Synergies Technique et Économique des drones civils et des drones de sécurité

ENSAM – 20Mar08

USEP - CGARM Report by Dr C. Fargeon & Gen F. Lefaudeux

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CGARM UVS I

- CGARM & UVS International
- Global Security:
  - Defence,
  - Homeland Security, Civil Security,
  - Customs, Illegal Immigration, Police …
  - Environment
- UAV = UAS

CIVILIAN & COMMERCIAL APPLICATIONS

Federating The International UAV Community

CURRENT

Publicity Spots, TV & Cinema (Europe & USA)
Atmospheric Research (USA)
Meteorological (Australia)
Agricultural (Japan & S.Korea)
Border Patrol (S.Africa, USA)

UPCOMING

Forest Fire Detection (Port.)
Power Line Maint. (Austr)
Env... M...

FUTURE

Aerial Surveying
Mineral Detection
Atmospheric Sampling
Wildlife Monitoring
Power Cable Verification
Pollution Control
Search & Rescue
Disaster Relief
Law Enforcement
Mapping
Telecommunications
Cargo Transport (Fedex)
NBC Detection
News Broadcasting
Farming & Ranching
Fishing Industry
Maritime Surveillance
Perimeter Surveillance
Industrial Site Surveillance
Rail Line Monitoring
Avalanche Control
Riot & Crowd Control
Traffic Surveillance
Smuggling Control

DRIVERS: Cost-Effectiveness
Missions impossible with manned aircraft
or more efficient than with manned aircraft

To be economically viable,
e UAS military market has to be supplemented by civilian marke

Category	EU Military market	Vectors	Export Limitation
Mini and micro UAS	To open	Thousands if cost matching	
Tactical enduring UAS	nearly mature	200 to 400	strong competition
Heavy Payload Long Endurance	emergent volume / timing uncertainties	50 to 120	MTCR treaty

- MTCR: Missile Technology Control Regime – 300 kg / 500 km

- **Report 2003 – 2004**
  - oriented U[C]AV defence
  - French working group, European market
  - 50 people involved from HQs / industry / FR procurement
  - Report English version finalised with UVS International

- **Report 2006 – 2007**
  - oriented UAS security, environmental and commercial related UAS applications
  - European working group –EU, AED, FRONTEX well informed
  - other ministers implication
  - UVS International profession backbone free participation

Needs Prospective

Missions Collection

UAS Solutions

Compare UAS / current means & alternate solutions

Equipments Perspective

Strategies

Technical Synergies Military/Security

Services / Patrimonial Acquisition

Market Accessibility

Organisation EU/N

Recommendations

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Date Submitted
Scenario Number
Customer /Institutions
Scenario Name
Mission type
service =S; acquisition=A
Mission Area
Security/info. Level
Discretion, stealth
Payload description
Data precision & function (detect, classify, track, identify, localize, analyse), ammunition (attack), NBC (sample)
Gross weight payload
1
2
3
4
5
6
7
Payload Capacity (kg)
Typical bandwidth need

Endurance*(hours)
Range (km)
Max. Altitude (feet ASL)
Typical Op. Alt. (feet AGL)
Min. Op. Alt. (feet AGL)
Operation Type
Deployment time (hour) including time for reaching service ceiling
Flight profile
Weather
Alternate Solution System Types
Gross T.O. Weight (kg)
Man/Machine Control Level
Primary UAS Command/Control Link Up-link: 10 - 100 kbps; Down-link: 10 - 100 kbps
Secondary UAS Command/Control Link
Primary Sensor Data Link (PSDLK) Up-link: 10 – 100 kbps; Down-link: according to payloads
Secondary Sensor Data Link
ATC Voice Communications
Other Comm. Link

Max. Speed (km/h)
Cruise Speed (km/h)
Min. Speed (km/h)
Airspace Utilized (class)
Taxi Method
Launch Method
Launch Env.
Recovery Method
Sense and Avoid
UAS/aircraft Pilot Qual.
UAS Commander Qual.
Navigation
Contingency
Comments

Application's data base

- Airworthiness
- Operational regulations (use of controlled airspace)
  - One sky – reduction of military controlled airspace
  - "Sense and Avoid"
  - ATM 2015
- UAS operators and air traffic controllers
  - Education and training
  - Judiciary responsibility
- Maintenance
  - Education

