

ICAO Interface to the Estimation of Fuel Savings Accrued from Operational Improvements



**IFSET Workshop
Singapore - December 2011**



CANSO's Work on the Environment

Common metrics

Excess Time Flown converted to fuel	Measured by additional time versus an unimpeded time and converted for various ac types. This method could apply to the taxi phase or a flight phase as a first approximation
Vertical Inefficiency	Measured by level flight segments on departure or approach as well as non-optimal cruise altitudes
Distance flown	Measured in NM or km, a potential proxy for fuel burn and emissions
Excess Fuel on Oceanic Routes	Measured as a modelled optimum versus actual fuel burn. Requires sophisticated wind modeling
Percentage achievement of CCO and CDO	A potential measure of flight in a relatively efficient mode
NATS 3DI score	Evaluates entire trajectory for distance and vertical based inefficiencies.



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Combined Vertical + Horizontal

Given an Actual Trajectory – Act (x)

Actual Trajectory

Let

Opt(x₀) be an Optimum Trajectory

Vertical efficiency

With

X₀ as an un-impeded distance for Act (x)

Unconstrained Vertically
(Same distance)

Total ATM benefits pool
Time & Fuel

Horizontal efficiency

Let Fuel Benefit =

Unconstrained Trajectory

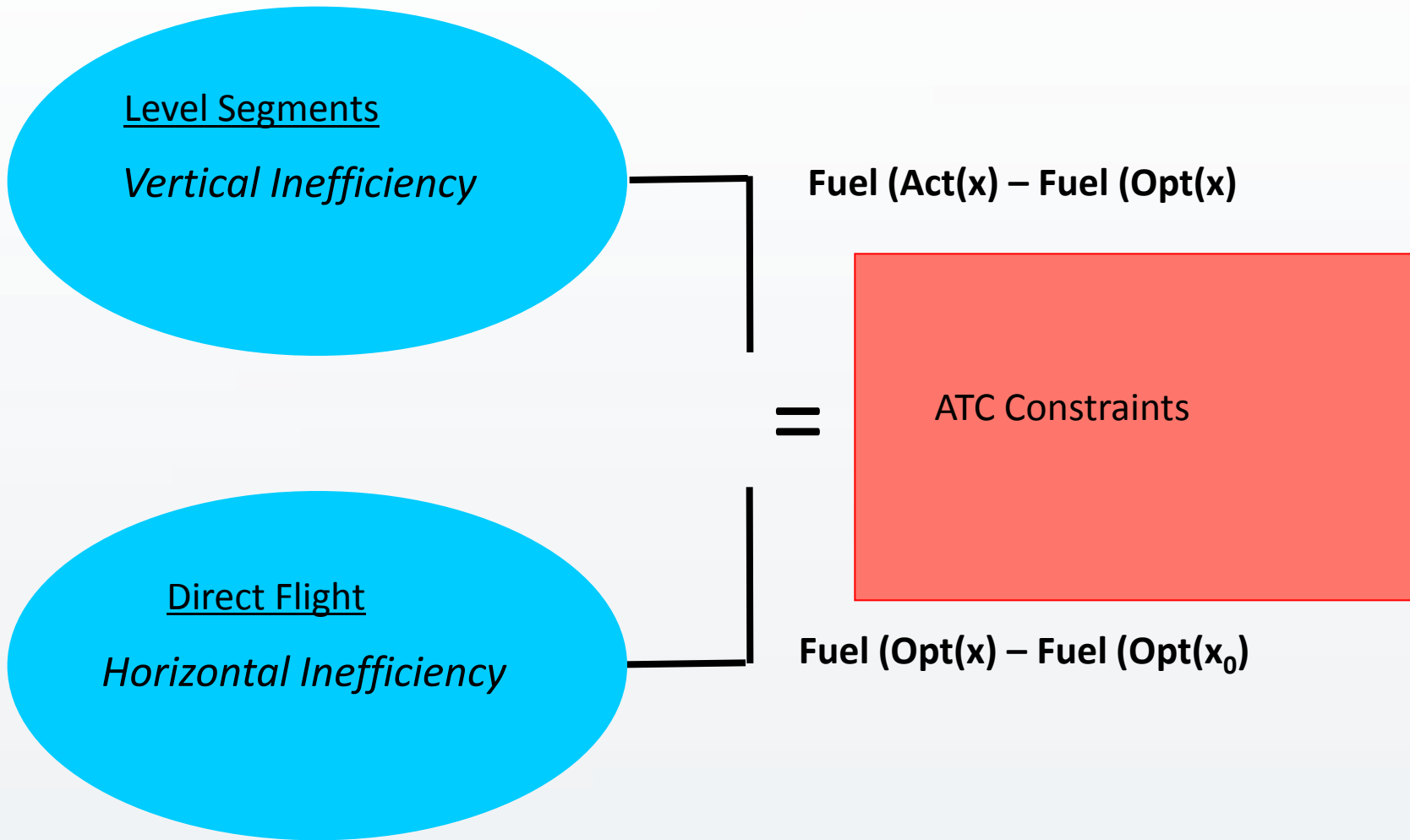
Fuel (Act(x)) – Fuel (Opt(x₀))



