xNOTAM Concept of Operations

- Overview –

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1 INTRODUCTION

1.1 General

This document "xNOTAM Concept of Operations - Overview" has been produced by Sofreavia under contract for the EUROCONTROL Directorate of ATM Strategies – Aeronautical Information Management Domain. The purpose of the document is to introduce the xNOTAM concept, its technical aspects, and to evaluate the potentially affected actors and workflows.

This document focuses on technical issues about the xNOTAM concept, and does not address the implementation strategies or risk assessment, which will be evaluated in separate documents.

A general comparison between the current NOTAM system and the new xNOTAM concept is provided in the conclusion.

1.2 Objective

Timeliness of the data is a key requirement of the present and future Air Traffic Management (ATM) system. At present, this means NOTAM. The usefulness is quite restricted, at least from the digital information processing chain point of view.

NOTAM messages are not sufficiently structured for intelligent machine use. It is not unusual that the content of a database, be it on-board or on the ground, is 'superseded by NOTAM'. There is a risk that safety critical, last minute information remains outside of the automated data processing chains on which the ATM system is increasingly dependent.

The "NOTAM current concept of operations" summarises the essential NOTAM system drawbacks :

- Insufficient level of automation of NOTAM processing,
- Failure in the AIS data chain leading to NOTAM database integrity issues,
- Pilot's difficulties in taking into account NOTAM information provided in PIB.

A study of this problem was introduced by EUROCONTROL in 2003 called 'xNOTAM Proof of Concept'. As a result, an extension of the Aeronautical Information Exchange Model (AIXM) was considered as a strong candidate for an enhanced structured NOTAM. This concept is referred to as "xNOTAM".

The proof of concept xNOTAM study demonstrates that :

- xNOTAM messages can automatically update an AIXM based aeronautical database,
- Enhanced briefing, including graphical display can be produced from such real time database.

The main objective of the xNOTAM concept is to merge "static" and "dynamic" data in a single data exchange format in order to describe the underlying data content for intelligent machine use, equally suitable for in-flight and ground systems.

1.3 From product centric to data centric

xNOTAM may be seen as the borderline between a product centric AIS and a data centric AIM system. At the core of the AIM activity is a database of reference aeronautical information, which integrates static and dynamic data. The database can be local or regional, centralised or distributed.

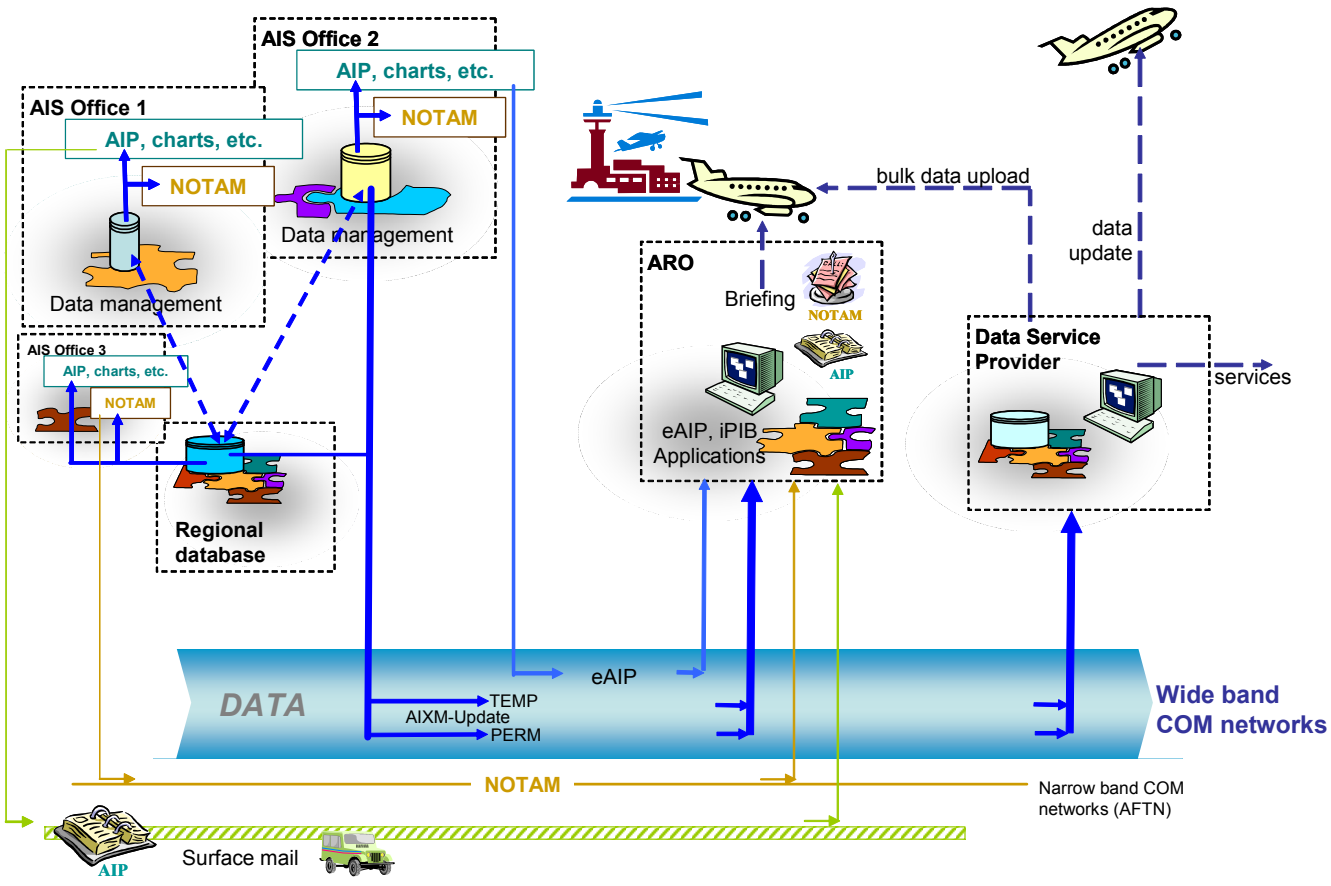
Whenever a change occurs in the aeronautical environment and needs to be promulgated by the AIS office, the first step is the update of the database. In the second step, the AIS office issues:

- machine understandable messages (AIXM), which are distributed to the clients having subscribed to this a service;
- classical AIS products: AIP, SUP, AMDT, NOTAM, etc.; for example, if the change is temporary, a NOTAM or an AIP SUP will be issued, following the current ICAO SARPS

At the heart of the xNOTAM concept is the idea that AIXM changes of temporary nature can be published as NOTAM. Occasionally, permanent AIXM changes can also be published as NOTAM, if occurring on short notice and there is not sufficient time to prepare an AIP AMDT.

Generally speaking, NOTAM are messages, xNOTAM are events on aeronautical objects.

The diagram below presents possible main interactions in a data centric AIM system.



1.4 XNOTAM planning

The implementation of the xNOTAM concept in the ECAC Area will be done through a dedicated Programme, defined and initiated by the AIM Domain. This includes the development of the following:

- Concept of Operations
- Technical requirements
- Operational requirements
- Evaluation of benefits and implementation costs
- Risk assessment
- Programme Charter

Some major milestones are indicated in the table below:

Event	Date
xNOTAM Proof of Concept study	End 2003
AIXM release 4.0	End 2004
xNOTAM Concept of Operations study	End 2004
Programme Initiation Charter	End 2005
AIXM release 5.0 with xNOTAM concept	End 2005
Implementation of AIXM 5.0 (with xNOTAM capabilities)	2006-2009
xNOTAM fully operational in ECAC	2010

2 XNOTAM SYSTEM REQUIREMENTS

In this chapter the main requirements applicable to the xNOTAM system, and the improvements and enhancements expected by such a concept will be described.

2.1 Primary Requirements

The first step is to summarise the high level requirements of the new xNOTAM system.

2.2 Solution completeness

The primary objective of xNOTAM is to make all information currently exchanged as NOTAM understandable by computers. Therefore, it shall be possible to create equivalent AIXM-update messages for all currently published NOTAM.

This requirement has many impacts on the AIXM structure. In particular, the AIXM model has to be extended to include operational status and time table structures for several existing features. It is also likely that new AIXM features or structures will have to be created.

Some examples of AIXM temporary updates with their NOTAM conversion are presented further in the document (xNOTAM Samples), to express the required model improvements. It is already visible from these examples that new feature attributes and new structures have been added in the AIXM XML Schema in order to support temporary changes.

2.2.1 Backward compatibility

The xNOTAM concept should be fully backward compatible with current NOTAM and ATS systems.

In other words, current actors or organisations involved in the NOTAM system should not be affected by the partial of complete migration of other actors towards xNOTAM.

2.2.2 Migration Objectives

The main objective for the migration phase is to ensure that the xNOTAM concept progressively replaces the current NOTAM system. In order to prove its viability and attractiveness, xNOTAM implementations shall deliver immediate improvements for the users. For example: enhanced PIB capabilities or the possibility to display temporary information in a graphical environment.

By its nature, the xNOTAM concept can only be implemented on a regional/global basis. An isolated national implementation would provide only very limited benefits.

Full benefits can only be obtained through a global implementation (ICAO). This worldwide migration will probably not occur before decades. A realistic intermediate objective would be to see group of neighbouring states exchanging AIXM data , thus forming an xNOTAM area isolated from none migrated states.

2.2.3 Data responsibility

States should continue to keep the entire responsibility and management of their own NOTAM or xNOTAM processing. Data provided by state organisations, especially by AIP or NOTAM office, have to remain under their responsibility.

On the other hand, organisations wishing to delegate xNOTAM processing should be able to do so as they do with current NOTAM processing.

As a consequence of the first previous requirements, migrated NOTAM Data Providers will continue to publish NOTAM for non migrated actors, but will also produce corresponding xNOTAM information for migrated ones.

2.2.4 Database responsibility

Organisations should be able to validate and check xNOTAM received from other organisation, before taking them into account for their own database.

Even if xNOTAM are fully understandable by computers, an organisation may decide to manually validate and even reject xNOTAM received from any organisation, using their own filtering criteria or submission workflow.

2.2.5 Human factors

xNOTAM users should be able to handle xNOTAM data in an ergonomic way.

The primary beneficiary of xNOTAM will be automated data processing systems. Even though xNOTAM are described or exchanged using XML, which is more or less human readable, users should never have to face XML syntax or description.

In addition, enhanced HMI should be designed to display aeronautical information, for instance using dynamic charts, automatically updated by real time xNOTAM data.

Nevertheless and despite HMI improvements, future xNOTAM Data Providers will have to acquire a sound AIXM/AICM knowledge, in particular when dealing with complex features, such as Procedure or Route description.

2.3 Secondary Requirements

These requirements are derived from primary ones, taking into account the technical software implementation for xNOTAM concept.

2.3.1 Database coverage

As xNOTAM concept is fully based on AIXM, all xNOTAM users or providers should have access to an AIXM database dynamically updated. In general, xNOTAM cannot be created or used without access to a corresponding underlying AIXM database.

This does not exclude usage scenarios in which the client receives, together with the xNOTAM message, all complementary information in order to display it on a screen, for example, without the need for a local database. However, somewhere in the data processing chain, the complementary information was added to the core xNOTAM message by a data service provider, based on an up-to-date AIXM database.

To be able to handle and understand xNOTAM from one state, the receiver should have the complete AIXM database from this particular state. This requirement points out the fact that the AIXM database required for an xNOTAM user will contain a larger amount of data than the aeronautical reference databases currently required for current NOTAM processing.