Needs Prospective

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- **UAS Solutions**
- Compare UAS / current means & alternate solutions
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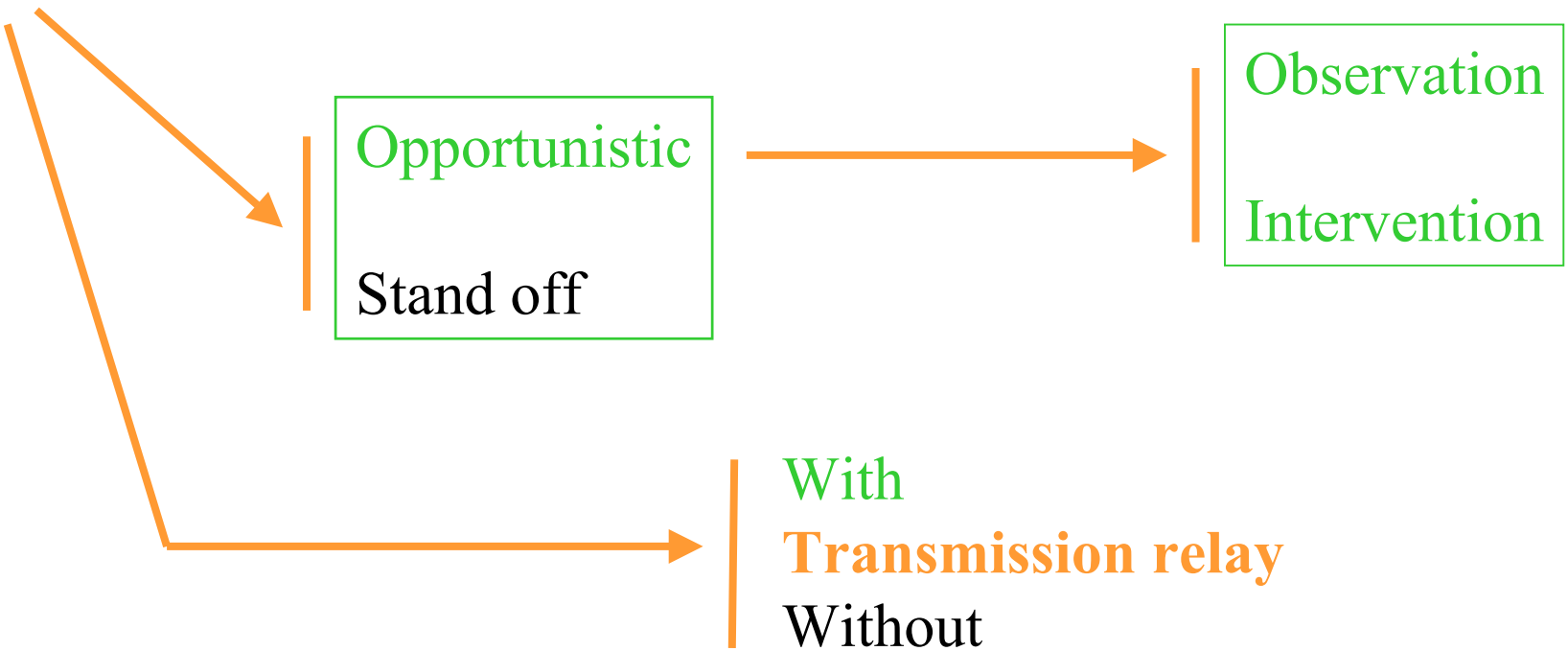
Recommendations

Autonomous — **Individual use**

In the network — **Coordinated use**



Some explanations to users

- **Micro "crash & go"** (<1,5 kg) **and Mini UAS** (1,5 kg < MTOW < 25 kg)
  - Armed or not
  - Fixed wing or rotary

- **TUAS for tactical / opportunistic** (25 kg – 150 kg & > 150 kg)
  - **Optionally piloted or not**
  - Fixed wing or rotary
  - Certified 'USAR' or not certified

- **HP LE for heavy payload long endurance UAS** (payload > 500 kg)

- **UCAV,** specifically designed for combat, are out of scope for this study.


