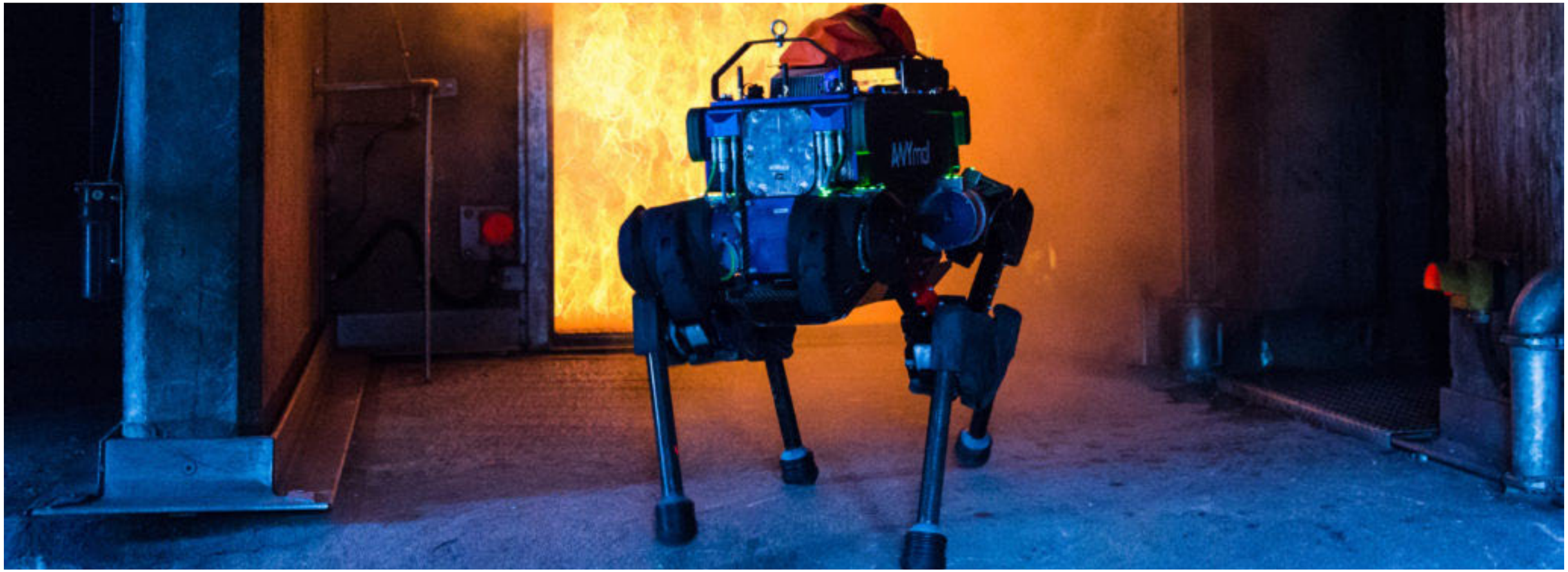
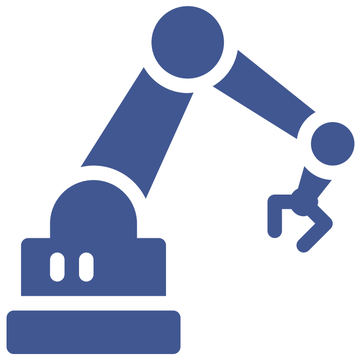


Surveillance & First Response with the Legged Robot ANYmal

Dr. Péter Fankhauser
pfankhauser@anybotics.com
www.anybotics.com

Webinar
March 26, 2019

Robots change the way we work.



