

Leonardo Live: Using GPS and mobile networks to monitor small UAV

Dr Andreas Gazis
ICCS, Athens, Greece
Loughborough University, UK

A.Gazis@lboro.ac.uk

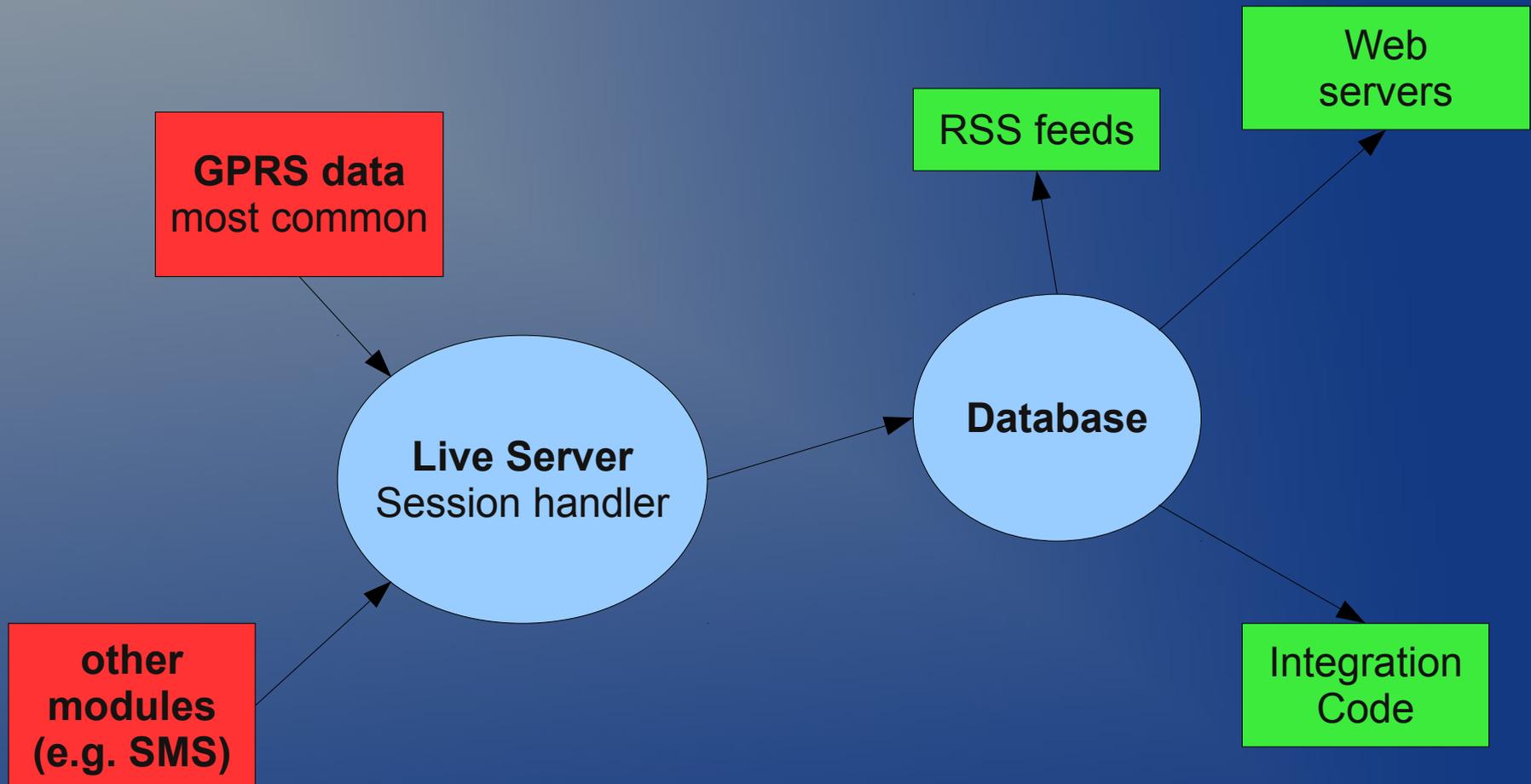
Contents

- 1.Context
- 2.Leonardo Live Architecture
- 3.Example of web front end
- 4.Web based tracking page
- 5.Current Adoption
- 6.Expandability
- 7.Robustness
- 8.Relevance to UAS
- 9.RxTx
- 10.Houston, we have a problem
- 11.Summing up

Context

- SUAVe: proposed project for autonomous soaring UAV.
- Leonardo Live: existing online tool used originally by paraglider pilots, expanded to include live tracking of outdoor activities.

Leonardo Live Architecture



Example of web front end: www.livetrack24.com

[+]		robertottofritz ▾							
[+]	📍	🇩🇪	Rosenheim - DE ~8.2km	🕒	01-11-2009	11:26:00	00:17:30	0.4 km	
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[+]	📍	No GPS position yet		🕒	31-10-2009	22:04:37	00:00:00	0.0 km	
[+]		Tony ▾							
[+]	Track this user			🗑		03	03:26:18	40.5 km	
[+]		Track this user in Google maps 3D★				41	01:58:07	7.7 km	
[+]		Track this user in Google maps 2D							
[+]		Track this user in Google Earth				33	00:38:36	0.5 km	
[+]		[Select Color 3D <input checked="" type="checkbox"/>]							
[+]		Track this user (Text Info)				00	00:30:43	2.1 km	
[+]		Track this user (Page for mobile phones)				45	02:19:40	9.7 km	
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[+]	📍	🇨🇭	Niesen - CH ~0.8km	🕒	31-10-2009	13:21:10	01:33:27	5.4 km	
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[+]	📍	🇨🇭	Niesen - CH ~0.8km	🕒	31-10-2009	12:58:43	00:55:57	5.8 km	
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[+]	📍	No GPS position yet		🕒	30-10-2009	20:21:54	00:00:00	0.0 km	
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[+]	📍	🇨🇱	Patillos -Iquiq... - CL	🕒	30-10-2009	19:24:31	03:51:58	29.5 km	
[+]		Rodrigo ▾							

