

# Innovate UK Initiatives on Verification & Validation of “Autonomous” Systems

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Workshop on Industrial Perspectives on the V&V of Autonomous Systems  
Sheffield, 1<sup>st</sup> July 2016

**Innovate UK**

# Overview

- Update on Innovate UK
- Review of past Innovate UK activities on
  - Robotics & Autonomous Systems
  - Verification & Validation activities
- Current activities & plans

# Innovate UK



return to the economy

7,600



organisations  
supported



of GVA for every  
£1 invested



**> 7 jobs** created for every business invested in

# A new phase

- The start of a new Spending Review period, 2016-20
- The government plans to publish a National Innovation Plan in 2016.
- Part of this will be Innovate UK's new strategy, describing our aims over the next four years.
- Meanwhile our Delivery Plan explains what we are doing in the first year of this new phase – the financial year 2016/17.



# Important changes

We are:

- aligning our programmes into new simpler sector groups
- changing our sector funding competitions to be simpler and broader in scope
- enhancing our innovation networks - nationally and regionally
- piloting competitions for new innovation finance products
- Introducing a new online competition applications system – the Innovation Funding Service

# 5 point plan

**1**

**Working with the research community and across Government to turn scientific excellence into economic impact**

**2**

**Accelerating UK economic growth, nurturing small, high-growth companies with strong productivity and export success**

**3**

**Building on innovation excellence throughout the UK, investing locally in areas of strength**

**4**

**Developing Catapults within a national innovation network**

**5**

**Evolving our funding models; helping public funding go further**

# Sector focus to accelerate growth

- **Emerging and Enabling Technologies**
  - Identifying and investing in technologies and capabilities that will lead to the new products, processes and services of tomorrow
- **Health and Life Sciences**
  - Focused on agriculture and food and healthcare, underpinned by bioscience and medical research and enabled by engineering and physical sciences
- **Infrastructure Systems**
  - Optimising transport and energy systems and integrating them with other systems such as health and digital
- **Manufacturing and Materials**
  - Advancing manufacturing readiness so R&D and technology developments increase productivity and capture value in the UK

# Funding: simpler competitions

- Two broad competitions for funding in each sector group this year
  - each open to a much wider range of applications than previously
- An “open” funding programme
  - two rounds per year
  - for applications from any technology area or sector
- Competitions and programmes run in partnership with other public sector organisations

# New simplified Innovate UK competitions

	<b>Expected open date</b>
Manufacturing and Materials	9 May 2016
Open	6 Jun 2016
Infrastructure Systems	4 Jul 2016
Health and Life Sciences	12 Sep 2016
Emerging and Enabling Technologies	3 Oct 2016

We will also run competitions in partnership with other organisations.  
For all competitions see the Delivery Plan or [www.innovateuk.gov.uk](http://www.innovateuk.gov.uk)

# New innovation finance products

- Businesses at different stages of their development can benefit best from different forms of innovation support.
- We are preparing to widen our range of products beyond grants in future.
- Later this year we will run three pilot competitions for new innovation finance products

# Review of past Innovate UK activities on Robotics & Autonomous Systems (RAS) Verification & Validation (V&V) activities

- Various RAS related activities & funding, not always with targeted competitions
  - SW engineering was an area of the ICT team's strategy 2012-15
- The RAS SIG established with the KTN
- A SW Engineering Working group established with the KTN
- No RAS specific activity/team
- Innovate UK RAS-related past funding allocation
  - Unmanned vehicles 57 %
  - Health related 6%
  - Industrial RAS 14%
  - Service RAS 8%
  - Cross-cutting RAS capabilities/technologies 15%

