



Flight Efficiency - the Group Rerouting Tool (GRRT)

Guidelines

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1 Introduction

1.1 General

- (1) The objective of the *Flight Efficiency – the Group Rerouting Tool (GRRT) Guidelines* document is to frame the support of the Network Manager's (NM's) Flight Efficiency implementation strategic project provisions to operational stakeholders, focusing on the flight plan originators and improvement of their flight plan with the support of the NM's automated rerouting tool (Group rerouting tool - GRRT). The document is intended to provide information and guidance related to the utilisation of the Group rerouting tool (GRRT) by airspace users.
- (2) The NM's Flight Efficiency implementation strategic project pursues to improve flight efficiency performance, supporting airspace users, mainly aircraft operators (AOs), to optimise their operations. In parallel, it supports AOs to improve the processes and systems in the areas of flight planning, which would result in a wider array of flight planning options allowing AOs to respond adequately to the network dynamical component (e.g. military activity and delays).
- (3) The Network Manager Flight efficiency implementation strategic project aims to strengthen and provide a functional platform for the NM activities related to supporting AOs in raising flexibility in flight planning, widespread utilisation of the NM system capabilities, continuing NM system developments of the rerouting tools, and providing strategic and tactical reinforcement to airspace users in relation to the evolution of their flight planning system and process.
- (4) The NM's group rerouting tool (GRRT) gives aircraft operators visibility on other possible routing options in the Network and helps them in the selection of shorter and more efficient routes, but also supports the identification of possible inefficiencies in their flight planning while considering the AOs' selected business criteria.
- (5) The purpose of this document is to describe the features of the NM's system rerouting tool (GRRT) used for flight efficiency, by providing information about:
 - the customised GRRT templates subscription guidance;
 - the GRRT parameters;
 - the access and utilisation of the GRRT results.

1.2 Intended Audience

- (1) The provisions of the document apply to all personnel engaged in these activities, mainly:
 - Airspace users / Aircraft operators;
 - EUROCONTROL NM;

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2 Aircraft Operators subscription

- (1) The group rerouting tool will calculate possible route improvements in accordance with Aircraft operator's (AO's) predefined criteria stored in the Group rerouting tool (GRRT) template.
- (2) AOs interested in the definition of their own parameters for the generation of flight efficiency-related Rerouting Opportunities (OPPs) for selected flights will have to subscribe to this service by submitting an email to NM Flight Efficiency Taskforce: nm.fetaskforce@eurocontrol.int. Following this, a dedicated meeting with AO will be organised by the NM Flight Efficiency Taskforce to confirm the GRRT parameters setup that would be used to fit the AO's operational goal in the best manner. The same will be applied in case AO requests modification of existing templates.
- (3) For subscription, AOs will have to provide information on various parameters that have to be inserted in the GRRT template, including:
 - AO's ICAO three-letter code(s);
 - Cost criteria;
 - Constraints controlling the selection of alternatives;
 - Selection criteria;
 - Schedule of runs.
- (4) In addition to the list above, AOs will have to indicate if they are interested in receiving only OPPs or also Rerouting Proposal Messages (RRPs) and/or Emails when interesting routing alternatives are found by GRRT.

Note: RRP's will be used on limited traffic selection and GRRT will be executed with a more conservative rerouting schedule. These RRP's will be tagged with Purpose: Flight Efficiency.

- (5) Identified alternative routing options, calculated by automated GRRT reroutings, are validated by IFPS (within IFPS Zone), but the additional manual check is not applied. AOs that are using the service shall perform qualitative checks (validation) of received rerouting alternatives before amending their FPL, to ensure that these are operationally acceptable for them, and the route is still valid at the moment of change and indicated the ATFM delay has not deteriorated. The routes identified are *not recommended* routes by NM; it is the Airspace Users responsibility to determine the operational acceptability of the routes before use.

Note: By default, all flights can receive opportunity calculated by GRRT's Generic templates, unless differently requested by an AO. Flights of AO's subscribed for a Customised GRRT template shall not be rerouted by Generic GRRT templates (will be excluded from this template), unless otherwise requested by AO.

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3 Group rerouting tool (GRRT)

3.1 Introduction

- (1) The Network Managers' Group rerouting tool (GRRT) is the ETFMS tool capable of recalculating routes based on selected criteria, the latest state of the network and information about the wind available in the NM System. The GRRT is a multifunctional tool, used for automated (executed based on the predefined schedule) or manual (controlled by an operator, e.g. NMOC) rerouting of the flights, according to the specified criterion and objectives.
- (2) Though the GRRT is a multipurpose tool, this document aims to describe only the utilisation of the GRRT for NM's Flight efficiency support to AOs, and no other use cases.
- (3) When executed in support of NM's Flight efficiency, this tool will provide aircraft operators visibility on other possible routing options in the Network and help them in the selection of shorter and more efficient routes but will also support the identification of possible inefficiencies in their flight planning while considering the AOs selected business criteria.

3.2 Group rerouting tool (GRRT) for Flight efficiency

- (1) After the flight plan is filed and then accepted by IFPS, it will be regularly reprocessed by the GRRT, to detect potential route improvements allowing shorter routes within a certain cost-efficient perspective for the flight plan filer. Proposals (alternative routes) are being made available for AOs to consult and apply if accepted.
- (2) The GRRT operates based on a dynamic route generator and a historical catalogue of routes flown in the past.
- (3) The GRRT executes calculations based on the predefined schedule and in accordance with parameters defined by AOs. These parameters consider specific rerouting operational goals (such as cost-effective route, shorter route, ASM notification etc.) and AOs inputs to constraints and cost preferences. In addition, the tool also factors in wider variables such as the wind and the latest state of the Network (route availability, the ATFM regulations etc.) known to the NM system at the moment of tool execution. As a result of its calculations, the tool proposes an alternative route (which satisfies all selected conditions) and sends it to AOs. The scheme of automated rerouting is highlighted in Figure 1.

