

Enhancing Connectivity Through Technology

**E-TAXI SYSTEM(S) – A SMALL STEP FOR
AIRCRAFT A BIG LEAP FOR AVIATION**

September 2013

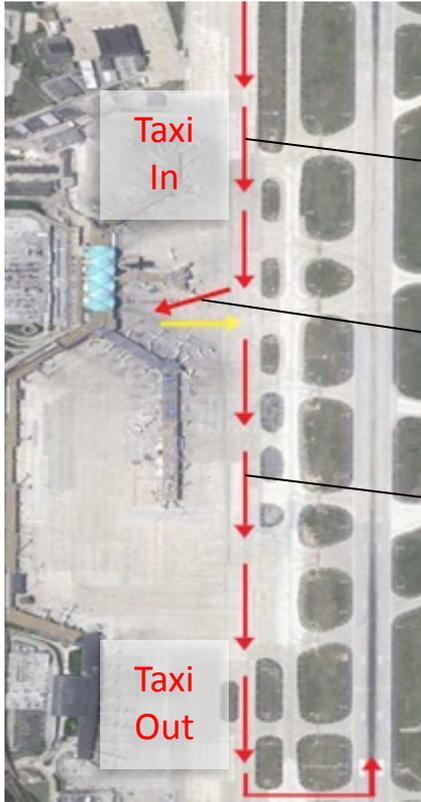
What is E-Taxi?

Ground movement without engines or tugs

**Nobody cared too much till now , because no solution other than single engine taxi available
YET**

Conventional Taxi vs. E-TAXI

TODAY

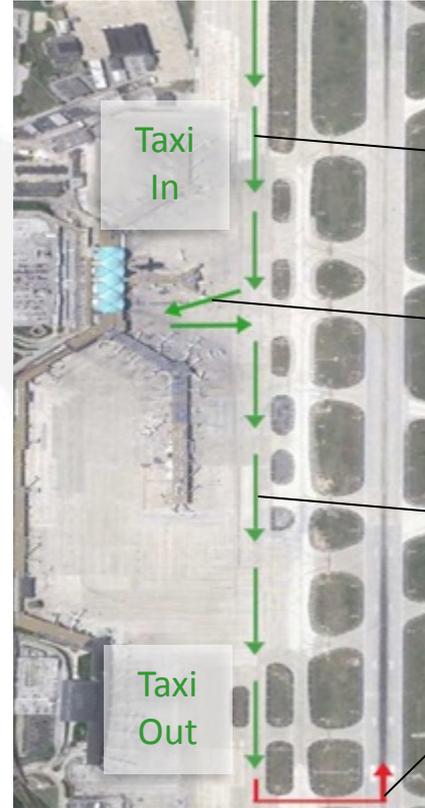


Engine active from landing to terminal

Tug required for pushback from gate

Engine active from terminal to takeoff

E-TAXI



E-taxi active from landing to terminal

E-taxi to/from gate
No tug required

E-taxi active from terminal until warmup

Engine active from warmup to takeoff
(E-taxi can continue operations during engine start)

E-Taxi Impact on Aircraft/Airport Operations

WheelTug's electric drive system

simplifies taxi ops

and thus provides operational...

