



Engineering, Operations & Technology
Boeing Research & Technology

Research & Technology

Airbridge Intelligent Trajectory Management for Sequencing

China – U.S. Aviation New Technology Workshop

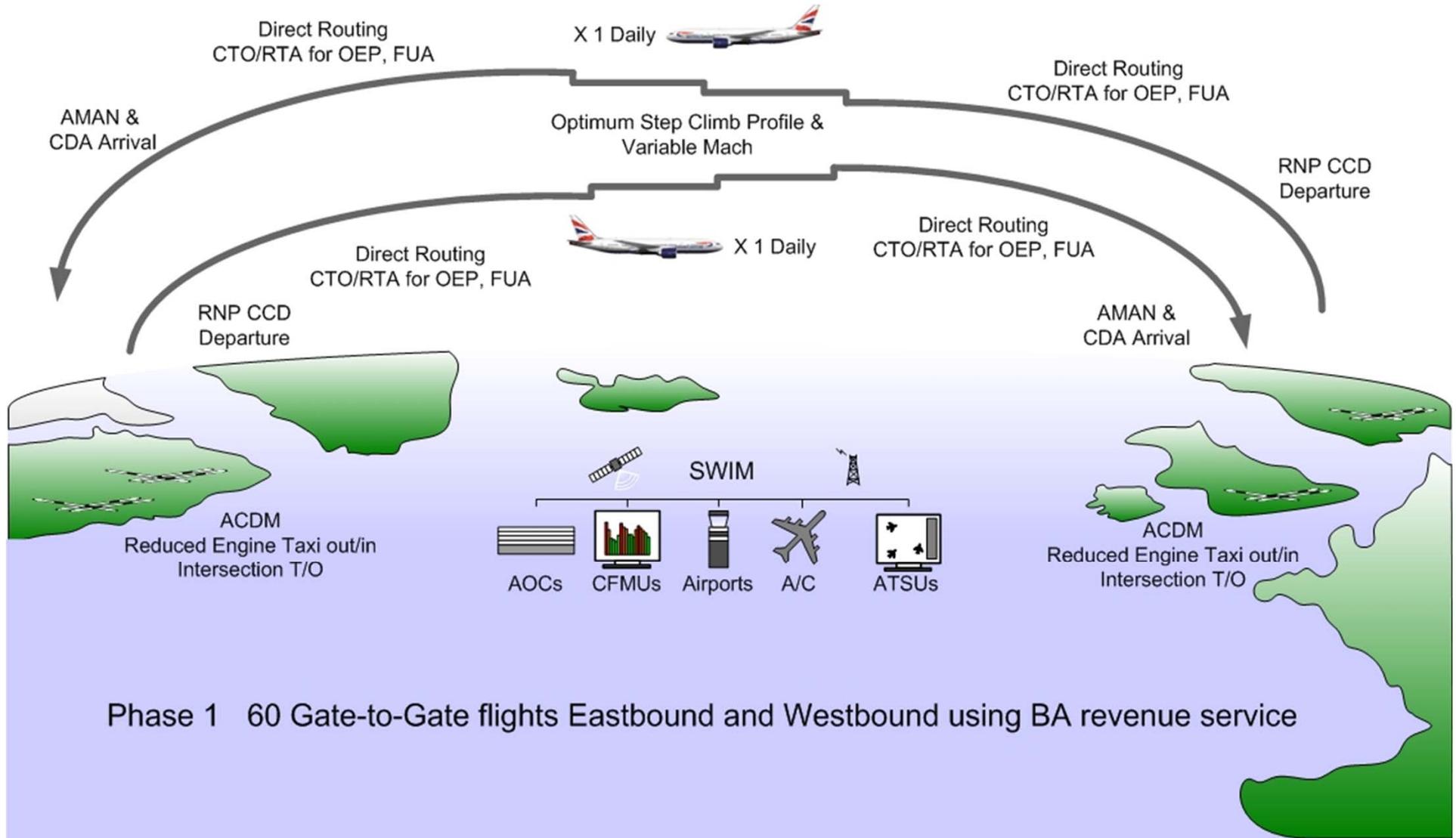
June 6-7, 2012
Beijing, China

Chip Meserole, PhD
Director, Advanced Air Traffic Management
Boeing Research and Technology