# Review of past Innovate UK activities on RAS and V&V activities

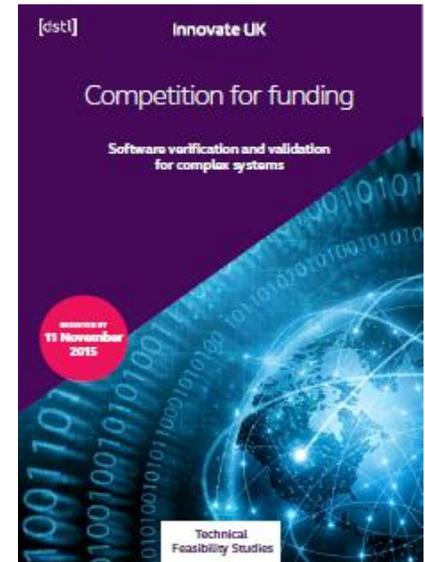
1. “Developing novel concepts in autonomous service robotics” competition
  - 2013
  - Investment of up to £1m in feasibility studies to accelerate the development of novel robotics and autonomous systems (RAS) concepts towards technology demonstration and commercialisation in multiple sectors."
  - One of the identified as targeted areas was “validation and certification
  - Projects completed
2. “*Software Verification & Validation for Complex Systems*” competition
  - 2015
  - Projects started
  - Details....

# Software Verification & Validation Competition overview

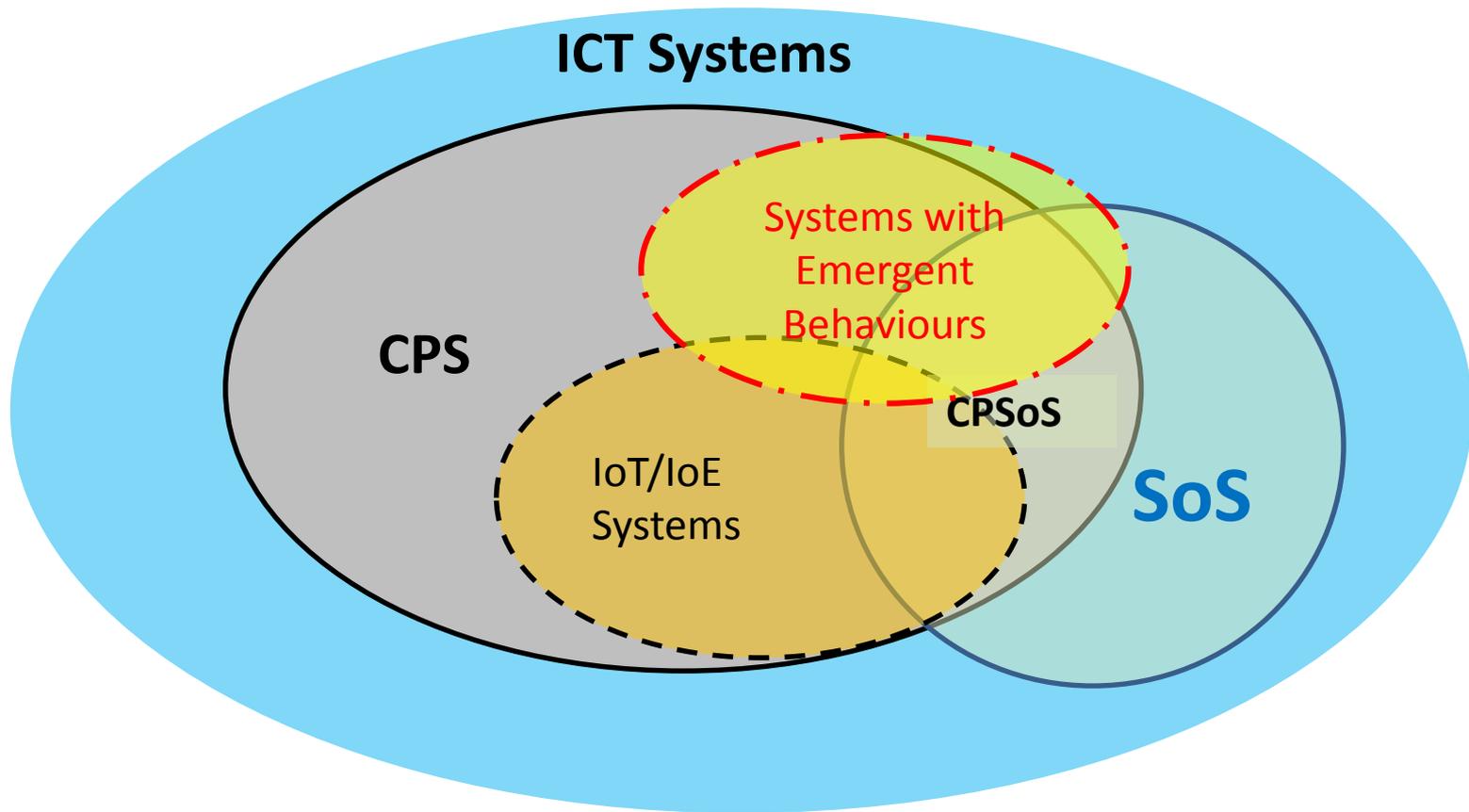
- Innovate UK and Defence Science and Technology Laboratory (DSTL) agreed to invest up to £580,000 in technical feasibility studies to stimulate innovation throughout the software development lifecycle (SDLC) focusing upon the Software Verification and Validation (V&V) of two classes of complex systems:
  1. cyber physical systems (CPS)
  2. systems with emergent behaviours
    - NOT identical with most of the so called “*autonomous*” systems
- This competition intended to:
  - encourage businesses to develop appropriate ‘links’ between the behaviour of a system in the physical world and the software implementing its planned interactions.
  - stimulate the development of new engineering methods for systems in which a machine – rather than a human user or operator – drives the decision- making process.
  - both help small/micro businesses further develop their early capabilities in this area of Software development for non-typical systems, and to allow/support the cooperation with the large companies.
- Projects should have focused on early-stage technical opportunities that:
  - contained a **significant level of technical risk**, in that there was some level of uncertainty about how the proposed methods/techniques/tools/processes will work in practice

