A Computer Simulation of the System-Wide Effects of Parallel-Offset Route Maneuvers

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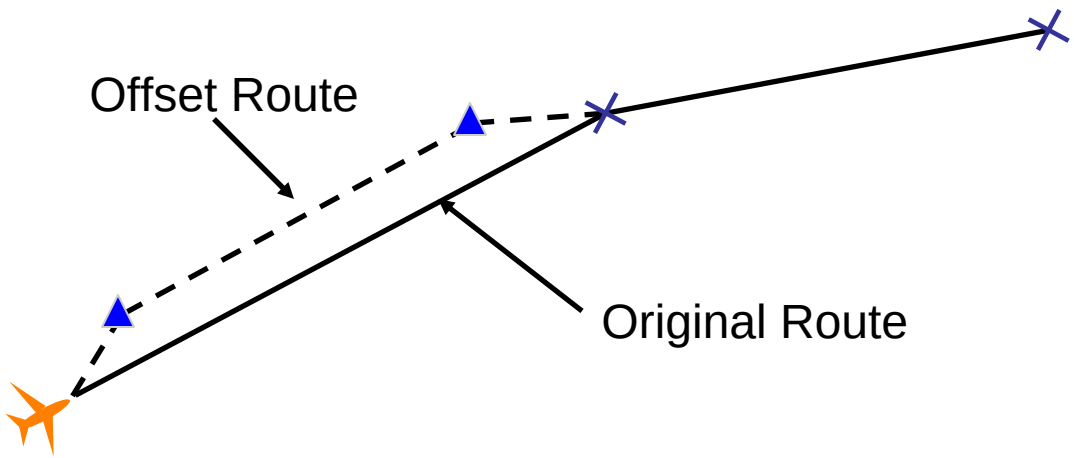
Parallel-Offset Route



- Aircraft flies parallel to the original route
- Modern Flight Management Systems automate this process

Outline

- Motivation
- Objectives
- System Benefits
- Situational Benefits
- Vectoring Comparison
- Conclusions

Motivation

- FAA adding automation capabilities to advance towards NextGen
- Parallel-Offset route capabilities may:
  - Add resolution possibilities leading to more efficient resolution maneuvers
  - Be an easily communicated and executed closed trajectory
  - Improve ground-based automation intent data

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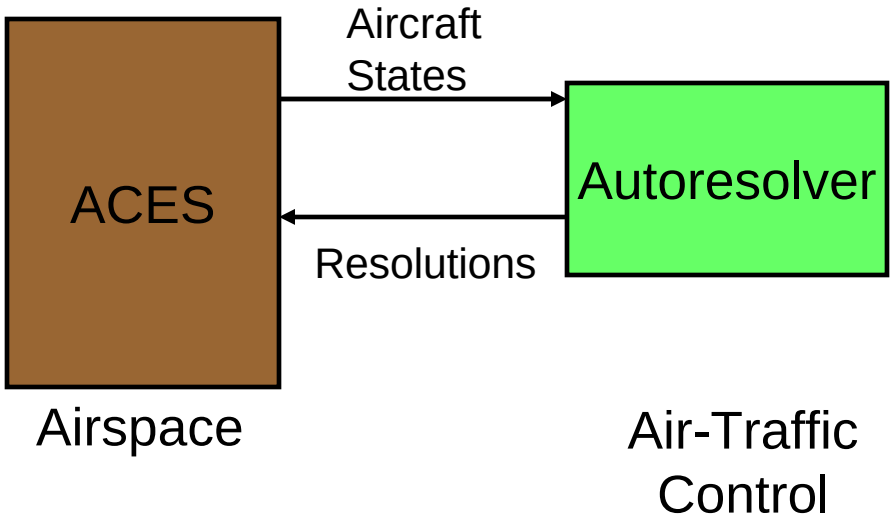
Study □□Objectives

Determine system benefits of parallel-offset routes as conflict resolution maneuvers

Identify situations better suited to these resolutions

Simulation Environment

- Airspace Simulator: Airspace Concept Evaluation System (ACES)
- Air-Traffic Control Emulation: Advanced Airspace Concept (AAC) Autoresolver