1980

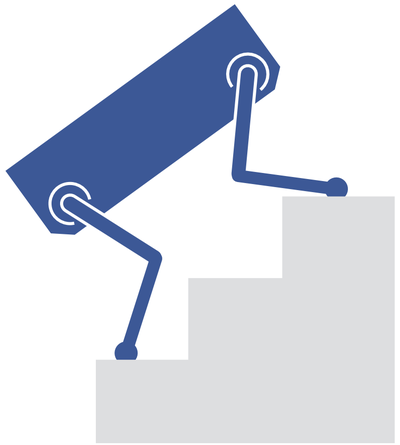
Manufacturing

Stationary

2010

Logistics

Structured Facilities

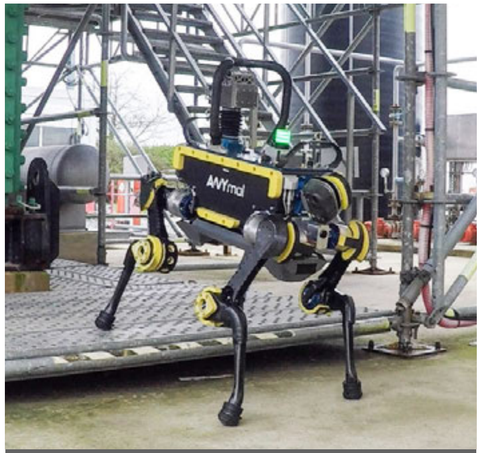


2020

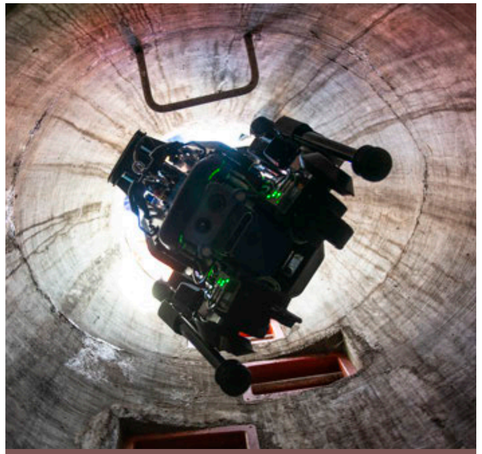
New Applications

Industrial, Urban, and Natural Environments

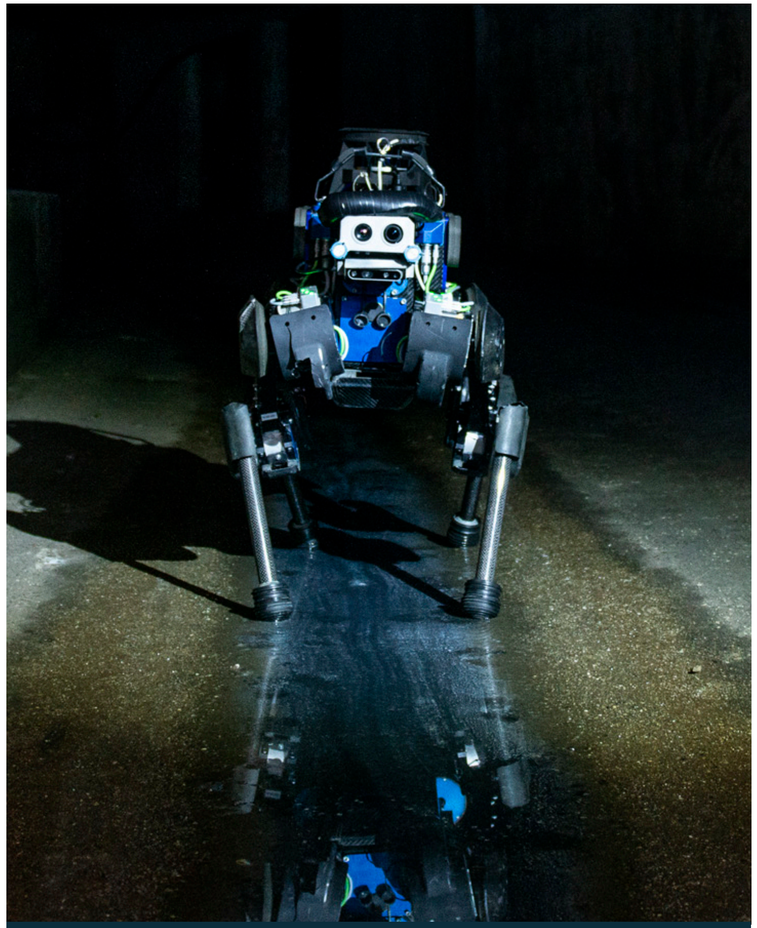
Applications for Autonomous Mobile Robots



