



DEVELOPING
WORLD-LEADING
NANO UAV TECHNOLOGY



NTNU ITK 60 YEAR

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Jørgen Syvertsen

My Background

- MSc Engineering Cybernetics (2004-2009)
 - Guidance and control of vehicles
 - Modeling and control of robots
 - Project with Sintef (ITC Applied Cybernetics)
 - Obstacle-aided locomotion with snake robots
 - Master with ABB (Oil&Gass)
 - Improve model confidence by utilizing robot mounted sensors
- Prox Dynamics (2009-)
 - R&D Engineer - Control Systems, Software Department
 - 5 employees at that time

Introducing Prox Dynamics

<http://www.bloomberg.com/video/tiniest-drone-sees-everything-in-slow-motion-Sq8jahyvQIyGwt8QMJKD9w.html>

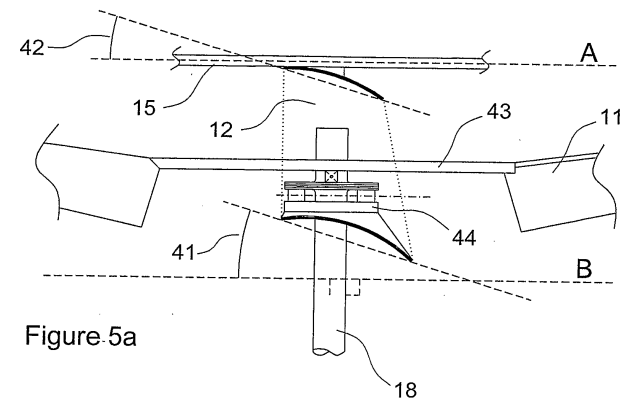


Contents

- A brief look at Prox Dynamics' history
- From prototypes to world-leading products
 - Applied cybernetics in focus
- The PD100 Black Hornet PRS (Personal Reconnaissance System)

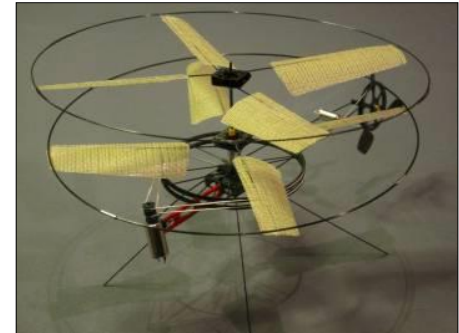
Passively Stable Hover

- Petter Muren, founder of Prox Dynamics AS
- He imagined a small, stable, silent helicopter
- Is it possible to hover completely stable with respect to the surrounding air?
- Challenging «known» facts; helicopters are inherently unstable
- Coaxial rotors
- Passively stable hover for first time in 2002
- Proxflyer AS founded in 2003 and a patent application for the Proxflyer rotor was filed



Hobby – Toys – Military Systems

- Proxflyer Micron was the first in a series of World records for smallest radio controlled helicopters and ornithopters.
- ITC Bladerunner was the first successful stable indoor toy helicopter and became the starting point for a series of flying toys from the Canadian company Interactive Toy Concepts.
- AV-1 Nano Air Vehicle was part of the DARPA Nano Air Vehicle program and as such inspired the startup of Prox Dynamics.



Prox Dynamics

Operational in April 2008

- 50+ Employees today
- Owned by Employees and three External Investors
- Turn Over 2013 ~ 90 MNOK

System Development (2008 – 2011)

- Internally Funded with Grants from Norwegian MoD, Innovation Norway and Norwegian Research Council
- Cooperation with Norwegian Defense Research Establishment

System Production (2012)

- All Design Work Performed Internally
- Produced in Norway

2014 US Incorporation

- Prox Dynamics INC established in Kentucky



Mission Statement

Mission

Develop, produce and sell airborne nano reconnaissance and surveillance systems and ancillary equipment for professional use.

Vision

Prox Dynamics' vision is to be the world leading supplier of airborne Nano reconnaissance and surveillance systems.

Customers

Governmental lower echelon dismounted and mounted units.

