Drones: From Technology to Policy, Security to Ethics

Industry and Business Applications

ETH Zürich

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Drones: From Technology to Policy, Security to Ethics

Industry and Business Applications

- Where is the business for the industry?
- A Swiss experience: ADS 95 Ranger and Meteomatics Meteodrone
- Customers – their requirements, their environment
- From research to operation
- Technologies needed
- Conclusions

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Drones – UAV – UAS - RPV – RPAS – the future looks promising

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Industry and commercial application: A sustainable business case is mandatory.

Product life cycle

- Where is the business for the industry?
- For which industry?

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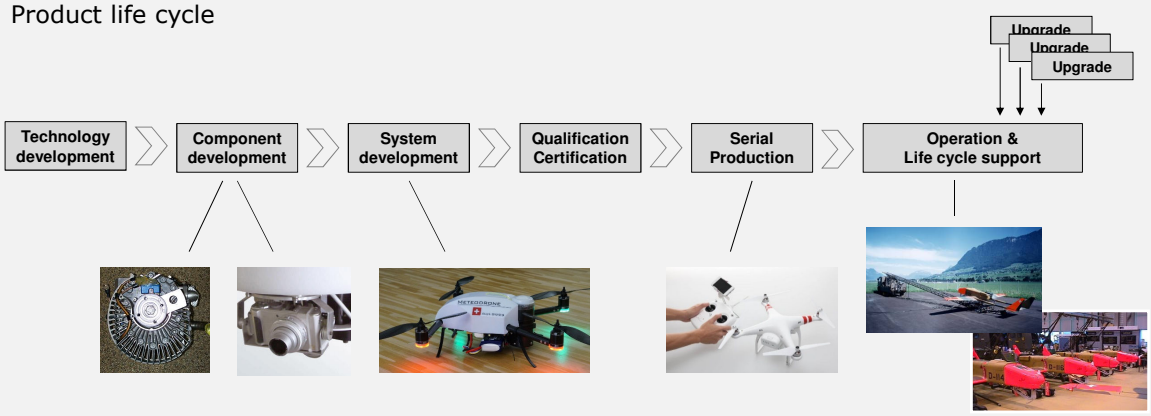
Industry and commercial application: A sustainable business case is mandatory.

Product life cycle

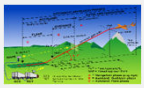


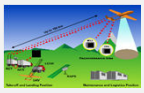
An industrial experience in Switzerland: ADS 95 Ranger

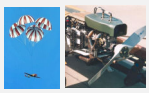
System Performance		
Operational range:	Mission range	up to 180 km
Data link:	Primary command uplink Secondary command uplink (backup) Video and telemetry down link	C; S or Ku Band UHF Band C; S or Ku Band
Communication ranges:	Dish antenna C; S or Ku Band Omni antenna, UHF-band Omni antenna, C; S or Ku Band	up to 180 km up to 180 km 5 km
Accuracy:	AV locating error at 100 km range	<50 m CEP
Air Vehicle Performance		
Engine:	2-cylinder, 2-stroke	31.5 kW / 4500 rpm
Speed:	maximum loiter stall	130 kts 70 kts 55 kts
Service ceiling:		up to 18'000 ft
Endurance:		up to 9 hours
Air Vehicle Dimensions		
Wingspan: Overall length: Overall height: Take-off Weight		5.71 m 4.61 m 1.13 m 285 kg
Payload		
Payload weight (Different payloads available)		45 kg max

An industrial experience in Switzerland: ADS 95 Ranger

Technology development → Component development → System development → Qualification Certification → Serial Production → Operation & Life cycle support







Examples

- Auto take off and landing
- Safety concept
- Engine ignition unit

- Airframe
- Propulsion unit
- Landing skids
- Launcher

- Component integration
- Communication

- Military certification
- Component qualification
- Overall system qualification