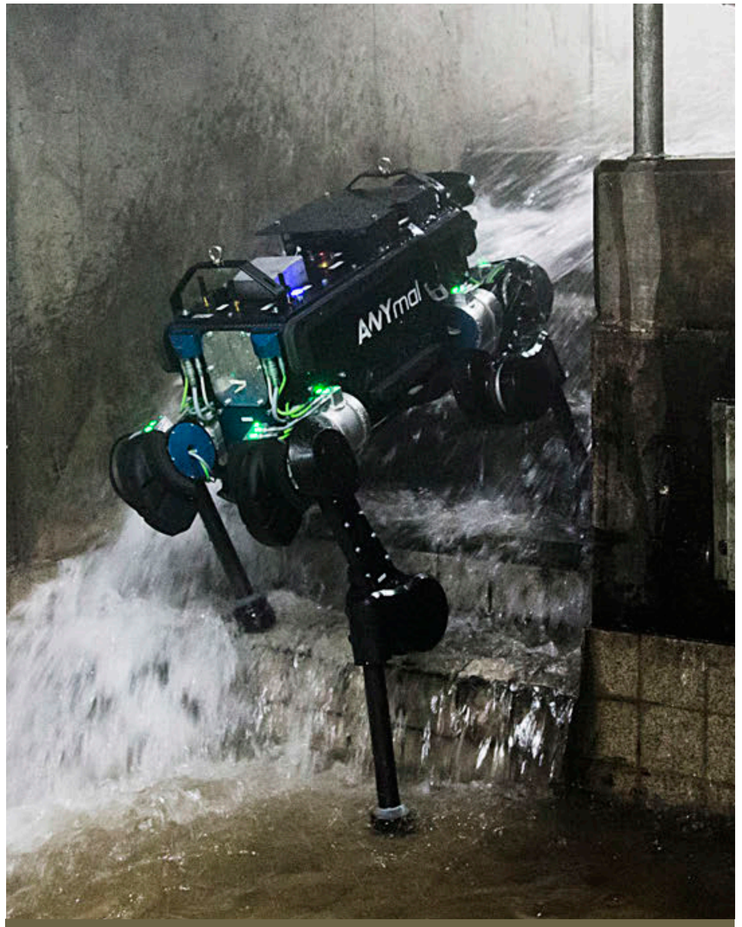
Industrial Inspection



Utilities



Surveillance & Patrolling

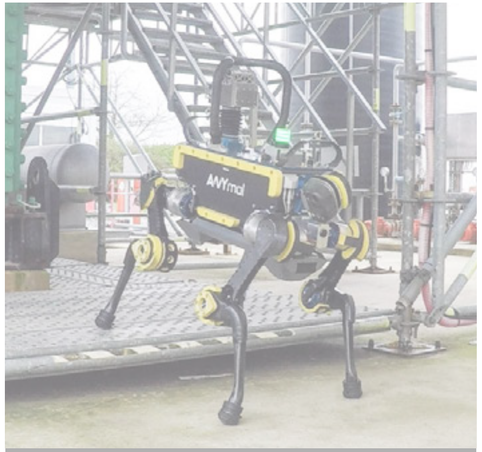


First Response

Agriculture

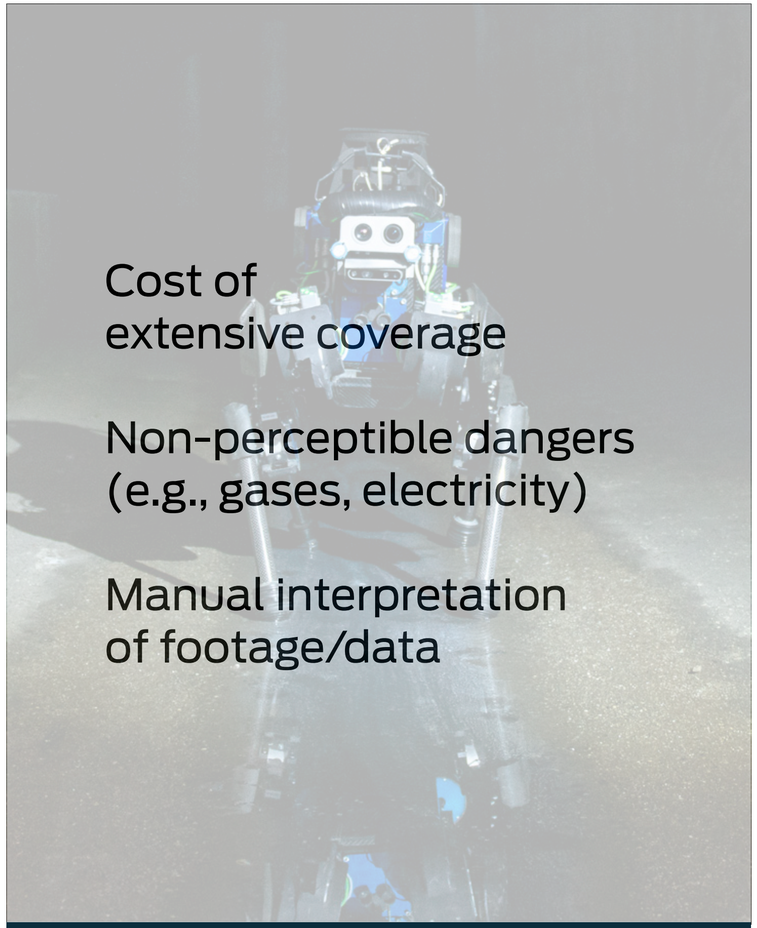
Delivery

Applications for Autonomous Mobile Robots



Industrial Inspection

Utilities

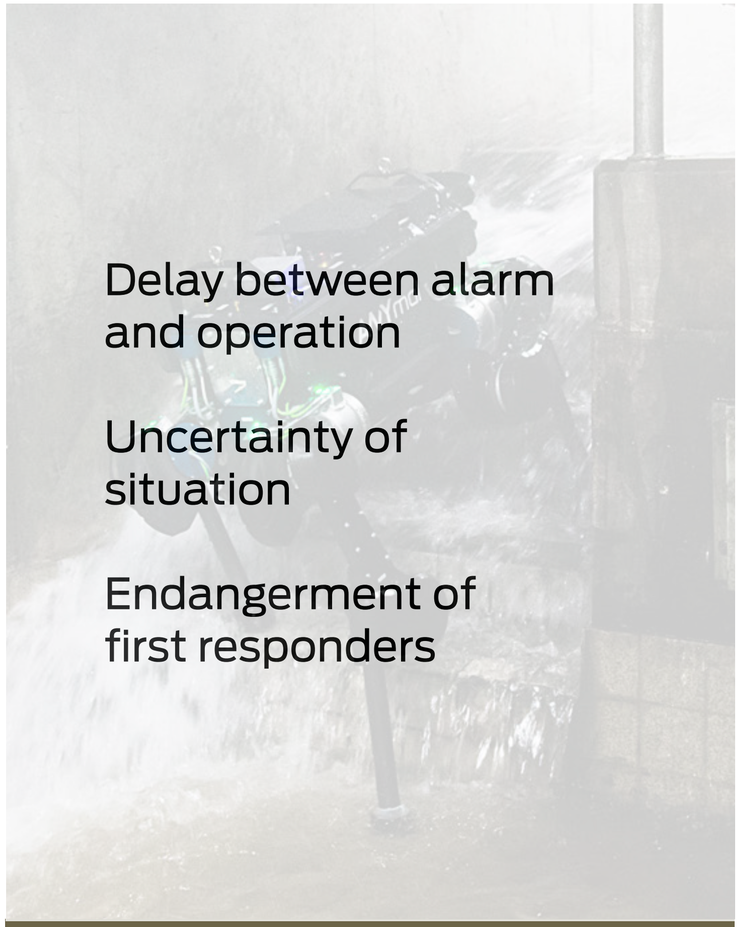


Cost of extensive coverage

Non-perceptible dangers (e.g., gases, electricity)

Manual interpretation of footage/data

Surveillance & Patrolling



Delay between alarm and operation

Uncertainty of situation

Endangerment of first responders

First Response

Agriculture

Delivery

Robotic Operation Features

Surveillance & Patrolling

Environment monitoring & status reporting

Automated & frequent data collection

Accurate, reliable & enduring

All walkable areas, no changes needed

First Response

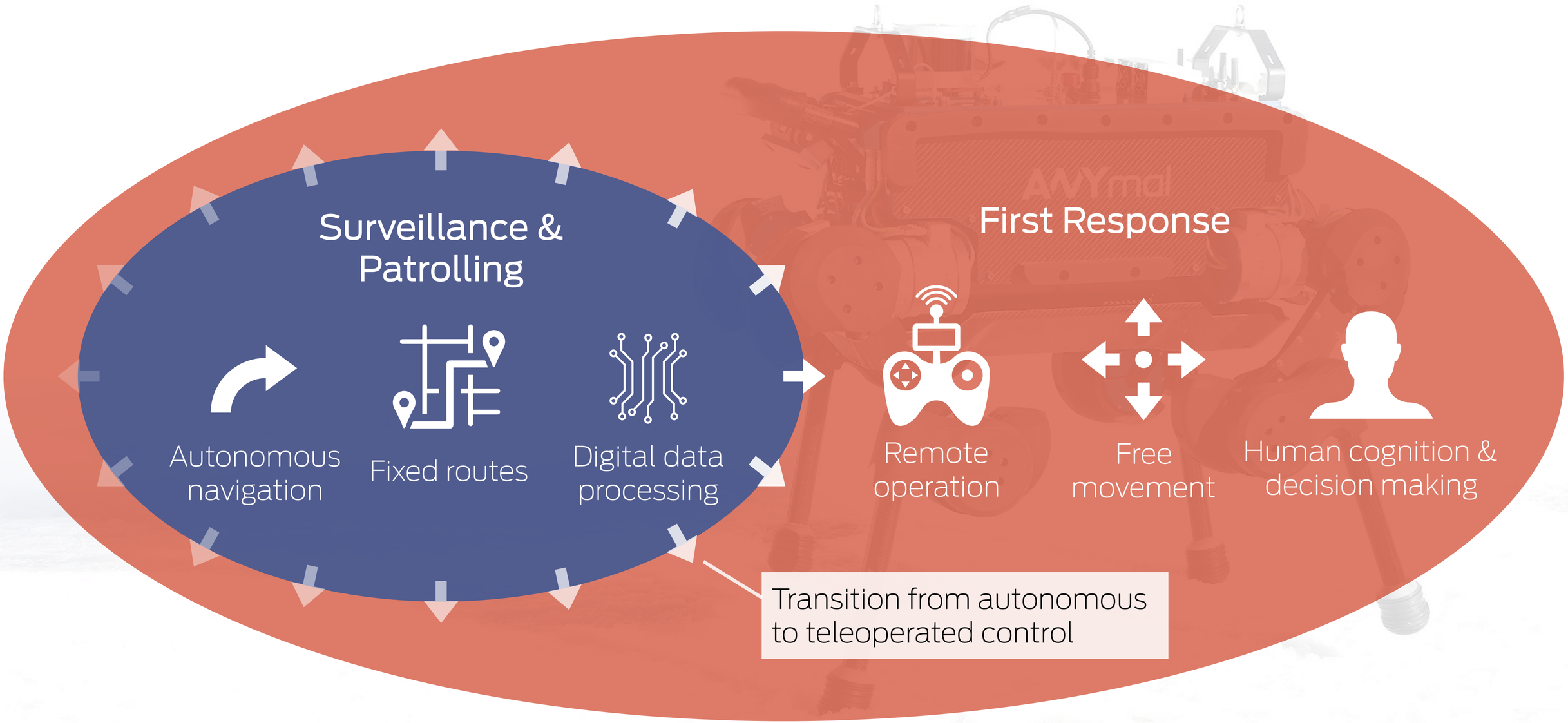
Fast first response & hazardous task assistance