Background to Airbridge

- **London Heathrow has noise abatement limits on movements, with a curfew before 6 am**
- **40 flights scheduled to land 6 – 7 am**
- **Transatlantic inbounds often arrive before 6 am**
- **Early flights are held at medium level**
- **Medium level holds burn more fuel than high level cruise**
- **Heathrow is implementing a EUROCONTROL Arrival Manager**
- **The arrival manager will create a sequence for inbound flights**
- **This will require coordination with:**
 - **Upstream air traffic service providers**
 - **Departure airports and air traffic service providers in North America**

UK NATS TOPFLIGHT Project with SESAR Phase 1



Phase 1 60 Gate-to-Gate flights Eastbound and Westbound using BA revenue service

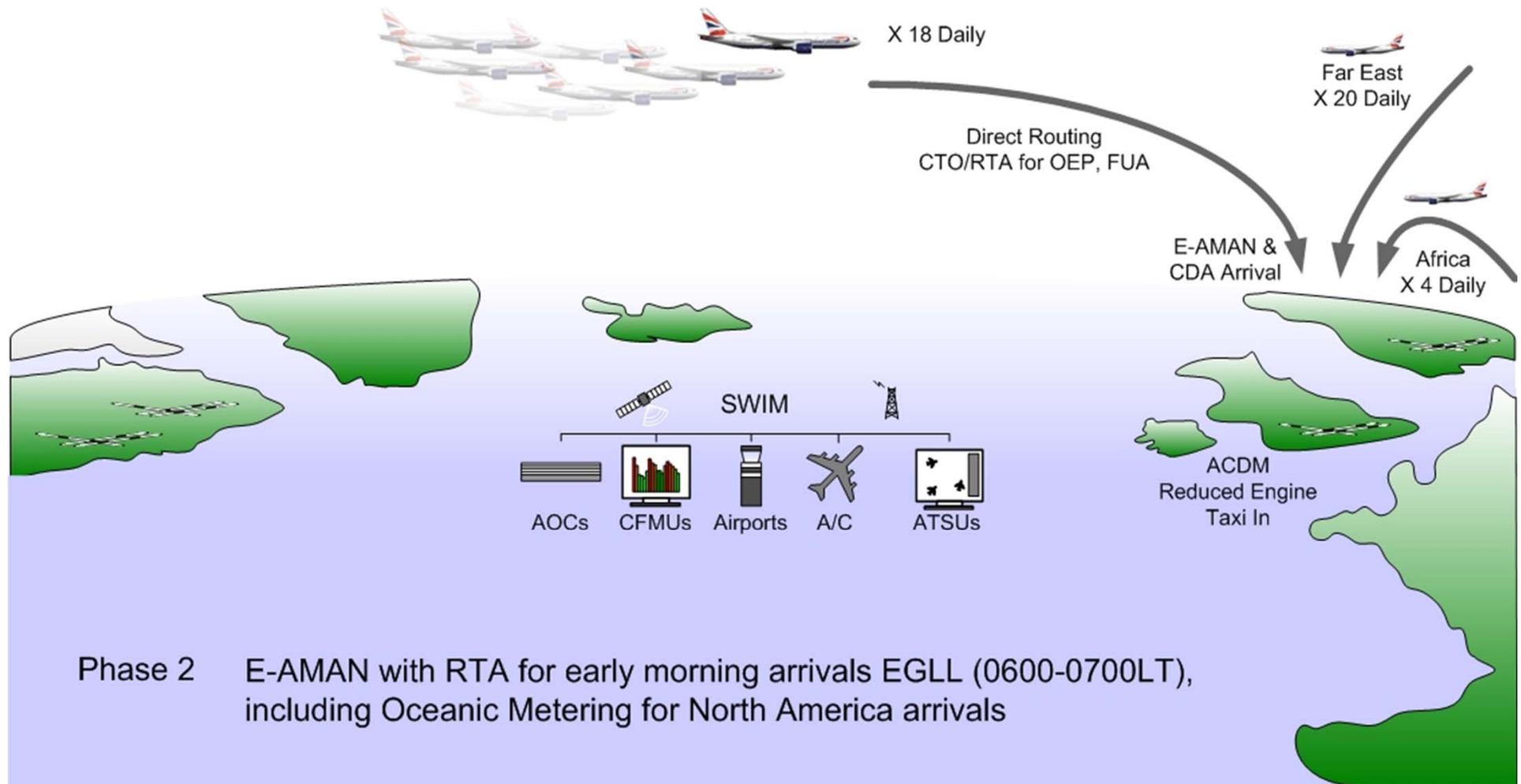
Current ATM Concepts and Procedures

- **Current ATM concepts are:**
 - First come first served
 - Hot-potato concept – aircraft expedited whenever possible regardless of arrival time
 - Departures are as soon as possible with unpredictable delays
 - Aircraft packed into ocean track structure at minimum separations to ‘reduce delay’
 - Tracks are minimum lateral separation apart
 - Aircraft fly Reduced Vertical Separation Method (RVSM)
 - All levels are in one direction Flight Level 300 – 430
 - Aircraft fly at Reduced Longitudinal Separation Method (RLongSM)