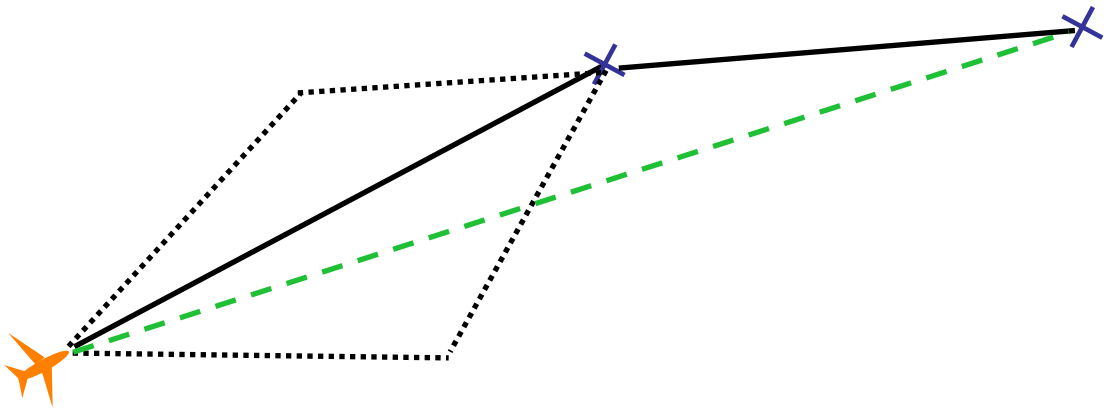


ACES

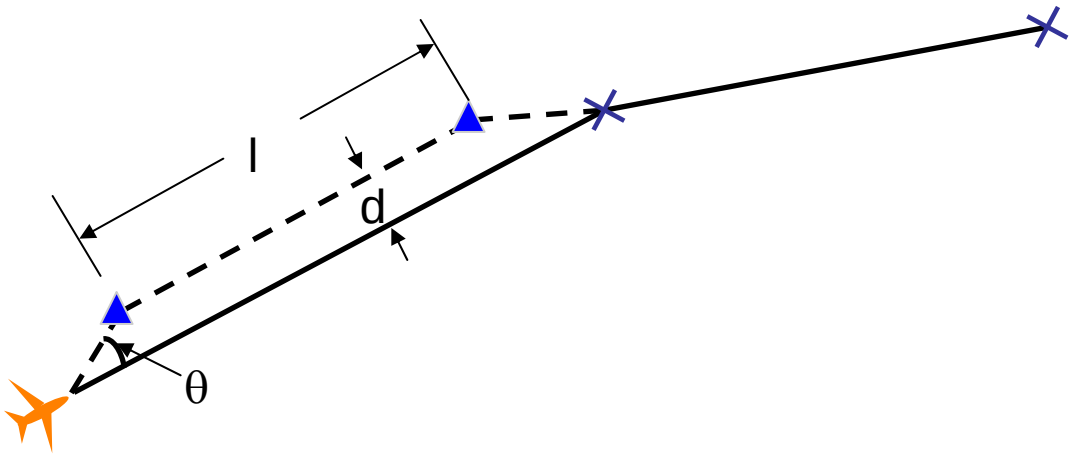
- Nationwide gate-to-gate simulation
- Four-dimensional trajectory generation from departure fix to arrival fix

AAC Autoresolver

- Iteratively resolves conflicts
- Evaluates resolutions of many types
- Generally chooses minimum-delay successful resolution



