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Characterization of Response Times based on Voice Communication and Traffic Surveillance

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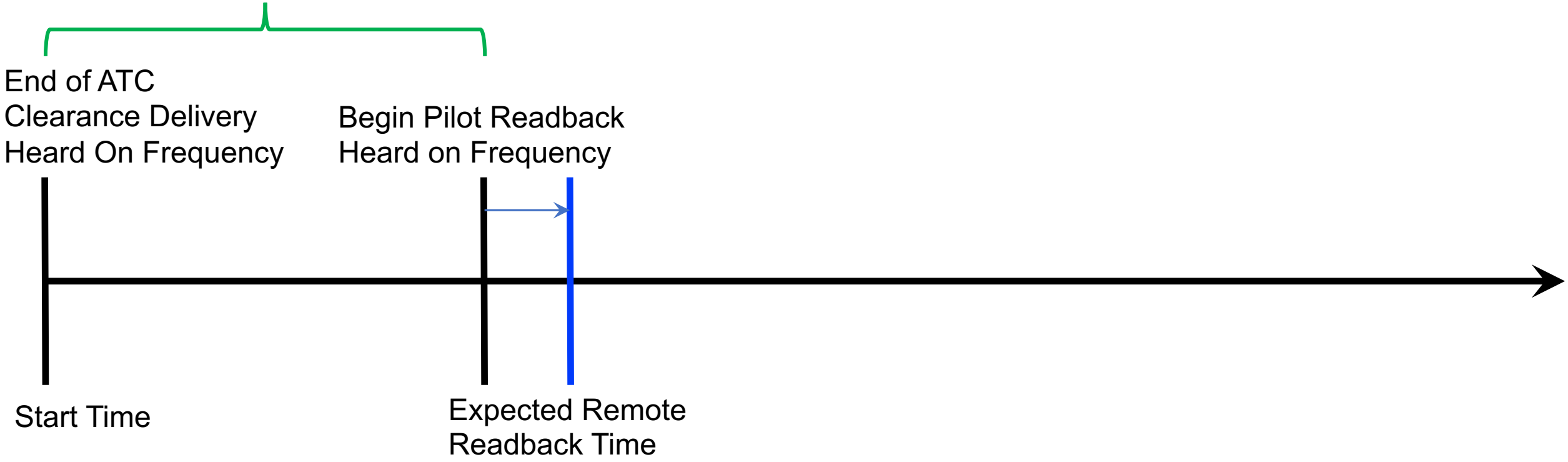
Motivation

- Communication delay (satellite-based) is a potential barrier to integration of Remotely Piloted Aircraft (RPA) in the national airspace:
  - Voice communication delay between the air traffic controller and the remote pilot
  - Command and Control delay between the remote pilot and the remotely piloted aircraft
- A baseline of pilot readback delay and maneuver initiation and maneuver completion delays with respect to air traffic control clearance is needed

Definition of Delays

Pilot Readback Delay
End of ATC Clearance to
Begin Pilot Readback



Definition of Delays

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Approach

- 24-hours of Northwest Los Angeles Arrival voice data
- ADS-B track data within 150 nautical-miles of Los Angeles airport
- Voice data transcribed to text using Automatic Speech Recognition
- Altitude, speed and heading commands determined via keyword search in transcribed text
- Command attributes such as 1,000 feet determined with rule-based parsing
- Callsign recognized using rule-based and track-data-based process

ATC Clearance	Altitude (feet)	Heading (degrees)	Speed (knots)	Callsign
Alaska 370 turn right heading 150 descend and maintain 4000	4000	150	N/A	ASA370