- **Flight crews always accept expedite to destination**

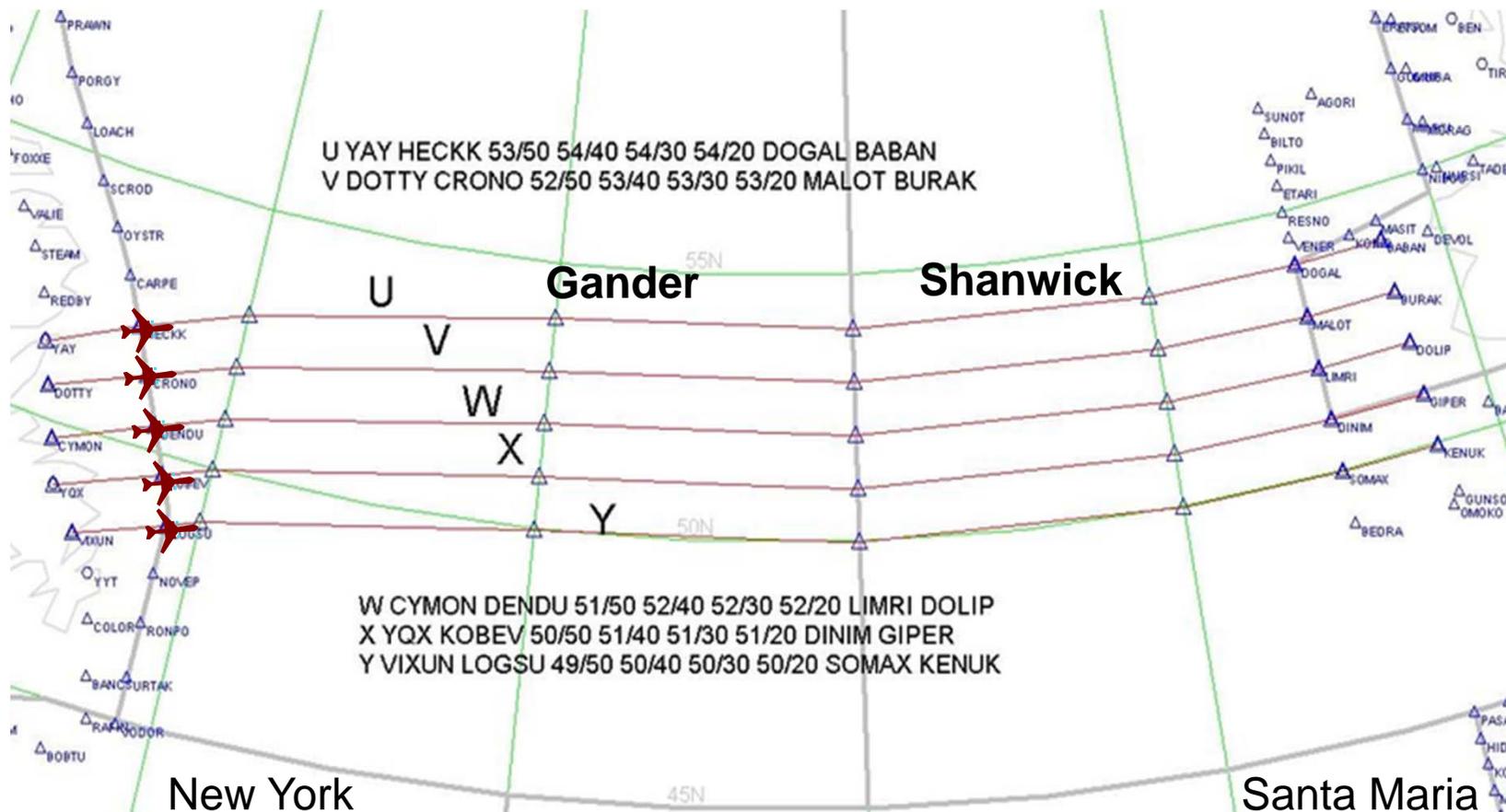
TOPFLIGHT Initial Oceanic Metering

Phase 2



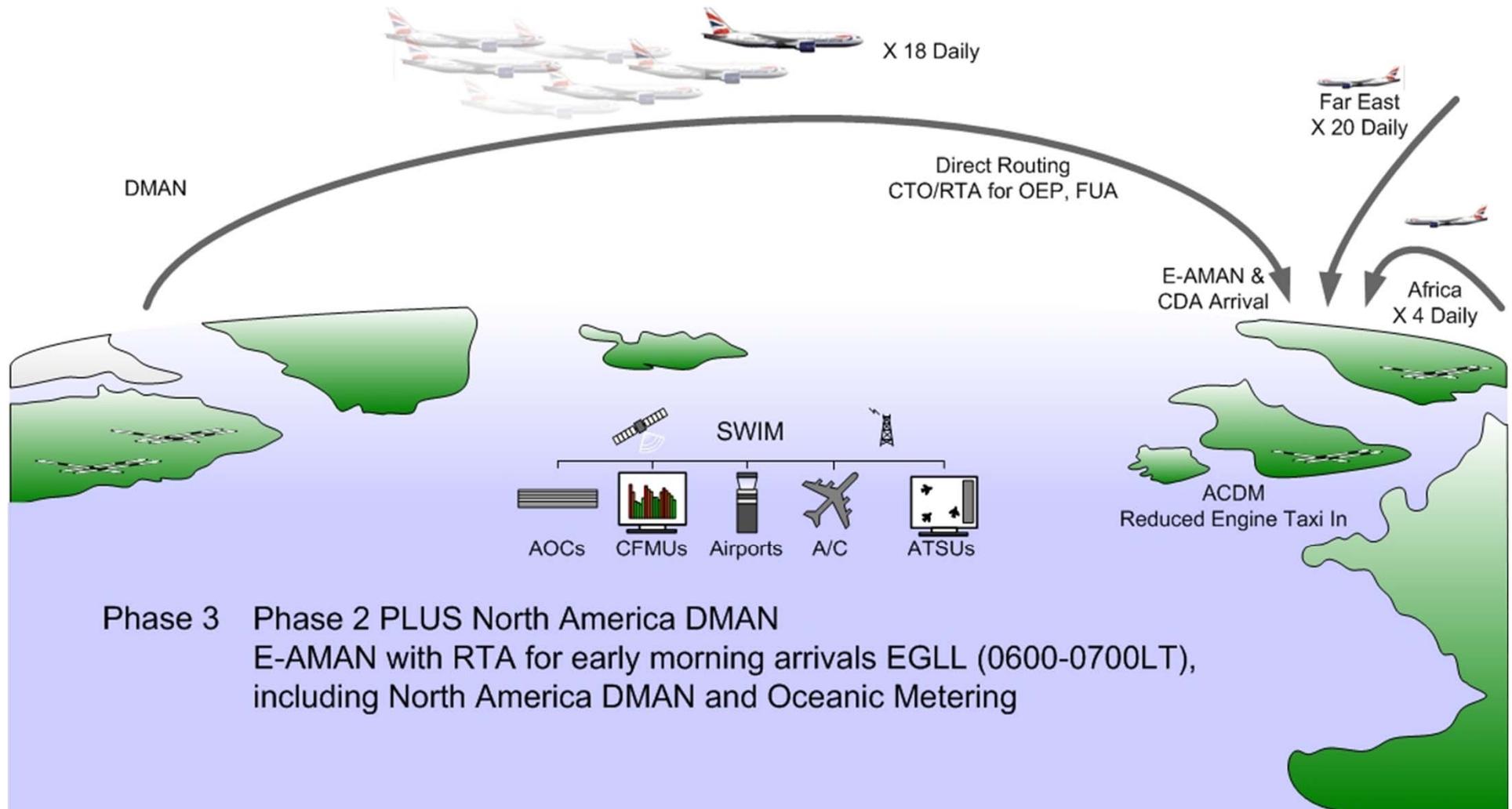
North Atlantic Ocean Track Structure

- North Atlantic Oceanic tracks are created for 8 hours into the future to 'follow the winds'
 - westbound in the morning by UK NATS **Shanwick ACC** – tracks A -> G
 - Eastbound in the evening/night by NAV Canada **Gander ACC** – tracks Z -> U
- Track **W** in this case follows the 'best tailwind' at ~FL 330
- The best tailwind eastbound is normally following the polar jetstream (speeds of 60 - 200Kts)