This is justified by the xNOTAM concept itself, which aims at merging static and dynamic data updates in a single electronic message.

2.3.2 Network capacity

As a consequence of the previous requirement, an xNOTAM user or provider should use a network with appropriate bandwidth, to be able to send or receive large AIXM files, for its database updates.

AFTN, even using compression and encoding processing, will obviously not support large AIXM exchanges.

For example, in the ECAC area, the EAD system network has sufficient bandwidth to support this requirement.

This network capacity requirement does not disqualify xNOTAM concept for in-flight systems. For these applications, the aircraft AIXM database could be loaded before departure, while only AIXM updates would be sent on-board during flight duration.

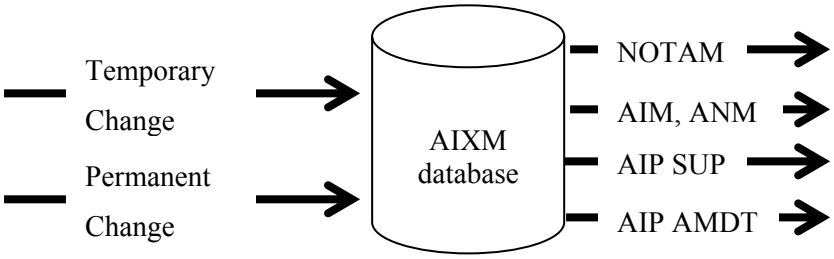
Another way to avoid this network constraint could be to develop internet Web services, where Data Originators would provide only essential data to a centralised AIXM database.

2.3.3 xNOTAM conversion

To achieve the backward compatibility requirement, it should be possible to publish by current AIS means any temporary or permanent AIXM changes.

Basically, permanent AIXM changes will be published using AIRAC AIP amendments, while temporary AIXM changes will be published by NOTAM or AIP supplements. The current ICAO SARPS with regard to the split between NOTAM, AIP AMDT and AIP SUP remain fully applicable.

In some other cases, AIXM changes will be translated into AIM, ANM, CRAM, SNOWTAM or ASTHAM.



This requirement implies that the same level of information is available to migrated or non-migrated organisations.

2.3.4 NOTAM conversion

Most of the enhanced capabilities envisaged by xNOTAM can only be achieved by users working in a full xNOTAM environment. For a long time period, users of data coming from many States will have to cope with a mixed environment.

For the xNOTAM workflow point of view, this requirement may allow an organisation to convert received NOTAM into AIXM updates. This organisation will be able to work in a 100% AIXM environment. It is expected that service data providers and regional AIS databases will offer such translation services, similar to the NOTAM validation process of today.

3 XNOTAM SYSTEM IMPROVEMENTS

Several expected benefits of the xNOTAM concept can be identified.

The first paragraph describes the technical enhancements, followed by the operational application of these technical improvements.

3.1 Technical enhancements

The major technical improvement is that AIXM updates can be exchanged between automated systems without any human intervention, and so an AIXM database can be automatically updated in real time. This increased interoperability could significantly improve the AIS data chain.

3.1.1 Database integrity

AIXM is based on XML language and follows a fully described schema in XSD.

In that context, computer exchanges are therefore automatically protected against any inconsistency or ambiguity. By using secured networks implementing protocols like SSL or VPN, AIXM files can be safely exchanged between systems without any concerns with regard to data integrity.

3.1.2 Real time updated database

AIXM databases integrate a temporal dimension. AIXM records are effective during a specified period of time.

Automated systems based on AIXM can thus provide aeronautical information at different time, basically linked to the AIRAC schedule for the “static” information.

Using temporary AIXM updates, automated systems will be able to provide real-time information at any given time.

3.1.3 Accurate aeronautical information

AIXM is a very accurate and detailed model, compared for instance with existing aeronautical reference database. Based on AIXM, xNOTAM systems will be able to provide the status of aeronautical entities at a very detailed and accurate level.

Using this characteristic, xNOTAM systems could retrieve or filter information using very sophisticated rules, which could be used for instance to improve PIB filtering.

3.1.4 Dynamic display

Dynamic and interactive graphical display can be easily achieved using the AIXM information. For instance standard ICAO aeronautical charts can be produced directly through the AIXM information, except for topographical, hydrographical or cultural data which are not described in the current model.

Even if final AIP charts will still require cartographic operators for touch-up and validation, basic aeronautical charts can be fully generated from an AIXM database.

In addition, many textual AIP parts, like ENR or AD2 tables, can directly be generated from an AIXM database. Using xNOTAM concept, a real time updated eAIP could be implemented.

3.1.5 Automatic and exhaustive data analysis

A major benefit of aeronautical information modelling, is to allow automatic check and validation, based on a predefined set of rules. These rules, generally called “Semantic rules” can be used to detect inconsistency or errors in the database. The AIXM already implements such rules.

For instance, one of these rules requires that a heliport must have at least one touch down and lift-off area.

Rules:

1. *If CODE_TYPE = 'AH' or 'HP', there must be at least one related touch down and lift-off area (relationship to TLOF_M is becoming mandatory).*

Many AIXM rules are already available to improve the database consistency.

These rules can be used to validate the :

- Consistency between individual fields :

If VAL_GEO_ACCURACY is specified, then UOM_GEO_ACCURACY is mandatory.

- Consistency of entities relationships :

RWY must be situated at one and only one AD_HP

Some rules also implies geographical computation:

The difference between the VAL_TRUE_TRACK in the RTE_SEG and the (calculated) VAL_TRUE_TRACK of the related SEGMENT having the same CODE_TYPE as CODE_TYPE_PATH of the route segment cannot exceed 2 (degrees)

3.1.5.1 AIXM supplementary rules

Any organisation can decide to add new rules, on top of the existing AIXM ones, for its own usage.

