Air Traffic Data Integration using the Semantic Web Approach

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Air traffic management systems require constant development. Whenever regular radar devices are out of range, the wide network of the receivers may constitute global air traffic monitoring solutions. Surveillance methods of controlling aircrafts are being improved and the one which stands apart from the others is ADS-B (Automatic Dependent Surveillance Broadcast) introduced in most commercial and private aircrafts, and which was obligatory after the year 2020. Nowadays ADS-B receivers cover about 70% of European and 30% of U.S air traffic. The ADB-S system is based on GPS communication. Aircrafts estimate their position using satellite based navigation systems. Along with plane position, there is a vast number of additional data broadcasted by the ADS-B transponder, including speed, altitude, plane and flight identification data, also emergency codes. The large amount of professional and amateur ADS-B receivers located on most continents, covering significant amount of the airspace, has led to the conclusion that this kind of crowd-processing may establish valuable and reliable source of data using common interface. Currently there is no uniform layer of the ADS-B data presentation and interfaces over the Web.

This paper regards standardisation of the data layer using WEB 3.0 - Semantic Web principals. It covers acquisition, processing and presentation of the data coming from the ADS-B receiver. A method of unifying data from distributed virtual radar stations has been proposed and is being presented in a way that allows this data to be combined across many sources with existing knowledge. Having ADS-B information integrated and expressed in RDF (Resources Description Format), it would be easy to perform such a query against these data sets, using Protocol and RDF Query Language (SPARQL).

Now we stand at the verge of WEB 3.0, where applications vastly utilising Artificial Intelligence, semantic solutions and Natural Language Processing systems are going to become common.

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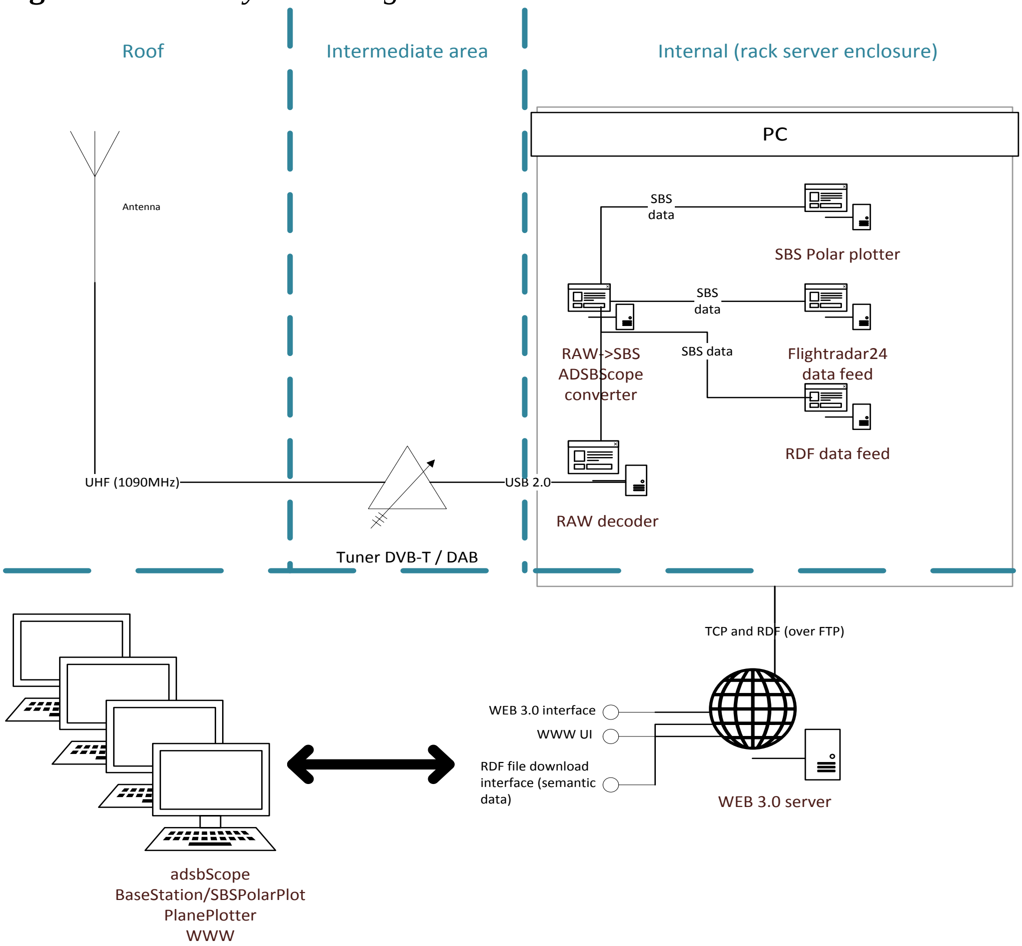
Introduction

