Estimation of Aircraft Performance Parameters from ADS-C EPP Data

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Introduction

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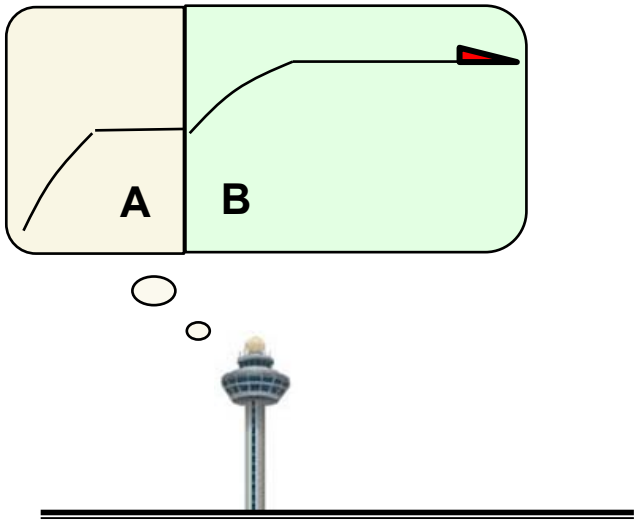
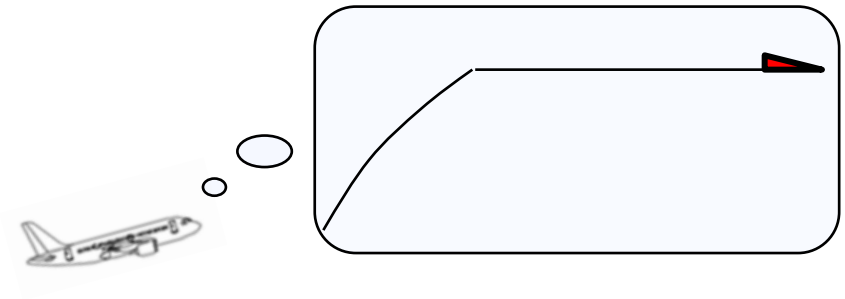
ADS-C EPP is a data link service that provides aircraft 4D trajectory for ground ATSU
(Automatic Dependent Surveillance – Contract Extended Predicted Profile)

Cooperation with ANSPs to support efficient ADS-C EPP implementation





Difference between ground
and air predicted trajectories

EPP vs. Ground TP

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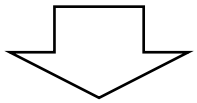
Comparison of data sources for trajectory predictions:

Data for trajectory prediction	AIRBORNE (EPP)	GROUND TP tools
A/C performance model	Provided by OEM	Generic
Actual A/C weight	Known	Unknown
Cost index	Known	Unknown
Thrust reduction setting	Known	Unknown
Climb/descent speed profile	Known	Unknown
Weather forecast	Known	Known
ATC constraints / intention	Published in Nav DB	All



Method of the EPP usage, which allows to respect ATC intentions.

ADS-C EPP Basic Structure

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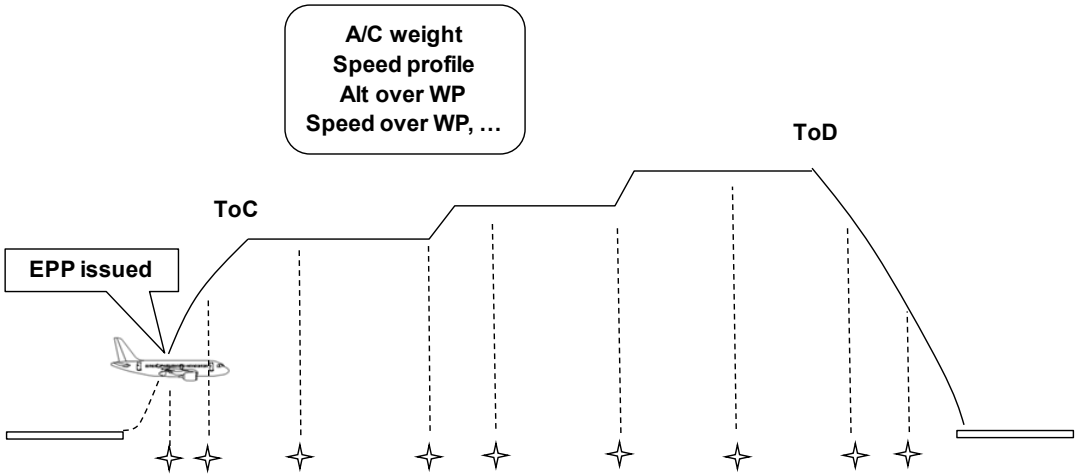
- FMS computes trajectory (shared in EPP) in accordance with all known parameters (A/C weight, speed profile, cost index, thrust reduction, weather,…)

