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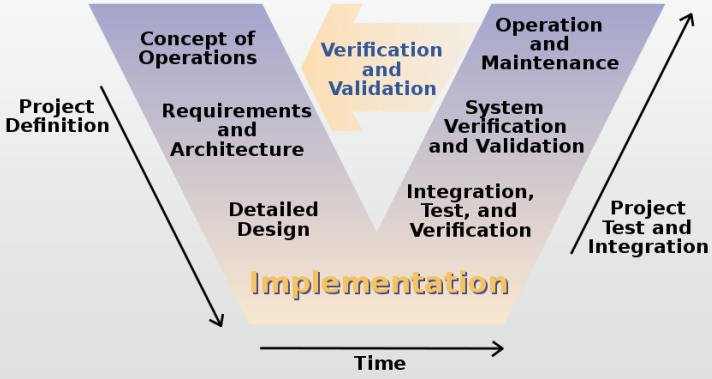
Research in software design, safety and test

Michael Butler

Electronics and Computer Science

www.ecs.soton.ac.uk/people/mjb



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Engineering Cyber-Physical Systems (CPS)

- CPS: Integrations of software, electronics, sensing, information, intelligence/autonomy, networking, mechanics,
- Domains: Aerospace, Automotive, Defence, Rail, Utilities, Medical, Manufacturing, Exploration, …
- Engineering challenges:
  - *Safety* increasingly depends on *complex software*
  - Networking increases *cyber threats* to operation and safety
  - Software and electronic *design* and *assurance* dominating *engineering costs*

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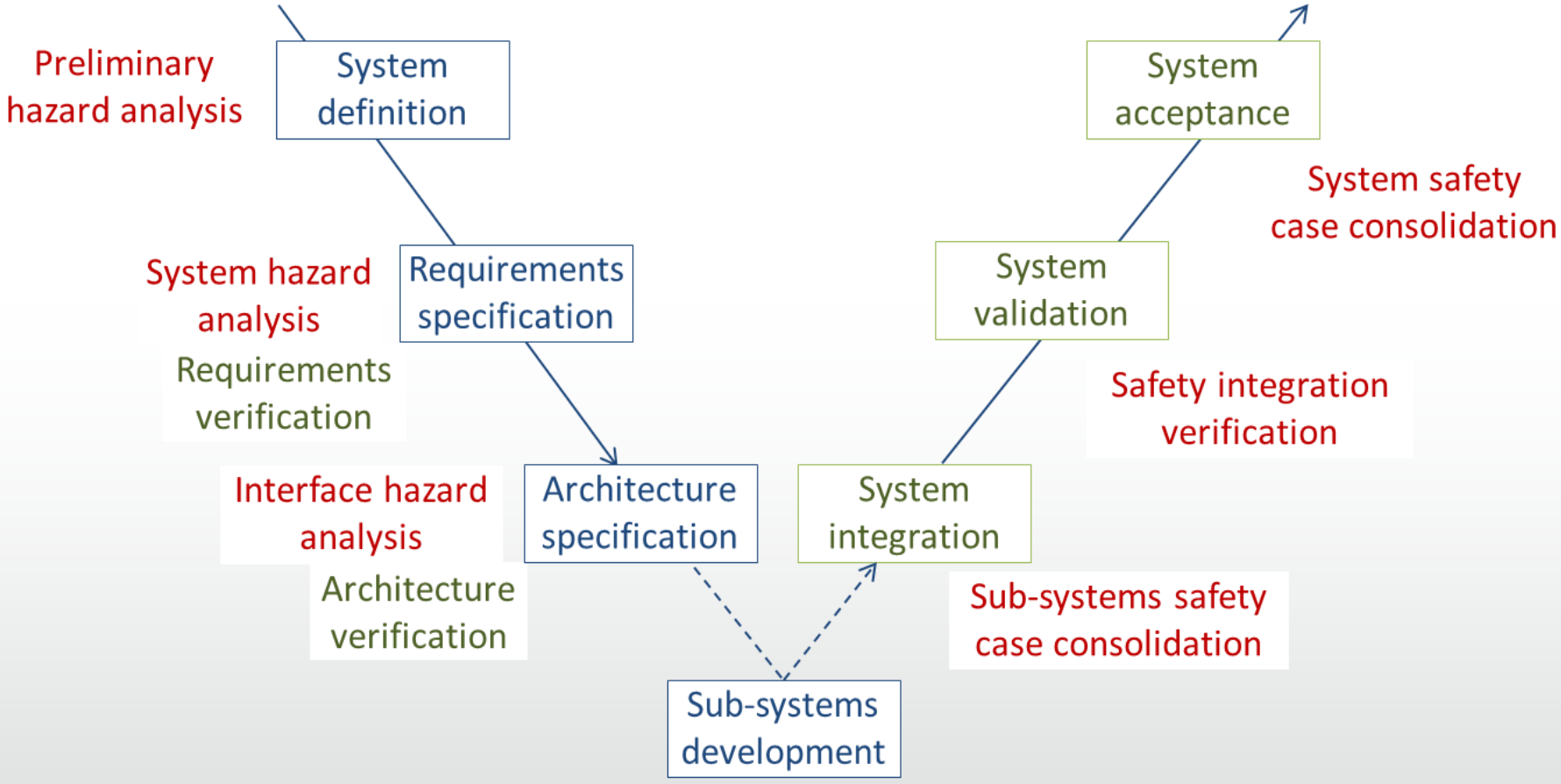
Safety Lifecycle with Formal Modelling