and financial benefits

Tugless Pushback

Reduces pushback cost

Reduces unpredictability

Improves safety & throughput

Eliminates towbar disconnect time

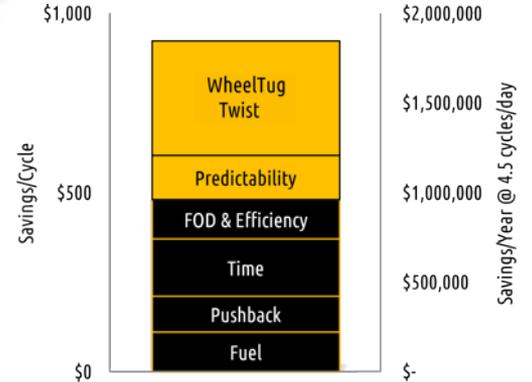
Engines-off Taxi

Enables no-pushback parallel-to-gate operations

Cuts engine wear & FOD

Reduces emissions

Cuts taxi fuel use

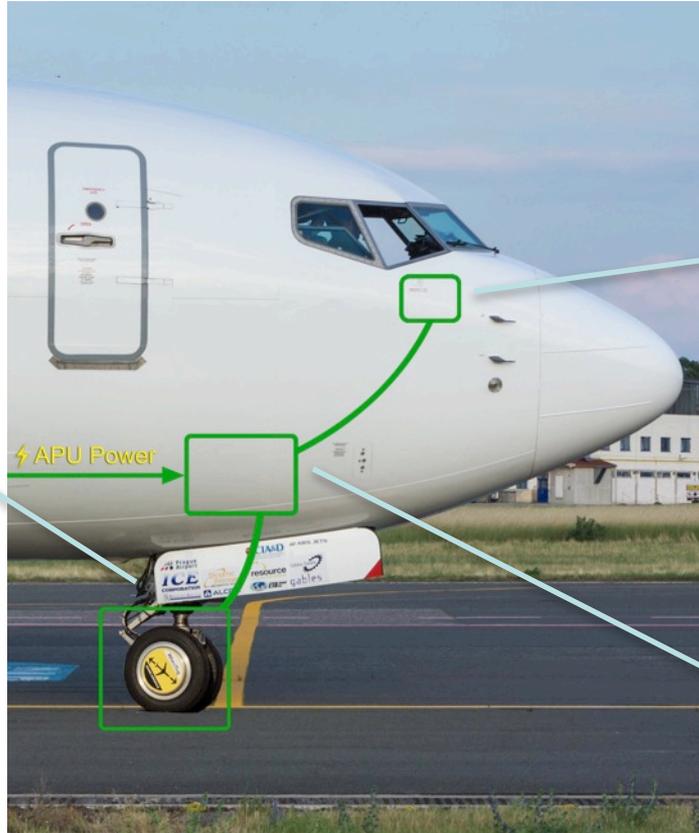


WheelTug's twin electric nosewheel drives are powered by the APU

NO NEED FOR ANY NEW INVESTMENT



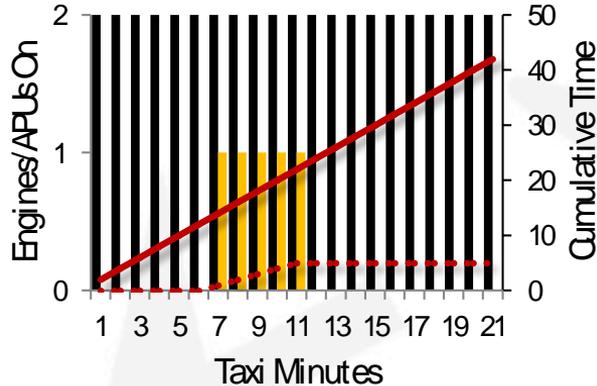
The WheelTug[®] System



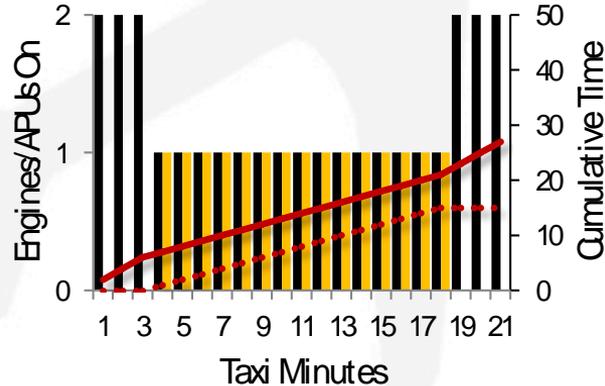
E-TAXI Saves Fuel and Engines

- The average US narrowbody taxis for 21 min/cycle
- Engine warm-up & cool-down requires 3 minutes each
- Single-engine taxi keeps the APU on to avoid cross-bleed starts