EPP message = **Header**
A/C related data
(e.g. A/C gross weight, guidance mode, speed profile)
+ **Body**
Trajectory related data
For each WP (up to 128)
(e.g. Lat/Lon, altitude, speed, ETA)

The full contents of an EPP report and data formats are specified by RTCA SC214/ EUROCAE WG78



Climb – Rate of Climb (ROC) Estimation Method

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Based on one EPP message

predicted **altitude** and **ETA**

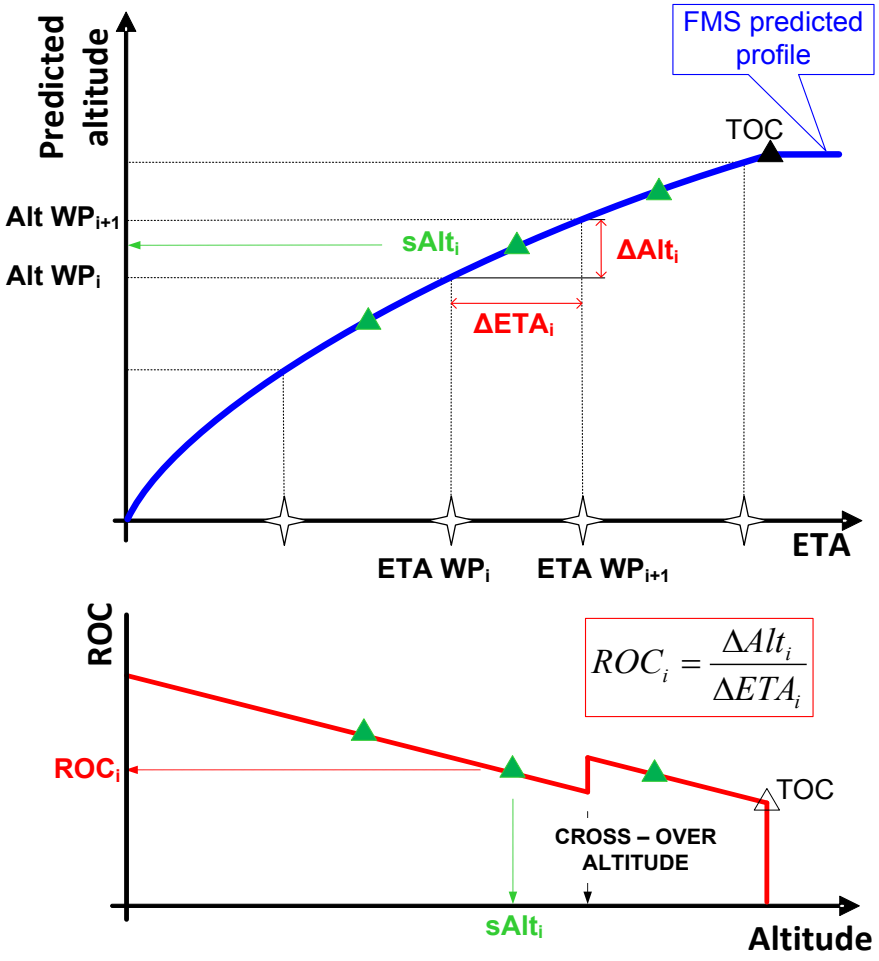
$$ROC_i = \frac{\Delta Alt_i}{\Delta ETA_i}$$