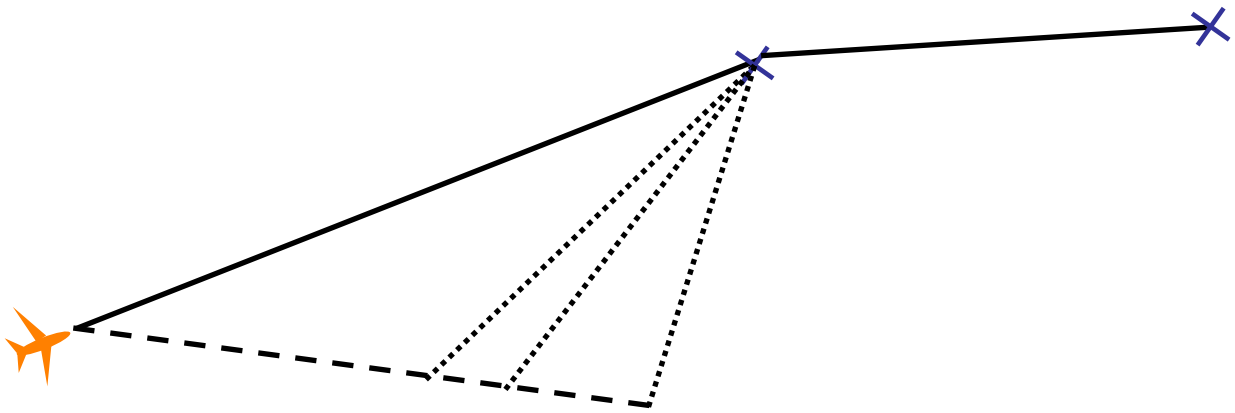
Offset Resolution Implementation



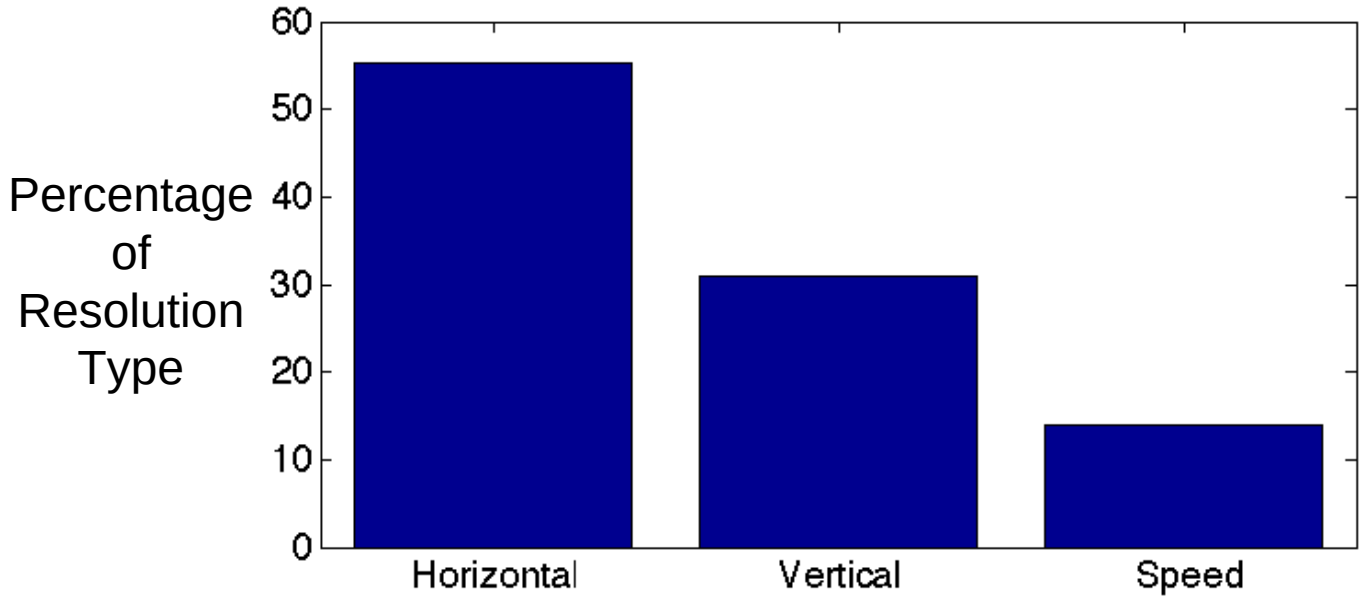
- Requires straight route for next 100 nmi
- Offsets 6 or 10 nmi
- Turn-out angle 30 degrees
- Flies 50, 100 or 150 nmi along offset

Autoresolver Calibration

- Want to calibrate the Autoresolver to match current system
- Two calibration points:
  - Resolution type ratio
  - Horizontal vectoring approximation

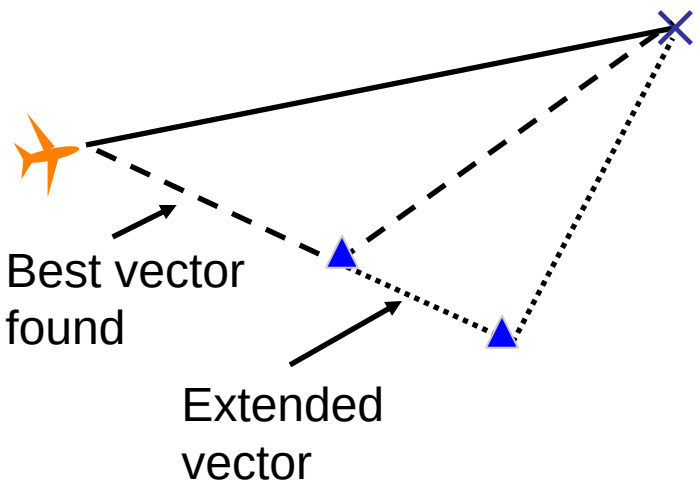


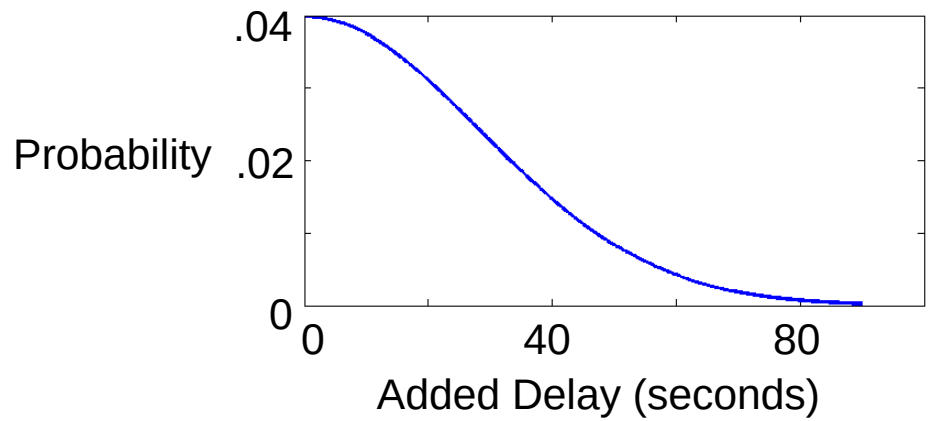
Resolution Proportions



- Resolution ratios found from radar track data
- Autoresolver calibrated to match these ratios