To edict a specific regulation
allowing use of UAV < 1.5kg
STAFF
STAFF

- Specified as
  - Engine stops before crash, when loss of control
  - Lighter than 1,5 kg
  - Less than 80 J when crashing
  - Embedded stability enabling gentle uncontrolled landing
  - Soft materials, i.e. plastic propeller blades, etc.
  - Flying at an altitude less than 100m
- Used by governmental institutions or service providers supplying those institutions, when operated
  - out of sight
  - over public
  - in non segregated space

"Crash & Go" Definition

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Needs Prospective

- Missions Collection
- UAS Solutions
- **Compare UAS / current means & alternate solutions**
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Recommendations

- **Tethered balloons, preferred due to noise, energy saving for**
  - Criminal investigation over a few days
  - Surveillance of public gatherings (Cultural events, Sporting events, G8, Raves party)
  - Police permanent surveillance
  - Wild game surveillance

- **Satellites, alternates on large scale missions**
  - Sea plankton monitoring
  - Sandbank shifts measurement
  - Glacier & ice cap monitoring
  - Large scale terrain mapping

- **Automatic take-off and landing**
  - Increase operational availability
    - Example Hunter 100 days; Hunter B 250 days /year
- **Back office man-machine interface**
  - Team professionalization: cohesion, team efficiency
  - Important for take over procedures and delocalized teams working procedure training
- **Plug and play**
  - Deployment time
  - Payloads flexibility in operations
  - Multi source acquisition
  - Fleet monitoring technical and operational evolution, multi-services and multinational co-operations

Issues with operational incidence

Leading lines collected from users for study

- Security market and other civilian markets seriously concerned by
  - Low cost approaches
  - No 'mistakes'
  - Private life respect – warrants
  - Certification (communications, air traffic integration)

- Security UAS solutions
  - Low operation cost – service procurement (see further slides)
  - Development cost reduction – Optionally piloted use
  - Low maintenance cost – General aviation platforms
  - Low cost EO/IR payloads – UAV speed bandwidth

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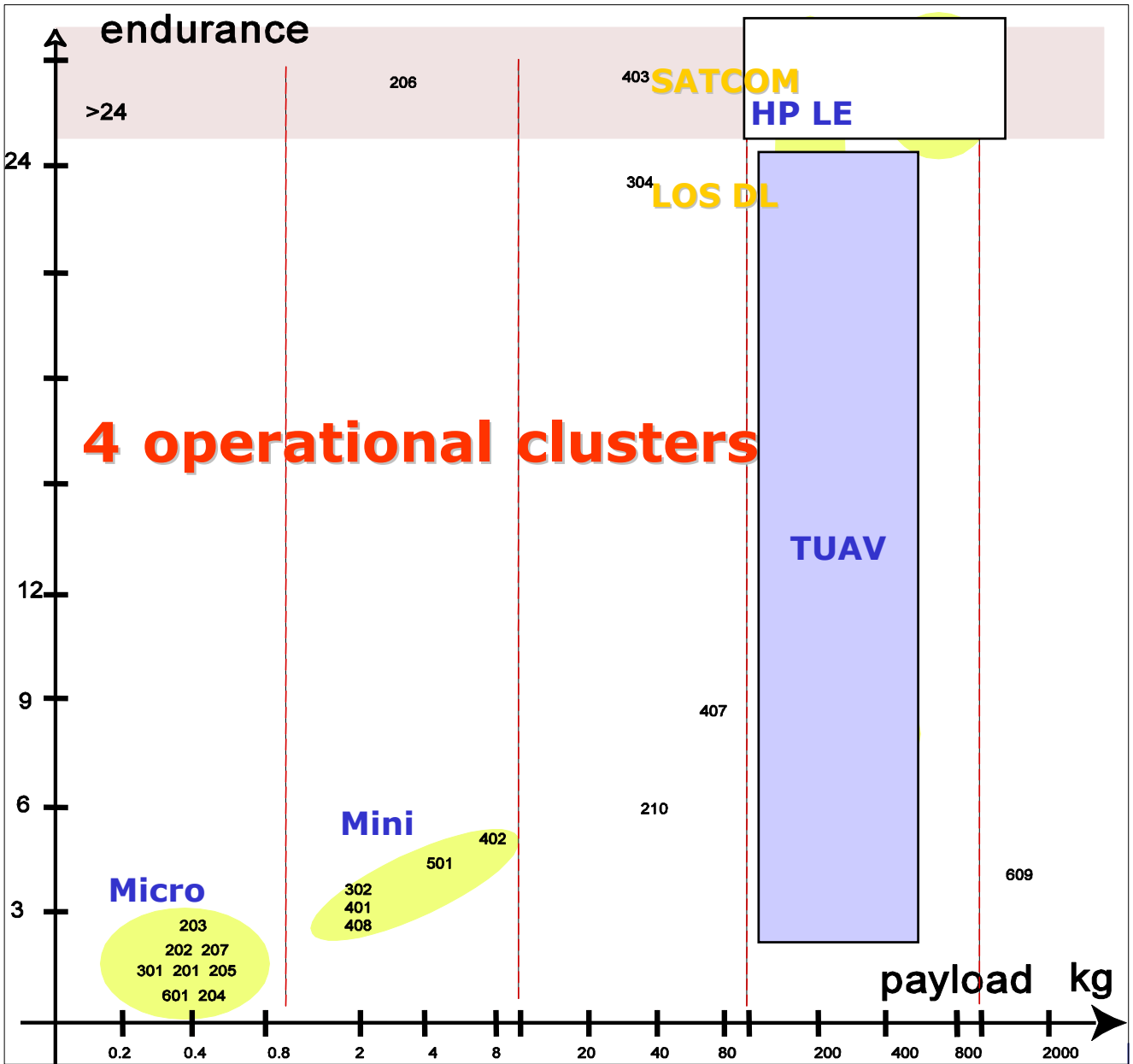