Air traffic management systems require constant development. Whenever regular radar devices are out of range, the wide network of the receivers may constitute global air traffic monitoring solutions. Surveillance methods of controlling aircrafts are being improved and the one which stands apart from the others is ADS-B (Automatic Dependent Surveillance Broadcast) introduced in most commercial and private aircrafts, obligatory after year 2020. The ADB-S system is based on GPS communication. Aircrafts estimate their position using satellite based navigation systems. Along with plane position, there is a vast number of additional data broadcasted by the ADS-B transponder, including speed, altitude, plane and flight identification data, and also emergency codes. However this data, coming from different sources has to be consolidated in order to be truly useful. In subsequent sections, the authors describe ADS-B hardware, its receiver-related data format and most important – a uniform layer solution based on Semantic Web concept.

ADSB Receiver

Figure 1. *ADS-B System Design*



The ADSB receiver is an essential and core component of the system. A worldwide network of the receivers, capable to cover airspace may play a significant role in ensuring the security and safety of the air traffic. Most of it can be done with relatively small expenditure. One may find the wide number of the samples over the WEB, presenting solutions to the receiver antennas, high frequency down-samplers, protocol decoders, including those implemented as embedded devices (i.e. PIC based, see adsbPIC project by Sprut (2010)). The system components and connections between them are presented on Figure 1. It includes full receiver infrastructure, but its description is above the scope of this paper.

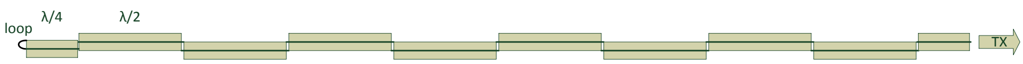
The Antenna HF Section

The first part of the data reception is the high frequency antenna. As noted by Balara (2010), it should be capable to receive communicates on 1090MHz frequency where all ADS-B communicates are transmitted. Because the HF receiver is usually connected to the antenna using a somewhat long cable (authors use about 7m) the antenna construction should bring the maximum possible gain to compensate signal drop. As the frequency of the ADS-B communicates is 1.09GHz, the wavelength λ in the copper collinear cable is given by:

$$\lambda = \frac{k \cdot c}{f} \tag{1}$$

where *c*-stands for the velocity of the light, *f*=1090MHz, *k*=0.83-velocity coefficient, for the RG-6U cable. The antenna is composed of 8 half *λ* segments, connected such that the core of the first is connected to the shield of another and so on, constituting a chain by turns. There are two extra quarter *λ* segments at each end of the antenna, improving its performance (Figure 2).

Figure 2. *ADS-B Coaxial Antenna*



The antenna is located on the roof of the Faculty of Automation Control, Electronics and Computer Science building, about 40m over the ground level (Figure 3). The location of the antenna is N 50.288307019, E 18.67676767292.

Figure 3. *ADS-B Antenna Location*

The range of the antenna is presented by the polar plot, based on the collection of over 13 million samples (received ADS-B communicates) within 6 months of work. The detected antenna range is 235NM radius max, the maximum altitude observed is 38 275 feet, see Figure 4. The maximum amount of the planes observed simultaneously was over 200 and the average reception quality (measured by the number of the invalid frames) is about 80% subject to the weather changes and neighbor radio noise.

