System Solution Engine

A systems approach to address
complex challenges like
Animal Disease Control and AMR

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What makes addressing these challenges so hard?

- Complicated problems that won't go away

- Myriad inter-connected issues

- Knowledge resides in multiple organisations, geographies and experts

- Solutions are only as good as their weakest link on the pathway to impact

- And of course, there no magic bullets

What can we do in response?

- **Deploy a strategic systemic approach**

- **Curate players in the ecosystem**

- **Manage portfolios of research initiatives**

- **Stimulate inter-disciplinary and cross-institutional collaboration**

- **Provide common frameworks & ways of working**

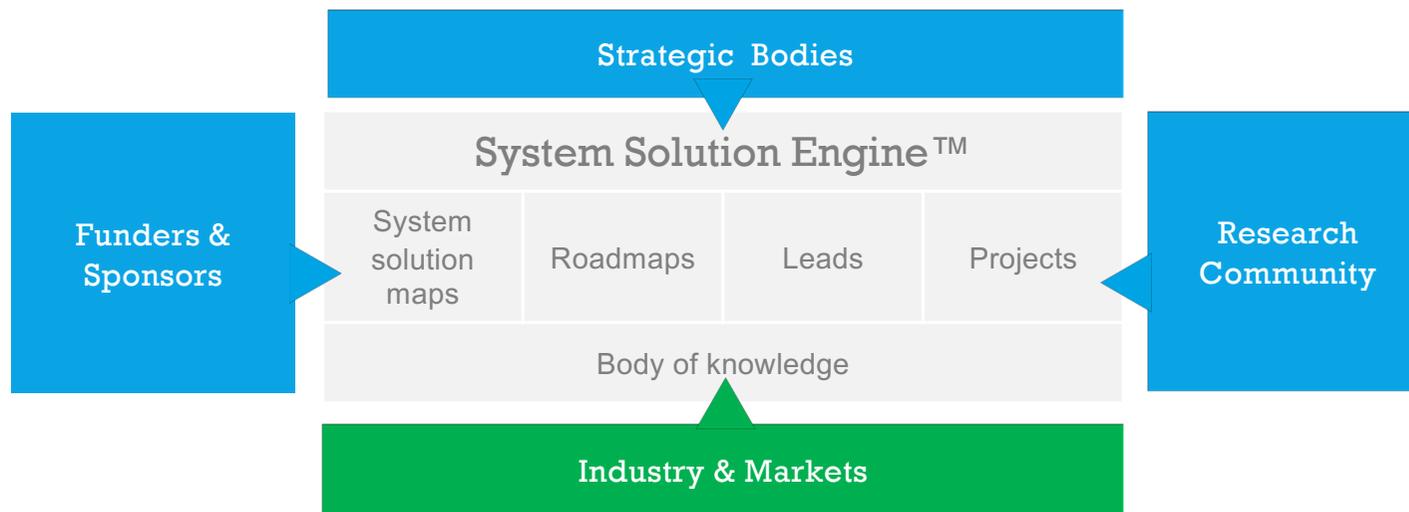- **Underpin with an integrated software platform**