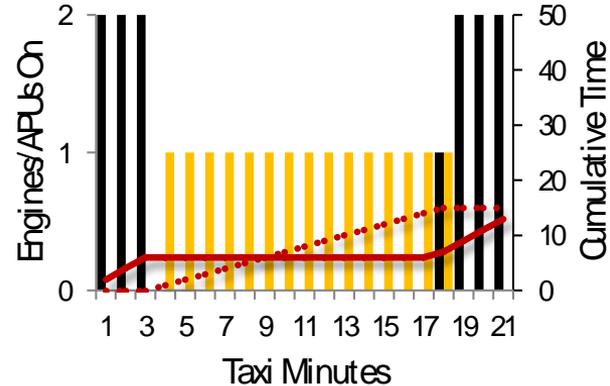
Dual-Engine Taxi



Single-Engine Taxi



WheelTug Taxi

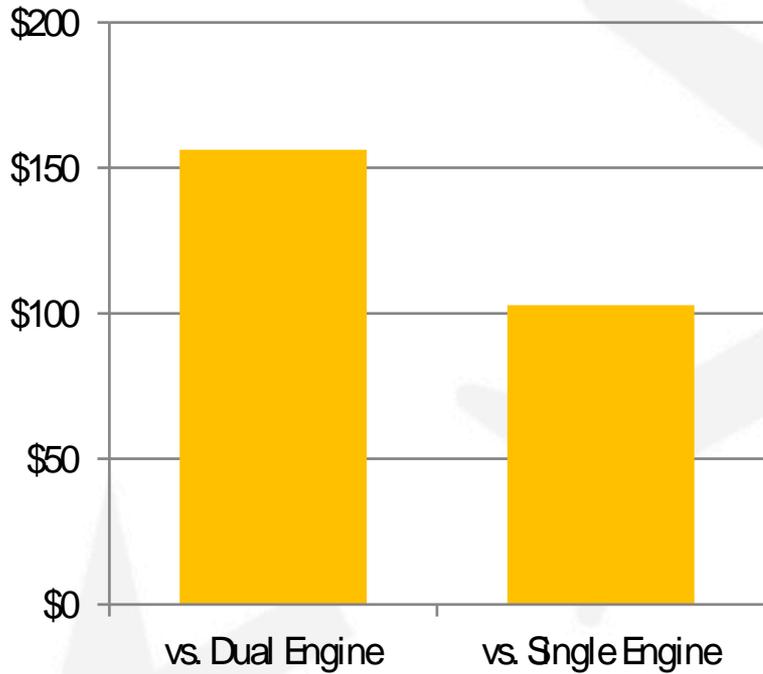


■ Engine Time/Min ■ APU Time/Min
— Total Engine Time Total APU Time

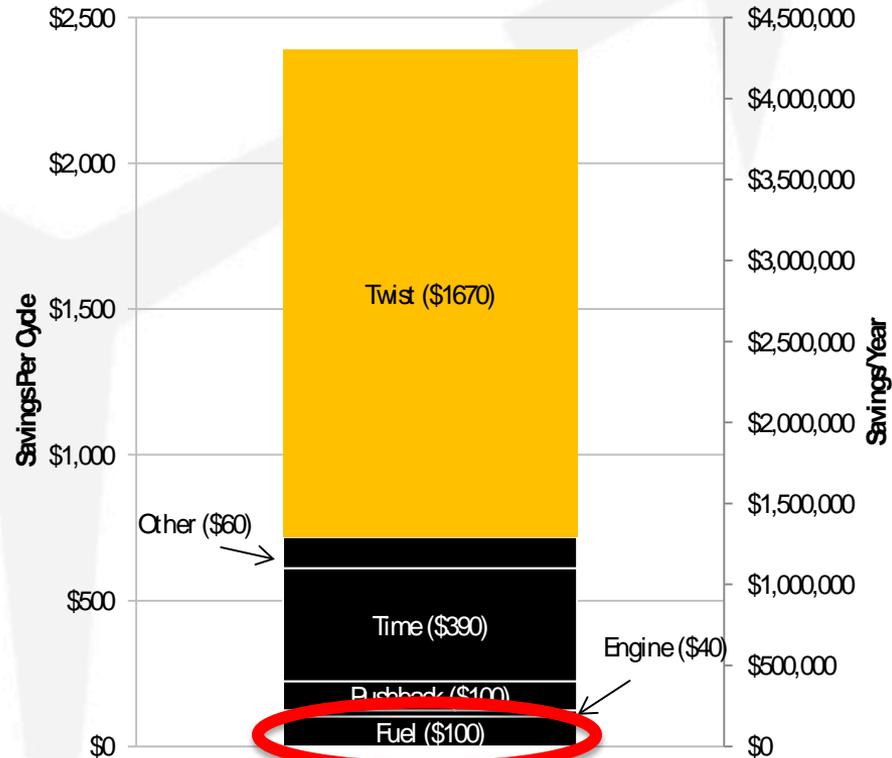
■ Engine Time/Min ■ APU Time/Min
— Total Engine Time Total APU Time