Figure 4. *Reception Range*

The Receiver and Decoder Section

The approach used by the authors of the paper was pretty straightforward – an SDR1[1] approach to the ADS-B reception was implemented. It limits the implementation of the HF and decoder hardware to employing the appropriate

[1]SDR - Software Defined Radio – a software solution that is decoding the digital data that comes out as a stream (sound, vision, other) from the universal, programmable, wide range RF receiver, i.e. Radio or DVB-T USB dongle, connected to the PC computer (http://sdr-radio.com/)

DVB-T USB stick (Realtek RTL2832U and R820T tuner) acting as HF receiver / decoder as noted by Sprut (2010). The popular SDR ADSB# software to decode ADS-B communicates was used (Touil, 2012). The ADSB# decoder uses RAW (binary) data on its output, providing TCP/IP port. The adsbSCOPE software is a first line visualization and reporting solution that connects directly to the ADSB# decoder using TCP, here via local loopback (Figure 1). It also contains an SBS (text based, BaseStation format) server, thus acting as a RAW to SBS converter. Authors use SBS data format, as presented in the following chapter.

ADSB Data in Depth

The SBS server provides data for programs connected to its TCP 30003 port, on the data stream basis. It is served in the BaseStation format, ASCII encoded, comprising information about aircrafts. Incoming data is divided into individual messages, each separated with new line characters (Figure 5). A Single message carries information coming either from aircraft or from a surveillance system. However, an individual message does not provide complete evidence of an aircraft, rather a piece of information, not necessarily being complete. Software has been developed for this reason and its role is to gather these scattered data, assemble them and finally present them to the user. This has been exhaustingly described in the subsequent section.

Figure 5. *Exemplary Data Stream Consisting of Individual Messages*

```
MSG,5,0,1,4BA8EC,1,2014/04/18,09:02:06.282,2014/04/18,09:02:06.282,,37000,,,,,,,0,0,0,0
MSG,6,0,1,4BA8EC,1,2014/04/18,09:02:06.282,2014/04/18,09:02:06.282,,37000,,,,,,4641,0,0,0,0
MSG,5,0,1,4BA8EC,1,2014/04/18,09:02:06.282,2014/04/18,09:02:06.282,,37000,,,,,,,0,0,0,0
MSG,5,0,48,489787,48,2014/04/18,09:02:06.282,2014/04/18,09:02:06.282,,37000,,,,,,,0,0,0,0
MSG,1,0,8,461F65,8,2014/04/18,09:02:06.300,2014/04/18,09:02:06.300,FIN765V ,,,,,,,,0,0,0,0
MSG,6,0,34,4BAA53,34,2014/04/18,09:02:06.406,2014/04/18,09:02:06.406,,34050,,,,,,3254,0,0,0,0
MSG,8,0,19,738060,19,2014/04/18,09:02:06.455,2014/04/18,09:02:06.455,,,,,,,,,0,0,0,0
MSG,5,0,8,461F65,8,2014/04/18,09:02:06.485,2014/04/18,09:02:06.485,,38025,,,,,,,0,0,0,0
MSG,3,0,19,738060,19,2014/04/18,09:02:06.485,2014/04/18,09:02:06.485,,36000,,,50.9248,17.8164,,,0,0,0,0
MSG,5,0,19,738060,19,2014/04/18,09:02:06.532,2014/04/18,09:02:06.532,,36000,,,,,,,0,0,0,0
MSG,6,0,19,738060,19,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,36000,,,,,,5641,0,0,0,0
MSG,4,0,3,49DF29,3,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,,174,89,,,0,,0,0,0,0
MSG,5,0,20,4BAA69,20,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,35975,,,,,,,0,0,0,0
MSG,4,0,13,4BA94D,13,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,,473,146,,,0,,0,0,0,0
MSG,4,0,4,40666C,4,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,,381,112,,,-1984,,0,0,0,0
MSG,5,0,43,4A08E9,43,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,40000,,,,,,,0,0,0,0
MSG,8,0,30,4B198E,30,2014/04/18,09:02:06.562,2014/04/18,09:02:06.562,,,,,,,,,0,0,0,0
MSG,5,0,8,461F65,8,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,38025,,,,,,,0,0,0,0
MSG,3,0,1,4BA8EC,1,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,37000,,,49.7688,18.2964,,,0,0,0,0
MSG,5,0,8,461F65,8,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,38025,,,,,,,0,0,0,0
MSG,5,0,40,4CA97D,40,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,33825,,,,,,,0,0,0,0
MSG,4,0,21,47C54B,21,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,,114,321,,,0,,0,0,0,0
MSG,4,0,50,4CA5B8,50,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,,444,47,,,0,,0,0,0,0
MSG,5,0,2,4CA806,2,2014/04/18,09:02:06.580,2014/04/18,09:02:06.580,,29075,,,,,,,0,0,0,0
MSG,6,0,6,47A619,6,2014/04/18,09:02:06.610,2014/04/18,09:02:06.610,,37975,,,,,,4266,0,0,0,0
MSG,5,0,40,4CA97D,40,2014/04/18,09:02:06.625,2014/04/18,09:02:06.625,,33825,,,,,,,0,0,0,0
MSG,5,0,1,4BA8EC,1,2014/04/18,09:02:06.625,2014/04/18,09:02:06.625,,37000,,,,,,,0,0,0,0
MSG,5,0,8,461F65,8,2014/04/18,09:02:06.625,2014/04/18,09:02:06.625,,38025,,,,,,,0,0,0,0
MSG,6,0,1,4BA8EC,1,2014/04/18,09:02:06.625,2014/04/18,09:02:06.625,,37000,,,,,,4641,0,0,0,0
```

