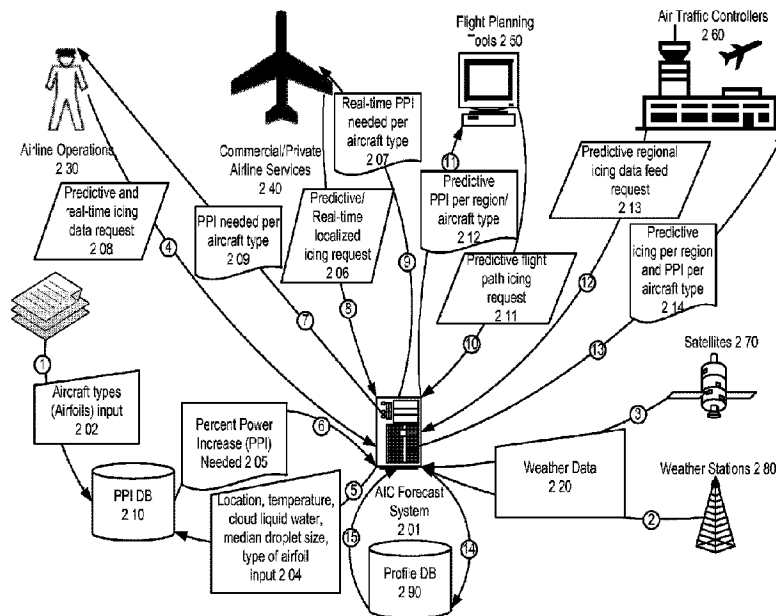




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(54) **Titre : APPAREILS, PROCÉDES ET SYSTÈMES DE RÉGULATION DE GIVRAGE DE PROFIL D'AILE**  
 (54) **Title: AIRFOIL ICING CONTROLLER APPARATUSES, METHODS AND SYSTEMS**



(57) **Abrégé/Abstract:**

The airfoil icing controller apparatuses, methods and systems ("AIC") transforms weather and flight parameter data via AIC components into icing determinations and icing avoidance optimized flight plans based on airfoil type. In one implementation, the AIC comprises a processor and a memory disposed in communication with the processor and storing processor-issuable instructions to receive anticipated flight plan parameter data, obtain weather data based on the flight plan parameter data, obtain atmospheric data based on the flight plan parameter data, and determine a plurality of four-dimensional grid points based on the flight plan parameter data. The AIC may then determine a percent power increase (PPI) required by the aircraft to overcome power loss due to icing conditions. With dynamic, (near) real-time icing information and/or predictive icing forecast specific to airfoil type, the AIC may allow aircraft to efficiently avoid areas where PPI is greater than a predetermined percentage and/or avoid areas where dangerous icing may occur.

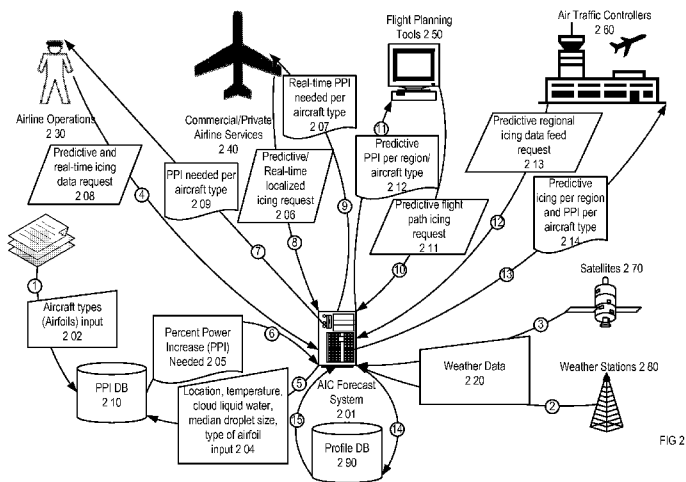


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# AIRFOIL ICING CONTROLLER APPARATUSES, METHODS AND SYSTEMS

1       **[0001]**       This application for letters patent document discloses and describes inventive  
2  
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4 that is subject to copyright, mask work, and/or other intellectual property protection. The  
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7 reserve all rights.

## TECHNICAL FIELD

9  
10       **[0002]**       The present application relates generally to aircraft icing forecasting and  
11 route planning.

## BACKGROUND

12  
13       **[0003]**       A variety of weather monitoring systems, including ground-based and satellite-  
14 based observations, are used to provide weather reports and forecasts, including icing conditions.  
15 Icing determination may rely on sensors located on an aircraft. This, however, does not provide  
16 any advance warning and does not allow for course correction to reducing icing conditions and  
17 improve aircraft performance.

## BRIEF DESCRIPTION OF THE DRAWINGS

1 [0004] The accompanying appendices and/or drawings illustrate various non-limiting,  
2 example, inventive aspects in accordance with the present disclosure:

3 [0005] FIGURE 1 provides an overview of an aspect of the AIC;

4 [0006] FIGURE 2 shows a data flow diagram illustrating an example of a AIC accepting  
5 inputs and data requests, utilizing internal data repositories for data request execution and  
6 outputting both predictive and (near) real-time data in some embodiments of the AIC;

7 [0007] FIGURE 3 shows a data flow diagram illustrating an example of an AIC  
8 initializing internal data repositories for input while accepting inputs and data requests and  
9 outputting both predictive and (near) real-time data in some embodiments of the AIC;

10 [0008] FIGURE 4 demonstrates a logic flow diagram illustrating example AIC data  
11 requests, creating an aircraft profile, accepting input and outputting grid point percent power  
12 increase (PPI) in some embodiments of the AIC;

13 [0009] FIGURE 5 demonstrates a logic flow diagram illustrating example AIC data  
14 requests, accessing an aircraft profile, accepting input and outputting grid point percent power  
15 increase (PPI) in some embodiments of the AIC;

1 **[0010]** FIGURE 6 demonstrates an example user interface where icing prediction is  
2 integrated into an existing and/or future flight planning tool, allowing users to alter flight path  
3 creation to account for projected icing in some embodiments of the AIC;

4 **[0011]** FIGURE 6A shows a logic flow diagram illustrating an example of an AIC  
5 integrating icing modeling into flight path creation, facilitating user preference in flight  
6 planning variation in some embodiments of the AIC;

7 **[0012]** FIGURES 7-11 show various example and/or visual input/output component  
8 aspects of the AIC;

9 **[0013]** FIGURE 12 illustrates aspects of ice accumulation and resultant PPI values with  
10 respect to a Beechcraft King Air airfoil, in one implementation of the AIC;

11 **[0014]** FIGURE 13 illustrates aspects of ice accumulation and resultant PPI values with  
12 respect to a Boeing 737 airfoil, in one implementation of the AIC;

13 **[0015]** FIGURE 14 shows an example percent power increase (“PPI”) component  
14 installation and usage scenario, in one implementation of the AIC;

15 **[0016]** FIGURES 15A-F show an example PPI component hardware component, in one  
16 implementation of the AIC; and

17 **[0017]** FIGURE 16 shows a block diagram illustrating embodiments of a AIC controller;

18 **[0018]** The leading number of each reference number within the drawings indicates the  
19 figure in which that reference number is introduced and/or detailed. As such, a detailed  
20 discussion of reference number 101 would be found and/or introduced in Figure 1. Reference  
21 number 201 is introduced in Figure 2, etc.

## DETAILED DESCRIPTION

### AIRFOIL ICING CONTROLLER (AIC)

1  
2  
3 **[0019]** In some embodiments, the AIRFOIL ICING CONTROLLER (“AIC”) as  
4 disclosed herein transforms weather and flight parameter data via AIC components into icing  
5 avoidance optimized flight plans based on airfoil type. In one implementation, the AIC  
6 comprises a processor and a memory disposed in communication with the processor and storing  
7 processor-issuable instructions to receive anticipated flight plan parameter data, obtain weather  
8 data based on the flight plan parameter data, obtain atmospheric data based on the flight plan  
9 parameter data, and determine a plurality of four-dimensional grid points based on the flight  
10 plan parameter data. The AIC may then determine a percent power increase (PPI) required by  
11 the aircraft to overcome power loss due to icing conditions. With (near) real-time icing  
12 information and/or predictive icing forecast specific to airfoil type, the AIC may allow aircraft  
13 to avoid areas where PPI is greater than a predetermined percentage and/or avoid areas where  
14 icing may occur.

15 **[0020]** Icing forecasting methods may focus on general categories of aircraft, such as  
16 aircraft size, and real-time icing information rely primarily on pilot reports (PIREPS), other  
17 subjective/observational data, and local sensors for determining icing airspace regions. In one  
18 embodiment, an array of sensors both local and remote may be periodically polled by an aircraft  
19 itself, directly by the AIC, and/or the like. The polled array of sensors may include, for  
20 example, sensors for measuring altitude, heading, speed, pitch, temperature, barometric  
21 pressure, the water content of the atmosphere and/or clouds, fuel consumption, fuel remaining

1 for flight, number of passengers, aircraft weight, and/or the like. The AIC as disclosed herein  
2 utilizes unique predictive determination components of icing per unique airfoil type and utilizes  
3 these predictive components to generate a comprehensive forecasting map display and/or  
4 overlay that is not merely a generalized icing projection for aircraft of a broad-spectrum type,  
5 but is the specification of icing to any airfoil known to the AIC, providing an accurate, model of  
6 icing over a specified spatial/temporal area.

7 **[0021]** Icing determination may rely on sensors located on an aircraft to determine when  
8 icing has occurred. This method fails to give advance warning aircraft personnel to potential  
9 icing hazards and may not give sufficient notice for course correction to improve icing  
10 conditions. In some scenarios, an aircraft advancing into icing conditions may lose altitude  
11 and/or be forced to terminate a specific flight plan without adequate notification of impending  
12 icing conditions. Icing forecasts may rely on weather conditions alone to determine if icing may  
13 occur and may apply only a generalized aircraft type to forecasting methods, an example of  
14 which might be that a small aircraft may experience more significant icing than a larger aircraft  
15 or require a greater power increase in icing conditions. However, airfoils, generally defined as  
16 curved surface structures that provide aircraft with positive lift to drag ratios, under identical  
17 weather conditions may ice differently, without respect to other aspects of aircraft  
18 construction and/or size 101. In one example, a medium size propeller plane 102 may form ice  
19 encasing the endpoint of its airfoil requiring a PPI of 0.3548. In this example under duplicate  
20 weather conditions, a large passenger aircraft 103 may experience only slight icing of its airfoil,  
21 requiring a much smaller PPI of 0.0051. Lastly, in this example, under these replicated weather  
22 conditions, a small private aircraft 104 may experience larger ice formation on its airfoils than  
23 the passenger aircraft and require a PPI of 0.0880, which is greater than that of the passenger

1 aircraft, but less than that of the medium-sized propeller aircraft. By way of example, the terms  
2 "small", "medium", and "large" have been employed to describe diverse aircraft generalized in  
3 Figure 1. The AIC, however, may be indeterminate of aircraft size, purpose, and/or the like. In  
4 this embodiment, the AIC uses airfoil type to determine how, where, under what conditions,  
5 and/or the like of icing occurrence. In some embodiments, the AIC may associate aircraft with  
6 their known airfoil types. In some embodiments, the AIC may maintain information exclusive  
7 to airfoils. In some embodiments, the AIC may use aircraft type reciprocally with airfoil type.

8 **[0022]** In some embodiments of the disclosure, the AIC 201 may maintain a data  
9 repository 210 of aircraft PPI. In some embodiments, the data repository may be organized by  
10 aircraft type. In some embodiments, the data repository may be organized by airfoil type. In  
11 some embodiments, data tables of aircraft and airfoil types may be linked by information keys,  
12 associating aircraft and airfoil types. In other embodiments, the aircraft and/or airfoil  
13 parameters for use by the AIC may be stored with respect to a PPI module, such as that  
14 disclosed with respect to Figure 16 (e.g., PPI Component 1649; AIC data store 1619, Weather  
15 1619h, Aircraft 1619i, Airfoil 1619l; and/or the like); Figures 15A-F (e.g., an example PPI  
16 hardware module); and/or the like. The PPI component and/or data repository may be internally  
17 searchable to the AIC by a database query language and/or platform. In some embodiments, the  
18 AIC may allow external sources to query the data repository. In this embodiment, aircraft types  
19 are independently input 202 to the PPI data repository, which is maintained internally to the  
20 AIC. Weather data and/or modeling such as the Global Forecasting System (GFS) and Rapid  
21 Refresh (RAP) may be made available to the AIC through satellite transmission 270, weather  
22 station input 280, and/or the like. In some embodiments, the AIC may reduce weather data to  
23 determinate icing factors. In some embodiments, the AIC may request specific numerical

1 weather input that is icing condition related. In some embodiments of the AIC, weather input is  
2 continuous and/or updated at systematic intervals. In the example of Figure 2, airline operations  
3 230 may request both predictive and (near) real-time icing data 208 from the AIC. In this  
4 example, the operational request contains the aircraft type(s) for which icing conditions should  
5 be predicted. In some embodiments, the AIC may contain user profile information under which  
6 a user, having created a profile with the AIC, may provide identifying information other than  
7 aircraft type. In some embodiments, the AIC may store user information in a profile data  
8 repository 290 and access aircraft type(s) and/or other user information based on identifying  
9 input data. The AIC may then submit operational data, such as airfoil type and location,  
10 localized and real-time weather data, such as temperature, cloud liquid water, and median  
11 droplet size, and/or the like 204 to the PPI data repository 210 which may then return PPI(s) 205  
12 needed for requested aircraft and/or conditions. The AIC may return 209 this output to the  
13 airline operations as requested. In one example, commercial and/or private airline services 240  
14 may request predictive and/or (near) real-time localized icing information. In some  
15 embodiments, this request may contain aircraft type and other user information. In some  
16 embodiments, this request may contain identifying information to access user profile data stored  
17 in a AIC profile data repository. The AIC may submit the relevant operational and weather data  
18 to the PPI data repository and receive PPI(s) as described, returning output to the requestor 240.  
19 In some embodiments, in-house and/or third party flight planning tools 250 may request 211  
20 predictive icing conditions over a region for one or more aircraft types. In some embodiments,  
21 the flight planning tools may have and/or share user profile information of a profile data  
22 repository with the AIC in making this request. In some embodiments, the AIC may return a  
23 PPI grid overlay for the requested region 212. In some embodiments, the AIC may return a

1 flight path over PPI grid overlay for the requested region, according to flight path request  
2 parameters, as described in Figures 6-6A. In some embodiments, the AIC may return multiple  
3 paths and/or PPI grid overlays for the requested regions. In another example, air traffic  
4 controllers 260 may request predictive localized icing data 213 for its common regional aircraft  
5 from the AIC. As in other examples, this request may provide all necessary input data singly  
6 and/or with identifying information with which the AIC may access stored profile information  
7 from a profile data repository. The AIC may submit the necessary inputs and return a regional  
8 icing grid overlay 214 and/or PPI(s) for all aircraft type which may have been named in the data  
9 request or which may be part of an accessed profile. In some embodiments, the AIC may use  
10 request data to maintain and/or update a profile data repository to assist in future data requests  
11 from sources for which a profile has been created. In some embodiments, the AIC may use  
12 request data to create user profile data for sources for which no profile data previously existed.

13 **[0023]** Figure 3 shows an alternate embodiment of AIC data flow in which data requests  
14 are received from like sources 330, 340, 350, 360, such as in Figure 2 and which aircraft/airfoil  
15 type 302, aircraft specific icing 305, location/region, weather data such as temperature, cloud  
16 liquid water, median droplet size 304, and/or the like is input to the AIC. In this embodiment, a  
17 PPI data repository 310 may store aircraft/airfoil type in the manner(s) described in Figure 2,  
18 and may be used as an input source to the AIC. In this embodiment, data requests such as 306  
19 308 311 313 are fulfilled through the AIC, with data requests providing either input singly  
20 and/or with identifying user information to access profile data from a profile repository 390, as  
21 may be maintained by the AIC as described in Figure 2. In some embodiments of the  
22 disclosure, the data repositories storing PPI, aircraft/airfoil type, and/or user profile information  
23 may be separate from, but accessible to, the AIC. As in Figure 2, the AIC may provide similar

1 outputs 307 309 312 314 to requesting parties. The AIC may maintain/update its profile data  
2 repository with information from processed requests.

3 **[0024]** In Figure 4, one embodiment of the AIC's PPI calculation component is put forth.  
4 In this embodiment, an icing request is initiated to the AIC 401. The AIC may request the  
5 aircraft type(s) 402. In some embodiments, the AIC may use provided identifying user  
6 information as part of a user profile maintained by the AIC to determine aircraft type(s). In this  
7 embodiment, the AIC maintains a PPI data repository, which may be internal or external to the  
8 AIC, of aircraft types and/or airfoil types which may be maintained in separate tables or  
9 repository with information keys linking types. In all subsequent aspects of the diagram,  
10 reference aircraft and/or airfoil may be singular or plural, i.e. the AIC may be considered to  
11 process multiple types in each request or the AIC may process a single type in a request. The  
12 AIC may query the PPI data repository 403 to determine if the aircraft type is already known to  
13 the system. If the aircraft type is not stored in the PPI 404, the AIC may assign an aircraft type  
14 405 by creating a new or finding an existing matching record in the PPI that conforms to the  
15 aircraft specifications. If the aircraft is not associated with a known airfoil type 406, the AIC  
16 may request that an airfoil type be associated with the aircraft 407 and request an airfoil  
17 identification. If the airfoil type identified is not in system 408, the AIC may issue an  
18 insufficient data notice 409 and request the parameters of the airfoil type 410. If the input  
19 parameters of the airfoil match a known airfoil type, the input airfoil is recorded as the existing  
20 airfoil type 412. If the input parameters of the airfoil do not match an existing type, the AIC  
21 may create a new record in the PPI data repository with the input airfoil parameters 413. If the  
22 aircraft type is known and/or the airfoil type is known, and/or the AIC has input new  
23 aircraft/airfoil types in the PPI, the AIC may request gridpoints and time to calculate icing data

1 414. The AIC may execute a query on its icing component for the requested points and time  
2 415. The AIC may then determine the PPI necessary for input aircraft under the defined  
3 conditions, as predicted by the AIC weather model. The following non-discursive PPI  
4 calculation/determination embodiment, presented substantially in the form of a Fortran code  
5 fragment, shows one embodiment of a methodology for such processing:

```
6      C
7      C* Get grid file user input.
8      C
9          WRITE ( 6, 1002 )
10         READ ( 5, 999 ) gdfile
11         WRITE ( 6, 1003 )
12         READ ( 5, 999 ) gdout
13         WRITE ( 6, 1004 )
14         READ ( 5, 999 ) fhour
15         WRITE ( 6, 1005 )
16         READ ( 5, 999 ) acft
17      C
18      C* Fill aircraft performance loss table depending on aircraft type.
19      C
20         IF ( acft .eq. 'be20 ' ) THEN
21             DO m = 1,14
22                 DO n = 1,10
23                     apltbl (m,n) = be20(m,n)
24                 END DO
25             END DO
26         ELSE
27             DO m = 1,14
28                 DO n = 1,10
29                     apltbl (m,n) = be20(m,n)
30                 END DO
31             END DO
32         END IF
33      C
34      C* Get grid file user input.
```

```

1      C
2      WRITE ( 6, 1002 )
3      READ ( 5, 999 ) gdfile
4      WRITE ( 6, 1003 )
5      READ ( 5, 999 ) gdout
6      WRITE ( 6, 1004 )
7      READ ( 5, 999 ) fhour
8      WRITE ( 6, 1005 )
9
10     C
11     C* Find levels in model.
12     C
13     CALL DG_GLEV ( 1, time, ivcord, LLMXLV,
14     + iflev, nlev, iret )
15     DO j = 1, nlev
16     rlevel (j) = FLOAT ( iflev (1,j) )
17     END DO
18     CALL LV_SORT ( ivcord, nlev, rlevel, iret )
19     C
20     DO j = 1, nlev
21     CALL ST_INCH ( INT(rlevel(j)), glevel, iret )
22     C
23     C* Read icing parameter grids.
24     C
25     gvcord = 'HGHT'
26     gfunc = 'TMPC'
27     CALL DG_GRID ( timfnd, glevel, gvcord, gfunc, pfunc, t,
28     + igx, igy, time, level, ivcord, parm, iret )
29     gfunc = 'CWTR'
30     CALL DG_GRID ( timfnd, glevel, gvcord, gfunc, pfunc, cwtr,
31     + igx, igy, time, level, ivcord, parm, iret )
32     gfunc = 'MVD'
33     CALL DG_GRID ( timfnd, glevel, gvcord, gfunc, pfunc, mvd,
34     + igx, igy, time, level, ivcord, parm, iret )
35     maxpts = igx*igy
36     C
37     C* Compute aircraft performance loss.
38     C
39     DO i = 1, maxpts
40     IF ( t(i) .eq. RMISSD .or. cwtr(i) .eq. RMISSD ) THEN
41     apl(i) = RMISSD
42     ELSE IF ( (t(i) .ge. 0.0) .or. (t(i) .le. -40.0) .or.
43     + (cwtr(i) .le. 0.0) ) THEN
44     apl(i) = 0.0
45     ELSE

```

```

1      C
2      C* Bi-linearly interpolate aircraft icing values.
3      C
4          IF ( cwtr(i) .le. .001 ) THEN
5              rcol = cwtr(i)/.0001
6              icol = rcol
7              c = rcol - FLOAT(icol)
8              oc = 1. - c
9      ELSE IF ( cwtr(i) .le. .002 ) THEN
10             rcol = 10. + (cwtr(i)- .001)/.00025
11             icol = rcol
12             c = rcol - FLOAT(icol)
13             oc = 1.0 - c
14     ELSE
15         icol = 14
16     END IF
17     IF ( t(i) .gt. -2.0 ) THEN
18         r = -t(i)/2.0
19         apl(i) = apltbl(1,icol)*r*oc + apltbl(1,icol+1)*r*c
20     ELSE IF ( t(i) .gt. -4.0 ) THEN
21         irow = 1
22         r = (-t(i) - 2.0)/2.0
23         or = 1. - r
24         IF ( icol .eq. 14 ) THEN
25             apl(i) = apltbl(1,14)*or + apltbl(2,14)*r
26         ELSE
27             apl(i) = apltbl(irow,icol)*oc*or
28                 + + apltbl(irow,icol+1)*c*or
29                 + + apltbl(irow+1,icol)*oc*r
30                 + + apltbl(irow+1,icol+1)*c*r
31         END IF
32     ELSE
33         rrow = (-t(i)/4.0) + 1.0
34         irow = rrow
35         r = rrow - FLOAT(irow)
36         or = 1.0 - r
37         IF ( icol .eq. 14 ) THEN
38             apl(i) = apltbl(irow,14)*or + apltbl(irow+1,14)*r

```

```

1           ELSE
2           apl(i) = apltbl(irow,icol)*oc*or
3             + + apltbl(irow,icol+1)*c*or
4             + + apltbl(irow+1,icol)*oc*r
5             + + apltbl(irow+1,icol+1)*c*r
6           END IF
7         END IF
8       END IF
9     END DO
10    C
11    C* Output PPI
12    C
13    ifl(1) = INT(rlevel(j))
14    ifl(2) = -1
15    parm = 'apl'
16    CALL DG_NWDT ( apl, time, ifl, ivcord, parm,ighdr,
17      + gpack, .true., irect )
18    IF ( irect .eq. 0 ) write (6,*) time(1), parm, ' at ',
19      + ifl(1), ' grid write successful'
20    END DO
21    CALL DG_NTIM ( .false., .false., time, nxttm, ier )
22

```

23 **[0025]** Figure 5 shows an alternate embodiment of AIC's PPI determination component.

24 In all subsequent aspects of the diagram, reference aircraft and/or airfoil may be singular or

25 plural, i.e. the AIC may be considered process multiple types in each request or the AIC may

26 process a single type in a request. As in Figure 4, the component processes the initial request

27 501 and aircraft type 502 and queries a PPI data repository 503. In this embodiment, if the

28 requested aircraft type is not known to the AIC, the AIC may use an airfoil based on the aircraft

29 size in which the largest PPI may eventually be generated 505. In this embodiment, the AIC

30 may assign this airfoil to the aircraft for icing calculation purposes 506. The PPI calculation

31 proceeds through requesting gridpoints and time 507, querying the AIC weather model 508, and

1 determining the PPI for the given airfoil 509, as shown in Figure 4. The requested PPI(s) are  
2 then output to the initiator of the request.

3 **[0026]** Figure 6 shows an example of how the AIC may be incorporated into existing  
4 and/or prospective flight planning tools, such as AviationSentry Online®. The AIC may be  
5 included with online services, with desktop services, with mobile applications, and/or the like.  
6 In this embodiment of the disclosure, a flight planning tool has an interface 601 representative  
7 of an online flight planning service with user profile information. As an interactive element  
8 602, the AIC may allow users to factor icing prediction into flight path creation. The AIC may  
9 allow users to consider several ways of incorporating icing prediction into their flight path  
10 considering their flight requirements 603. In this example, the AIC may offer shortest path  
11 generation where icing may not be a considering factor in flight path creation, icing  
12 circumvention where icing avoidance is a serious flight consideration, some icing  
13 circumvention with emphasis on shortest path generation where icing avoidance warrants some  
14 consideration, but may not be a primary goal and/or the like. The AIC may then generate a  
15 regional icing forecast within the specified flight path region 604 and suggest flight path  
16 alterations with respect to the level of icing circumvention desired. In this embodiment, the  
17 AIC outputs a color-coded map overlay where black may represent no necessary PPI, green  
18 may represent mild PPI, yellow may represent moderate necessary PPI, and red may represent  
19 severe necessary PPI.

20 **[0027]** Figure 6A shows one example of an expanded logic flow diagram of flight path  
21 considerations when the AIC is part of an integrated flight planning tool. In one embodiment of  
22 the disclosure, the flight planning service may access/input user profile information 605 which  
23 may include such information as the type of aircraft and/or flight service such as passenger 606,

1 private 607 and/or commercial cargo/transport 608, the consideration of which may influence  
2 icing avoidance (i.e. commercial cargo transport may prioritize shortest path with minimal  
3 evasion while passenger may emphasize discursive icing circumvention over speed or  
4 directness). The AIC may request additional user profile information for flight path  
5 construction 609. In some embodiments of the disclosure, such information may include the  
6 origin grid point and departure time of the flight, the destination grid point, and/or the  
7 maximum travel time the flight can utilize in constructing its path 611. In some embodiments  
8 of the disclosure, the AIC may infer user information from previously stored user profile data  
9 and/or prior flight path generation 612. In some embodiments, this information may include the  
10 aircraft type, its fuel requirements, its standard flying altitude, previous planned flight paths,  
11 and/or the like 613. In some embodiments, user profile and flight creation information that is  
12 both input and/or inferred by the AIC may be used to update the user profile data for future AIC  
13 use 614. In some embodiments of the disclosure, the AIC may use other stored profile  
14 information where similar parameters resulted in successful flight path creation. In some  
15 embodiments of the disclosure, the AIC may use additional input, such as those from sources  
16 external to the flight planning tool, such as historical flight plan data and/or the like. The AIC  
17 may then calculate the grid size of the region 615 over which the AIC may consider flight path  
18 creation, using input such as the origin, destination, maximum flight time, and/or facilities of  
19 the aircraft and/or type of flight. In some embodiments of the disclosure, two dimensional grid  
20 space may be considered for initial path planning purposes. In some embodiments of the  
21 disclosure, three dimensional grid space may be considered for path planning purposes. In  
22 some embodiments of the disclosure, two dimensional grid space may be considered for initial  
23 path planning purposes, which may then be integrated with additional dimensional information

1 as necessary to accurately determine available grid space inside which the flight path may still  
2 meet flight path parameters.