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Inefficiency Detected from RADAR Data or improvements related to airspace design

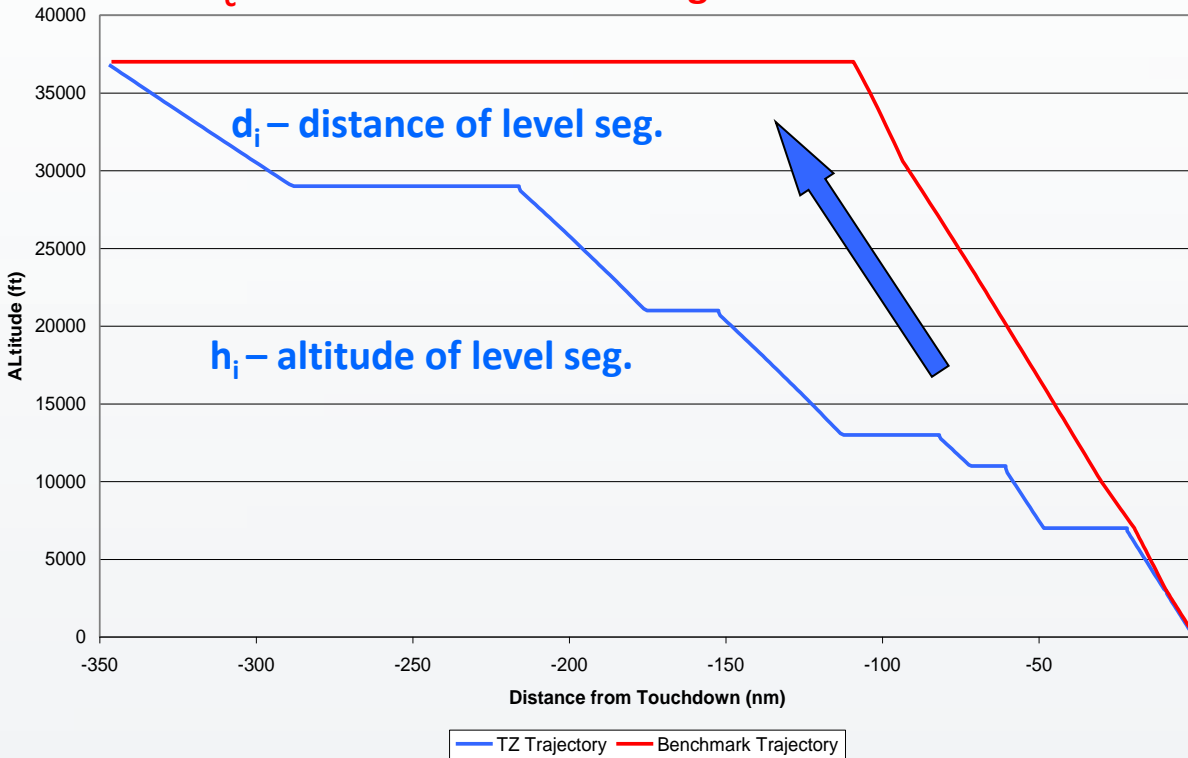


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Vertical Component

h_c – new altitude of level segment



ΔT Change in Time

ΔF Change in Fuel

From BADA

$v(h)$ – Speed at Alt h

$f(h)$ – Fuelburn at Alt h



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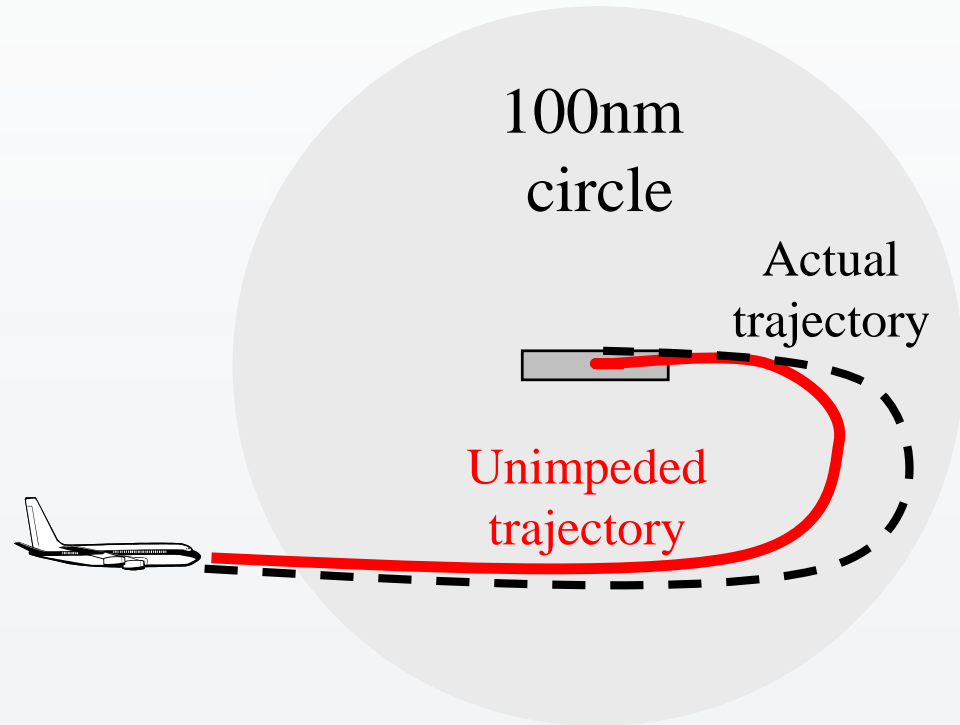
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Horizontal Component