System Solution Approach
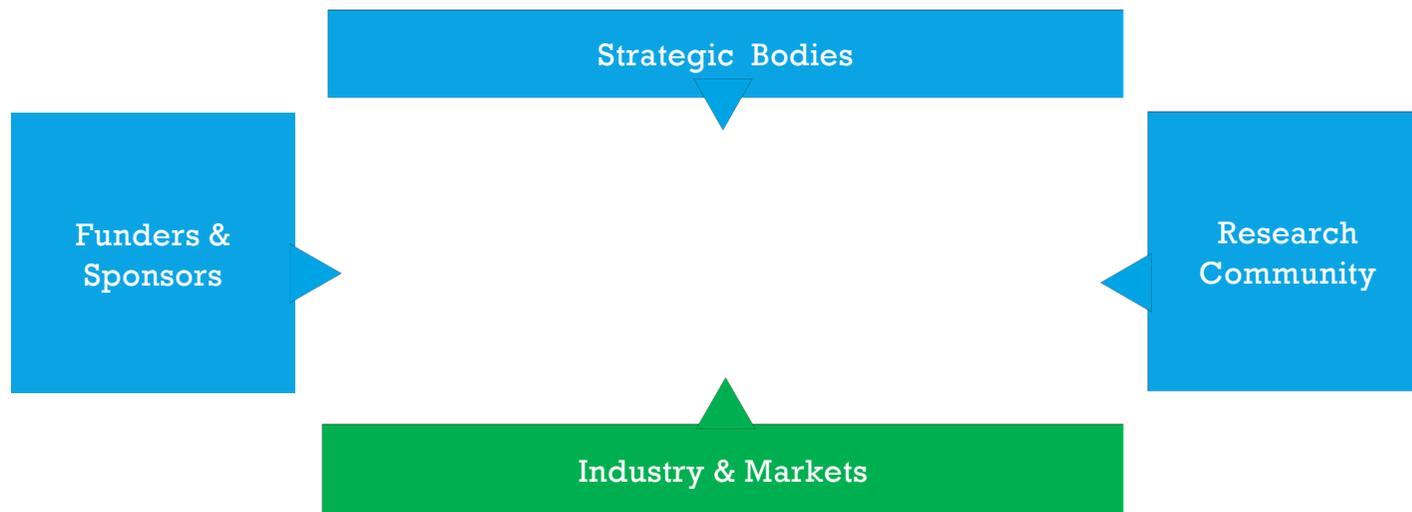
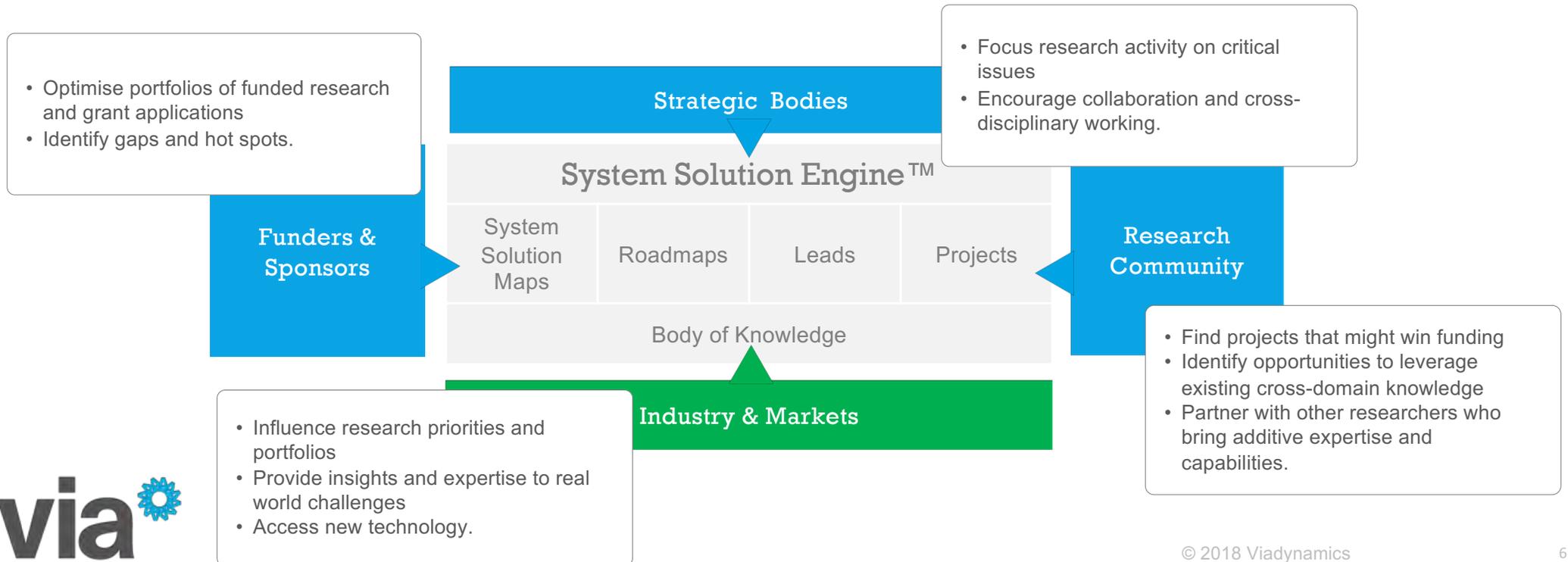## Orchestrate multi-party ecosystems to address complex challenges

System Solution Approach

Orchestrate multi-party ecosystems to address complex challenges

Strategic Bodies			
System Solution Engine™			
System solution maps	Roadmaps	Leads	Projects
Body of knowledge			
Industry & Markets			

Funders & Sponsors

Research Community

System Solution Approach

Orchestrate multi-party ecosystems to address complex challenges

- Optimise portfolios of funded research and grant applications
- Identify gaps and hot spots.

- Focus research activity on critical issues
- Encourage collaboration and cross-disciplinary working.

Strategic Bodies

Funders & Sponsors

System Solution Engine™

| System Solution Maps | Roadmaps | Leads | Projects |

Body of Knowledge

Research Community

Industry & Markets

- Influence research priorities and portfolios
- Provide insights and expertise to real world challenges
- Access new technology.

- Find projects that might win funding
- Identify opportunities to leverage existing cross-domain knowledge
- Partner with other researchers who bring additive expertise and capabilities.

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What is a lead?