Auxiliary Waypoint Uncertainty



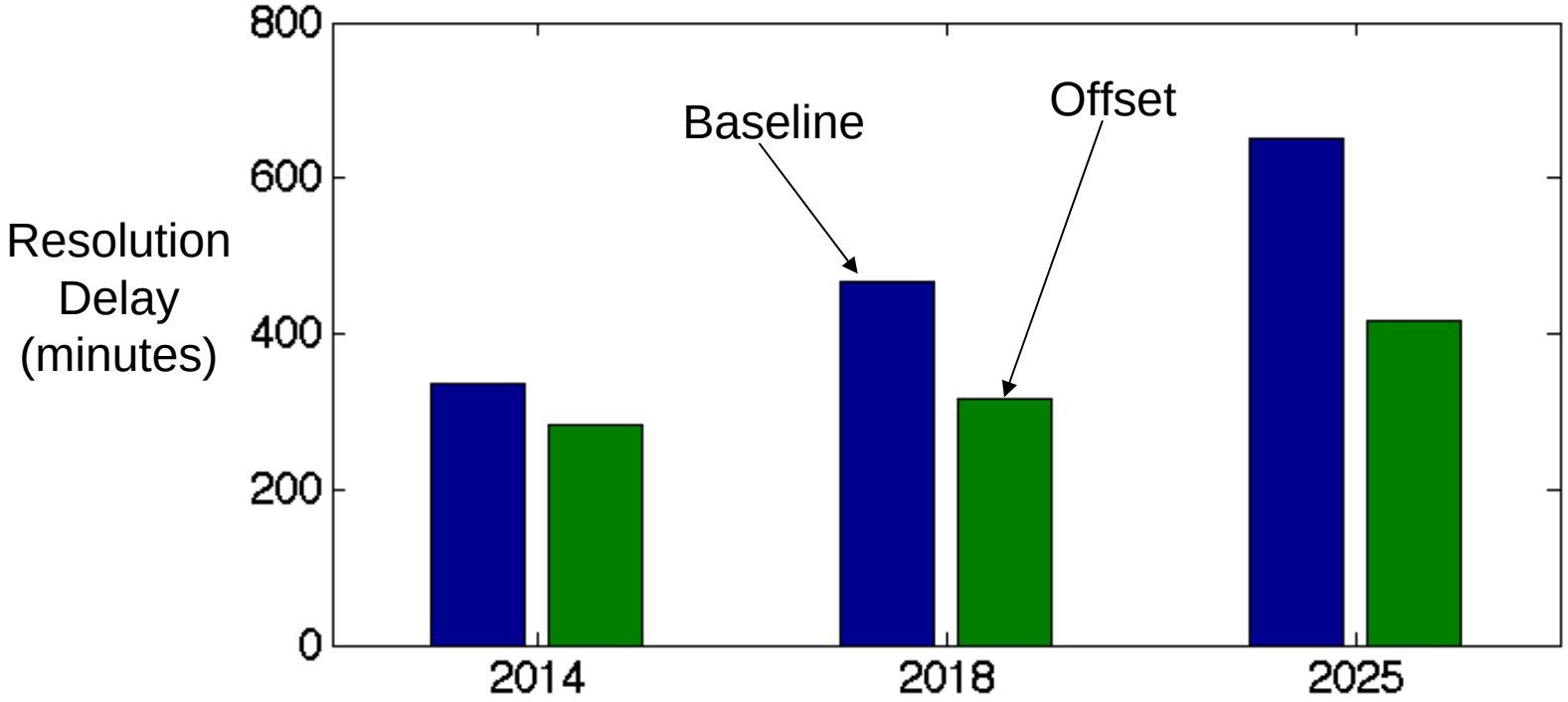


Resolution is extended to attempt to mimic variations in horizontal vectoring

Benefit Study Setup

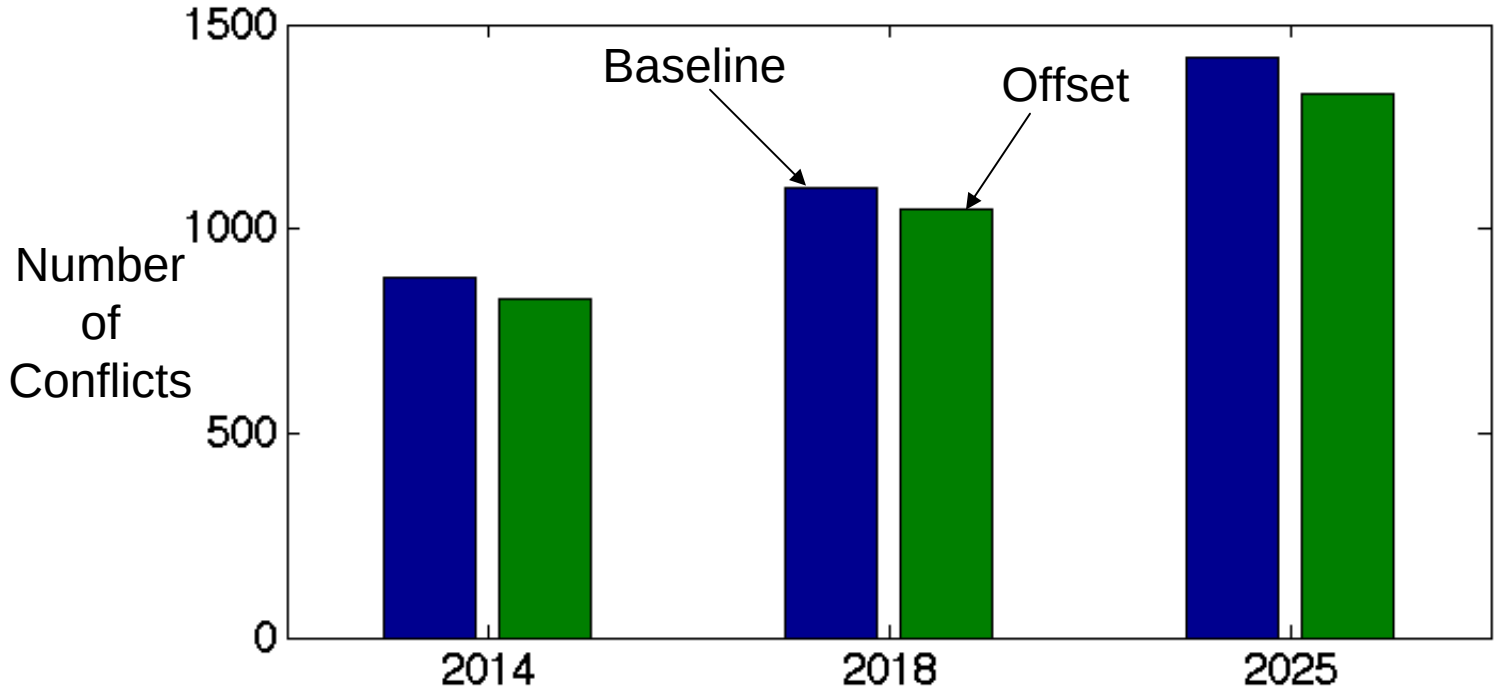
- Four representative Centers
- Three 24-hour demand sets: 2014, 2018, 2025
- Twelve baseline runs with no offsets
- Twelve runs with offsets