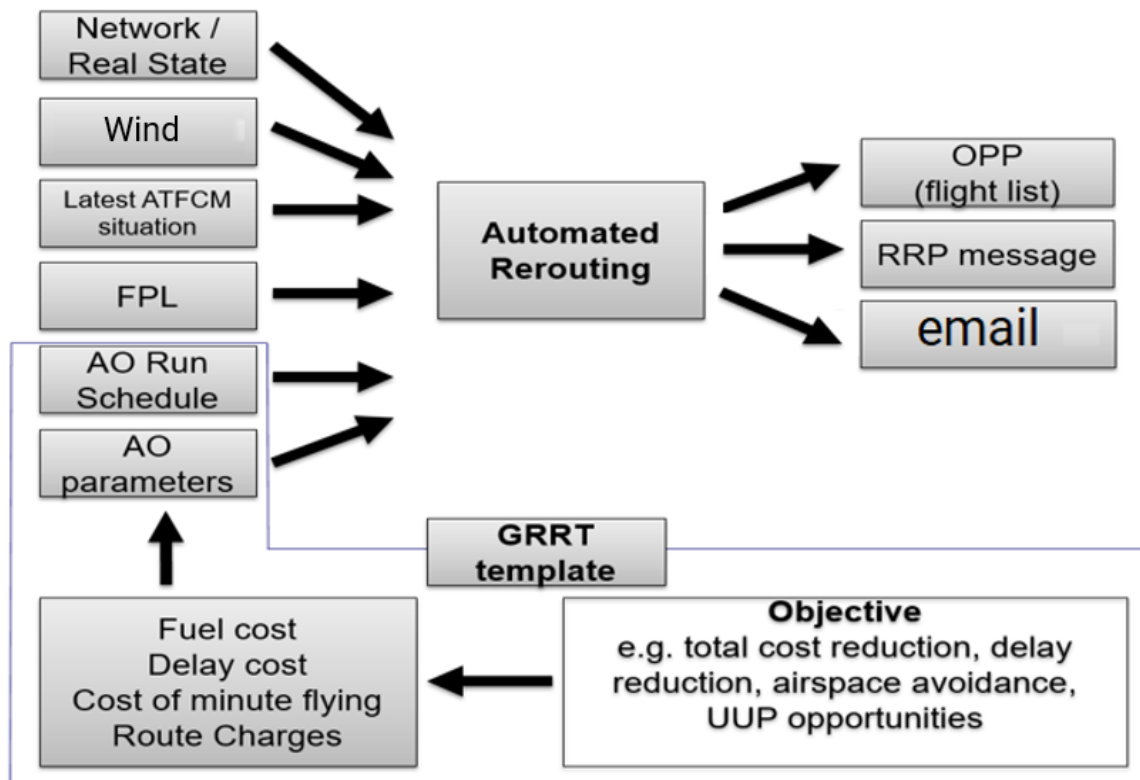


Figure 1. Automated rerouting - scheme

- (4) Rerouting involves constructing alternatives for a selected list of flights or a count location. This consists of modifying the flight profiles either horizontally (by changing their 2D track) or vertically (by changing their list of RFLs). For the purpose of NM's Flight efficiency, most of the reroutings will be executed horizontally, while preserving cruising level sequences indicated in the filed (current) route.
- (5) The cost of any kind of impact that the rerouting may have on the flight is measured using an artificial measurement unit, converting each elementary cost criterion to a common unit of measure. The converted values for each criterion can be added together to give a unique value for a flight (or flight alternative) that will be called the Total Cost of the flight (or alternative).
- (6) Multiple criteria can be considered to compute the cost of a route. Cost factors associated allow the tuning of "balance" between each criterion (the system proposes default cost values). These criteria are hard-coded in the NM System (ETFMS). The main cost criteria used are costs of the ATFM Delay, flying time, route length, fuel, and route charges.
- (7) Enhancing route network utilization can be accomplished by aiding Aircraft Operators (AOs) in recognizing route possibilities highlighted by the GRRT. Therefore, the results of the GRRT calculations can serve:
 - In strategic planning, to support improvement of AO's route catalogue and as a support to address flight planning-related issues;
 - In tactical operations, by helping AOs to identify the latest route opportunities detected by the system, in a dynamic network, which could

be used immediately by updating the filed flight plan with the proposed route.

- (8) Results of the GRRT calculations are provided in a:
- Basic format (always communicated)
 - Rerouting opportunities (OPPs) - flights identified as possibly benefiting from an opportunity marked in the Opp column of NOP / CHMI / NMP Flight / B2B flight list (Figure 2);

Flight list		Enter a name	336 flights	High 0	Medium 0	Low 0	updated 13:35 query wi				
>	☆	ARCID	REG	ADEP	ADES	EOBT	EOBT Validity	E/CTOT	DELAY	REGUL+	OPP
>	☆	AFR81WP	FGKXV	LOWW C	LFPG	22-11:10		11:24E			C-404, D 0

Figure 2. OPP in the flight list column (NMP Flight)

- Additional format (sent in addition to the basic, under conditions confirmed with AOs)
 - Rerouting proposal messages (RRPs) - will be sent only to subscribed AOs. GRRT execution conditions and parameters applied in that case will be stricter and more conservative, to limit the number of sent RRP.
 - Emails - will be sent only to subscribed AOs.

Note: Rerouting opportunities can be accessed in the structured format and linked with the AOs flight planning tool through NM B2B services (for more details, visit <https://www.eurocontrol.int/service/network-manager-business-business-b2b-web-services>).

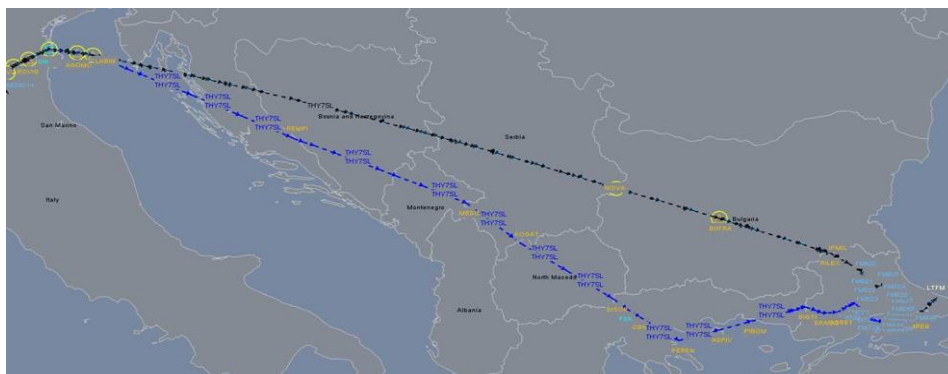


Figure 3. Example of an alternative route (Black) identified by the GRRT (Blue is FPL route)

3.3 GRRT template - Management

- (1) When rerouting a flight, GRRT will take into consideration a set of parameters stored in a rerouting template. The main parameters defined in the template are:
- Routing Constraints and conditions;
 - Costs;
 - Flight selection and filters;
 - Rerouting schedule;

- (2) The AOs might receive rerouting alternatives from:
 - Generic GRRT templates - one or more rerouting templates containing a generic set of parameters agreed upon by NM FE Taskforce team and AUs;
 - or**
 - Customised (AO specific) GRRT templates - one or more rerouting templates containing a set of parameters decided by the subscribed AO, for their specific rerouting needs (business / operational goal).
- (3) The management, testing and (re)validation of the GRRT templates (including creation and maintenance) is done by NM Flight Efficiency taskforce with the support of NMOC staff. Management of the GRRT templates is done in the ETFMS. The (re)validation of the FE GRRT templates is based on a series of checks and amending the templates if required. Revalidation aims to identify and correct GRRT template errors caused by obsolete airspace data (from CACD).