# Software Verification & Validation for Complex Systems Competition details

- Up to £ 580,000 Competition
- Single stage competition process
- Projects summary:
  - Projects must have been collaborative
  - Must be led by a small or micro company
  - Partners could be industrial and/or academic
  - Projects lasting 6-12 months
  - Expected project sizes: £50-100k
- Dates
  - Competition opening: 21<sup>st</sup> September 2015
  - Competition briefing: 23<sup>rd</sup> September 2015
  - Various dissemination events with KTN Oct-Nov 2015
  - Registration deadline: 11 November 2015
  - Application submission deadline: 18 November 2015



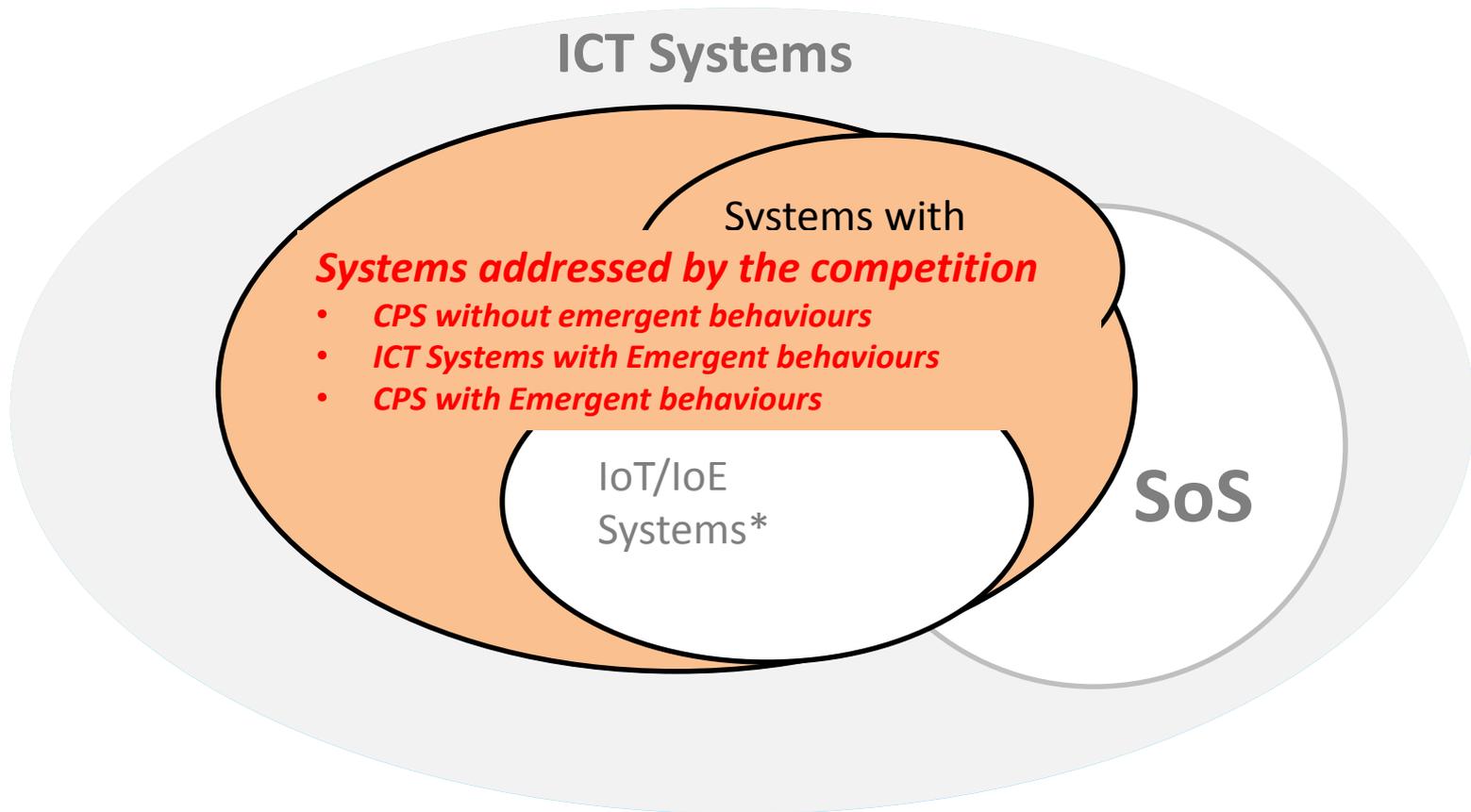
# A context & positioning for CPS & Systems with Emergent Behaviours



\* IoT/E systems are considered as not supporting seamless integration of, and close interaction between, the cyber and physical worlds, usually addressing sensing, with low-power constraints and non-real-time apps