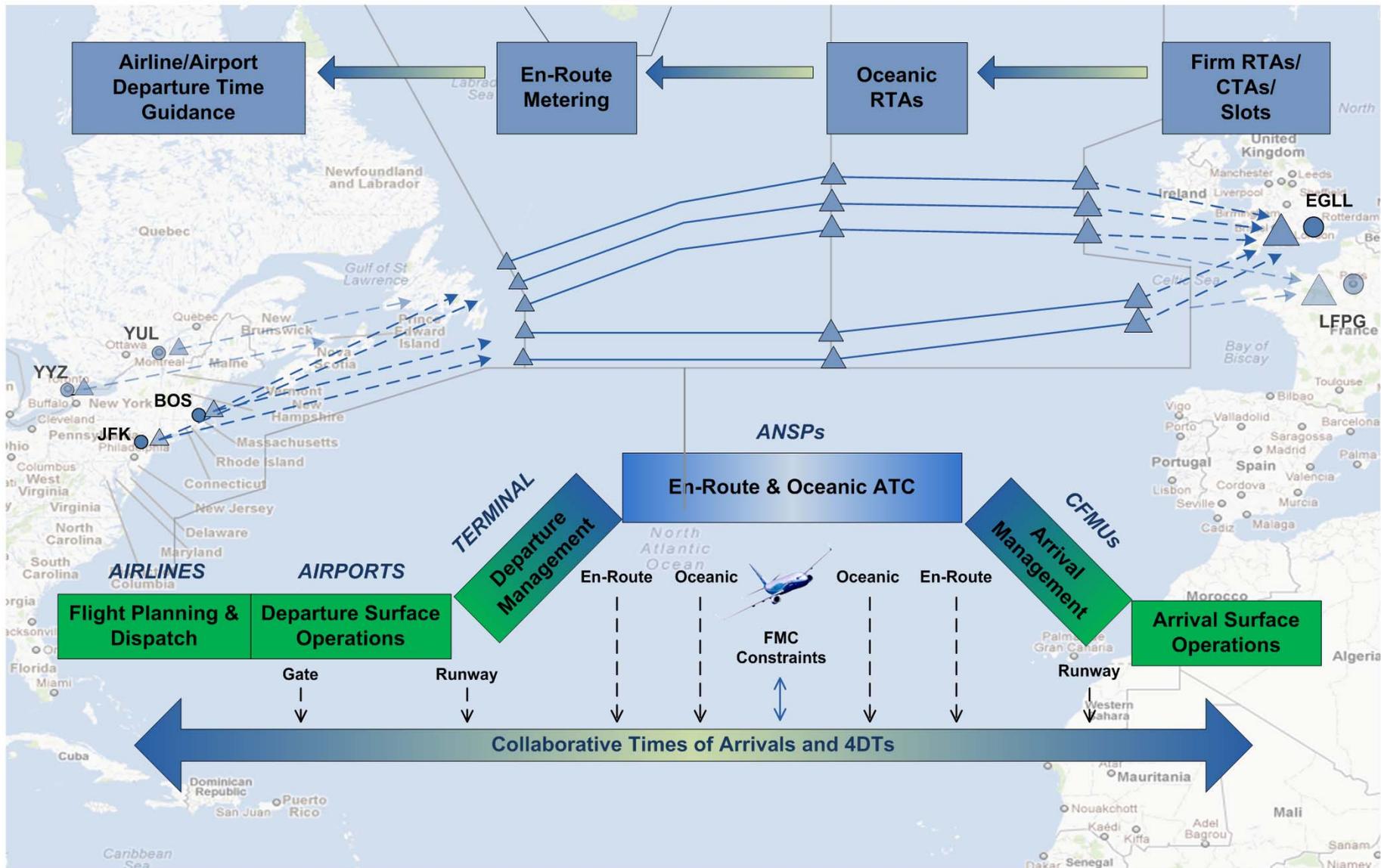
TOPFLIGHT with Airbridge

Phase 3