3.4 GRRT template - Parameters

- (1) The information for the parameters of the GRRT template is provided by the concerned AUs. NM doesn't have an influence on the choice of preferred AU's parameters or on the information provided by AUs.
- (2) This Chapter provides an explanation of the GRRT template parameters used in automated rerouting of a flight in support of the flight efficiency.
- (3) When creating a new flight efficiency automated GRRT template (for an AO), the following categories of parameters need to be defined in GRRT Reroute Editor:
 - **Description** – this category is used to define Name of the template, the initial selection of the traffic (based on the AO, airspace, aerodrome, segment, point, etc.), and to control format in which an alternative route will be communicated with AO (OPP, RRP, email);

Note: The name of a GRRT template needs to be unique, to ensure unambiguous communication of the alternative routing options.
 - **Traffic Selection** – allows filtering of flights that will be rerouted by a template, through selection/exclusion of city pairs, aircraft type(s), max FLs etc;
 - **Schedule** – is used to control the frequency of a GRRT template execution and flights capturing intervals, according to the AO's business requirements;
 - **Rerouting source** - defines the source through which alternatives will be generated. At least one source needs to be selected. The rerouting sources are:
 - Path Generator (CPG): is an algorithm that generates alternative routes satisfying a predefined set of constraints. The following options to control the generation of alternatives can be selected. The reference used when generating new proposals is the Original route – from the filed flight (the algorithm will consider all points in the selected flight route during the graph creation) or DCT (the algorithm will consider only the ADEP and ADES during the graph creation);

- City Pair Stats (CPS): the NM system uses flight route alternatives that originate from CPS flight routes (routes generated between city pairs as filed by the aircraft operators).
- Mixer (MIX): the system shall construct new routes by mixing routes existing in the City-Pair Stats database. This consists of combining the first part of any route departing from the ADEP of the original profile with the last part of any routes ending at the ADES of the original profile;
- Flights Currently in System (FCS) the rerouting will consider flight route alternatives that are flown by flights currently in the system;
- Vertical (VER): the original flight route (2D) stays the same, however, the flight profile is rerouted vertically. The required vertical rerouting is specified with the usage of the Constraints tab of the Reroute Editor display;
- Manual (MAN): this source allows definition of a route or part of the new route for the flights to be evaluated. The manual routes are in ICAO FPL2012 ITEM 15 syntax, where it is possible to define complete or partial route.
- When more than one source is selected, the order of execution is: MAN, VER, FCS, CPS, CPG, MIX.
- In addition, it is possible to specify (applied to horizontal sources):
 - *Reference RFL*, that will be considered during the profile calculation. Feasible options are:
 - *Optimal Flight Level*: the path generator constructs 4D profiles by invoking a profile calculation that uses the minimum of the highest reached RFL and the optimal FL of the selected flights. The optimum FL is computed based on the profile length, aerodrome elevations and the BADA performance table;
 - *Original RFL*: profiles of the generated flight alternatives are built using all RFLs of the selected flights (used as the default option - these RFLs might be modified in alternative routings, due to the vertical availabilities of a route);
 - *Highest RFL*: profiles of the generated flight alternatives are built using only the highest reached RFL of the selected flights;
 - *Longest RFL*: profiles of the generated flight alternatives are built using only the longest RFL of the selected flights;
 - *Length Limit (%)* and *Length Limit (fixed)* together define the maximum length of all alternatives;
 - *Freezing of terminal procedures (TP)* – controls if terminal procedures associated with the FPL at the moment of a rerouting will be preserved or others might be selected:

Note: For each generated alternative, the system shall ensure that only published SID/STAR or DCT connections shall be used in the route.

- **Rerouting Outside Zone** (by default selected): the system shall not reroute portions of the original trajectory outside the Rerouting Area and instruct the path generator not to expand any new route alternatives that go outside the IFPZ (it shall only generate alternatives that stay within the IFPZ). It shall neither expand new route alternatives that go from IFPZ entry to IFPZ exit and stay within IFPZ;
- **Expensive Search**: set to OFF by default. When selected, the system spends additional resources and computing time to explore a larger number of alternatives, through enhanced algorithms. The default *10 seconds per flight* computation time is significantly extended.

Note: All alternatives will be validated by IFPS (only within IFPS Zone). Alternatives passing this validation will be proposed.

Note: AIRAC switch: the rerouting measure is re-evaluated against the AIRAC environment used for the processing of the concerned flight. If environment inconsistencies are found between the two AIRAC environments, the system will not reroute the flight (error will be logged).

Note: For all sources except Manual the system shall ensure that no duplicate routes will be proposed as alternatives. A duplicate route is defined as a route with the same en-route 2D portion and/or RFL sequence as previously generated alternative routes or the original route. The 2D portion will be compared if the alternative was generated from a horizontal source. The RFL sequence will be compared when the alternative was generated using Vertical Constraints (always true when the source is VER). The 2D en-route portion and the RFL sequence are both compared if the alternative is generated from a horizontal source and has vertical constraints. A TP portion is never considered in the duplicate check.

- **Constraints** – allows specification of conditions against which the flight alternatives will be checked. The generated alternatives that do not comply with the defined constraints will be excluded and not proposed to AOs. (VIA POINT, AIRSPACE, OBT Validity, Level range etc.). Constraints are used to tune the rerouting results, based on the feedback from AOs. It is possible to define complex subset of conditions by using OR/AND operators. The following types of constraints can be specified:
 - **Condition Via**:
 - Point: the generated flight alternative will have to pass via the specified point;
 - Route: the alternative must follow a selected flight route Portion (completely or partially), defined as an airway or DCT option;
 - Airspace: the generated alternative will have to pass via the specified airspace identification (Id);
 - **Condition Avoid**:
 - Point: the generated flight route alternative will have to avoid passing via the specified Point;
 - Route: the alternative will avoid passing via a specified route portion specified. Also, a DCT option can be selected;

- **Airspace:** the generated alternative will avoid the specified airspace identification, previously indicated by the AO user, either Horizontally or Vertically, or Horizontally and Vertically;
- **Conditions controlling FL and or Speed:** these constraints instruct the vertical profile/speed calculation of each alternative with an additional set of parameters, allowing definition of when, where and how FL/speed change should commence;
- **Opportunity:** this constraint controls if an alternative route must contain an airspace condition (CDR, Restriction, etc.) that was applicable at the date indicated, but is not applicable anymore at the current time. An alternative is an *opportunity* if its profile is invalid at the date of the opportunity constraint, but it is valid against the current time.
- **OBT validity:** defines minimal duration in minutes between the time when the rerouting is applied and the time when the OBT of the flight alternative is no longer valid. Thus, an alternative whose OBT validity period expires before this duration violates this constraint and cannot be selected. The maximum value to be selected is 240 minutes (maximum value computed by ETFMS);
- **Conditions Include:** this constraint allows the user to select already existing GRRT templates and include their constraints when creating a new template in GRRT;
- **Freeze Route Portion Inside Airspace:** the route will not be altered within the limit of the specified airspaces when the alternative route is crossing said airspace. To ensure that the proposal route will cross the specified airspace and not change the trajectory portion within, this feature shall be used in combination with the "VIA AIRSPACE" constraint;
- **Freeze Route Portion Outside:** Airspace the system will freeze the trajectory outside the specified airspace i.e., the scope rerouting would be limited to the specified airspace;
- **Auto Avoid the Most Penalised Regulation (MPR):** if selected, MPR of the flight to be rerouted shall be converted into constraints and appended to the already existing constraints. The system shall convert and append constraints as follows:
 - An Avoid Airspace constraint if the MPR reference location is an airspace. An attempt shall be made to apply the constraint both Horizontal and Vertical, possibly leading to 2 generated alternative routes;
 - An Avoid Point constraint if the MPR reference location is a point.

Note: When performing calculations, GRRT considers all relevant information available in ETFMS. However, to increase the effectiveness of the tool and facilitate solution generation, it is necessary to define airspaces through which rerouting will not be offered by GRRT algorithm (supplement to the CACD data available in ETFMS):

• In the case of a Generic template, this will be introduced based on the information available on the Crisis Management page at NOP Protected portal (officially closed areas

and airspaces for which a warning is issued will be introduced as "AVOID AIRSPACE" criteria);

• In the case of the custom AO templates, this will be done in accordance with AO preferences.