For instance, an organisation may decide to check if :

- All coordinates are entered in WGS84 datum code,
- All ARP coordinates have the required accuracy,
- All elevations are described in FT,
- All NDB frequencies are expressed in kHz….

Obviously more sophisticated rules can be implemented like :

- All positions are included within the state’s boundaries
- Declared magnetic variations follow the geodesic magnetic model
- Navaid frequency allocation do not overlap

These internal rules will be implemented using tools like XSLT, Schematron or SQL with spatial functions.

It has to be noted that these rules may be used to validate data received from an external source, or to check internal data entries.

3.1.5.2 AIXM 'change impact' rules

Previous rules are mainly useful to evaluate and validate the static model structure and entities relationship.

In the scope of the xNOTAM concept, it is possible to create a large set of rules to evaluate AIXM changes, and their consequences on other entities of the model.

The following table gathers samples of such rules, based on an operational status change :

AIXM change	Affected Entities
En Route NAVAID out of service	DESIGNATED_POINT based on this NAVAID through ANGLE or DISTANCE INDICATION relationship HOLDING_PROCEDURE based on this NAVAID
Aerodrome NAVAID out of service	SID,STAR or IAP using this NAVAID even if the case of COLLATED aerodromes
RUNWAY closed	Aircraft categories available at the aerodrome
ILS GP or LLZ out of service	IAP using this ILS
OBSTACLE erected	Obstacle Clearance for SID, STAR or IAP RUNWAY DIRECTION located near the OBSTACLE
GATE STAND or TAXIWAY closed	Aircraft categories available at the aerodrome
Activation of Restricted Area	Route Segments crossing this Airspace
Ash Cloud	Routes and Aerodromes surrounded by this cloud
Fuel availability at a GROUND SERVICE	Aircraft type available at the aerodrome
RUNWAY threshold displacement	Runway Direction declared distance Obstacle Clearance for procedures based on this threshold ILS glide path slope
RUNWAY direction approach lightning system failure	Precision approach category

Therefore, using such a set of rules, an organisation may proceed to an exhaustive and automated analysis of the operations affected by a change of the operational status of any entity. Obviously these rules may be used to evaluate a planned change, or analyse the impact of a change already in force.

3.2 Operational Improvements

3.2.1 AIP and NOTAM Office synergy

Current AIXM users are mainly AIP Office operators. The xNOTAM concept, which will merge “static” and “dynamic” data, will obviously affect the NOTAM Office operators work and procedures.

xNOTAM operators will become AIXM users too, and will work on the same AIXM repository as the AIP Office.

It is therefore expected that AIP and NOTAM office process and procedures will move closer, probably up to using the same integrated AIS system.

3.2.2 NOTAM automatic generation

NOTAM can be automatically generated by AIXM changes.

The generation of most NOTAM fields is quite obvious (A,B,C,Q fields), except for D and E ones.

D field is related to the AIXM TIMESHEET feature, but generating a compact and still readable D field from a fully structured set of TIMESHEETS requires sophisticated algorithms.

The E field is typically specific for each data change and data type and its content may be drafted automatically. Still, a human touch might be necessary in order to make it look closer to the natural language.

Several software implementations can be designed to provide such functions, from basic templates substitutions to artificial intelligence technology.

An automated NOTAM generation has many advantages :

- It homogenises NOTAM content, for instance to prevent excessive use of abbreviations, or to guarantee standard use of units of measurement.
- It encourages small NOTAM with individual scope and purpose, instead of large generic information, improving further filtering.
- It forces standard phraseology, in particular for D field sentences.

In addition, NOTAM automatic generation does not prevent NOTAM translation. States currently using NOTAM translated in the national language for their local use will still be able to do so. In this case, the automatic NOTAM generation will basically produce the NOTAM in two releases, using the same software component.

Overall, the NOTAM quality will be increased.

3.2.3 xNOTAM validation

NOTAM validation processing, currently achieved by NOTAM Data Providers, or Data Service Providers will be greatly reduced in xNOTAM system.

This task will be limited to the evaluation of the data consistency, but will not require any syntactic correction or data alteration. The AIXM XML Schema provides all the means for full exhaustive validation.

In addition, using "semantic rules", the validation process can be improved. An organisation can define its own set of rules to specify whether received data require manual analysis or not.

The xNOTAM validation process will focus on semantic analysis, and no longer on syntactic work. The aeronautical database consistency will be improved.

3.2.4 PIB improvements

Using xNOTAM system, PIB could be improved in two ways.

First, using a more accurate aeronautical model, the AIS system can filter more efficiently the information really required by pilots.

For instance, using an AIXM database, the system could reduce the amount of retrieved information, based on flight plan parameters not currently exploited by PIB like the aircraft type or category.

Flight plan parameter	Filtered-out AIXM data
Aircraft Type	Fuel availability not used by this aircraft Runway closure for helicopters FATO closure for airplanes
Aircraft Category	Change on procedure legs not concerned by this flight category
Aircraft Communication and Equipment	Radio navigation failure for devices not available on board (GPS) Warnings for RNAV routes for non equipped aircraft

Next, PIB information can be displayed in a more ergonomic way, mainly by using graphic display, but also by sorting textual data according to more sophisticated criteria.

A dynamic display of aeronautical charts could provide interactive and dynamic information:

- En Route charts with updated Navaid frequencies and active Restricted Area,
- Temporary obstacles displayed in Obstacle charts,
- Use of true colors for ground lights, or obstacles on Aerodrome chart,
- Runway or Taxiway surface conditions with a specific pattern,
- Runway or Taxiway closure with a specific symbology.