Simplicity – Innovation - Dedication



NUAS vs SUAS



nano = 1e-9?



Hornet – stepwise development

- Hornet-1
 - Off-the-shelf parts
 - Yaw gyro
- Hornet-2
 - I quite similar to Hornet-1
 - New Rotor system, 3-axis gyro
- Hornet-3
 - Sensors for inertial navigation
 - CPU, accelerometer, gyro, pressure, compass
 - Digital radio link for video and control
 - Brushless main motor (no gears)
 - Brushless servo (PDS-3)
- Hornet-4
 - Full body (fuselage)
 - GPS navigation
 - Fully functional autopilot
 - All systems as in PD-100



Flight Testing Prototypes

<http://www.youtube.com/watch?v=feVoX26W6MU>

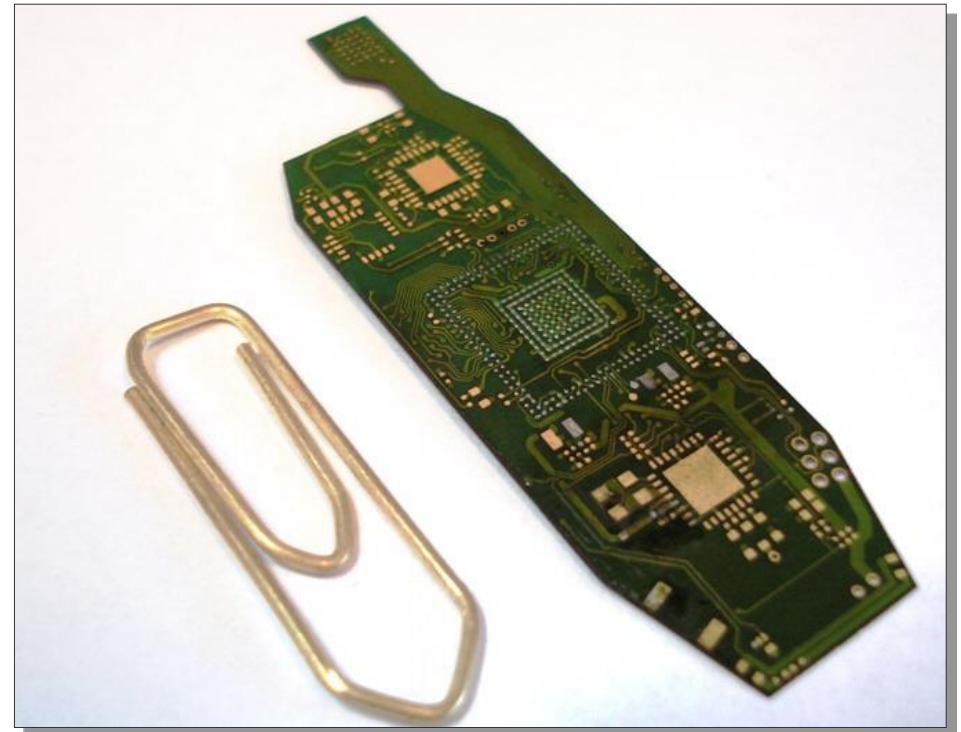


In-house developed parts



Main motor

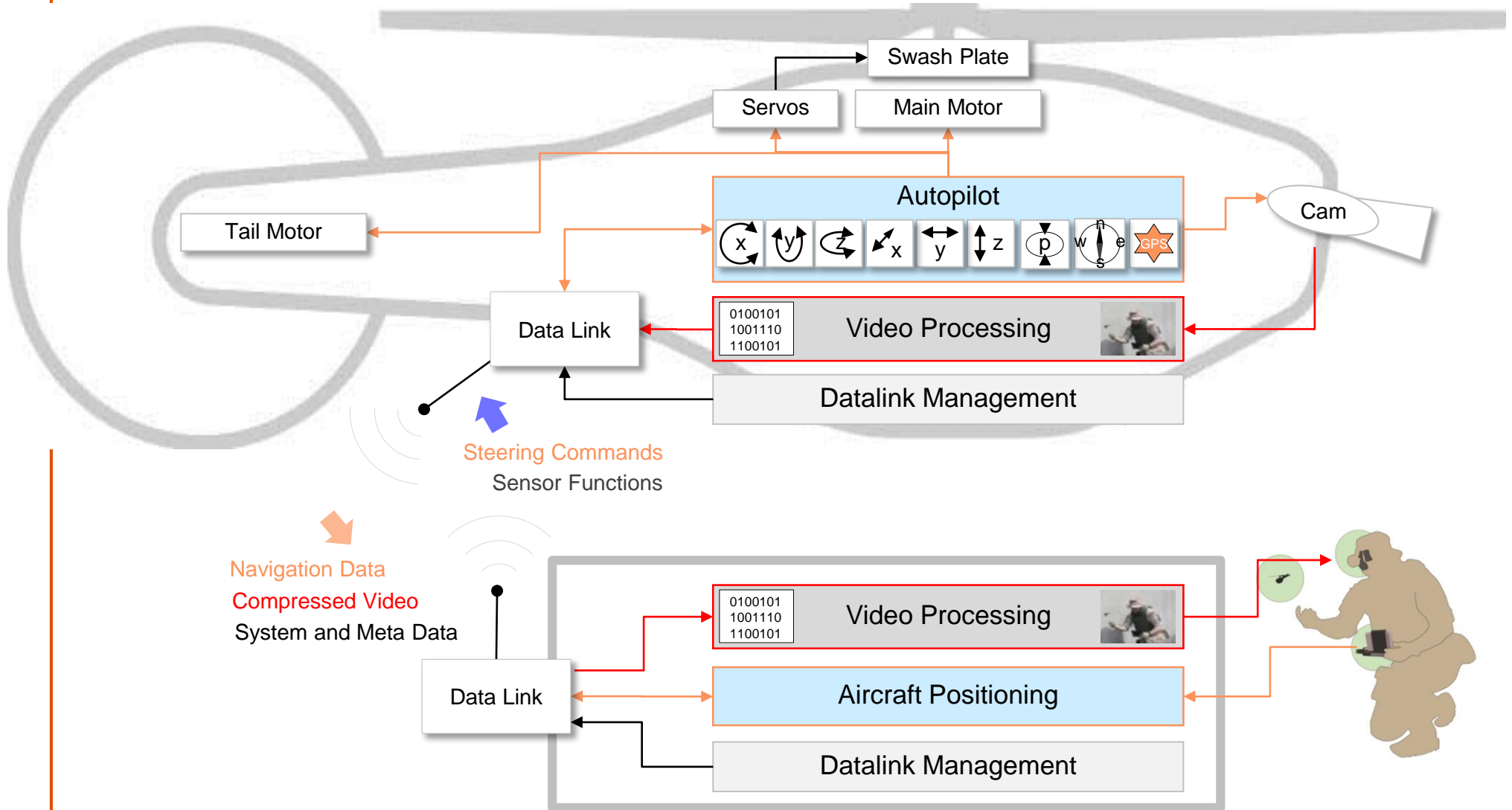
Coils and low weight, low friction Bearing
Rotor with Magnets
Carbon fiber and Steel tube Shaft
Total Weight 1.6 gram