All listed criteria need to be satisfied when trajectory calculation is performed.

If only one criterion (or group of criteria) should be satisfied in the proposal, then OR operator will be used for separation.

- **Costs** – allows selection of a set of criteria that will be used to decide which one of the generated alternatives will be applied on each flight. The system will initially propose default cost values that can be manually modified. During rerouting, the system will compute the total cost of each profile considered as the sum of all costs specified and compare it with the reference route. Some criteria have a "Limit Deterioration" option with an associated value. The system will discard, and not consider, any alternative that exceeds the specified limit (in other words, any alternative that exceeds the specified limit for any of the criteria for which a limit is specified is considered "infinitely costly"). The available criteria are described below:

- **Fixed cost:** this option allows the addition of a fixed value to the total cost of the original flight prior to comparison with the total cost of the generated alternative. A positive cost penalizes the normal profile, making all alternative profiles cheaper in comparison and making it more likely that an alternative will be cheaper than the normal profile. The fixed cost can also be negative; in this case, the system selects an alternative only if it improves on the normal profile by at least this many cost units. Thus, a negative fixed cost is the minimal improvement necessary for an alternative to be proposed;
- **Delay:** Departure (ATFM) delay of the alternative, estimated at the moment of the GRRT execution for all alternatives. The AO user specifies the cost of each minute of the delay incurred by the alternative. A limit on the deterioration of the delay can be selected;
- **Flying time (total elapsed time):** the cost of each minute of flying time via the "cost/minute" field. A limit on the deterioration of the flying time can be selected;
- **Route Length (ADEP to ADES length):** the cost of each nautical mile of route length via the "cost/NM" field. A limit on the deterioration of the route length can be selected;
- **En-Route Length:** the cost of each nautical mile of the en-route route length via the "cost/NM" field. A limit on the deterioration of the en-route length can be selected;
- **Suspension:** a fixed cost to be added to the total cost of the alternative due to the flight suspension, via the "cost if suspended" field. By default, option Forbid suspension is selected (the alternative that causes suspension will not be considered);
- **Opportunity:** the cost of an alternative due to not complying with at least one of the specified opportunity constraints if the

alternative is applied. If the option Opportunity only is selected, then the alternative that is not an opportunity will not be proposed;

- **Overload:** a cost per minute of overloads caused by the alternative on all other flights. More specifically, for each (active) traffic volume that will be overloaded if the alternative is applied, the system computes the minutes of delay caused by a regulation on this TV that will resolve this overload. When Overload is selected, the cost of each minute of delay must be specified via the cost/minute of estimated additional delay caused by the overload field. A limit on the deterioration of the overload can be selected;

Note: The accurate assessment will depend on the information about the capacities, sector configurations and opening schemes available in the NM system.

- **Fuel cost:** the estimated price of fuel per ton via the "cost/ton" field. An upper limit to the fuel consumption, in kg, can be selected. Information on fuel prices is available at IATA website (<http://www.iata.org/publications/economics/fuel-monitor/Pages/index.aspx>);
- **Take-Off Weight Factor (TOWF):** a way to estimate route charges. When "TOWF" is selected, the TOW (take-off weight) of the aircraft as a percentage of the maximum take-off weight of the aircraft type is considered. Thus, a percentage lower than 100% will lower the estimated cost of route charges, whereas a percentage higher than 100% will increase the cost. An upper limit for the estimated cost of route charges with "Limit Deterioration" can be defined;
- **Route Deviation:** the cost for each nautical mile where the alternative profile uses a segment not on the original profile. In other words, the criterion will cause the system to select the alternative that least deviates from the original profile, even if the original profile does not use the shortest possible route. If the Route Deviation cost per nautical mile is nonzero, the system adjusts the internal parameters of the algorithm to find routes that deviate from the original profile as little as possible. The user can also specify an upper limit on the cost with "Limit Deterioration".

Note: Deterioration limitation. Setting one criterion to an exceptionally large value means that an improvement in it will allow a huge degradation in other criteria. To avoid this, for each criterion, it is possible to limit the maximum deterioration. A negative value of the "Limit Deterioration" means that these cost criteria must improve for the selected value.

Note: To secure the minimum impact on the operations, NM will ensure the utilization of the right combination of parameters, in alignment with the operational agreements. All cases of unanticipated reroutings should be reported to further adjust parameters to NM Flight Efficiency Taskforce nm.fetaskforce@eurocontrol.int.

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4 GRRT Results for Aircraft operators

4.1 Introduction

- (1) Results of the GRRT calculations are provided in a:
 - Basic format (always communicated)
 - **Rerouting opportunities** (OPPs) - flights identified as possibly benefiting from an opportunity marked in the Opp column of NOP / CHMI / NMP Flight / B2B flight list;
 - Additional format (sent in addition to the basic, under conditions confirmed with AOs)
 - **Rerouting proposal messages** (RRPs) - will be sent only to subscribed AOs, if requested. GRRT execution conditions and parameters applied in that case will be stricter and more conservative, to limit the number of sent RRP.
 - **Emails** - will be sent only to subscribed AOs, if requested.

4.2 GRRT results - OPPs (Rerouting opportunities)

- (1) When a flight has been identified as possibly benefiting from an opportunity ("interesting" opportunity identified), the flight is marked in the Flight list accessible via Network Operations Portal (NOP), NM CHMI, NMP Flight, with an indication in the 'OPP' column (default column in the flight list – however, if not visible, should be included by the AO user). In addition, an email with the results of the execution is sent to the address specified in the GRRT template. The same information may be retrieved using NM B2B services.
- (2) The OPP column indicator (flag) contains two values:
 - **C** – total cost improvement (delta total costs), representing savings offered by an alternative route in comparison with the filed (current) route, assessed based on the value of selected GRRT cost parameters used for the comparison.
 - **D** – the estimated value of the ATFM delay savings, offered by the alternative route, and calculated at the moment of the GRRT template execution. In case when D takes the value "N/A", it would mean that the flight was not regulated at the moment of the GRRT execution, or that Delay costs are not selected in the GRRT template.
- (3) In case more than one GRRT template executes rerouting of the flight, then the OPP column will highlight the highest savings identified among all the latest executions of all templates (Best non-proposal indicator, also known as Best rerouting indicator). If no interesting OPP is identified by any GRRT template's latest run, OPP indicator will be removed.
- (4) By clicking on the column header, AO User can sort the column values - per C or D value of the OPP indicator (Figure 4).

OPP	NOTE
C-1089, D 0	
C-841, Cost: -1089, Delay: 0	
C-775, D 0	
C-712, D 0	
C-685, D 0	
C-679, D 0	
C-583, D 0	
C-514, D 0	
C-486, D 0	
C-454, D 0	
C-431, D 0	

Figure 4. Opportunity display in the NMP Flight List – sorted by C

4.2.1 Rerouting opportunities in the NMP Flight

- (1) This Chapter provides information about the standard OPP evaluation in the NMP Flight – Flight management panel (not applicable for CHMI and NOP – for these applications see Chapter 4.2.2 Rerouting opportunities in ETFMS Ops log).
- (2) Standard OPP evaluation workflow is shown in Figure 5:
 - Selecting a value in the OPP cell of a flight in the NMP Flight list (1) will open the Flight management panel / Section Rerouting Opportunities (2);
 - Opportunities can be evaluated by using the table with detailed results (3) and map (4);
 - After evaluation, feedback shall be provided (5);

Note: In the Map, the blue line represents the current route and green/red lines indicate alternative routes.