Remote operation at safe distance

Multi-modal situational assessment

All weather & light conditions

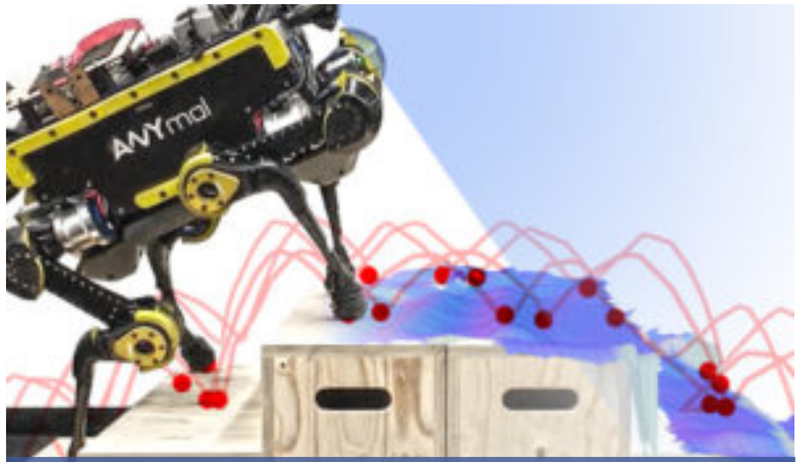
Robotic Operation Modes



ANYmal Capabilities

Video
youtu.be/m1-s8iOJaI4

Extreme Mobility



Advanced Autonomy

Outdoor Ready

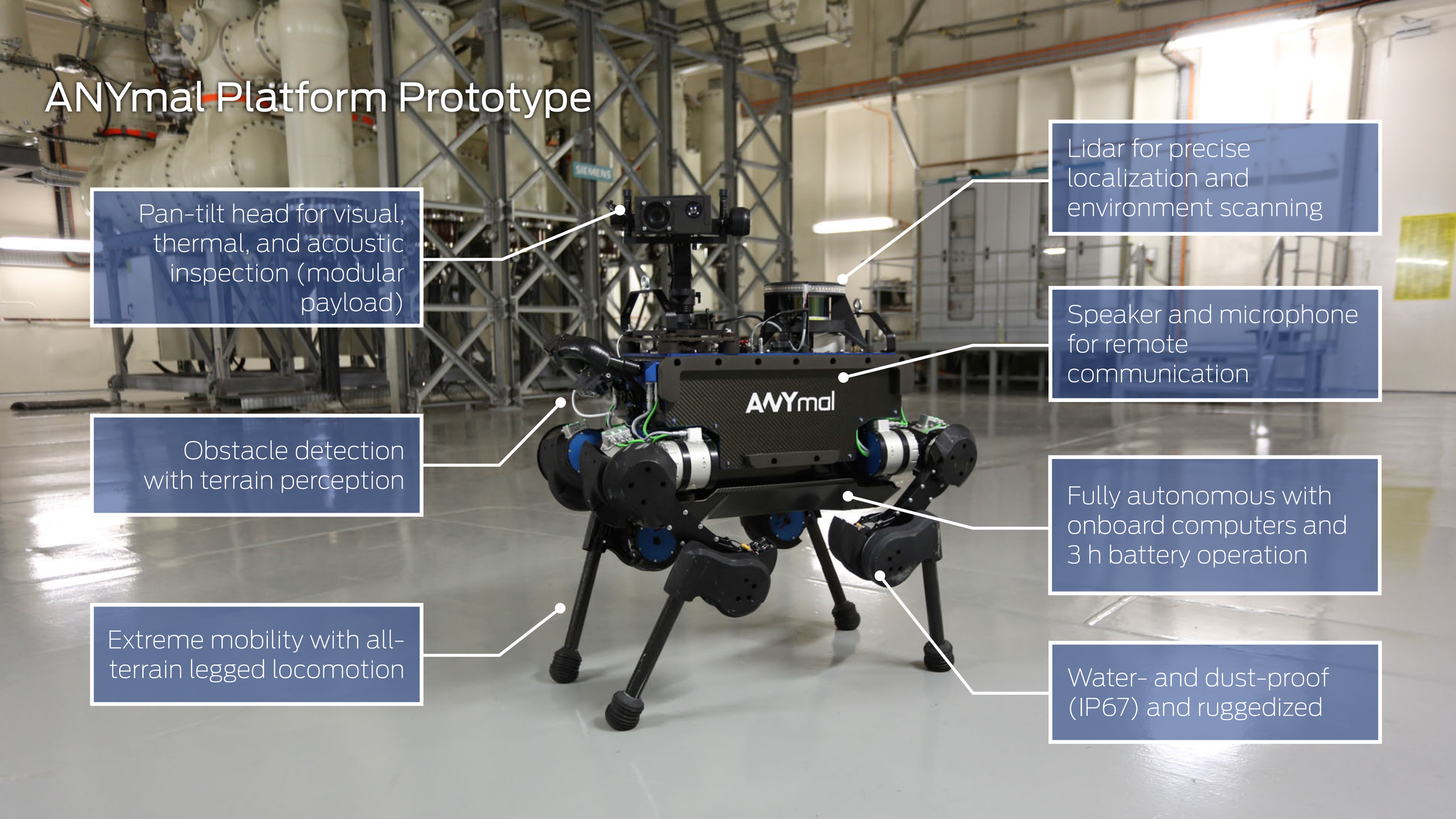
Lightweight, Small & Safe

Long Lasting Endurance

Mobile Interaction

x

ANYmal Platform Prototype



Pan-tilt head for visual, thermal, and acoustic inspection (modular payload)

Obstacle detection with terrain perception

Extreme mobility with all-terrain legged locomotion

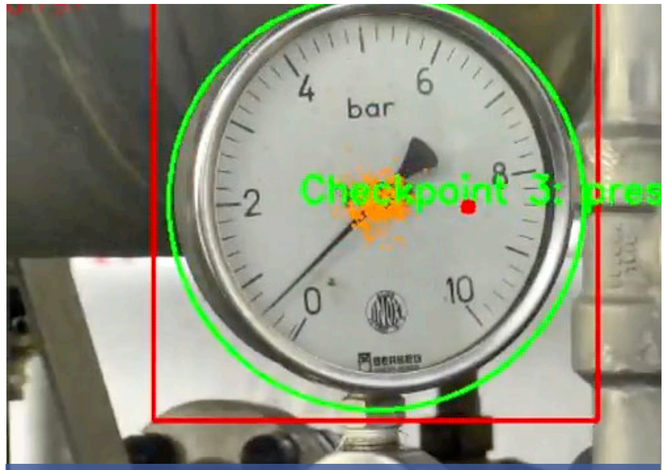
Lidar for precise localization and environment scanning