Rate of Climb

ROC vs. Altitude

$$sAlt_i = \frac{(AltWP_i + AltWP_{i+1})}{2}$$

ROC is not affected by wind speed



Example: Climb With Particular Altitude Clearance (1/3)

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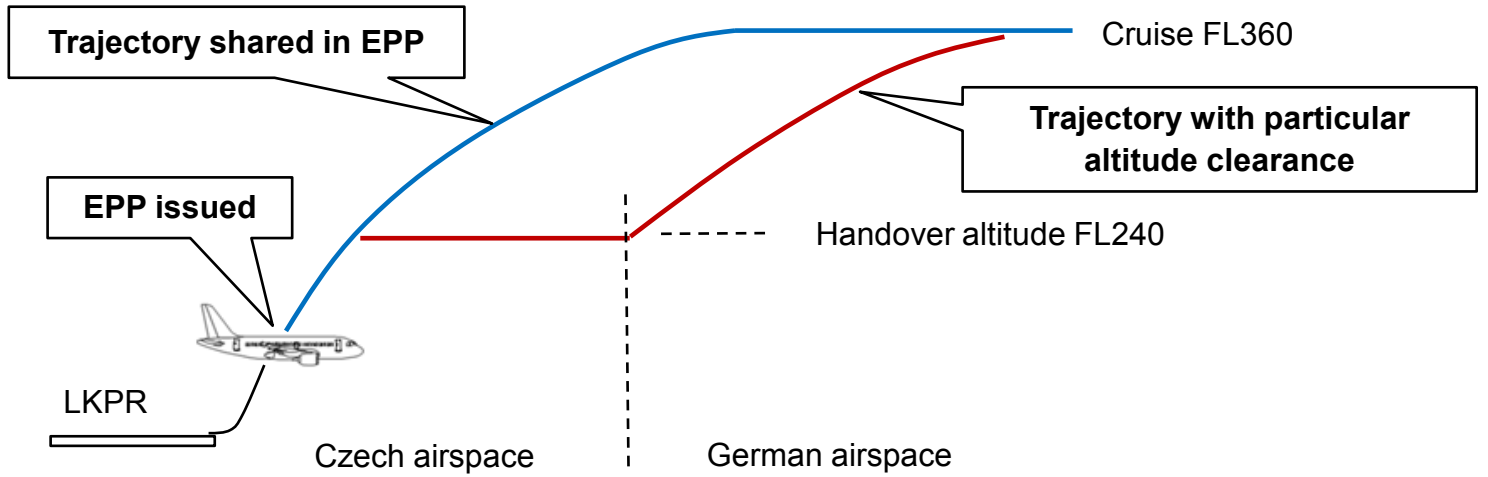
Previous technique allows **combination of AIRBORNE and GROUND inputs**

Scenario description

- Vaclav Havel Airport Prague (LKPR) to Charles de Gaulle Airport (LFPG)
- Airbus 320 aircraft
- Required cruise FL360
- Initial clearance to FL240 (handover FL between Czech and German airspace)
- ISA, no wind condition
- Computer simulation – i4D FMS prototype in high fidelity simulation environment



Example: Climb With Particular Altitude Clearance (2/3)