Delay Benefit of Offsets



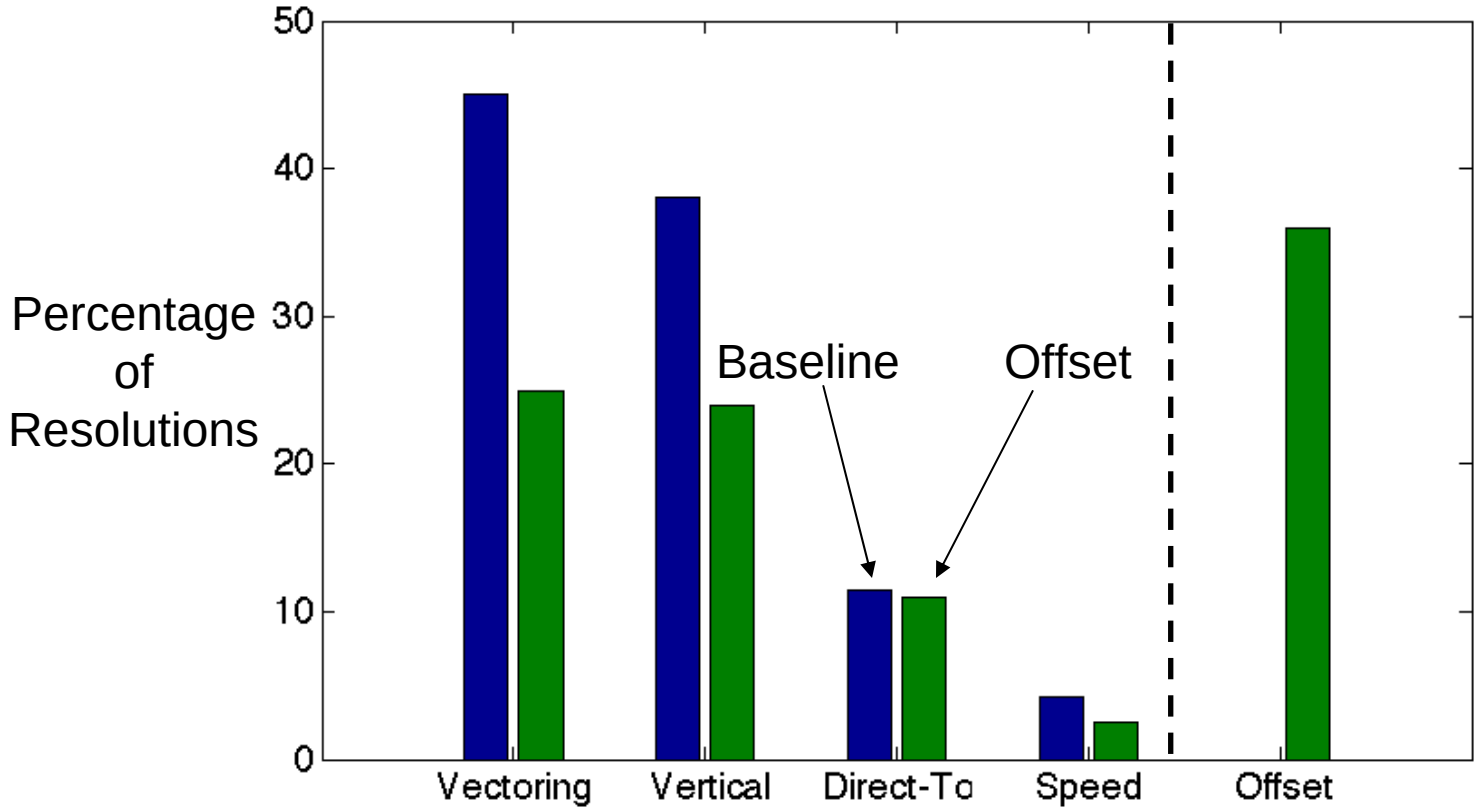
Offsets can reduce the total resolution delay up to 30%

