Presentation by

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Green Software Engineering for Airbus Avionics

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Why Green Software Engineering?

Key Messages

- Software Engineering without sustainability requirements = significant risk

- United Nations Sustainable Development Goals (SDGs) = strong, holistic sustainability agenda to 2030

- How can we de-risk avionics software engineering through full traceability to SDGs?
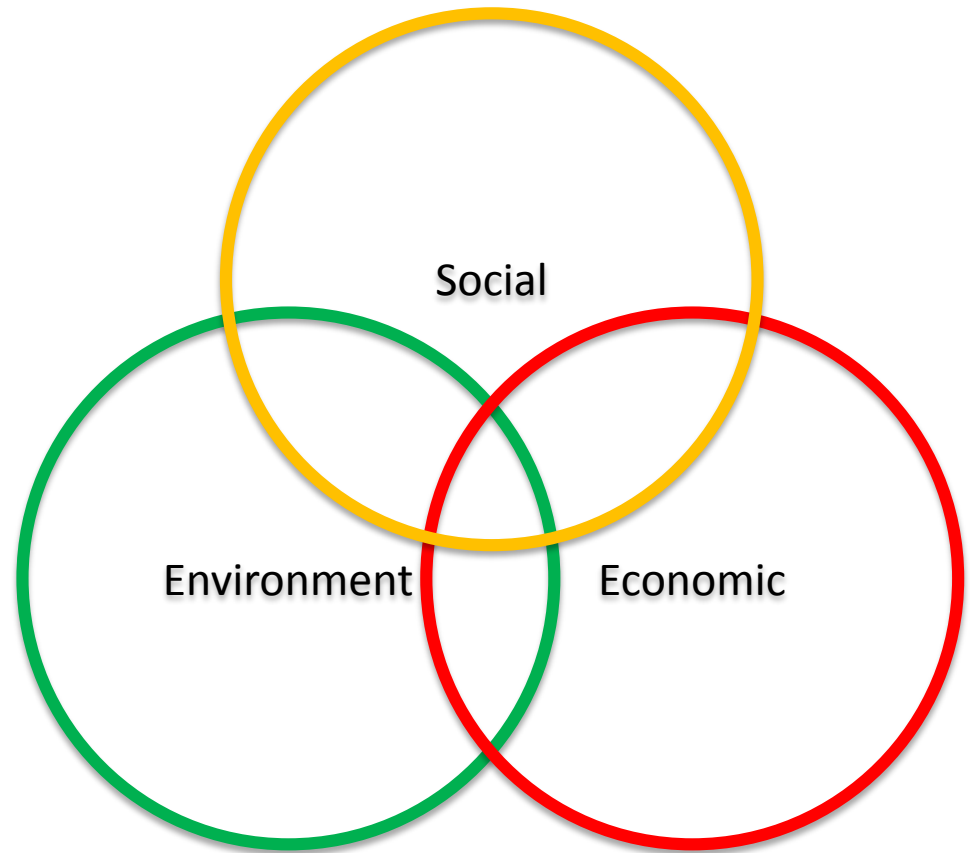
PhD Research Project starting

Ian Brooks

- ian.brooks@uwe.ac.uk
- BSc Software Engineering
- IT and Business Strategy consultancy with PricewaterhouseCoopers and IBM
- IBM's Sustainability leader on Defra IT outsourcing
- MSc Environmental Consultancy
- Senior Lecturer in Sustainable IT, University of the West of England
- Starting PhD research Autumn 2016.
- Industrial case study with Airbus. Industrial Supervisor: Mario Kossmann mario.kossmann@airbus.com

Terms: Green, Eco, Sustainable?

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs

Brundtland Commission 1987

Software Engineering without sustainability requirements = significant risk

Green damage from Software Engineering?

- Sept – Oct 2015. Volkswagen lost over $30 bn market capital after news broke that some diesel engines had software engineered to defeat air quality / emissions testing.