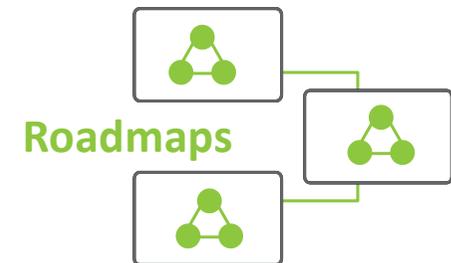**The DNA of the Via System Solution Engine is a Lead.**

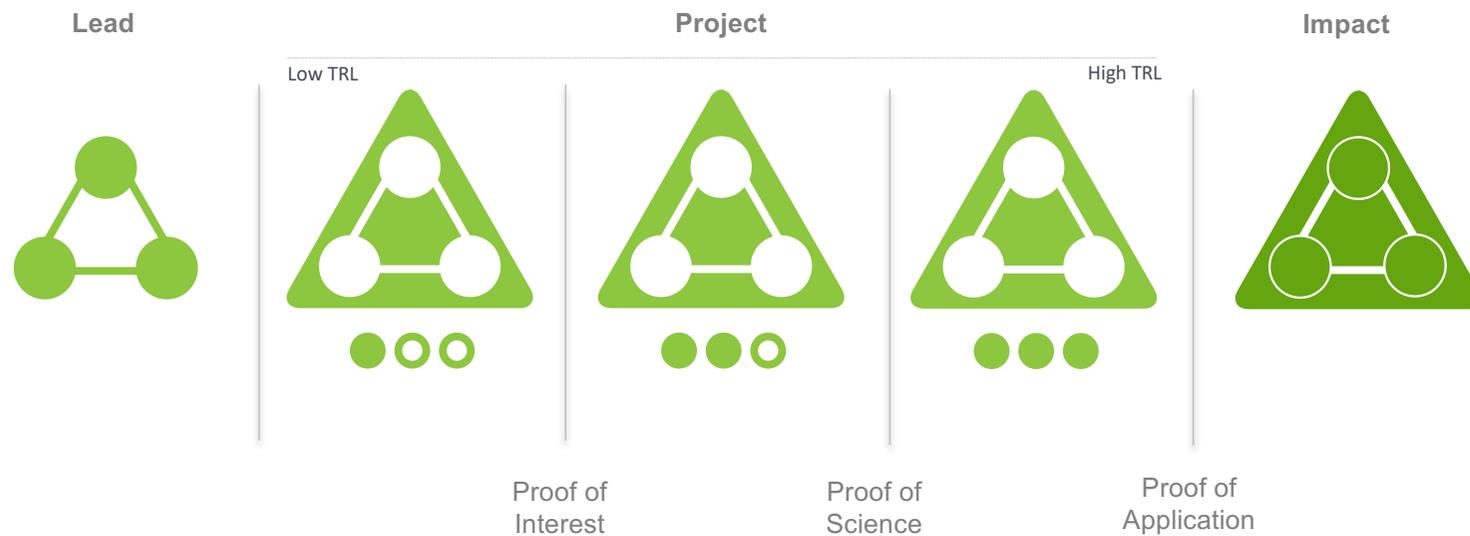# Where do leads come from?

Leads bring rigour to ideas.

What do we do with leads

## Leads can be linked into roadmaps that provide pathways to impact

Ideas

Lead

Challenge

Need

Solution

Roadmaps

How do leads deliver impact?

Projects are how Leads are executed to deliver impact.

Lead

Project

Impact

Low TRL

High TRL

Proof of Interest

Proof of Science

Proof of Application

How do we generate ideas and leads?

Teams progressively explore problem and potential solution domains looking for opportunities by sharing knowledge in collaborative inter-disciplinary workshops.

Ideas

Domain experts

Capability experts

Leads
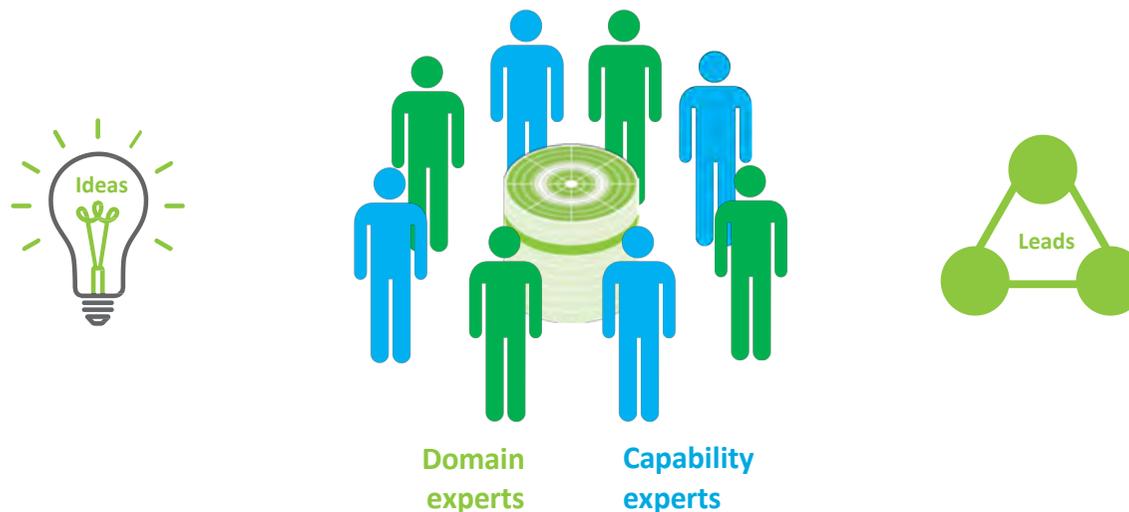
Ways Of Working

Example of collaborative inter-disciplinary AMR workshop.