3 **[0028]** In some embodiments of the disclosure, this initial input component may then be  
4 followed by AIC PPI calculation 616 of the generated geospatial grid region, some examples of  
5 which have been described in Figures 2, 3, 4 and 5. The AIC may create a PPI overlay to the  
6 generated grid region 618 and may request additional information about the desired parameters  
7 of the flight path through this grid region 618. In some embodiments of the disclosure, these  
8 parameters may include schedule-based path-finding (shortest path immediacy), schedule-based  
9 but with circumvention of acute icing (shortest path avoiding high hazard icing areas),  
10 discursive icing circumvention (navigating out of icing areas), and/or any combination of or  
11 intermediate stage to these parameters 619. The AIC may then use available input as described  
12 in the input component to determine all flight path creation parameters 620. The AIC may then  
13 create a flight path over the PPI grid region 621, considering flight path creation parameters  
14 619. The AIC may then provide the user the proposed flight path as a terminal overlay,  
15 standard or high definition map overlay and/or the like 622, as is applicable to the flight  
16 planning tool. If the flight path is satisfactory 623, the user may then exit the flight path  
17 planning component of the AIC as an incorporated flight planning tool option. In some  
18 embodiments of the disclosure, the AIC may allow the user to export the determined flight path  
19 to other media, save the flight path to the user profile, share the flight path with additional users,  
20 and/or the like. In some embodiments of the disclosure, if the proposed flight path is not  
21 satisfactory 623, the AIC may allow the user to modify flight path creation parameters 624. In  
22 some embodiments of the disclosure, the user may re-enter a flight path creation component as  
23 specified earlier. In some embodiments of the disclosure, users may be allowed to visually

1 manipulate flight path options using the proposed flight path PPI grid overlay. In some  
2 embodiments of the disclosure, the user may be able to reenter flight path creation, visually  
3 manipulate the proposed flight path and/or combine these methods in any intermediate path  
4 modification.

5 **[0029]** Figure 7 shows an example four-hour Rapid Refresh model data (RUC2 format)  
6 numerical temperature forecast at 4572 m (FL150) over the Washington state region, which the  
7 AIC may use as an input for PPI calculation.

8 **[0030]** Figure 8 shows one example of cloud liquid water forecast 801 at FL150, as  
9 computed by the AIC using the model data of Figure 7.

10 **[0031]** Figure 9 shows one example of a median droplet diameter forecast 901 at FL150,  
11 as computed by the AIC using the model data of Figure 7.

12 **[0032]** Figure 10 shows one example of a color-coded PPI map grid overlay 1001 as  
13 calculated and generated by the AIC for the Beechcraft Super King 200 aircraft, if it were to fly  
14 in the icing conditions described in Figures 7-9. In this example, PPI is the percent power  
15 increase necessary to overcome performance loss after five minutes exposure to the shown icing  
16 conditions, where black indicates less than 1% PPI, green indicates less than 10% PPI, yellow  
17 indicates less than 60% PPI, and red indicates greater than 60% PPI.

18 **[0033]** Figure 11 shows one example of a color-coded PPI map grid overlay 1101 as  
19 calculated and generated by the AIC for a larger aircraft than was shown in Figure 10, if it were  
20 to fly in the icing conditions described in Figures 7-9. In this example, PPI is the percent power  
21 increase necessary to overcome performance loss after five minutes exposure to the shown icing

1 conditions, where black indicates less than 1% PPI, green indicates less than 10% PPI, yellow  
2 indicates less than 60% PPI, and red indicates greater than 60% PPI.

3 **[0034]** In some embodiments, the AIC server may issue PHP/SQL commands to query a  
4 database table (such as FIGURE 16, Profile 1619c) for profile data. An example profile data  
5 query, substantially in the form of PHP/SQL commands, is provided below:

```
6 <?PHP
7 header('Content-Type: text/plain');
8
9 // access database server
10 mysql_connect("254.93.179.112", $DBserver, $password);
11
12 // select database table to search
13 mysql_select_db("AIC_DB.SQL");
14
15 //create query
16 $query = "SELECT field1 field2 field3 FROM ProfileTable WHERE user LIKE
17     '% ' $prof";
18
19 // perform the search query
20 $result = mysql_query($query);
21
22 // close database access
23 mysql_close("AIC_DB.SQL");
24 ?>
25
```

26 **[0035]** The AIC server may store the profile data in a AIC database. For example, the  
27 AIC server may issue PHP/SQL commands to store the data to a database table (such as  
28 FIGURE 16, Profile 1619c). An example profile data store command, substantially in the form  
29 of PHP/SQL commands, is provided below:

```
30 <?PHP
```

```
1  header('Content-Type: text/plain');
2
3  // access database server
4  mysql_connect("254.92.185.103", $DBserver, $password);
5
6  // select database to append
7  mysql_select("AIC_DB.SQL");
8
9  // add data to table in database
10 mysql_query("INSERT INTO ProfileTable
11             (fieldname1, fieldname2, fieldname3)
12             VALUES ($fieldvar1, $fieldvar2, $fieldvar3)");
13
14 // close connection to database
15 mysql_close("AIC_DB.SQL");
16 ?>
17
```

18 **[0036]** Various embodiments of the AIC may be used to provide real-time, pre-flight  
19 and/or in-flight icing reporting, planning and response. The integrated, unified icing system  
20 provided by the AIC may be used in flight equipment and/or ground equipment. The AIC may  
21 provide weather/aviation decision support (e.g., via graphical displays) and/or provide  
22 alerts/triggers. Although it is discussed in terms of re-routing in time of increased icing, in  
23 some embodiments, the AIC may identify more efficient paths based on real-time updates  
24 where there is decreased icing over a shorter physical distance, and may update a flight plan  
25 accordingly. The AIC identifies 4D areas for flight hazards, and a user may choose or set their  
26 profile based on particular hazards (e.g., a passenger airline would have a different hazard/icing  
27 profile than an air freight company, and a large airliner would have a different profile from a  
28 small plane or helicopter). Various cost calculations and risk calculations may also be used in  
29 determining alerts and/or flight paths. In some embodiments, real-time feedback may come  
30 from plane-mounted instrument sensors and provide updates to predicted icing. Such

1 information may be used to refine components for icing determination. Although examples  
2 were discussed in the context of jet airliners, it is to be understood that the AIC may be utilized  
3 for low-level services, such as helicopters, unmanned aerial vehicles, as well as high speed  
4 and/or military aircraft, and may even have potential ground applications, especially in  
5 mountainous terrain. The AIC may work with air traffic control, particularly in management of  
6 routing. In some embodiments, the AIC may receive input from and render output directly to  
7 avionics systems to guide planes.

8 **[0037]** Many pilots view aircraft icing as one of the most dangerous in-flight hazards.  
9 Prior to the AIC, icing forecasts have been one-size-fits-all. Different aircraft accumulate ice  
10 differently even in the same meteorological environment, and thus a generic icing forecast may  
11 not be useful to a pilot. The AIC addresses this situation by providing a universal and objective  
12 quantitative metric for aircraft performance loss and applying it to ice accumulation for specific  
13 airfoils. In some embodiments, an icing component, module or program, such as NASA  
14 LEWICE, may be used to generate the accumulations and a computational fluid dynamics  
15 (CFD) component, module or program to analyze the resulting performance losses, and the AIC  
16 generates aircraft-specific icing forecasts.

17 **[0038]** In some embodiments, ice accumulation on aircraft surfaces may depend on many  
18 aerodynamic (e.g., body shape, body size, angle attack, exposure time, and flight speed) and  
19 meteorological variables (e.g., air temperature, liquid water content (LWC), and median volume  
20 droplet (MVD) size). In some embodiments, the AIC, utilizing one or more various  
21 thermodynamic analysis (TdA) components, modules, and/or programs (e.g., LEWICE 3.2.2  
22 software) may evaluate the thermodynamics of supercooled droplets as they impinge on a body  
23 given aerodynamic, flight, and atmospheric inputs and compute the resulting ice shape(s).

1 Using computation fluid dynamics (CFD) component(s), the AIC may analyze aerodynamic  
 2 performance changes. In some embodiments, a CFD component may solve equations of motion  
 3 for the resulting airflow. In some embodiments, the Percent Power Increase (PPI) metric may  
 4 be determined and/or computed from CFD results, providing an elegant way to quantify the  
 5 post-icing performance change. For additional detail, see McCann, D.W. and P.R. Kennedy,  
 6 2000: Percent power increase. Proc. 9<sup>th</sup> Conf. on Aviation, Range, and Aerospace Meteorology,  
 7 Amer. Meteor. Soc., Boston MA, 266-269.

8

9 **[0039]** For example, in some implementations, lift and drag are functions of the aircraft's  
 10 speed (V)

$$11 \quad Lift = C_L A \frac{\rho V^2}{2}$$

$$12 \quad Drag = C_D A \frac{\rho V^2}{2}$$

13 **[0040]** where  $\rho$  is the air density, A is the aircraft component's cross sectional area, and  
 14  $C_L$  and  $C_D$  are coefficients of lift and drag respectively. In this example, in order to maintain  
 15 speed and altitude, the new thrust (power) is

$$16 \quad Thrust_{iced} = Thrust_{clean} \frac{C_{L:clean}}{C_{L:iced}} \frac{C_{D:iced}}{C_{D:clean}}$$

17 **[0041]** where the subscripts *clean* and *iced* indicate conditions before and after ice  
 18 accumulation. Thus

$$19 \quad PPI \times .01 = \frac{Thrust_{iced}}{Thrust_{clean}} - 1 = \frac{C_{L:clean}}{C_{L:iced}} \frac{C_{D:iced}}{C_{D:clean}} - 1$$

1 **[0042]** In some implementations of the AIC, this elegant relationship may be utilized to  
2 determine performance loss with ice accumulation on any airfoil. For example, Figures 12 and  
3 13 show ice accumulation and resulting PPI values on a Beechcraft King Air airfoil and a  
4 Boeing 737 airfoil, respectively. Figure 12 shows ice (red) accumulation, e.g., 1201, on a  
5 Beechcraft King Air airfoil using the inputs, e.g., 1202, in the figure. The resulting  
6 performance change is also shown, e.g., 1203. Figure 13 shows ice (red) accumulation, e.g.,  
7 1301, on a Boeing 737 airfoil using the inputs, e.g., 1302, in the figure. The resulting  
8 performance change is also shown, e.g., 1303.

9 **[0043]** In some embodiments of the AIC, aircraft-specific icing forecasting may be a two  
10 element process. The AIC creates numerous ice accumulation simulations modifying the  
11 meteorological variables for each aerodynamic configuration. The combinations of air  
12 temperature, LWC, and MVD are may be limited by choosing representative values for each  
13 variable. For example, supercooled liquid water exists only in a finite range of air temperatures  
14 (0C to -40C). With temperatures less than about -20C ice shapes are similar because  
15 supercooled drops freeze quickly. Similarly, cloud liquid water amounts rarely exceed  $2 \text{ g m}^{-3}$ .  
16 While most icing occurs with small droplet sizes, supercooled large drops pose a significant  
17 icing threat, so the AIC may test ice shapes over a fairly large droplet size range. Properly  
18 implemented parameters provide significant ranges of variables to analyze. The AIC may  
19 select/recieve representative values to ensure sufficient granularity yet limit the time necessary  
20 to create a PPI profile or determine a PPI value given a particular input set. A TdA component  
21 may create an ice shape for the chosen meteorological and aerodynamic configuration. In some  
22 implementations, a CFD component may analyze the resulting ice shape for the airfoil's  
23 performance. Various implementations may do hundreds or thousands of iterations to converge

1 on a suitable solution. The AIC may be configured to create PPI profiles for as many aircraft as  
2 desired, or even for every available aircraft. Initially, PPI profiles may be generated for popular  
3 aircraft, both in terms of ownership and in terms of airfoil shapes and sizes used by  
4 manufacturers.

5 **[0044]** In some embodiments, aircraft-specific icing forecasts can be implemented with  
6 any forecast of air temperature, LWC, and MVD. Forecast air temperature may be determined  
7 or computed by numerical weather forecast (NWF) components. For example, a VVICE  
8 module may be utilized that post-processes any numerical model for the LWC and MVD. The  
9 VVICE module parameterizes vertical motions then uses straight-forward cloud physics  
10 relationships to create the cloud parameters (additional detail may be found in McCann, D.W.,  
11 2006: Parameterizing convective vertical motions for aircraft icing forecasts. Proc.12<sup>th</sup> Conf. on  
12 Aviation, Range, and Aerospace Meteorology, Amer. Meteor. Soc., Boston MA.).

13

14 **[0045]** In some embodiments, to produce an aircraft-specific forecast, the AIC makes a  
15 three-dimensional lookup table for every aircraft type for which a PPI profile was created. A  
16 user may specify an aircraft type, and the AIC interpolates the appropriate PPI profile table at  
17 every grid point, horizontally, vertically, and in time. If the selected aircraft type is not in the  
18 AIC database, the AIC may be configured with relatively more flexible tables based on aircraft  
19 size. Thus, the AIC can create horizontal maps at the user's requested altitude, cross sections  
20 along the user's requested flight path, and/or other useful displays.

21 **[0046]** By providing aircraft-specific icing forecasts, the AIC may remove much of the  
22 ambiguity inherent in previous one-size-fits-all icing forecasts. In particular, there may be a  
23 unique situation in which a particular aircraft may be more vulnerable to icing than a traditional

1 forecast indicates. By providing icing hazards in quantitative terms, the AIC forecasts give  
2 more detail than previously available and pilots may utilize to the Percent Power Increase  
3 metric directly since increasing power is one of the ways a pilot can combat the effects of icing.

4 **[0047]** Moreover, by being aircraft-specific, the AIC forecasts may create goodwill with  
5 users. Knowing the icing forecasts are tailored to their aircraft type, users can better utilize and  
6 rely on forecasts as meaningful to them. This also creates less doubt about how to interpret the  
7 forecasts.

8 **[0048]** Figure 14 illustrates an example PPI component installation. In one embodiment,  
9 an aircraft 1401 may have installed an AIC containing a PPI component 1402 for the  
10 determination of an instantaneous percent-power-increase value for a given input set. The PPI  
11 component may be configured, as in the current example, as an integrated hardware component  
12 containing one or more hardware logic circuits for determining a PPI value. In alternative  
13 embodiments, portions (or, in some cases, substantially all) of the PPI value determination may  
14 be performed by the AIC utilizing software commands substituted for one or more of the PPI  
15 component integrated hardware logic circuits. An example PPI component and configuration is  
16 disclosed herein and particularly with respect to Figure 4, Figure 5 and Figures 15A-F.

17 **[0049]** In one configuration, airplane 1401 may provide an electrical signal to  
18 `airfoilDesign_IN` terminal 1403 representing the aircraft or airfoil design on which the  
19 PPI value determination is to be made. For example, if the current aircraft in which the PPI  
20 component is installed is a Boeing 737, the aircraft flight control software may signal a value of  
21 “101” on `airfoilDesign_IN`, that value representing the current aircraft type. The value  
22 “101” may be expressed as three electrical voltages (“high-low-high”) across three  
23 `airfoilDesign_IN` hardware input pins. By utilizing three input pins, the

1 airfoilDesign\_IN input may be used to represent at least 7 different aircraft  
2 configurations (e.g., “000”, “001”, “010”, “100”, “110”, “101”, “111”). By way of further  
3 examples, in one embodiment “110” may represent a Beechcraft Super King 200 aircraft, “111”  
4 may represent a default medium-body airframe, etc. In alternative embodiments, additional  
5 hardware input pins or other serial communication input may be utilized to allow the PPI  
6 component to determine instantaneous PPI values for a limitless number of aircraft and/or  
7 airfoil designs.

8 **[0050]** In one embodiment, aircraft 1401 may provide the PPI component 1402 with  
9 input, using currentCWTR\_IN terminal 1404, representing the current atmospheric water  
10 droplet density. The value provided may be electrical signals representing an integer value. For  
11 example, if the aircraft water density sensor determines that the current water density about the  
12 aircraft is .002, the aircraft may signal the integer value of “2” (representing  $.002 * 1000$ ) to  
13 currentCWTR\_IN. In one embodiment, the value “2” may be represented as a 16-bit value  
14 (e.g., “0000 0000 0000 0010”) signaled as 16 high-or-low voltages across an equivalent number  
15 of hardware input pins. Additionally, airplane 1401 may similarly signal a current ambient  
16 temperature value for the temperature about the plane to PPI input  
17 currentTemperature\_IN terminal 1405.

18 **[0051]** As disclosed herein, the PPI component configuration discussed with respect to  
19 Figure 14 may be utilized to determine an instantaneous PPI value for a current airframe and  
20 ambient condition inputs. However, other PPI component configurations may be utilized in  
21 association with the other embodiments of the AIC discussed herein. For example, if the PPI  
22 component is configured to provide a PPI value for a point in space an aircraft will encounter  
23 after 10-minutes of further flight time (e.g., a future point/time), then the values provided to

1 currentCWTR\_IN and currentTemperature\_IN may be estimated values for that  
2 time/location. In further embodiments, the discrete PPI value determinations by the PPI  
3 component may be utilized to perform an optimized flight-path determination. For example, the  
4 PPI component may be repeatedly utilized to determine PPI values for all points in a 3-D space.  
5 In an alternate embodiment, the PPI component may have multiple input/output terminals  
6 and/or accept an array of inputs and provide an array of outputs on one or more input/output  
7 terminals. As such, the PPI component embodiment described herein may be utilized with the  
8 other components of the AIC to perform any or all of the embodiments of the AIC described  
9 herein.

10 **[0052]** Additionally, it should be noted that the signal inputs/outputs disclosed herein are  
11 representative of example PPI component inputs/outputs. For example, a PPI input for aircraft  
12 type may be represented as a single aircraft designator, an airfoil designator, an aircraft airfoil  
13 configuration (e.g., a representation of airfoil geometry such as, for example, a height and angle  
14 of curvature), a default designator (e.g., “medium aircraft”), and/or the like. Further, the  
15 percent-power-increase output value determination may be made by the PPI component on the  
16 basis of inputs other than those illustrated herein without departing from the disclosure. For  
17 example, the PPI component may utilize the instantaneous or expected aircraft altitude in lieu of  
18 temperature, may utilize a cloud density forecast in lieu of water droplet density, and/or the like.

19 **[0053]** Figure 15A shows an example PPI hardware component. In one embodiment, an  
20 aircraft flight planning system and/or the like may provide electrical inputs to the PPI  
21 component. Thereafter, the one or more electrical inputs may be processed by the logic circuits  
22 (for example, integrated ASIC's, FPGA's, and/or the like) to produce a percent-power-increase  
23 value representing the PPI for the given aircraft and input parameters. In one embodiment, the

1 flight planning system may provide an atmospheric water droplet density value  
2 currentCWTR\_IN 1501a, an airfoil or aircraft design or state value airfoilDesign\_IN  
3 1501b, a temperature value currentTemperature\_IN 1501c, and/or the like and receive as  
4 output electrical signals representing a determined PPI value, e.g., ppi\_OUT 1501g.

5 **[0054]** In one embodiment, the atmospheric water droplet density is provided to a  
6 ppi\_ivertical PPI sub-component 1501d, which is described herein with respect to Figure  
7 15C and the temperature value is provided to a ppi\_ihorizontal PPI sub-component  
8 1501e, which is described herein with respect to Figure 15B. In one embodiment, the output  
9 from both the ppi\_ivertical and ppi\_ihorizontal PPI sub-components as well as  
10 one or more of the original input signals are provided to a ppi\_apl PPI sub-component 1501f,  
11 which is described herein with respect to Figure 15D. In one embodiment, the ppi\_apl PPI  
12 sub-component may provide a calculated PPI value to the PPI component, which may be output  
13 on ppi\_OUT terminal 1501g.

14 **[0055]** In one embodiment, a PPI hardware component, represented substantially in the  
15 form of VHDL hardware description statements suitable for configuring an FPGA to operate as  
16 an integrated hardware logic circuit performing the features described herein, is:

```
17 library IEEE;  
18 use IEEE.STD_LOGIC_1164.ALL;  
19 use IEEE.NUMERIC_STD.ALL;  
20  
21 entity PPI_Component is  
22     Port ( airfoilDesign_IN : in STD_LOGIC_VECTOR(2 downto 0);  
23           currentCWTR_IN : in STD_LOGIC_VECTOR(15 downto 0);  
24           currentTemperature_IN : in STD_LOGIC_VECTOR(15 downto 0);  
25           ppi_OUT : out STD_LOGIC_VECTOR(15 downto 0)
```

```
1         );
2     end PPI_Component;
3
4     architecture PPI of PPI_Component is
5
6         --sub-component to determine vertical (icol) offset
7         --assumes cwtr values are multiplied by 1,000 (so .001 is input as "1")
8         component ppi_ivertical is
9             port(cwtr : in signed;
10                invert : inout integer;
11                c : inout signed;
12                oc : inout signed
13            );
14         end component;
15         signal invert : integer;
16         signal c, oc : signed(15 downto 0);
17
18         --sub-component to determine horizontal (irow) offset
19         --assumes temp is inverse of value input
20         --(so -32deg is input as "32")
21         component ppi_ihorizontal is
22             port(temperature : in signed;
23                ihoriz : inout integer;
24                r : inout signed;
25                orv : inout signed
26            );
27         end component;
28         signal ihoriz : integer;
29         signal r, orv : signed(15 downto 0);
30
31         --sub-component to determine customized airframe PPI
32         component ppi_apl is
33             port( temperature : in signed;
34                airfoilDesign : in signed;
35                ihoriz : integer;
```

```

1         iverit : integer;
2         c : in signed;
3         oc : in signed;
4         r : in signed;
5         orv : in signed;
6         aplv : inout signed
7     );
8 end component;
9 signal aplv : signed(15 downto 0);
10
11
12 begin
13
14     --sub-components
15     CPNT_ppi_iverit : ppi_iverit port
16         map (signed(currentCWTR_IN), iverit, c, oc);
17     CPNT_ppi_ihoriz : ppi_ihoriz port
18         map (signed(currentTemperature_IN), ihoriz, r, orv);
19     CPNT_ppi_apl : ppi_apl port
20         map (signed(currentTemperature_IN),
21             signed(airfoilDesign_IN), ihoriz, iverit, c, oc, r, orv, aplv);
22
23     --output PPI
24     process(airfoilDesign_IN)
25     begin
26         ppi_OUT <= std_logic_vector(aplv);
27     end process;
28
29 end PPI;
30

```

31 **[0056]** Figure 15B represents a ppi\_ihoriz PPI sub-component. The sub-  
32 component takes input temperature 1502b and outputs a horizontal offset value for PPI  
33 determination, e.g., 1502a and one or more coefficient values for use by the ppi\_apl PPI sub-

1 component, e.g., 1502c, 1502d. Within the `ppi_ihorizontal` sub-component, the input  
2 value signal crosses a plurality of logic gates as represented herein and described below. In one  
3 embodiment, a `ppi_ihorizontal` PPI sub-component, represented substantially in the form  
4 of VHDL hardware description statements suitable for configuring an FPGA to operate as an  
5 integrated hardware logic circuit performing the features described herein, is:

```
6 library IEEE;
7 use IEEE.STD_LOGIC_1164.ALL;
8 use IEEE.NUMERIC_STD.ALL;
9
10 entity ppi_ihorizontal is
11     Port ( temperature : in signed;
12           ihoriz       : inout integer;
13           r             : inout signed;
14           orv          : inout signed
15           );
16 end ppi_ihorizontal;
17
18 architecture Behavioral of ppi_ihorizontal is
19
20 begin
21     process(temperature)
22     begin
23         if (temperature > to_signed(2,16)) then
24             ihoriz <= 1;
25             r <= resize(temperature / to_signed(2,16),16);
26         else
27             if (temperature > to_signed(4,16)) then
28                 ihoriz <= 1;
29                 r <= resize((temperature -
30                             to_signed(2,16)) / to_signed(2,16),16);
31                 orv <= to_signed(1,16) - r;
32             else
```

```

1         ihoriz <= to_integer((signed(temperature) / to_signed(4,16)));
2         r <= to_signed(0,16);
3         orv <= to_signed(1,16);
4     end if;
5     end if;
6     end process;
7 end Behavioral;
8

```

9 **[0057]** Figure 15C represents a `ppi_ivertical` PPI sub-component. The sub-  
10 component takes input atmospheric water droplet density 1503a and outputs a vertical offset  
11 value for PPI determination, e.g., 1503d and one or more coefficient values for use by the  
12 `ppi_apl` PPI sub-component, e.g., 1503b, 1503c. Within the `ppi_ivertical` sub-  
13 component, the input value signal crosses a plurality of logic gates as represented herein and  
14 described below. In one embodiment, a `ppi_ivertical` PPI sub-component, represented  
15 substantially in the form of VHDL hardware description statements suitable for configuring an  
16 FPGA to operate as an integrated hardware logic circuit performing the features described  
17 herein, is:

```

18 library IEEE;
19 use IEEE.STD_LOGIC_1164.ALL;
20 use IEEE.NUMERIC_STD.ALL;
21
22 entity ppi_ivertical is
23     Port ( cwtr : in signed;
24           invert : inout integer;
25           c : inout signed;
26           oc : inout signed
27           );
28 end ppi_ivertical;
29
30 architecture Behavioral of ppi_ivertical is

```

```
1
2  signal rcol : signed(15 downto 0);
3
4  begin
5      process(cwtr)
6          begin
7              if (cwtr <= to_signed(1,16)) then
8                  rcol <= resize(cwtr * to_signed(10,16),16);
9                  ivert <= to_integer(rcol);
10                 c <= rcol - ivert;
11                 oc <= to_signed(1,16) - c;
12             else
13                 if (cwtr <= to_signed(2,16)) then
14                     rcol <= resize(to_signed(10,16) +
15                         ((cwtr - to_signed(1,16)) * to_signed(4,16)),16);
16                     ivert <= to_integer(rcol);
17                 else
18                     ivert <= 14;
19                 end if;
20             end if;
21         end process;
22     end Behavioral;
23
```

24 **[0058]** Figure 15D represents a `ppi_apl` PPI sub-component. The sub-component  
25 takes inputs `airfoil design`, `temperature`, and the output from `ppi_ihorizontal` and  
26 `ppi_ivertical`, e.g., 1504a, and provides output representing an instantaneous PPI value,  
27 e.g., 1504c. Within the `ppi_apl` sub-component, the input value signal crosses a plurality of  
28 logic gates as represented herein and described below and which may route the inputs to one or  
29 more of a plurality of airframe specific customization modules, e.g., `airFrame_boeing747`  
30 `1504b`, `airFrame_defaultMed 1504c`, `airframe_bCKingAir 1504d`. An example  
31 airframe specific customization module is described herein with respect to Figures 15E-F.