- (3) Section Rerouting Opportunities contains:
 - *Route comparisons* - The original route, as well as the alternative route. For each of those routes, the NM calculated costs (the ATFM delay, flying time, route length, fuel burn and route charges) are given. A comparison of the two sets of costs is done which results in a colour highlight of the alternative route costs when they are higher (red) or lower (green):
 - Table *Original Route* with the current route information (note that this route might be different from the one that was used as the reference in the GRRT calculations – this may happen when AO updates the flight plan route after EXEC time).
 - Table *Proposed Routes* with information on interesting alternatives calculated by one or more GRRT templates' latest executions, where:
 - **Route (F15)** - will become visible after selecting the black triangle symbol in the column (it also contains RR Purpose and Route ID information)
 - **EXEC TIME** - highlights the time at which the GRRT template was executed.
 - **REROUTING NOTE** - indicates the name of the GRRT template that calculated results.

- **Cost Parameters** - each is compared against the current route values (colour code indicates: improvement - green; deteriorations – red; no difference - white):
 - *DELAY* – the ATFM delay estimated at the moment of execution – EXEC time (if the parameter is defined in the GRRT template/trajectory regulated). Might be different at the moment of the proposed route analysis;
 - *EET* - estimated elapsed time of a trajectory (in minutes);
 - *NM* - estimated length of a trajectory (in NM);
 - *FCI* - estimated fuel of a trajectory (in kg);
 - *RCI* - estimated route charges of a trajectory (in euros);
- **EV** - EOBT validity of trajectory (when used in GRRT).

Note: Hovering the mouse over the values will indicate savings.

- **OPP ACTION** (Feedback)
 - *Like* (green) / *Dislike* (red) - when selected an additional window will be opened, where Feedback selection is visible, Reason specified, and optional comment added (for additional details, see Chapter 5.2: Reroute feedback).
- **REROUTE ACTION**
 - *Copy FPL* - the new FPL message with an alternative route will be copied (in PC's clipboard and in the Flight plan editor above)
 - *Copy F15* - the alternative route's Item 15 will be copied into the PC's clipboard.
 - *Validate* - the new FPL message with a proposed (alternative) route will be copied in the Flight plan editor and validated by IFPS (the route is validated only in IFPS Zone).

Note: AOs that are using the GRRT service shall perform qualitative checks (validation) of received rerouting alternatives before submitting the amended FPL, to ensure that these are operationally acceptable for them, and route is still valid at the moment of change and indicated the ATFM delay has not deteriorated. To further evaluate and improve the proposed route, AOs may use NMP's Flight Management - "Propose route" function. Executing this function, on the alternative route proposed by GRRT, with different parameters manually selected by an AO user, might identify further improvements (one of the reasons is that when the "Propose route" function is executed, the NM system allocates more processing time to this feature).

- Checkbox "*Show Opportunities for this flight in the Flight list*", controls if the OPP cell of the flight, in the NMP Flight - Flight list, will show that OPPs are available for that flight (use case: after evaluating the OPP for a flight, an AO user can select this checkbox to hide future indications on OPP for that flight, within the Flight list).
- By default, only the top 5 interesting opportunities from each GRRT template will be presented. To reveal all identified opportunities (max 20 per template), the checkbox "*Show all results*" should be used.

Note: More information about the NMP Flight management, might be found on Network Manager Flight Management Zone YouTube channel (https://www.youtube.com/channel/UCSBhxXXAITbhov9QyuEwH6A).

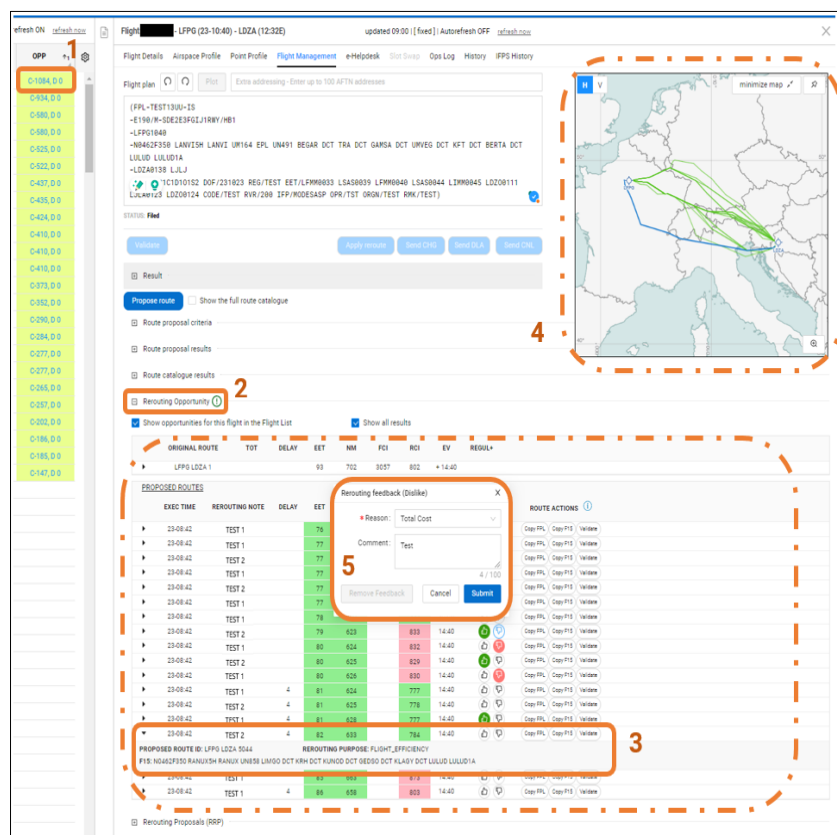


Figure 5. GRRT results - OPPs in the NMP Flight / Flight Management

4.2.2 Rerouting opportunities in the ETFMS Ops log

- (1) A report is created after the search for opportunities successfully identified a potential reroute alternative. The report is available in the Operational Log of the flight (Applicable for NMP Flight/NOP/CHMI).
 - To access the Operational Log in the NMP Flight, click on the arrow in the flight list to expand the panel with more detailed information about the flight and select Ops Log (Figure 6). The opportunities report is available via the "Ops Log Type: HI REROUTE". The green colour indicates log with "interesting" opportunities.

