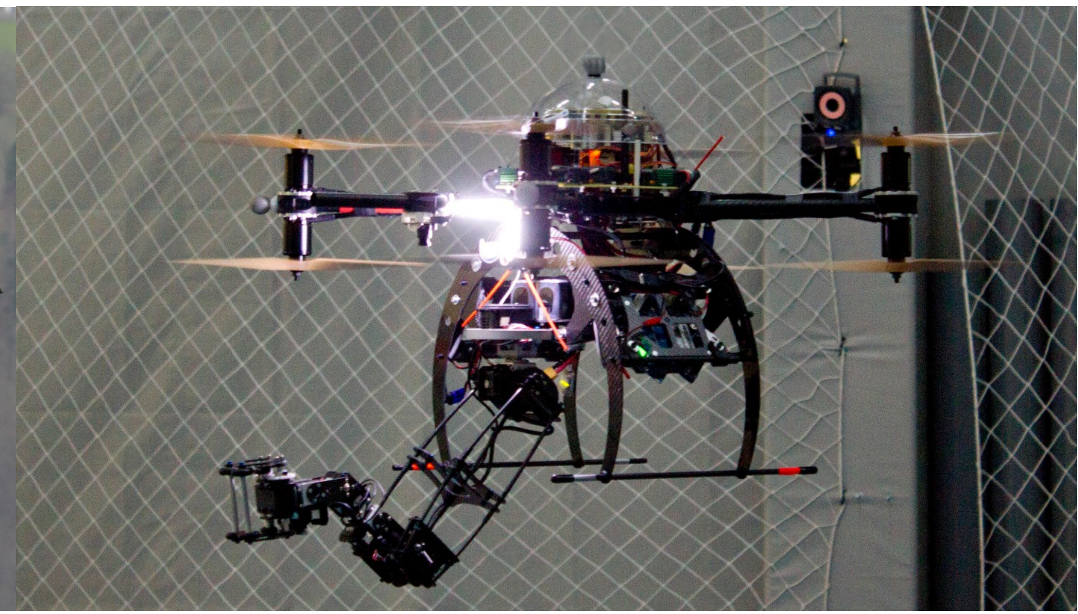
Hardware & Software for new platforms

Aerial Robotics for Inspection and Maintenance



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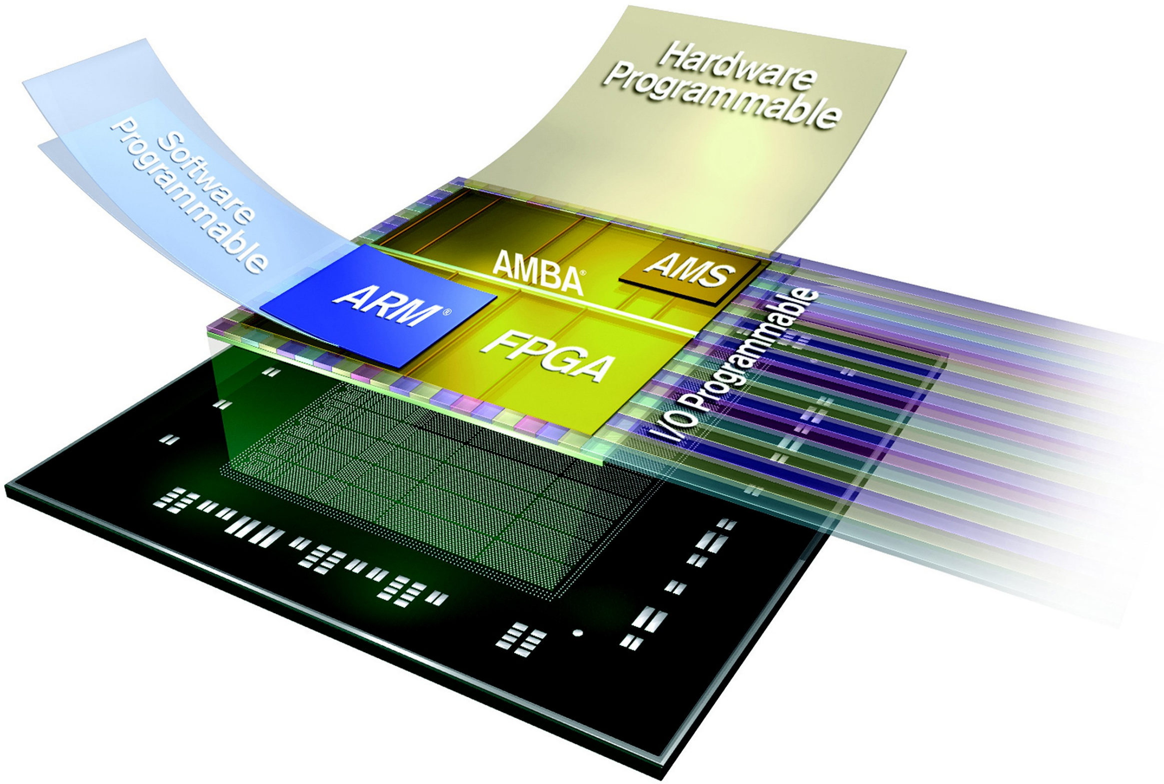
http://www.aircraft-certification.de/