1 Although three airframe customization modules have been illustrated herein, other  
2 embodiments may contain only one airframe customization module (e.g., in the case of a “hard”  
3 installation that will only be used with respect to one airframe). Furthermore, in other  
4 embodiments the airframe customization modules may be provided as a “snap in” module that  
5 may be connected to the PPI component after manufacture. In still other embodiments, the  
6 airframe customization module’s capabilities may be performed by a local data/logic store (such  
7 as, for example, that disclosed with respect to Figure 16) , a remote data/logic store (for  
8 example, by transmitting an in-flight wireless signal to a remote airframe customization module  
9 configured to respond to remote queries), or via a specially configured general purpose  
10 computing platform (such as, for example, that disclosed herein and particularly with respect to  
11 Figure 4 and Figure 5, which describe alternate PPI component configurations). In one  
12 embodiment, a ppi\_apl PPI sub-component, represented substantially in the form of VHDL  
13 hardware description statements suitable for configuring an FPGA to operate as an integrated  
14 hardware logic circuit performing the features described herein, is:

```
15 library IEEE;  
16 use IEEE.STD_LOGIC_1164.ALL;  
17 use IEEE.NUMERIC_STD.ALL;  
18  
19 entity ppi_apl is  
20     Port ( temperature : in signed;  
21           airfoilDesign : in signed;  
22           ihoriz : in integer;  
23           invert : in integer;  
24           c : in signed;  
25           oc : in signed;  
26           r : in signed;  
27           orv : in signed;
```

```
1         aplv : inout signed
2         );
3     end ppi_apl;
4
5     architecture Behavioral of ppi_apl is
6
7     component airFrame_bCKingAir is
8         port(   temperature : in signed;
9               ihoriz      : in integer;
10              ivert       : in integer;
11              airFrame_val : inout signed
12            );
13     end component;
14     signal airFrame_bCKingAir_val : signed(15 downto 0);
15
16     component airFrame_boeing747 is
17         port(   temperature : in signed;
18               ihoriz      : in integer;
19               ivert       : in integer;
20               airFrame_val : inout signed
21            );
22     end component;
23     signal airFrame_boeing747_val : signed(15 downto 0);
24
25     component airFrame_defaultMed is
26         port(   temperature : in signed;
27               ihoriz      : in integer;
28               ivert       : in integer;
29               airFrame_val : inout signed
30            );
31     end component;
32     signal airFrame_defaultMed_val : signed(15 downto 0);
33
34     begin
35         --airframe customization modules
```

```

1   CPNT_airFrame_bCKingAir : airFrame_bCKingAir port
2       map (temperature,ihoriz,ivert,airFrame_bCKingAir_val);
3   CPNT_airFrame_boeing747 : airFrame_boeing747 port
4       map (temperature,ihoriz,ivert,airFrame_boeing747_val);
5   CPNT_airFrame_defaultMed : airFrame_defaultMed port
6       map (temperature,ihoriz,ivert,airFrame_defaultMed_val);
7
8   process(ihoriz, ivert, c, oc, r, orv)
9   begin
10      if (airfoilDesign = 1) then
11          aplv <= resize(airFrame_bCKingAir_val * r,16);
12      else
13          if (airfoilDesign = 2) then
14              aplv <= resize(airFrame_boeing747_val * orv,16);
15          else
16              aplv <= resize(airFrame_defaultMed_val,16);
17          end if;
18      end if;
19  end process;
20  end Behavioral;
21

```

**[0059]** Figure 15E represents a PPI sub-component aircraft customization module. The aircraft customization module takes as input horizontal/vertical offset values, e.g., 1505a, 1505b, and temperature 1505c and outputs an airframe customization value 1505e for use in determining airframe specific PPI. Within the sub-component, the input value signal crosses a plurality of logic gates as represented herein and described below. Furthermore, the aircraft customization module may contain non-volatile memory such as ROMs 1505d for storing airframe specific customization parameters. The aircraft customization module represented herein is for a Beechcraft Super King 200 aircraft. However, similarly configured customization modules may be used for other aircraft or airframes. In one embodiment, a PPI

1 sub-component aircraft customization module, represented substantially in the form of VHDL  
2 hardware description statements suitable for configuring an FPGA to operate as an integrated  
3 hardware logic circuit performing the features described herein, is:

```
4 library IEEE;
5 use IEEE.STD_LOGIC_1164.ALL;
6 use IEEE.NUMERIC_STD.ALL;
7
8 entity airFrame_bCKingAir is
9     Port ( temperature : in signed;
10           ihoriz : in integer;
11           invert : in integer;
12           airFrame_val : inout signed
13           );
14 end airFrame_bCKingAir;
15
16 architecture Behavioral of airFrame_bCKingAir is
17
18     --airfoil customization params
19     type airfoilDesignParams is array (1 to 10, 1 to 7) of integer;
20     shared variable airfoil_p1: airfoilDesignParams :=(
21         (0,0,0,0,0,0,0),
22         (62,110,160,164,172,176,184),
23         (31,62,157,228,369,440,448),
24         (21,42,83,117,289,376,548),
25         (16,31,62,78,156,250,438),
26         (12,25,50,62,88,100,297),
27         (10,21,42,52,73,83,141),
28         (8,18,36,45,62,71,89),
29         (8,16,31,39,55,62,78),
30         (7,14,28,35,49,56,69)
31     );
32     shared variable airfoil_p2: airfoilDesignParams :=(
33         (0,0,0,0,0,0,0),
```

```
1      (188,196,200,208,212,220,224),
2      (452,460,464,472,476,484,488),
3      (634,724,728,736,740,748,752),
4      (531,719,812,1000,1004,1012,1016),
5      (395,592,690,887,985,1182,1280),
6      (242,445,546,749,851,1053,1154),
7      (98,286,390,597,701,908,1011),
8      (86,121,226,437,542,752,850),
9      (76,90,97,270,377,590,696)
10 );
11
12 signal INT_ihoriz, INT_ivert : integer :=0;
13
14 begin
15     process(ihoriz, ivert)
16     begin
17
18         --determine horiz and vert offset values
19         if (temperature > to_signed(2,16)) then
20             INT_ihoriz <= ihoriz;
21             INT_ivert <= ivert + 1;
22         else
23             INT_ihoriz <= ihoriz + 1;
24             INT_ivert <= ivert;
25         end if;
26
27         --return correct offset value
28         if (INT_ivert <= 7) then
29             airFrame_val <= to_signed(airfoil_p1(INT_ihoriz,INT_ivert),16);
30         else
31             airFrame_val <= to_signed(airfoil_p2(INT_ihoriz,INT_ivert-7),16);
32         end if;
33
34     end process;
35 end Behavioral;
```

1  
2 **[0060]** Figure 15F is an alternate representation of the Beechcraft Super King 200  
3 airframe customization module described with respect to Figure 15E. However, in this  
4 representation each of the internal input wires carrying component signals representing the input  
5 values have been broken out to further the reader's understanding. For example, the input for  
6 temperature has been represented herein as 16 wires each capable of providing a single "1" or  
7 "0" (e.g., high/low voltage) input. The aircraft customization module takes as input  
8 horizontal/vertical offset values, e.g., 1506a, 1506b, and temperature 1506c, utilizes the  
9 described logic gates and ROMs 1506d, and outputs an airframe customization value 1506e for  
10 use in determining airframe specific PPI, as further described herein and particularly above with  
11 respect to Figure 15E.

12 **[0061]** Throughout this disclosure, 'atmospheric data' may refer to any environmental  
13 data related to the atmosphere, e.g., at some point of interest. By way of non-limiting example,  
14 the atmospheric data received and/or processed by the DATCM may include one or more of the  
15 following: temperature, moisture/water content, humidity, pressure, wind speed, wind direction,  
16 local EDR, wind shear, liquid water content, ozone concentration, pollution, and/or the like.  
17 Atmospheric data may comprise partial or full contents of forecast models (e.g., numerical  
18 weather forecast model data), meteograms, atmospheric soundings, surface observations, radar  
19 pictures, meteorological charts (e.g., surface pressure charts), weather maps, numerical weather  
20 prediction maps, and/or the like. Atmospheric data may, in some embodiments, be obtained  
21 directly or indirectly from sensors (e.g., infrared radiometers, microwave radiometers,  
22 hygrometers, pitot-static systems, gyroscopes, thermometers, barometers, optical sensors, radar,  
23 lidar, sodar, ceilometers, spectrometers, weather balloons, water vapor sensors, and/or the like),  
24 as well as from pilot reports. Depending on the embodiment, instruments (e.g., sensors) for

1 measuring the atmospheric data used by the DATCM may be positioned in/on the aircraft itself,  
2 may be located on earth (e.g., as part of a grounded weather station), and/or may be part of an  
3 extraneous system, such as a weather balloon, satellite, avionics on another aircraft/spacecraft,  
4 etc.

5 **[0062]** Various embodiments of the AIC are contemplated by this disclosure, with the  
6 below exemplary, non-limiting embodiments A1-A86 provided to illustrate aspects of some  
7 implementations of embodiments of the AIC.

8 **[0063]** A1. A dynamic AIC platform processor-implemented flight planning method,  
9 comprising: receiving parameter data for an initial anticipated flight plan; determining airfoil  
10 type for an aircraft associated with the initial anticipated flight plan; obtaining atmospheric data  
11 based on the flight plan parameter data; determining a plurality of four-dimensional grid points  
12 based on the flight plan parameter data; determining corresponding icing data for each point of  
13 the plurality of four-dimensional grid point based on the airfoil type; determining via a  
14 processor a percent power increase for the initial anticipated flight plan; determining an at least  
15 one alternative flight plan based on the flight plan parameter data and the determined percent  
16 power increase for the initial anticipated flight plan; and providing the determined at least one  
17 alternative flight plan.

18 **[0064]** A2. The method of embodiment A1, wherein the parameter data includes aircraft  
19 data.

20 **[0065]** A3. The method of embodiment A1 or A2, wherein the parameter data includes  
21 the airfoil type.

1 [0066] A4. The method of any of the preceding embodiments, wherein the initial  
2 anticipated flight plan comprises a shortest route flight plan.

3 [0067] A5. The method of any of the preceding embodiments, wherein the at least one  
4 alternative flight plan comprises an optimized route flight plan.

5 [0068] A6. The method of embodiment A5, wherein the optimized route flight plan is  
6 optimized for safety.

7 [0069] A7. The method of embodiment A6, wherein the optimized route flight plan is  
8 optimized for safety and fuel consumption.

9 [0070] A8. The method of any of the preceding embodiments, wherein the flight plan  
10 parameter data includes take-off time.

11 [0071] A9. The method of any of the preceding embodiments, wherein the flight plan  
12 parameter data includes take-off location.

13 [0072] A10. The method of any of the preceding embodiments, wherein the flight plan  
14 parameter data includes destination location.

15 [0073] A11. A dynamic AIC platform flight planning system, comprising: means to  
16 receive parameter data for an initial anticipated flight plan; means to determine airfoil type for  
17 an aircraft associated with the initial anticipated flight plan; means to obtain atmospheric data  
18 based on the flight plan parameter data; means to determine a plurality of four-dimensional grid  
19 points based on the flight plan parameter data; means to determine corresponding icing data for  
20 each point of the plurality of four-dimensional grid point based on the airfoil type; means to  
21 determine a percent power increase for the initial anticipated flight plan; means to determine an  
22 at least one alternative flight plan based on the flight plan parameter data and the determined

1 percent power increase for the initial anticipated flight plan; and means to provide the  
2 determined at least one alternative flight plan.

3 **[0074]** A12. The system of embodiment A11, wherein the parameter data includes  
4 aircraft data.

5 **[0075]** A13. The system of embodiment A11 or A12, wherein the parameter data  
6 includes the airfoil type.

7 **[0076]** A14. The system of any of embodiment(s) A11, A12, or A13, wherein the initial  
8 anticipated flight plan comprises a shortest route flight plan.

9 **[0077]** A15. The system of any of embodiment(s) A11, A12, A13, or A14, wherein the at  
10 least one alternative flight plan comprises an optimized route flight plan.

11 **[0078]** A16. The system of embodiment A15, wherein the optimized route flight plan is  
12 optimized for safety.

13 **[0079]** A17. The system of embodiment A15 or A16, wherein the optimized route flight  
14 plan is optimized fuel consumption.

15 **[0080]** A18. The system of any of embodiment(s) A11, A12, A13, A14, A15, A16, or  
16 A17, wherein the flight plan parameter data includes take-off time.

17 **[0081]** A19. The system of any of embodiment(s) A11, A12, A13, A14, A15, A16, A17,  
18 or A18, wherein the flight plan parameter data includes take-off location.

19 **[0082]** A20. The system of any of embodiment(s) A11, A12, A13, A14, A15, A16, A17,  
20 A18, or A19, wherein the flight plan parameter data includes destination location.

1 **[0083]** A21. A processor-readable non-transitory medium storing processor-issuable  
2 dynamic AIC flight plan generating instructions to: receive parameter data for an initial  
3 anticipated flight plan; determine airfoil type for an aircraft associated with the initial  
4 anticipated flight plan; obtain atmospheric data based on the flight plan parameter data;  
5 determine a plurality of four-dimensional grid points based on the flight plan parameter data;  
6 determine corresponding icing data for each point of the plurality of four-dimensional grid point  
7 based on the airfoil type; determine a percent power increase for the initial anticipated flight  
8 plan; determine an at least one alternative flight plan based on the flight plan parameter data and  
9 the determined percent power increase for the initial anticipated flight plan; and provide the  
10 determined at least one alternative flight plan.

11 **[0084]** A22. The medium of embodiment A21, wherein the parameter data includes  
12 aircraft data.

13 **[0085]** A23. The medium of embodiment A21 or A22, wherein the parameter data  
14 includes the airfoil type.

15 **[0086]** A24. The medium of any of embodiment(s) A21, A22, or A23, wherein the initial  
16 anticipated flight plan comprises a shortest route flight plan.

17 **[0087]** A25. The medium of any of embodiment(s) A21, A22, A23, or A24, wherein the  
18 at least one alternative flight plan comprises an optimized route flight plan.

19 **[0088]** A26. The medium of embodiment A25, wherein the optimized route flight plan is  
20 optimized for safety.

21 **[0089]** A27. The medium of embodiment A25 or A26, wherein the optimized route flight  
22 plan is optimized for fuel consumption.

1 **[0090]** A28. The medium of any of embodiment(s) A21, A22, A23, A24, A25, A26, or  
2 A27, wherein the flight plan parameter data includes take-off time.

3 **[0091]** A29. The medium of any of embodiment(s) A21, A22, A23, A24, A25, A26,  
4 A27, or A28, wherein the flight plan parameter data includes take-off location.

5 **[0092]** A30. The medium of any of embodiment(s) A21, A22, A23, A24, A25, A26,  
6 A27, A28, or A29, wherein the flight plan parameter data includes destination location.

7 **[0093]** A31. A dynamic airfoil icing controller/platform flight planning apparatus,  
8 comprising: a processor; and a memory disposed in communication with the processor and  
9 storing processor-issuable instructions to: receive parameter data for an initial anticipated flight  
10 plan; determine airfoil type for an aircraft associated with the initial anticipated flight plan;  
11 obtain atmospheric data based on the flight plan parameter data; determine a plurality of four-  
12 dimensional grid points based on the flight plan parameter data; determine corresponding icing  
13 data for each point of the plurality of four-dimensional grid point based on the airfoil type;  
14 determine a percent power increase for the initial anticipated flight plan; determine an at least  
15 one alternative flight plan based on the flight plan parameter data and the determined percent  
16 power increase for the initial anticipated flight plan; and provide the determined at least one  
17 alternative flight plan.

18 **[0094]** A32. The apparatus of embodiment A31, wherein the parameter data includes  
19 aircraft data.

20 **[0095]** A33. The apparatus of embodiment A31 or A32, wherein the parameter data  
21 includes the airfoil type.

1 [0096] A34. The apparatus of any of embodiment(s) A31, A32, or A33, wherein the  
2 initial anticipated flight plan comprises a shortest route flight plan.

3 [0097] A35. The apparatus of any of embodiment(s) A31, A32, A33, or A34, wherein the  
4 at least one alternative flight plan comprises an optimized route flight plan.

5 [0098] A36. The apparatus of embodiment A35, wherein the optimized route flight plan  
6 is optimized for safety.

7 [0099] A37. The apparatus of embodiment A35 or A36, wherein the optimized route  
8 flight plan is optimized fuel consumption.

9 [00100] A38. The apparatus of any of embodiment(s) A31, A32, A33, A34, A35, A36, or  
10 A37, wherein the flight plan parameter data includes take-off time.

11 [00101] A39. The apparatus of any of embodiment(s) A31, A32, A33, A34, A35, A36,  
12 A37, or A38, wherein the flight plan parameter data includes take-off location.

13 [00102] A40. A dynamic AIC flight planning method, comprising: receiving a PPI flight  
14 parameter input associated with an aircraft; determining an airfoil type for the aircraft associated  
15 with the PPI flight parameter input; determining atmospheric data based on the PPI flight  
16 parameter input; providing the determined airfoil type and atmospheric data to a PPI component  
17 for the determination of a PPI icing avoidance value; receiving, from the PPI component, an  
18 indication of the determined PPI icing avoidance value; and providing the determined PPI icing  
19 avoidance value in response to the PPI flight parameter input.

20 [00103] A41. The method of embodiment A40, wherein the PPI flight parameter input is  
21 configured to represent the present airfoil configuration and atmospheric conditions being  
22 experienced by the aircraft.

1 **[00104]** A42. The method of embodiment A40, wherein the PPI flight parameter input is  
2 configured to represent the expected airfoil configuration and atmospheric conditions that will  
3 be experienced by the aircraft at a future point in time.

4 **[00105]** A43. The method of embodiment A40, wherein the determined atmospheric data  
5 includes a temperature.

6 **[00106]** A44. The method of embodiment A40, wherein the determined atmospheric data  
7 includes a value associated with the water content of the atmosphere about the aircraft at a point  
8 in time.

9 **[00107]** A45. The method of any of the embodiment(s) A41, A42, A43 or A44 wherein  
10 the PPI component is a hardware PPI component.

11 **[00108]** A46. The method of embodiment A45, wherein the hardware PPI component is  
12 an ASIC.

13 **[00109]** A47. The method of embodiment A45, wherein the hardware PPI component is an  
14 FPGA.

15 **[00110]** A48. The method of any of the embodiment(s) A41, A42, A43 or A44 wherein  
16 the PPI component is a PPI component containing processor executable instructions.

17 **[00111]** A49. The method of any of the embodiment(s) A41, A42, A43 or A44 wherein  
18 the PPI component is a PPI component composed of two-or-more sub-components.

19 **[00112]** A50. The method of embodiment A49, wherein the PPI component is comprised  
20 of a first sub-component in hardware for determining a first value associated with the PPI icing  
21 avoidance value and a second sub-component containing processor executable instructions for  
22 determining a second value associated with the PPI icing avoidance value.

1 **[00113]** A51. The method of embodiment A50, wherein the first and second value  
2 associated with the PPI icing avoidance value are used to determine the PPI icing avoidance  
3 value.

4 **[00114]** AA51. A dynamic AIC flight planning apparatus, comprising a processor, and a  
5 memory disposed in communication with the processor and storing processor-issuable  
6 instructions to perform the method of any of embodiments A40-A51.

7 **[00115]** A52. A dynamic AIC flight planning system, comprising: means to receive a PPI  
8 flight parameter input associated with an aircraft; means to determine an airfoil type for the  
9 aircraft associated with the PPI flight parameter input; means to determine atmospheric data  
10 based on the PPI flight parameter input; means to provide the determined airfoil type and  
11 atmospheric data to a PPI component for the determination of a PPI icing avoidance value;  
12 means to receive, from the PPI component, an indication of the determined PPI icing avoidance  
13 value; and means to provide the determined PPI icing avoidance value in response to the PPI  
14 flight parameter input.

15 **[00116]** A53. The system of embodiment A52, wherein the PPI flight parameter input is  
16 configured to represent the present airfoil configuration and atmospheric conditions being  
17 experienced by the aircraft.

18 **[00117]** A54. The system of embodiment A52, wherein the PPI flight parameter input is  
19 configured to represent the expected airfoil configuration and atmospheric conditions that will  
20 be experienced by the aircraft at a future point in time.

21 **[00118]** A55. The system of embodiment A52, wherein the determined atmospheric data  
22 includes a temperature.

1 [00119] A56. The system of embodiment A52, wherein the determined atmospheric data  
2 includes a value associated with the water content of the atmosphere about the aircraft at a point  
3 in time.

4 [00120] A57. The system of any of the embodiment(s) A53, A54, A55 or A56 wherein the  
5 PPI component is a hardware PPI component.

6 [00121] A58. The system of embodiment A57, wherein the hardware PPI component is  
7 an ASIC.

8 [00122] A59. The system of embodiment A57, wherein the hardware PPI component is an  
9 FPGA.

10 [00123] A60. The system of any of the embodiment(s) A53, A54, A55 or A56 wherein the  
11 PPI component is a PPI component containing processor executable instructions.

12 [00124] A61. The system of any of the embodiment(s) A53, A54, A55 or A56 wherein the  
13 PPI component is a PPI component composed of two-or-more sub-components.

14 [00125] A62. The system of embodiment A61, wherein the PPI component is comprised  
15 of a first sub-component in hardware for determining a first value associated with the PPI icing  
16 avoidance value and a second sub-component containing processor executable instructions for  
17 determining a second value associated with the PPI icing avoidance value.

18 [00126] A63. The system of embodiment A62, wherein the first and second value  
19 associated with the PPI icing avoidance value are used to determine the PPI icing avoidance  
20 value.

21 [00127] A64. A dynamic AIC flight planning system, comprising: means to receive  
22 parameter data for an initial anticipated flight plan; means to determine airfoil type for an

1 aircraft associated with the initial anticipated flight plan; means to obtain atmospheric data  
2 based on the flight plan parameter data; means to determine a plurality of grid points based on  
3 the flight plan parameter data; means to determine corresponding icing data for each grid point  
4 of the plurality of grid points based on the airfoil type and atmospheric data; and means to  
5 determine a percent power increase for the initial anticipated flight plan.

6 **[00128]** A65. The system of embodiment A64, further comprising means to output the  
7 determined percent power increase.

8 **[00129]** A66. The system of embodiment A64 or A65, further comprising means to  
9 determine an at least one alternative flight plan.

10 **[00130]** A67. The system of embodiment A66, further comprising means to determine a  
11 percent power increase for the at least one alternative flight plan.

12 **[00131]** A68. The system of embodiment A67, further comprising means to output the  
13 determined percent power increase for the at least one alternative flight plan.

14 **[00132]** A69. The system of embodiment A67, further comprising means to compare the  
15 initial anticipated flight plan and the at least one alternative flight plan.

16 **[00133]** A70. The system of embodiment A69, wherein the comparison is based on  
17 determined percent power increase.

18 **[00134]** A71. The system of embodiment A69 or A70, wherein the comparison is based on  
19 distance.

20 **[00135]** A72. The system of any of embodiments A69-A71, wherein the comparison is  
21 based on flight time.

1 [00136] A73. The system of any of embodiments A69-A72, wherein the comparison is  
2 based on fuel consumption.

3 [00137] A74. The system of any of embodiments A69-A73, wherein the comparison is  
4 based on risk.

5 [00138] A75. The system of any of embodiments A66-A73, further comprising means to  
6 determine at least one alternative flight plan based on the flight plan parameter data and the  
7 determined percent power increase for the initial anticipated flight plan.

8 [00139] A76. The system of any of embodiments A66-A75, further comprising means to  
9 provide the determined at least one alternative flight plan.

10 [00140] A77. The system of any of embodiments A64-A76, wherein the grid points are  
11 four-dimensional grid points.

12 [00141] A78. The system of any of embodiments A64-A77, wherein the parameter data  
13 includes aircraft data.

14 [00142] A79. The system of any of embodiments A64-A78, wherein the parameter data  
15 includes the airfoil type.

16 [00143] A80. The system of any of embodiments A64-A79, wherein the initial anticipated  
17 flight plan comprises a shortest route flight plan.

18 [00144] A81. The system of any of embodiments A66-A80, wherein the at least one  
19 alternative flight plan comprises an optimized route flight plan.

20 [00145] A82. The system of embodiment A81, wherein the optimized route flight plan is  
21 optimized for safety.

1 **[00146]** A83. The system of embodiment A81 or A82, wherein the optimized route flight  
2 plan is optimized fuel consumption.

3 **[00147]** A84. The system of any of embodiments A64-A83, wherein the flight plan  
4 parameter data includes take-off time.

5 **[00148]** A85. The system of any of embodiments A64-A84, wherein the flight plan  
6 parameter data includes take-off location.

7 **[00149]** A86. The system of any of embodiments A64-A85, wherein the flight plan  
8 parameter data includes destination location.

9

## AIC Controller

10 **[00150]** FIGURE 16 shows a block diagram illustrating embodiments of an AIC controller  
11 1601. In this embodiment, the AIC controller 1601 may serve to aggregate, process, store,  
12 search, serve, identify, instruct, generate, match, and/or facilitate interactions with a computer  
13 through various technologies, and/or other related data.

14 **[00151]** Typically, users, e.g., 1633a, which may be people and/or other systems, may  
15 engage information technology systems (e.g., computers) to facilitate information processing.  
16 In turn, computers employ processors to process information; such processors 1603 may be  
17 referred to as central processing units (CPU). One form of processor is referred to as a  
18 microprocessor. CPUs use communicative circuits to pass binary encoded signals acting as  
19 instructions to enable various operations. These instructions may be operational and/or data  
20 instructions containing and/or referencing other instructions and data in various processor  
21 accessible and operable areas of memory 1629 (e.g., registers, cache memory, random access  
22 memory, etc.). Such communicative instructions may be stored and/or transmitted in batches

1 (e.g., batches of instructions) as programs and/or data components to facilitate desired  
2 operations. These stored instruction codes, e.g., programs, may engage the CPU circuit  
3 components and other motherboard and/or system components to perform desired operations.  
4 One type of program is a computer operating system, which, may be executed by CPU on a  
5 computer; the operating system enables and facilitates users to access and operate computer  
6 information technology and resources. Some resources that may be employed in information  
7 technology systems include: input and output mechanisms through which data may pass into  
8 and out of a computer; memory storage into which data may be saved; and processors by which  
9 information may be processed. These information technology systems may be used to collect  
10 data for later retrieval, analysis, and manipulation, which may be facilitated through a database  
11 program. These information technology systems provide interfaces that allow users to access  
12 and operate various system components.

13 **[00152]** In one embodiment, the AIC controller 1601 may be connected to and/or  
14 communicate with entities such as, but not limited to: one or more users from user input devices  
15 1611; peripheral devices 1612; an optional cryptographic processor device 1628; and/or a  
16 communications network 1613. For example, the AIC controller 1601 may be connected to  
17 and/or communicate with users, e.g., 1633a, operating client device(s), e.g., 1633b, including,  
18 but not limited to, personal computer(s), server(s) and/or various mobile device(s) including,  
19 but not limited to, cellular telephone(s), smartphone(s) (e.g., iPhone®, Blackberry®, Android  
20 OS-based phones etc.), tablet computer(s) (e.g., Apple iPad™, HP Slate™, Motorola Xoom™,  
21 etc.), eBook reader(s) (e.g., Amazon Kindle™, Barnes and Noble's Nook™ eReader, etc.),  
22 laptop computer(s), notebook(s), netbook(s), gaming console(s) (e.g., XBOX Live™,  
23 Nintendo® DS, Sony PlayStation® Portable, etc.), portable scanner(s), and/or the like.

1 **[00153]** Networks are commonly thought to comprise the interconnection and  
2 interoperation of clients, servers, and intermediary nodes in a graph topology. It should be noted  
3 that the term “server” as used throughout this application refers generally to a computer, other  
4 device, program, or combination thereof that processes and responds to the requests of remote  
5 users across a communications network. Servers serve their information to requesting “clients.”  
6 The term “client” as used herein refers generally to a computer, program, other device, user  
7 and/or combination thereof that is capable of processing and making requests and obtaining and  
8 processing any responses from servers across a communications network. A computer, other  
9 device, program, or combination thereof that facilitates, processes information and requests,  
10 and/or furthers the passage of information from a source user to a destination user is commonly  
11 referred to as a “node.” Networks are generally thought to facilitate the transfer of information  
12 from source points to destinations. A node specifically tasked with furthering the passage of  
13 information from a source to a destination is commonly called a “router.” There are many forms  
14 of networks such as Local Area Networks (LANs), Pico networks, Wide Area Networks  
15 (WANs), Wireless Networks (WLANs), etc. For example, the Internet is generally accepted as  
16 being an interconnection of a multitude of networks whereby remote clients and servers may  
17 access and interoperate with one another.

18 **[00154]** The AIC controller 1601 may be based on computer systems that may comprise,  
19 but are not limited to, components such as: a computer systemization 1602 connected to  
20 memory 1629.