Conflict Count Comparison



Offsets do not increase the total number of conflicts

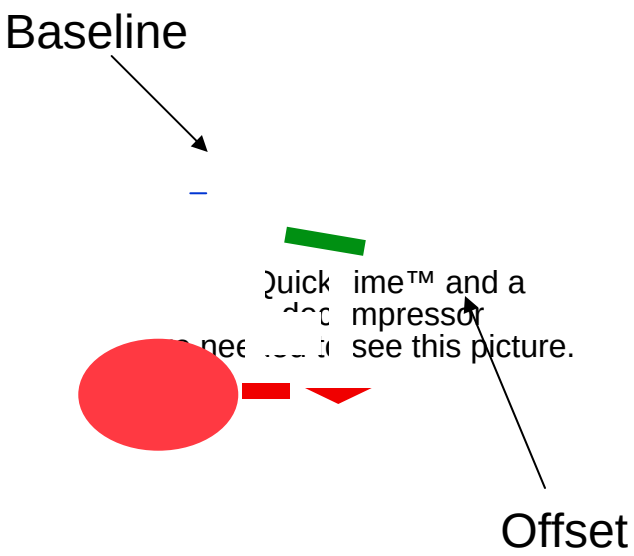
Maneuver Frequency



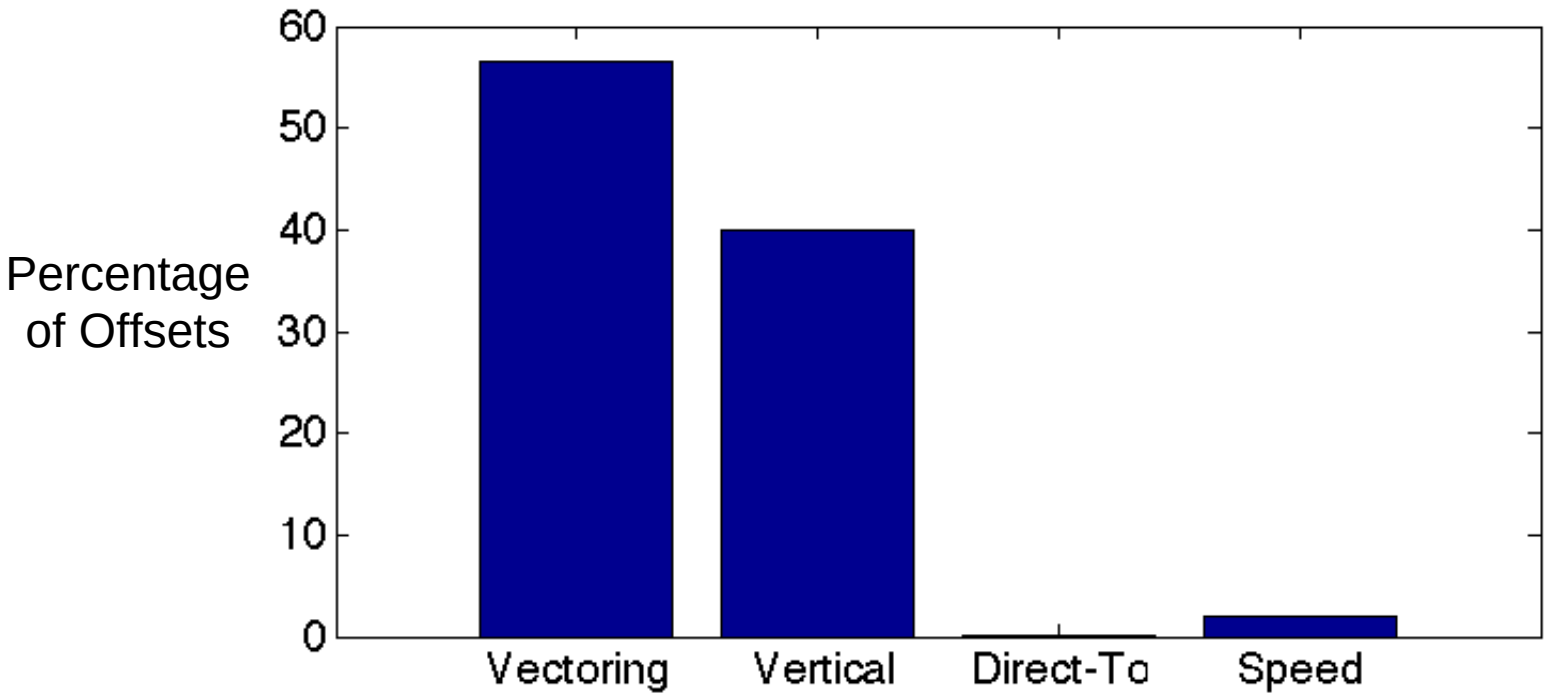
Offsets are a significant contributor to resolutions