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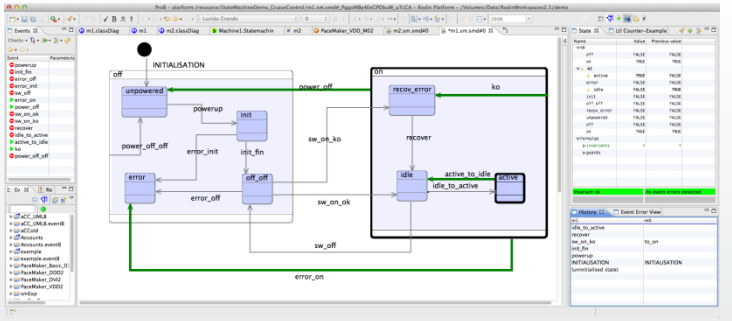
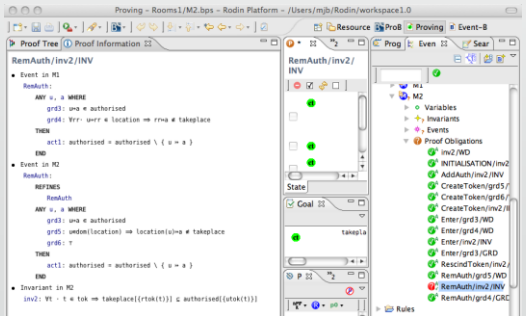
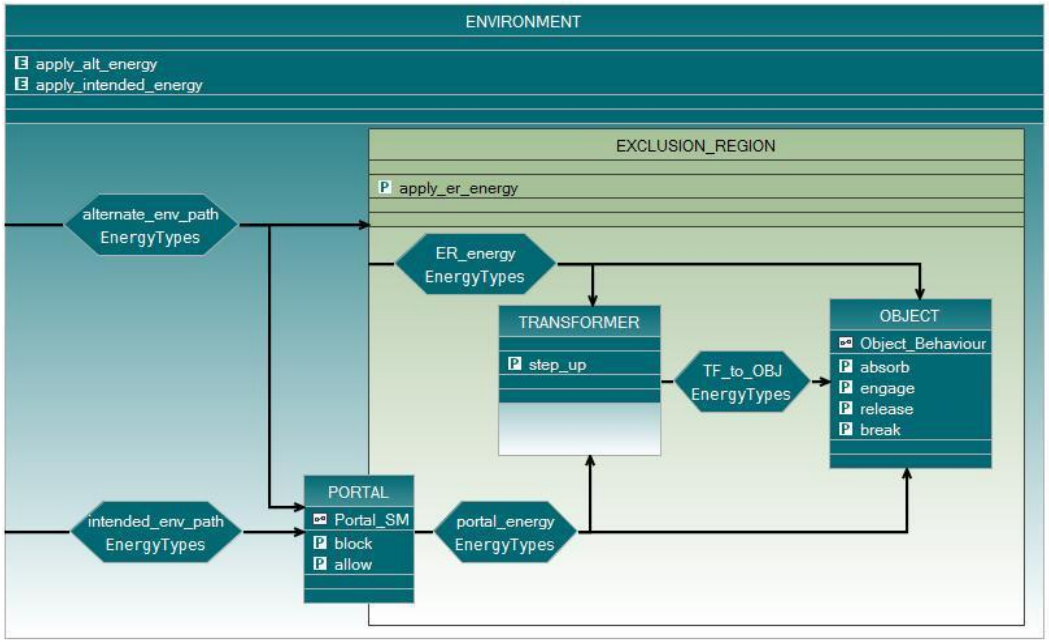
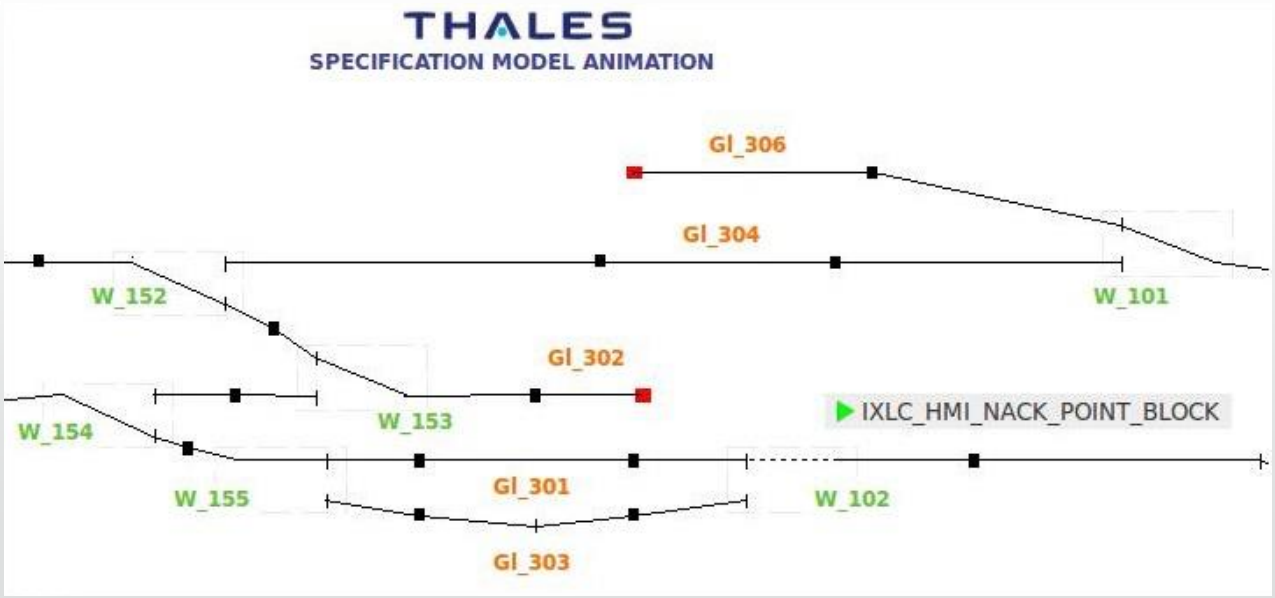
Formal model-based engineering