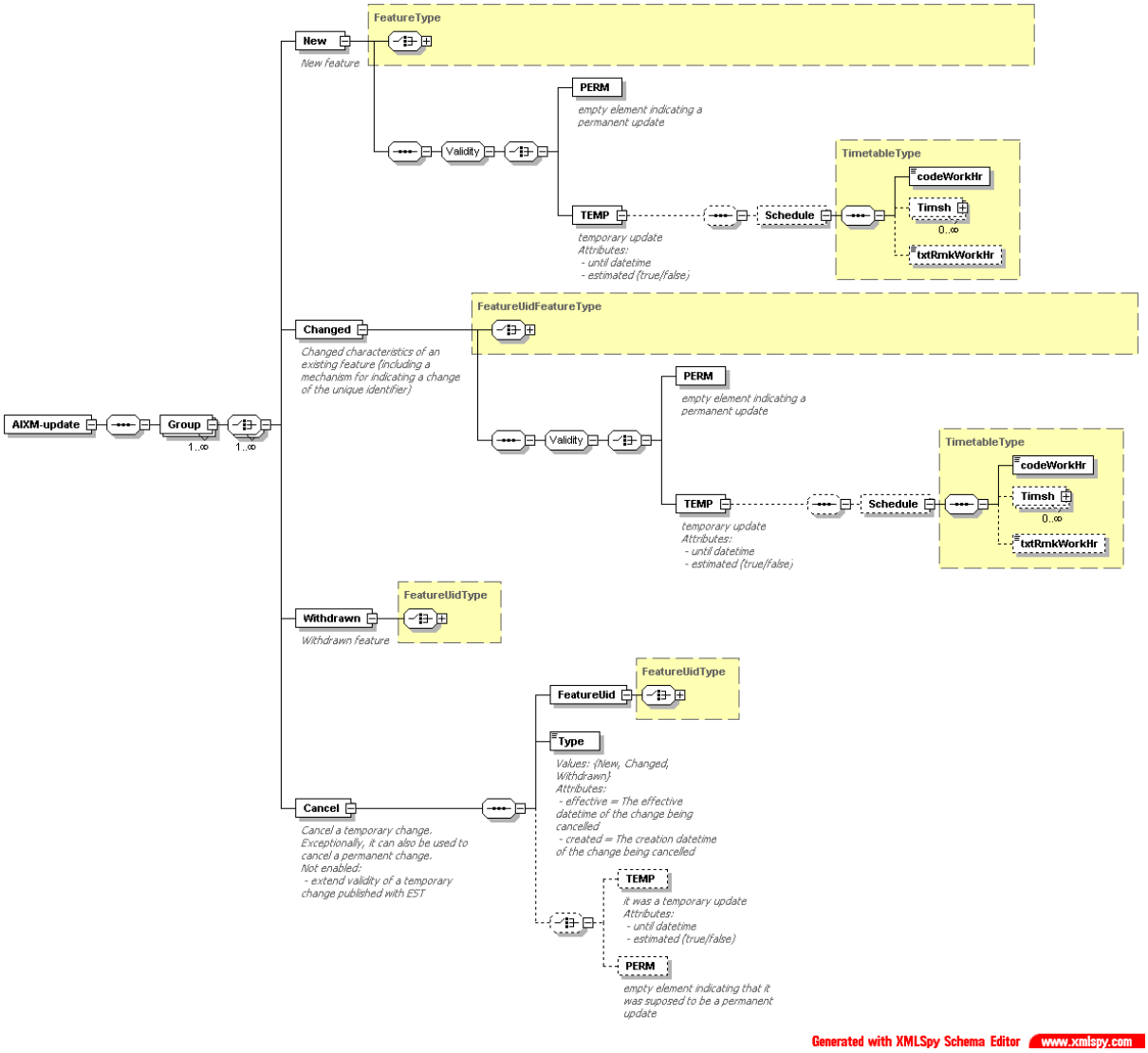
Even the basic PIB textual output could be improved by using more efficient or relevant data sorting :

- Aerodrome data sorted by runway directions,
- En Route information sorted by the flight plan route: significant points and planned schedule.

4 XNOTAM DESCRIPTION

The xNOTAM concept merges into the AIXM schema temporary and permanent changes.

A Validity group is added to identify PERManent or TEMPorary changes. For temporary changes an applicability schedule may be specified, based on the existing TIMETABLE data type.



This following paragraph describes samples of AIXM changes which can be published as current NOTAM.

4.1 xNOTAM Samples

The following samples are AIXM temporary changes which can be published as NOTAM.

Obviously the purpose of xNOTAM concept is not to focus on this technical compatibility issue, as the xNOTAM to NOTAM conversion is only a small part of the global concept, but these samples will clarify typical workflows and processing.

These samples show different uses of the xNOTAM concept:

- An ILS on test phase, described in xNOTAM as a change of the operational status of the ILS object.
- A Danger Area activation, described in xNOTAM as a change of the operational status of the AIRSPACE. A TIMETABLE is used to described the activation period.
- A crane erected at an aerodrome, described in xNOTAM by the temporary creation of an OBSTACLE object.
- A correction to a published AIP chart, described in xNOTAM by a permanent change to an AIS-PRODUCT object.

It has to be noted that the selected NOTAM are real NOTAM written by humans, and probably an automated AIS system will not translate them exactly in the same way.

In addition, the AIXM samples are more verbose than their equivalent NOTAM, but also more accurate and fully structured.

4.1.1 ILS on test

In this sample, the data provider wants to inform that an ILS will be set on test during a planned period of time.