As Woodside (2013) concludes, on the top of BaseStation format there are six main types of messages (Table 1). The first five types come from the surveillance system, whereas *MSG* is related to the messages generated by the aircraft hardware.

Table 1. *Main Message Types (Woodside, 2013)*

ID	Type	Description
SEL	SELECTION CHANGE MESSAGE	Produced when the user changes the selected aircraft in BaseStation.
ID	NEW ID MESSAGE	Produced when an aircraft being tracked changes its callsign.
AIR	NEW AIRCRAFT MESSAGE	Produced when the SBS receives a new signal for an aircraft that wasn't tracked so far.
STA	SATUS CHANGE MESSAGE	Produced when an aircraft's status changes due to the time-out values.
CLK	CLICK MESSAGE	Produced when the user double-clicks on an aircraft in BaseStation.
MSG	TRANSMISSION MESSAGE	Produced by the aircraft, gives information about flight parameters. There are eight different MSG types.

The transmission message is divided into eight sub-types and may be one of the following, see Table 2.

Table 2. *MSG Sub Messages (Woodside, 2013)*

ID	Type	Description
MSG,1	ES Identification and Category	Conveys aircraft's callsign
MSG,2	ES Surface Position Message	Triggered by nose gear squat switch.
MSG,3	ES Airborne Position Message	As it says.
MSG,4	ES Airborne Velocity Message	As it says.
MSG,5	Surveillance Alt Message	Triggered by ground radar if aircraft has sent before MSG,1, 2, 3, 4 or 8 signal.
MSG,6	Surveillance ID Message	Triggered by ground radar if aircraft has sent before MSG,1, 2, 3, 4 or 8 signal.
MSG,7	Air To Air Message	Triggered from TCAS. Conveys altitude and "Ground" flag.
MSG,8	All Call Reply	Broadcast but also triggered by ground radar. Conveys only "Ground" flag.

Each of the aforementioned message types and sub-types can contain up to twenty-two comma-separated fields. Table 3 presents these entities with the proviso that the first ten fields apply to each message type, except *Field 2* predestined only for *MSG* type. Fields from eleven to twenty-two appear only along with the Transmission Message (MSG), and carry mainly airborne information. First ten fields provide data coming from the surveillance system.

Table 3. *Fields of Messages of Type MSG (Woodside, 2013)*

ID	Type	Description
Field 1:	Message type	(MSG, STA, ID, AIR, SEL or CLK)
Field 2:	Transmission Type	MSG sub types 1 to 8. Empty field for other message types.
Field 3:	Session ID	Database Session record number
Field 4:	AircraftID	Database Aircraft record number
Field 5:	HexIdent	Aircraft Mode S hexadecimal code
Field 6:	FlightID	Database Flight record number
Field 7:	Date message generated	As it says
Field 8:	Time message generated	As it says
Field 9:	Date message logged	As it says
Field 10:	Time message logged	As it says
Field 11:	Callsign	An eight digit flight ID - can be flight number or registration (or even nothing).
Field 12:	Altitude	Mode C altitude. Height relative to 1013.2mb (Flight Level). Not height AMSL..
Field 13:	GroundSpeed	Speed over ground (not indicated airspeed)
Field 14:	Track	Track of aircraft (not heading). Derived from the velocity E/W and velocity N/S
Field 15:	Latitude	North and East positive. South and West negative.
Field 16:	Longitude	North and East positive. South and West negative.
Field 17:	VerticalRate	64ft resolution
Field 18:	Squawk	Assigned Mode A squawk code.
Field 19:	Alert (Squawk change)	Flag to indicate squawk has changed.
Field 20:	Emergency	Flag to indicate emergency code has been set
Field 21:	SPI (Ident)	Flag to indicate transponder Ident has been activated.
Field 22:	IsOnGround	Flag to indicate ground squat switch is active