endurance
>24
24
12
9
6
3
206
403
SATCOM
HP LE
304
LOS DL
4 operational clusters
TUAV
407
210
609
Mini
402
501
302
401
408
Micro
203
202 207
301 201 205
601 204
payload kg
0.2
0.4
0.8
2
4
8
20
40
80
200
400
800
2000

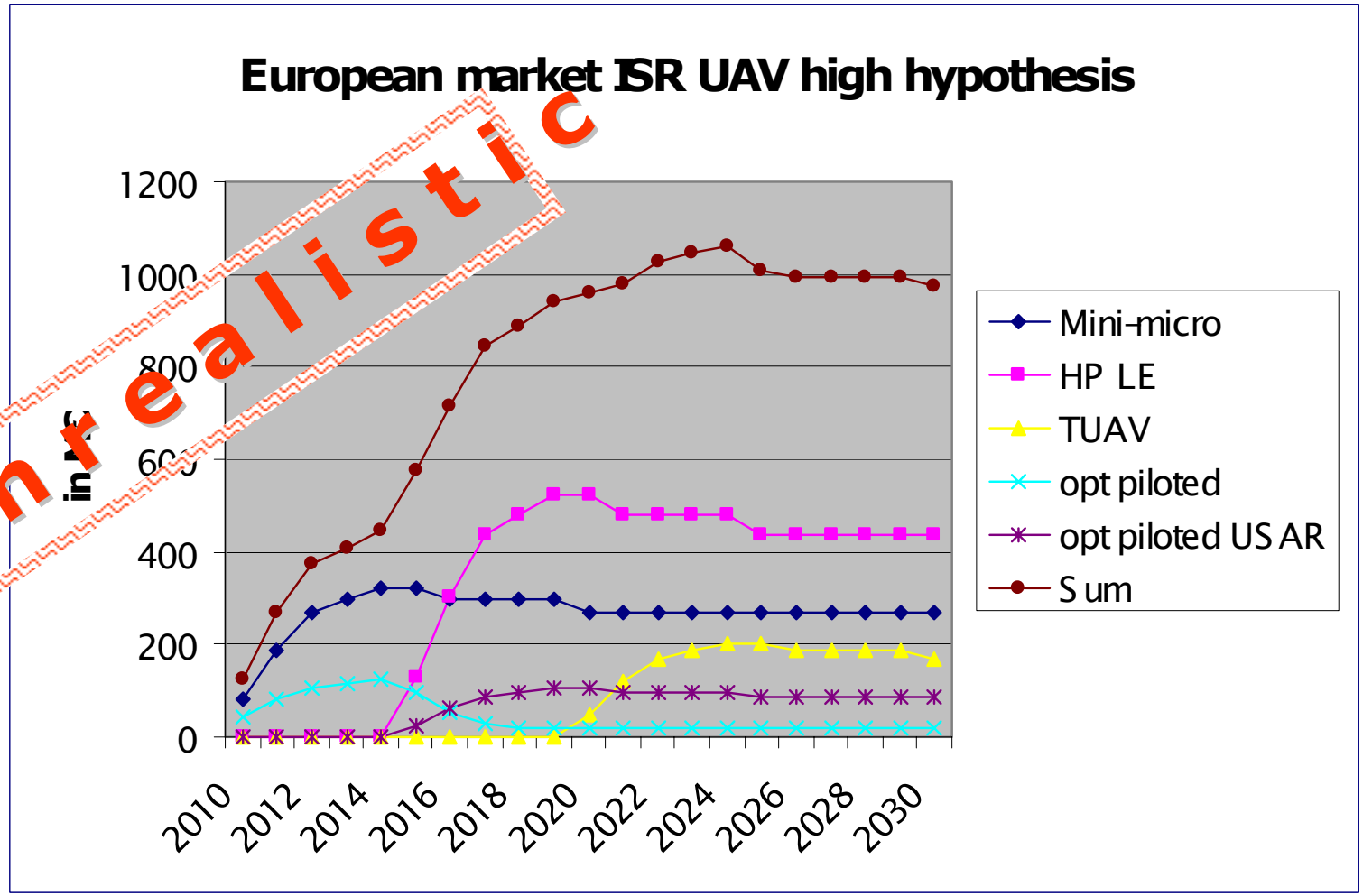
Type	Market opening	Nb of vectors Europe	Number of missions											
			Defence		Customs		Police		Civil Security		Environ-ment		Service	
			A	S	A	S	A	S	A	S	A	S	A	S
Micro (MAV)	2010	56 000	1				4		1					1
Mini	2020	4 000						3		2	2			2
Tactical opportunistic and optionally piloted	2020 2006	500	3	1		2	1	3		5		1		3
Heavy payload LE	2015	60	1	1		2		2		1		2		3