Resolution Comparison

- Baseline and offset cases have common conflicts
- These conflicts illustrate how offsets change the system

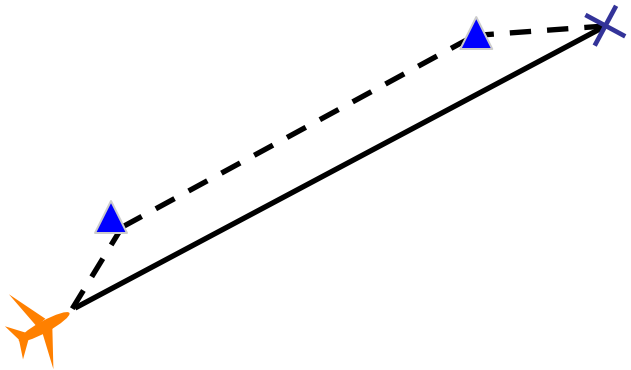


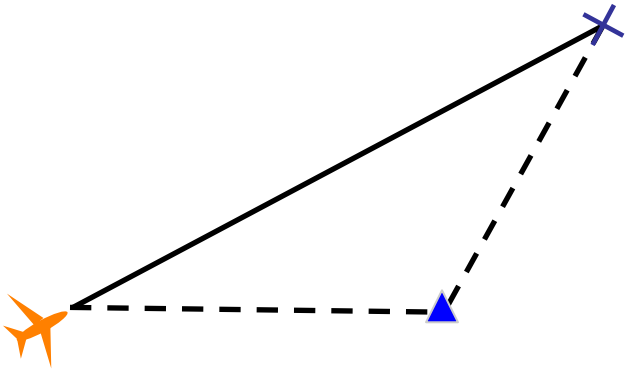
Replaced Resolution



Offsets most often replace vectoring resolutions

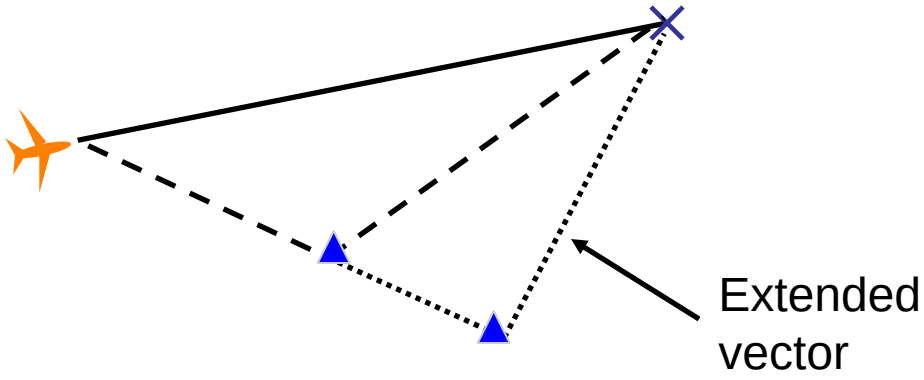
Vectoring and Offset Comparison





- 20 Centers
- Three hours of traffic for 2014 and 2018 demand

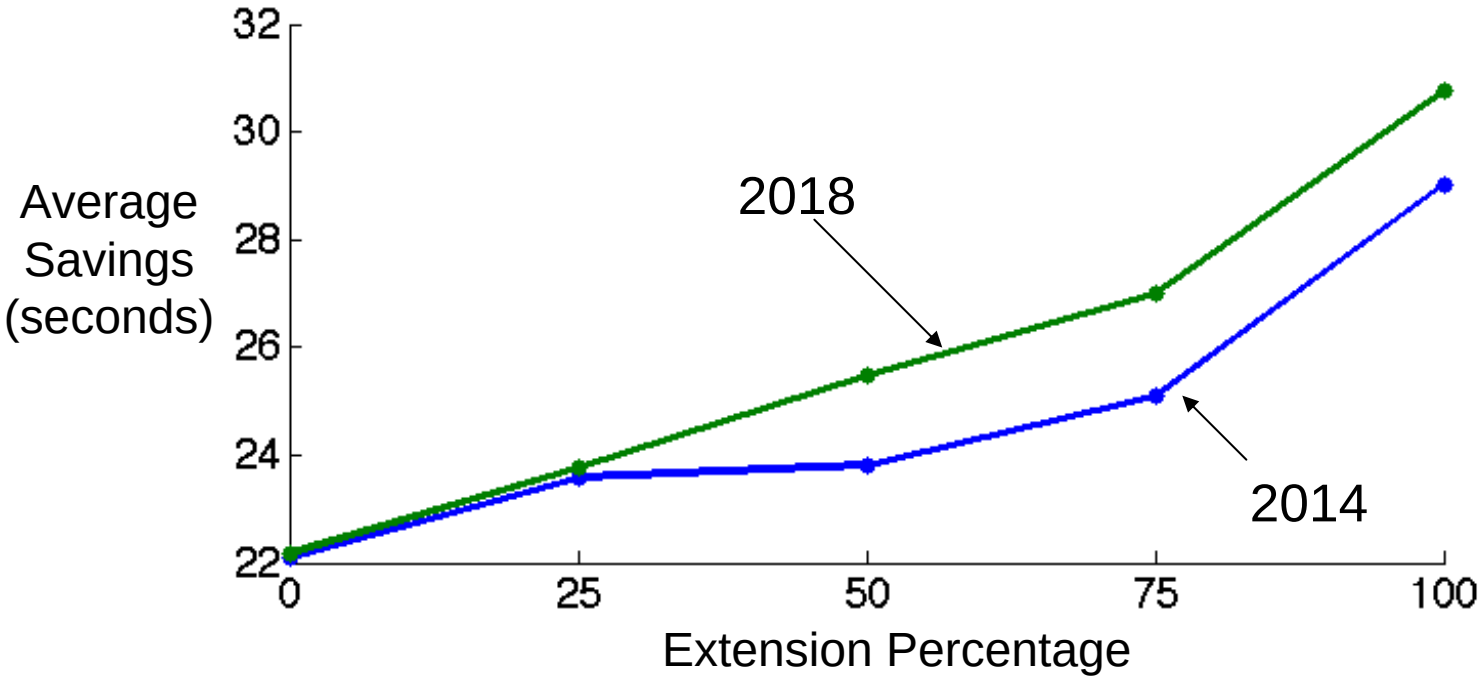
Extension Percentage



Additional delay is varied from 0% to 100% of best delay for sensitivity study