21

### Computer Systemization

22 **[00155]** A computer systemization 1602 may comprise a clock 1630, central processing  
23 unit (“CPU(s)” and/or “processor(s)” (these terms are used interchangeable throughout the

1 disclosure unless noted to the contrary)) 1603, a memory 1629 (e.g., a read only memory  
2 (ROM) 1606, a random access memory (RAM) 1605, etc.), and/or an interface bus 1607, and  
3 most frequently, although not necessarily, are all interconnected and/or communicating through  
4 a system bus 1604 on one or more (mother)board(s) 1602 having conductive and/or otherwise  
5 transportive circuit pathways through which instructions (e.g., binary encoded signals) may  
6 travel to effectuate communications, operations, storage, etc. The computer systemization may  
7 be connected to a power source 1686; e.g., optionally the power source may be internal.  
8 Optionally, a cryptographic processor 1626 and/or transceivers (e.g., ICs) 1674 may be  
9 connected to the system bus. In another embodiment, the cryptographic processor and/or  
10 transceivers may be connected as either internal and/or external peripheral devices 1612 via the  
11 interface bus I/O. In turn, the transceivers may be connected to antenna(s) 1675, thereby  
12 effectuating wireless transmission and reception of various communication and/or sensor  
13 protocols; for example the antenna(s) may connect to: a Texas Instruments WiLink WL1283  
14 transceiver chip (e.g., providing 802.11n, Bluetooth 3.0, FM, global positioning system (GPS)  
15 (thereby allowing AIC controller to determine its location)); Broadcom BCM4329FKUBG  
16 transceiver chip (e.g., providing 802.11n, Bluetooth 2.1 + EDR, FM, etc.); a Broadcom  
17 BCM4750IUB8 receiver chip (e.g., GPS); an Infineon Technologies X-Gold 618-PMB9800  
18 (e.g., providing 2G/3G HSDPA/HSUPA communications); and/or the like. The system clock  
19 typically has a crystal oscillator and generates a base signal through the computer  
20 systemization's circuit pathways. The clock is typically coupled to the system bus and various  
21 clock multipliers that will increase or decrease the base operating frequency for other  
22 components interconnected in the computer systemization. The clock and various components  
23 in a computer systemization drive signals embodying information throughout the system. Such

1 transmission and reception of instructions embodying information throughout a computer  
2 systemization may be commonly referred to as communications. These communicative  
3 instructions may further be transmitted, received, and the cause of return and/or reply  
4 communications beyond the instant computer systemization to: communications networks, input  
5 devices, other computer systemizations, peripheral devices, and/or the like. It should be  
6 understood that in alternative embodiments, any of the above components may be connected  
7 directly to one another, connected to the CPU, and/or organized in numerous variations  
8 employed as exemplified by various computer systems.

9 **[00156]** The CPU comprises at least one high-speed data processor adequate to execute  
10 program components for executing user and/or system-generated requests. Often, the processors  
11 themselves will incorporate various specialized processing units, such as, but not limited to:  
12 integrated system (bus) controllers, memory management control units, floating point units, and  
13 even specialized processing sub-units like graphics processing units, digital signal processing  
14 units, and/or the like. Additionally, processors may include internal fast access addressable  
15 memory, and be capable of mapping and addressing memory 1629 beyond the processor itself;  
16 internal memory may include, but is not limited to: fast registers, various levels of cache  
17 memory (e.g., level 1, 2, 3, etc.), RAM, etc. The processor may access this memory through the  
18 use of a memory address space that is accessible via instruction address, which the processor  
19 can construct and decode allowing it to access a circuit path to a specific memory address space  
20 having a memory state. The CPU may be a microprocessor such as: AMD's Athlon, Duron  
21 and/or Opteron; ARM's application, embedded and secure processors; IBM and/or Motorola's  
22 DragonBall and PowerPC; IBM's and Sony's Cell processor; Intel's Celeron, Core (2) Duo,  
23 Itanium, Pentium, Xeon, and/or XScale; and/or the like processor(s). The CPU interacts with

1 memory through instruction passing through conductive and/or transportive conduits (e.g.,  
2 (printed) electronic and/or optic circuits) to execute stored instructions (i.e., program code)  
3 according to conventional data processing techniques. Such instruction passing facilitates  
4 communication within the AIC controller and beyond through various interfaces. Should  
5 processing requirements dictate a greater amount speed and/or capacity, distributed processors  
6 (e.g., Distributed AIC), mainframe, multi-core, parallel, and/or super-computer architectures  
7 may similarly be employed. Alternatively, should deployment requirements dictate greater  
8 portability, smaller Personal Digital Assistants (PDAs) may be employed.

9 **[00157]** Depending on the particular implementation, features of the AIC may be achieved  
10 by implementing a microcontroller such as CAST's R8051XC2 microcontroller; Intel's MCS  
11 51 (i.e., 8051 microcontroller); and/or the like. Also, to implement certain features of the AIC,  
12 some feature implementations may rely on embedded components, such as: Application-  
13 Specific Integrated Circuit ("ASIC"), Digital Signal Processing ("DSP"), Field Programmable  
14 Gate Array ("FPGA"), and/or the like embedded technology. For example, any of the AIC  
15 component collection (distributed or otherwise) and/or features may be implemented via the  
16 microprocessor and/or via embedded components; e.g., via ASIC, coprocessor, DSP, FPGA,  
17 and/or the like. Alternately, some implementations of the AIC may be implemented with  
18 embedded components that are configured and used to achieve a variety of features or signal  
19 processing. An example AIC component (e.g., PPI Component 1649) substantially in the form  
20 of a field-programmable gate array configured as an integrated circuit for performing the  
21 features of the PPI component may be found with respect to Figures 15A-F. It should be  
22 appreciated that the example PPI hardware component disclosed is provided to enhance the  
23 reader's understanding of the instant disclosure and is but one embodiment of the AIC disclosed

1 herein. Furthermore, as substantially all integrated circuits may be represented as one or more  
2 alternative integrated circuits, hardware description language statements (e.g., VHDL, Verilog,  
3 and/or the like), programming language commands, and/or the like, embodiments of the  
4 disclosed PPI hardware component represented as alternative hardware designs and/or software  
5 or software/hardware combinations are possible based on this disclosure.

6 **[00158]** Depending on the particular implementation, the embedded components may  
7 include software solutions, hardware solutions, and/or some combination of both  
8 hardware/software solutions. For example, AIC features discussed herein may be achieved  
9 through implementing FPGAs, which are a semiconductor devices containing programmable  
10 logic components called "logic blocks", and programmable interconnects, such as the high  
11 performance FPGA Virtex series and/or the low cost Spartan series manufactured by Xilinx.  
12 Logic blocks and interconnects can be programmed by the customer or designer, after the  
13 FPGA is manufactured, to implement any of the AIC features. A hierarchy of programmable  
14 interconnects allow logic blocks to be interconnected as needed by the AIC system  
15 designer/administrator, somewhat like a one-chip programmable breadboard. An FPGA's logic  
16 blocks can be programmed to perform the operation of basic logic gates such as AND, and  
17 XOR, or more complex combinational operators such as decoders or simple mathematical  
18 operations. In most FPGAs, the logic blocks also include memory elements, which may be  
19 circuit flip-flops or more complete blocks of memory. In some circumstances, the AIC may be  
20 developed on regular FPGAs and then migrated into a fixed version that more resembles ASIC  
21 implementations. Alternate or coordinating implementations may migrate AIC controller  
22 features to a final ASIC instead of or in addition to FPGAs. Depending on the implementation

1 all of the aforementioned embedded components and microprocessors may be considered the  
2 “CPU” and/or “processor” for the AIC.

### 3 **Power Source**

4 **[00159]** The power source 1686 may be of any standard form for powering small  
5 electronic circuit board devices such as the following power cells: alkaline, lithium hydride,  
6 lithium ion, lithium polymer, nickel cadmium, solar cells, and/or the like. Other types of AC or  
7 DC power sources may be used as well. In the case of solar cells, in one embodiment, the case  
8 provides an aperture through which the solar cell may capture photonic energy. The power cell  
9 1686 is connected to at least one of the interconnected subsequent components of the AIC  
10 thereby providing an electric current to all subsequent components. In one example, the power  
11 source 1686 is connected to the system bus component 1604. In an alternative embodiment, an  
12 outside power source 1686 is provided through a connection across the I/O 1608 interface. For  
13 example, a USB and/or IEEE 1394 connection carries both data and power across the  
14 connection and is therefore a suitable source of power.

### 15 **Interface Adapters**

16 **[00160]** Interface bus(es) 1607 may accept, connect, and/or communicate to a number of  
17 interface adapters, conventionally although not necessarily in the form of adapter cards, such as  
18 but not limited to: input output interfaces (I/O) 1608, storage interfaces 1609, network  
19 interfaces 1610, and/or the like. Optionally, cryptographic processor interfaces 1627 similarly  
20 may be connected to the interface bus. The interface bus provides for the communications of  
21 interface adapters with one another as well as with other components of the computer  
22 systemization. Interface adapters are adapted for a compatible interface bus. Interface adapters

1 conventionally connect to the interface bus via a slot architecture. Conventional slot  
2 architectures may be employed, such as, but not limited to: Accelerated Graphics Port (AGP),  
3 Card Bus, (Extended) Industry Standard Architecture ((E)ISA), Micro Channel Architecture  
4 (MCA), NuBus, Peripheral Component Interconnect (Extended) (PCI(X)), PCI Express,  
5 Personal Computer Memory Card International Association (PCMCIA), and/or the like.

6 **[00161]** Storage interfaces 1609 may accept, communicate, and/or connect to a number of  
7 storage devices such as, but not limited to: storage devices 1614, removable disc devices, and/or  
8 the like. Storage interfaces may employ connection protocols such as, but not limited to: (Ultra)  
9 (Serial) Advanced Technology Attachment (Packet Interface) ((Ultra) (Serial) ATA(PI)),  
10 (Enhanced) Integrated Drive Electronics ((E)IDE), Institute of Electrical and Electronics  
11 Engineers (IEEE) 1394, fiber channel, Small Computer Systems Interface (SCSI), Universal  
12 Serial Bus (USB), and/or the like.

13 **[00162]** Network interfaces 1610 may accept, communicate, and/or connect to a  
14 communications network 1613. Through a communications network 1613, the AIC controller is  
15 accessible through remote clients 1633b (e.g., computers with web browsers) by users 1633a.  
16 Network interfaces may employ connection protocols such as, but not limited to: direct connect,  
17 Ethernet (thick, thin, twisted pair 10/100/1000 Base T, and/or the like), Token Ring, wireless  
18 connection such as IEEE 802.11a-x, and/or the like. Should processing requirements dictate a  
19 greater amount speed and/or capacity, distributed network controllers (e.g., Distributed AIC),  
20 architectures may similarly be employed to pool, load balance, and/or otherwise increase the  
21 communicative bandwidth required by the AIC controller. A communications network may be  
22 any one and/or the combination of the following: a direct interconnection; the Internet; a Local  
23 Area Network (LAN); a Metropolitan Area Network (MAN); an Operating Missions as Nodes

1 on the Internet (OMNI); a secured custom connection; a Wide Area Network (WAN); a wireless  
2 network (e.g., employing protocols such as, but not limited to a Wireless Application Protocol  
3 (WAP), I-mode, and/or the like); and/or the like. A network interface may be regarded as a  
4 specialized form of an input output interface. Further, multiple network interfaces 1610 may be  
5 used to engage with various communications network types 1613. For example, multiple  
6 network interfaces may be employed to allow for the communication over broadcast, multicast,  
7 and/or unicast networks.

8 **[00163]** Input Output interfaces (I/O) 1608 may accept, communicate, and/or connect to  
9 user input devices 1611, peripheral devices 1612, cryptographic processor devices 1628, and/or  
10 the like. I/O may employ connection protocols such as, but not limited to: audio: analog, digital,  
11 monaural, RCA, stereo, and/or the like; data: Apple Desktop Bus (ADB), IEEE 1394a-b, serial,  
12 universal serial bus (USB); infrared; joystick; keyboard; midi; optical; PC AT; PS/2; parallel;  
13 radio; video interface: Apple Desktop Connector (ADC), BNC, coaxial, component, composite,  
14 digital, Digital Visual Interface (DVI), high-definition multimedia interface (HDMI), RCA, RF  
15 antennae, S-Video, VGA, and/or the like; wireless transceivers: 802.11a/b/g/n/x; Bluetooth;  
16 cellular (e.g., code division multiple access (CDMA), high speed packet access (HSPA(+)),  
17 high-speed downlink packet access (HSDPA), global system for mobile communications  
18 (GSM), long term evolution (LTE), WiMax, etc.); and/or the like. One typical output device  
19 may include a video display, which typically comprises a Cathode Ray Tube (CRT) or Liquid  
20 Crystal Display (LCD) based monitor with an interface (e.g., DVI circuitry and cable) that  
21 accepts signals from a video interface, may be used. The video interface composites information  
22 generated by a computer systemization and generates video signals based on the composited  
23 information in a video memory frame. Another output device is a television set, which accepts

1 signals from a video interface. Typically, the video interface provides the composited video  
2 information through a video connection interface that accepts a video display interface (e.g., an  
3 RCA composite video connector accepting an RCA composite video cable; a DVI connector  
4 accepting a DVI display cable, etc.).

5 **[00164]** User input devices 1611 often are a type of peripheral device 1612 (see below)  
6 and may include: card readers, dongles, finger print readers, gloves, graphics tablets, joysticks,  
7 keyboards, microphones, mouse (mice), remote controls, retina readers, touch screens (e.g.,  
8 capacitive, resistive, etc.), trackballs, trackpads, sensors (e.g., accelerometers, ambient light,  
9 GPS, gyroscopes, proximity, etc.), styluses, and/or the like.

10 **[00165]** Peripheral devices 1612 may be connected and/or communicate to I/O and/or  
11 other facilities of the like such as network interfaces, storage interfaces, directly to the interface  
12 bus, system bus, the CPU, and/or the like. Peripheral devices may be external, internal and/or  
13 part of the AIC controller. Peripheral devices may include: antenna, audio devices (e.g., line-in,  
14 line-out, microphone input, speakers, etc.), cameras (e.g., still, video, webcam, etc.), dongles  
15 (e.g., for copy protection, ensuring secure transactions with a digital signature, and/or the like),  
16 external processors (for added capabilities; e.g., crypto devices 1628), force-feedback devices  
17 (e.g., vibrating motors), network interfaces, printers, scanners, storage devices, transceivers  
18 (e.g., cellular, GPS, etc.), video devices (e.g., goggles, monitors, etc.), video sources, visors,  
19 and/or the like. Peripheral devices often include types of input devices (e.g., cameras).

20 **[00166]** It should be noted that although user input devices and peripheral devices may be  
21 employed, the AIC controller may be embodied as an embedded, dedicated, and/or monitor-less  
22 (i.e., headless) device, wherein access would be provided over a network interface connection.

1 **[00167]** Cryptographic units such as, but not limited to, microcontrollers, processors 1626,  
2 interfaces 1627, and/or devices 1628 may be attached, and/or communicate with the AIC  
3 controller. A MC68HC16 microcontroller, manufactured by Motorola Inc., may be used for  
4 and/or within cryptographic units. The MC68HC16 microcontroller utilizes a 16-bit multiply-  
5 and-accumulate instruction in the 16 MHz configuration and requires less than one second to  
6 perform a 512-bit RSA private key operation. Cryptographic units support the authentication of  
7 communications from interacting agents, as well as allowing for anonymous transactions.  
8 Cryptographic units may also be configured as part of the CPU. Equivalent microcontrollers  
9 and/or processors may also be used. Other commercially available specialized cryptographic  
10 processors include: the Broadcom's CryptoNetX and other Security Processors; nCipher's  
11 nShield, SafeNet's Luna PCI (e.g., 7100) series; Semaphore Communications' 40 MHz  
12 Roadrunner 184; Sun's Cryptographic Accelerators (e.g., Accelerator 6000 PCIe Board,  
13 Accelerator 500 Daughtercard); Via Nano Processor (e.g., L2100, L2200, U2400) line, which is  
14 capable of performing 500+ MB/s of cryptographic instructions; VLSI Technology's 33 MHz  
15 6868; and/or the like.

16

## Memory

17 **[00168]** Generally, any mechanization and/or embodiment allowing a processor to affect  
18 the storage and/or retrieval of information is regarded as memory 1629. However, memory is a  
19 fungible technology and resource, thus, any number of memory embodiments may be employed  
20 in lieu of or in concert with one another. It is to be understood that the AIC controller and/or a  
21 computer systemization may employ various forms of memory 1629. For example, a computer  
22 systemization may be configured wherein the operation of on-chip CPU memory (e.g.,  
23 registers), RAM, ROM, and any other storage devices are provided by a paper punch tape or

1 paper punch card mechanism; however, such an embodiment would result in an extremely slow  
2 rate of operation. In a typical configuration, memory 1629 will include ROM 1606, RAM 1605,  
3 and a storage device 1614. A storage device 1614 may be any conventional computer system  
4 storage. Storage devices may include a drum; a (fixed and/or removable) magnetic disk drive; a  
5 magneto-optical drive; an optical drive (i.e., Blu-ray, CD ROM/RAM/Recordable  
6 (R)/ReWritable (RW), DVD R/RW, HD DVD R/RW etc.); an array of devices (e.g., Redundant  
7 Array of Independent Disks (RAID)); solid state memory devices (USB memory, solid state  
8 drives (SSD), etc.); other processor-readable storage mediums; and/or other devices of the like.  
9 Thus, a computer systemization generally requires and makes use of memory.

10

### Component Collection

11 **[00169]** The memory 1629 may contain a collection of program and/or database  
12 components and/or data such as, but not limited to: operating system component(s) 1615  
13 (operating system); information server component(s) 1616 (information server); user interface  
14 component(s) 1617 (user interface); Web browser component(s) 1618 (Web browser);  
15 database(s) 1619; mail server component(s) 1621; mail client component(s) 1622; cryptographic  
16 server component(s) 1620 (cryptographic server); the AIC component(s) 1635; and/or the like  
17 (i.e., collectively a component collection). These components may be stored and accessed from  
18 the storage devices and/or from storage devices accessible through an interface bus. Although  
19 non-conventional program components such as those in the component collection, typically, are  
20 stored in a local storage device 1614, they may also be loaded and/or stored in memory such as:  
21 peripheral devices, RAM, remote storage facilities through a communications network, ROM,  
22 various forms of memory, and/or the like.

## Operating System

1  
2 **[00170]** The operating system component 1615 is an executable program component  
3 facilitating the operation of the AIC controller. Typically, the operating system facilitates access  
4 of I/O, network interfaces, peripheral devices, storage devices, and/or the like. The operating  
5 system may be a highly fault tolerant, scalable, and secure system such as: Apple Macintosh OS  
6 X (Server); AT&T Plan 9; Be OS; Unix and Unix-like system distributions (such as AT&T's  
7 UNIX; Berkley Software Distribution (BSD) variations such as FreeBSD, NetBSD, OpenBSD,  
8 and/or the like; Linux distributions such as Red Hat, Ubuntu, and/or the like); and/or the like  
9 operating systems. However, more limited and/or less secure operating systems also may be  
10 employed such as Apple Macintosh OS, IBM OS/2, Microsoft DOS, Microsoft Windows  
11 2000/2003/3.1/95/98/CE/Millennium/NT/Vista/XP (Server), Palm OS, and/or the like. An  
12 operating system may communicate to and/or with other components in a component collection,  
13 including itself, and/or the like. Most frequently, the operating system communicates with other  
14 program components, user interfaces, and/or the like. For example, the operating system may  
15 contain, communicate, generate, obtain, and/or provide program component, system, user,  
16 and/or data communications, requests, and/or responses. The operating system, once executed  
17 by the CPU, may enable the interaction with communications networks, data, I/O, peripheral  
18 devices, program components, memory, user input devices, and/or the like. The operating  
19 system may provide communications protocols that allow the AIC controller to communicate  
20 with other entities through a communications network 1613. Various communication protocols  
21 may be used by the AIC controller as a subcarrier transport mechanism for interaction, such as,  
22 but not limited to: multicast, TCP/IP, UDP, unicast, and/or the like.

## Information Server

1

2 **[00171]** An information server component 1616 is a stored program component that is  
3 executed by a CPU. The information server may be a conventional Internet information server  
4 such as, but not limited to Apache Software Foundation's Apache, Microsoft's Internet  
5 Information Server, and/or the like. The information server may allow for the execution of  
6 program components through facilities such as Active Server Page (ASP), ActiveX, (ANSI)  
7 (Objective-) C (++), C# and/or .NET, Common Gateway Interface (CGI) scripts, dynamic (D)  
8 hypertext markup language (HTML), FLASH, Java, JavaScript, Practical Extraction Report  
9 Language (PERL), Hypertext Pre-Processor (PHP), pipes, Python, wireless application protocol  
10 (WAP), WebObjects, and/or the like. The information server may support secure  
11 communications protocols such as, but not limited to, File Transfer Protocol (FTP); HyperText  
12 Transfer Protocol (HTTP); Secure Hypertext Transfer Protocol (HTTPS), Secure Socket Layer  
13 (SSL), messaging protocols (e.g., America Online (AOL) Instant Messenger (AIM),  
14 Application Exchange (APEX), ICQ, Internet Relay Chat (IRC), Microsoft Network (MSN)  
15 Messenger Service, Presence and Instant Messaging Protocol (PRIM), Internet Engineering  
16 Task Force's (IETF's) Session Initiation Protocol (SIP), SIP for Instant Messaging and Presence  
17 Leveraging Extensions (SIMPLE), open XML-based Extensible Messaging and Presence  
18 Protocol (XMPP) (i.e., Jabber or Open Mobile Alliance's (OMA's) Instant Messaging and  
19 Presence Service (IMPS)), Yahoo! Instant Messenger Service, and/or the like. The information  
20 server provides results in the form of Web pages to Web browsers, and allows for the  
21 manipulated generation of the Web pages through interaction with other program components.  
22 After a Domain Name System (DNS) resolution portion of an HTTP request is resolved to a  
23 particular information server, the information server resolves requests for information at

1 specified locations on the AIC controller based on the remainder of the HTTP request. For  
2 example, a request such as http://123.124.125.126/myInformation.html might have the IP  
3 portion of the request “123.124.125.126” resolved by a DNS server to an information server at  
4 that IP address; that information server might in turn further parse the http request for the  
5 “/myInformation.html” portion of the request and resolve it to a location in memory containing  
6 the information “myInformation.html.” Additionally, other information serving protocols may  
7 be employed across various ports, e.g., FTP communications across port 21, and/or the like. An  
8 information server may communicate to and/or with other components in a component  
9 collection, including itself, and/or facilities of the like. Most frequently, the information server  
10 communicates with the AIC database 1619, operating systems, other program components, user  
11 interfaces, Web browsers, and/or the like.

12 **[00172]** Access to the AIC database may be achieved through a number of database bridge  
13 mechanisms such as through scripting languages as enumerated below (e.g., CGI) and through  
14 inter-application communication channels as enumerated below (e.g., CORBA, WebObjects,  
15 etc.). Any data requests through a Web browser are parsed through the bridge mechanism into  
16 appropriate grammars as required by the AIC. In one embodiment, the information server would  
17 provide a Web form accessible by a Web browser. Entries made into supplied fields in the Web  
18 form are tagged as having been entered into the particular fields, and parsed as such. The  
19 entered terms are then passed along with the field tags, which act to instruct the parser to  
20 generate queries directed to appropriate tables and/or fields. In one embodiment, the parser may  
21 generate queries in standard SQL by instantiating a search string with the proper join/select  
22 commands based on the tagged text entries, wherein the resulting command is provided over the  
23 bridge mechanism to the AIC as a query. Upon generating query results from the query, the

1 results are passed over the bridge mechanism, and may be parsed for formatting and generation  
2 of a new results Web page by the bridge mechanism. Such a new results Web page is then  
3 provided to the information server, which may supply it to the requesting Web browser.

4 **[00173]** Also, an information server may contain, communicate, generate, obtain, and/or  
5 provide program component, system, user, and/or data communications, requests, and/or  
6 responses.

### 7 **User Interface**

8 **[00174]** Computer interfaces in some respects are similar to automobile operation  
9 interfaces. Automobile operation interface elements such as steering wheels, gearshifts, and  
10 speedometers facilitate the access, operation, and display of automobile resources, and status.  
11 Computer interaction interface elements such as check boxes, cursors, menus, scrollers, and  
12 windows (collectively and commonly referred to as widgets) similarly facilitate the access,  
13 capabilities, operation, and display of data and computer hardware and operating system  
14 resources, and status. Operation interfaces are commonly called user interfaces. Graphical user  
15 interfaces (GUIs) such as the Apple Macintosh Operating System's Aqua, IBM's OS/2,  
16 Microsoft's Windows 2000/2003/3.1/95/98/CE/Millennium/NT/XP/Vista/7 (i.e., Aero), Unix's  
17 X-Windows (e.g., which may include additional Unix graphic interface libraries and layers such  
18 as K Desktop Environment (KDE), mythTV and GNU Network Object Model Environment  
19 (GNOME)), web interface libraries (e.g., ActiveX, AJAX, (D)HTML, FLASH, Java,  
20 JavaScript, etc. interface libraries such as, but not limited to, Dojo, jQuery(UI), MooTools,  
21 Prototype, script.aculo.us, SWFObject, Yahoo! User Interface, any of which may be used and)  
22 provide a baseline and means of accessing and displaying information graphically to users.

1 **[00175]** A user interface component 1617 is a stored program component that is executed  
2 by a CPU. The user interface may be a conventional graphic user interface as provided by, with,  
3 and/or atop operating systems and/or operating environments such as already discussed. The  
4 user interface may allow for the display, execution, interaction, manipulation, and/or operation  
5 of program components and/or system facilities through textual and/or graphical facilities. The  
6 user interface provides a facility through which users may affect, interact, and/or operate a  
7 computer system. A user interface may communicate to and/or with other components in a  
8 component collection, including itself, and/or facilities of the like. Most frequently, the user  
9 interface communicates with operating systems, other program components, and/or the like. The  
10 user interface may contain, communicate, generate, obtain, and/or provide program component,  
11 system, user, and/or data communications, requests, and/or responses.

12

### Web Browser

13 **[00176]** A Web browser component 1618 is a stored program component that is executed  
14 by a CPU. The Web browser may be a conventional hypertext viewing application such as  
15 Microsoft Internet Explorer or Netscape Navigator. Secure Web browsing may be supplied with  
16 128bit (or greater) encryption by way of HTTPS, SSL, and/or the like. Web browsers allowing  
17 for the execution of program components through facilities such as ActiveX, AJAX, (D)HTML,  
18 FLASH, Java, JavaScript, web browser plug-in APIs (e.g., FireFox, Safari Plug-in, and/or the  
19 like APIs), and/or the like. Web browsers and like information access tools may be integrated  
20 into PDAs, cellular telephones, and/or other mobile devices. A Web browser may communicate  
21 to and/or with other components in a component collection, including itself, and/or facilities of  
22 the like. Most frequently, the Web browser communicates with information servers, operating  
23 systems, integrated program components (e.g., plug-ins), and/or the like; e.g., it may contain,

1 communicate, generate, obtain, and/or provide program component, system, user, and/or data  
2 communications, requests, and/or responses. Also, in place of a Web browser and information  
3 server, a combined application may be developed to perform similar operations of both. The  
4 combined application would similarly affect the obtaining and the provision of information to  
5 users, user agents, and/or the like from the AIC enabled nodes. The combined application may  
6 be nugatory on systems employing standard Web browsers.

### 7 **Mail Server**

8 **[00177]** A mail server component 1621 is a stored program component that is executed by  
9 a CPU 1603. The mail server may be a conventional Internet mail server such as, but not limited  
10 to sendmail, Microsoft Exchange, and/or the like. The mail server may allow for the execution  
11 of program components through facilities such as ASP, ActiveX, (ANSI) (Objective-) C (++),  
12 C# and/or .NET, CGI scripts, Java, JavaScript, PERL, PHP, pipes, Python, WebObjects, and/or  
13 the like. The mail server may support communications protocols such as, but not limited to:  
14 Internet message access protocol (IMAP), Messaging Application Programming Interface  
15 (MAPI)/Microsoft Exchange, post office protocol (POP3), simple mail transfer protocol  
16 (SMTP), and/or the like. The mail server can route, forward, and process incoming and  
17 outgoing mail messages that have been sent, relayed and/or otherwise traversing through and/or  
18 to the AIC.

19 **[00178]** Access to the AIC mail may be achieved through a number of APIs offered by the  
20 individual Web server components and/or the operating system.

1 **[00179]** Also, a mail server may contain, communicate, generate, obtain, and/or provide  
2 program component, system, user, and/or data communications, requests, information, and/or  
3 responses.