- Lead: Michael Butler
- Model-based CPS design with Event-B www.event-b.org
  - All stages – early identification of flaws - reduce costs
  - Hazard/vulnerability analysis and mitigation
  - Provide V&V evidence for high assurance
- Open source Rodin toolset supporting
  - Incremental modelling
  - Automated formal verification
  - Co-simulation
  - Visualisation
  - Functional test generation/coverage
  - Code generation









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UoS in industrial projects on SW V&V

- AWE/UoS: V&V of safety-critical embedded systems
- Sandia Labs/UoS: V&V of safety-critical embedded systems
- Imagination Technologies/UoS: V&V of many-core memory transactions
- DSTL ASUR Programme/Tekever/UoS: V&V of safety of UAV movements
- SECT-AIR, Aerospace Technology Institute Programme, 3 Year, £10M
  - Methods and Tools for aerospace software V&V
  - Rolls Royce, BAE, GE, MBDA, Selex, Cobham,..., UoS, U. Oxford, U. York,
- ENABLE-S3, EU H2020 ECSEL Programme, 3 Year €68M
  - Methods and tools for safety and security of CPS
  - >50 EU partners
  - Thales/UoS: V&V of railway interlocking product families

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Code level Software verification

- *Leads: Dr Gennaro Parlato, Dr Denis Nicole*
- Model checking: algorithms and tools
- ESBMC www.esbmc.org
  - SMT model checker for embedded C/C++ software
  - arithmetic under- and overflow, pointer safety, memory leaks, array bounds
  - multi-threaded software: atomicity and order violations, deadlock and data race

