



# Tailored Arrivals (TA)



## Current Status:

- Current work is focused on preparing for oceanic TA field trials involving ZOA/NCT, scheduled to begin April 2006. This effort is being led by NASA with support from Boeing, UAL, FAA, and SFO airport.
- Above effort is progressing well:
  - This activity has received strong support and cooperation from the FAA at various levels
  - An initial Test Plan that conveys procedures, CDA profile optimization, test matrix, and data collection/analysis is nearing completion
  - Test will leverage the FAA's ATOP/Ocean 21 system as a means of delivering TA clearances via data-link. A high-fidelity ATOP simulation capability has been developed at NASA Ames to support procedural development.
  - An important objective of this test is to include a prototype version of NASA's En Route Descent Advisor (EDA) tool as a mechanism for dynamically "tailoring" the arrival in upper airspace. This clearly distinguishes this activity from past related CDA efforts, and provides a path for enabling TA/CDA procedures during congested traffic conditions.
- A long-term CONOPS is under development that explores the feasibility and benefits of conducting TA operations under complex traffic/airspace constraints.





# Tailored Arrivals (TA) Future Work



- Continue to develop and refine TA CONOPS and supporting benefit studies
- Further define the role of TA in a larger system context (e.g., NGATS, GATI)
- Explore opportunities for follow-on field evaluations, with clear technical objectives in mind
- Continue to develop ground automation required to “tailor” arrivals. This work will look into expanding the role of EDA into the lower altitude, TRACON airspace.





# General Objectives of OTA trials



Progress towards a near-term application of TA for immediate benefit to non-congested oceanic arrival operations:

- Develop static profiles and procedures that can be “left behind” for immediate benefit to community, airlines, and FAA
- Measure economic and environmental benefits in comparison with a baseline that represents current, non-congested oceanic arrival operations

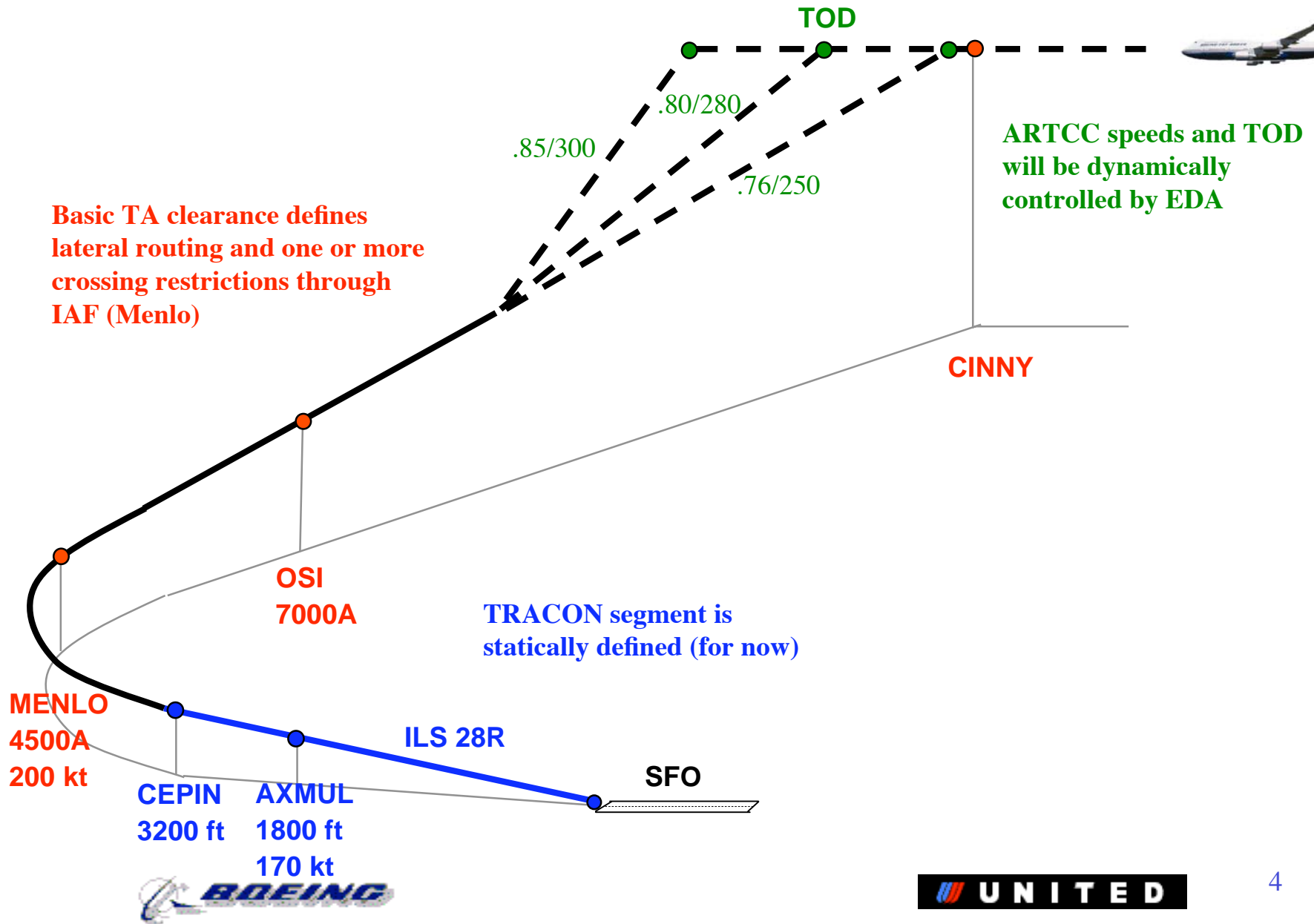
Progress towards a further-term application of TA for congested arrival operations:

- Study ability of ground-based automation to “tailor” arrivals to accommodate capacity constraints, and ability of aircraft to fly those trajectory solutions.
- Measure potential economic and environmental benefits in comparison with a baseline that represents capacity-constrained arrival operations





# Focus area for NASA OTAs







# Clearance as it will be sent



- The following clearance will load the approach procedure and MENLO transition from the published procedures in the a/c navigational database
  - No changes to published procedures.
  - Just as the crew would select them from a voice clearance
- ATC DL Uplink Message AT1 - ATCCTR1 - .N777BO - CRC is valid
- 19,,  
0(83) : AT [pos] CLEARED [routeclr]  
pos(fix): CINNY  
dest airport(): KSFO  
arr runway(): 28R  
app proc(): APP,ILS28R,MENLO  
route info(): 2  
 (pub): OSI  
 (pub): MENLO  
route info add():  
wp spd alt: 2  
pos(nav): OSI;ATWalt(qnh): 7000A  
pos(fix): MENLO;spd(ias): 200;ATWalt(qnh): 4500A





# Latest OTA Profile Candidate for CINNY Arrivals to 28R



SAN FRANCISCO INTL ATIS 113.7 118.85

11 JAN 06

OSI TA/CDA ARRIVAL

## VERTICAL NAVIGATION PLANNING INFORMATION

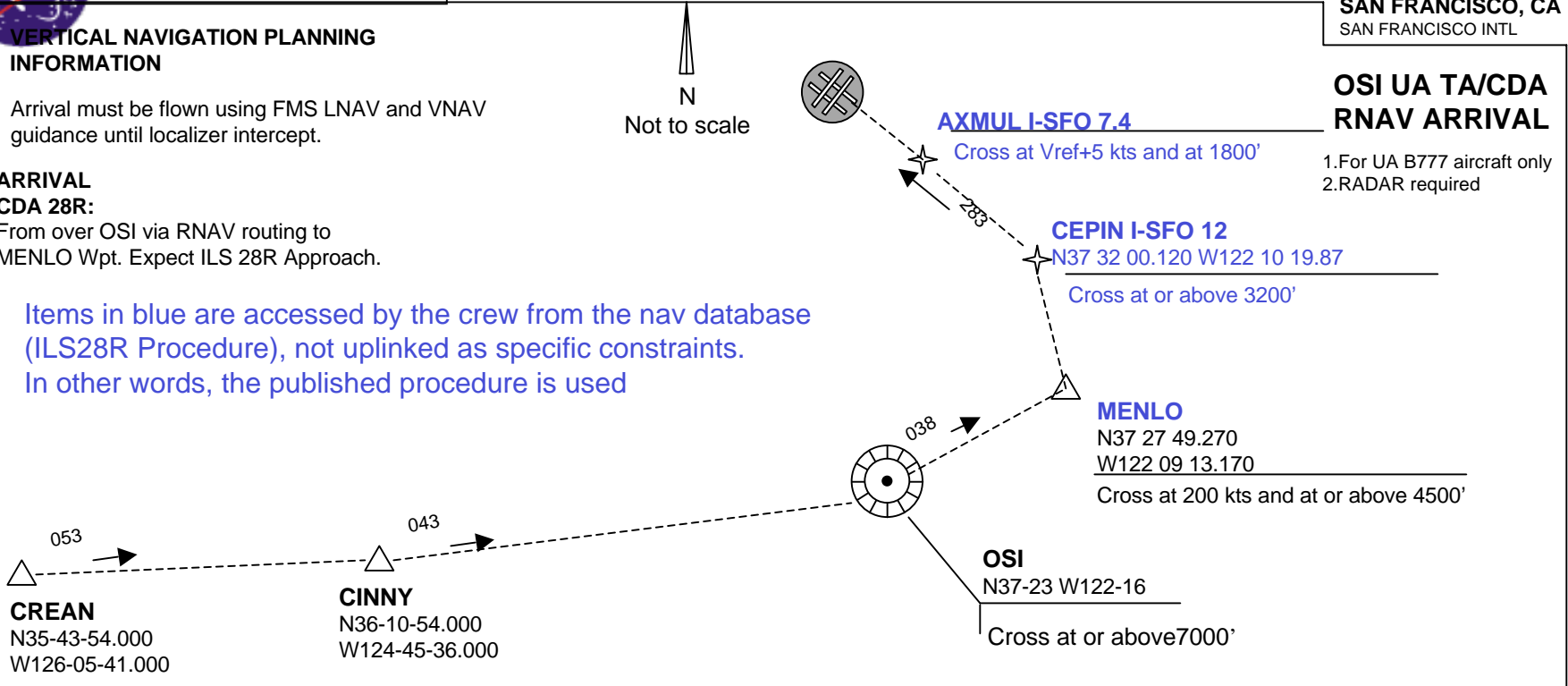
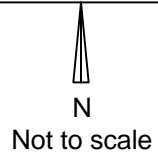
Arrival must be flown using FMS LNAV and VNAV guidance until localizer intercept.