A = Acquisition, S = Service

56 scenarios identified

9 scenarios ranked non-UAV

47 included in the business plan



Equipment perspective - High

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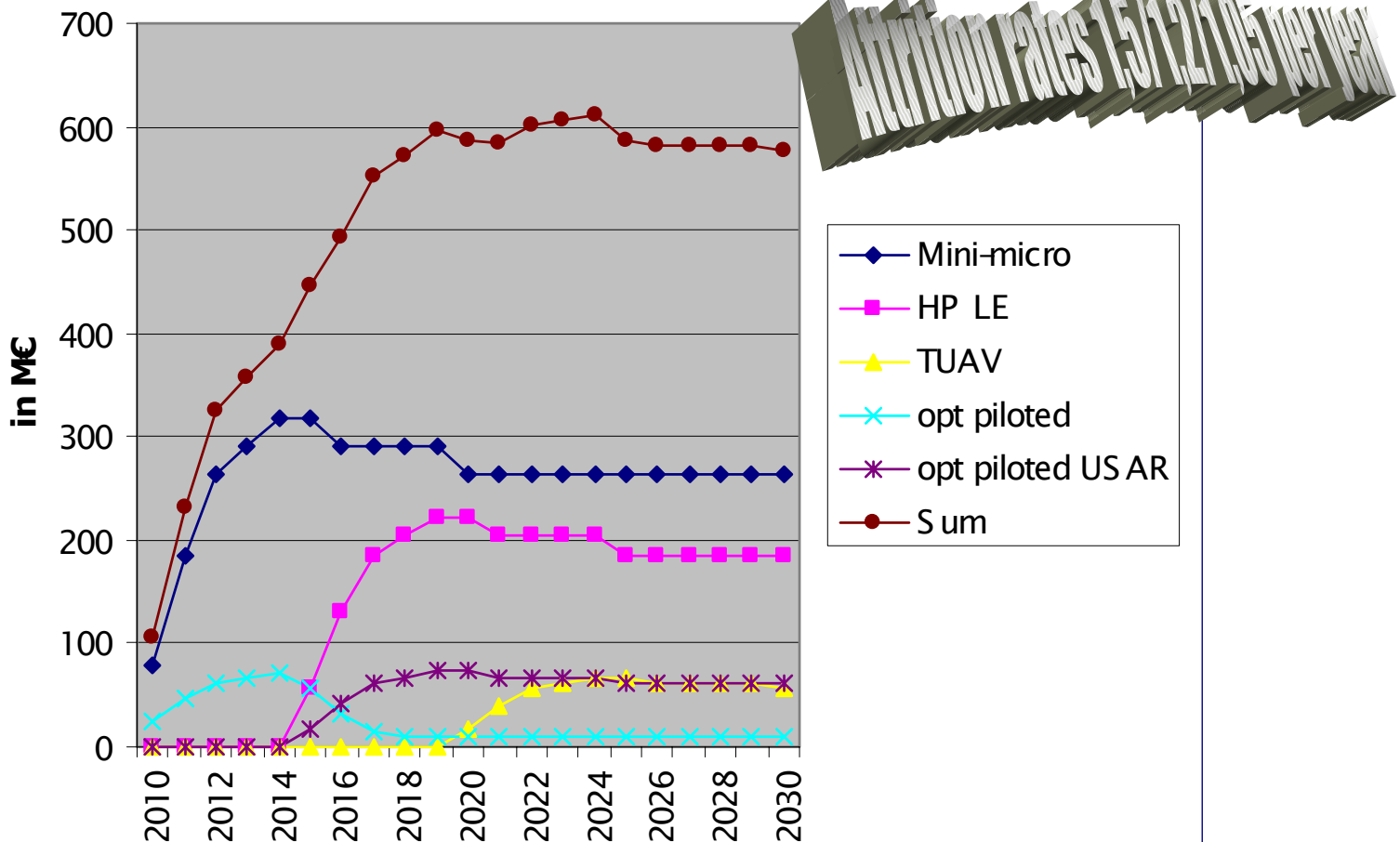
Security UAV European Market Low hypothesis