Command Recognition Keywords and Queries

Altitude Command

Keywords

- altitude
- ascend
- climb
- descend

Attribute Search

- Is divisible by 100
- First instance after the keyword

Heading Command

Keywords

- heading
- left
- right
- turn

Attribute Search

- Three digits long
- < 360
- Within two words to the right of the last keyword

Speed Command

Keywords

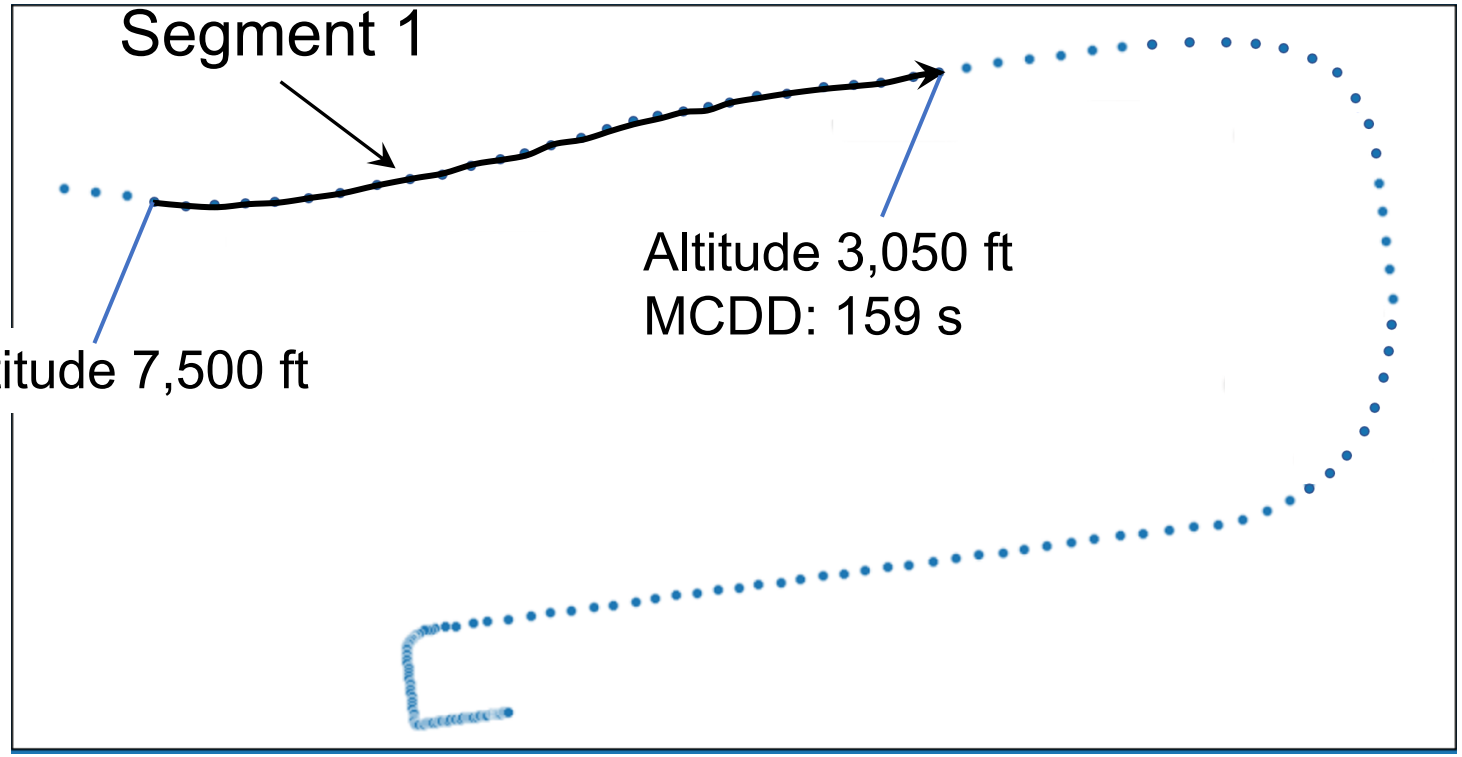
- knot
- slow
- Speed

Attribute Search

- < 1,000
- Within two words to the left of “knot”
- Within three words to the right of “slow” and “speed”

Results

ATC Clearance	t_0	MCDD
Air Canada 558 descend and maintain 3000	22:19:10 (PST)	159 s
Air Canada 558 turn right heading 160	22:22:18 (PST)	51 s
Air Canada 558 fly heading 220 to join final	22:23:44 (PST)	20 s