Uniform Data Layer

The large amount of professional and amateur ADS-B receivers located on most continents, covering significant amount of the airspace, led to the conclusion that this kind of crowd-processing may establish valuable and reliable source of the data if using common interface. In this paper, authors have proposed the Semantic Web approach as a solution to the data integration problem. However, currently there is no uniform layer of the ADS-B data presentation and interfaces over the Web. One of the most popular air traffic tracking applications using ADS-B is Flightradar24. Although it is widespread and useful, it doesn't provide common interface. Being a commercial solution, it doesn't allow third-party applications to reuse the data.

Authors of this paper perceive information reprocessing as an upcoming challenge, especially in terms of ongoing development of Semantic Web technologies.

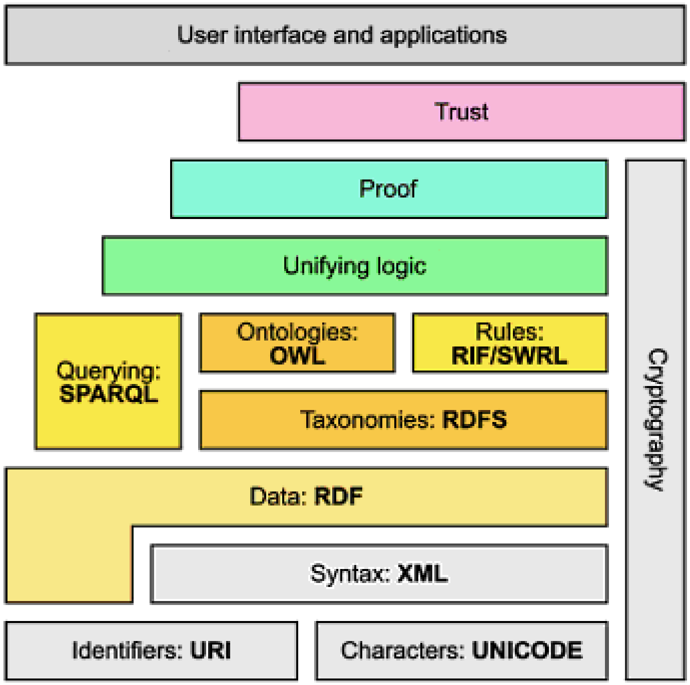
Concept of Semantic Web

Nowadays, we face a flood of information in every field. Bratt (2006) argues that keyword searching is effective for traditional text based data, but it can't provide satisfactory results from images, audio and video resources. Traditional searching is also sensitive due to ambiguity of words. These problems as well as data integration are the key issues that Semantic Web successfully addresses. It is an extension to the current web, which allows machines to carry out searching and processing of knowledge. Moreover, it allows reasoning processes to be performed, which may lead to the creation of new facts based on relations between existing knowledge.

For example, imagine two simple relations: Adam is husband of Eva and Adam is brother of Jenny. Knowing this and using proper ontology, machines could create the new fact that Jenny is the sister-in-law of Eva.

Bratt (2006) concludes that the Semantic Web is a machine-readable web, where resources are described using well-defined standards such as: URI, XML, RDF. There are new concepts being developed, built on top of the above-mentioned ones. This constitutes Semantic Web specifics. For this reason it's often called *layer cake* or *semantic stack*. Fundamental standards as well as concepts being developed are shown in Figure 6.

Figure 6. *Semantic Stack*



As Fensel, Hendler, Lieberman and Wahlster (2003) noted, HTML provides the proper display of the data, however it is not machine-readable. In other words, machines don't know the meaning of the data when they are parsing HTML markup; they only know how the information should be displayed.