■ Engine Time/Min ■ APU Time/Min
— Total Engine Time Total APU Time

Fuel Savings/Cycle

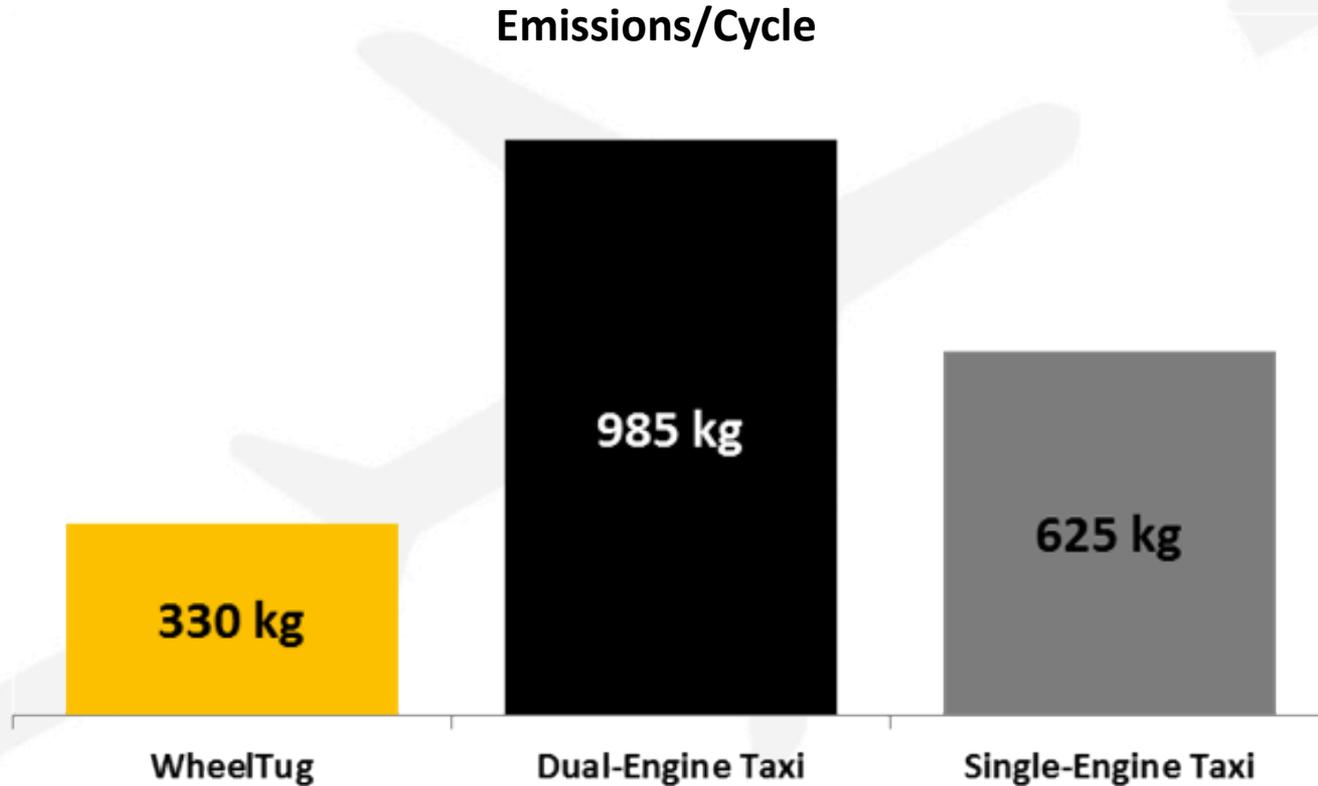


Fuel-Savings Only



Total Savings/Cycle
vs. Single-Engine Taxi

E-Taxi reduces Emissions



Airport benefits

NO NEED FOR ANY NEW INVESTMENT

Without disconnects or engine warm-ups, jets move forward as soon as they finish taxiing back. This means ramps are not blocked by immobile aircraft