A culture of engagement with 'goal-orientated' research between Physical, Biological, Arts & Humanities and Social Scientists

Active and developing collaborations to enable knowledge exchange

What was left behind?

Insights	Leads	Wants	Initial Proposals
what? how?	problems worth solving? ...	... by us?	... who with?
~520	52	21	7

A clear and shared understanding of the elements of the AMR Challenge that UoY is best placed to address
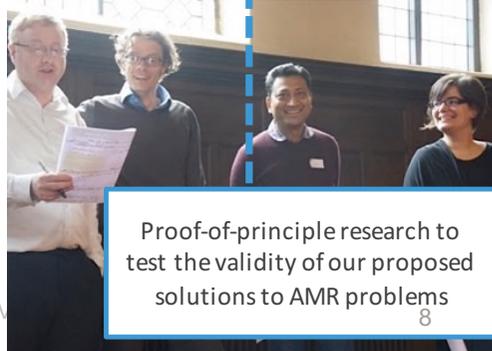
Proof-of-principle research to test the validity of our proposed solutions to AMR problems

UNIVERSITY *of York*
TARGeTED EPSRC

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System Solution Maps

What are all the potential ways to address a system problem?

ACTORS systems have components, from the very smallest to the very largest, that each play a role.
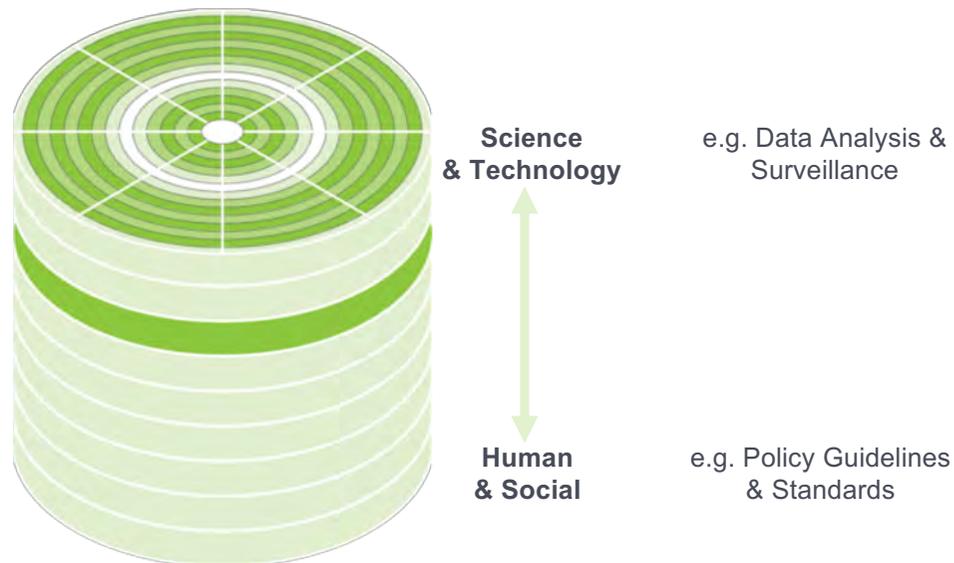
Macro-scale e.g. Society & Consumers

Micro-scale e.g. Pathogen
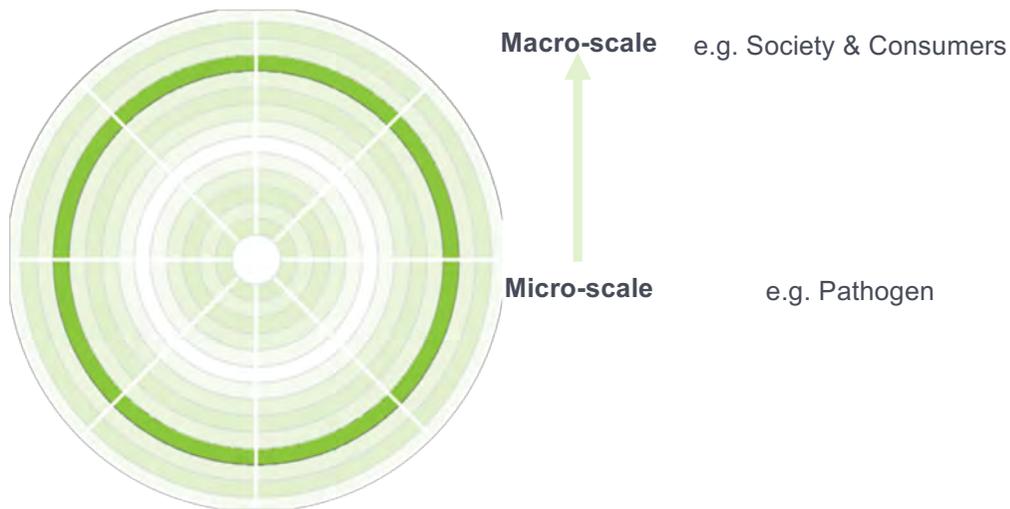
System Solution Maps

What are all the potential ways to address a system problem?