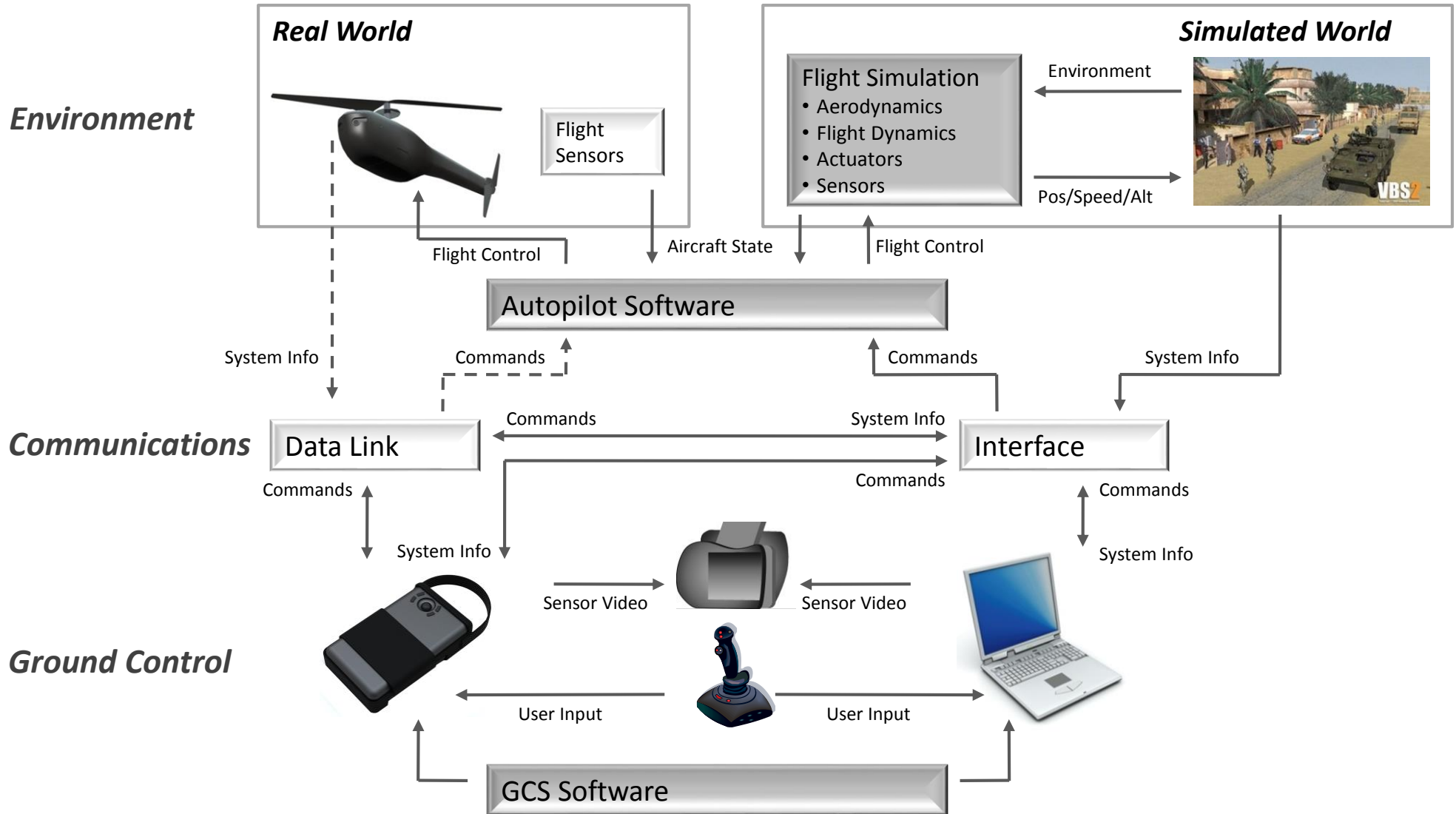
Main Processor Board

High Performance Processor and Memory
Camera, Accelerometer (x3), Gyro (x3),
Magnetometer (x3), Pressure Sensor
Digital Radio Link
Total Weight 2 grams

Helicopter system-processes



Test and Simulation System



System Identification of GPS Sensor Model



Video Stabilization

- Rolling Shutter Camera
- Feed-forward of attitude from state estimator



The Team in Action



PD-100 Black Hornet PRS



The world's first operational Nano UAV system.