Equipment perspective - Low

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Recommendations

Range (km)	Military	Security - Civilian
Mini – Micro	–	–
TUAV	500 – 1000	200 – 300 (LOS)
HP LE	3000 – 4000	< 2500

Persistence on scene (hours)	Military	Security - Civilian
Mini – Micro	Limited by energy technology	
TUAV	8 – 12	3 – 9
HP LE	> 24	> 24

Pre-Flight preparation (minutes, hours)	Military	Security - Civilian
Mini – Micro	30’	< 10’
TUAV	1,5 – 3	< 30’ – 45’
HP LE	5	< 4

Payloads	Military	Common needs	Security - Civilian
Mini – Micro	Links	EO/IR, NBC sensors (Low cost)	Weather sensors, Links
TUAV	SAR, EW, Links	EO/IR, MTI, Detect & Avoid, GPS	Weather, multi spectral sensors, Links
HP LE	SAR, SIGINT, EW, Links	EO/IR, MTI, ISAR, COMINT, Detect & Avoid, GPS	Weather, multi spectral sensors, Links

EW: Electronic Warfare

Stealth	Military	Security - Civilian
Mini – Micro	Acoustic	Acoustic
TUAV	No	Acoustic
HP LE	No	No

Launch and recovery	Military	Security - Civilian
Mini – Micro	Hand	Hand
TUAV	Boost/parachute, tarmac, sea frigate	Tarmac
HP LE	Tarmac, Aircraft carrier	Tarmac

Weather	Military	Security - Civilian
Mini – Micro	All weather, day and night	Day and night, wind
TUAV	All weather, day and night	Day
HP LE	All weather, day and night	All weather, day and night

Network Links, secondary DL	Military	Security - Civilian
Mini – Micro	–, No	with local civil authorities, No
TUAV	Encryption, Military network, Yes	with local civil authorities, No
HP LE	Encryption, Military network, Yes	with local civil authorities, No

	Major differences	Commonalities
Range (km)	Within LOS (300 km) for civilian TUAV	Mini-micro, HP LE
Persistence on scene (H)	TUAV: 3-9 (C) and 8-12 (D)	Mini-micro, HP LE
Pre-flight preparation	Mini-micro and TUAV civilian asks for quicker readiness	HP LE
Stealth	TUAV: acoustic req. stronger on civilian side	Mini-micro, HP LE
Launch and recovery	TUAV	Mini-micro, HP LE
Network links	Local relays for civilian, strong satellites demand for military use	
Payloads	SAR precision, BLOS Links	EO/IR

- **IR:** to work on the reduction of cost and "bulk" – including weight and power consumption (IR is needed by most potential users, but miniaturization must be pursued).

- N: this is a completely new option to be developed in the context of anti-terrorism and civil security.

- **COMINT:** beacon homing is meant for rescue and team co-ordination, mobile phone tracking is suitable for enemy homing for neutralisation purposes; but is probably difficult to implement on this category of UAS.

- Operational software's: car tracking is requested on-board to enable micro and mini UAS to home on this type of mobile target at beginning of a pursuit in urban zone and for instance enable to stick the Micro UAS on the car for further tracking by GPS.