x - Actual Distance

x_0 - Minimum Distance

h_c - Cruise Altitude



From BADA

$v(h_c)$ Nominal Speed at Cruise

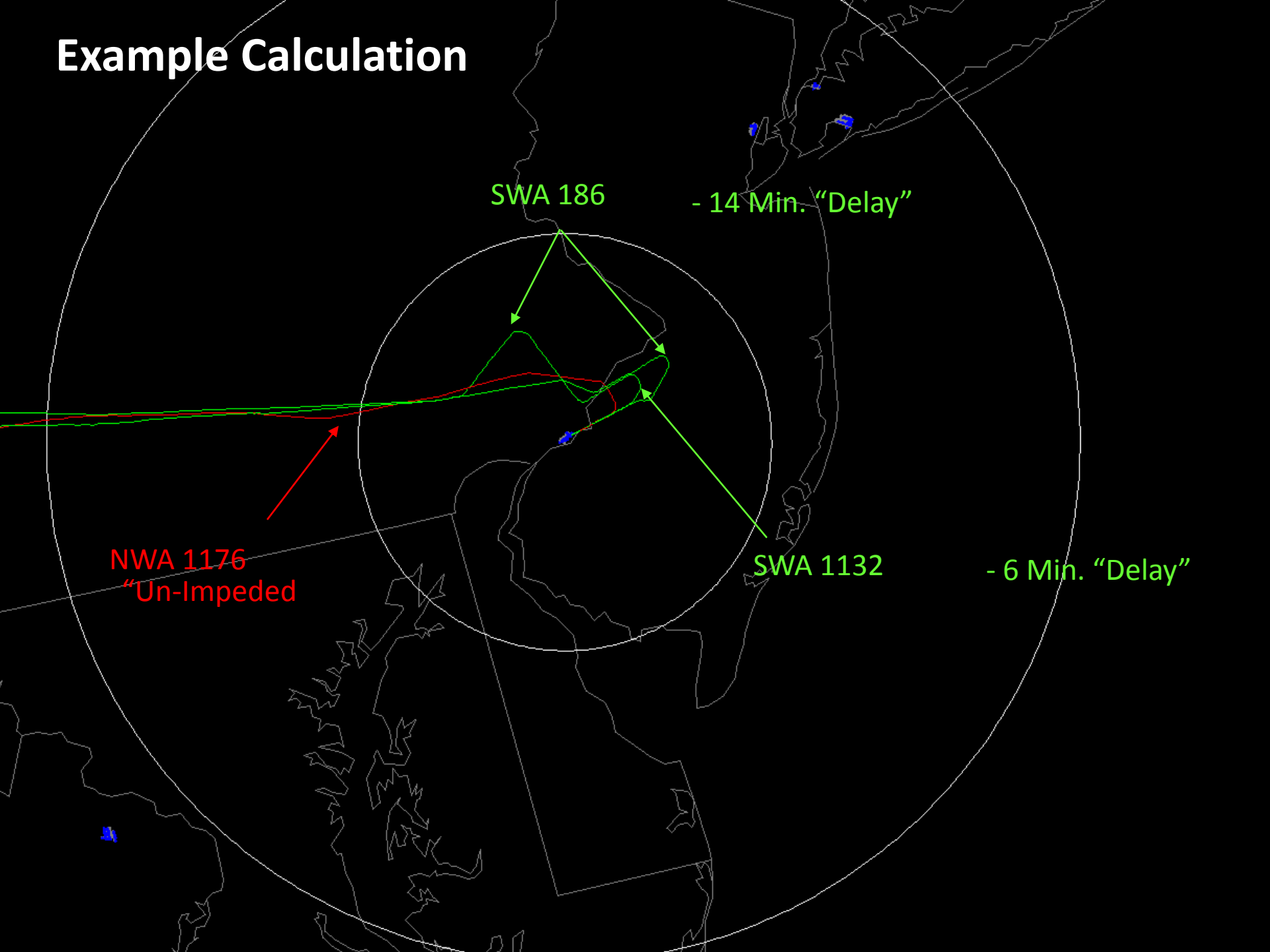
$f(h_c)$ Nominal Fuel at Cruise



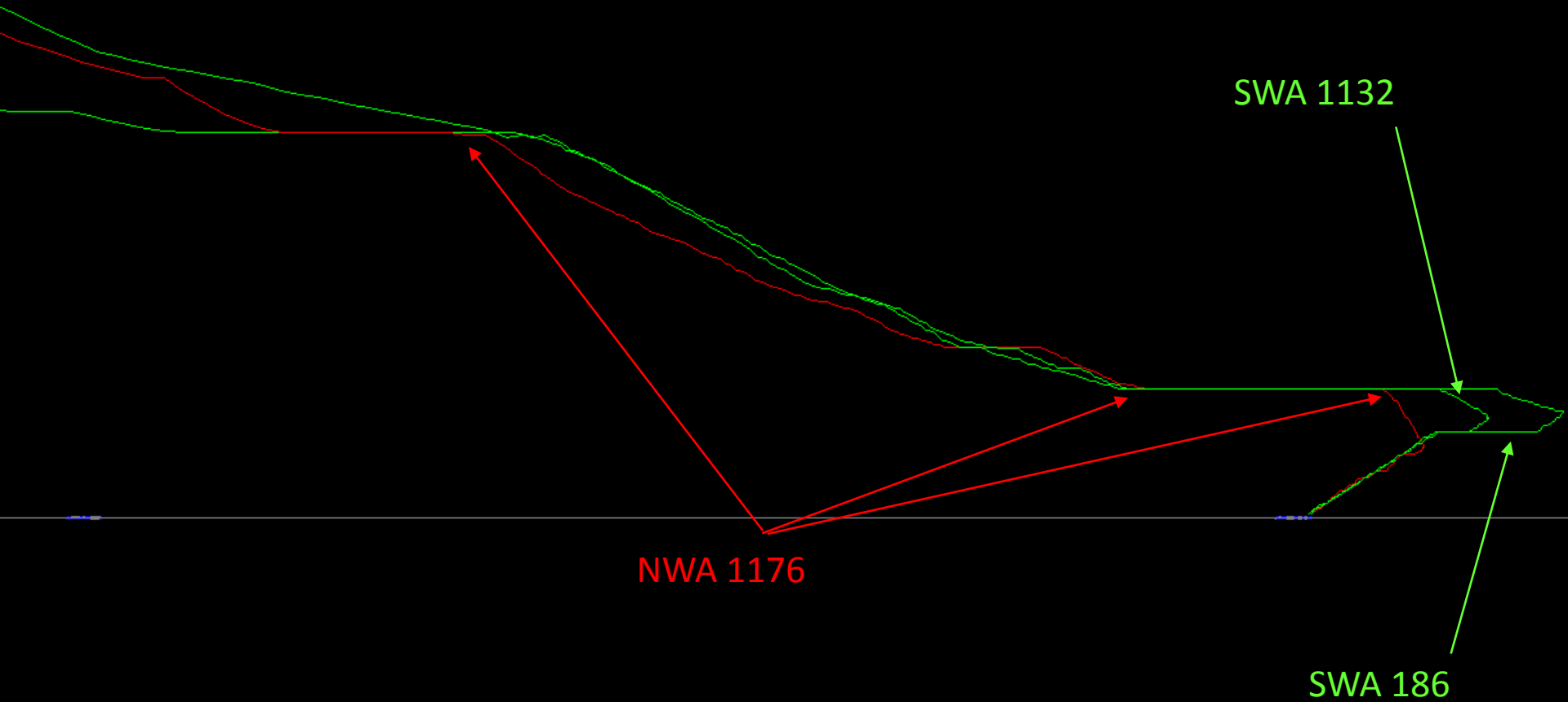