- "this was a couple of software engineers who put this in, for whatever reasons." *Michael Horn, CEO Volkswagen Group of America*

Sources: Volkswagen Aktiengesellschaft, 2015, Committee on Energy and Commerce, 2015, Barchart.com Inc, 2016, german.performance, 2015

Risk management is also about securing green benefits

- Delivering aviation customer value. Lower emissions => lower payments to Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

- Green Regional Aircraft Avionics Architecture for Mission and Trajectory Management (GRA3M)

- Power consumption reduction e.g. CleanSky2 - cooling systems for embedded power electronics

- IEC 62239-1:2015 Process management for avionics. lead-free (but no recycled components)

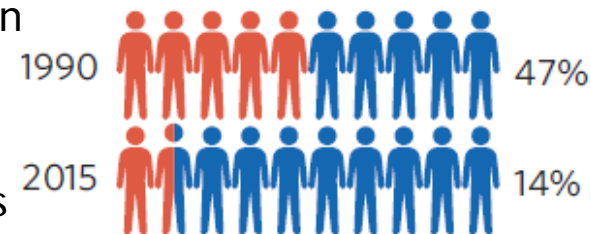UWE Bristol | University of the West of England

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United Nations Sustainable Development Goals (SDGs) = strong, holistic sustainability agenda to 2030

Millennium Development Goals - Success

- Adopted by World Leaders at the United Nations in 2000
- 8 goals with a 2015 target
  - Goal 1: Eradicate extreme poverty and hunger
  - Goal 2: Achieve universal primary education
  - Goal 3: Promote gender equality and empower women
  - Goal 4: Reduce child mortality
  - Goal 5: Improve maternal health
  - Goal 6: Combat HIV/AIDS, malaria and other diseases
  - Goal 7: Ensure environmental sustainability
  - Goal 8: Develop a global partnership for development
- "the most successful anti-poverty movement in history" Ban Ki-Moon

Extreme poverty rate in developing countries

1990   47%

2015   14%

Sources: United Nations, 2015

SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

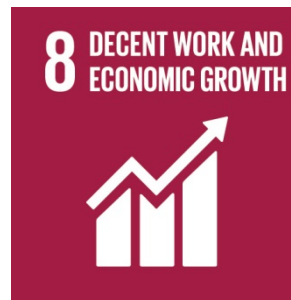**16 PEACE, JUSTICE AND STRONG INSTITUTIONS**

17 PARTNERSHIPS FOR THE GOALS

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Sources: United Nations General Assembly, 2015

Airbus Group Focus

Sources: United Nations General Assembly, 2015, Airbus Group, 2016, International Civil Aviation Organization, 2016b

Sample SDGs

8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour [...] and by 2025 end child labour in all its forms

12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, [...]

13.2 Integrate climate change measures into national policies, strategies and planning
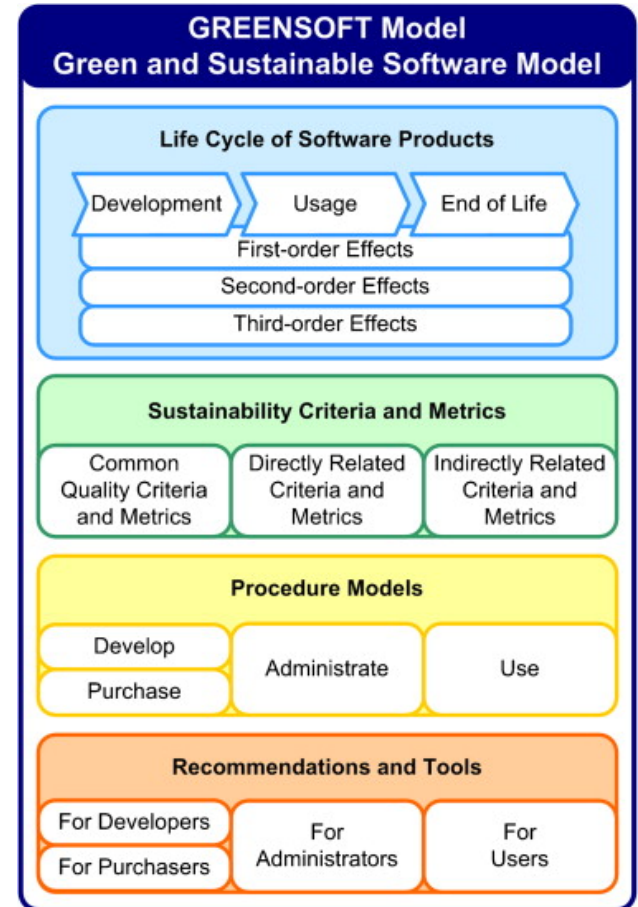
How can we de-risk avionics software engineering through full traceability to SDGs?

Prior Green Software Engineering Research

- Greensoft – Stefan Naumann. What is energy-efficient software?