For this reason eXtensible Markup Language (XML) was created. XML comes with special codes, called tags, which nested in documents give additional information about wrapped text. For example book can be characterised on the website using tags: <Author>, <Title>, <Publisher> etc. Programs can use these annotations in sophisticated ways, but a software developer must know what the website owner uses these tags for. In other words XML allows some structure to be built, but does not explain its meaning.

Berners-Lee, Hendler and Lassila (2001) state that the meaning can be provided by Resource Description Framework (RDF), using triples consisting of subject, predicate and object. Particular things (person, book, website) can have properties ("is spouse of", "has title") with literal values (another person, title, another website), vide previous example with Adam and Eva. Objects and subjects are expressed as Uniform Resource Identifiers (URIs). The most common type of URI is Uniform Resource Locator (URL) which is simply the web address (Berners-Lee, Hendler and Lassila 2001). One object can point to several subjects, where each of those subjects may be an object to another subject, creating a web (or a graph) of linked data. We distinguish different formats of RDF like Turtle, TriG, N-Triples, N-Quad or RDF/XML. Code snippet below is an example of how we could express this paper using machine-readable, RDF syntax.

```
<rdf:RDF
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:foaf="http://xmlns.com/foaf/0.1/"
    xmlns:dc="http://purl.org/dc/elements/1.1/" >

 <foaf:Document rdf:about="http://www.example.com/article.htm">
     <dc:title>Air traffic data integration using Semantic Web
approach</dc:title>
     <dc:type>Scientific paper</dc:type>
     <dc:date>2014-05-19</dc:date>
     <dc:creator>
          <foaf:Person>
              <foaf:name>Marcin Klauza</foaf:name>
              <foaf:phone>(+44)7776624885</foaf:phone>
              <foaf:homepage
rdf:resource="http://www.marcinklauza.com" />
          </foaf:Person>
     </dc:creator>
     <dc:creator>
          <foaf:Person>
              <foaf:name>Piotr Czekalski</foaf:name>
              <foaf:phone>(+48)322372577</foaf:phone>
          </foaf:Person>
     </dc:creator>
     <dc:creator>
          <foaf:Person>
              <foaf:name>Krzysztof Tokarz</foaf:name>
              <foaf:phone>(+48)322372300</foaf:phone>
          </foaf:Person>
     </dc:creator>

 </foaf:Document>
</rdf:RDF>
```

In the abovementioned example, the first tag comprises definitions of *rdf*, *foaf* and *dc* namespaces. *Foaf* (an acronym for Friend of a friend) is an ontology describing people and their relations (Grimnes, Edwards and Preece 2004), whilst *dc* (Dublin Core) is one of the most popular vocabulary set used for describing websites and physical artworks (books, CDs etc.) (Colomb, 2007). Words *foaf* and *dc* are used thereafter instead of long URLs. Later in this example one can see the description of the document, its title, type, date, and authors. It is worth emphasising the semantics: *Document* is an object, *type* is a predicate and S*cientific paper* is a subject. Document also has a *creator* which is a person, having its own features.

Web 3.0 Solution

Software developed has been broken into two parts. First, Windows Service listening to 30003 port of SBS server, gathers and assembles data into the RDF repository. That collected data is published on the remote server, making it available for third-party applications. Finally web application residing in the server reads the RDF repository, checks whether some changes have been made and updates view in the client browser.

The Code snippet shown below is an example of aircraft description complying with RDF standard and using RDF/XML format.

