th>
<th>OLA</th>
<th>OLB</th>
<th>OLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLC</td>
<td>OLA</td>
<td>OLB</td>
<td>OLD</td>
</tr>
</tbody>
</table>

CLEAR TRACK GREEN (CTG) | PREEMPTION HOLD INTERVAL

PROTECTED ONLY, NOT PERMITTED

NOTE: AT PREEMPTION, ALL ACTIVE PHASES WILL TERMINATE WITH PROGRAMMED PHASE CLEARANCES PRIOR TO CTG PHASE. WHEN RAILROAD PREEMPTION IS COMPLETE A MINIMUM RECALL WILL BE PLACES ON ALL PHASES.
FYA Investigation

- 2014 TSITE meeting presentation
- Recognition of parclo interchange
- Consider 4-ring phase operation
- Identify FYA phase/overlap assignments with delay
The Tennessee Department of Transportation is recommending the use of the Flashing Yellow Arrow for permissive left turn indication to provide a safer, more efficient left turn for motorists.

**WHAT ARE THE BENEFITS OF THE FLASHING YELLOW ARROW?**

**SAFETY**
Provides a distinct indication to permissive left turn movements, minimizing confusion with the green ball interpretation.

**FLEXIBLE SIGNAL TIMING**
Provides more options to handle all types of traffic volumes by adjusting the mode of operation in different times of the day.

**SHORTER WAIT TIMES**
Due to its operational characteristics, the use of the flashing yellow arrow may reduce driver delay.

**ENVIRONMENTALLY FRIENDLY**
Provides improved traffic flow resulting in reduction of fuel consumption and vehicle emissions.

For more information, including a link to download this brochure and a demo of how the Flashing Yellow Arrow for permissive left-turns work, go to TDOT's web site:

**TDOT TRAFFIC OPERATION DIVISION OFFICE MISSION STATEMENT**
To maximize the capacity of the existing infrastructure in Tennessee with the use of technological innovations, standardized traffic management procedures and practices, and by forming strong strategic partnerships with local and state agencies.

**VISION**
To lead TDOT to the forefront of Transportation Management & Operations practices nationally.

A SAFER, MORE EFFICIENT LEFT-TURN SIGNAL

STATE OF TN FLASHING YELLOW ARROW
Figure 7.12 – Flashing Yellow Arrow (Permissive Left-Turn Movement Display)

**SOLID RED ARROW**
Drivers intending to turn left must stop and wait.
Do not enter an intersection to turn left when a solid red arrow
is being displayed.

**SOLID YELLOW ARROW**
The left-turn signal is about to change to red. Prepare to stop
or to complete the left turn if legally within the intersection
and there is no conflicting traffic present.

**FLASHING YELLOW ARROW**
Drivers are allowed to turn left after yielding to all oncoming
traffic and to any bicyclists and pedestrians in the crosswalk.
Drivers must wait for a safe gap in oncoming traffic before turning.
Oncoming traffic has a green light.

**SOLID GREEN ARROW**
Left turners have the right of way. Proceed.
Oncoming traffic has a red light.
FYA Design

- Required new controller, signal heads and signage
- Added new loops for internal approaches
- Programming recognizes new phasing, detectors, FYA overlaps and delay
<table>
<thead>
<tr>
<th>Ph</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>GRN</th>
<th>YEL</th>
<th>Red</th>
<th>TG PreEmpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olap A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>5.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Start Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stop G/Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olap B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>5.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Start Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stop G/Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olap C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>5.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Start Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stop G/Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olap D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Start Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stop G/Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olap E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Start Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stop G/Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olap F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Start Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>4.0</td>
<td>2.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stop G/Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Future Improvements

- Restore internal clearance trailing green (overlaps E & F pin assignments to phases 3 and 7)

- External FYA left arrows continue to display during trailing green (adjacent thru lane displays red)
Future Improvements

- Signing improvements (consider Plano, TX display)
Average Change in Total Crashes at Intersections Converted from PPLT Control to FYA PPLT

FIGURE 23 Changes in total Crashes in PPLT to FYA PPLT Conversions
Crash Reduction

- High speed intersection PPLT display (becomes second Franklin FYA)
- One year pre- & post- FYA crash comparison (lefts 9/12 vs. 3/12)
- Additional improvement by reducing intersection width
Conclusions

- Effective improvement for overcoming yellow trap limitations
- Flexibility in displays by interval
- Proven crash reductions where displayed
- Well-received & understood by public