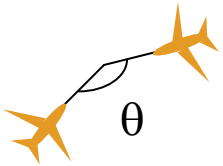
Saving of Offset

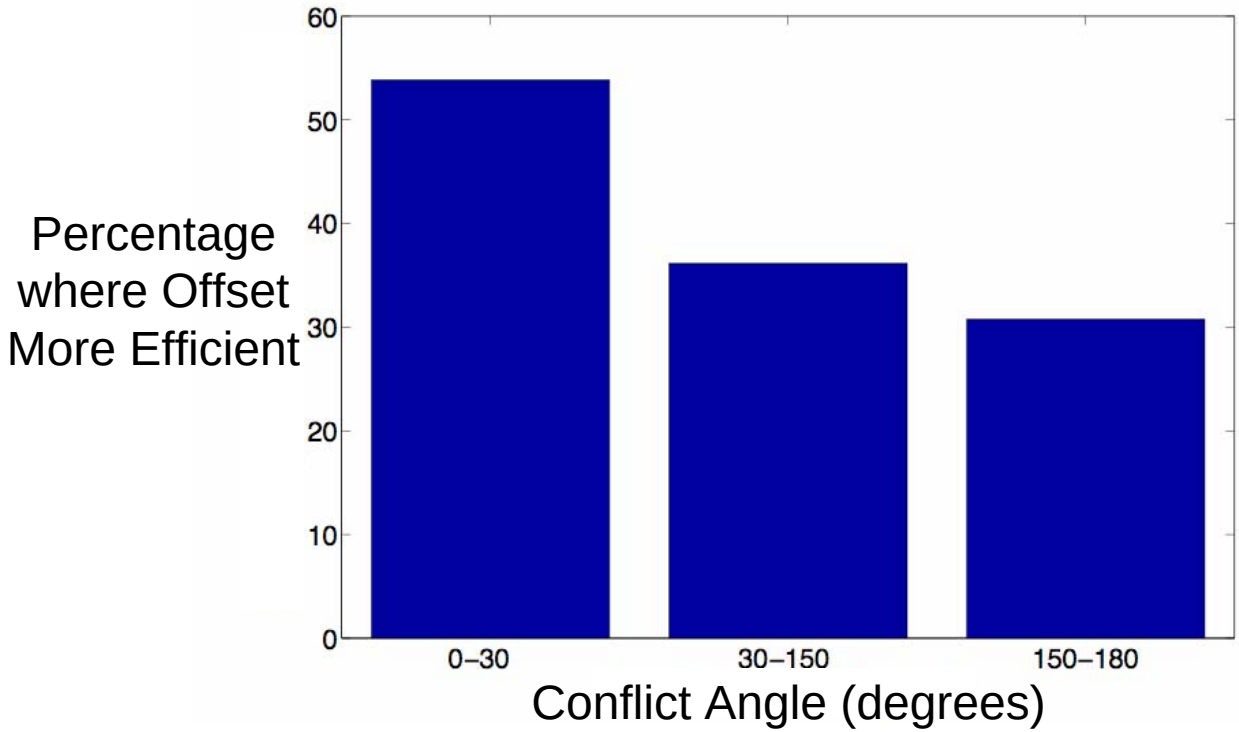
Resolutions where offset provided benefit over vectoring



At least 22 seconds of benefit realized increasing to over 31 seconds

Conflict Angles





Offsets more efficient for majority of in-trail conflicts

Conclusions

- Parallel-offset resolutions may reduce resolution delays by up to 30%
- Offset resolutions are often useful in horizontal-vectoring situations
- Offsets are generally more efficient than vectoring for in-trail conflicts