ACTORS systems have components, from the very smallest to the very largest, that each play a role.

ACTIONS components interact, systems evolve over time and go through changing states.

Macro-scale

Micro-scale

Changing system state

e.g. From Infection to Impact
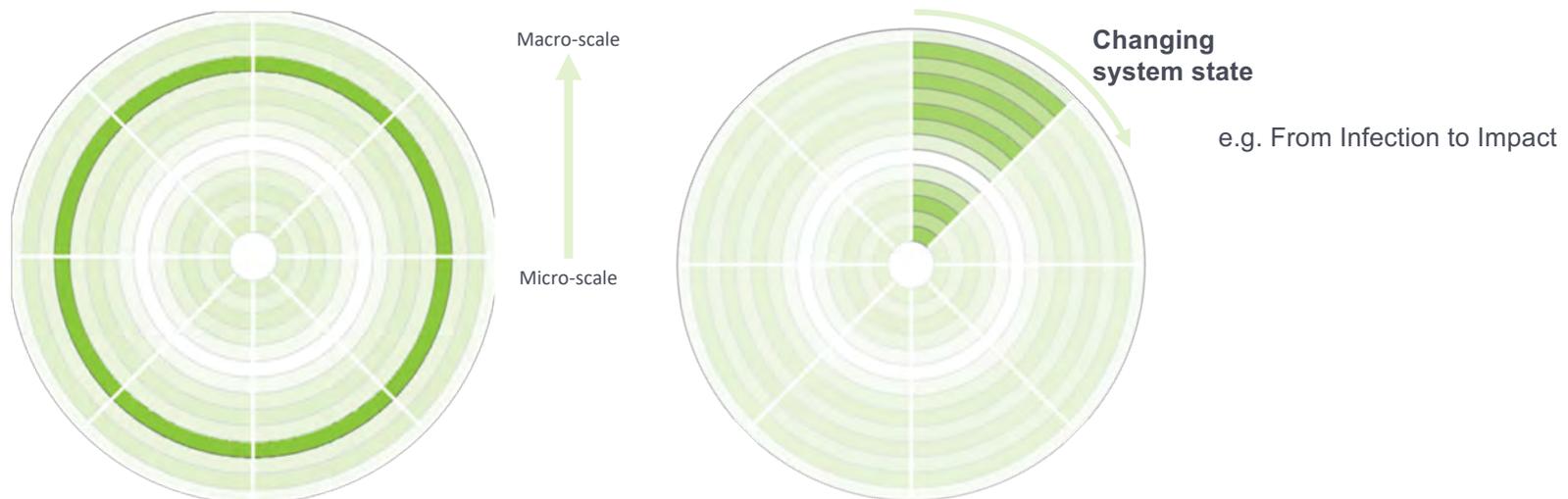
System Solution Maps

What are all the capabilities that can help deliver the change required?

CAPABILITIES   the body of knowledge and practices that can be exploited.

Science & Technology — e.g. Data Analysis & Surveillance

**Human & Social** — e.g. Policy Guidelines & Standards

Web based System Solution Engine

On-line collaborative platform

- Customised to specific domains (like AMR, Vaccine Development et al)
- Provides top down system, portfolio and roadmap views with filters
- Search database of Leads, Projects, Researchers and capabilities
- Signposts pathways to impact
- Builds a progressive Body of Knowledge
- Private organisational views
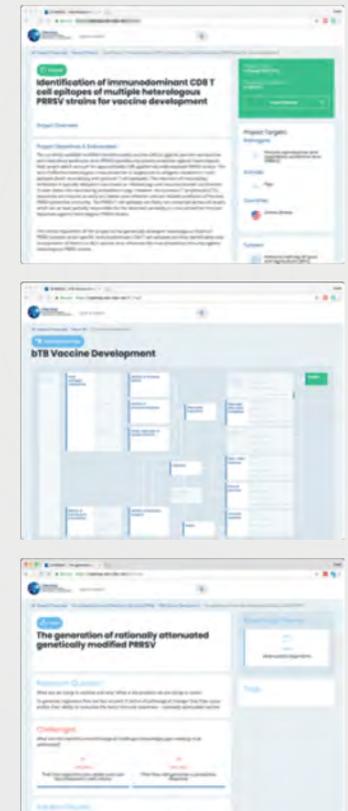
System Solution Map – Animal Disease Control

Actors

Pathogen
A micro-organism or other agent that causes disease

Biome
The habitat and other similar organisms with which the pathogen cohabits

Reservoir
The place in which the pathogen is generally found

Vector
The means of transference of the pathogen from the reservoir to the animal

Animal
The individual animal that becomes diseased as a result of the pathogen

Animal population
The population of animals that live with the diseased animal

Production environment
The context and habitat in which the population of animals live

Farmer / owner
The person that has responsibility for and benefits from the population of animals

Specialist services
Externally provided specialist services like veterinary

Supply organizations
Suppliers and manufacturers of external inputs to the production environment e.g. feed and pharma

Meat Processors
Transporters, receivers and processors of the animals

Market / retail
Channel or supply chain into which the meat products are provided

Environment
The natural environment that is affected by the system

Regulators / government
The bodies that regulate and control the behaviour of the actors in the system

Society / consumers
Those that consume the results of the animal production

Actions

Infection
Establishment of the pathogen in the animal

Disease
Pathogen growth results in disease

Spread
Disease movement within the population

Detection
Symptoms become apparent

Diagnosis
Identification of the disease

Control
Design of control strategy for the control of the disease in the animal and population

Intervention
Carrying out the control strategy

Monitoring
Monitoring the impact of the control strategy on the population

Impact
Resulting direct and indirect impacts of the disease and control strategy.