#### 4 **Mail Client**

5 **[00180]** A mail client component 1622 is a stored program component that is executed by  
6 a CPU 1603. The mail client may be a conventional mail viewing application such as Apple  
7 Mail, Microsoft Entourage, Microsoft Outlook, Microsoft Outlook Express, Mozilla,  
8 Thunderbird, and/or the like. Mail clients may support a number of transfer protocols, such as:  
9 IMAP, Microsoft Exchange, POP3, SMTP, and/or the like. A mail client may communicate to  
10 and/or with other components in a component collection, including itself, and/or facilities of the  
11 like. Most frequently, the mail client communicates with mail servers, operating systems, other  
12 mail clients, and/or the like; e.g., it may contain, communicate, generate, obtain, and/or provide  
13 program component, system, user, and/or data communications, requests, information, and/or  
14 responses. Generally, the mail client provides a facility to compose and transmit electronic mail  
15 messages.

#### 16 **Cryptographic Server**

17 **[00181]** A cryptographic server component 1620 is a stored program component that is  
18 executed by a CPU 1603, cryptographic processor 1626, cryptographic processor interface  
19 1627, cryptographic processor device 1628, and/or the like. Cryptographic processor interfaces  
20 will allow for expedition of encryption and/or decryption requests by the cryptographic  
21 component; however, the cryptographic component, alternatively, may run on a conventional  
22 CPU. The cryptographic component allows for the encryption and/or decryption of provided

1 data. The cryptographic component allows for both symmetric and asymmetric (e.g., Pretty  
2 Good Protection (PGP)) encryption and/or decryption. The cryptographic component may  
3 employ cryptographic techniques such as, but not limited to: digital certificates (e.g., X.509  
4 authentication framework), digital signatures, dual signatures, enveloping, password access  
5 protection, public key management, and/or the like. The cryptographic component will facilitate  
6 numerous (encryption and/or decryption) security protocols such as, but not limited to:  
7 checksum, Data Encryption Standard (DES), Elliptical Curve Encryption (ECC), International  
8 Data Encryption Algorithm (IDEA), Message Digest 5 (MD5, which is a one way hash  
9 operation), passwords, Rivest Cipher (RC5), Rijndael, RSA (which is an Internet encryption and  
10 authentication system that uses an algorithm developed in 1977 by Ron Rivest, Adi Shamir, and  
11 Leonard Adleman), Secure Hash Algorithm (SHA), Secure Socket Layer (SSL), Secure  
12 Hypertext Transfer Protocol (HTTPS), and/or the like. Employing such encryption security  
13 protocols, the AIC may encrypt all incoming and/or outgoing communications and may serve as  
14 node within a virtual private network (VPN) with a wider communications network. The  
15 cryptographic component facilitates the process of “security authorization” whereby access to a  
16 resource is inhibited by a security protocol wherein the cryptographic component effects  
17 authorized access to the secured resource. In addition, the cryptographic component may  
18 provide unique identifiers of content, e.g., employing and MD5 hash to obtain a unique  
19 signature for a digital audio file. A cryptographic component may communicate to and/or with  
20 other components in a component collection, including itself, and/or facilities of the like. The  
21 cryptographic component supports encryption schemes allowing for the secure transmission of  
22 information across a communications network to enable the AIC component to engage in secure  
23 transactions if so desired. The cryptographic component facilitates the secure accessing of

1 resources on the AIC and facilitates the access of secured resources on remote systems; i.e., it  
2 may act as a client and/or server of secured resources. Most frequently, the cryptographic  
3 component communicates with information servers, operating systems, other program  
4 components, and/or the like. The cryptographic component may contain, communicate,  
5 generate, obtain, and/or provide program component, system, user, and/or data communications,  
6 requests, and/or responses.

### 7 **The AIC Database**

8 **[00182]** The AIC database component 1619 may be embodied in a database and its stored  
9 data. The database is a stored program component, which is executed by the CPU; the stored  
10 program component portion configuring the CPU to process the stored data. The database may  
11 be a conventional, fault tolerant, relational, scalable, secure database such as Oracle or Sybase.  
12 Relational databases are an extension of a flat file. Relational databases consist of a series of  
13 related tables. The tables are interconnected via a key field. Use of the key field allows the  
14 combination of the tables by indexing against the key field; i.e., the key fields act as  
15 dimensional pivot points for combining information from various tables. Relationships  
16 generally identify links maintained between tables by matching primary keys. Primary keys  
17 represent fields that uniquely identify the rows of a table in a relational database. More  
18 precisely, they uniquely identify rows of a table on the “one” side of a one-to-many  
19 relationship.

20 **[00183]** Alternatively, the AIC database may be implemented using various standard data-  
21 structures, such as an array, hash, (linked) list, struct, structured text file (e.g., XML), table,  
22 and/or the like. Such data-structures may be stored in memory and/or in (structured) files. In  
23 another alternative, an object-oriented database may be used, such as Frontier, ObjectStore,

1 Poet, Zope, and/or the like. Object databases can include a number of object collections that are  
2 grouped and/or linked together by common attributes; they may be related to other object  
3 collections by some common attributes. Object-oriented databases perform similarly to  
4 relational databases with the exception that objects are not just pieces of data but may have  
5 other types of capabilities encapsulated within a given object. If the AIC database is  
6 implemented as a data-structure, the use of the AIC database 1619 may be integrated into  
7 another component such as the AIC component 1635. Also, the database may be implemented  
8 as a mix of data structures, objects, and relational structures. Databases may be consolidated  
9 and/or distributed in countless variations through standard data processing techniques. Portions  
10 of databases, e.g., tables, may be exported and/or imported and thus decentralized and/or  
11 integrated.

12 **[00184]** In one embodiment, the database component 1619 includes several tables 1619a-l.  
13 A User table 1619a may include fields such as, but not limited to: user\_id, ssn, dob, first\_name,  
14 last\_name, age, state, address\_firstline, address\_secondline, zipcode, devices\_list, contact\_info,  
15 contact\_type, alt\_contact\_info, alt\_contact\_type, user\_equipment, user\_plane, user\_profile,  
16 and/or the like. An Account table 1619b may include fields such as, but not limited to: acct\_id,  
17 acct\_user, acct\_history, acct\_access, acct\_status, acct\_subscription, acct\_profile, and/or the like.

18 **[00185]** A Profile table 1619c may include fields such as, but not limited to: prof\_id,  
19 prof\_assets, prof\_history, prof\_details, profile\_aircraft, and/or the like. A Terrain table 1619d  
20 may include fields such as, but not limited to: terrain\_id, terrain\_details, terrain\_parameters,  
21 terrain\_var, and/or the like. A Resource table 1619e may include fields such as, but not limited  
22 to: resource\_id, resource\_location, resource\_acct, and/or the like. An Equipment table 1619f  
23 may include fields such as, but not limited to: equip\_id, equip\_location, equip\_acct,

1 equip\_contact, equip\_type, and/or the like. A Model table 1619g may include fields such as, but  
2 not limited to: model\_id, model\_assc, model\_PPI, model\_feedback, model\_param, model\_var,  
3 and/or the like. A Weather data table 1619h may include fields such as, but not limited to:  
4 weather\_data\_id, weather\_source, weather\_location, weather\_data\_type, weather\_acct,  
5 weather\_icing, weather\_var, and/or the like. In one embodiment, the weather data table is  
6 populated through one or more weather data feeds. A Feedback table 1619i may include fields  
7 such as, but not limited to: feedback\_id, feedback\_source, source\_location, feedback\_time,  
8 feedback\_acct, and/or the like.

9 **[00186]** An Aircraft table 1619j may include fields such as, but not limited to: aircraft\_id,  
10 aircraft\_type, aircraft\_profile, aircraft\_fuel\_capacity, aircraft\_route, aircraft\_use,  
11 aircraft\_owner, aircraft\_location, aircraft\_acct, aircraft\_flightplan, aircraft\_parameters,  
12 aircraft\_airfoil, aircraft\_alerts, and/or the like. A Flight Plan table 1619k may include fields  
13 such as, but not limited to: flightplan\_id, flightplan\_source, flightplan\_start\_location,  
14 flightplan\_start\_time, flightplan\_end\_location, flightplan\_end\_time, flightplan\_acct,  
15 flightplan\_aircraft, flightplan\_profile, flightplan\_type, flightplan\_alerts, flightplan\_parameters,  
16 flightplan\_airfoil, flightplan\_PPI and/or the like. An Airfoil table 1619l may include fields such  
17 as, but not limited to: airfoil\_id, airfoil\_source, airfoil\_aircraft, airfoil\_icing\_profile,  
18 airfoil\_icing\_determination, airfoil\_profile, airfoil\_type, airfoil\_pi, airfoil\_alerts,  
19 airfoil\_parameters, airfoil\_PPI, and/or the like.

20 **[00187]** In one embodiment, the AIC database may interact with other database systems.  
21 For example, employing a distributed database system, queries and data access by search AIC  
22 component may treat the combination of the AIC database, an integrated data security layer  
23 database as a single database entity.

1 **[00188]** In one embodiment, user programs may contain various user interface primitives,  
2 which may serve to update the AIC. Also, various accounts may require custom database tables  
3 depending upon the environments and the types of clients the AIC may need to serve. It should  
4 be noted that any unique fields may be designated as a key field throughout. In an alternative  
5 embodiment, these tables have been decentralized into their own databases and their respective  
6 database controllers (i.e., individual database controllers for each of the above tables).  
7 Employing standard data processing techniques, one may further distribute the databases over  
8 several computer systemizations and/or storage devices. Similarly, configurations of the  
9 decentralized database controllers may be varied by consolidating and/or distributing the  
10 various database components 1619a-I. The AIC may be configured to keep track of various  
11 settings, inputs, and parameters via database controllers.

12 **[00189]** The AICAIC database may communicate to and/or with other components in a  
13 component collection, including itself, and/or facilities of the like. Most frequently, the AIC  
14 database communicates with the AIC component, other program components, and/or the like.  
15 The database may contain, retain, and provide information regarding other nodes and data.

### 16 The AICs

17 **[00190]** The AIC component 1635 is a stored program component that is executed by a  
18 CPU. In one embodiment, the AIC component incorporates any and/or all combinations of the  
19 aspects of the AIC discussed in the previous figures. As such, the AIC affects accessing,  
20 obtaining and the provision of information, services, transactions, and/or the like across various  
21 communications networks. The features and embodiments of the AIC discussed herein increase  
22 network efficiency by reducing data transfer requirements by the use of more efficient data  
23 structures and mechanisms for their transfer and storage. As a consequence, more data may be

1 transferred in less time, and latencies with regard to transactions, are also reduced. In many  
2 cases, such reduction in storage, transfer time, bandwidth requirements, latencies, etc., will  
3 reduce the capacity and structural infrastructure requirements to support the AIC's features and  
4 facilities, and in many cases reduce the costs, energy consumption/requirements, and extend the  
5 life of AIC's underlying infrastructure; this has the added benefit of making the AIC more  
6 reliable. Similarly, many of the features and mechanisms are designed to be easier for users to  
7 use and access, thereby broadening the audience that may enjoy/employ and exploit the feature  
8 sets of the AIC; such ease of use also helps to increase the reliability of the AIC. In addition, the  
9 feature sets include heightened security as noted via the Cryptographic components 1620, 1626,  
10 1628 and throughout, making access to the features and data more reliable and secure.  
11 Additionally, the AIC enables more efficient and safe flight planning and routing, including  
12 real-time dynamic responsiveness to changing weather conditions.

13 **[00191]** The AIC component may transform weather data input via AIC components into  
14 real-time and/or predictive icing feeds and displays, and/or the like and use of the AIC. In one  
15 embodiment, the AIC component 1635 takes inputs (e.g., weather forecast data, atmospheric  
16 data, models, sensor data, and/or the like) etc., and transforms the inputs via various  
17 components (a Tracking component 1644; a Pathing component 1645; a Display component  
18 1646; an Alerting component 1647; a Planning component 1648; a PPI component 1649; an  
19 input component 1650; an icing component 1651; a CFD component 1652; a TdA component  
20 1653; an NWF component 1654; and/or the like), into outputs (e.g., predictive flight path icing,  
21 percent power increase needed, real-time airfoil-specific icing data, flight path  
22 modifications/optimizations, icing alerts, and/or the like).

1 **[00192]** The AIC component enabling access of information between nodes may be  
2 developed by employing standard development tools and languages such as, but not limited to:  
3 Apache components, Assembly, ActiveX, binary executables, (ANSI) (Objective-) C (++), C#  
4 and/or .NET, database adapters, CGI scripts, Java, JavaScript, mapping tools, procedural and  
5 object oriented development tools, PERL, PHP, Python, shell scripts, SQL commands, web  
6 application server extensions, web development environments and libraries (e.g., Microsoft's  
7 ActiveX; Adobe AIR, FLEX & FLASH; AJAX; (D)HTML; Dojo, Java; JavaScript;  
8 jQuery(UI); MooTools; Prototype; script.aculo.us; Simple Object Access Protocol (SOAP);  
9 SWFObject; Yahoo! User Interface; and/or the like), WebObjects, and/or the like. In one  
10 embodiment, the AIC server employs a cryptographic server to encrypt and decrypt  
11 communications. The AIC component may communicate to and/or with other components in a  
12 component collection, including itself, and/or facilities of the like. Most frequently, the AIC  
13 component communicates with the AIC database, operating systems, other program  
14 components, and/or the like. The AIC may contain, communicate, generate, obtain, and/or  
15 provide program component, system, user, and/or data communications, requests, and/or  
16 responses.

17

### Distributed AICs

18 **[00193]** The structure and/or operation of any of the AIC node controller components may  
19 be combined, consolidated, and/or distributed in any number of ways to facilitate development  
20 and/or deployment. Similarly, the component collection may be combined in any number of  
21 ways to facilitate deployment and/or development. To accomplish this, one may integrate the  
22 components into a common code base or in a facility that can dynamically load the components  
23 on demand in an integrated fashion.

1 **[00194]** The component collection may be consolidated and/or distributed in countless  
2 variations through standard data processing and/or development techniques. Multiple instances  
3 of any one of the program components in the program component collection may be instantiated  
4 on a single node, and/or across numerous nodes to improve performance through load-balancing  
5 and/or data-processing techniques. Furthermore, single instances may also be distributed across  
6 multiple controllers and/or storage devices; e.g., databases. All program component instances  
7 and controllers working in concert may do so through standard data processing communication  
8 techniques.

9 **[00195]** The configuration of the AIC controller will depend on the context of system  
10 deployment. Factors such as, but not limited to, the budget, capacity, location, and/or use of the  
11 underlying hardware resources may affect deployment requirements and configuration.  
12 Regardless of if the configuration results in more consolidated and/or integrated program  
13 components, results in a more distributed series of program components, and/or results in some  
14 combination between a consolidated and distributed configuration, data may be communicated,  
15 obtained, and/or provided. Instances of components consolidated into a common code base from  
16 the program component collection may communicate, obtain, and/or provide data. This may be  
17 accomplished through intra-application data processing communication techniques such as, but  
18 not limited to: data referencing (e.g., pointers), internal messaging, object instance variable  
19 communication, shared memory space, variable passing, and/or the like.

20 **[00196]** If component collection components are discrete, separate, and/or external to one  
21 another, then communicating, obtaining, and/or providing data with and/or to other components  
22 may be accomplished through inter-application data processing communication techniques such  
23 as, but not limited to: Application Program Interfaces (API) information passage; (distributed)

1 Component Object Model ((D)COM), (Distributed) Object Linking and Embedding ((D)OLE),  
2 and/or the like), Common Object Request Broker Architecture (CORBA), Jini local and remote  
3 application program interfaces, JavaScript Object Notation (JSON), Remote Method Invocation  
4 (RMI), SOAP, process pipes, shared files, and/or the like. Messages sent between discrete  
5 component components for inter-application communication or within memory spaces of a  
6 singular component for intra-application communication may be facilitated through the creation  
7 and parsing of a grammar. A grammar may be developed by using development tools such as  
8 lex, yacc, XML, and/or the like, which allow for grammar generation and parsing capabilities,  
9 which in turn may form the basis of communication messages within and between components.

10 **[00197]** For example, a grammar may be arranged to recognize the tokens of an HTTP  
11 post command, e.g.:

```
12           w3c -post http://... Value1
```

13

14 **[00198]** where Value1 is discerned as being a parameter because “http://” is part of the  
15 grammar syntax, and what follows is considered part of the post value. Similarly, with such a  
16 grammar, a variable “Value1” may be inserted into an “http://” post command and then sent.  
17 The grammar syntax itself may be presented as structured data that is interpreted and/or  
18 otherwise used to generate the parsing mechanism (e.g., a syntax description text file as  
19 processed by lex, yacc, etc.). Also, once the parsing mechanism is generated and/or instantiated,  
20 it itself may process and/or parse structured data such as, but not limited to: character (e.g., tab)  
21 delineated text, HTML, structured text streams, XML, and/or the like structured data. In another  
22 embodiment, inter-application data processing protocols themselves may have integrated and/or  
23 readily available parsers (e.g., JSON, SOAP, and/or like parsers) that may be employed to parse  
24 (e.g., communications) data. Further, the parsing grammar may be used beyond message

1 parsing, but may also be used to parse: databases, data collections, data stores, structured data,  
2 and/or the like. Again, the desired configuration will depend upon the context, environment, and  
3 requirements of system deployment.

4 **[00199]** For example, in some implementations, the AIC controller may be executing a  
5 PHP script implementing a Secure Sockets Layer (“SSL”) socket server via the information  
6 server, which listens to incoming communications on a server port to which a client may send  
7 data, e.g., data encoded in JSON format. Upon identifying an incoming communication, the  
8 PHP script may read the incoming message from the client device, parse the received JSON-  
9 encoded text data to extract information from the JSON-encoded text data into PHP script  
10 variables, and store the data (e.g., client identifying information, etc.) and/or extracted  
11 information in a relational database accessible using the Structured Query Language (“SQL”).  
12 An exemplary listing, written substantially in the form of PHP/SQL commands, to accept  
13 JSON-encoded input data from a client device via a SSL connection, parse the data to extract  
14 variables, and store the data to a database, is provided below:

```
15 <?PHP
16 header('Content-Type: text/plain');
17
18 // set ip address and port to listen to for incoming data
19 $address = '192.168.0.100';
20 $port = 255;
21
22 // create a server-side SSL socket, listen for/accept incoming communication
23 $sock = socket_create(AF_INET, SOCK_STREAM, 0);
24 socket_bind($sock, $address, $port) or die('Could not bind to address');
25 socket_listen($sock);
26 $client = socket_accept($sock);
27
28 // read input data from client device in 1024 byte blocks until end of message
29 do {
30     $input = "";
```

```

1     $input = socket_read($client, 1024);
2     $data .= $input;
3 } while($input != "");
4
5 // parse data to extract variables
6 $obj = json_decode($data, true);
7
8 // store input data in a database
9 mysql_connect("201.408.185.132",$DBserver,$password); // access database server
10 mysql_select("CLIENT_DB.SQL"); // select database to append
11 mysql_query("INSERT INTO UserTable (transmission)
12 VALUES ($data)"); // add data to UserTable table in a CLIENT database
13 mysql_close("CLIENT_DB.SQL"); // close connection to database
14 ?>
15

```

16 **[00200]** Also, the following resources may be used to provide example embodiments  
 17 regarding SOAP parser implementation:

```

18 http://www.xav.com/perl/site/lib/SOAP/Parser.html
19 http://publib.boulder.ibm.com/infocenter/tivihelp/v2r1/index.jsp?topic=/com.ibm
20 .IBMDI.doc/referenceguide295.htm
21

```

22 **[00201]** and other parser implementations:

```

23 http://publib.boulder.ibm.com/infocenter/tivihelp/v2r1/index.jsp?topic=/com.ibm
24 .IBMDI.doc/referenceguide259.htm
25

```

26 **[00202]** Z

27 **[00203]** In order to address various issues and advance the art, the entirety of this  
 28 application for AIRFOIL ICING CONTROLLER APPARATUSES, METHODS AND  
 29 SYSTEMS (including the Cover Page, Title, Headings, Field, Background, Summary, Brief  
 30 Description of the Drawings, Detailed Description, Claims, Abstract, Figures, Appendices  
 31 and/or otherwise) shows by way of illustration various embodiments in which the claimed  
 32 innovations may be practiced. The advantages and features of the application are of a  
 33 representative sample of embodiments only, and are not exhaustive and/or exclusive. They are

1 presented only to assist in understanding and teach the claimed principles. It should be  
2 understood that they are not representative of all claimed innovations. As such, certain aspects  
3 of the disclosure have not been discussed herein. That alternate embodiments may not have  
4 been presented for a specific portion of the innovations or that further undescribed alternate  
5 embodiments may be available for a portion is not to be considered a disclaimer of those  
6 alternate embodiments. It will be appreciated that many of those undescribed embodiments  
7 incorporate the same principles of the innovations and others are equivalent. Thus, it is to be  
8 understood that other embodiments may be utilized and functional, logical, operational,  
9 organizational, structural and/or topological modifications may be made without departing from  
10 the scope and/or spirit of the disclosure. As such, all examples and/or embodiments are deemed  
11 to be non-limiting throughout this disclosure. Also, no inference should be drawn regarding  
12 those embodiments discussed herein relative to those not discussed herein other than it is as  
13 such for purposes of reducing space and repetition. For instance, it is to be understood that the  
14 logical and/or topological structure of any combination of any program components (a  
15 component collection), other components and/or any present feature sets as described in the  
16 figures and/or throughout are not limited to a fixed operating order and/or arrangement, but  
17 rather, any disclosed order is exemplary and all equivalents, regardless of order, are  
18 contemplated by the disclosure. Furthermore, it is to be understood that such features are not  
19 limited to serial execution, but rather, any number of threads, processes, services, servers,  
20 and/or the like that may execute asynchronously, concurrently, in parallel, simultaneously,  
21 synchronously, and/or the like are contemplated by the disclosure. As such, some of these  
22 features may be mutually contradictory, in that they cannot be simultaneously present in a  
23 single embodiment. Similarly, some features are applicable to one aspect of the innovations, and

1 inapplicable to others. In addition, the disclosure includes other innovations not presently  
2 claimed. Applicant reserves all rights in those presently unclaimed innovations, including the  
3 right to claim such innovations, file additional applications, continuations, continuations in part,  
4 divisions, and/or the like thereof. As such, it should be understood that advantages,  
5 embodiments, examples, functional, features, logical, operational, organizational, structural,  
6 topological, and/or other aspects of the disclosure are not to be considered limitations on the  
7 disclosure as defined by the claims or limitations on equivalents to the claims. It is to be  
8 understood that, depending on the particular needs and/or characteristics of a AIC individual  
9 and/or enterprise user, database configuration and/or relational model, data type, data  
10 transmission and/or network framework, syntax structure, and/or the like, various embodiments  
11 of the AIC may be implemented that enable a great deal of flexibility and customization. For  
12 example, aspects of the AIC may be adapted for integration with flight planning and route  
13 optimization. While various embodiments and discussions of the AIC have been directed to  
14 predictive icing, however, it is to be understood that the embodiments described herein may be  
15 readily configured and/or customized for a wide variety of other applications and/or  
16 implementations.

**CLAIMS**

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What is claimed is:

1. A dynamic airfoil icing flight planning system, comprising:
  - a memory;
  - a processor coupled to the memory to execute computer-readable code stored in the memory to:
    - receive parameter data for an initial anticipated flight plan through a region;
    - determine airfoil type for an aircraft associated with the initial anticipated flight plan;
    - obtain atmospheric data based on the flight plan parameter data, wherein the atmospheric data comprises aircraft sensor data;
    - determine a plurality of four-dimensional grid points for said region based on the flight plan parameter data;
    - determine corresponding icing data for each grid point of the plurality of grid points based on the airfoil type and atmospheric data;
    - determine a percent power increase required by the aircraft to overcome performance loss corresponding to the icing data for the initial anticipated flight plan; and
    - determine at least one alternative flight plan based on the flight plan parameter data and the determined percent power increase for the initial anticipated

1 flight plan, the at least one alternative flight plan having a lower percent  
2 power increase than the initial anticipated flight plan; and  
3 an output device coupled to the processor to output information associated with the  
4 determined at least one alternative flight plan to a user.

5 2. The dynamic airfoil icing flight planning system of claim 1, wherein the output device  
6 outputs the information associated with the determined at least one alternative flight plan for  
7 updating the initial anticipated flight plan to the at least one alternative flight plan.

8 3. The system of claim 1 or claim 2, wherein the processor, when executing the computer-  
9 readable code compares the initial anticipated flight plan and the at least one alternative flight  
10 plan, wherein the comparison is based on at least one of:

11 distance;

12 flight time;

13 fuel consumption; and

14 risk.

15 4. The system of claim 1 or claim 2, wherein the at least one alternative flight plan  
16 comprises an optimized route flight plan which is optimized for safety and/or fuel consumption.

17 5. The system of any one of claims 1 to 4, wherein the parameter data includes aircraft  
18 data and/or the airfoil type.

19

- 1 6. The system of any one of claims 1 to 5, wherein the flight plan parameter data includes  
2 at least one of:
- 3 take-off time;
  - 4 take-off location;
  - 5 destination location.
- 6 7. The system of any one of claims 1 to 6, wherein the computer-readable code causes the  
7 system to poll at least one aircraft sensor to obtain the aircraft sensor data.
- 8 8. The system of claim 7, wherein at least one of the at least one aircraft sensor is a plane-  
9 mounted instrument sensor.
- 10 9. The system of claim 7 or claim 8, wherein at least one of the at least one aircraft sensor  
11 is a sensor for measuring at least one of altitude, heading, speed, pitch, temperature, barometric  
12 pressure, fuel consumption, fuel remaining for flight, number of passengers, and aircraft weight.
- 13 10. The system of claim 7 or claim 8, wherein at least one of the at least one aircraft sensor  
14 is at least one of an accelerometer, ambient light sensor, GPS, gyroscope, and proximity sensor.
- 15 11. The system of claim 7 or claim 8, wherein the aircraft sensor data comprises real-time  
16 icing conditions.
- 17 12. The system of any one of claims 7 to 11 further comprising the at least one aircraft  
18 sensor.  
19

- 1 13. A processor-implemented method for flight planning, comprising:  
2 receiving parameter data for an initial anticipated flight plan through a region;  
3 determining airfoil type for an aircraft associated with the initial anticipated flight plan;  
4 obtaining atmospheric data based on the flight plan parameter data, wherein the  
5 atmospheric data comprises aircraft sensor data;  
6 determining a plurality of four-dimensional grid points for said region based on the  
7 flight plan parameter data;  
8 determining corresponding icing data for each point of the plurality of four dimensional  
9 grid point based on the airfoil type;  
10 determining via a processor a percent power increase required by the aircraft to  
11 overcome performance loss corresponding to the icing data for the initial  
12 anticipated flight plan;  
13 determining an at least one alternative flight plan based on the flight plan parameter data  
14 and the determined percent power increase for the initial anticipated flight plan,  
15 the at least one alternative flight plan having a lower percent power increase than  
16 the initial anticipated flight plan; and  
17 providing information associated with the determined at least one alternative flight plan  
18 to a user.
- 19 14. The method of claim 13, wherein the parameter data includes at least one of aircraft data  
20 and airfoil type.

1 15. The method of claim 13, wherein the initial anticipated flight plan comprises a shortest  
2 route flight plan, and/or wherein the at least one alternative flight plan comprises an optimized  
3 route flight plan which is optimized for safety and/or for safety and fuel consumption.

4 16. The method of any one of claims 13 to 15, wherein the flight plan parameter data  
5 includes at least one of flight take-off time, flight take-off location, flight destination location,  
6 and anticipated flight destination location arrival time.

7 17. The method of any one of claims 13 to 16, wherein the information associated with the  
8 determined at least one alternative flight plan is output to update the initial anticipated flight  
9 plan to the at least one alternative flight plan.

10 18. The method of any one of claims 13 to 17, further comprising polling at least one aircraft  
11 sensor to obtain the aircraft sensor data.

12 19. The method of claim 18, wherein at least one of the at least one aircraft sensor is a plane-  
13 mounted instrument sensor.