SMS Credits ✕
New policy for SMS, [Read more...](#)
[Dont show this message again](#)

Alert: New Server IP ✕
We have upgraded our server and got a new IP address. Because of this the java client must get the new IP otherwise it will not function after 31 July 2009
[Read more...](#)
[Dont show this message again](#)

[close all]

Web based tracking page

The screenshot displays a web-based tracking interface. On the left, a map shows a flight track in red, starting from a green dot labeled "Start for Tony" and ending at a blue dot labeled "Tony". The map includes road markers for highways 1, 5, A-680, A-690, A-710, and A-760. A control panel on the right provides the following information:

Control Panel

- Current GMT Time Time : 20:04:08
- Next update at: Updates are stopped
- Update every: Stop updates
- Auto Center Map on active User:

Tracks List

Name	Alt	Vario	Speed
Tony	17 m	0 m/s	0 km/h

User Info

Tony FR3

Last position

- Time: 18:33:03 GMT
- Height / Speed: 17 m 0 m/sec / 0 km/h
- Takeoff Distance: 33.21 km
- Location: Palo Buque - CL [~ 6.3 km]
- Lat/Long: -70.1558 / -20.4407 [more]

Flight Info

- Start: 2009-10-31 15:06:45
- End: 2009-10-31 18:33:03 GMT
- Track was ended normally
- Original Timezone of track: GMT-3
- Duration: 03:26:18

Website will also export a kml file allowing tracking inside Google Earth

Current Adoption

- Leonardo Live has currently received tracks from 628 users from 53 countries.
- Over 5000 live tracks have been recorded on the server .
- Leonardo servers are used as national free flight databases in Greece, Germany, Portugal, Brazil, Turkey. Also used in Italy, Latvia, Israel, Belgium, UK, France, Canada.
- Leonardo software has been translated into 24 languages.

Expandability

- The Live Server has a public API and can interface with proprietary protocols.
- Apart from the default client, third party developers have used the public API to create:
 - 2 iPhone clients
 - 1 WinMobile client (server also supports 3 existing WinMobile live tracking programs)
 - 1 Java client for bikes
 - There are currently 2 more iPhone and 1 Android client under development.

Robustness

- Default clients have the advantage of using very small UDP packets (~60-90 bytes/packet) over GPRS. In contrast HTTP would use ~500 bytes/packet assuming no error. This means that although packets might be lost, some will go through and keep the track live. Error checking protocols will waste time and bandwidth trying to renegotiate transmission of stale data.
- Although not normally used, the Live Server has the capability of receiving data over SMS.
- Other services can be added by writing a module for the Live Server.

Relevance to UAS

- Regulatory measures should balance risk vs hampering innovation.
- Active transmitters help identify aircraft but typically expensive and power hungry. In contrast, mobile network offers extensive coverage and a mobile transmitter is cheap, light and lower power.
- Research UAS above a certain class can be required to incorporate hardware capable of running a Leonardo Live or similar client and fly in non restricted airspace with mobile coverage.
- National bodies can register UAS researchers and get a global live picture of UAS in their airspace without burdening existing ATC infrastructure.
- This data can then be integrated with traditional ATC data to check for possible problems.

RxTx

- Unlike transponder equipped manned aircraft which listen on radio frequencies, UAS would not normally have the capability of communicating with anything beyond their ground station.
- Leonardo Live already implements server to client transmission with space in the packet structure for additional data.
- It is easy to establish a public protocol for transmitting simple data sentences to UAS in flight.
- This way, both the developer and potentially the overseeing national body, can have one more level of safety built into the design without hampering the aircraft with prohibitive costs, high power consumption and too much extra weight.

Houston, we have a problem

The integration of live flight tracks by a national body offers the following advantages:

- other traffic can be notified/diverted around an area of UAV activity
- The UAV controllers can perhaps be notified (through their own mobile phones) in case there is something they need to do.
- Adding the mobile-network-to-UAS standardised protocol offers the capability of limited (due to bandwidth constraints) interference with the craft's microcontroller, e.g. data sentences can be sent over the network in order to effect some change (divert course, land, stay below a certain level etc).

Summing up

- Leonardo Live is a tried and tested platform in manned and womanned free flight.
- In a UAV context, it offers a cheap, lightweight method of live tracking a UAV.
- In a regulatory framework, it can offer a very easy way of getting a live global picture of UAV activity in an airspace with mobile coverage.
- An appropriate national institution using the system can register UAV developers using aircraft above a certain class and oversee their flights without burdening existing ATC infrastructure. This task can be largely automated.
- If a standard protocol is developed and adopted, it will be possible to send simple command sentences directly to the UAV over the mobile network. This can be used as a fallback by the developers themselves, as well as by the national institution in case of emergencies.