- Switzerland
- Finland

- Maintenance, Repair, Overhaul
- New payload integration

1985 ——— **1995** ——→ **2017**

The drone operation is tailored to specific customer requirements

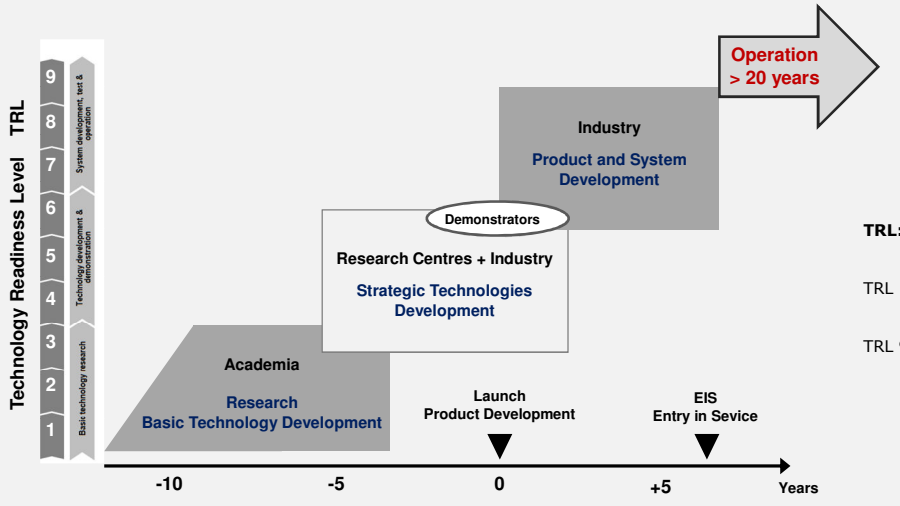
Military	- fleet operation
	- air vehicle as part of a system, information distribution in a complex network
	- long-term operation with life cycle support
	- request for reliability, security (data link) and safety
Government	- cooperation with military operator
Civil	- single system operation
	- point to point data link
	- low procurement cost + low operation cost
	- operation by low trained staff
	- safety requirements will increase

Military and civil environment for UAS operation

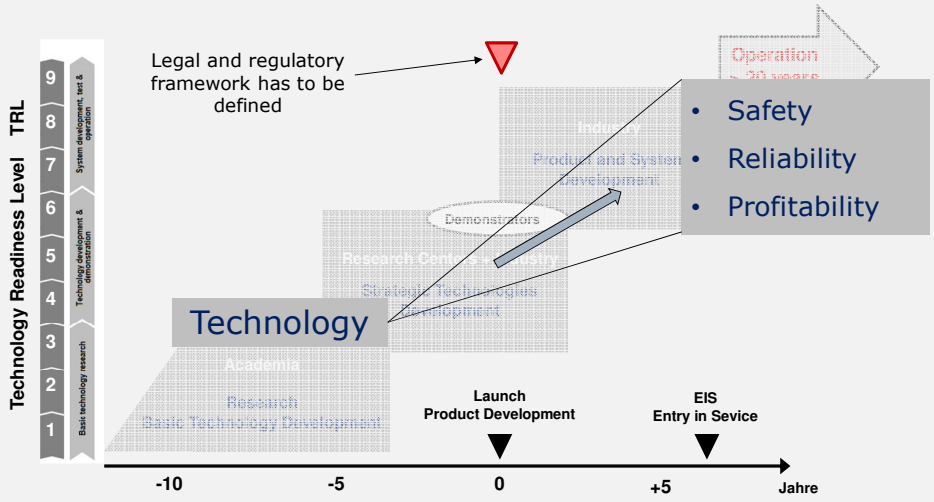
Military
- technical and operational requirements are defined
- the regulation and certification agencies are close to the operator
- the customer participates in the development (launching customer)
- the customer asks for life cycle support

Civil
- customers express their needs or wishes or manufacturers create customer needs
- future requirements are not exactly defined, desires exist
- regulation agencies are independent from drone operator
- certification body is experienced in "traditional" aviation