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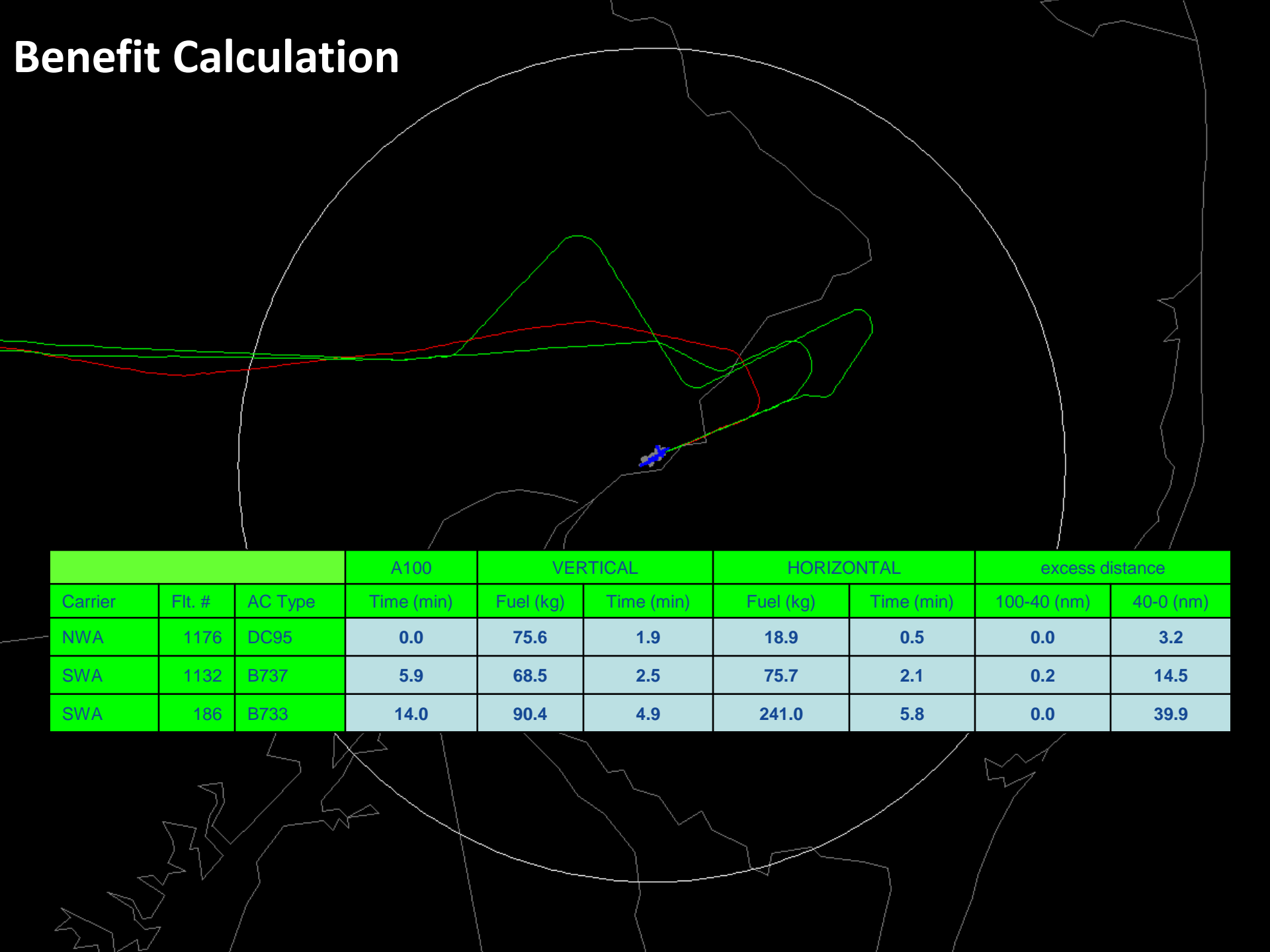
Example Calculation