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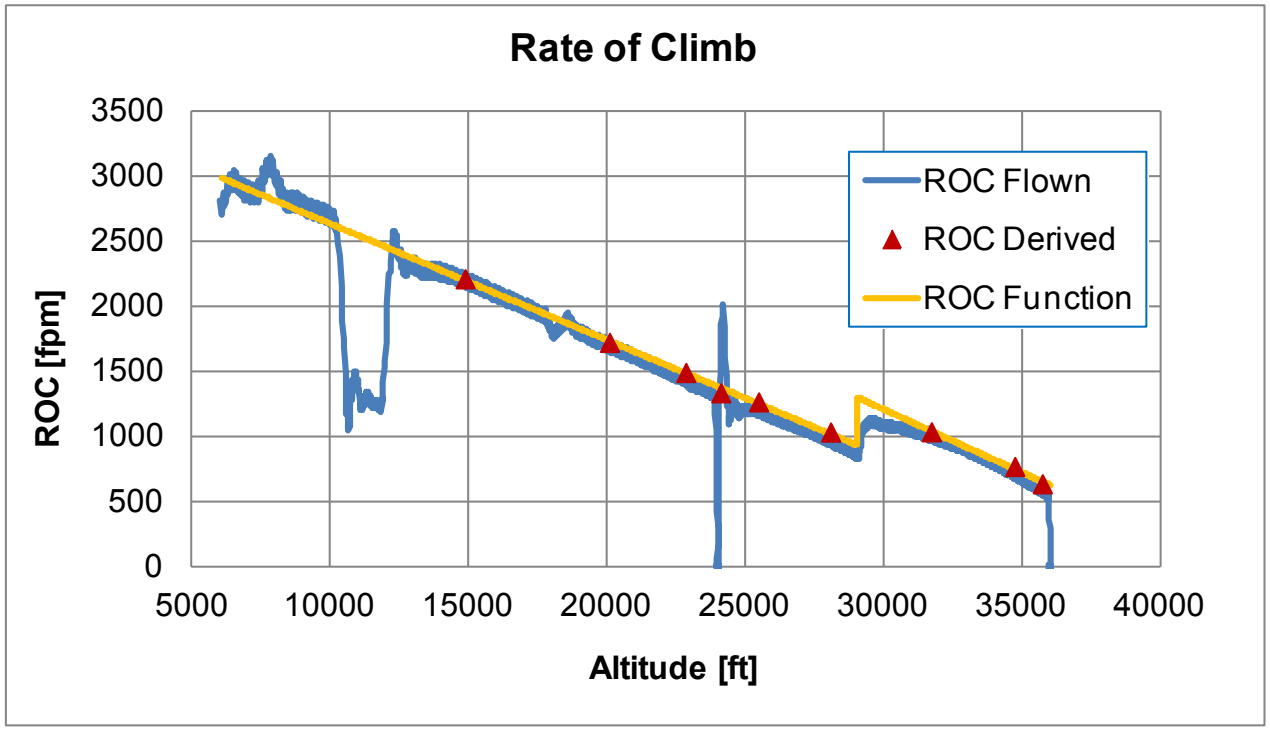
- Climb computation based on one EPP report issued around FL60
- ROC vs. Alt → linearly approximated in two intervals (below and above cross – over altitude)
- Cross-over altitude and Ground Speed – computed from climb CAS/Mach schedule



ROC vs. Altitude

Example: Climb With Particular Altitude Clearance (3/3)