Speaker and microphone for remote communication

Fully autonomous with onboard computers and 3 h battery operation

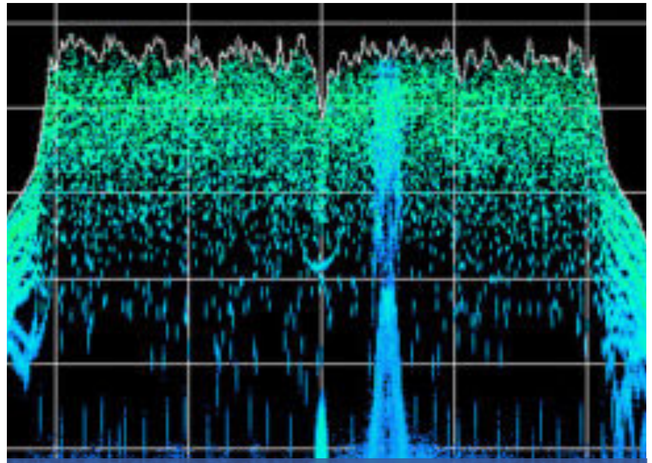
Water- and dust-proof (IP67) and ruggedized

ANYmal Inspection Capabilities

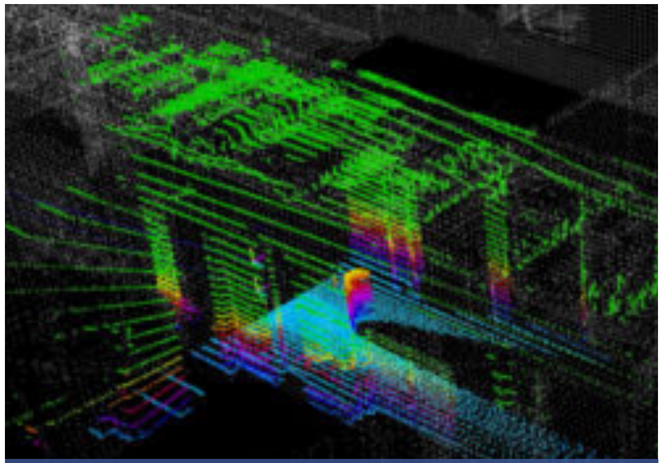


Visual Inspection

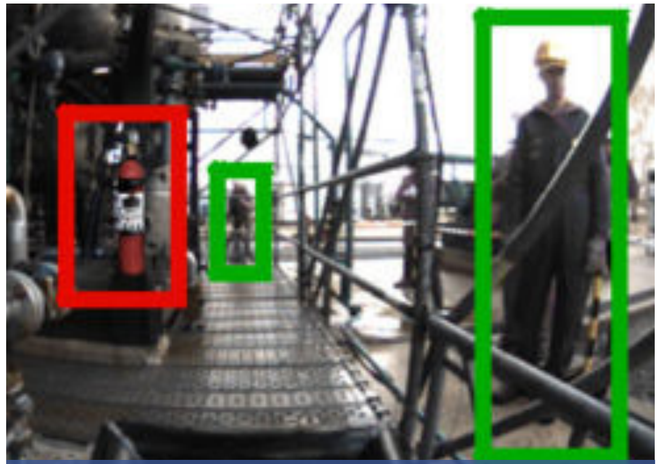
Thermal Inspection



Audio Inspection



3D Mapping



Object Detection

Gas Detection

Your Sensors

ANYmal Operation Modes

	Example 1 Teleoperated	Supervised	Example 2 Autonomous
Control	Velocity commands sent via remote joystick	Goal position and sensor orientation commands via computer user interface	Teach & repeat of full surveillance missions
Navigation	Robot coordinates legs to walk and maneuver over obstacles	Robot navigates safely to goal while avoiding obstacles	Robot executes the entire missions while finding alternative routes if blocked
Feedback	Feedback via video, thermal images, audio and 3D environment map	Full or intermittent feedback via all sensors if bandwidth allows (same as teleop)	Full feedback for progress and all sensors if bandwidth allows
Bandwidth	High bandwidth and low latency required via WiFi & 4G/ LTE (coming soon)	Low bandwidth and high latency ok	No wireless data connection required