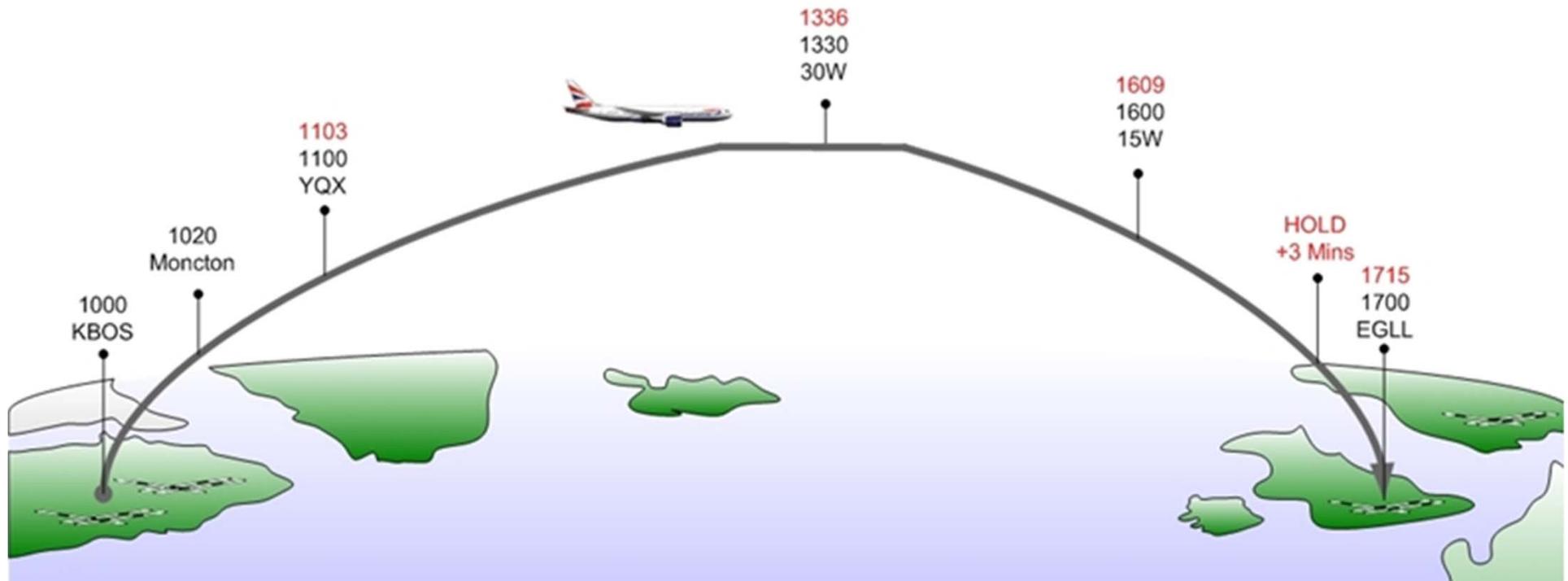
Airbridge (In Conjunction with UK NATS TOPFLIGHT)