### ARRIVAL

#### CDA 28R:

From over OSI via RNAV routing to MENLO Wpt. Expect ILS 28R Approach.

Items in blue are accessed by the crew from the nav database (ILS28R Procedure), not uplinked as specific constraints. In other words, the published procedure is used



SAN FRANCISCO, CA  
SAN FRANCISCO INTL

## OSI UA TA/CDA RNAV ARRIVAL

- 1. For UA B777 aircraft only
- 2. RADAR required

### PILOT NOTES

1. Load TA Clearance in FMS
2. Verify speed and altitude constraints on MCDU LEGS page
3. Enter VREF +5 as speed constraint for waypoint AXMUL
4. Report Top of Descent (T/D) location to ATC 5 minutes before reaching T/D
5. Altitude clearance required to initiate descent
6. Add drag when indicated airspeed exceeds FMC speed + 10 kts
7. Use Speed brakes above 10000 feet as required to maintain VNAV path and speed, use flaps after OSI
8. Arm APPROACH after starting turn on the localizer and receiving ATC clearance for ILS
9. After glide slope capture, manage approach and landing normally
10. Set gear and flaps as needed for normal landing No later than 1 mile prior to final approach, select gear down and flap 25

### ATC CLEARANCE INFORMATION (from flight test plan)

1. The data linked route clearance is the Tailored Arrival (TA) to ILS28R using MENLO Transition, OSI at or above 7000, MENLO at or above 4500 and speed 200 kts
2. Initial TA Descent Clearance:  
"Descend at pilot's discretion, maintain 8000 ft"  
or "Descend via Tailored Arrival, maintain 8000 feet"
3. TA continuation clearance:  
"Continue descent via Tailored Arrival, cleared ILS approach 28R"
4. Contact SFO TWR on final





# Thanks

Elements of this presentation courtesy of  
Airservices Australia, NASA Ames,  
Qantas, United, LVNL, and other  
Tailored Arrivals partners





# Specific Research Objectives



## Quantitative

- ➔ Validate assumed benefit mechanisms with real-world data:
  - Fuel savings
  - Noise reduction in TRACON (for near-term application, we want to specifically address noise signature over OSI)
  - Emissions reduction in TRACON
  - Time predictability (leading to improved schedule integrity and better use airline operator assets)
  - Engine stress reduction
  
- ➔ Study underlying trajectory prediction accuracy and flight performance
  - Effect of data exchange (primarily winds) on trajectory prediction accuracy
  - Comparison of EDA and FMS trajectory predictions
  - Comparison of EDA trajectory predictions with actual flight track
  - Comparison of FMS trajectory predictions with actual flight track





# Specific Research Objectives (continued)



## Qualitative

- Design and validate methods that can be used to routinely coordinate and issue a clearance that stretches across multiple sectors and facilities.
- Evaluate “Basic OTA” as a method for delivering a clearance prior to TOD that allows continuous descent under FMC guidance using a descent profile selected by the ground.
- Assess the robustness, suitability and efficiency of the “Basic OTA” to determine whether it can be left behind to provide immediate operational benefit.
- Demonstrate the ability to control the vertical OTA profile and arrival time at a metering fix using speeds generated by EDA-lite
- Help define requirements for follow-on TA research activities