After selection of the corresponding Qcode, the user will type the E Field, to provide the following NOTAM :

```
(B0956/04 NOTAMN
Q) EDWW/QICAS/I/NBO/A/000/999/5227N00941E005
A) EDDV
B) 0410150817 C) 0410151200
E) ILS 09R NOT AVBL DUE TO TESTING, DO NOT USE, FALSE
INDICATION POSSIBLE.)
```

In the xNOTAM concept, the user will select the affected ILS and will set its Operational status to 'TEST' value. This change will produce the following AIXM-Update message:

```
<AIXM-update effective="2004-10-15T08:17:00"
origin="GERMANY NOF" created="2004-10-15T08:16:14">
<Group Name="">
    <Changed>
        <Ils><!—ILS Identifier -->
            <IlsUid>
                <RdnUid><!—Runway direction Identifier -->
                    <RwyUid>
                        <AhpUid>
                            <codeId>EDDV</codeId>
                        </AhpUid>
                        <txtDesig>09R/27L</txtDesig>
                    </RwyUid>
                        <txtDesig>09R</txtDesig>
                    </RdnUid>
            </IlsUid>
            <codeOpsStatus>TEST</codeOpsStatus>
            <!-- On test, do not use -->
        </Ils>
        <TEMP until="2004-10-15T12:00:00" />
    </Changed>
</Group>
</AIXM-update>
```

4.1.2 Restricted area activation

In this case, the data provider wants to inform that a known danger area will be activated during a certain period of time. After selection of the corresponding Qcode and vertical limits, the user will type the D and E Field, to provide the following NOTAM :

```
(A1905/04 NOTAMN
Q) LGGG/QRDCA/IV/BO/W/000/150/3648N02342E028
A) LGGG
B) 0411010600 C) 0412311300
D) NOV 01 TIL DEC 31 DAILY 1600-1930
E) LGD76  KARAVIA ISLANDS  ACTIVATED  RAC 5-1-9 REF.
F) AMSL G) FL150)
```

In the xNOTAM concept, the user will select the corresponding AIRSPACE, will set its operational status to 'ACTIVE', and will specify the TIMETABLE attributes.

This change will produce the following AIXM-Update message:

```
<AIXM-update effective="2004-11-01T06:00:00" origin="GREECE NOF" created="2004-10-15T10:18:34">
<Group Name=" "><Changed>
<Ase>
   <AseUid><!—Airspace Identifier -->
        <codeType>D</codeType>
        <codeId>LGD76</codeId>
    </AseUid><!—Airspace limits -->
    <codeDistVerUpper>STD</codeDistVerUpper>
    <valDistVerUpper>150</valDistVerUpper>
    <uomDistVerUpper>FL</uomDistVerUpper>
    <codeDistVerLower>ALT</codeDistVerLower>
    <valDistVerLower>0</valDistVerLower>
    <uomDistVerLower>FT</uomDistVerLower>
    <codeOpsStatus>ACTIVE</codeOpsStatus>
     <Att><!—Activation description-->
        <codeWorkHr>TIMSH</codeWorkHr>
        <Timsh>
          <codeTimeRef>UTC</codeTimeRef>
          <dateValidWef>01-11</dateValidWef>
          <dateValidTil>31-12</dateValidTil>
          <codeDay>WD</codeDay>
          <timeWef>16:00</timeWef>
          <timeTil>19:30</timeTil>
        </Timsh></Att>
</Ase>
<TEMP until="2004-12-31T11:30:00" />
</Changed></Group></AIXM-update>
```

4.1.3 Obstacle erected

In this case, the data provider wants to inform that several cranes will been erected on the aerodrome. The following NOTAM will be published :

```
(A2474/04 NOTAMN
Q) LFMM/QOBCE/IV/M/A/000/999/4340N00713E005
A) LFMN
B) 0409200330 C) 0410222100
D) 2004 SEP 20 TO OCT 22 : 0330-2100
E) OBST : 2 OR 3 CRANES ERECTED :
 PSN : RDL170DEG/1400M FROM ARP
HEIGHT : 6M AGL - ALT ON TOP : 10M AMSL - LIGHTING :
NIGHT AND DAY)
```

In the xNOTAM concept, the data provider will create an OBSTACLE object with corresponding attributes (Position, Type, Ligthing, Elevation, ..), specifying also the activation period through a TIMETABLE element.

In addition, to express the fact that these obstacles have significance for the aeronautical operations at the aerodrome, the data provider will create an AD_HP_OBSTACLE element, making the link between the aerodrome and the obstacle.

```
<AIXM-update effective="2004-09-20T03:30:00" origin="GREECE NOF" created="2004-
09-15T10:18:34">
<Group Name=" ">
<New><!—New Obstacle created -->
   <Obs>
      <ObsUid><!—Obstacle Identifier, the coordinates -->
        <geoLat>434034.18N</geoLat>
        <geoLong>0071327.01E</geoLong>
     </ObsUid>
     <txtDescrType>CRANE</txtDescrType>
      <codeGroup>Y</codeGroup><!—This is a group of obstacles-->
     <codeLgt>Y</codeLgt> <!—Ligthed obstacle-->
     <codeDatum>WGE</codeDatum>
      <valElev>10</valElev> <!—Elevation-->
     <valHgt>6</valHgt> <!—Obstacle height-->
     <uomDistVer>M</uomDistVer>
     <txtRmk>2 or 3 cranes</txtRmk>
```

```
        <Ott><!—Active period for this group of obstacles-->
            <codeWorkHr>TIMSH</codeWorkHr>
          <Timsh>
              <codeTimeRef>UTC</codeTimeRef>
              <dateValidWef>20-09</dateValidWef>
              <dateValidTil>22-10</dateValidTil>
              <codeDay>ANY</codeDay>
              <timeWef>03:30</timeWef>
              <timeTil>21:00</timeTil>
          </Timsh>
        </Ott>
      </Obs>
      <TEMP until="2004-10-22T21:00:00" estimated="true" />
</New>
<!—Obstacle affects aerodrome operations -->
<New><Aho>
      <AhoUid>
          <ObsUid><!—Obstacle Identifier, the coordinates -->
                <geoLat>434034.18N</geoLat>
                <geoLong>0071327.01E</geoLong>
          </ObsUid>
          <AhpUid><!—Aerodrome Identifier -->
                <codeId>LFMN</codeId>
          </AhpUid>
       </AhoUid>
       <txtRmk>RDL170°/1400M from ARP</txtRmk>
      </Aho>
      <TEMP until="2004-10-22T21:00:00" estimated="true" />
</New>
</Group>
</AIXM-update>
```

4.1.4 Correction to published AIP

The AIP data provider wants to warm users about an error published in a chart. The NOTAM is declared as PERMANENT, even if it will be cancelled by the next AIP AMDT.