14 20. The method of claim 18 or claim 19, wherein at least one of the at least one aircraft  
15 sensor is a sensor for measuring at least one of altitude, heading, speed, pitch, temperature,  
16 barometric pressure, fuel consumption, fuel remaining for flight, number of passengers, and  
17 aircraft weight.

18 21. The method of claim 18 or claim 19, wherein at least one of the at least one aircraft  
19 sensor is at least one of an accelerometer, ambient light sensor, GPS, gyroscope, and proximity  
20 sensor.

1 22. The method of claim 18 or claim 19, wherein the aircraft sensor data comprises real-  
2 time icing conditions.

3 23. The method of any one of claims 18 to 22 further comprising using the at least one  
4 aircraft sensor to generate the aircraft sensor data.

5 24. An aircraft comprising:

6 an airfoil;

7 an icing component for determining existing icing accumulation on the airfoil; and

8 a dynamic airfoil icing flight planning system for determining a first icing forecast, the

9 first icing forecast being associated with a first flight plan,

10 wherein determining the first icing forecast comprises:

11 receiving a first set of parameter data, the first set of parameter data being  
12 associated with the first flight plan;

13 obtaining a first set of atmospheric data, the first set of atmospheric data being  
14 associated with the first set of parameter data;

15 determining a first set of grid points, each grid point of the first set of grid points  
16 being a four-dimensional grid point associated with the first flight plan;

17 and

18 determining a first set of icing data, the first set of icing data being associated  
19 with the first set of grid points and being determined based on an airfoil  
20 type of the airfoil.

1 25. The aircraft of claim 24, further comprising a computation fluid dynamics component  
2 for determining anticipated percent power increase required by the aircraft based on the first  
3 icing forecast.

4 26. The aircraft of claim 24 or claim 25, wherein the dynamic airfoil icing flight planning  
5 system is configured to determine a second icing forecast, the second icing forecast being  
6 associated with a first alternative flight plan,

7 wherein determining the second icing forecast comprises:

8 receiving a second set of parameter data, the second set of parameter data being  
9 associated with the first alternative flight plan;

10 obtaining a second set of atmospheric data, the second set of atmospheric data  
11 being associated with the second set of parameter data;

12 determining a second set of grid points, each grid point of the second set of grid  
13 points being a four-dimensional grid point associated with the first  
14 alternative flight plan; and

15 determining a second set of icing data, the second set of icing data being  
16 associated with the second set of grid points and being determined based  
17 on the airfoil type of the airfoil.

18 27. The aircraft of any one of claims 24 to 26, further comprising a first sensor, at least  
19 some of the data of the first set of parameter data being obtained from the first sensor.

20

- 1 28. An aircraft control system comprising:  
2 a means of determining a first flight plan of a first aircraft; and  
3 a dynamic airfoil icing flight planning system for determining a first icing forecast, the  
4 first icing forecast being associated with the first flight plan of the first aircraft,  
5 wherein determining the first icing forecast comprises:  
6 receiving a first set of parameter data, the first set of parameter data being  
7 associated with the first flight plan of the first aircraft;  
8 obtaining a first set of atmospheric data, the first set of atmospheric data being  
9 associated with the first set of parameter data;  
10 determining a first set of grid points, each grid point of the first set of grid points  
11 being a four-dimensional grid point associated with the first flight plan  
12 of the first aircraft; and  
13 determining a first set of icing data, the first set of icing data being associated  
14 with the first set of grid points and being determined based on an airfoil  
15 type of the first aircraft.
- 16 29. The aircraft control system of claim 28, further comprising a computation fluid  
17 dynamics component for determining anticipated percent power increase required by the first  
18 aircraft based on the first icing forecast.

19

1 30. The aircraft of claim 28 or claim 29, wherein the dynamic airfoil icing flight planning  
2 system is configured to determine a second icing forecast, the second icing forecast being  
3 associated with a first flight plan of a second aircraft,

4 wherein determining the second icing forecast comprises:

5 receiving a second set of parameter data, the second set of parameter data being  
6 associated with the first flight plan of the second aircraft;

7 obtaining a second set of atmospheric data, the second set of atmospheric data  
8 being associated with the second set of parameter data;

9 determining a second set of grid points, each grid point of the second set of grid  
10 points being a four-dimensional grid point associated with the first flight  
11 plan of the second aircraft; and

12 determining a second set of icing data, the second set of icing data being  
13 associated with the second set of grid points and being determined based  
14 on an airfoil type of the second aircraft.

15 31. The aircraft control system of any one of claims 28 to 30, wherein the first aircraft  
16 comprises a first sensor, at least some of the data of the first set of parameter data being obtained  
17 from the first sensor.

18 32. The aircraft control system of any one of claims 28 to 31, wherein the first aircraft  
19 comprises an icing component for determining existing icing accumulation on an airfoil of the  
20 aircraft.

21

- 1 33. A method of improving flight safety for an aircraft, the method comprising:  
2 determining a first icing forecast, the first icing forecast being associated with a first  
3 flight plan,  
4 wherein determining the first icing forecast comprises:  
5 receiving a first set of parameter data, the first set of parameter data being  
6 associated with the first flight plan;  
7 obtaining a first set of atmospheric data, the first set of atmospheric data being  
8 associated with the first set of parameter data;  
9 determining a first set of grid points, each grid point of the first set of grid points  
10 being a four-dimensional grid point associated with the first flight plan;  
11 and  
12 determining a first set of icing data, the first set of icing data being associated  
13 with the first set of grid points and being determined based on an airfoil  
14 type of the airfoil.
- 15 34. The method of claim 33, further comprising determining anticipated percent power  
16 increase required by the aircraft based on the first icing forecast.
- 17 35. The method of claim 33 or claim 34, further comprising determining a second icing  
18 forecast, the second icing forecast being associated with a first alternative flight plan,  
19 wherein determining the second icing forecast comprises:  
20 receiving a second set of parameter data, the second set of parameter data being  
21 associated with the first alternative flight plan;

1           obtaining a second set of atmospheric data, the second set of atmospheric data  
2                   being associated with the second set of parameter data;  
3           determining a second set of grid points, each grid point of the second set of grid  
4                   points being a four-dimensional grid point associated with the first  
5                   alternative flight plan; and  
6           determining a second set of icing data, the second set of icing data being  
7                   associated with the second set of grid points and being determined based  
8                   on the airfoil type of the airfoil.

9   36.    The method of any one of claims 33 to 35, wherein at least some of the data of the first  
10 set of parameter data is obtained from a first sensor of the aircraft.

11 37.    The method of any one of claims 33 to 36, further comprising determining existing icing  
12 accumulation on an airfoil of the aircraft.

13 38.    The method of claim 37, wherein an icing component of the aircraft is utilized to  
14 determine the existing icing accumulation on the airfoil.

15 39.    A method of controlling air traffic during inclement weather, the method comprising:  
16           determining a first flight plan of a first aircraft; and  
17           determining a first icing forecast, the first icing forecast being associated with the first  
18                   flight plan of the first aircraft,  
19           wherein determining the first icing forecast comprises:  
20                   receiving a first set of parameter data, the first set of parameter data being  
21                   associated with the first flight plan of the first aircraft;

1           obtaining a first set of atmospheric data, the first set of atmospheric data being  
2           associated with the first set of parameter data;  
3           determining a first set of grid points, each grid point of the first set of grid points  
4           being a four-dimensional grid point associated with the first flight plan  
5           of the first aircraft; and  
6           determining a first set of icing data, the first set of icing data being associated  
7           with the first set of grid points and being determined based on an airfoil  
8           type of the first aircraft.

9   40.    The method of claim 39, further comprising determining anticipated percent power  
10   increase required by the first aircraft based on the first icing forecast.

11   41.    The method of claim 39 or claim 40, further comprising determining a second icing  
12   forecast, the second icing forecast being associated with a first flight plan of a second aircraft,  
13   wherein determining the second icing forecast comprises:

14           receiving a second set of parameter data, the second set of parameter data being  
15           associated with the first flight plan of the second aircraft;  
16           obtaining a second set of atmospheric data, the second set of atmospheric data  
17           being associated with the second set of parameter data;  
18           determining a second set of grid points, each grid point of the second set of grid  
19           points being a four-dimensional grid point associated with the first flight  
20           plan of the second aircraft; and

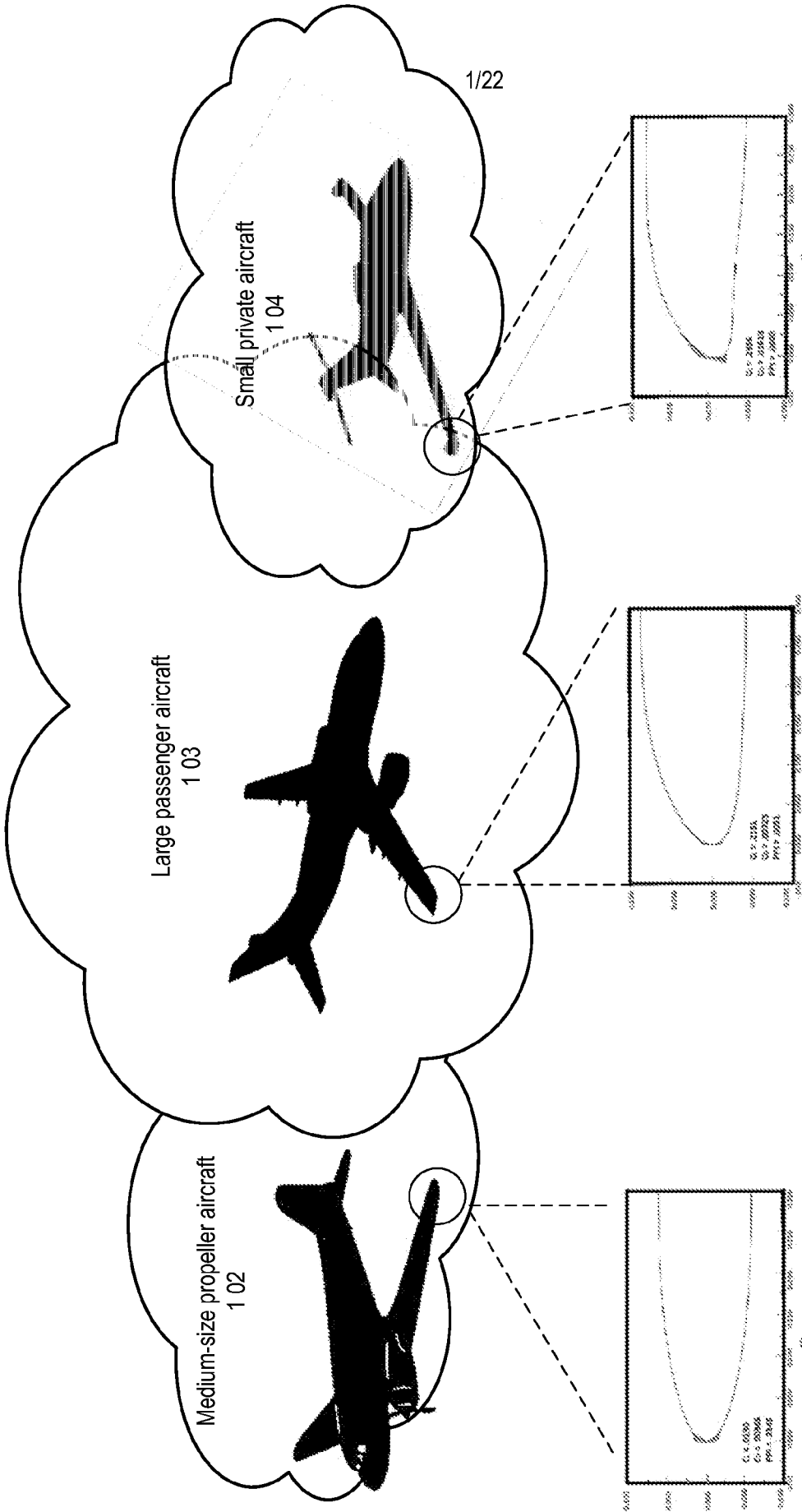
1           determining a second set of icing data, the second set of icing data being  
2           associated with the second set of grid points and being determined based  
3           on an airfoil type of the second aircraft.

4 42.    The method of any one of claims 39 to 41, wherein the first aircraft comprises a first  
5 sensor, at least some of the data of the first set of parameter data being obtained from the first  
6 sensor.

7 43.    The method of any one of claims 39 to 41, further comprising determining existing icing  
8 accumulation on an airfoil of the first aircraft.

9 44.    The method of claim 43, wherein an icing component of the first aircraft is utilized to  
10 determine the existing icing accumulation on the airfoil.

11



Different Airfoils under Identical Weather Conditions Ice Differently

FIG 1

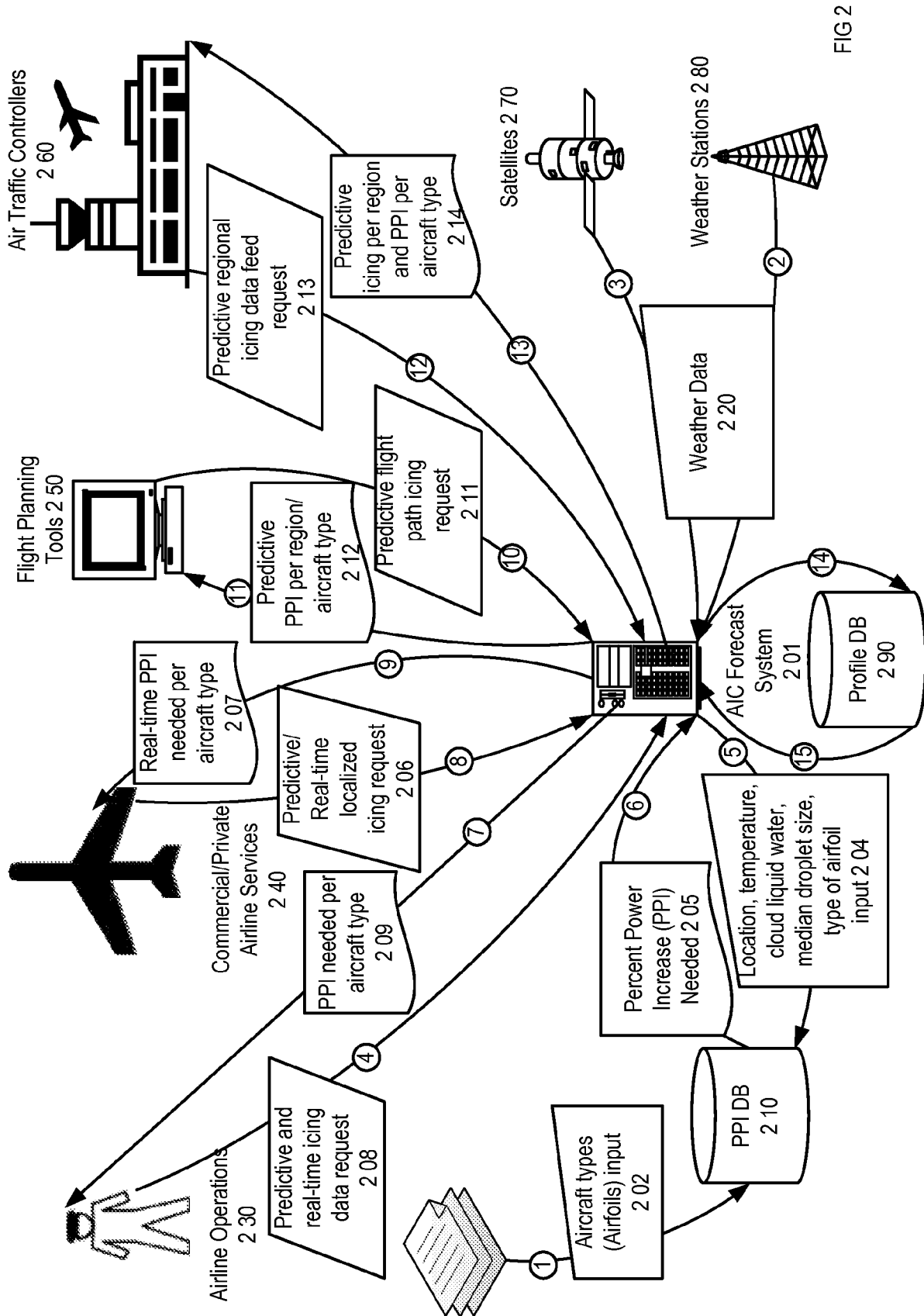


FIG 2

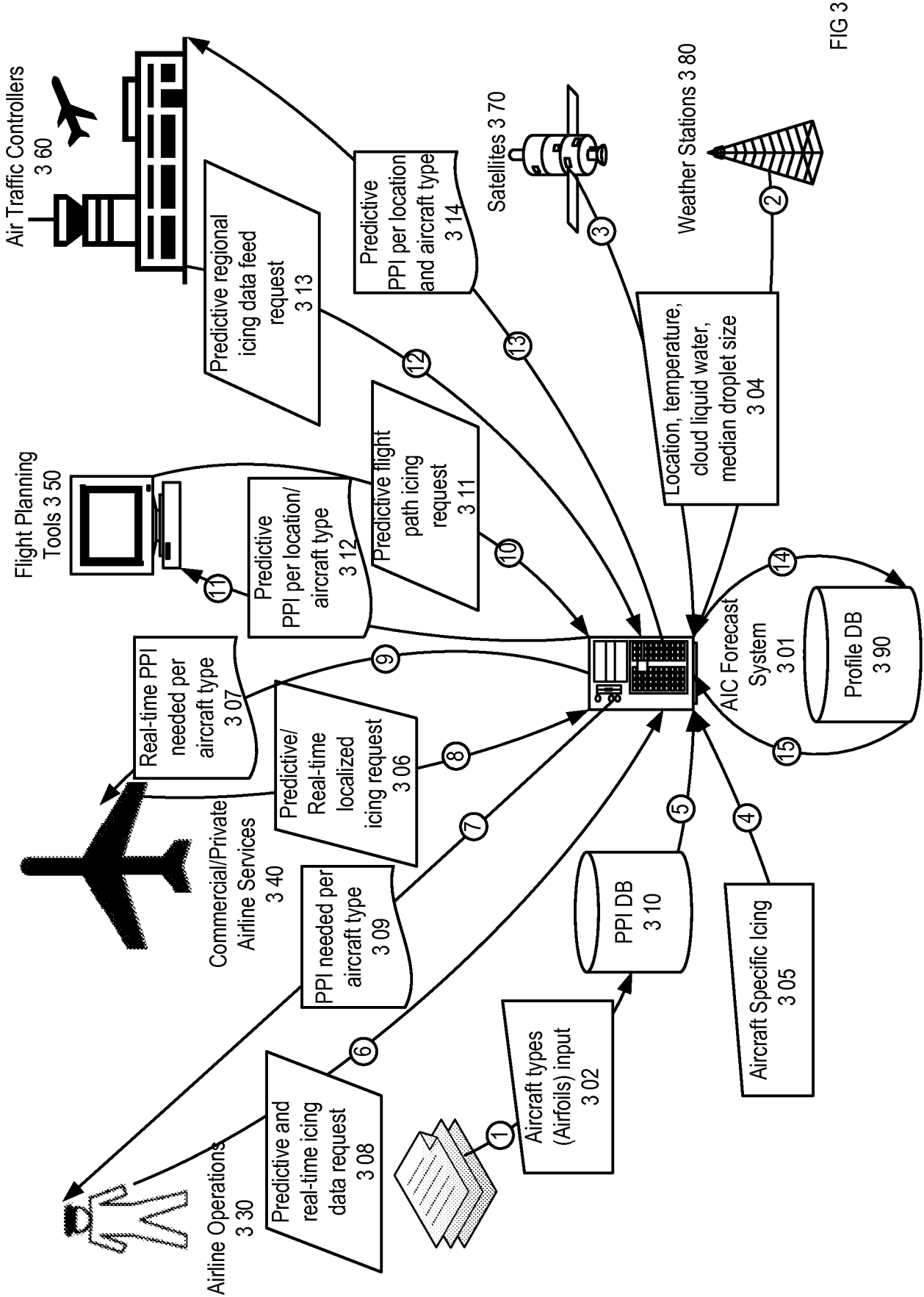


FIG 3

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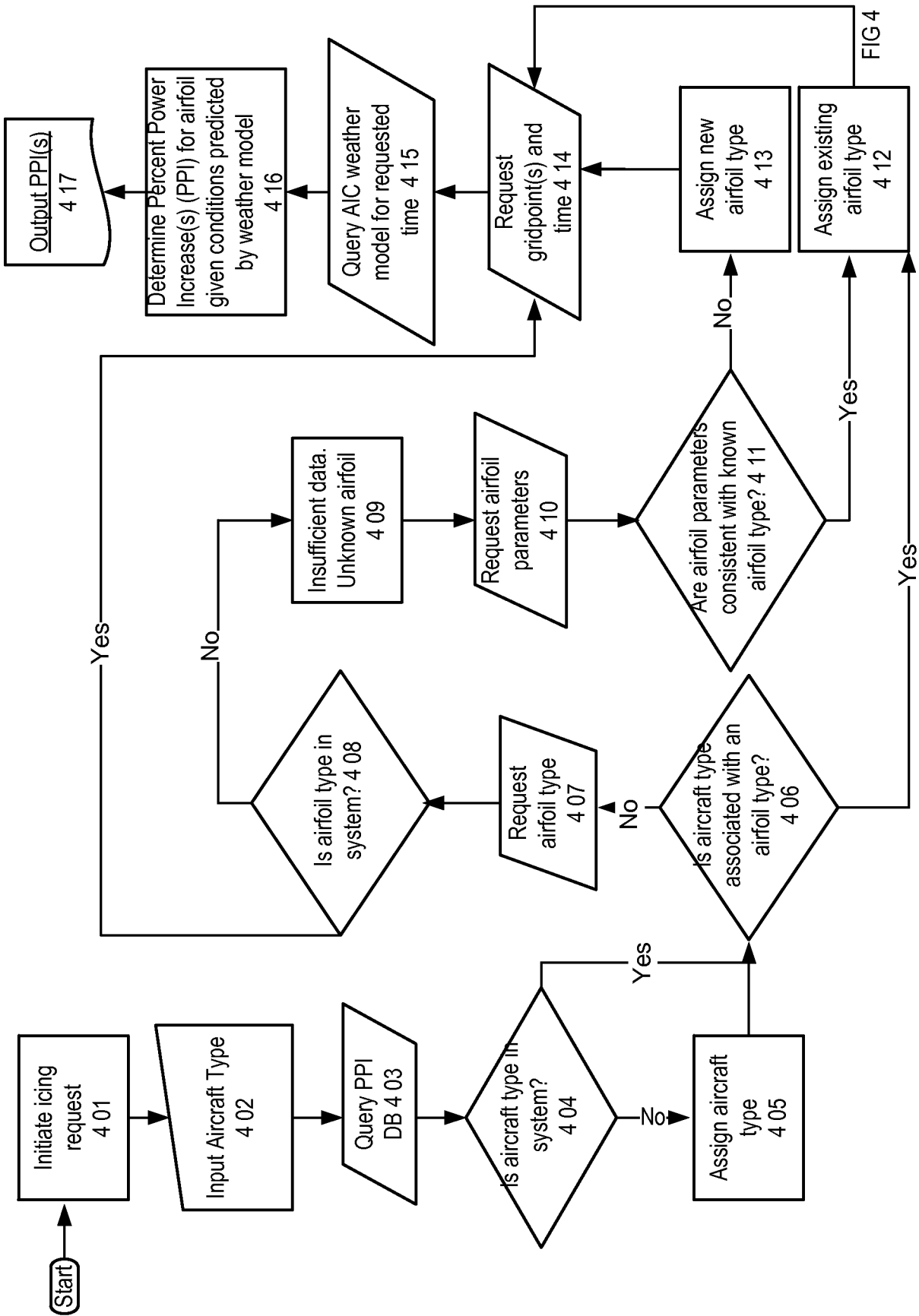


FIG 4

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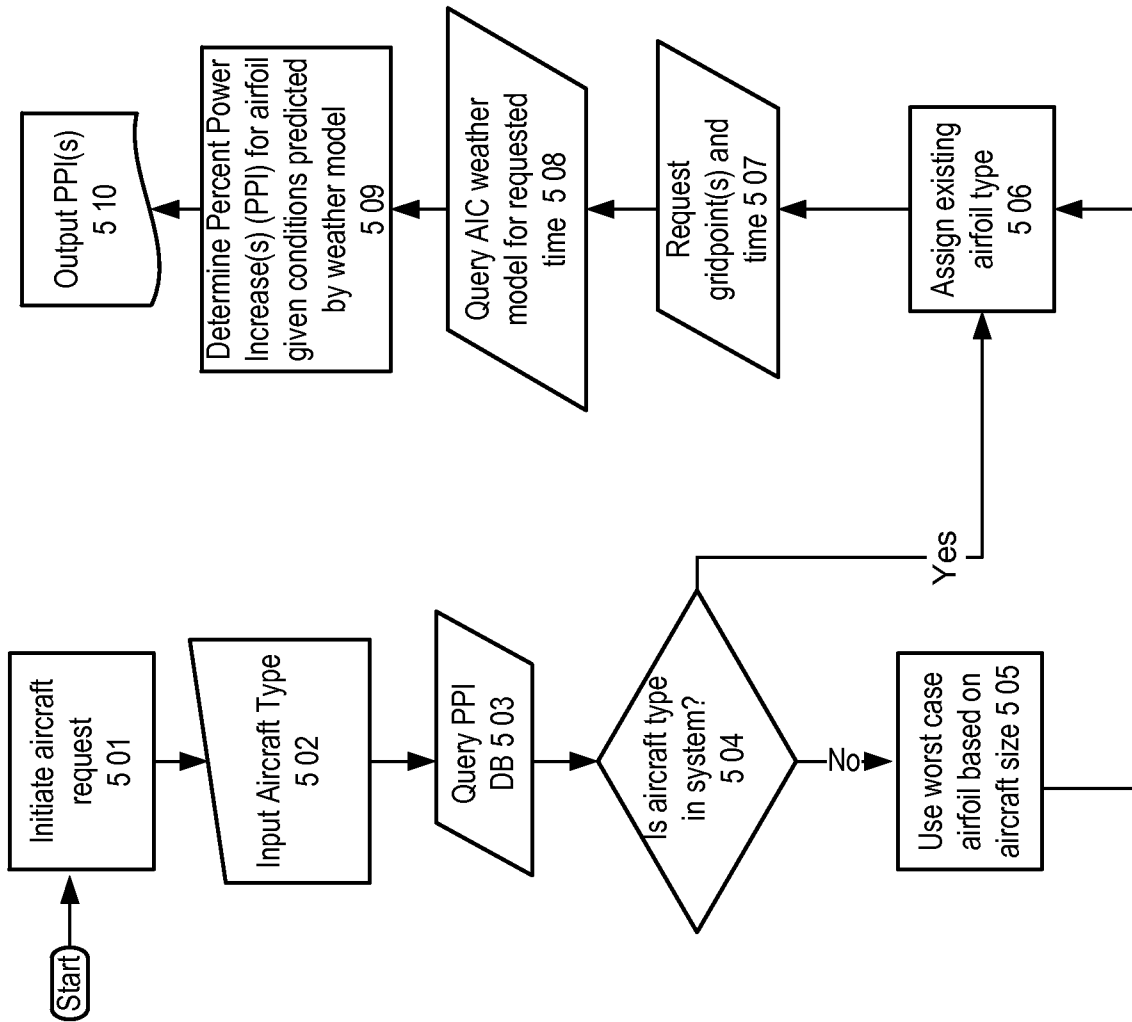