Engineering, Operations & Technology | Boeing Research & Technology



Point-in-space Time Windows

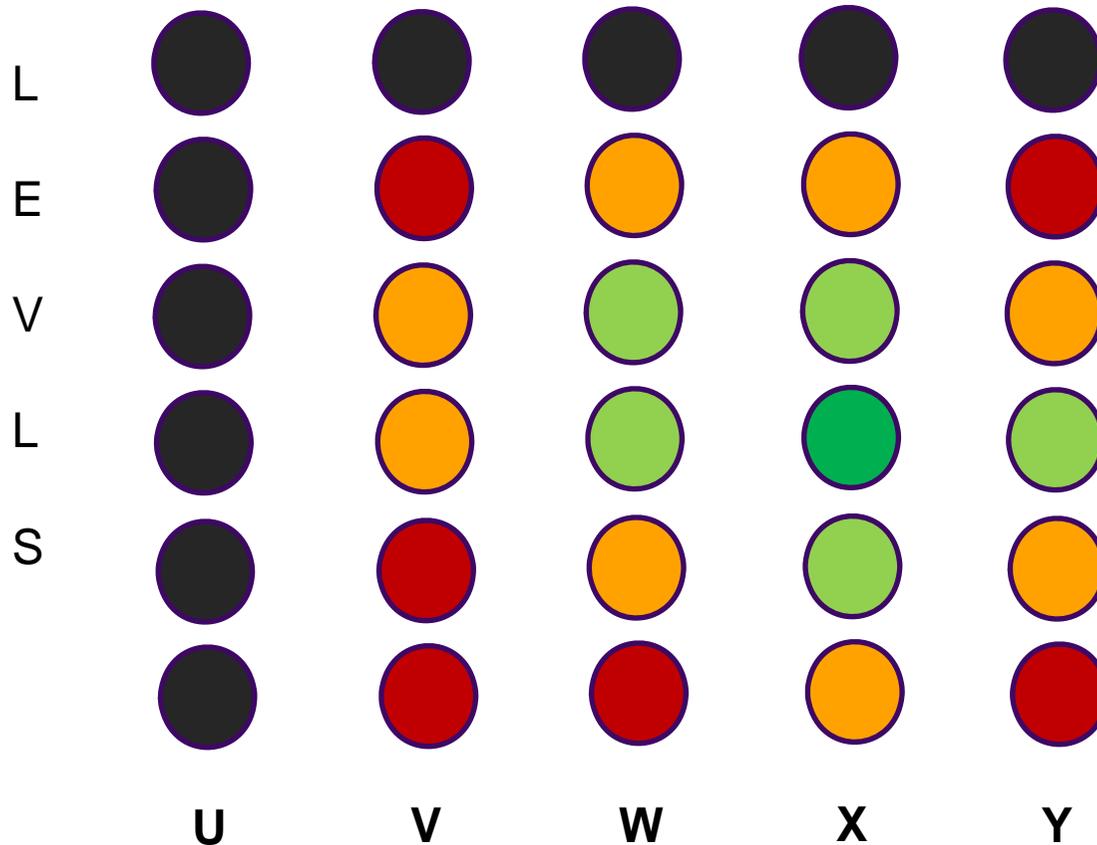
- A way of passing the sequence constraint times
- Time windows at waypoints or 'point-in-space' time windows
- The window is the latest time and earliest time of arrival at a the waypoint to make the arrival sequence



Intelligent Presort Approach

- **Varying speeds in the tracks is difficult**
- **But each track, and each level in it, is in different winds**
- **Aircraft will take different times (different air distance) on each**
- **Aircraft can be presorted onto tracks to create a sequence**
- **The aim: Predictability and efficient schedule integrity**
- **This requires a sophisticated presorting capability**
- **A simple ‘pigeon hole’ approach could be used**

Simple 'Pigeon Hole' Concept



- Each track and level has a duration
- Aircraft cannot use the black track and level fuel or ceiling
- Red track and level do not meet sequence
- Amber meet sequence but traffic may limit step climbs
- Green will meet sequence and traffic may allow step climbs
- Dark green meets sequence with least fuel burn

Ocean Track Entry Points

Generalized 'Airbridge' Concept

- **Airbridge optimizes traffic flow across boundaries of air navigation service provider**
- **Information is passed back from arrival airport to departure airport and to all service providers en-route**
- **Aircraft are assisted to meet time-window constraints to achieve sequenced arrival times**
 - By normal air traffic procedures if possible
 - By intelligent presorting onto efficient tracks and trajectories
- **This approach—**
 - Can be generalized to any ATM system with multiple service providers and alternate routings
 - Could be used for flexible alternate routes for flow control or weather avoidance