From research to operation…



… from technology to reliability, safety and profitability



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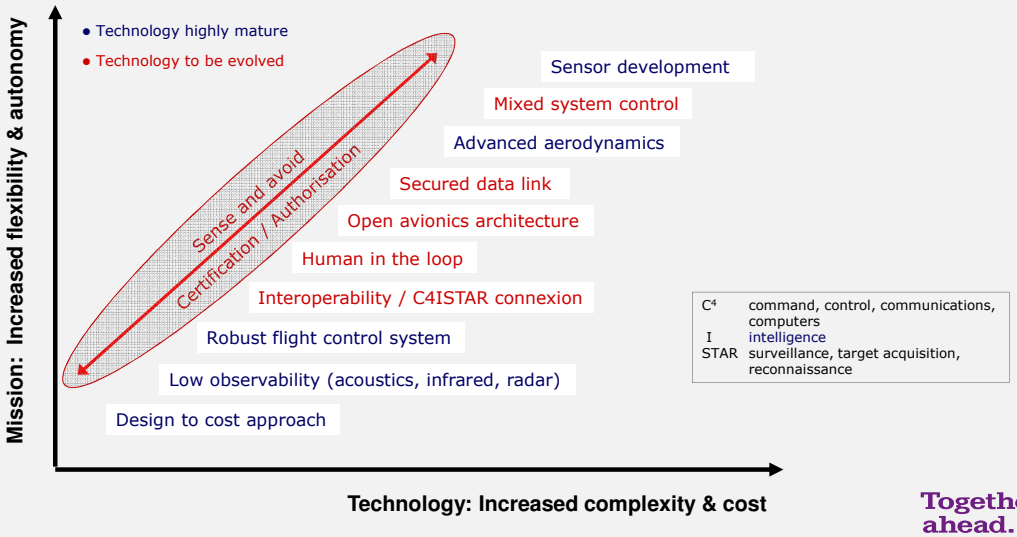
Which technology? The drivers (civil and military)



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Which technology? Sense and avoid

Technology to be evolved

”The intent of “sense and avoid“ is for pilots to use their sensors (eyes) and other tools to find and maintain situational awareness of other traffic and to yield the right-of-way in accordance with the rules, when there is a traffic conflict.“

Sense and avoid is the on-board, self-contained ability to
- detect traffic that may be a conflict
- evaluate flight paths
- determine traffic right of way, and
- manoeuvre well clear according to the established rules.“

Goal for UAS:
Mid air collision risk level has to be comparable to piloted aircraft in all situations.

Sense and avoid

Cooperative

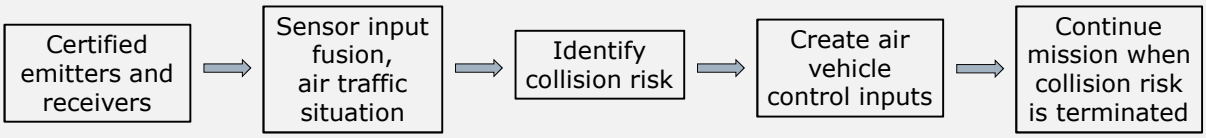
- All objects in airspace send identification signals
- Technology highly mature and operational (transponder, ADS-B, TCAS, FLARM)
- Pilot input needed for avoidance
- Autonomous avoidance not yet integrated in UAS

Non-cooperative

- Air space is populated by “silent” objects
  Manned aircraft: Pilot’s responsibility to avoid collision
- UAS: System without operator support shall be able to detect other traffic and to take the decision to avoid a collision risk

Sense and avoid: Approach for large UAV

Cooperative



But…

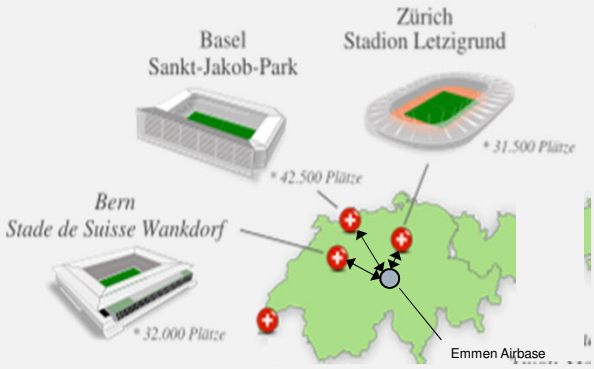
… pilot's ability to see a traffic is not on-board

Interim solution:

- Chase aircraft
- Create restricted airspace

Sense and avoid: Interim approach

Chase airplane in airspace with non-segregated traffic



EURO 08 Mission:
75 flight hours for observation service

And: Night flights

Sense and avoid: Approach for large UAV

Cooperative

Certified emitters and receivers → Sensor input fusion, air traffic situation → Identify collision risk → Create air vehicle control inputs → Continue mission when collision risk is terminated

Non-cooperative

additionally:

"Artificial" pilots eye:
- cameras
- radar

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The future – technologies and constraints

Foto: Meteomatics, 2014

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Regulation – how much, how restrictive? - the key for safety?

