



Introduction of the

Laser Coating Removal Robot (LCR)
&
Automatic Paint Robot (APR)

Surface Treatment

**Surface 2016 - ION congress
Den Bosch 4 October 2016**

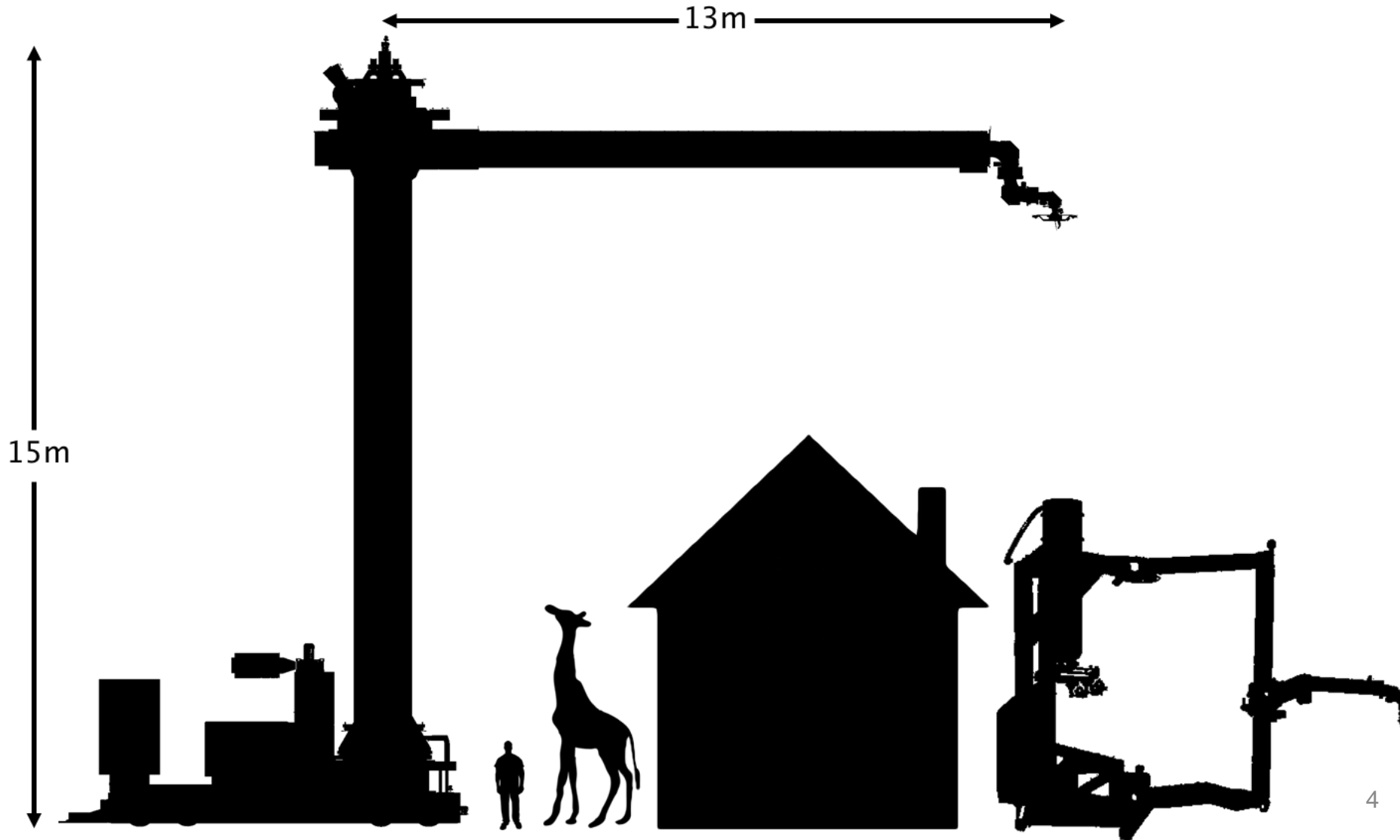
➤ Introduction to the robot

- Purpose | Key drivers
- Hardware specifications
- Systems control specifications