Snapshot



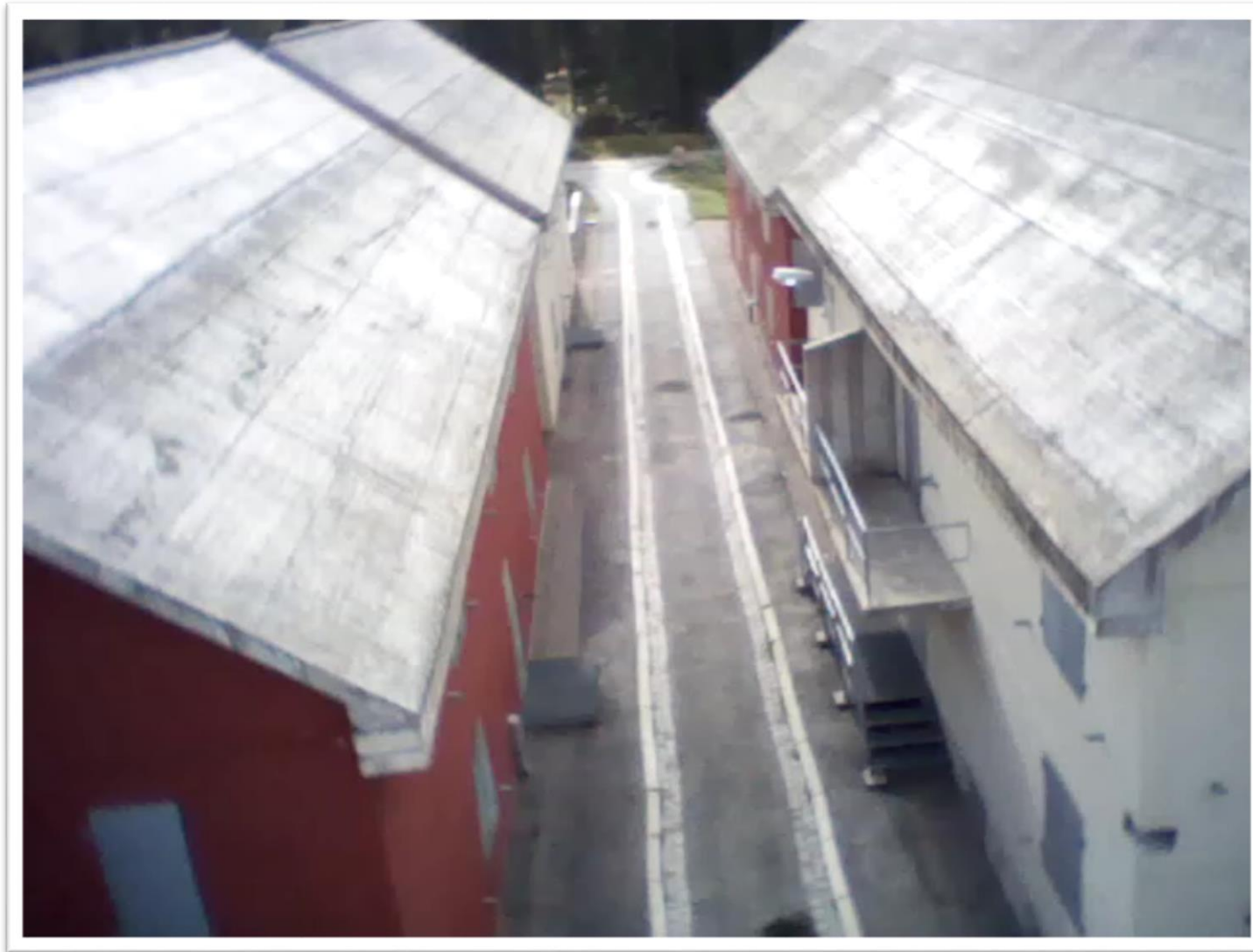
Snapshot



Snapshot



Snapshot



Snapshot



Demo Checkpoint



PD-100 Black Hornet PRS



COMBAT PROVEN

Offers amazing capabilities to the guys on the ground.

Sergeant Petherbridge, UK Army

GAME CHANGING

Black Hornet is a game changing piece of kit.

Major Foden, UK Army

UNIQUE

Black Hornet gives our troops the benefit of surveillance in the palm of their hands.

*Phillip Dunne
Minister of Defence Equipment*