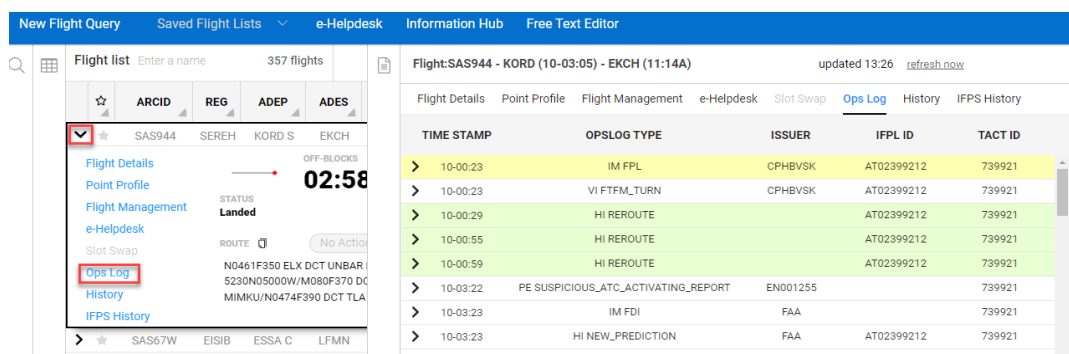


Figure 6. Operational Log – NMP flight

- (2) Each GRRT execution will be recorded in "Ops Log Type: HI REROUTE". In case GRRT is not able to identify any alternative routing option in accordance with predefined parameters, "Ops Log Type: HI REROUTE" will contain a simple report indicating that rerouting results are UNINTERESTING. When GRRT identifies alternative routing options, "Ops Log Type: HI REROUTE" will contain a more detailed report indicating that rerouting results are INTERESTING (Figure 7).

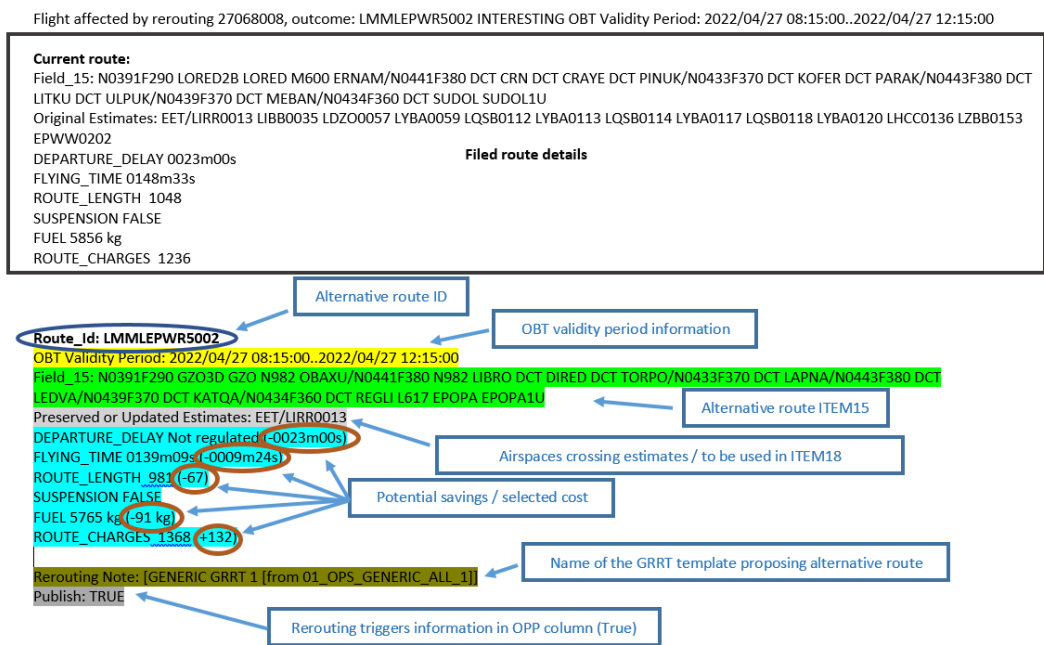


Figure 7. GRRT results - Opportunity OPS LOG HI_REROUTE report

- (3) In case of a report with INTERESTING results, the first line shows the opportunity route identification (e.g. LMMLEPWR5002). This is the alternative route that is regarded as the most interesting (see "chosen alternative", in Chapter 4.5: GRRT results - Example). A detailed analysis of this route is present in the report.
- (4) The first detailed analysis has the title *Current route*; this is the original route with the relevant values and ITEM 15, used for GRRT's calculations.
- (5) For each alternative route identified, there is a detailed analysis stored in the report. Each analysis starts with its Route_Id and has its relevant values shown, as well as ITEM 15. In each GRRT execution, and for each alternative option generated, the Route_Id will be created (this means that alternative routings described with the same F15, but calculated in different GRRT executions might have different ID numbers). Figure 8 shows the Route_Id Naming Convention.

RR Source	Route_Id	Example
MAN	ADEP + ADES + U + number (e.g. U1, U2..)	EBBRLYBEU1
VER	ADEP + ADES + V + number (e.g. U1, U2..)	EBBRLYBEV5
FCS	ADEP + ADES + number [9000-9999]	EBBRLYBE9003
CPS	ADEP + ADES + number [5000-5999]	EBBRLYBE5011
CPG	ADEP + ADES + G + number (e.g. G1, G2..)	EBBRLYBEG6
MIX	Used CP1 ADES + Used CP2 ADEP + G + number [0000-9999]	LTFJEDDFG9001

Figure 8. GRRT's Route_Id Naming Convention

4.3 GRRT results - RRP

- (1) If AO is subscribed to receive flight efficiency RRP (Figure 9 - example), the opportunity offering the highest savings in comparison with the current route, will be sent in the automatically generated RRP message (for other details about RRP refer to the latest edition of the NM's ATFCM Users manual).
- (2) To secure the proposal sent with the RRP message, including the new CTOT, the AO needs to update the flight plan or submit the new one with the proposed route before the Respond By (RESPBY) time in the RRP. Upon the reception of the new route in the flight plan, the ETFMS shall merge the new route with the proposal and transmit appropriate messages.
- (3) Alternatively, an AO may respond to an RRP by sending ETFMS a Rerouting Rejection (RJT) message. In this case, the last received slot remains valid. AOs not wishing to accept an RRP are requested to use the RJT, for the proposed improvement to be re-offered to another AO and the booked slot released (otherwise a booked slot will be left unused until the RESPBY time elapses, this reduces effective capacity and may cause slot wastage).

Note: To restrict the amount of (repetitive) RRP emitted by GRRT automated executions, and reduce the impact on slot booking, RRP will be proposed on limited traffic selection. In addition, GRRT will be executed with more conservative parameters and a rerouting schedule. The right combination of parameters that will increase the likelihood of RRP acceptance needs to be verified with AOs.

```
-TITLE RRP
-ARCID TEST111
-IFPLID RB00002136
-ADEP LEBL
-ADES LOWW
-EOBD 230912
-EOBT 0525
-ORGRTE N0436F340 DIPES1Q DIPES DCT TOSNU UN725 NOLVI/N0443F380 UN725 ORKUM
UM603 ELSAG DCT ALG DCT MINKA DCT POZZO DCT ROMPO DCT RUXOP DCT BATOX DCT
MAMAR DCT NIKOL/N0429F350 DCT LAPNA LAPNA2W
-RRTEREF LEBLLOWWG4
-NEW RTE N0436F340 AGENA5Q AGENA UM985 LUMAS UZ188 SOSUR/N0443F380 UZ188
STP UM985 EKSID M985 NOSTA DCT NOPMU DCT MALUG/N0429F350 DCT ABTAN ABTAN2W
-RESPBY 0205
-REASON OUTREG
-COMMENT PURPOSE IS FLIGHT EFFICIENCY
-TAXITIME 0005
-TOTLIMIT
-VALPERIOD 202309120530 202309120930
```

Figure 9. GRRT results - RRP message

4.4 GRRT results - Emails

- (1) The results of the GRRT executions, if requested by AO, might be sent automatically to the indicated email address.
- (2) When this GRRT's feature "Send Email" is activated, interesting results of the GRRT execution will be sent.
- (3) An email is generated after each GRRT execution in which alternative routing options have been identified (according to GRRT template parameters and the schedule).
- (4) The email generated by GRRT will contain (Figure 10):
 - Summary of "interesting", successfully rerouted flights (1)
 - Detailed information (2 and 3) about rerouting results for each successfully rerouted flight (current route, list of alternative routes with costs, Best non-proposal indicator, Rerouting note).