Technically	- Redundancy, failure tolerance, fail safe - Safety system
Process	- Company design / production approval - Type certificate
Operation	- Local, temporal and air space restrictions - Mission restriction - Operator licenses
Legal	- Privacy - Assurance

Regulation, technically: Safety system

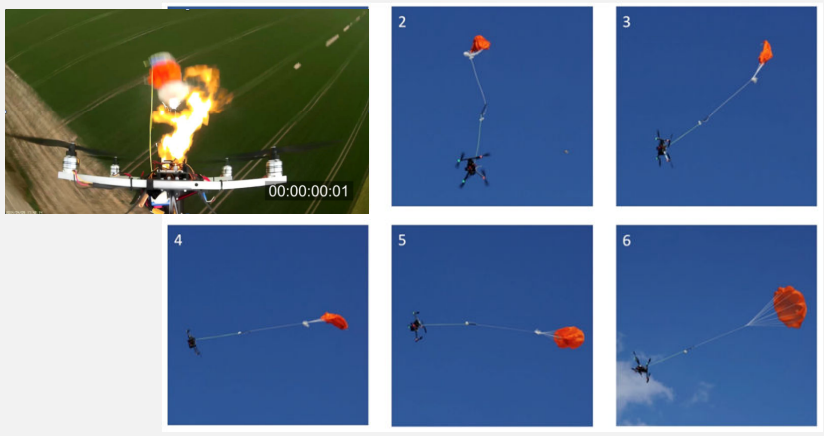


Foto: Meteomatics, 2014

Ranger (300kg)

Meteomatics Meteodrone (1.5 kg)

Meteomatics Meteodrone – a system almost ready for commercial missions

Mission	- Collect atmospheric data for better short term forecast in the lower atmosphere (ground to 1.5 km) - e.g. fog forecast - data transfer to MeteoSwiss data base
Air vehicle	- Quadrocopter (mass 1.5 kg)
Vision	- Drone stations at tbd > 20 locations in Switzerland - one flight (vertical ascent) every 30 min, 24/24 - fully autonomous

Regulation, processes: Type certificate? (> immatriculation)

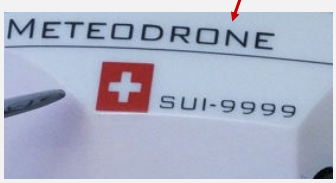
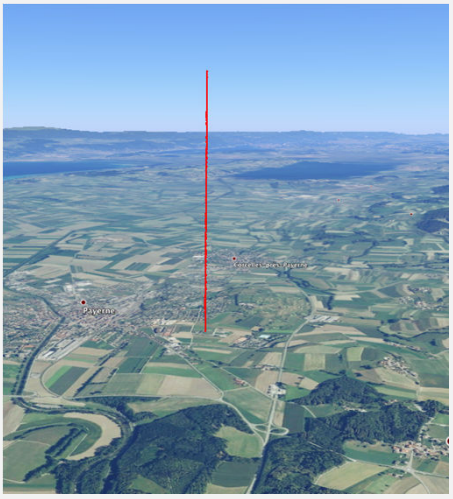


Foto: Meteomatics, 2014

Regulation, operation: Air space restrictions



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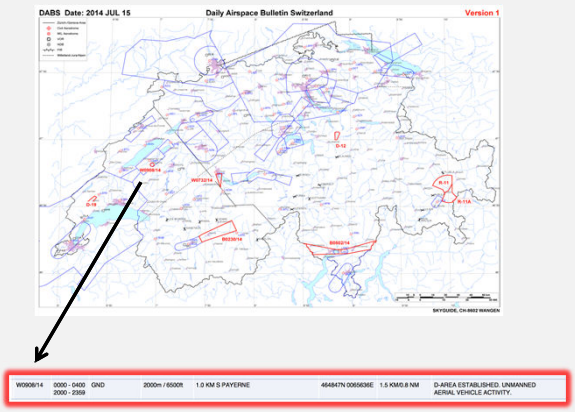