➤ Paint strip process on cars

- Details on the paint strip process
- Value proposition

A sense of scale

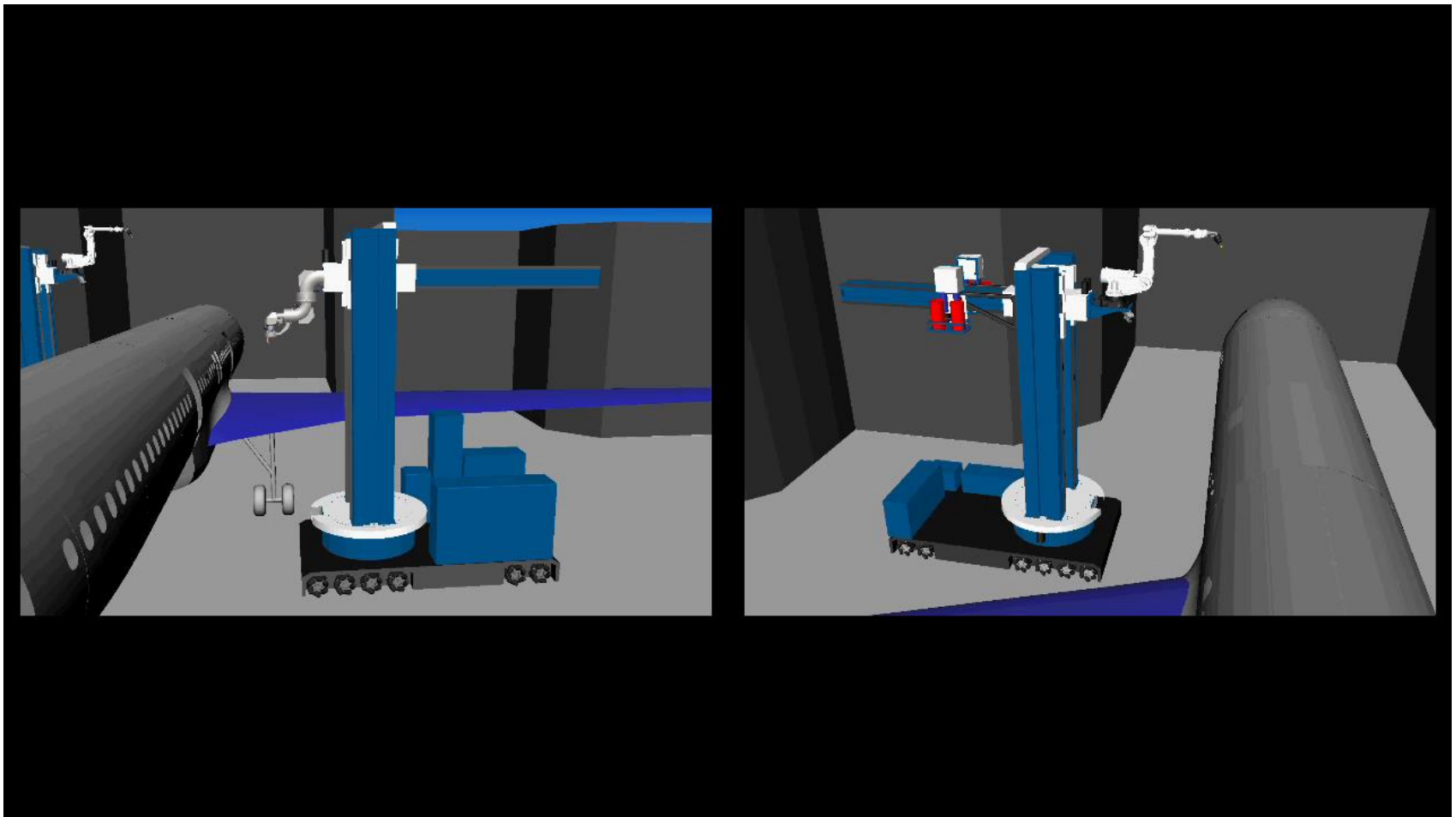


Introduction



Vision of LR Systems: automate surface treatment processes on aircraft, ships, oil & gas equipment, trains, bridges, etc.