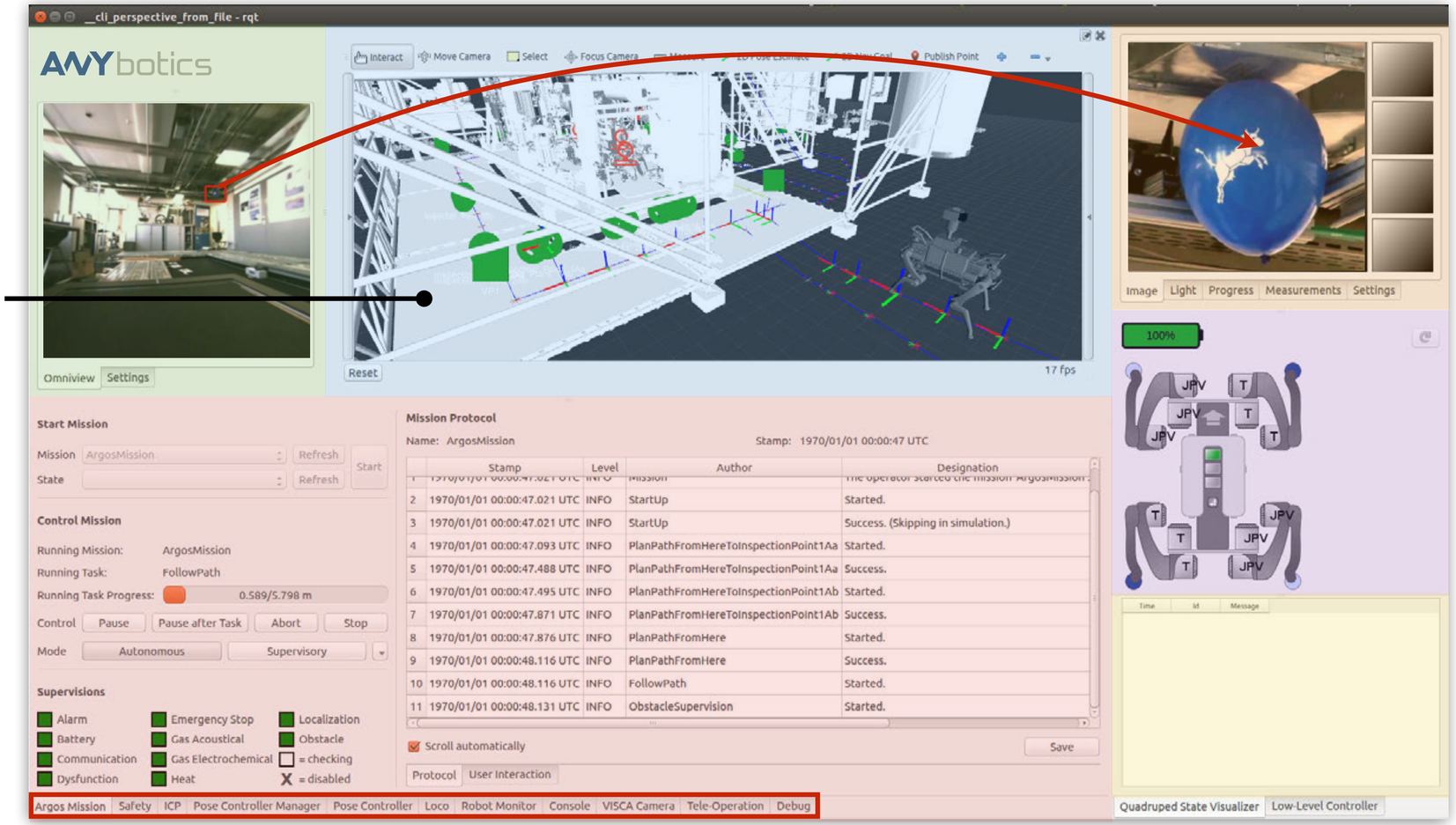
ANYmal User Interface

Situational camera

3D view

Mission control & protocol

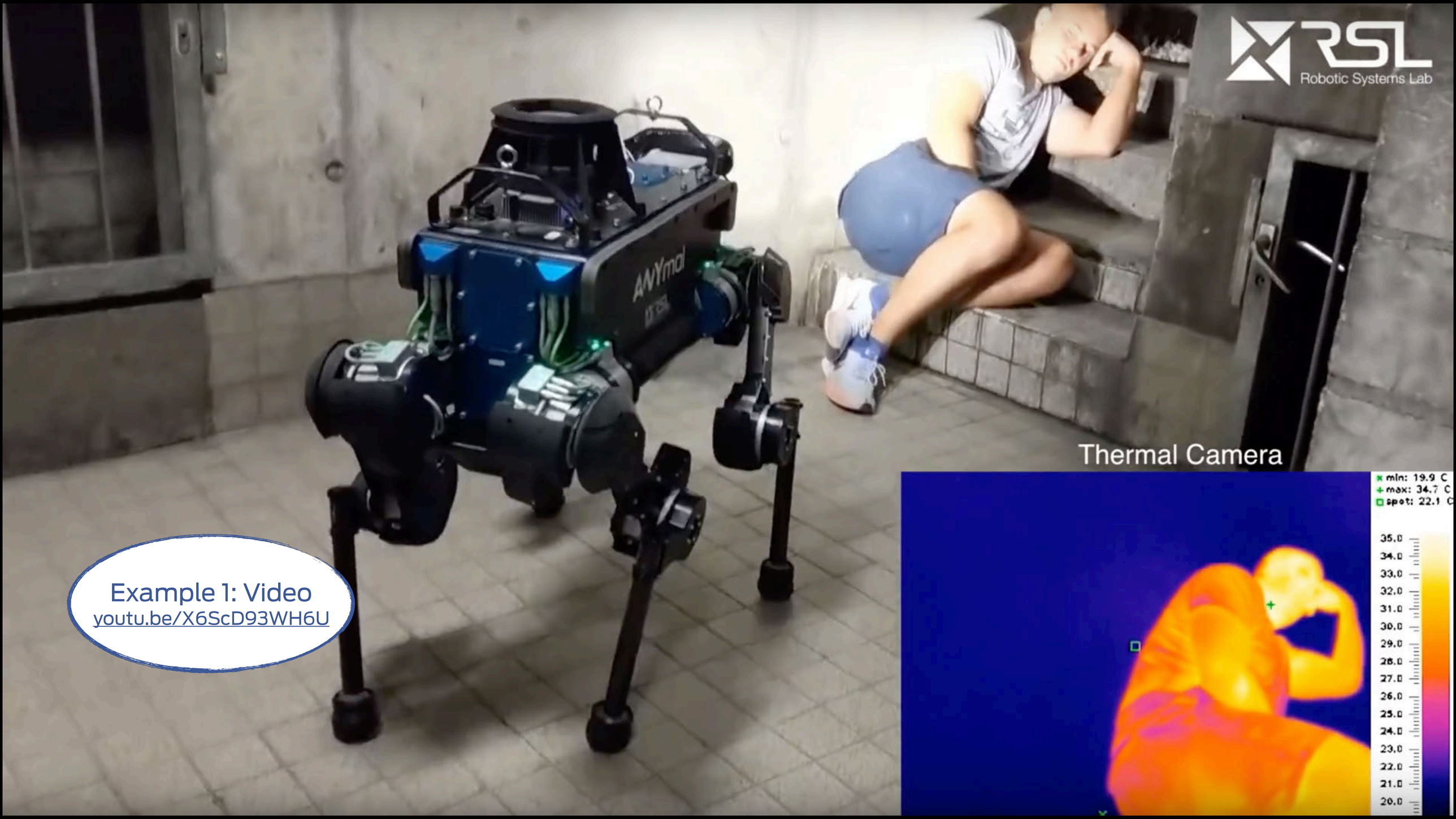
Other modules



Cameras

Robot actuators & sensors

Error protocol


RSL
Robotic Systems Lab
ANYmal
Thermal Camera
min: 19.9 C
max: 34.7 C
spot: 22.1 C
35.0
34.0
33.0
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
Example 1: Video
youtu.be/X6ScD93WH6U

Example 2: Video
youtu.be/DzTvIPrt0DY

Why Legs?

Accessibility	Flat and mildly rough and compact terrain	All human accessible terrain, all weather	All altitudes, limited by weather
Mobility	High speed, fixed footprint, limited by turning radius	Omni-directional, adjustable footprint for confined spaces	High speed and reach, flight zones only
Payload	> 10 kg	10 kg	< 1 kg
Operation time	Hours	Hours	Minutes
Environment impact	High ground traction forces	Low impact & collision-free obstacle negotiation	Noise and air turbulences
Deployment	Multi-person handling due to high weight	One person handling	One person handling
Safety	Stationary in case of failure	Controlled collapse & self-recovery	Requires controlled landing

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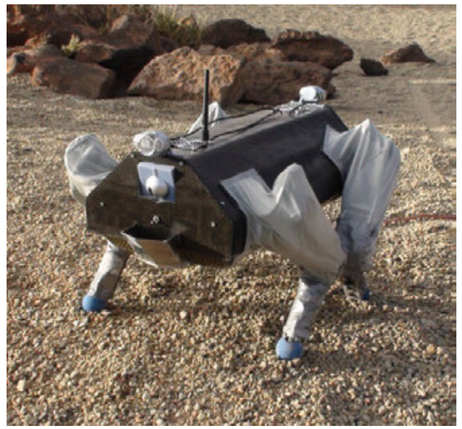
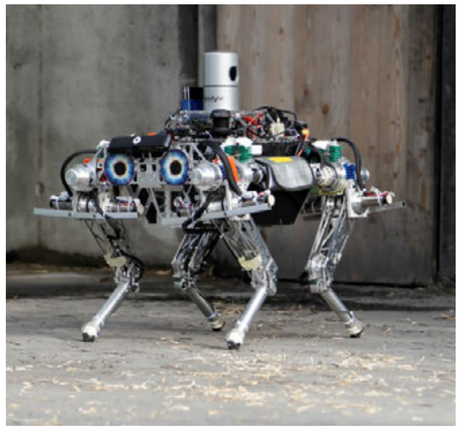
Legged locomotion combines the **versatility** of flying with the **power, endurance, and safety** of rolling.