DABS / Skyguide

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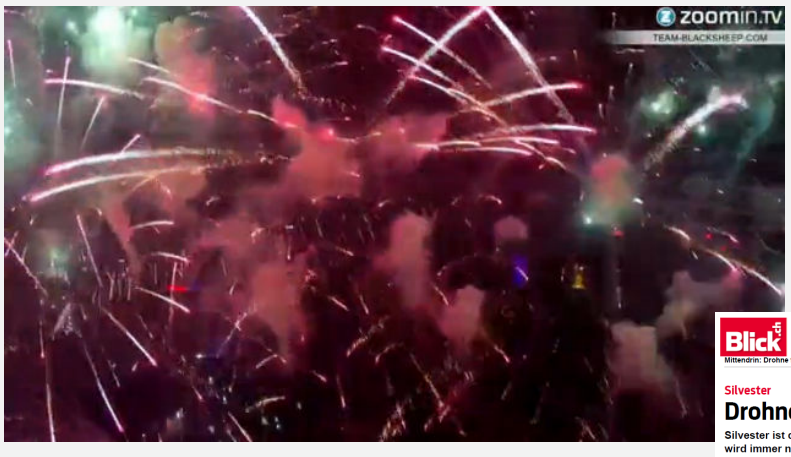
Regulation, operation: Is this safe?




Blick.ch
Mittendrin: Drohne filmt in gigantischem Feuerwerk

Silvester

Drohne filmt in gigantischem Feuerwerk

Silvester ist die Zeit grandioser Feuerwerke und Lichtspektakel. In einigen Ländern wird immer nochmal eine Schippe draufgepackt. So wie in Hongkong. Diese Drohne liefert spektakuläre Bilder. Fliegen Sie mitten durchs Feuerwerk.

Blick, 02.01.2015

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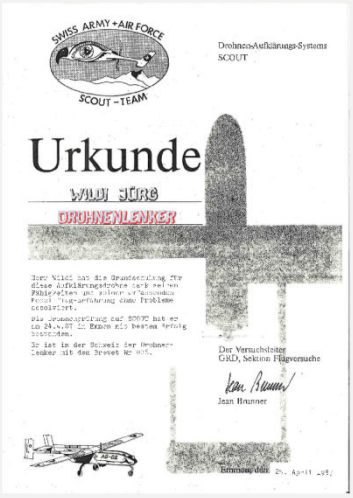
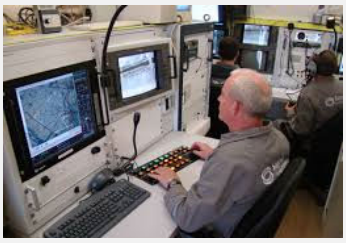
Regulation, operation: This is safe.

Photo: Aviation Week & Space technology, Dec.2014

Regulation, processes: Operator license





Pilotenschein 09. September 2014 17:31; Akt: 10.09.2014 16:54

Erster Drohnenpilot mit Bazl-Lizenz

von Alessandro Meocci - Der Berner Oberländer Remo Masina (25) ist der erste lizenzierte Drohnenpilot der Schweiz. Anlässlich der Air 14 in Payerne hat er den Bazl-Skilltest erfolgreich bestanden.

Fehler gesehen? Fehler beheben

Remo Masina hat es geschafft. Der Oberländer ist schweizweit der erste Pilot, der ferngesteuerte Flugdrohnen mit einer offiziellen Zertifizierung des Bundesamtes für Zivilluftfahrt (Bazl) lenken darf. «Die Aufregung war ähnlich wie an der Autoprüfung», sagt der 25-Jährige. Um die Lizenz zu erhalten, musste der Multikopter-Pilot einen sogenannten Skilltest des Bazl absolvieren. «Die Prüfung dauerte rund 20 Minuten», sagt Masina. Um sein Können unter Beweis zu stellen, habe er verschiedenen Flugmanöver demonstrieren müssen. «Natürlich alles manuell und auf Sicht – ohne technische Hilfsmittel wie GPS- oder Attitude-Unterstützung.» Zudem hätten die Bazl-Spezialisten die Sicherheitsmassnahmen und die Zuverlässigkeit der Systeme unter die Lupe genommen.

Conclusions

- The imperative precondition for industrial drone activities is a sustainable business case.
- The industry requires transparent regulations for drone design, production and operation.
- Technologies have to be evolved to ensure safety and reliability.
- The bridge to fill the gap between academic low TRL level research and industrial product development should be strengthened.
- Switzerland offers excellent potential to push the civil drone development towards successful commercial applications due to the established relations and demonstrated cooperation between academia, SME, industry, the aviation regulation agency and military including access to infrastructure.