Increased Throughput

Due to elimination of jet blast, engine noise & ingestion risk

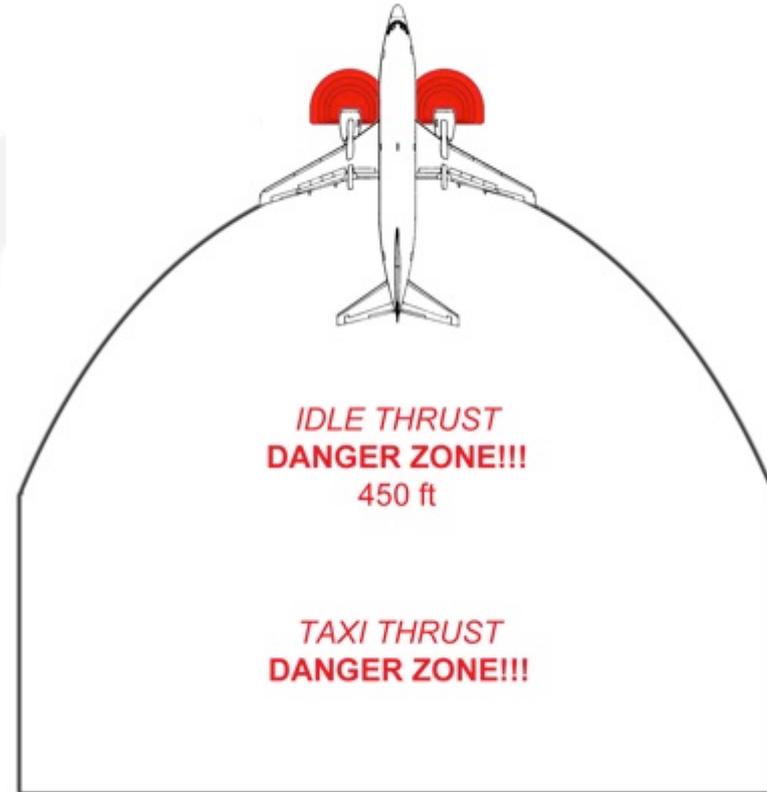
NO NEED FOR ANY NEW INVESTMENT

Higher gate throughput

- Service vehicles, passengers and personnel can operate around aircraft as soon as the airplane comes to a stop

Higher Airport throughput

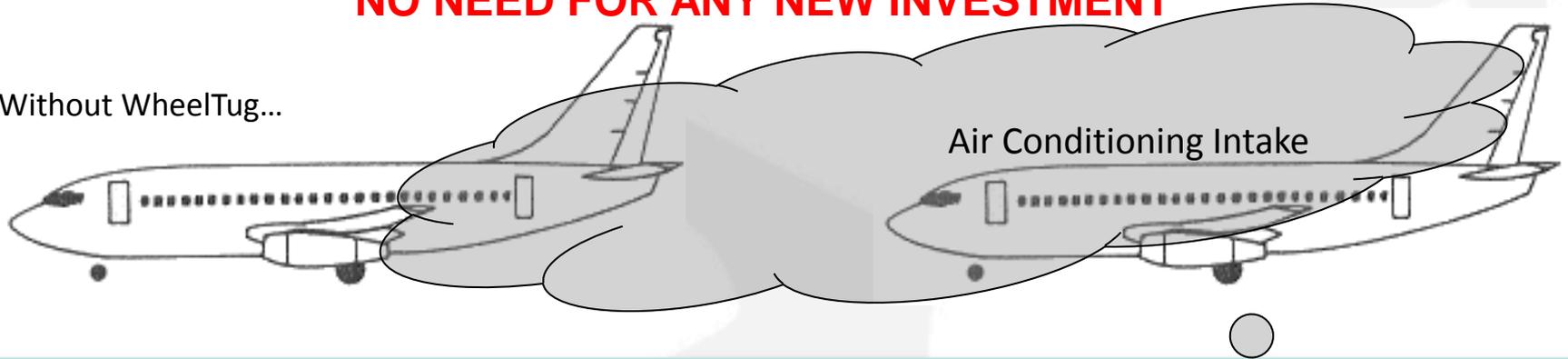
- Safety margins in taxi can be reduced allowing more vehicles in the same space
- Pushback time savings means aircraft don't block the taxiway for others especially in cramped ramp areas