FIG 5

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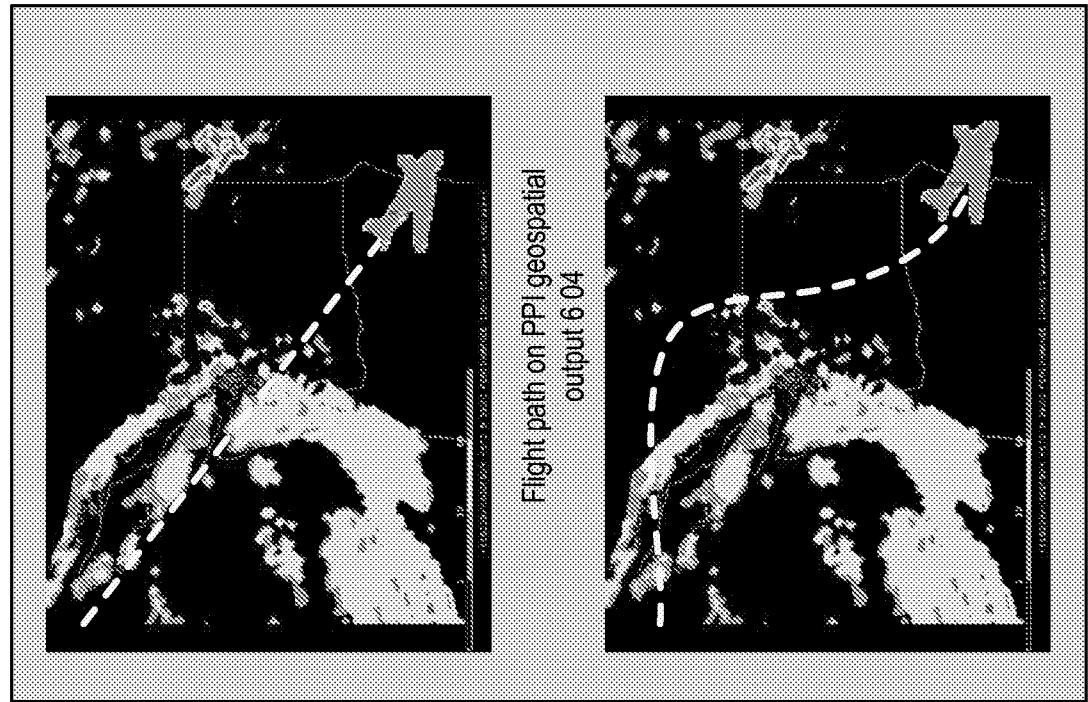
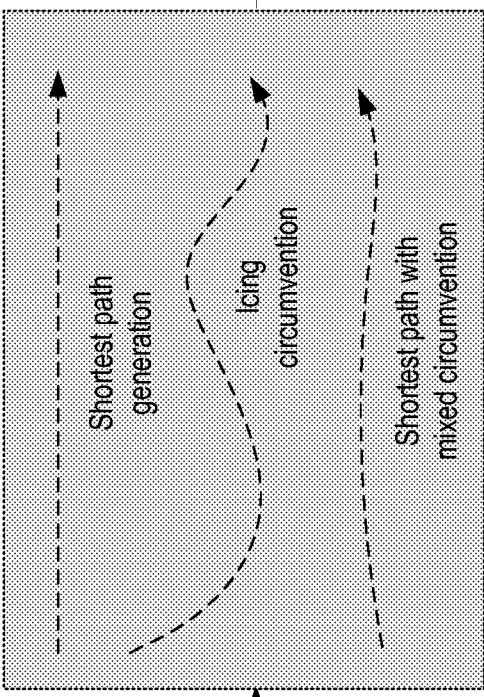


FIG 6

Flight planning component interface 6 01

Interactive element 6 02



Flight requirements 6 03

Flight path on PPI geospatial output 6 04

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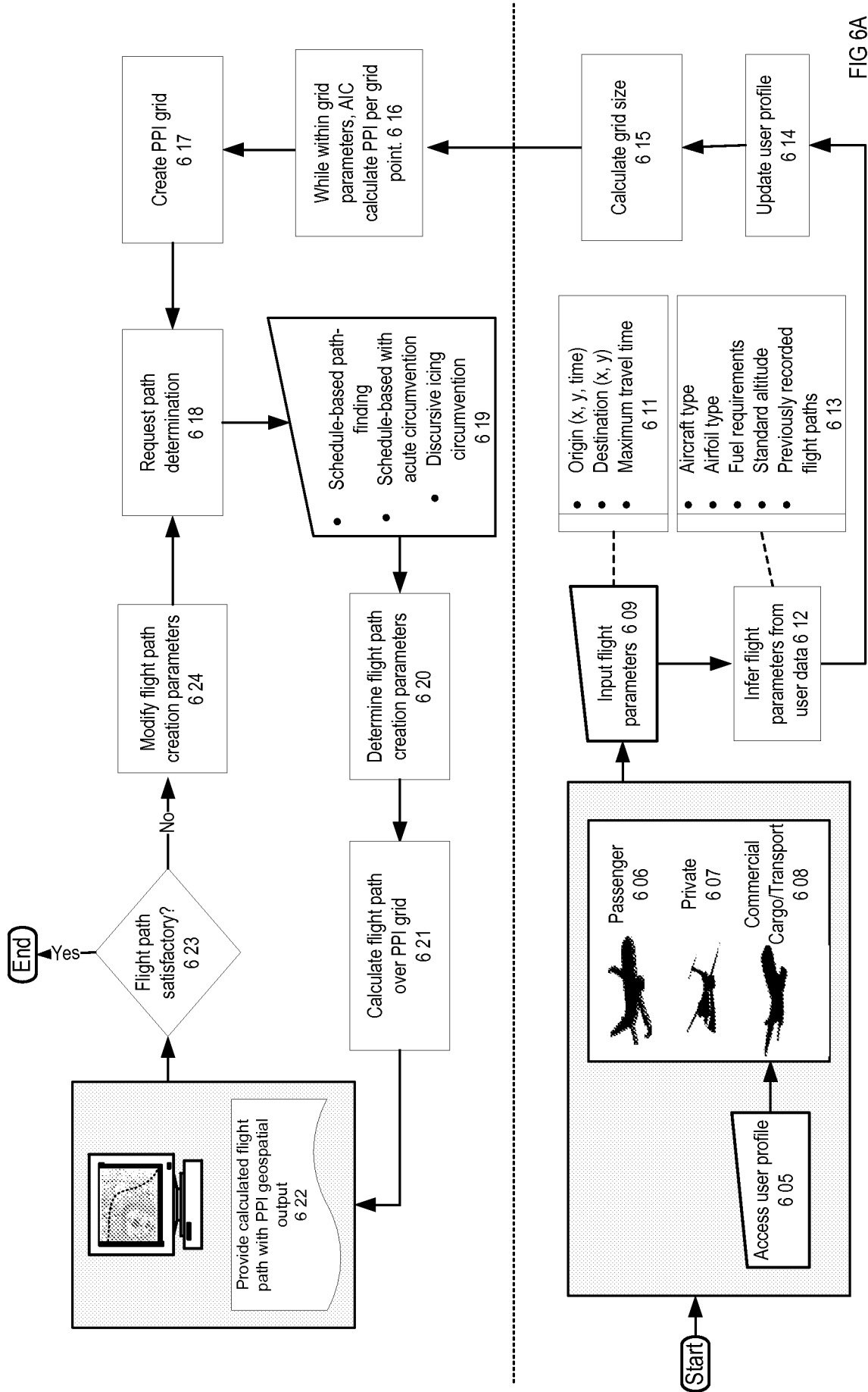
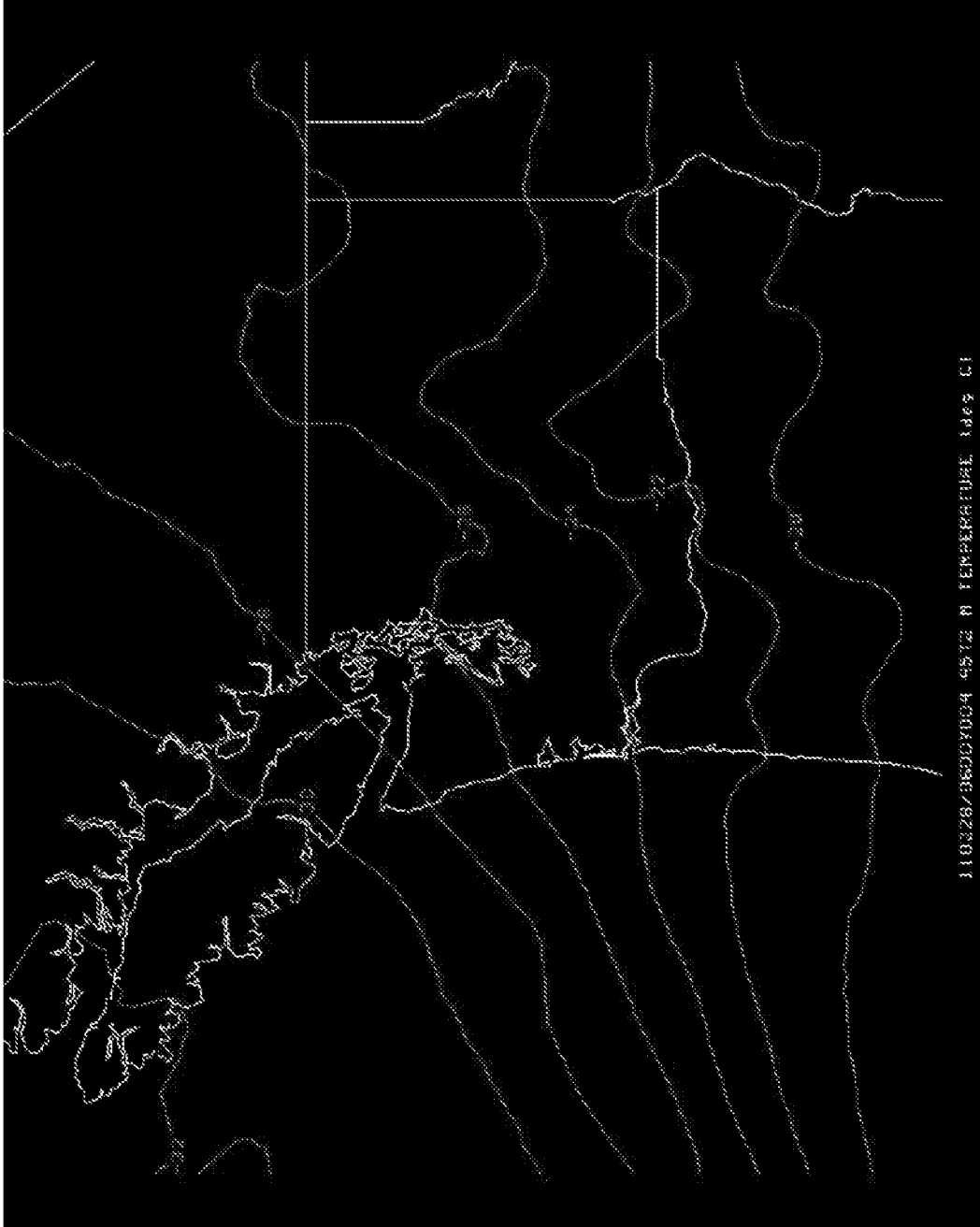


FIG 6A

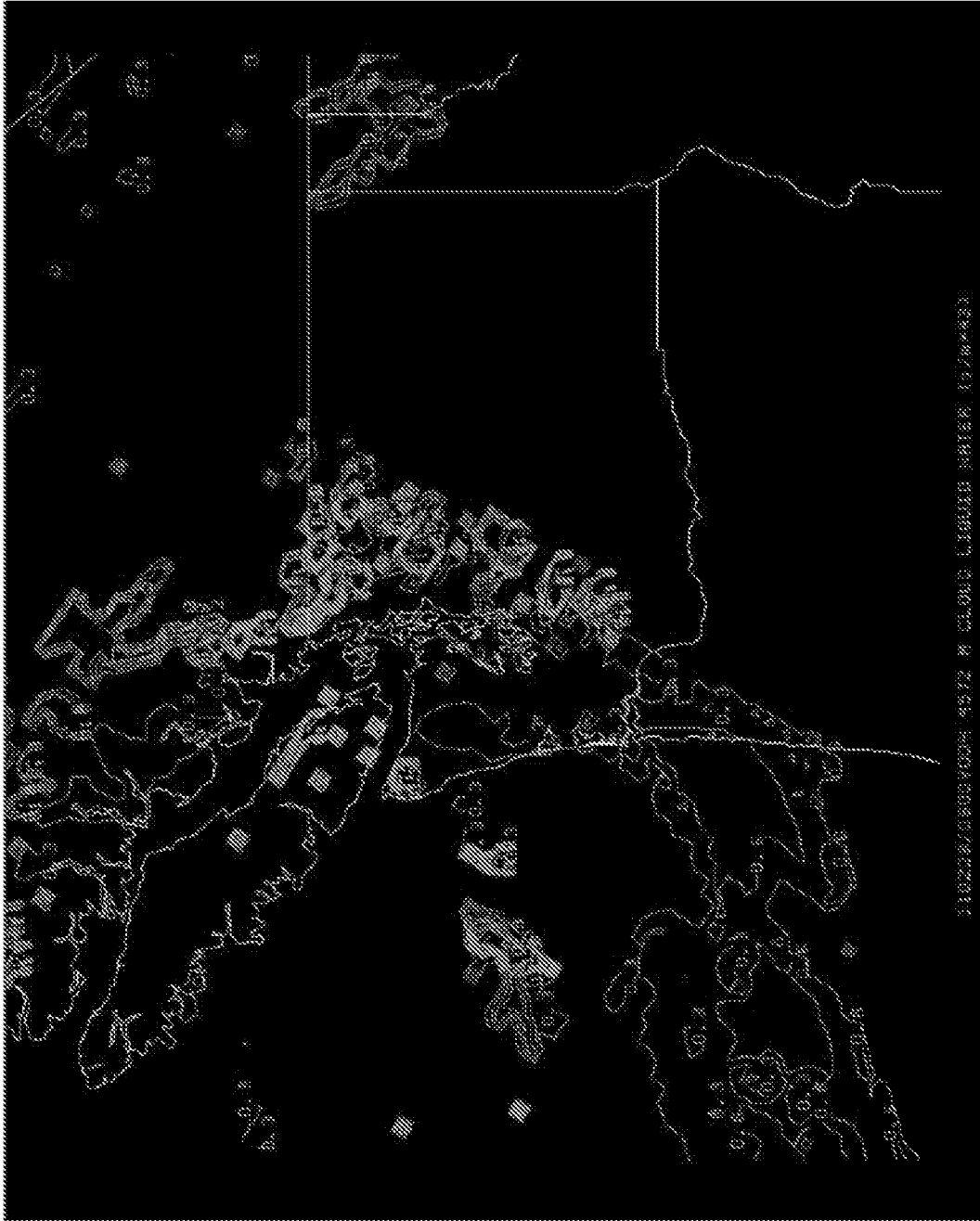
8/22



RUC2 numerical model  
temperature forecast 7 01

FIG 7

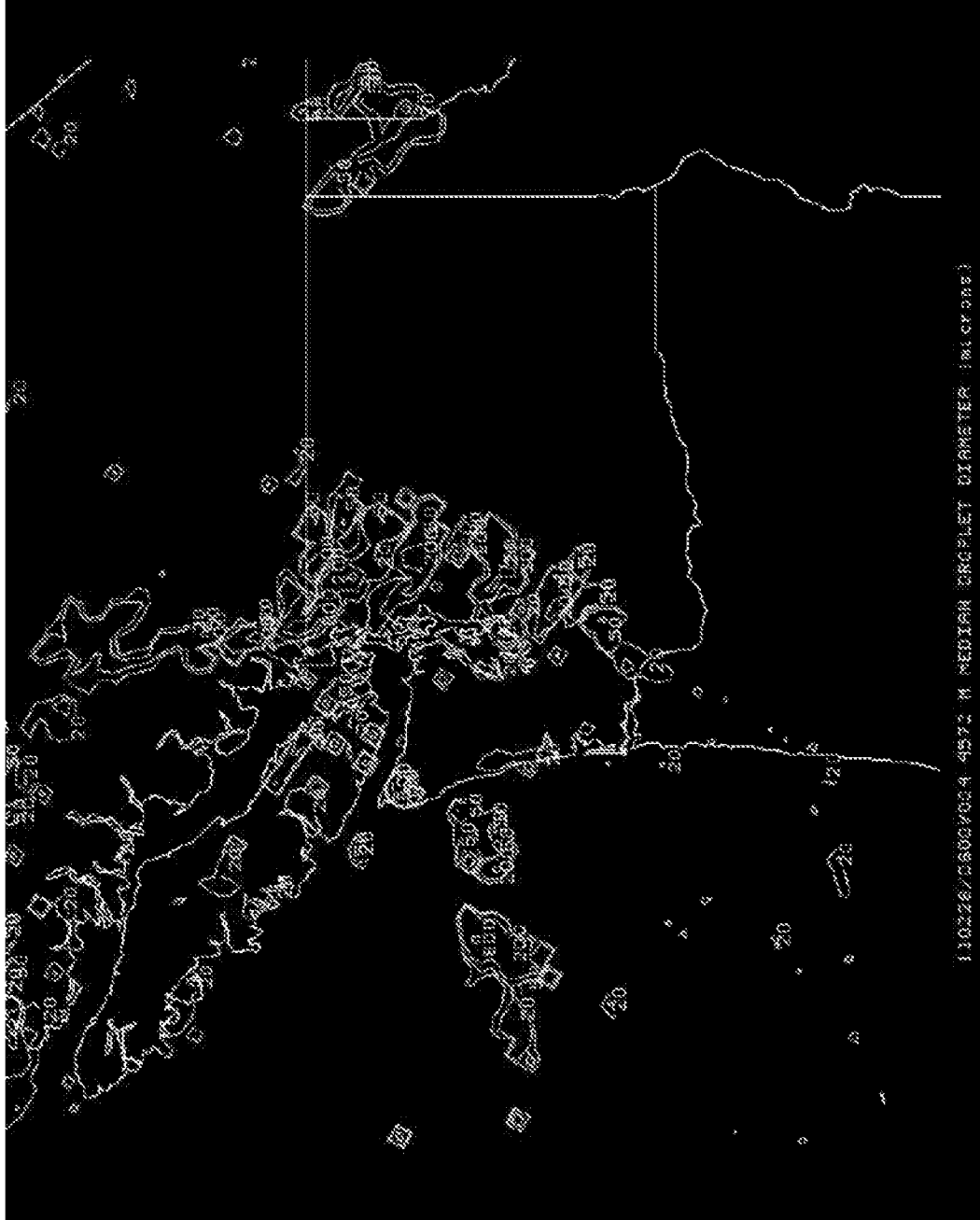
9/22



VVCE cloud liquid water  
forecast 8 01

FIG 8

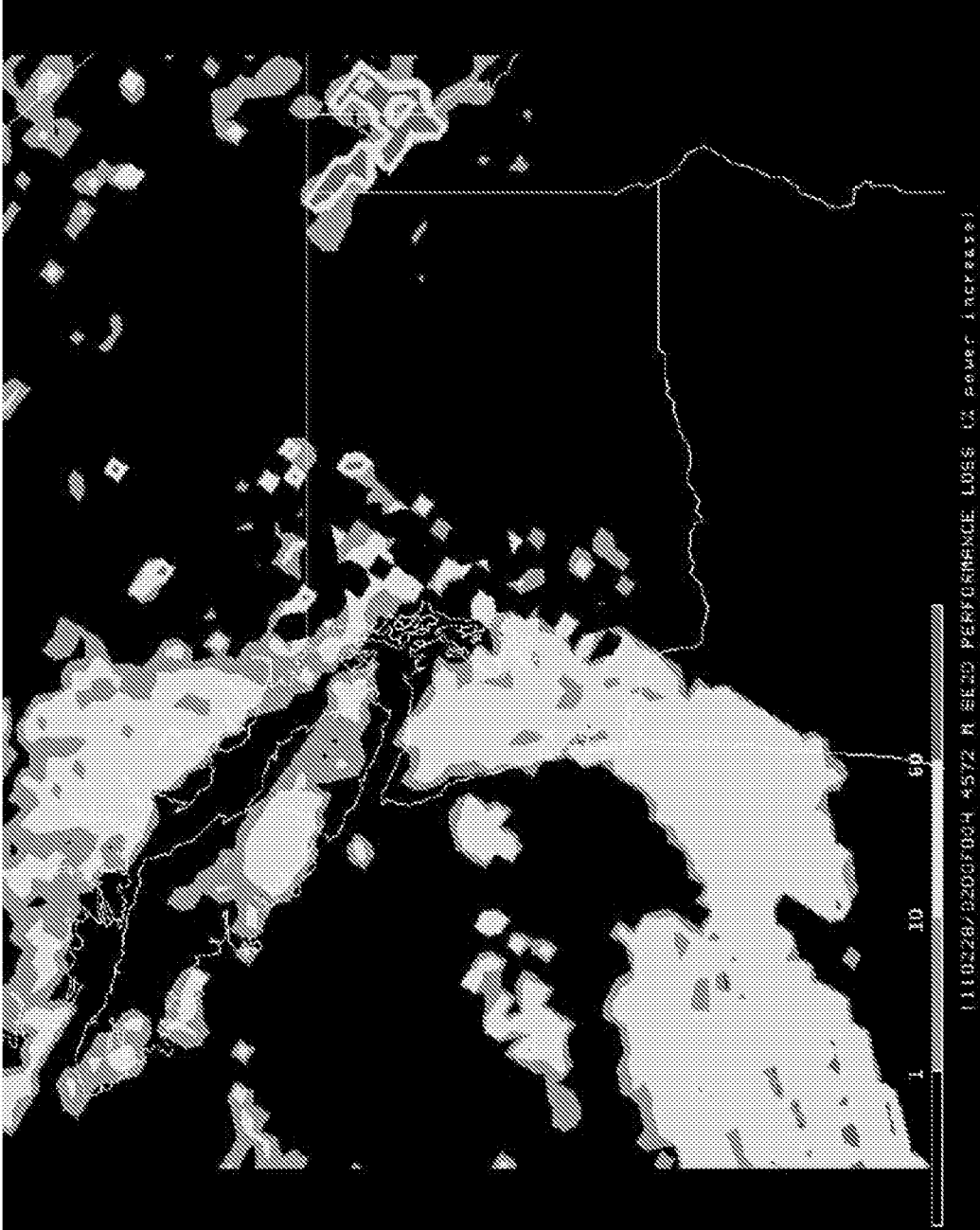
10/22



WICE median droplet diameter  
forecast 9 01

FIG 9

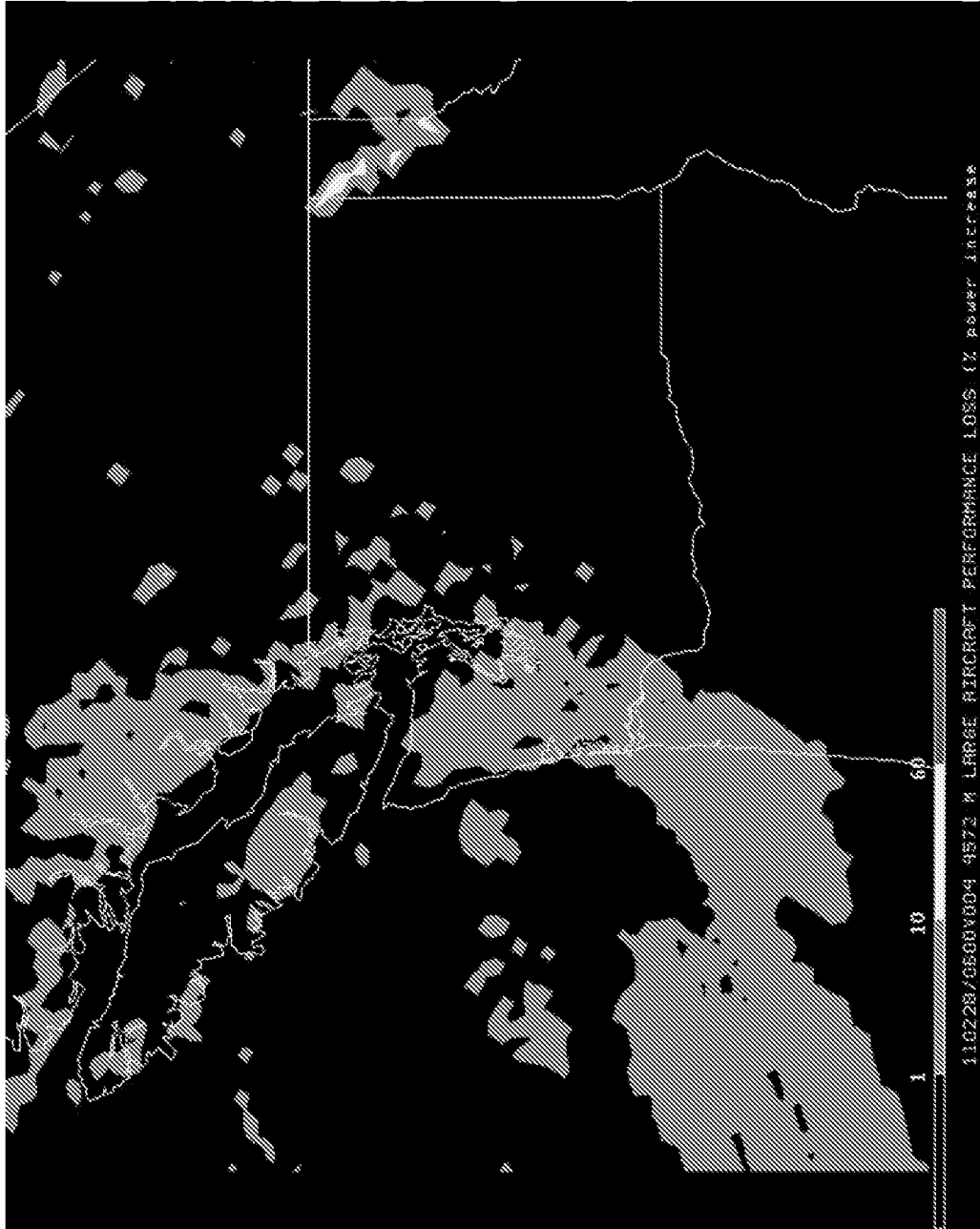
11/22



Small aircraft forecast  
performance loss 10 01

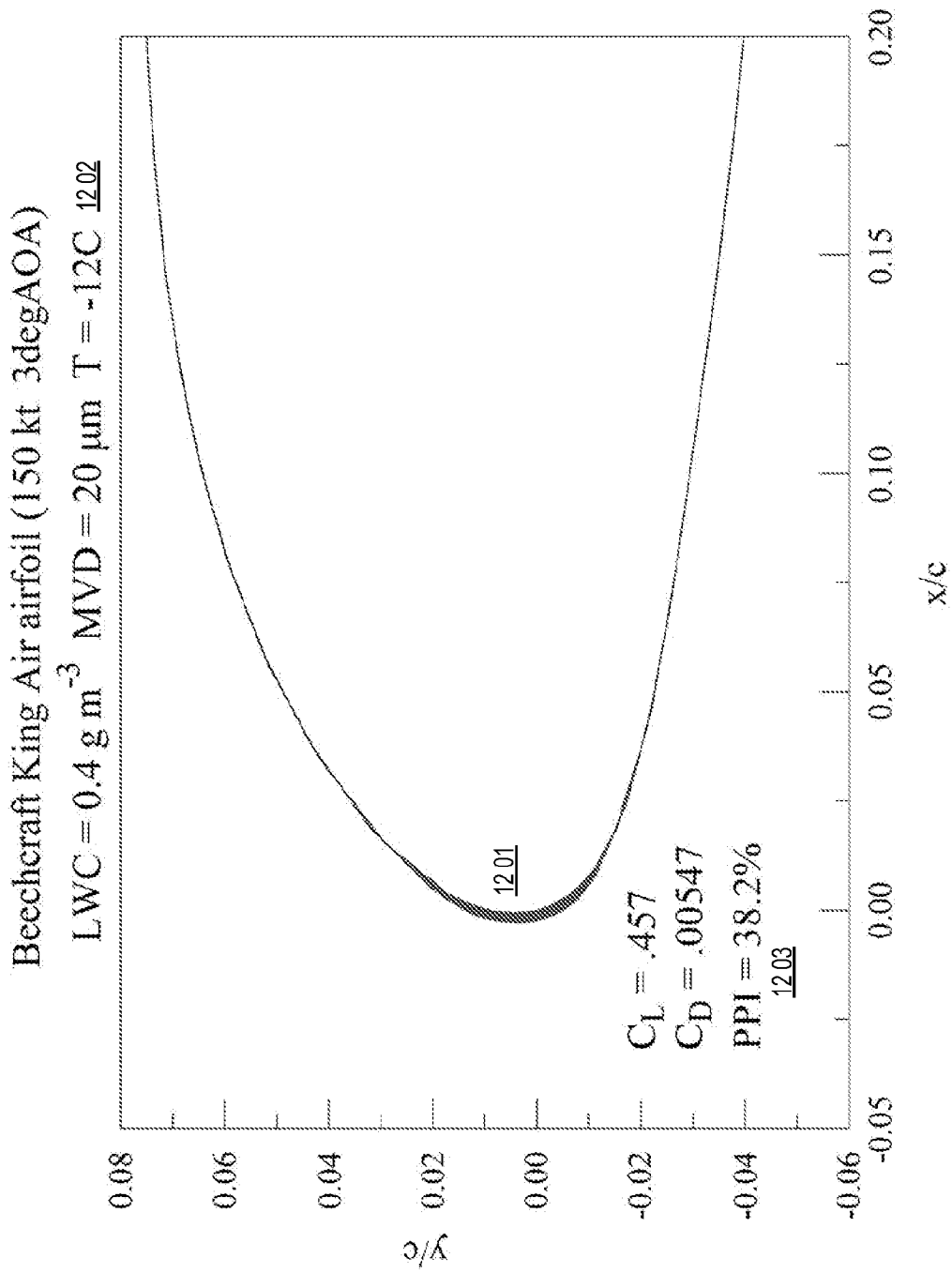
FIG 10

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Large aircraft forecast  
performance loss 11 01