(A0423/04 NOTAMN
Q) LOVV/QACCH/IV/NBO/AE/000/999/4716N01121E010
A) LOWI
B) 0407161259 C) PERM
E) REF ICAO CHART 1:500.000 DATED 15 APR 2004
CTR INNSBRUCKUPPER LIMIT IS
CORRECT TO READ AS FOLLOWS:11000FT MSL INSTEAD OF 1100FT MSL)

In the xNOTAM concept, the data provider will be able to describe a change on an AIS publication or product, such as an airport obstacle database. In this example, it is assumed that the change is only necessary on the chart and that the CTR AIRSPACE limits are correct inside other publications, in the AIS database and in the AIXM-Update messages issued from this database. Otherwise, a message correcting the CTR airspace limits would be necessary.

```
<AIXM-update effective="2004-07-16T12:59:00" origin="AUSTRIA NOF" created="2004-
07-16T12:59:00">
<Group Name=" ">
<Changed>
   <AIS-product>
        <codeType>CHART</codeType>
        <codeId>ICAO-1-500000</codeId>
        <txtName>ICAO CHART 1:500.000</txtName>
        <effective>2004-04-15</effective>
        <txtRmk>CTR INNSBRUCK upper limit is correct to read as
        follows:11000FT MSL instead of 1100FT MSL</txtRmk>
  </AIS-product>
  <PERM />
</Changed>
</Group>
</AIXM-update>
```

5 CONCLUSION

The conclusion section is split into three parts:

- The first part compares xNOTAM concept against the existing NOTAM system.
- It checks if problems due to NOTAM system limitations, identified in "NOTAM Current concept of operations" are significantly improved by the xNOTAM concept.
- The second part confirms that current NOTAM system advantages will be preserved by the xNOTAM systems,
- The last part checks if xNOTAM concept can handle enhanced functionalities currently studied for the NOTAM system.

5.1 NOTAM system limitations

The following table summarises main current NOTAM system limitations and shows xNOTAM improvements.

NOTAM Limitations	Analysis	xNOTAM improvements
Cannot be automatically read by computers in all cases	Multiple format distributed by data providers	AIXM exchanges will be fully readable for computers. Nevertheless, it is still possible to come into a configuration where data providers would use different AIXM releases, leading to communication problems. This risk could be lowered by a robust AIXM extension mechanism and AIXM backward compatibility.
	Inconsistency in the reference static data between NOTAM originators, producers and users	In the xNOTAM concept, the reference static database is the AIXM database itself. Therefore, permanent or temporary AIXM changes will follow the same workflow, and will be consistent. Nevertheless inconsistency may still arise if an organisation explicitly alters the received AIXM data.
Cannot be fully understood by computers in all cases	Unstructured E Field	E Field is replaced by a fully structured message, allowing automated computer analysis.
	Unstructured D Field	D Field is replaced by a TIMETABLE structure, which can be fully exploited.
	Qcode limitation to identify affected object	Affected objects are identified by a unique identifier into the AIXM update.

NOTAM Limitations	Analysis	xNOTAM improvements
Cannot be fully understood by human in all cases	D, E Field formatting : Abbreviations, Dates/Time, Upper cases	Generated NOTAM from AIXM updates will use standard phraseology and sentences. They will probably be shorter but more accurate.
	Translations from national to English and vice versa	Generated NOTAM from AIXM updates can be produced in several languages keeping consistency between translated releases.
Lack of priority, and relevance in NOTAM	NOTAM produced by series without priority level	Using "semantic rules", any organisation or system can defined its own priority rules to apply on received AIXM data.
Low database integrity	No CRC to protect data	On top of the protection offered by modern communication networks, the AIXM schema provides its own CRC mechanism in order to protect critical positional data, according to Annex 15 requirements. This might be extended in future to the full content of an AIXM message.
	No protocol for automatic data missing detection	A "Checklist" protocol should be defined to insure the synchronisation of AIXM databases.
Lack of visibility for planned or potential events	NOTAM only issued when known to be effective	Although not developed at this stage of the study, xNOTAM concept allows the definition of potential events, which could be scheduled in advance.

5.2 NOTAM current benefits

This table summarises the current NOTAM system main benefits, and shows how they can be preserved in xNOTAM system.

Benefits	Analysis	XNOTAM answer
Can be broadcasted worldwide Real time broadcasting Can be read/printed by humans without AIS system	Small size message Based on worldwide AFTN communication. Can be received by any teletype terminal. H24 worldwide support	As AIXM changes can be published as NOTAM, it is still possible to broadcast the information on low bandwidth networks like AFTN. It is nevertheless clear that AIXM data will travel through more secured and safe networks than AFTN.
Large support for methodology, training and process	Large ICAO and Eurocontrol documentation available Widely diffused and well known technology	Large AIXM support should be provided by Eurocontrol and ECAC states. A special effort should be considered on AIXM user's training.
Effective for critical messages like SNOWTAM,…	Clearly identified message with formatted wording	Dedicated HMI should be developed to avoid users being lost in the AIXM complexity, even when they have to deal with basic messages.
Manual processing also results in plausibility/impact analysis.	By manually processing NOTAM data, operators also check the impact and NOTAM content plausibility. Sometimes, obviously wrong content in the E/D fields triggers inquiries to the NOTAM producer and then corrected NOTAM broadcasting.	Received AIXM data can be highlighted to users, using "semantic rules" to automatically detect strange or abnormal records among the whole data set. xNOTAM system does not restrict an organisation from checking or controlling received data.

5.3 Current trends or improvements

This table summarises main current NOTAM system trends and improvements, to be taken into account in xNOTAM design.