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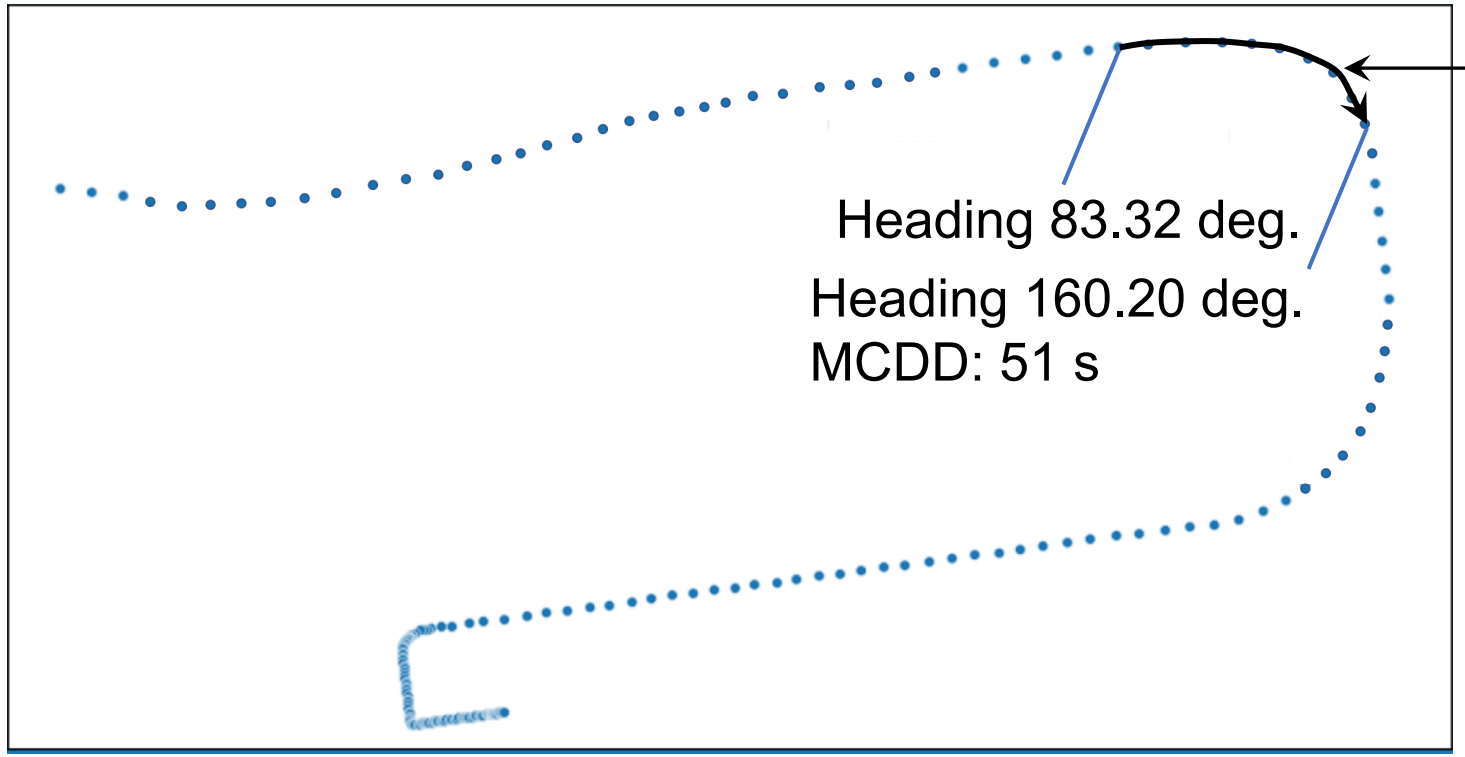