2 robots



RADS Concept Review Meeting

2 5 - 0 1 - 2 0 1 2



Recommended Approach

Introduction

Stripping Process

- Media Blast
- Laser

Stripping

Robotic

Manipulators

- COTS
- Custom

Platforms

- Fixed Frame
- Mobile

Examples

- AFRL
- SwRI
- EWI

Conclusions

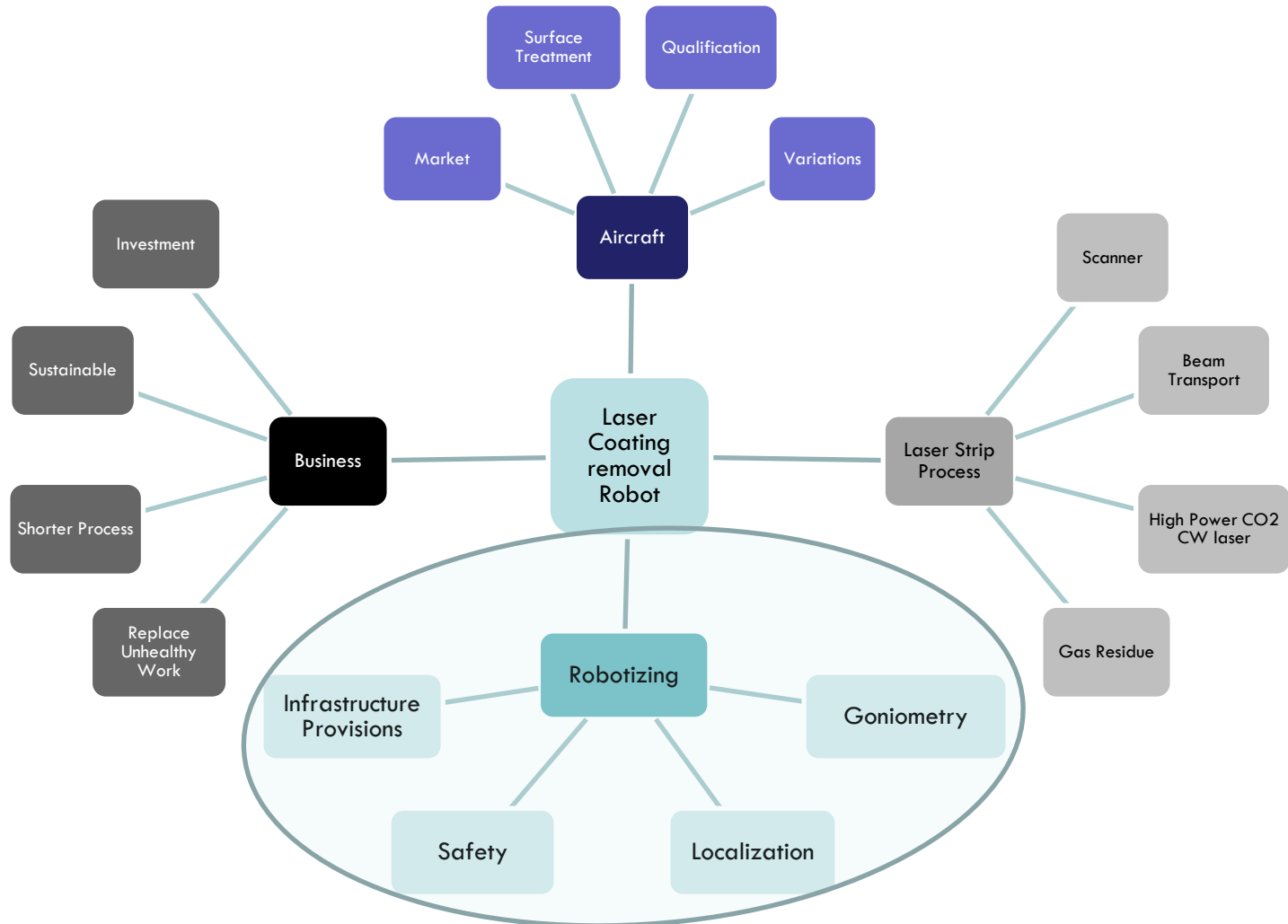
Proposed concept utilizes proven technologies that are currently in production for other applications:

- Mobile wheeled platform carrying a 7 axis manipulator and process equipment
- 12 kW CO₂ laser with EWI COTS scanner
- External tracking system for accurate positioning and control



- **2009-2011 – Solving the market-technology problem**
 - Understanding the problem of stripping
 - Global technology scan
 - Gate process to get technology choices & market demand aligned
 - Technology choice & risk mitigation
 - Defining the vision of LR Systems
- **2012-2014 – Defining the business case**
 - Creating Advisory board
 - Setting up and contracting relations with supply chain including Systems Requirements Documentation
 - Financing the development project – Dutch Government – Private investors
 - Conceptual design of the robot and developing subsystem to TRL6
- **2015-2017 – Developing the LCR**
 - Design, delivery, testing of the first LCR robot
 - Setup and plan manufacturing of the LCR
 - Testing and obtaining approval of use of LCR from OEMs
 - Introduce the LCR robot to the market and contracting
 - Setup LCR support structure together with supply chain

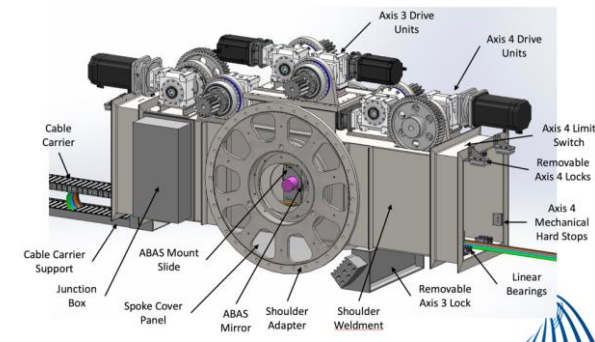
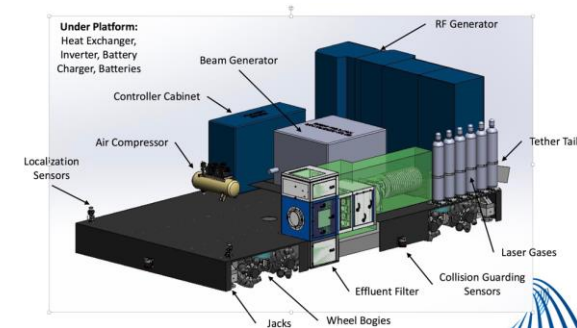
Introduction – Drivers - LCR



Key Robot Features - 1

➤ Mechanical

- 4 DOF Omni-directional platform – 20x 25” wheels
 - Passes gaps up to 5cm | bumps of 2,5cm | elevation 3%
- **8 DOF operating robot**
- 4 sizes – up to 26m high / 13m width – same components
- Load at wrist 100kg
- Basic weight of robot up to 40T
- Motion precision < 0,1mm
- Static deflection < 14mm (compensation via controller)
- Vibration < 1,1mm (mast) & < 3.5mm (beam)
- Dynamic overshoot at urgent stop < 10mm
- Battery pack included to run manually up to 500m
- Tether management system
- All application functions integrated on the platform