- **Detect and avoid:** the availability of such an anti-collision system is mandatory; it has to be of reasonable price and bulk not to impair the use of other payloads.

- **C and BC:** this is a completely new option to be developed in the context of anti-terrorism and civil security.

- **EO/IR:** it is mandatory to reduce drastically the cost of these payloads. The use of slow/fast platforms will help. Automatic tracking is already at use.

- **SAR/MTI/ISAR**: recent developments have achieved great improvement concerning bulk, so the major effort now is to reduce cost to open the civilian market and image processing to reduce communication bandwidth consumption. Payload tracking trajectory oriented is a less stringent issue.

- **COMINT:** on-board mobile phone detection, identification and tracking are key functions for TUAS security applications. If this technologic exploit is achieved price may be high at start.

- **Detect and avoid**: the availability of such an anti-collision system is mandatory; it has to be of reasonable price.

- **Links:** special attention has to be given to the development of conformal antennas to facilitate the use of general aviation platforms. On-board processing and also control station software's have to enable easy interoperability between users.

- **COMINT:** on-board mobile phone detection, identification and tracking are key functions for security applications. This technology is less complicated when bulk remains secondary, so key effort has to be oriented on precision at high flight levels. If achieved, price may be high at start.

- **SAR/MTI/ISAR:** recent developments have achieved great improvement concerning precision, so the major effort now is image processing to reduce communication bandwidth consumption and secondly to reduce cost to open the civilian market.

- **EO/IR:** it is mandatory to reduce drastically the cost of these payloads.

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Recommendations

Service renting levels from 1 to 4: "What would you buy

User buys:

1. Stored **data**
2. Real time **data**
3. **Time** of direct **Payload control** – service supplier has no access to information (confidential action)
4. **Time** of direct **Vehicle control**
5. Patrimonial acquisition

Low	Mutualisation effect (€)	
	Nations savings	Increase of margin for Service suppliers
Mini-micro	28 669 067	4 174 000
TUAV	38 673 818	24 684 873
HP LE	33 716 670	58 384 690

High	Mutualisation effect (€)	
	Nations savings	Increase of margin for Service suppliers
Mini-micro	36 010 400	12 761 600
TUAV	115 128 000	42 494 400
HP LE	99 710 100	106 610 700

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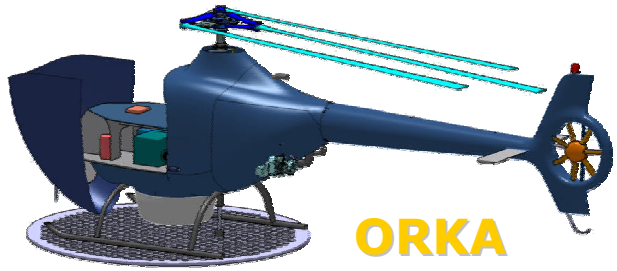
- **Limitation on risk development**

- **Safety**
  - Dyn'Aéro's parachute qualified as safest by French civil aviation authorities – more crashes recorded with two engine solution due to dissymmetric struggle for the Artificial Intelligence based UAS autonomous supervisor, demonstrated 2006
  - ONERA partnership on hyper-lifted wings
  - AIRBUS like leading edges

- **Optionally piloted are ready for use today**



- **Low cost**
  - Maintenance cost
  - Operation cost
  - Spare parts cost

Why to prefer a commercial airframe

Needs Prospective

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Recommendations

- **Maturity of needs** expressions differing widely from one Nation to another
  - Both at National and European level, applications government agencies have to talk together
  - Service providing companies awareness and involvement is to be increased

- Pressure on **standards** should be rethought of, in the light of technology progress concerning open architecture:
  - Incoherence between STANAGs. New upper level standards are now under discussion at NATO.
  - EDA implication in these discussion would defend European industry interests, its dedication to innovation
  - Civilian standards whenever applicable have to be preferred