Capabilities

Enabling technologies, fundamental and applied
Science and technology expertise that is brought to and developed in the domain

Human factors
Research into understand human behaviour and performance

Sensing and measurement
Sensing systems and approaches for gathering data

Data analysis and surveillance
Interpreting, understanding and building meaning from data

Multi-scale modelling
In-silico modelling of systems from micro to macro scales

Testing, trialling and evaluating
Processes and platforms to evaluate potential solutions from lab to field

Health economics and modelling
Understanding financial and social costs of changes to the system

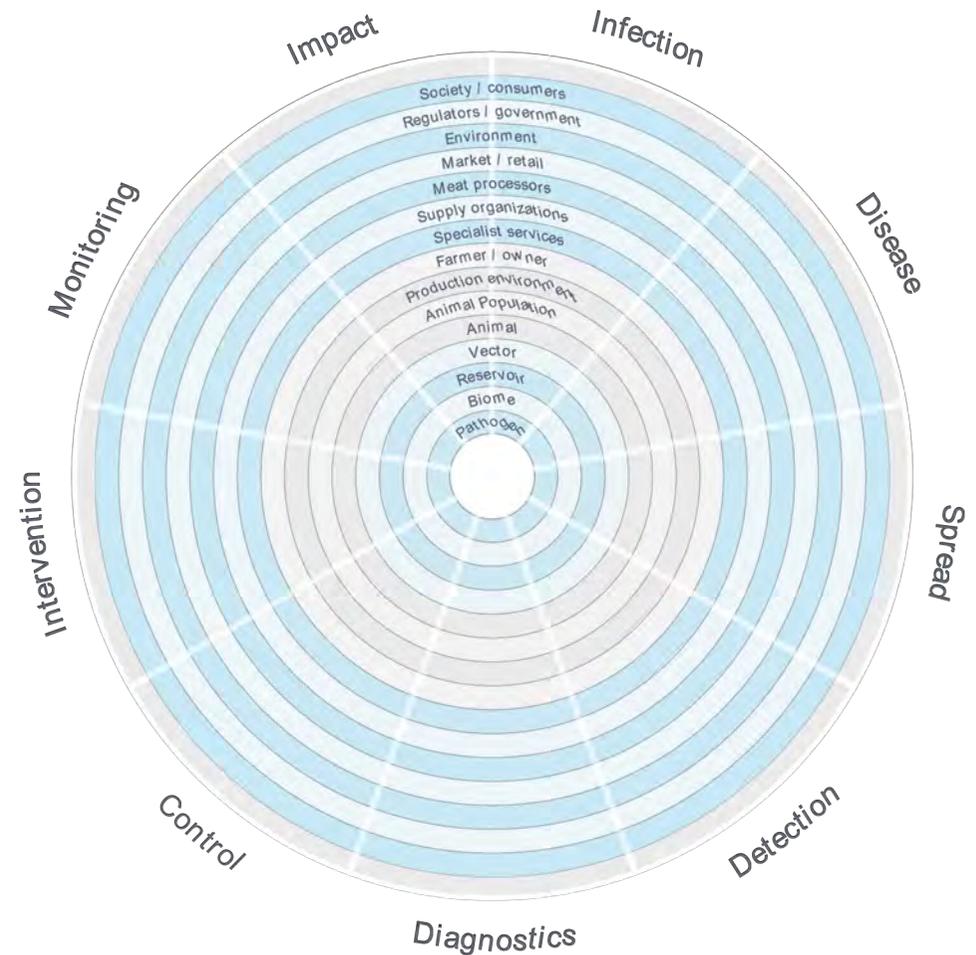**Policy, guidelines and standards**
Defined ways in which actors in the system should operate

Collaborative and creative ways of working
Defined ways in which problem and solution finders can work together to create value

Knowledge repository
A common place to store and share system knowledge

System Solution Map – Vaccine Development

Actors

Pathogen
A micro-organism or other agent that causes disease

Vector / Reservoir
The carrier or means of transference to the animal

Animal
Intended recipient of the vaccine

Immunisor
Deliverer or delivery system of the vaccine

Research Community
Public and private organisations involved in vaccine discovery

Funders
Those funding research and development of vaccines

Industry
Organisations that manufacture and distribute the vaccination system

Regulators
Regulatory bodies for vaccines and animal health

Customers
Buyers of vaccine systems or those economically impacted
by the effect of the pathogen

Society
Those affected by the vaccine system or potentially impacted by the disease