Note: In case no interesting rerouting alternatives are identified, an email will not be sent by GRRT.

Note: To reduce the number of emails sent, the frequency of GRRT executions should be reduced (or create an additional GRRT template for AO, only at sending emails with different schedules/frequencies).

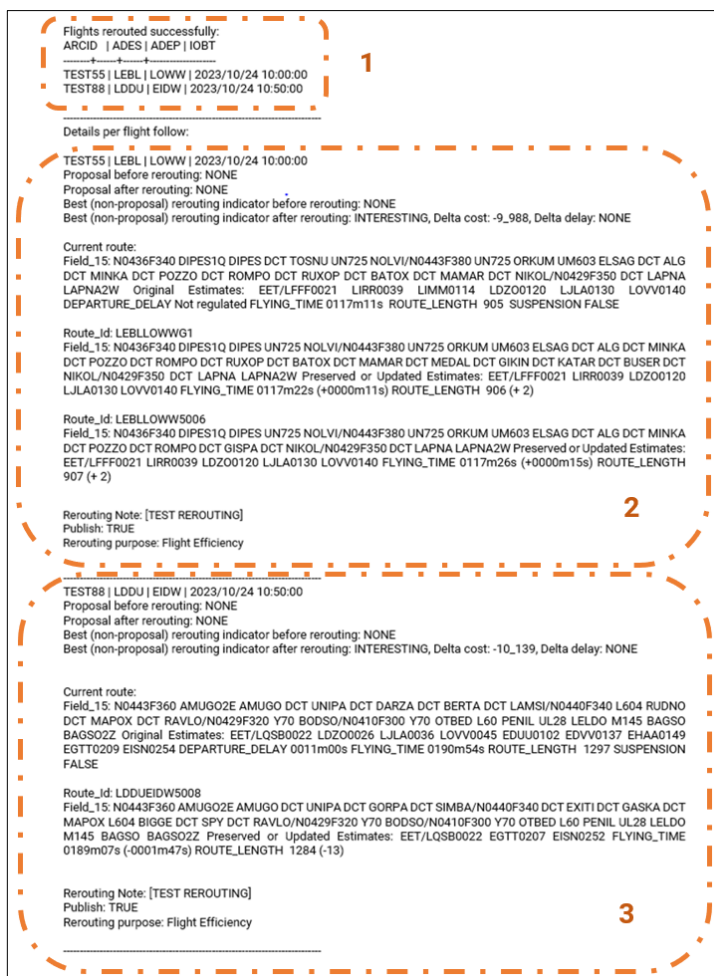


Figure 10. GRRT results in the Email

4.5 GRRT results - Example

- (1) To be highlighted as an alternative route, each needs to comply with the criteria defined within a GRRT template, be validated by IFPS, and have total costs lower than the current route. The total costs of the current and alternative routes are evaluated considering the Cost criteria defined in the GRRT template.
- (2) For each proposed route, a more detailed analysis provides information about the changes to specific parameters, in comparison with the reference route value. For example, the current route has a ROUTE_LENGTH of 1048 and the alternative route has a ROUTE_LENGTH of 981, the delta is -67 (the alternative route is 67NM shorter route).
- (3) Costs defined within the GRRT template, considered in the identification of interesting proposals, are not presented in the Ops Log (but are available in the detailed ETFMS Ops logs, and can be retrieved at the request of AO concerned).
- (4) The example below illustrates the computation of costs done in GRRT (Figure 11).
 - Selected GRRT parameters have associated costs in GRRT templates (Cost per unit of parameter);
 - During the rerouting algorithm execution, values of selected parameters and associated costs will be considered when evaluating the current and alternative route(s) - columns Values/Costs;
 - Total costs of current and alternative route (s) as a sum of individual parameters costs will be calculated. These values are not visible in the Ops Log record (but are available in the detailed ETFMS Ops logs);
 - For each identified alternative route, delta costs will be calculated as a difference between the total costs of that alternative route and the total costs of the current route. These values are not visible in the Ops Log record;
 - Alternative routes with associated negative delta costs (cheaper than the current route) will be presented as interesting routes. If that is not the case, the alternative route is Uninteresting and not presented in the Ops Log record;
 - Values of parameters (blue) will be visible in the Ops Log record of the current Route and interesting alternative route(s);
 - Improvement/deterioration of each parameter (Delta value - purple) will be presented in case of interesting routes.
 - The delta cost and the ATFM delay changes (in minutes) of interesting alternative routes will be used as the input in the calculation of the flight's Best non-proposal indicator (indicated in the OPP column).
 - In the example below, Alternative 1 input to the Best non-proposal indicator will be -895.4, -15 (indicating that it is estimated that Alternative 1 has the potential to save 895.4 EUR and 15 minutes of the ATFM delay). This value will become the Best non-proposal indicator in case no better cost savings are identified in the latest executions of other GRRT templates, rerouting this flight (in case of more templates). Note that here, total cost savings are strongly influenced by the ATFM delay

reduction (600 saved because of it, while another 295.4 EUR would be saved because of changes in values of other parameters).

- In the same example, Alternative 2 will not be presented (will be Uninteresting) because the delta costs of that route are indicating deterioration in comparison with the current route (Alternative 2 is 22.8 EUR more expensive than the current route).

Parameters	Cost per unit of parameter (EUR)	Current Route		Alternative 1				Alternative 2			
		Values	Costs	Values	Delta Value	Costs	Delta Costs	Values	Delta Value	Costs	Delta Costs
ATFM Delay (minutes)	40	15	600	0	-15	0	-600	0	-15	0	-600
Flying time (minutes)	80	137	10960	134	-3	10720	-240	142	5	11360	400
Route Length (NM)	10	954	9540	950	-4	9500	-40	951	-3	9510	-30
Fuel (t)	600	5002	3001.2	4998	-4	2998.8	-2.4	5385	383	3231	229.8
Route Charges	ON	1513	1513	1500	-13	1500	-13	1536	23	1536	23
Total Cost			25614.2			24718.8				25637	
Delta Cost							-895.4				22.8

Figure 11. Example - rerouting costs evaluation

- (5) Rerouting Note provides information about the template that proposed rerouting.
- (6) If AO is subscribed to receive the flight efficiency RRP messages, the opportunity (chosen alternative) with the highest delta costs (savings) will be sent (for other details about RRP refer to the latest ATFCM User’s manual).
- (7) The system will identify EETs that need to be reflected in flight plan updates (EET values provided with alternative routes should be considered when updating flight plans with alternative routes).