Trends	xNOTAM solution
Links between AIP and NOTAM Dynamic AIP consultation	As AIXM databases may be used to produce the AIP, xNOTAM system could provide real time updated AIP, integrating NOTAM information.
Graphic PIB or NOTAM display	AIXM data can currently be used to generate aeronautical charts. With xNOTAM concept these charts could dynamically integrate temporary changes.
Update PIB	xNOTAM system enables even more than the current NOTAM system "update PIB" implementations.
NOTAM upload on board	On board system based on AIXM could probably receive AIXM updates during the flight, even if these messages are longer than NOTAM. A better data filtering should compensate this network capacity issue. Alternatively, on board systems could be served with updates in proprietary formats, promulgated by Data Service Providers, which are in turn able to ingest AIXM-Update messages.
Automatic ingestion of NOTAM information in AIS databases	Automatically achieved by xNOTAM concept
Link between aeronautical static databases and NOTAM affecting them	
Attempts to structure the free text D and E fields for specific NOTAM	
Links between AIS and Meteorology	AIXM does not provide any particular link with meteorological data. However, most of the xNOTAM concept ideas might be applied to aviation MET messages.

6 GLOSSARY

A

ABI	Advance Boundary Information
ACC	Area Control Centre
ACT	Activation (message)
AD	Airport
ADEP	Aerodrome of Departure
ADES	Aerodrome of Destination
ADEXP	ATS Data Exchange Presentation
AFIL	Air-FILed Flight Plan
AFL	Actual Flight Level
AFP	ATC Flight plan Proposal (message)
AFTN	Aeronautical Fixed Telecommunication Network
AGDL	Air Ground Data Link
AIC	Aeronautical Information Circular
AICM	Aeronautical Information Conceptual Model
AIM	An AFTM message type
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information, Regulation and Control
AIS	Aeronautical Information Service
AIXM	Aeronautical Information Exchange Model
AMC	Airspace Management Cell
AME	ATM Messages Exchange
ANM	ATFM Notification Message
ANSP	Air Navigation Service Provider
AO	Aircraft Operator
ARO	Air Traffic Services Reporting Office
ARP	Aerodrome Reference Point
ASHTAM	NOTAM reporting (volcanic) ash hazard
ASM	AirSpace Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Services
AUP	Airspace Use Plan

B

BIRDTAM	NOTAM reporting bird hazard

C

CADF	Central Airspace Database Function
CDR	Conditional Route
CEU	Central Executive Unit
CFMU	Central Flow Management Unit
CRC	Cyclic Redundancy Check

D

DEP	ICAO defined DEParture Message
DLA	ICAO defined DLA (delay) message
DLY	OLDI delay message/status
DMAN	Departure MANager
DPI	Departure Planning Information

E

EAD	European AIS Database
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme
EATMS	European Air Traffic Management System
EATMP	European Air Traffic Management Programme
ECAC	European Civil Aviation Conference
ECIP	European Convergence and Implementation Plan
EFD	ETFMS Flight Data (message)
ENV	CFMU Environment System
EST	ESTimated
ETFMS	Enhanced Tactical Flow Management System
ETMS	Enhanced Traffic Management System
EUROCONTROL	European Organisation for the Safety of Air Navigation

F

FDPA	Flight Data Processing Area
FCM	Flight Confirmation Message
FDPS	Flight Data Processing System
FIR	Flight Information Region
FLS	FLight Suspension (message)
FMP	Flow Management Position
FMS	Flight Management System

FNM	Flow Notification Message
FPL	Flight Plan Message (ICAO format)
FSA	First System Activation
FSH	Flight SHift message
FUA	Flexible Use of Airspace
FUM	Flight Update Message

G

GAT	General Air Traffic

H

HMI	Human Machine Interface

I

IAF	Inbound Approach Fix
IAS	Indicated Air Speed (ICAO 8400/4)
ICAO	International Civil Aviation Organisation
ICD	Interface Control Document
IFPL	Individual Flight Plan Message
IFPS	Integrated Initial Flight Plan Processing System
IFPO	IFPS Operator
IFR	Instrument Flight Rules

J,K

L

LDA	Landing Distance Available

M

MDI	Minimum Departure Interval
MFS	Message From Shanwick
MPL	Mini flight PLan
MTCD	Medium Term Conflict Detection

N

NAVAID	Navigational Aid
NOTAM	Notice to Airmen
NOF	Notam OFfice
Nm	Nautical Miles
NSC	NOTAM Selection Criteria

O

OAT	Operational Air Traffic
OLDI	On-Line Data Interchange
OPADD	Operating Procedures for AIS Dynamic Data
ORM	Operational Reply Message

P

PAC	Pre Activation (message)
PAN-AIS	Procedure for Air Navigation Service
PIB	Pre-flight Information Bulletin
PFD	Planned Flight Data
PIAC	Peak Instantaneous Aircraft Count

Q

R

RADNET	Radar Data Exchange Network (EUROCONTROL)
RCA	Remote Client Application
RDPS	Radar Data Processing System
REA	REAdy to depart message
RENAR	Réseau de la Navigation Aérienne (France)
RFI	Ready For (direct) Improvement (message)
RFL	Requested Flight Level
RNAV	Area Navigation
RQNTM	Request NOTAM Creation
RQS	ReQuest Supplementary informtion message
RVSM	Reduced Vertical Separation Minimum
RVR	Runway Visual Range

S

SNOWTAM	NOTAM reporting snow hazard

T

TAA	Temporary Airspace Allocation
TFR	Traffic Flow Restriction
TRA	Temporary Reserved Airspace
TSA	Temporary Segregated Area
TWR	Tower

U

UAC	Upper Area Control Centre
UFN	Until For Notice
URD	Users Requirement Document

V

VFR	Visual Flight Rules

W

X

XML	Extensible Mark up Language
XNOTAM	XML NOTAM

Y, Z

7 REFERENCE

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