Air Quality

NO NEED FOR ANY NEW INVESTMENT

Without WheelTug...



With WheelTug...



With WheelTug, cabin air quality improves under certain conditions

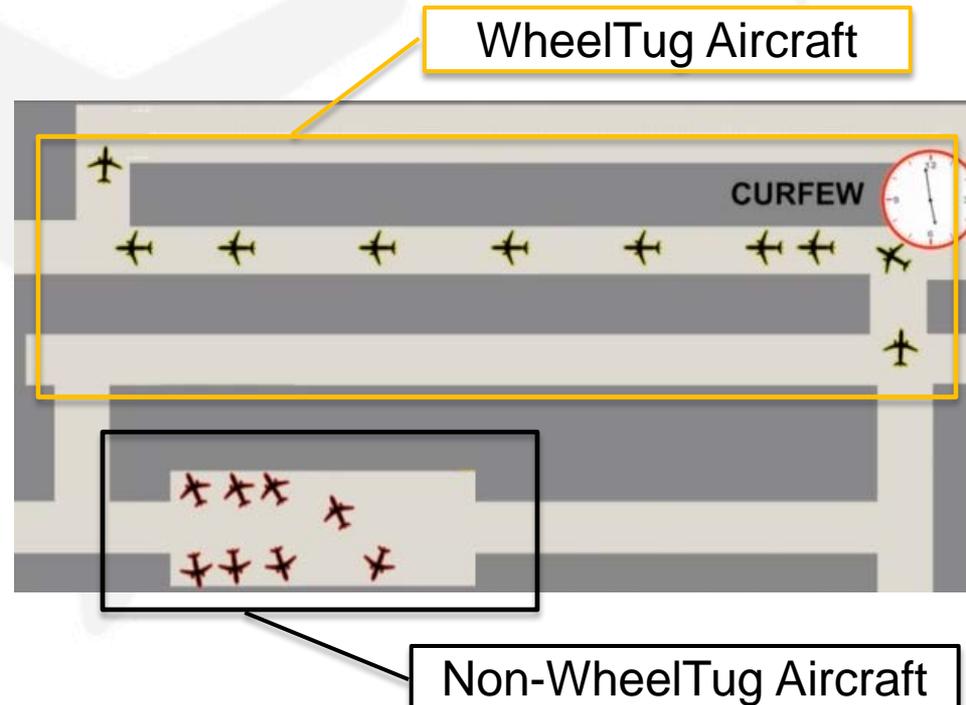
Pilots complain of as many as five “fume events” per week – and sometimes pursue legal action

New Slot Creation

NO NEED FOR ANY NEW INVESTMENT

- In airports with morning noise curfews, engines can't start until curfew lifts
 - With WheelTug, loaded aircraft can taxi to the runway prior to curfew
- This can add 5-10 additional daily morning take-off slots per runway
 - First-morning flights are the most valuable for business travelers
 - Premium slots "sell" for \$3 million or more