Note: When calculating proposals, GRRT will use aircraft performance and TOW information from BADA, if no additional information is available in the flight plan. Also, ETFMS wind information is considered. For that reason, estimated savings might be different from savings obtained after analysis of the proposal in the AO’s flight planning system (See Chapter 2: Aircraft Operators subscription – point 5).

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5 Monitoring, Reporting and Post Operations

- (1) EUROCONTROL NMD/ACD/Operational performance evolution unit measures, monitors and analyses actual trajectory (KEA) and last filed flight plan trajectory (KEP) KPIs.
- (2) Also, NM is using different methodologies and tools to assess the utilisation of GRRT opportunities, considering the acceptance rate of generated rerouting proposals (RRPs) and rerouting opportunities (OPPs).
- (3) Indication of low utilisation will be discussed with respected AOs, to further improve GRRT template parameters and address (possibly) obsolete templates (especially in the case of GRRT templates generating RRP)
- (4) Individual flight records (Reroute matching and Feedback feature) might be retrieved via Network Manager interactive reporting dashboard (Operational Log - Ops Log records).
- (5) More information on flight efficiency KPIs can be found in the Network Manager Annual Report and Network Manager Operations Report or by email nm.ops.perf@eurocontrol.int.

5.1 Reroute matching

- (1) To identify “acceptance” of the proposed alternatives, NM relies on different post-ops algorithms and on the automated function of the NM system “Reroute Matching”. After sending a proposal with an alternative route to the flight, NM system monitors the reply from the AO - flight plan update and new flight plan filing. If the proposed route is identified in this AO’s reply, the Reroute Matching function will record a “matching” between the proposed and filed/updated route.
- (2) The same function is used to confirm RRP message acceptance, to trigger an adequate response of the NM system (e.g., slot booking confirmation). However, conditions (parameters) under which matching is executed might be strict in terms of allowed lateral, vertical and time deviations of the updated current route from the proposed route.
- (3) For that reason, some cases of alternative route acceptance by AO might not be recorded (e.g. cruising levels in the updated route are different from the ones in the proposed route).
- (4) Furthermore, in practice, many of the rerouting proposals are used by AOs on the strategic level - the AO will not change the current route but will use the proposed route for the improvement of other flights. In that case, the Rerouting Matching function will not be executed, and “acceptance” of the proposed route is not recorded. This approach does not allow precise insight into the number of proposals evaluated by AO, and for that reason, the Reroute feedback feature is introduced in the NMP Flight application (see Chapter 4.2.1: Rerouting opportunities in the NMP Flight).

5.2 Reroute feedback

- (1) To better estimate the quality of proposal routes and analyse utilisation of the proposals, NM allows AO users of the NMP Flight application to provide feedback on any of the routes proposed (see Figure 5 - 5).
- (2) An AO user can provide feedback to an alternative route proposal using the Reroute Feedback option in the NMP Flight application, available for each OPP, even if after evaluation, there is no intention to refile the flight plan with the opportunity, but to use it strategically (post-ops, back-office etc.).
- (3) The feedback feature is one of the main inputs used to update GRRT templates and to assess the utilisation of the GRRT tools. For that reason, AOs should regularly submit use feedback feature, to support the Post-ops analysis. Low recorded utilisation will be further reviewed with AOs, to reduce unnecessary GRRT templates.
- (4) This feedback indicates if a route is liked (relevant) or disliked (not relevant/used) by AO with supporting information.
- (5) To indicate feedback, the AO user needs to select one of the feedback buttons - "thumb up" (like) or "thumb down" (dislike). This action will open a box in which additional feedback information might be introduced:
 - Reason - as a mandatory selection (the ATFM Delay value, Route charges, Distance, OBT Validity, Fuel Savings, Flying time, Total costs, AO internal reasons, Other);
 - Comment - as an optional input.
- (6) To remove/amend previously selected feedback, the AO user should re-select a feedback button. In the opened window, the option "Remove feedback" will delete the previously provided input, and a new one can be provided.
- (7) To change feedback (e.g., to select like instead of dislike), the adequate button needs to be selected, input provided, and then a new selection will be recorded.
- (8) The alternative routes displayed in the Results tab (ETFMS) are pre-filtered to consider feedback previously provided by the AO user.
- (9) When a route has previously been liked or disliked, it will not be presented again in the future rerouting results (including Propose Route) for that specific flight.
- (10) When comparing a newly found alternative route with a route for which feedback has previously been given, a comparison algorithm is used that considers each point in one route and its projected distance on the profile of the other route, allowing a small tolerance of difference. The terminal procedures, if present, are not considered in the comparison.

Note: Currently, after providing feedback on a route proposal that generated the Best non-proposal indicator, this indicator will be deleted, and this value in the OPP column for the flight will become empty (until the next GRRT execution that can provide a new Best non-proposal indicator).

Note: Report all unanticipated proposals, or unexpected behaviours to NM Flight Efficiency Taskforce: nm.fetaskforce@eurocontrol.int.

Abbreviations

Term	Definition
ADEP	Aerodrome of departure
ADES	Aerodrome of destination
AIRAC	Aeronautical Information Regulation and Control
AO	Aircraft Operator
ASM	Airspace Management
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
AU	Airspace User
BADA	Base of Aircraft Data
CACD	Central Airspace and Capacity Database
CDR	Conditional Route
CHMI	Collaboration Human Machine Interface
CPG	Path Generator
CPS	City Pair Stats
CTOT	Calculated Take-Off Time
DCT	Direct Routing
EET	Estimated Elapsed Time
EOBT	Estimated Off-Block Time
ETFMS	Enhanced Tactical Flow Management System
EU	European Union
EUR	Euro
EUROCONTROL	European Organisation for the Safety of Air Navigation
EV	EOBT validity (NMP Flight)
FCI	Fuel of trajectory (estimated)
FCS	Flights Currently in System
FE	Flight Efficiency
FL	Flight Level
FPL	Flight Plan
GRRT	Group rerouting tool
IATA	International Air Transport Association

ICAO	International Civil Aviation Organization
ID	Identification
IFPS	Integrated Initial Flight Plan Processing System
IFPZ	IFPS Zone
KEA	Average horizontal en-route flight efficiency of the actual trajectory
KEP	Average horizontal en-route flight efficiency of the last filed flight plan
KPI	Key Performance Indicator
MAN	Manual
MIX	Mixer
MPR	Most Penalised Regulation
NM	Network Manager
NMD	Network Management Directorate
NMIR	Network Manager Interactive Reporting
NMOC	Network Manager Operations Centre
NMP	Network Manager Portal
NOP	Network Operations Plan / Network Operations Portal
OBT	Off-Block Time
OPP	Rerouting opportunities
Ops log	Operational Log
PC	Personal Computer
RCI	Route charges of trajectory (estimated)
RESPBY	Respond By
RFL	Requested Flight Level
RJT	Rerouting Rejection message
RR	Rerouting
RRP	Rerouting Proposal Message
SID	Standard Instrument Departure
STAR	Standard Instrument Arrival
TOW	Take-Off Weight
TOWF	Take-Off Weight Factor
TP	Terminal Procedure
TV	Traffic Volumes
VER	Vertical



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