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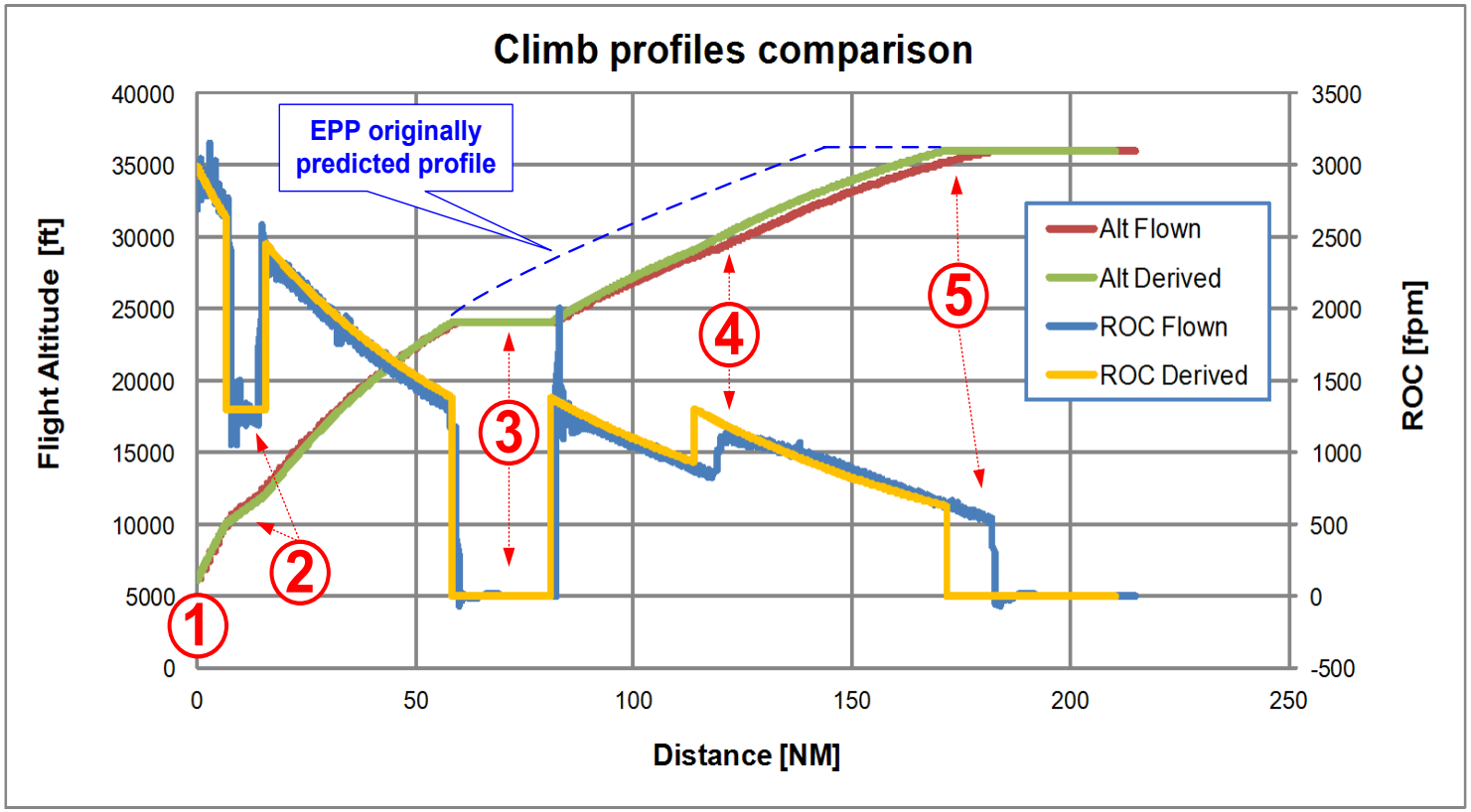

1	**FL060 (6000 ft) –** EPP DATA ISSUED	3	**FL240 –** CZECH → GERMAN ACC HANDOVER LEVEL SEGMENT	5	**FL360** – TOC REACHED
2	**FL100 –** ACCELERATION SEGMENT	4	**FL290** – CROSS OVER ALTITUDE REACHED		

Simulation results:

Max. vertical divergence: ~550 ft

TOC position: ~10 NM

TOC altitude reaching: ~55 sec

Cruise and Descent

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Cruise

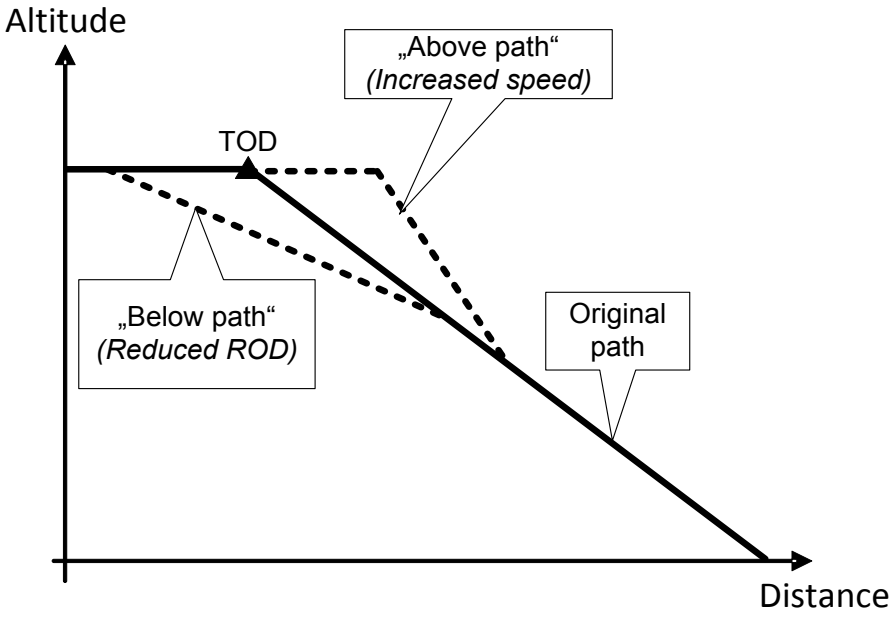
- Updated FPL data during flight
- Each intervention (ATC or pilot) initiates new EPP