Actions

Characterising pathogen
Understanding the characteristics of the pathogen and associated mechanisms

Identifying opportunity
Discovering or isolating the pathogen/antigen to be targeted and assessing potential viability (commercial, scientific & political)

Identifying protective elements
Finding promising targets and protective immunogens

Design vaccine
Creating and evaluating potential vaccine candidates and associated business models

Testing and trialling
Testing vaccine candidates and delivery mechanisms

Scaling-up
Scaling-up of the vaccine and delivery system

Licensing
Regulatory approval and commercial licensing

Using
Distribution and use of the vaccine and delivery system

Pathogen evolving
The continued evolution of the pathogen

Capabilities

Enabling technologies (fundamental & applied)
Science & technology expertise that is brought to and developed in the domain e.g. immunology

Sensing & measurement
Sensing systems and approaches for gathering data

Data analysis
Interpreting, understanding and building meaning from data

Multi-scale modelling
In-silico modelling of systems from micro to macro scales

Testing, trialling and evaluating
Processes and platforms to evaluate solutions from lab to field

Failure & root cause analysis
Systematically understanding failures and their causes

Economics & impact modelling
Understanding the full impacts of possible changes in the system

Policies, guidelines & standards
Defined frameworks that govern the behaviour of the actors in the system

Infrastructure, people & labs
Physical resources that are needed to carry out specialist tasks and research

Collaborative & creative ways of working
Defined ways in which problem and solution finders and owners in the system work together to create value

Knowledge repository
A common place where system knowledge can be shared

System Solution Map – Antimicrobial Resistance

Actors

Antibacterial compounds
The compounds used as anti-bacterials that give rise to resistance mechanisms (e.g. antibiotics, chemical stressors)

Resistance mechanisms
The ways in which bacteria develop and transfer resistance (e.g. mutation, horizontal transfer, active transport)

Bacteria
Individual micro-organisms

Microbiome
Community of symbiotic and pathogenic micro organisms including the bacteria

ABR Reservoir
Distinct area (e.g. container) where the micro-biome can be found (e.g. animals, rivers)

Transmission route
The means by which the resistant bacteria is transferred from the reservoir to the host (e.g. cannula, aerosol, food, water, human infrastructure)

Host
Individual who is infected by the resistant bacteria

Health professionals
Health care professionals at the 'front line'

Pharma and health industry
Pharma, diagnostic, manufacturers, distributers, chemical companies that create and supply the anti-bacterial compounds

Reservoir owners
Public and private individuals, institutes, companies responsible for designing and operating potential reservoirs (e.g. farmers, hospital operators)

Government and regulators
Policy and regulatory authorities and public influencers

Society and general public
Men, women and children - those potentially affected by or whose behaviour might affect ABR

Environment and context
The prevailing societal, environmental , economic, cultural, geographic factors

Actions

Resistance
The emergence of microbes with resistance mechanisms

Spread
The proliferation and evolution of microbes with resistance mechanism

infection
The invasion of the host by resistant microbes

Growth
The multiplication of the resistant microbe population in the host

Response
The triggering and action of the hosts immune system

Diagnosis
The identification of the infection causing microbe in the host

Treatment
The therapy administered to the host to counteract or mitigate the infection, reduce illness and potential for death

Mitigation
The prevention and limitation of the

Capabilities

Enabling technologies, fundamental and applied
Science and technology expertise that is brought to and developed in the domain

Human factors
Research into understand human behaviour and performance

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STAR-IDAZ
International Research Consortium on Animal Health

Coordinating animal health research globally to accelerate delivery of disease control tools and strategies

Efficient, effective and focussed research to reduce the impact of animal disease on animals, livestock sector, environment, public health and food security

Overview
The STAR-IDAZ International Research Consortium (IRC) of research funders and programme owners, aims to maximise the impact of animal disease research funding through coordination and cooperation.

Objectives
The overall objective of the STAR-IDAZ IRC is to coordinate research at the international level to contribute to new and improved animal health strategies for at least 30 priority diseases/infections/issues.

Deliverables
The deliverables include: candidate vaccines; diagnostics; therapeutics and other animal health products; procedures; and key scientific information/tools to support risk analysis and disease control.

SIRCAH (secretariat)

The Secretariat supports the STAR-IDAZ IRC Executive Committee, Scientific Committee and Working Groups.

IRC Executive Committee

Scientific Committee
The Scientific Committee brings expertise and representation from academia, livestock and animal health industry, and risk assessment/regulatory bodies.

Working Groups
The working groups comprise relevant science experts including representatives from funded projects, livestock industries and other stakeholders. Composition is geographically balanced.
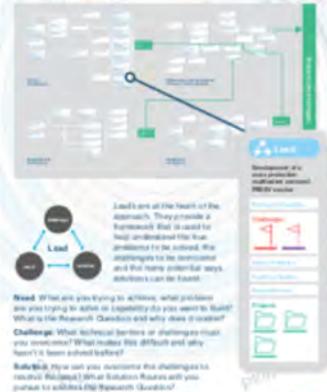
Animal Disease Control System Solution Engine
The Animal Disease Control SSE provides a common platform for the the STAR-IDAZ community to collaborate and deliver its strategic objectives by supporting more efficient, effective and focussed research that can deliver real impact to society

Research Roadmaps

The IRC Executive Committee comprises one representative per Partner Organisation, the Chair of the Scientific Committee and the STAR-IDAZ Chairperson.