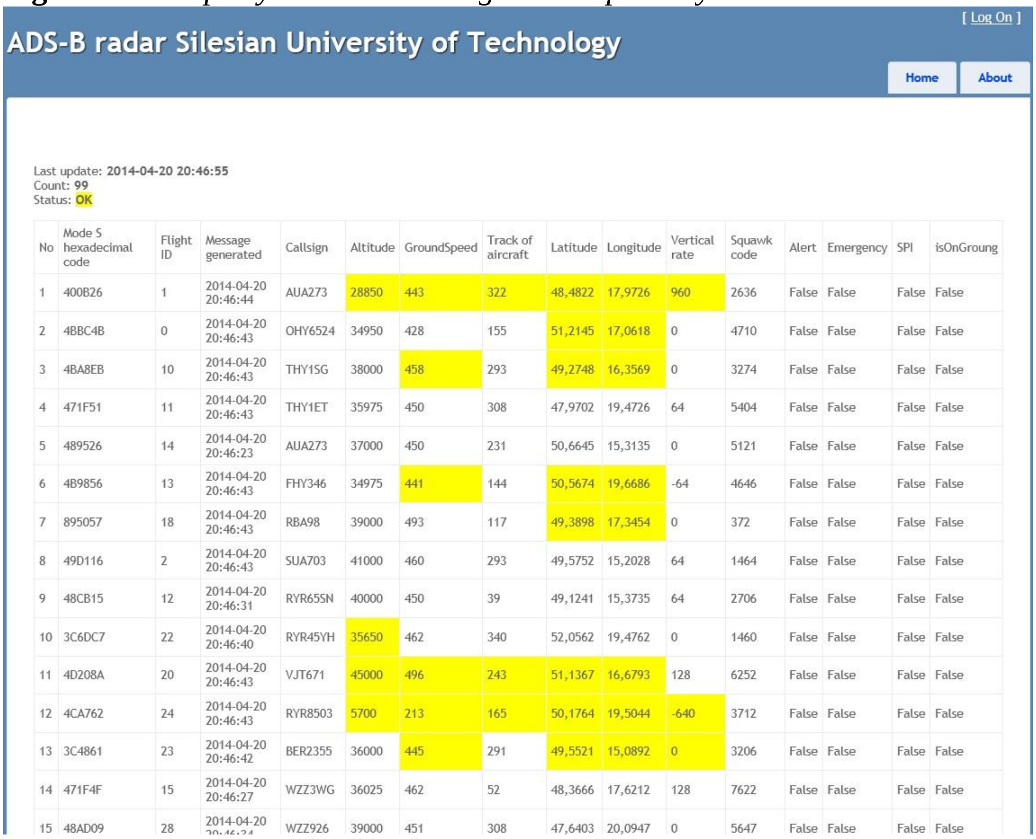
```
 <rdf:Description rdf:about="http://www.example/#Aircraft33">
    <ns303:Alert
xmlns:ns303="http://www.example/#">False</ns303:Alert>
    <ns304:Altitude
xmlns:ns304="http://www.example/#">37000</ns304:Altitude>
    <ns305:Callsign   xmlns:ns304="http://www.example/#">RYR64KJ
</ns304:Altitude>
    <ns305:Emergency
xmlns:ns305="http://www.example/#">False</ns305:Emergency>
    <ns307:GroundSpeed
xmlns:ns307="http://www.example/#">438</ns307:GroundSpeed>
    <ns308:HexIdent
xmlns:ns308="http://www.example/#">3C5EE3</ns308:HexIdent>
    <ns309:Latitude
xmlns:ns309="http://www.example/#">50,7815</ns309:Latitude>
    <ns310:Longitude
xmlns:ns310="http://www.example/#">17,7177</ns310:Longitude>
    <ns311:MsgGenerated
xmlns:ns311="http://www.example/#">2014-03-11
16:41:36</ns311:MsgGenerated>
    <ns313:SPI
xmlns:ns313="http://www.example/#">False</ns313:SPI>
    <ns314:Squawk
xmlns:ns314="http://www.example/#">2260</ns314:Squawk>
    <ns315:Track
xmlns:ns315="http://www.example/#">132</ns315:Track>
    <ns316:VerticalRate
xmlns:ns316="http://www.example/#">0</ns316:VerticalRate>
    <ns317:isOnGroung
xmlns:ns317="http://www.example/#">False</ns317:isOnGroung>
  </rdf:Description>
</rdf:RDF>
```