Descent

The method for climb can be used for ROD estimation as well

$$ROD_i = \frac{\Delta Alt_i}{\Delta ETA_i}$$

Descent is more complex than the climb due to recapture maneuvers



Conclusion

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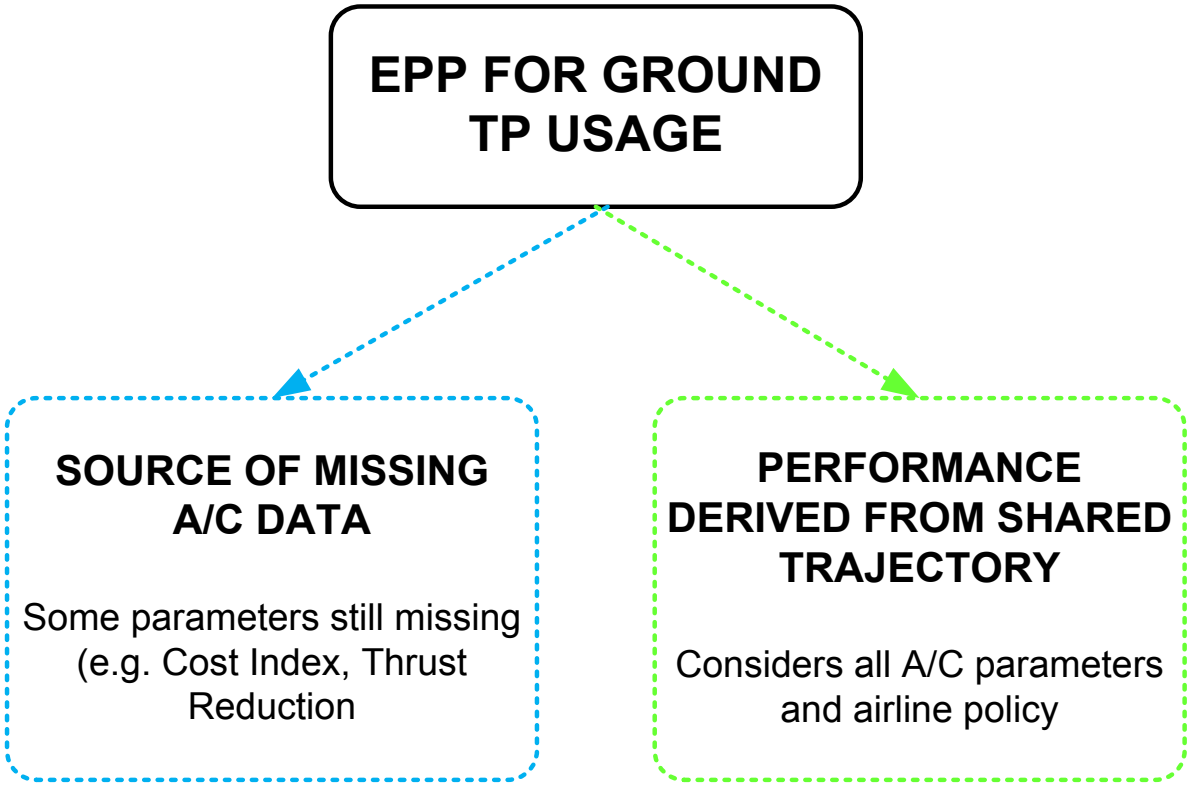

EPP can help to improve ground trajectory predictions even in case of ATC interventions

Thank you

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