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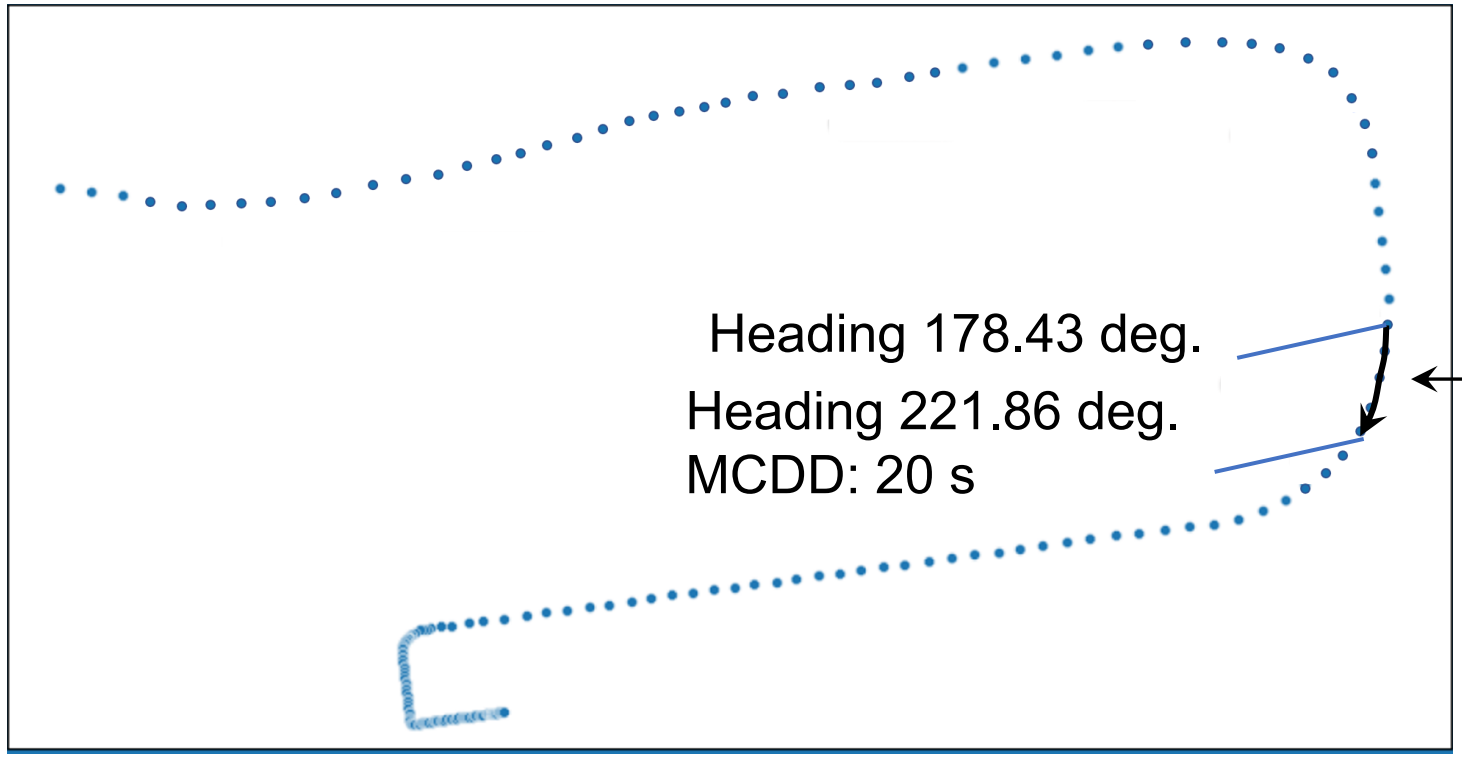