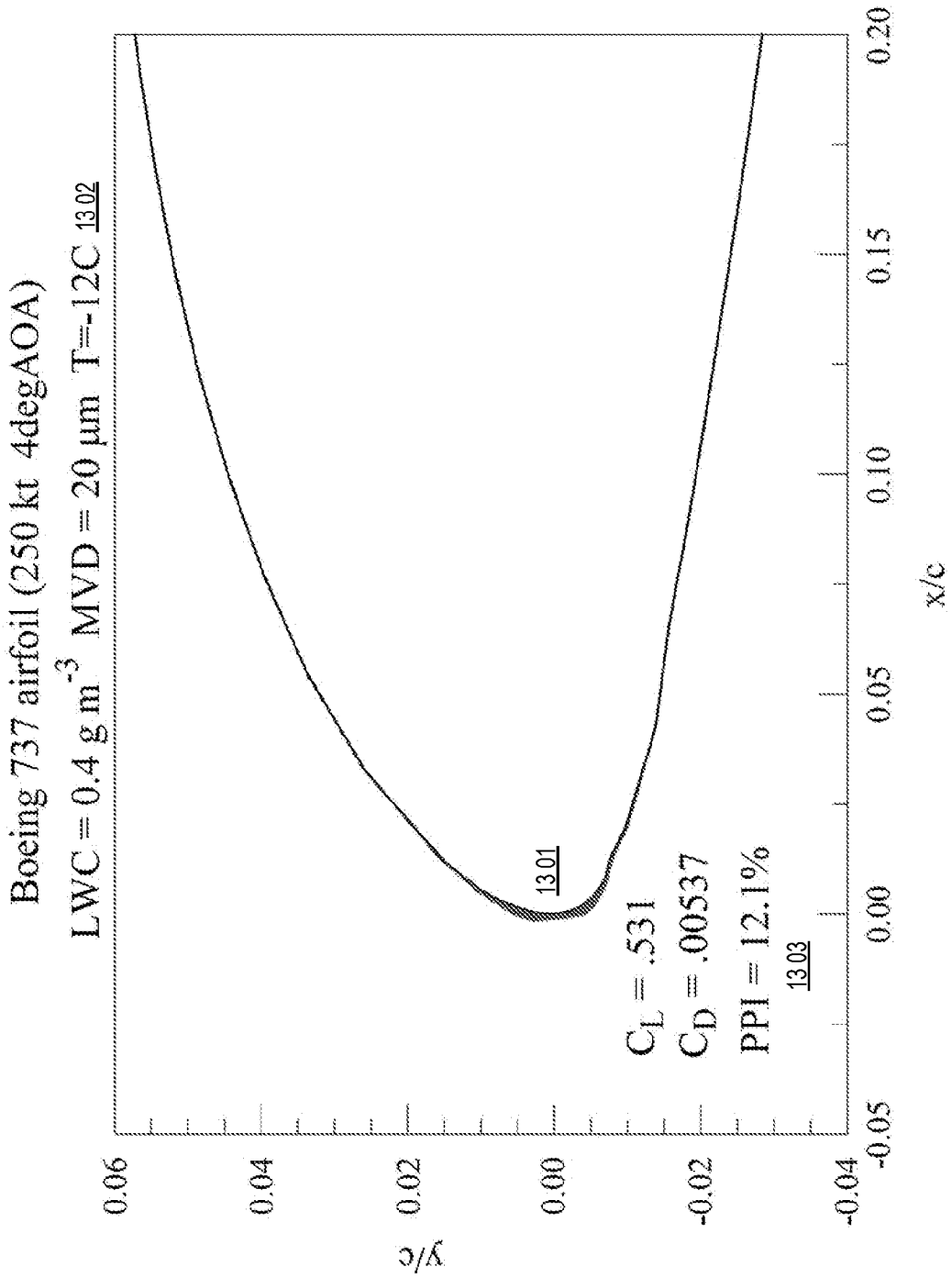
FIG 11



Example: Ice Accumulation and PPI for Beechcraft King Air Airfoil

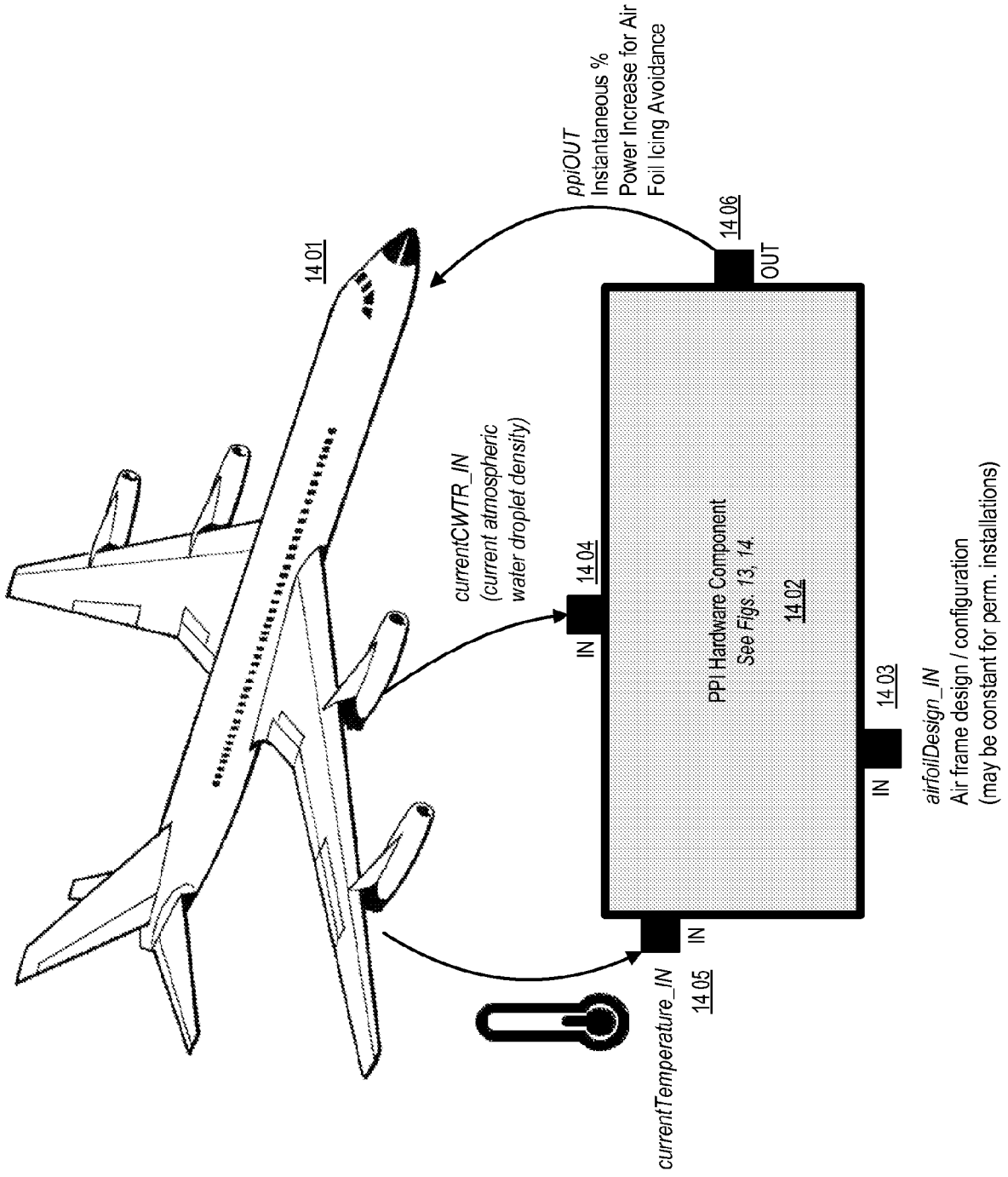
Figure 12

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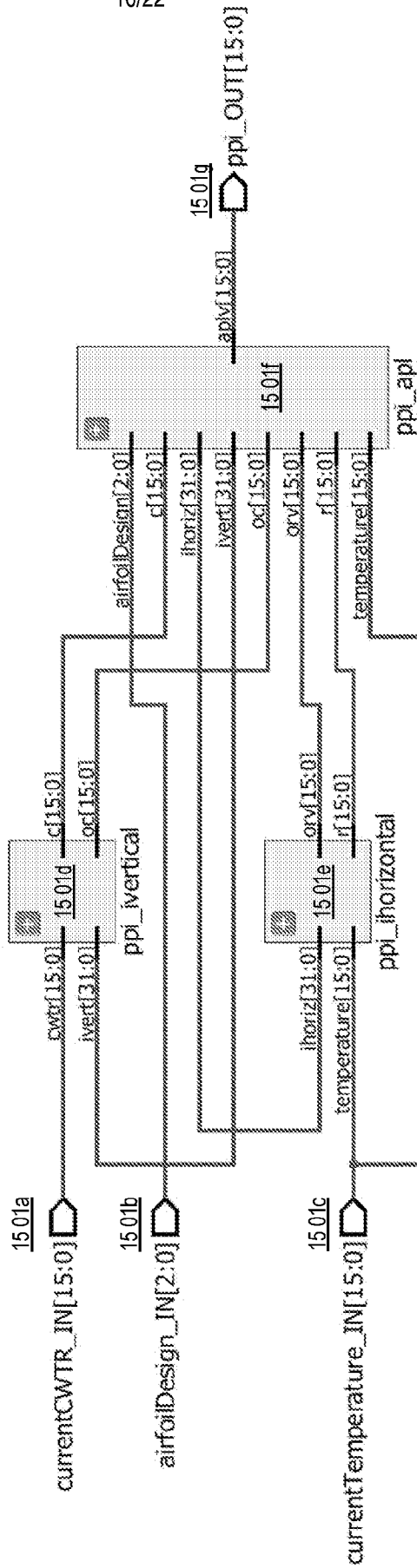
Example: Ice Accumulation and PPI for Boeing 737 Airfoil

Figure 13



Example: PPI Installation

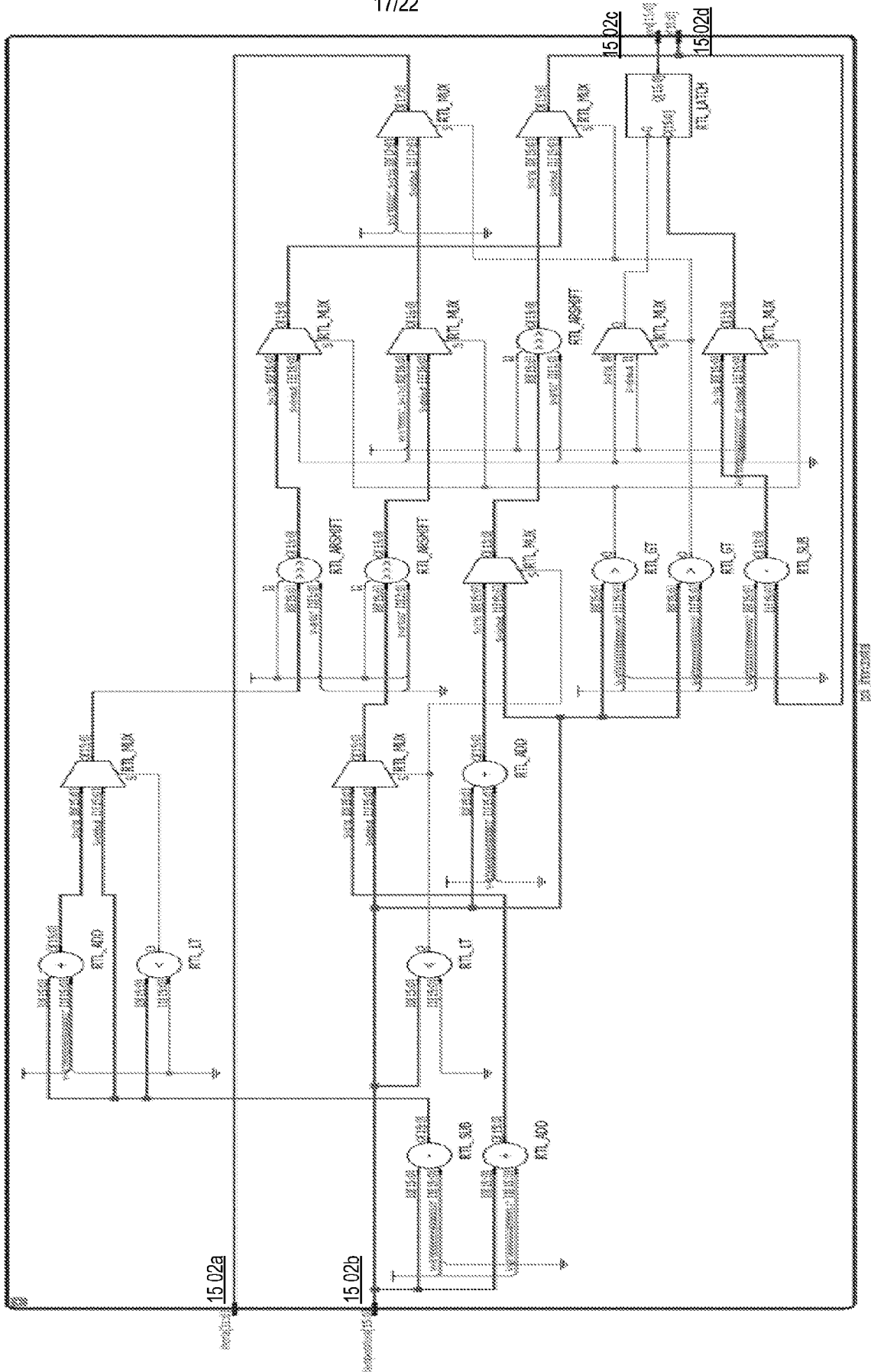
Figure 14



Example: PPI Component, Overview

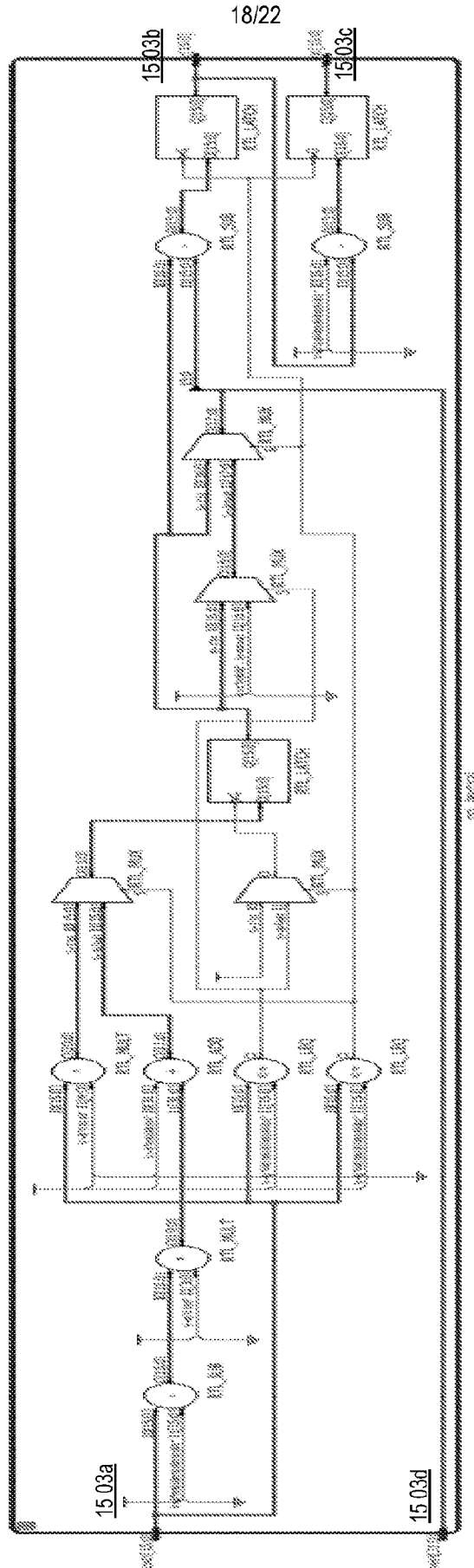
Figure 15A

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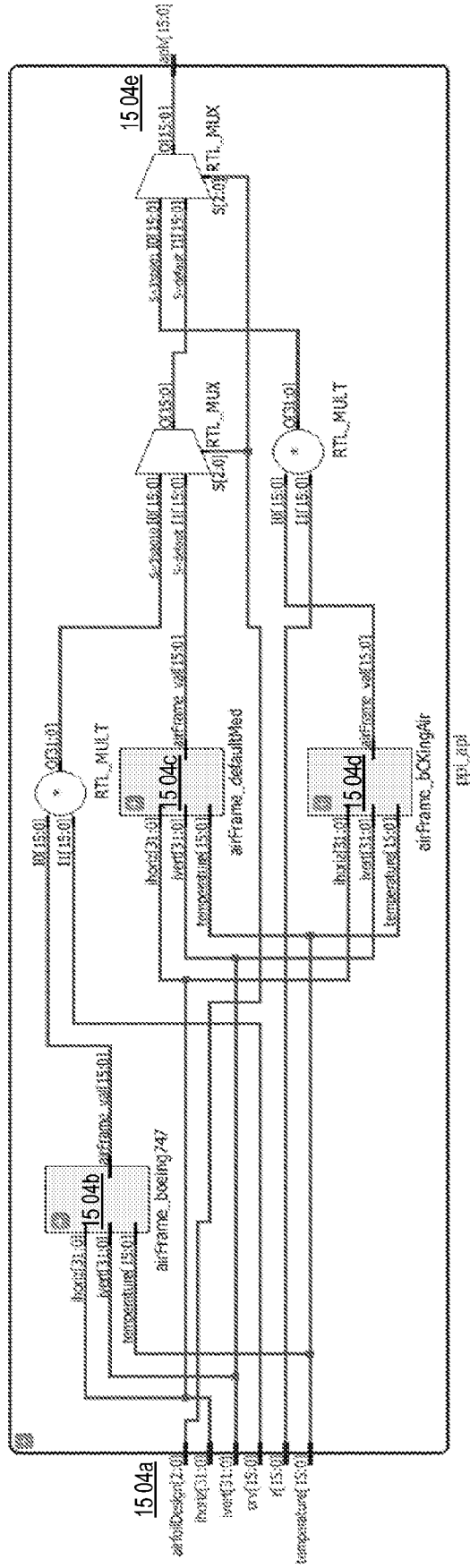
Example: PPI Component (sub-component view: ppi\_horizontal)

Figure 15B



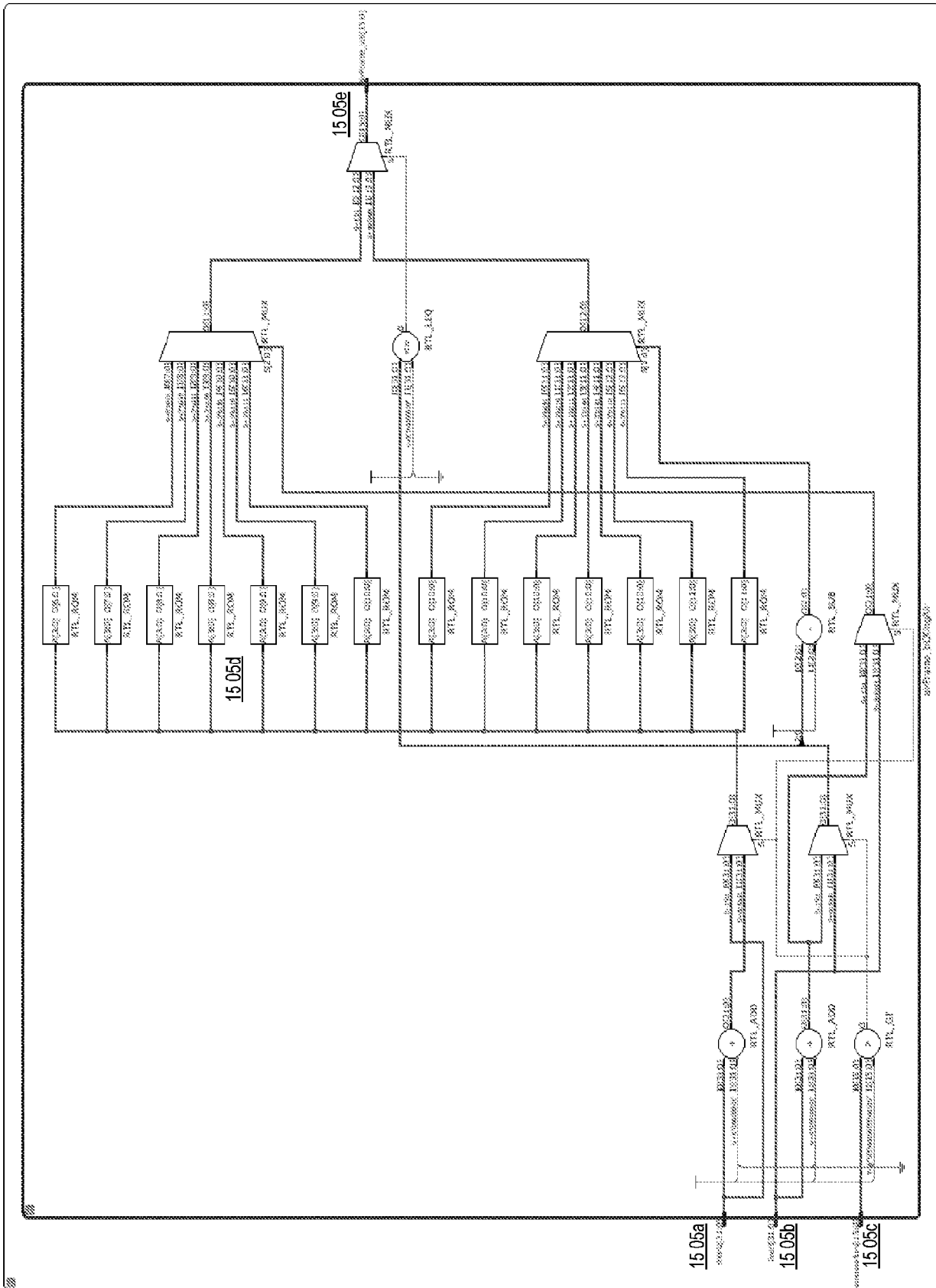
Example: PPI Component (sub-component view: ppi\_vertical)

Figure 15C



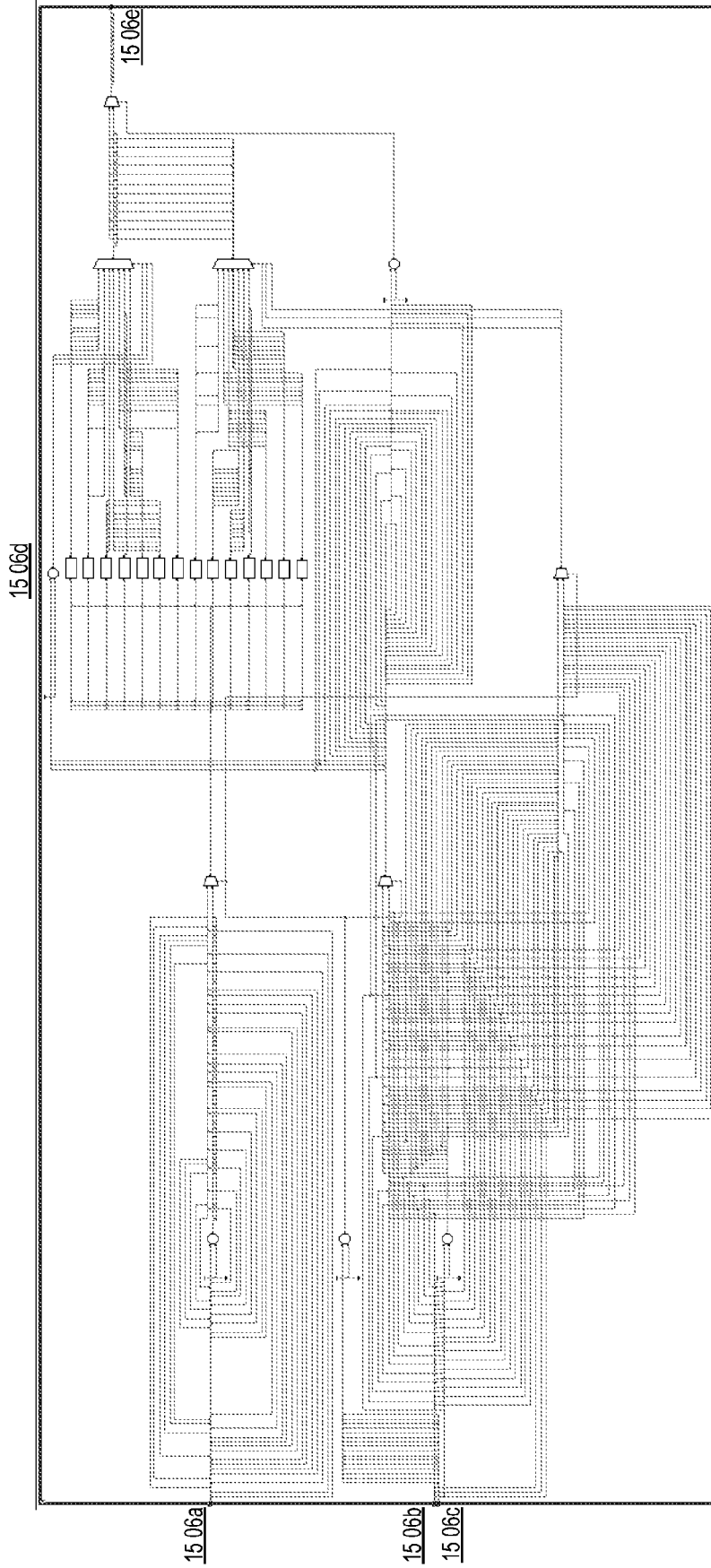
Example: PPI Component (sub-component view: ppi\_ap)

Figure 15D



Example: PPI Component (sub-component sub-view: airFrame Customization Module)

Figure 15E



Example: PPI Component (sub-component sub-view: aiFrame Customization Module Breakout)

Figure 15F

FIGURE 16