Aircraft Positions when curfew is lifted



WheelTug impact on Airline Earnings Before Tax

NO NEED FOR ANY NEW INVESTMENT

**WheelTug
Boost**
\$3.47/passenger

EBT *Without*
WheelTug*

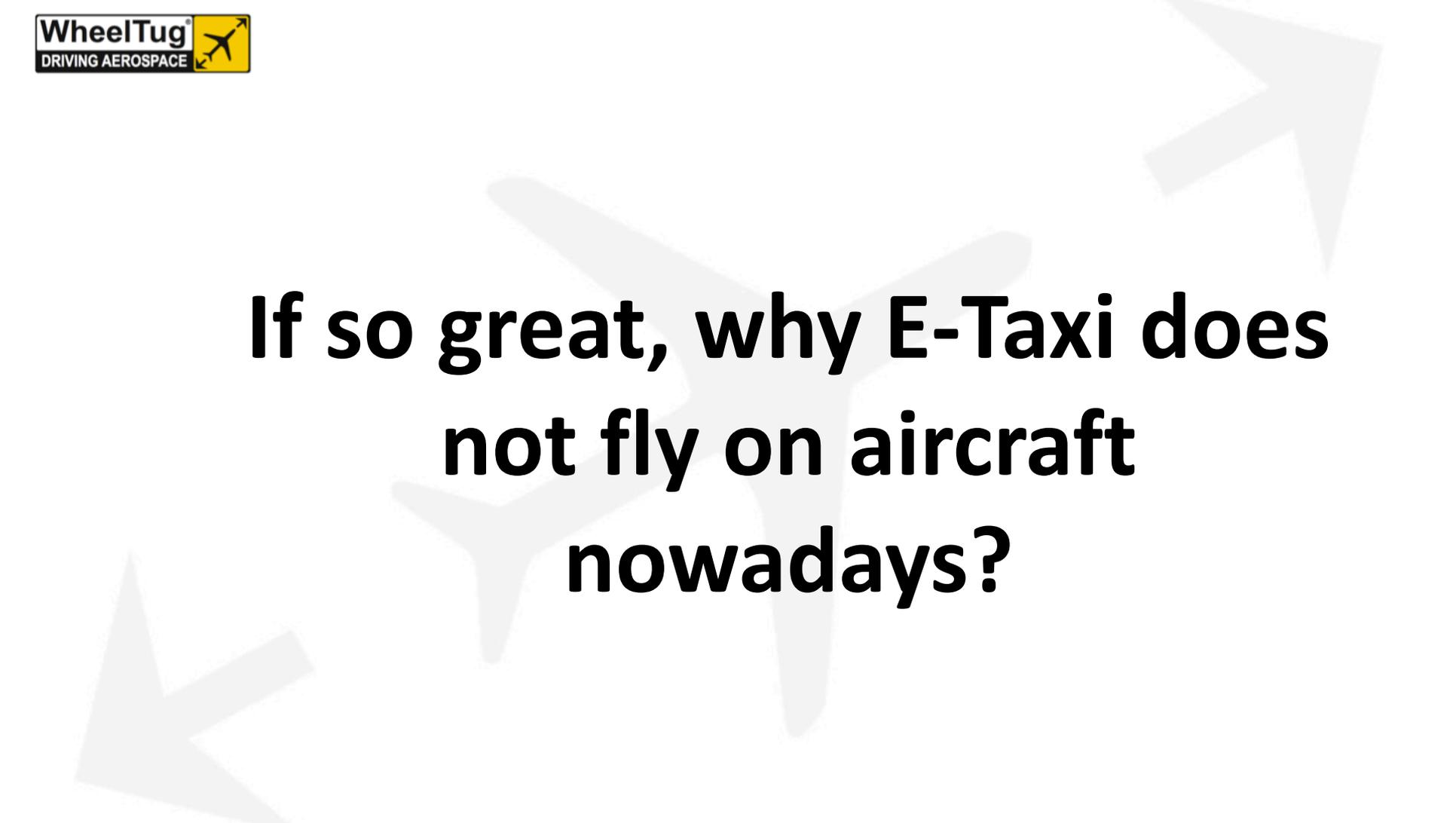
\$2.10/Passenger



\$5.57/Passenger

* Pre-Tax Income, 2010-2012, 10 largest U.S. passenger airlines by revenue. Source: BTS Transstats.