25 partner organizations

16 member countries

50 associated countries

$2.5B research investment

Research Community
The research community comprises all those people and organisations who can contribute towards tackling the overall problem.

Projects
Funded projects help overcome a particular challenge, through a number of maturity levels until a solution is reached. A key part of a project is identifying the areas of knowledge and capability that can help accelerate it and sharing the primary and secondary impacts for the benefit of the community. It's important that a portfolio approach is taken in choosing which projects to fund balancing opportunity, resources and risk.

System Solution Map – Antimicrobial Resistance

Manual mapping for the MRC of Research Council funded AMR calls prior to development of the SSE software platform. Showing activity hot spots and potential white space. One implication is the need to integrate AMR related research especially in Growth and Response.
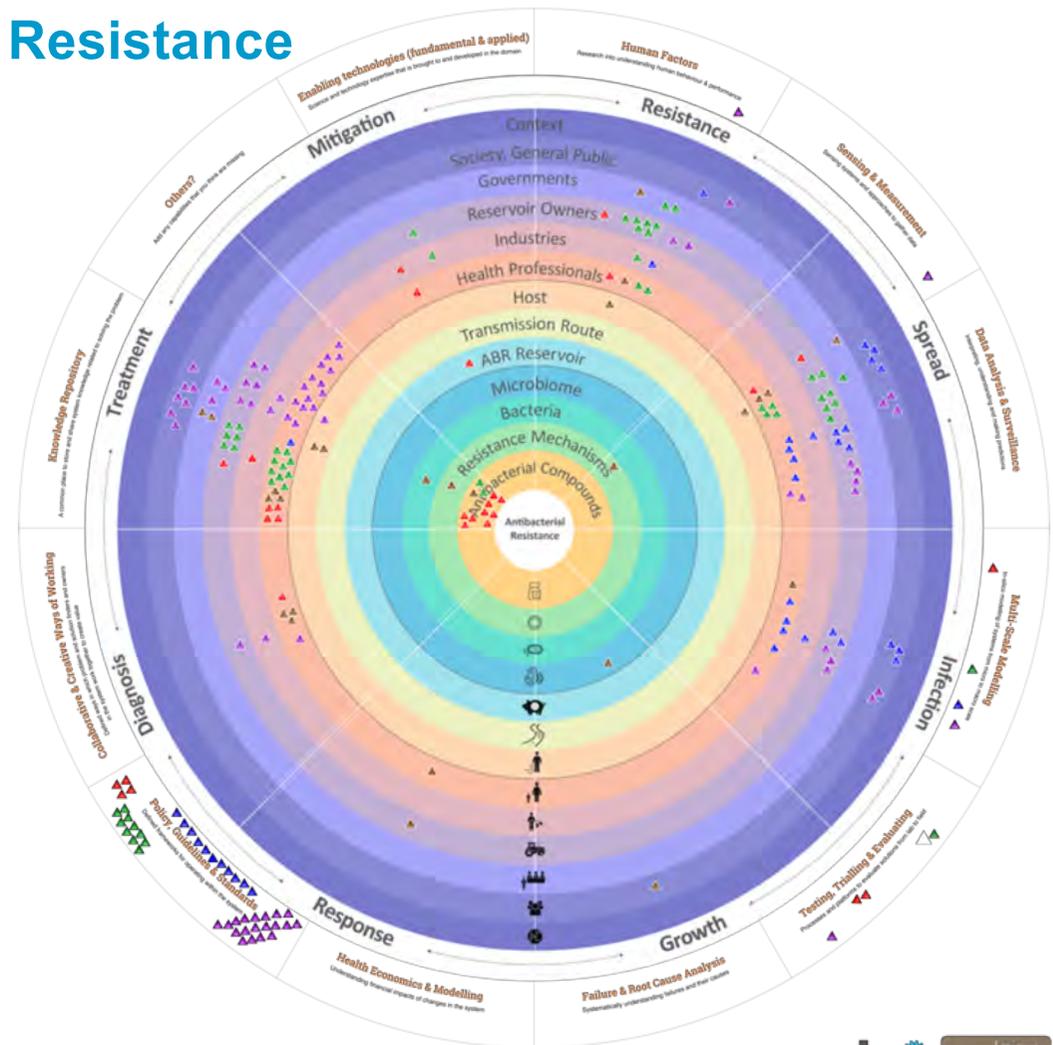
Theme 1
Understanding resistant bacteria

Theme 2
Accelerating therapeutic & diagnostics development

Theme 3a
Understanding the real world interactions
Outdoor sub-theme

Theme 3b
Understanding the real world interactions
Indoor sub-theme

Theme 4
Behaviour within and beyond the health care setting

△ Impact   △ Capability Impact

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