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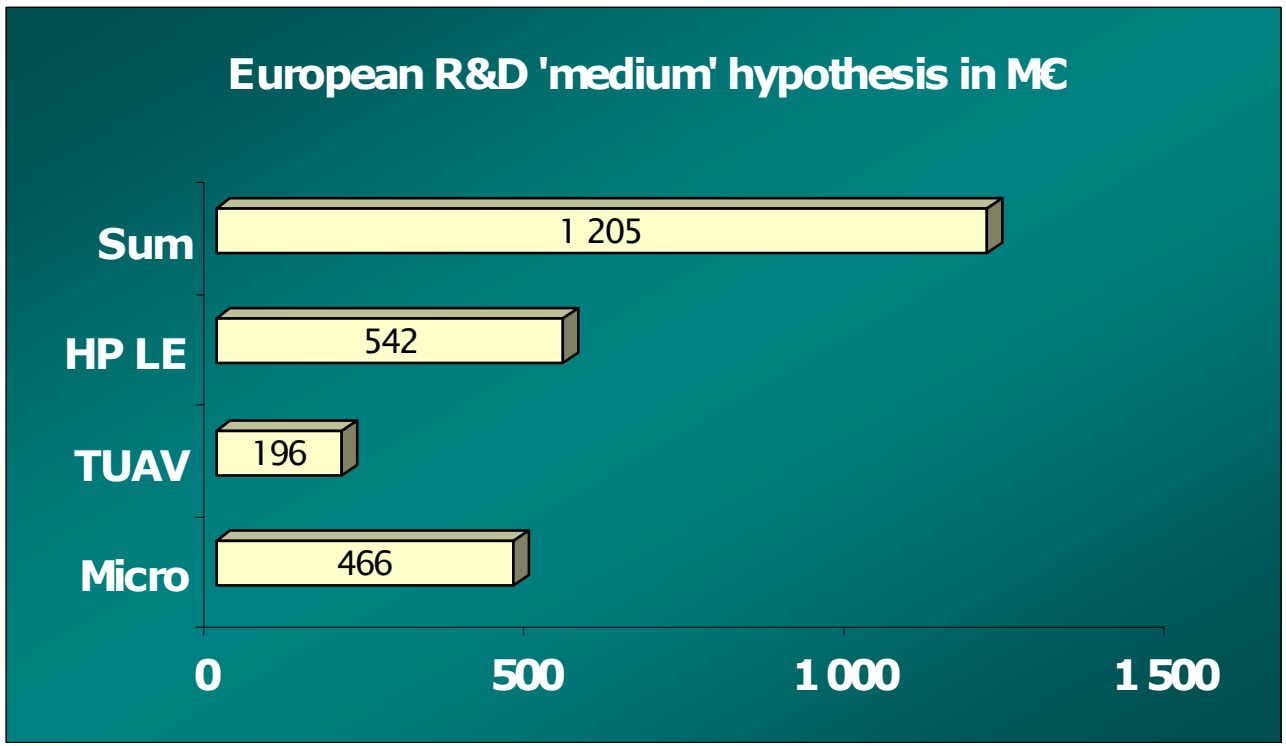
Recommendations

- Many UAS applications are relevant to service supply.
- Many UAS applications are relevant to service supply mutualisation at national level and R&T cooperation at European level.
- Technical synergies between military UAS solutions et civilian's in favour of European action.
- Supply service approach does not suppress need for equipment qualification as required by customer. This implies that test centres, most of military origin are necessary for civilian security applications.

- Dedicated **sense and avoid systems**,
- Interoperability qualification procedures,
- Secure communication links,
- Miniaturized imaging sensors (specifically SAR),
- Multi-spectral & hyper-spectral sensors,
- **Light detection and ranging (LIDAR) sensors** (of specific interest for missions in urban environments),
- **Mobile phone homing** is asked for by police and other users,
- **Flush mounted electronic arrays** for satellite communications,
- **Alternates to gasoline propulsion**, e.g. electric, hydrogen substitutes,
- Alternative airborne power sources (fuel cells, solar cells with increased efficiency, lithium polymer batteries, etc),
- **Improved airborne processing capabilities**, including image processing to extract the relevant parts to transmit,
- Large on board data mass-storage capacity.

7 years financial effort from "industry + nations + EU"
(incl. Payloads & Control stations)



European R&T budget needed today for tomorrow …

- **UAS market is a specific market, service oriented**
  - Poor R&D support at National level
  - National customers not ready to pay a high price for UAS
  - But open to service renting solutions
- **Services Providing Companies will be strongly sensitive to**
  - Investments costs
  - Direct flight hour cost
  - User friendliness
  - Maintenance load
- **This implies a brand new technical and market approach**, as debated in the report.
  - Consultation of customers must play a key role
  - Industry must adopt a dedicated industrial model

Conclusions

Questions