It has been generated using an open source C#. Net library for RDF: *dotNetRDF*. This framework facilitates creating and searching in RDF graphs. In order to retrieve information from such graphs, there have been formulated queries in SPARQL (recursive acronym for SPARQL Protocol and RDF Query Language). It combines advantages of SQL-like language and the RDF data model. To list all the aircrafts along with their properties from the above-like repository, one could execute the following query:

```
PREFIX has: <http://www.example/#>
SELECT * WHERE {
   ?plane has:HexIdent ?HexIdent .
   OPTIONAL{ ?plane has:MsgGenerated ?MsgGenerated } .
   OPTIONAL{ ?plane has:Callsign ?Callsign } .
   OPTIONAL{ ?plane has:Altitude ?Altitude } .
   OPTIONAL{ ?plane has:GroundSpeed ?GroundSpeed } .
   OPTIONAL{ ?plane has:Track ?Track } .
   OPTIONAL{ ?plane has:Latitude ?Latitude } .
   OPTIONAL{ ?plane has:Longitude ?Longitude } .
   OPTIONAL{ ?plane has:VerticalRate ?VerticalRate } .
   OPTIONAL{ ?plane has:Squawk ?Squawk } .
   OPTIONAL{ ?plane has:Alert ?Alert } .
   OPTIONAL{ ?plane has:Emergency ?Emergency } .
   OPTIONAL{ ?plane has:SPI ?SPI } .
   OPTIONAL{ ?plane has:isOnGroung ?isOnGroung } .
}
```

An exemplary website has been developed which queries RDF data set every few seconds and shows real-time information about the air traffic (Figure 7). This data comes from ADS-B receiver installed in the Silesian University of Technology; however this approach allows the integration of ADS-B data from different sources.

Figure 7. *Exemplary Website utilising RDF Repository*



[Log On]

ADS-B radar Silesian University of Technology

Home About

Last update: **2014-04-20 20:46:55**
Count: **99**
Status: **OK**

No	Mode S hexadecimal code	Flight ID	Message generated	Callsign	Altitude	GroundSpeed	Track of aircraft	Latitude	Longitude	Vertical rate	Squawk code	Alert	Emergency	SPI	isOnGroung
1	400B26	1	2014-04-20 20:46:44	AUA273	28850	443	322	48,4822	17,9726	960	2636	False	False	False	False
2	4BBC4B	0	2014-04-20 20:46:43	OHY6524	34950	428	155	51,2145	17,0618	0	4710	False	False	False	False
3	4BA8EB	10	2014-04-20 20:46:43	THY1SG	38000	458	293	49,2748	16,3569	0	3274	False	False	False	False
4	471F51	11	2014-04-20 20:46:43	THY1ET	35975	450	308	47,9702	19,4726	64	5404	False	False	False	False
5	489526	14	2014-04-20 20:46:23	AUA273	37000	450	231	50,6645	15,3135	0	5121	False	False	False	False
6	4B9856	13	2014-04-20 20:46:43	FHY346	34975	441	144	50,5674	19,6686	-64	4646	False	False	False	False
7	895057	18	2014-04-20 20:46:43	RBA98	39000	493	117	49,3898	17,3454	0	372	False	False	False	False
8	49D116	2	2014-04-20 20:46:43	SUA703	41000	460	293	49,5752	15,2028	64	1464	False	False	False	False
9	48CB15	12	2014-04-20 20:46:31	RYR65SN	40000	450	39	49,1241	15,3735	64	2706	False	False	False	False
10	3C6DC7	22	2014-04-20 20:46:40	RYR45YH	35650	462	340	52,0562	19,4762	0	1460	False	False	False	False
11	4D208A	20	2014-04-20 20:46:43	VJT671	45000	496	243	51,1367	16,6793	128	6252	False	False	False	False
12	4CA762	24	2014-04-20 20:46:43	RYR8503	5700	213	165	50,1764	19,5044	-640	3712	False	False	False	False
13	3C4861	23	2014-04-20 20:46:42	BER2355	36000	445	291	49,5521	15,0892	0	3206	False	False	False	False
14	471F4F	15	2014-04-20 20:46:27	WZZ3WG	36025	462	52	48,3666	17,6212	128	7622	False	False	False	False
15	48AD09	28	2014-04-20 [illegible]	WZZ926	39000	451	308	47,6403	20,0947	0	5647	False	False	False	False

Conclusions

Work described in this paper is a basis for the common interface for ADS-B airborne data. Although proposed uniform data layer is a step forward, proper ontology has to be developed, so we can use the full potential of Semantic Web in aviation. In the near future authors would need to address this challenge.

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