**If so great, why E-Taxi does
not fly on aircraft
nowadays?**



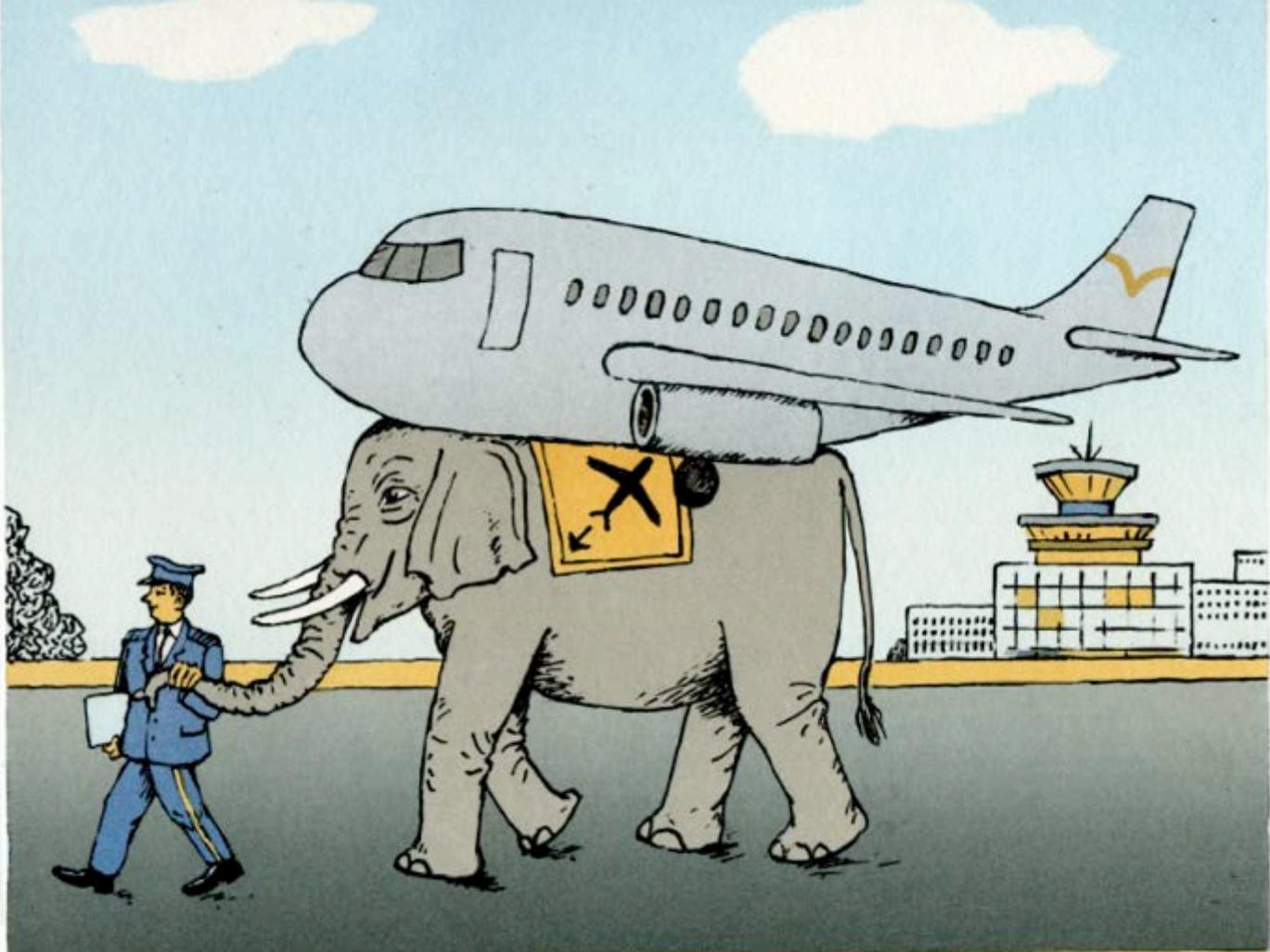
Technology is one reason WheelTug has not happened before now...



It's not easy to package the elephant in the nosewheel

If so great, why E-Taxi does not fly on aircraft today?

- *Idea is simple, execution is challenging*
- *Aircraft OEMs have other priorities and agenda*
- *It is not easy to be a new kid on the block*



Will taxi for peanuts