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Internet of Things – IoT@ecs

- *Champion: Dr Geoff Merrett*
- Applications
  - environmental monitoring, condition monitoring of infrastructure, …
- Networked sensing
- Wireless communications
- Software and hardware security
- Embedded intelligence
- Low power design, energy harvesting

Cyber Security Academy

- *Lead Prof Vladimiro Sassone*
- Industry/University partnership to advance cyber security through:
  - world class research
  - teaching excellence
  - industrial expertise
  - training capacity

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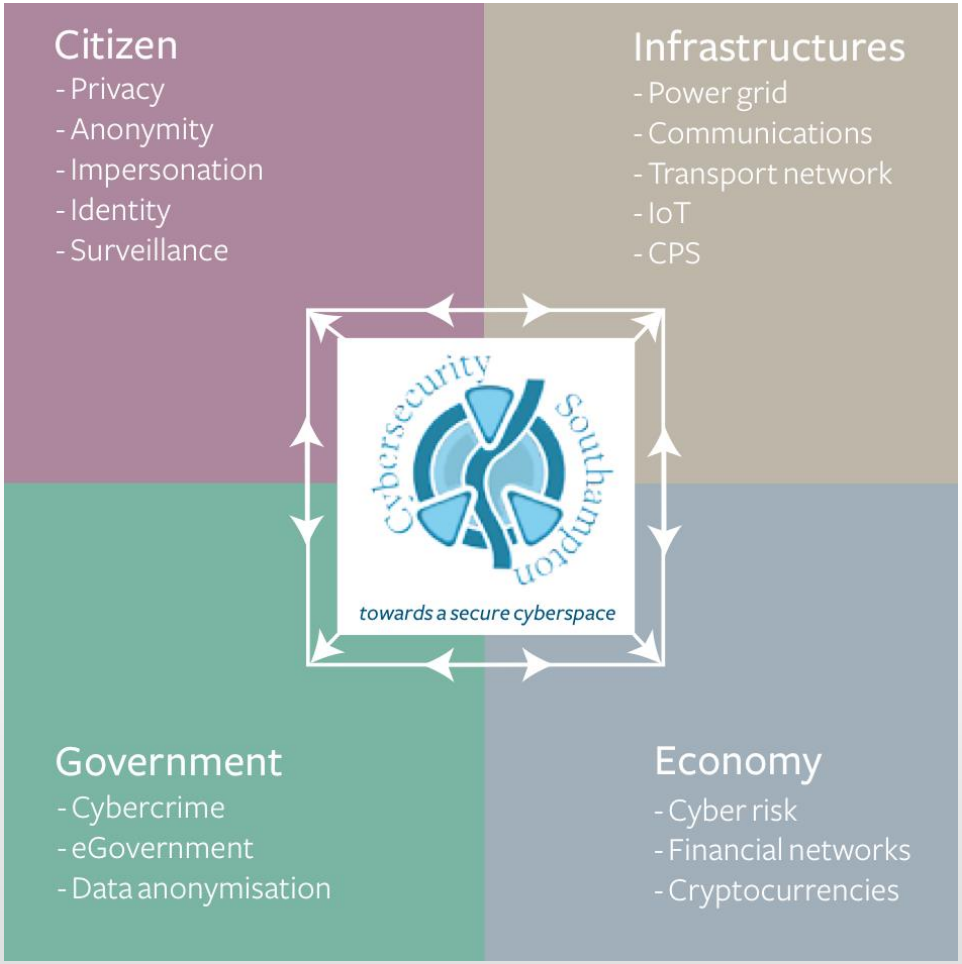
Cyber Security research



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Cyber Security Academy activities

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Power-efficient, Reliable, Many-core Embedded systems
£5.6M, 2013-2018

Lead Prof Bashir Al-Hashimi

EPSRC
Engineering and Physical Sciences Research Council

Knowledge Transfer Network
Electronics, Sensors Photonics

nmi Together We're Better

Knowledge Transfer Network
ICT

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Imperial College London

MANCHESTER 1824
The University of Manchester

Newcastle University

ARM

Imagination

ALTERA

freescale semiconductor

Microsoft Research

Runtime adaptive management

Step change in energy reduction and reliability improvement through **cross-layer system optimisation**