Vertical Profile View

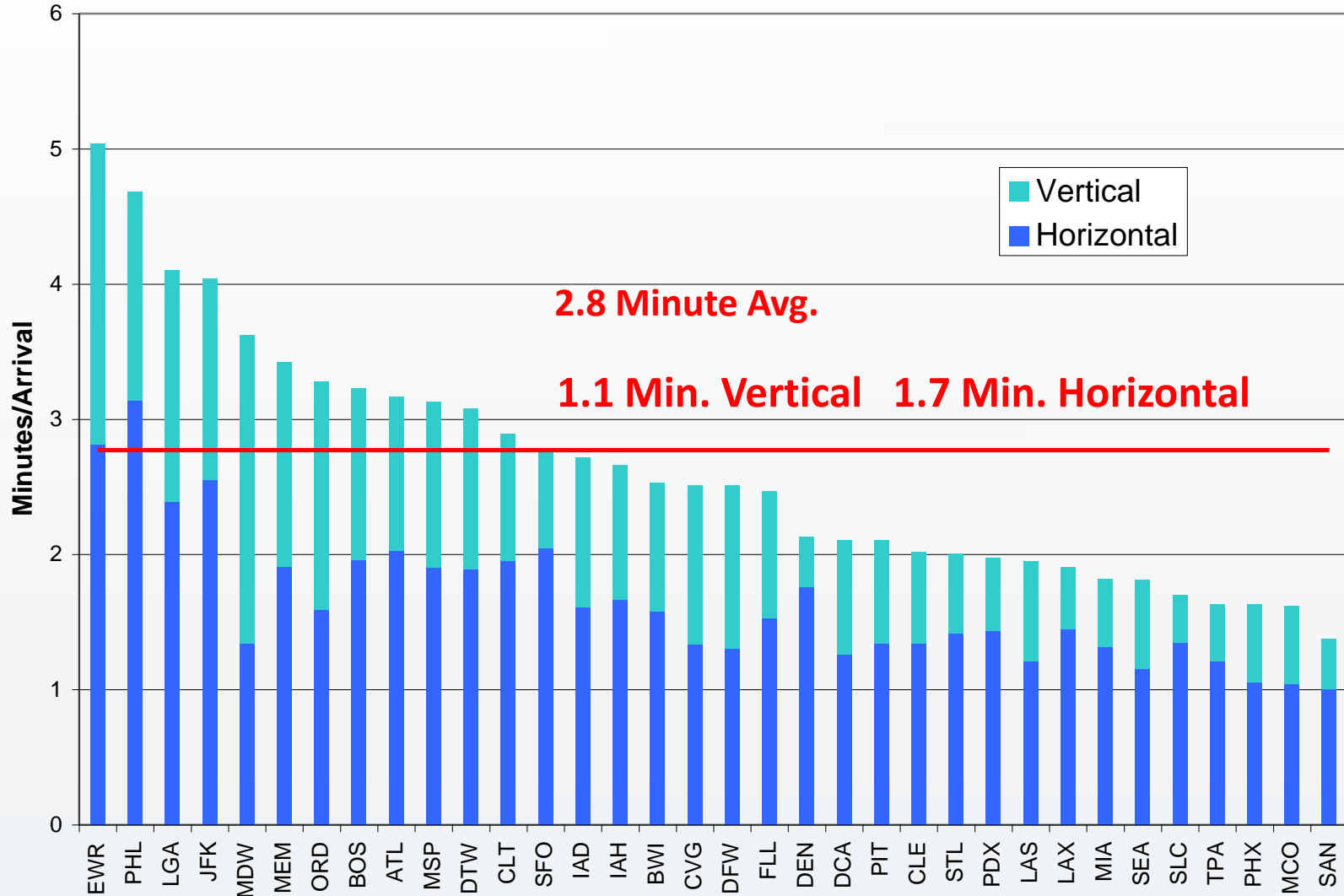


Benefit Calculation



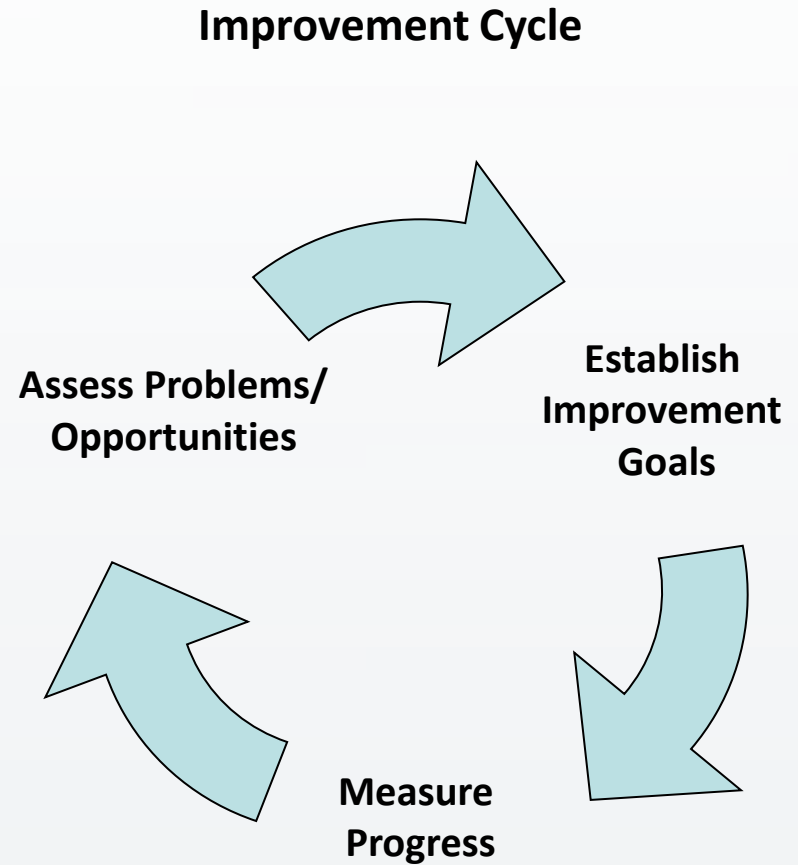
			A100	VERTICAL		HORIZONTAL		excess distance	
Carrier	Flt. #	AC Type	Time (min)	Fuel (kg)	Time (min)	Fuel (kg)	Time (min)	100-40 (nm)	40-0 (nm)
NWA	1176	DC95	0.0	75.6	1.9	18.9	0.5	0.0	3.2
SWA	1132	B737	5.9	68.5	2.5	75.7	2.1	0.2	14.5
SWA	186	B733	14.0	90.4	4.9	241.0	5.8	0.0	39.9

Potential Time Savings (Per Arrival)



Political Will for Environmental Change

- Identify Improvement opportunities
 - Deliver objective data to support decision making
 - Value Potential Investments
 - Drive Political Will for change/improve
- Identify Best Practices
- Accountability to Stakeholders



QUESTIONS?