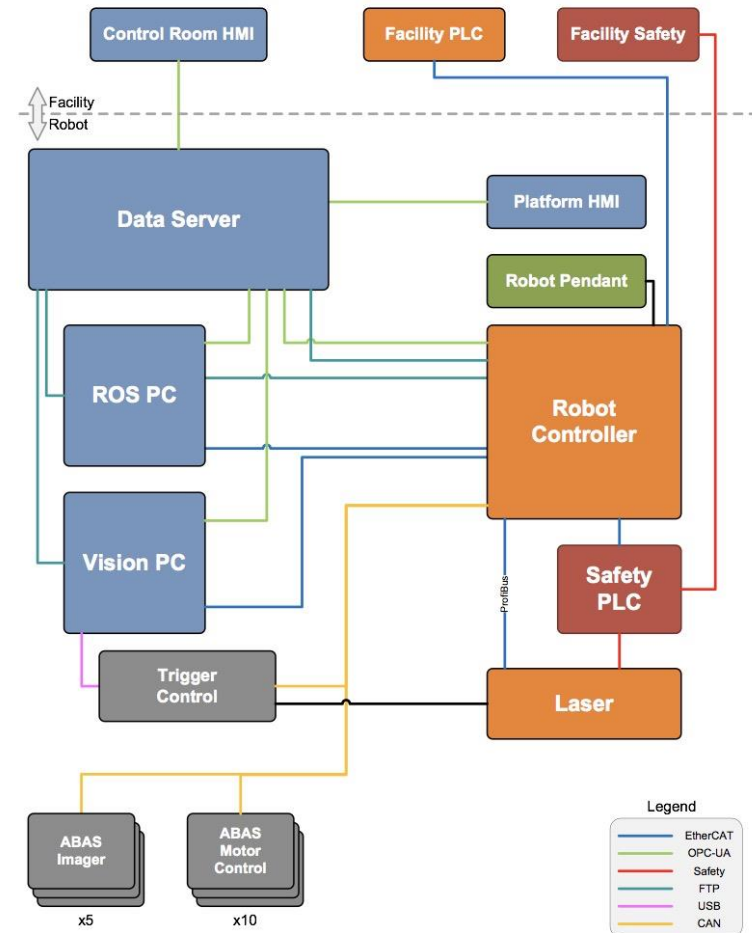
Key Robot Features - 2

➤ Systems control

- Path planning & path execution (4 DOF & 8 DOF)
- Start position calibration
- Real time adaption of head distance, arm speed and static load corrections
- Multiple robots negotiation
- Safety control
 - Touch sensors
 - Laser passive sensors
 - Laser scanning sensors
 - software space model
- Manual operation
- Application controllers

➤ Localization

- Robot & Aircraft localization in real time



Paint Strip Process



➤ Precision

- Equal Distribution of Energy in a Laser Beam Sweep
- Small Amount of Paint (10 micron) Removal per Sweep
- All Energy is Absorbed in the Paint, No Laser Energy Penetrates The Substrate
- **Any** Organic Coating can be Removed

➤ Control

- Closed Loop Control Process – High Speed Switching of Laser
- Selective Stripping by Pre-Learning the Paint System

Key STRIP Features - 2

➤ Process*

- Fast – 40m²/h (with 2 robots B777 in 32 hours stripped)
- Autonomous – One Operator
- Coverage 99% of Aircraft
- All Aircraft and Parts – F-16, B787 to A380
- All Paint Systems – Multilayer
- SAE MA4872A compliance

➤ Safety

- No contact with hazardous materials
- Labor allowed to work parallel on Aircraft
- Full set of safety systems to avoid any damage

Paint Stripping of Cars

Technology:

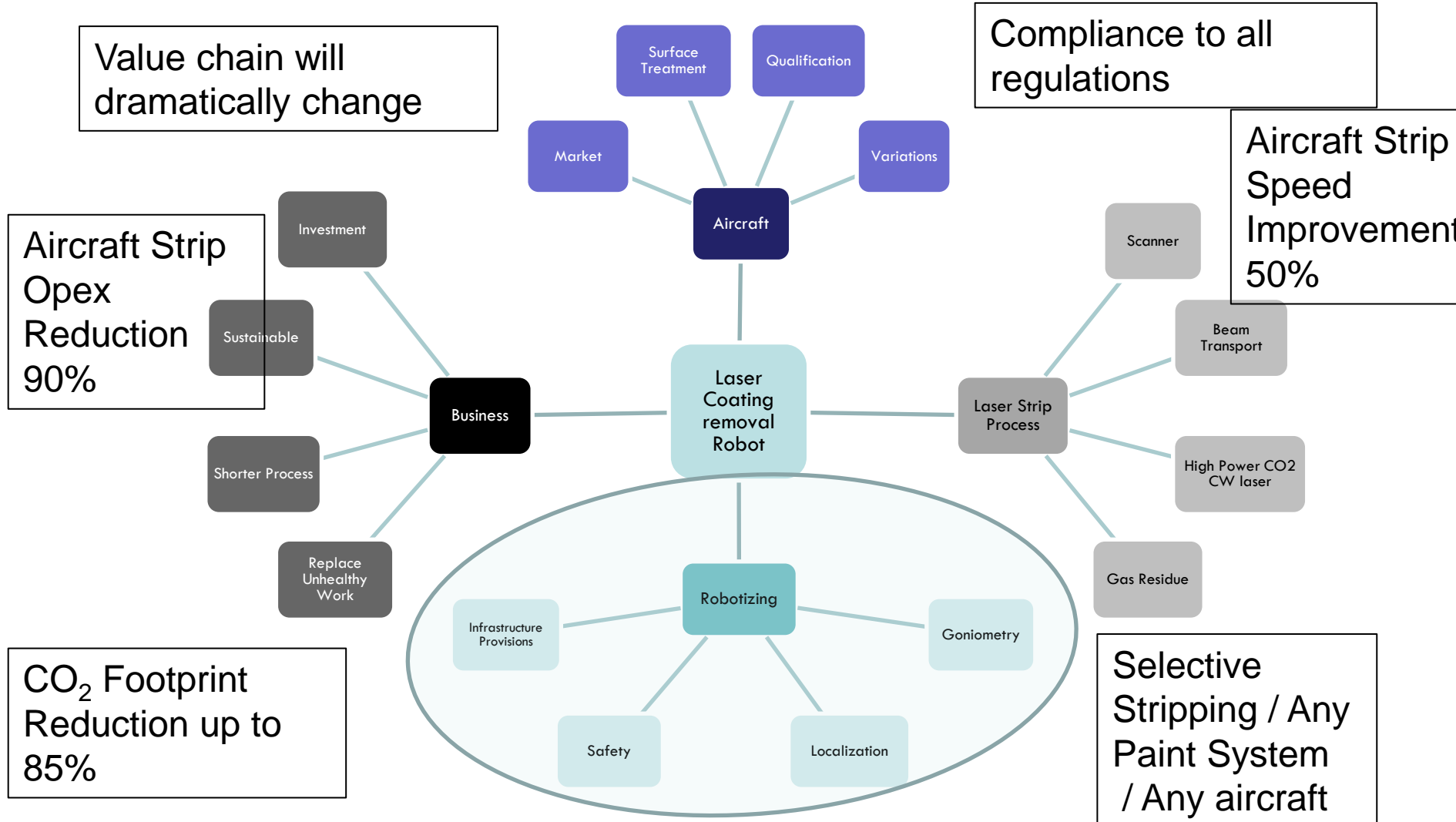
- First test show that technology works on car paint systems
- Selective stripping: further to optimize the pattern classification software for thin primer layer (i.e. 5 micron)

Business:

- Superior solution to repair paint on new cars
- New decorative paint designs on the flight in car manufacturing possible



Conclusion - Drivers



Business decision

Current business case for an aircraft maintenance operator to paint manually a B777 in new 3 different colors:

- Total around time 10 days → EUR 500k depreciation cost
- Total operational cost → EUR 200k labor and facilities cost

→ Only when it is absolutely needed



Robotized operations

- 2 days → 100k (depreciation)
- Capital cost → 50k (robots)
- Operational cost → 20k (labor)

→ Aircraft becomes a marketing tool!

Contact

Peter Boeijink, BSc MSc

Program Director

peter.boeijink@lrsystems.com

+31 612056271

www.lrsystems.com