http://www.aeroarms-project.eu/

FPGA based Flying Control Computer



Why a FPGA? Hardware interfacing

→ Software Serial Driver → AHRS

- 200Bytes x 1000Hz = 200K int / s
- ~25-30 % of CPU usage

→ HARDWARE Serial Driver ↓ Software Reader → AHRS

- 1000Hz = 1K interrupts / second
- < 0.2% of CPU usage

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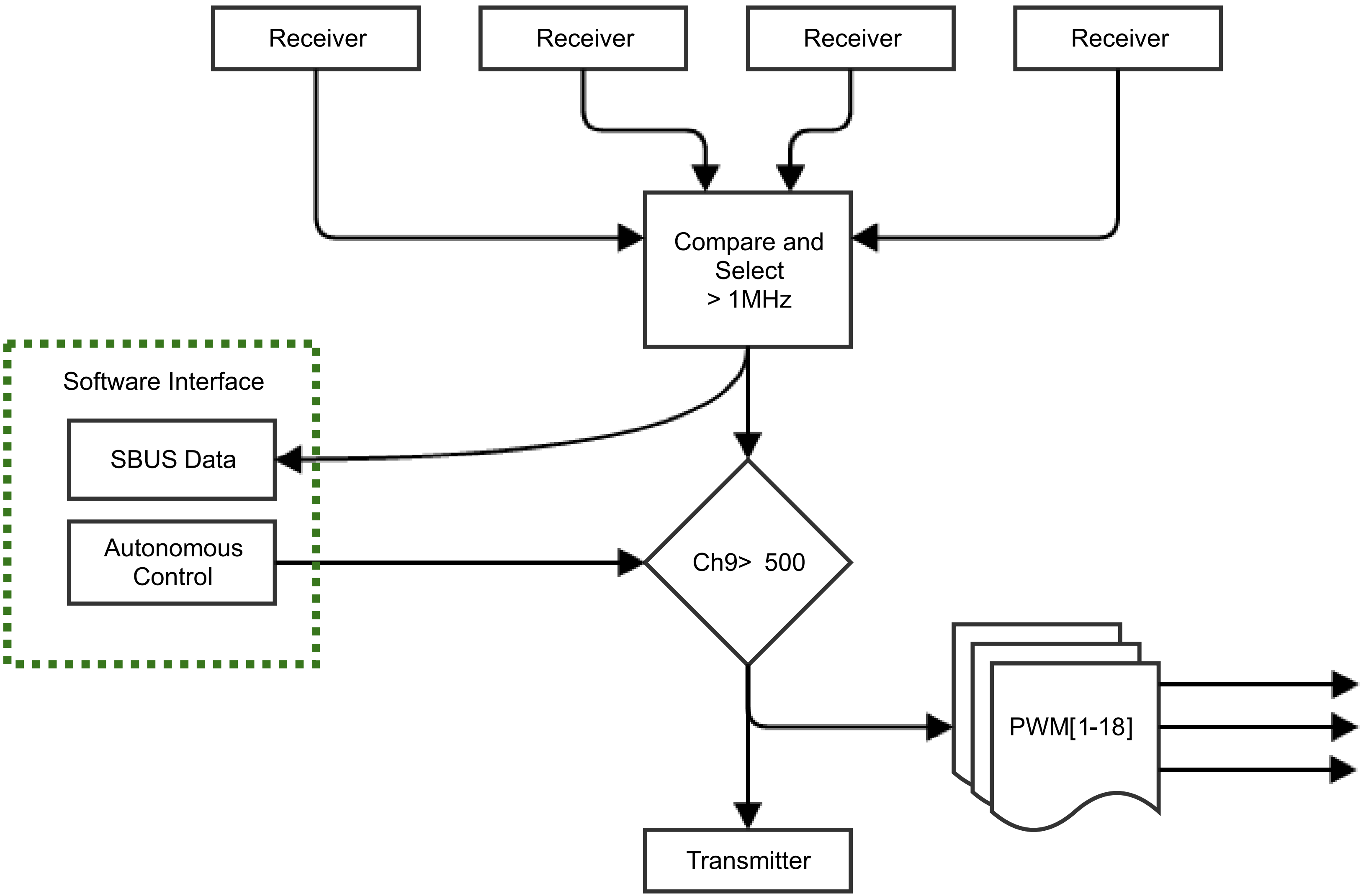
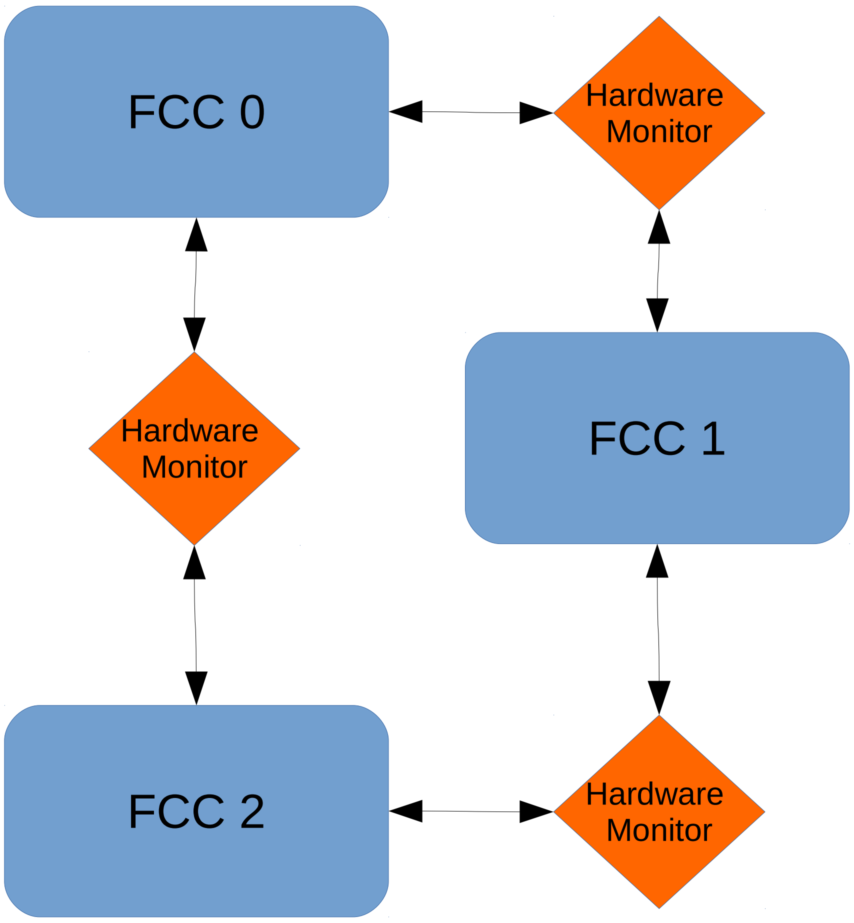
Why a FPGA? Devices Flexibility