10 Years of Research on Quadrupedal Robots

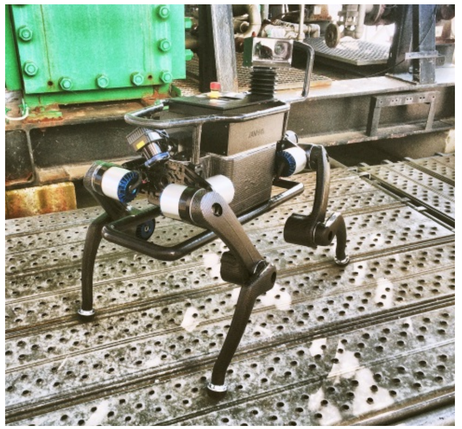
ETH zürich



ALoF
2009



StarlETH
2012



ANYmal
2015

ANYbotics

Spin-Off Company
2016

Maturity, Autonomy, Performance, Robustness

Research

Demonstration

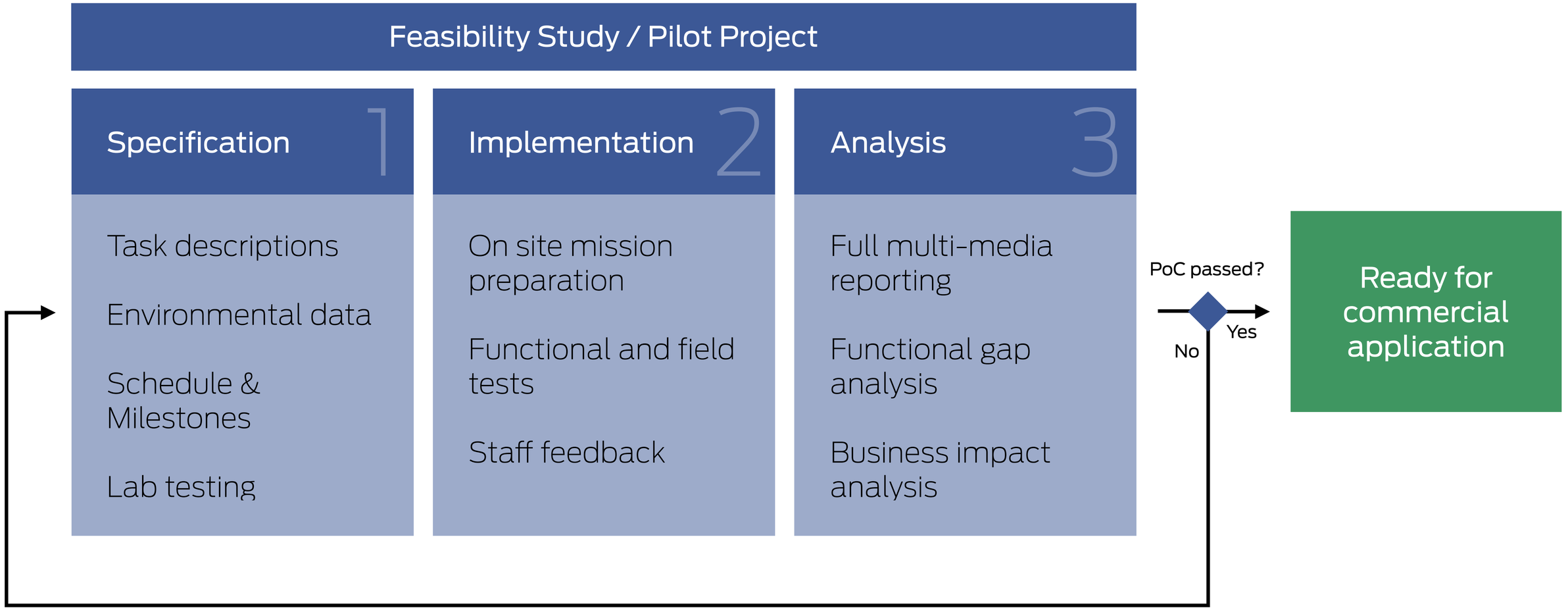
Application

Market Activities & Roadmap

2017	2018	2019	2020/21
TOTAL 3 year program for industrial inspection Video 1 & Video 2 	TenneT 2-week offshore installation Video & Article Stadt Zürich Sewage systems inspection Video & Article Oil & gas project Railway inspection	Continental Last-mile delivery Video & Article First long-term installation Process industry ...	Product launch