- Software Engineering for Sustainability SE4S - Birgit Penzenstadler. Taking responsibility for the long-term impacts we create.
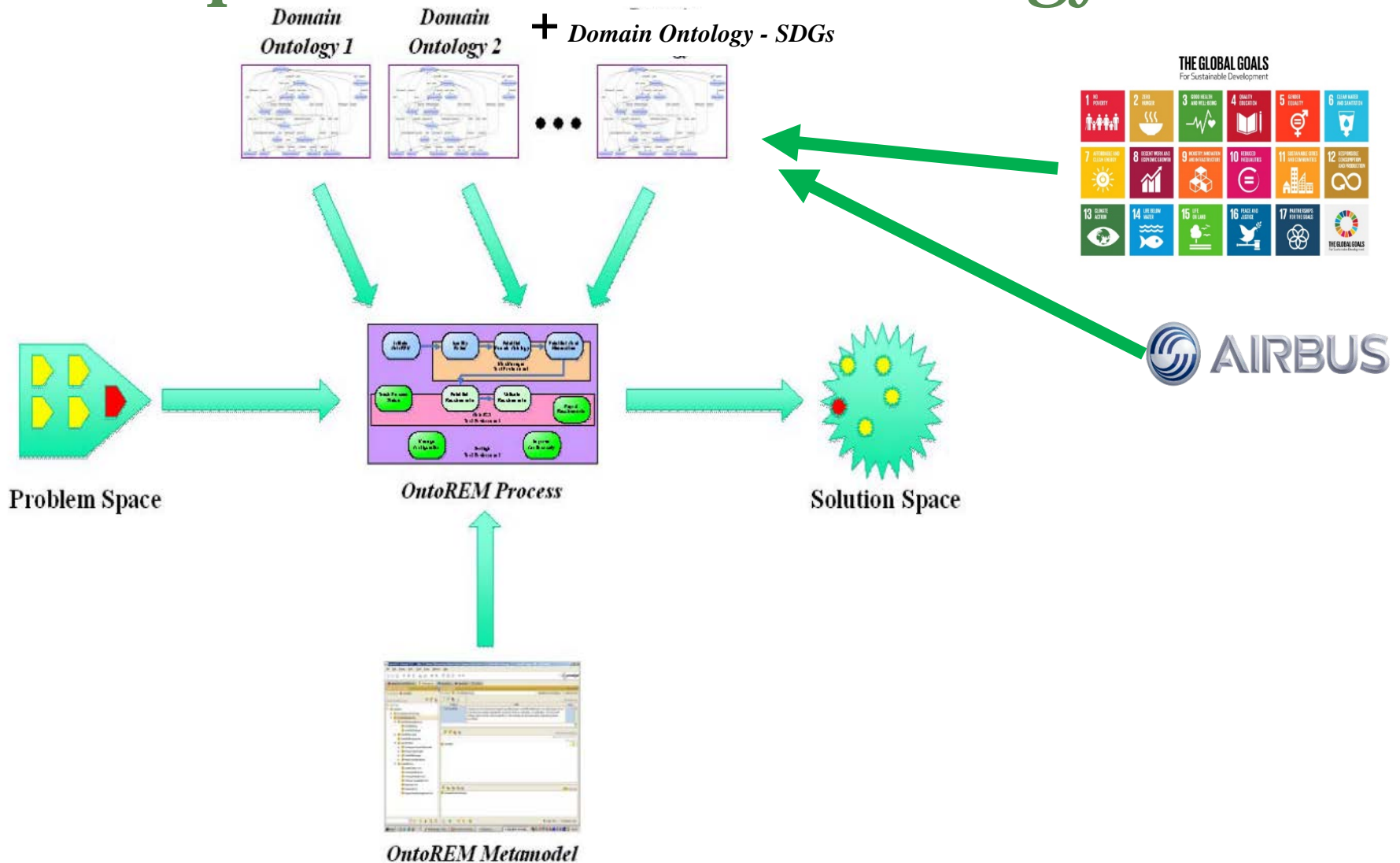
KARLSKRONA MANIFESTO
FOR SUSTAINABILITY DESIGN

GREENSOFT Model
Green and Sustainable Software Model

Life Cycle of Software Products

| Development | Usage | End of Life |

First-order Effects

Second-order Effects

Third-order Effects

Sustainability Criteria and Metrics

| Common Quality Criteria and Metrics | Directly Related Criteria and Metrics | Indirectly Related Criteria and Metrics |

Procedure Models

| Develop / Purchase | Administrate | Use |

Recommendations and Tools

| For Developers / For Purchasers | For Administrators | For Users |

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OntoREM: ontology-based requirements methodology

Sources: Kossmann and Odeh, 2010

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