Maneuver Delay Results

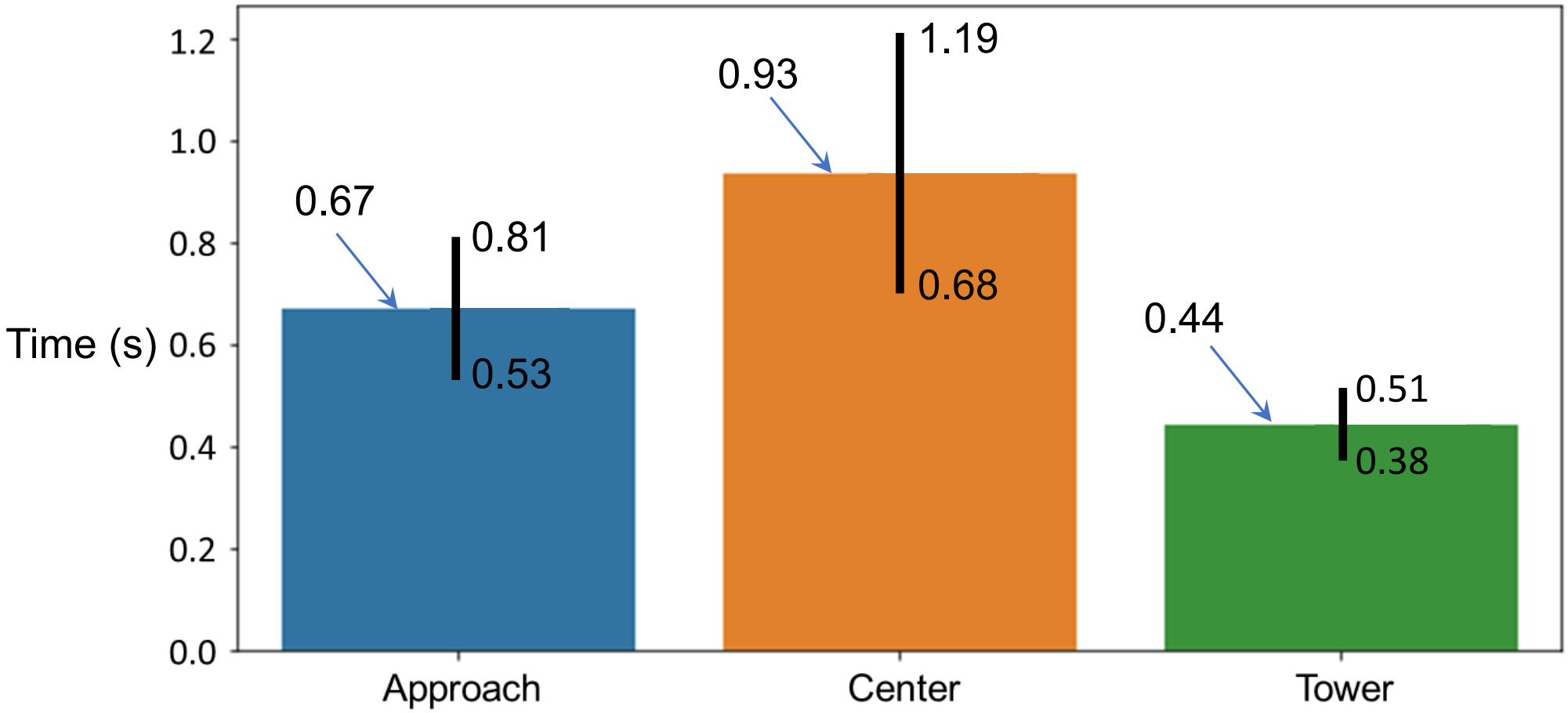
Maneuver Initiation Detection Delay (seconds)

	Altitude	Heading	Speed	All Commands
Average (seconds)	16.69	16.70	25.47	20.70
Standard Deviation (seconds)	11.23	6.47	16.35	13.60

Maneuver Completion Detection Delay (seconds)

	Altitude	Heading	Speed	All Commands
Average (seconds)	176.1	69.3	182.3	151.3
Standard Deviation (seconds)	62.3	43.5	107.8	98.3

Pilot Readback Results



Conclusions

- Pilot readback delay less than one second
- Speed change maneuver initiation detection delay longest
- Heading change maneuver completion detection delay less than half for altitude and speed change
- Pilot readback delay, maneuver initiation detection delay and maneuver completion detection delay results presented for the manned aircraft establish a baseline for comparison with those obtained for remotely piloted aircraft