ANYmal Prototype (TRL7 & higher) | ANYmal Comm. Product

Collaboration Model



Team & Financing

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Executive Chairman

Prof. Dr. Marco Hutter
Member of the Board

Prof. Dr. Roland Siegwart
Advisor

Dr. Péter Fankhauser
CBDO

Dr. Christian Gehring
CTO

Andreas Lauber
COO

Fredrik Isler
CFO

Spinoff ETH zürich

Wyss Zurich
Translating
Science into Life

robotics Spin Fund

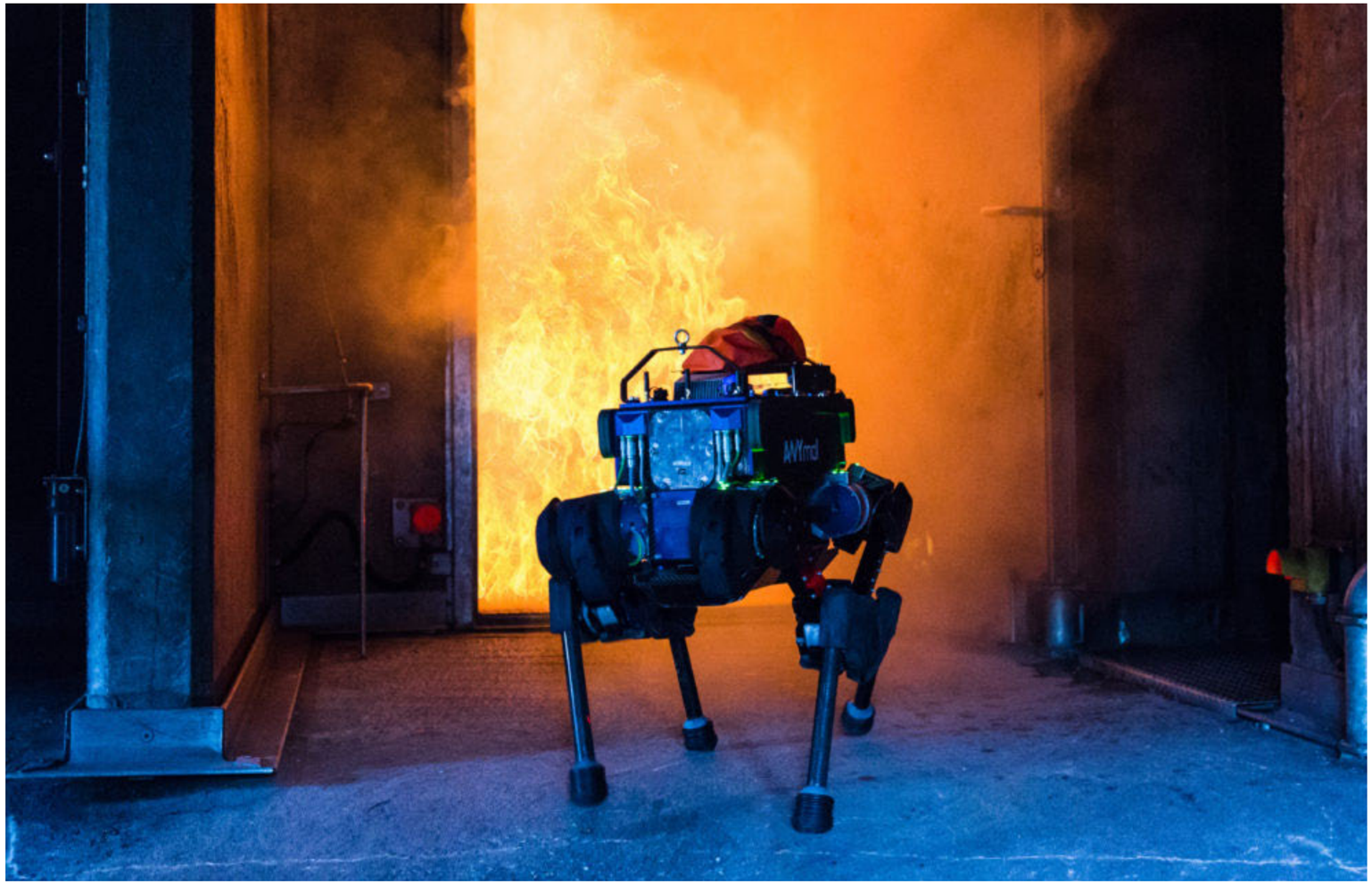
GEBERT RÜF STIFTUNG
WISSENSCHAFT.BEWEGEN

esa business incubation centre Switzerland

ECHORD

European Commission
HORIZON 2020

ANYbotics
Let Robots Go Anywhere



Dr. Péter Fankhauser
pfankhauser@anybotics.com

www.anybotics.com

@anybotics

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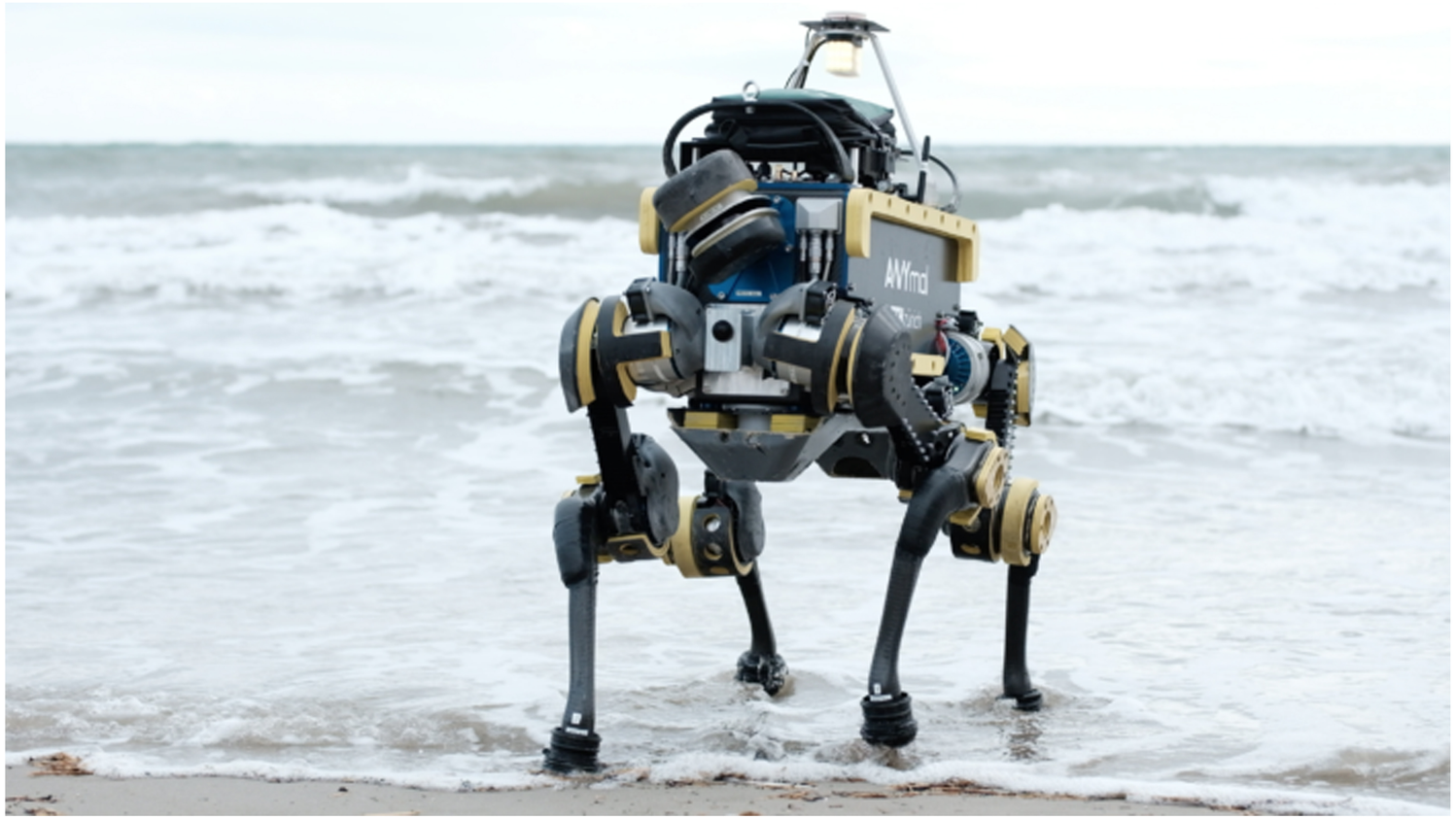

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W: WWW.AIRMET.COM.AU
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F: 1800 000 774