Device	Address	Size	Interrupt
uStrain_0	0x43C0_0000	64K	84
uStrain_1	0x43C1_0000	64K	85
RS-232_2	0x43C2_0000	64K	61
RS-232_3	0x43C3_0000	64K	62
RS-232_4	0x43C4_0000	64K	63
RS-232_5	0x43C5_0000	64K	64
RS-232_6	0x43C6_0000	64K	65
RS-232_7	0x43C7_0000	64K	66
RS-232_8	0x43C8_0000	64K	67
RS-232_9	0x43C9_0000	64K	68
RS-422_CR	0x43D1_0000	64K	-
RS-422_1	0x43CC_0000	64K	86
RS-422_2	0x43CD_0000	64K	87
RS-422_3	0x43CE_0000	64K	88
RS-422_4	0x43CF_0000	64K	89
RS-422_5	0x43D0_0000	64K	90
SBUS_Controller	0x43CB_0000	64K	-

Why a FPGA? Safety Algorithms



Why a FPGA? Redundancy



Software for new platforms

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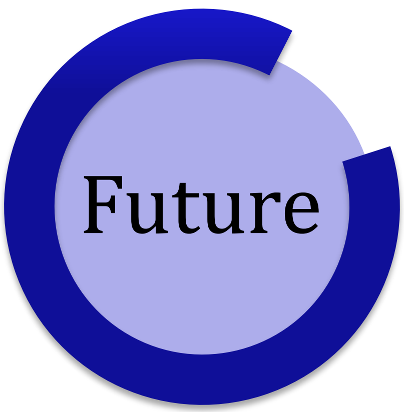
Towards UAV autonomy

- A significant part of the research efforts have been spent on the UAV autonomy.
- UAVs are able of carrying out on their pre-planned mission.
- Human supervision is still needed, especially in highly dynamic environments.



- **Overcome the car autonomy level in the flying robots.**
- **In tasks like Inspection and Maintenance, a maximal autonomy level of Aerial Robotics is desirable.**
- **Intelligence mission management.**

Formal verification of mission plans

- Analysis of the execution plans in terms of their correctness and errorless.

- A logic formalism or statements for the missions (relationships among the basic elements: states, actions, events…) which could be verifiable.

  => Verification

- One possibility: Linear temporal logic, LTL.

Special Temporal properties		
F Φ ≡ **F F** Φ	**G** Φ ≡ **G G** Φ	Φ **U** ψ ≡ Φ **U** (Φ **U** ψ)
Φ **U** ψ ≡ ψ ∨ (Φ ∧ **X**(Φ **U** ψ))	Φ **W** ψ ≡ ψ ∨ (Φ ∧ **X**(Φ **W** ψ))	Φ **R** ψ ≡ ψ ∧ (Φ ∨ **X**(Φ **R** ψ))
G Φ ≡ Φ ∧ **X**(**G** Φ)	**F** Φ ≡ Φ ∨ **X**(**F** Φ)	

DLR

Schema Mission Management Flow

Mission Description Language

Mission Creation

Revision

Mission Verification

Mission Generation

System Specification

Mission Execution

Environment

Platform

Control

Sensors