**Note:** The relative sizes of the areas do not indicate any scale.

# A context & positioning for CPS & Systems with Emergent Behaviours

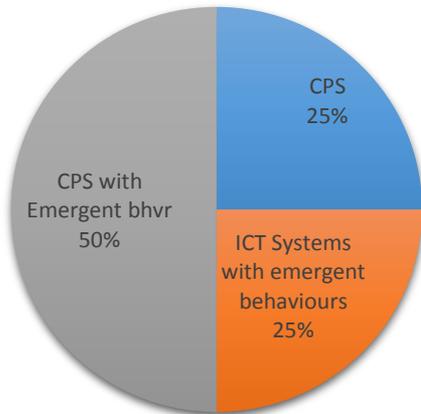


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# Competition Outcome

## Submissions



## Funded Projects

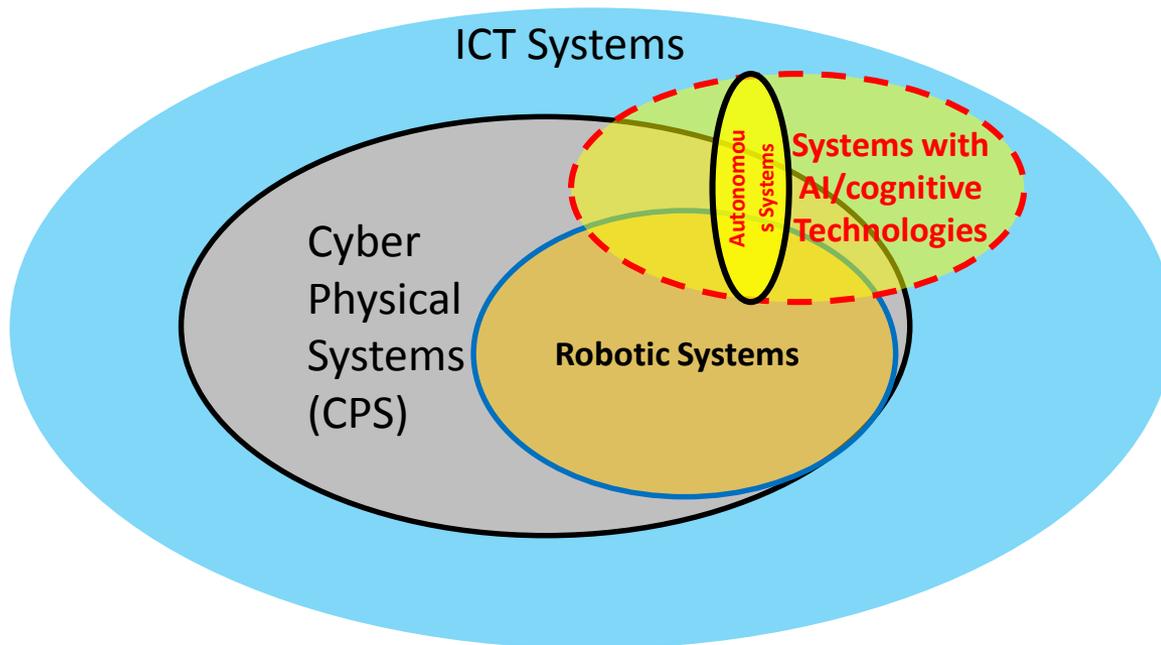
	Title	Lead	Area
1	SeaSwarm	D-RisQ Ltd.	CPS with Emergent bhvr
2	TestMiner	DRTS Limited	ICT Systems with emergent behaviours
3	Advanced Hardware Verification Techniques for CPS V&V	TVS Limited	CPS
4	SureSwarm	D-RisQ Ltd.	CPS with Emergent behaviour
5	Automated verification process for Vehicle-in-the-loop simulators	Vertizan Limited	CPS
6	Verification of UAS decisions in complex physical environments	SysBrain Ltd	CPS
7	PEnDAR - Performance ENSurance by Design, Analysing Requirements	Predictable Network Solutions Limited	CPS with Emergent bhvr

There will a workshop with all of them in 2017

# Current activities & plans on RAS

- RAS specific activity/team will exist within the Emerging & Enabling Technologies sector
- Coordination for RAS activities is being worked on among:
  - Innovate UK and EPSRC/Research councils
  - the other Innovate UK sectors for cross-cutting RAS issues/technologies
- A RAS specific competition is being planned
- The feasibility of a RAS dedicated Catapult is being explored

# A Context & positioning for Robotic, AI and Autonomous Systems



## Assumptions/Definitions:

1. Robotics cannot be software only
  - i.e. not ICT only
2. A system can be autonomous only with certain AI/Cognitive technologies
  - Automated systems are different to autonomous
3. Autonomous systems can be either software only or CPS

**Note:** The relative sizes of the areas do not indicate any scale.

# Autonomous systems

Different definitions exist for autonomous systems

- in most cases the view taken for them is one of the external observer, and refer to systems that operate without a Human-in-the- Loop during the execution of their tasks.
- While this definition can serve many purposes, it does not distinguish between systems that have “*operational*” autonomy, via some type of closed loop control with already embedded control laws or logic (which can also be called automated or adaptive systems) and systems which can “learn” and thus create their own logic, situation awareness, planning capabilities and their “own” laws or logic, thereby enabling “*decisional*” autonomy.
- While the terms automated and autonomous tend to be used interchangeably, in order to minimize confusion we adopt the ***automated vs autonomous distinction***
- The automated systems do not include AI technologies like reasoning, learning, knowledge representation, planning or other higher level cognition, only the autonomous systems do.
- Automation and autonomy can be thought of as comprising the two ends of a spectrum.
- The vast majority of current robotics systems are automated.
  - Driverless/self-driven vehicles, that are often called autonomous vehicles, are also referred to by the corresponding industrial or regulatory bodies as ‘automated vehicles’.
- Autonomous and/or automated systems may operate in the digital/cyber domain or, with the addition of sensors or actuators, within the real, physical world (e.g. autonomous robotics).

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