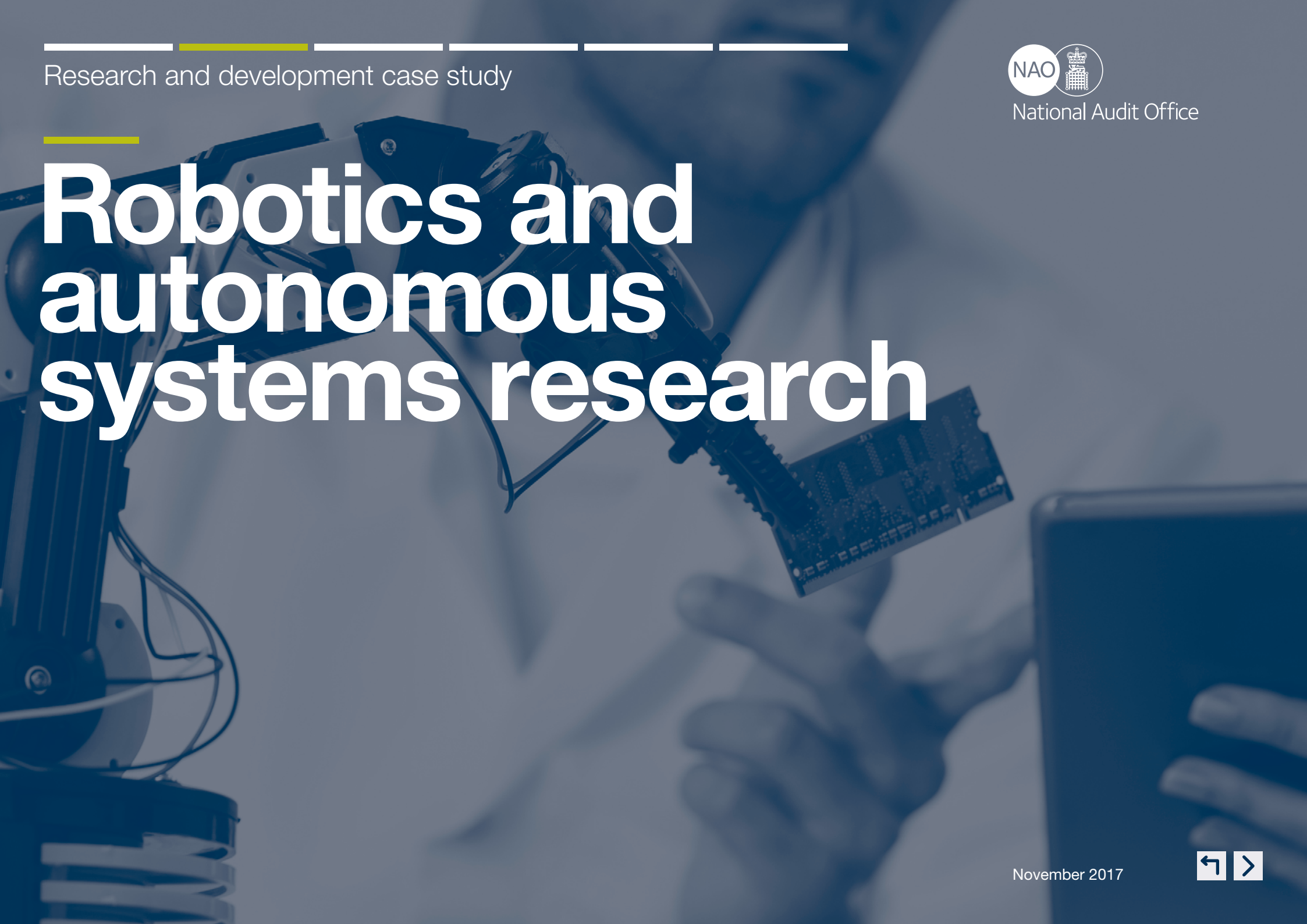
Research and development case study

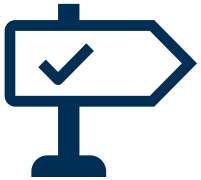
National Audit Office

Robotics and autonomous systems research



November 2017

Introduction



This case study on **robotics and autonomous systems research** is one of a series that we have developed to support and complement our published report on research and development.

Our examination of robotics and autonomous systems research focused on arrangements to coordinate the funding of research into new enabling technologies in areas ranging from health and social care to transport.

Other case studies focus on research relating to:

- advanced materials;
- animal and plant health;
- climate;
- energy; and
- human health.

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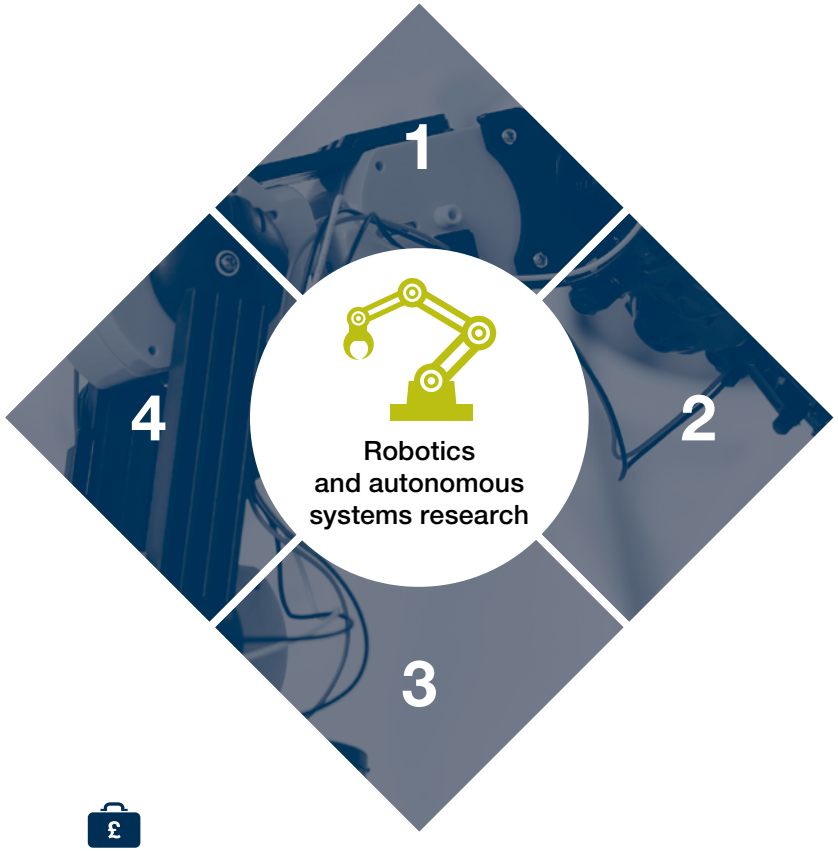
Summary

1 Who is involved?

Funders, coordinators, researchers, influencers



2 What happens?

Stages of research activity

Video
The real world view: autonomous car technology

3 How much is spent?

Government has invested or plans to invest over £300 million in robotics and autonomous systems research since 2012

4 What did we find?

- Some evidence of coordination mechanisms but an absence of strategic leadership
- Consolidated information to support decision-making is at an early stage of development

1 Who is involved?

The funders

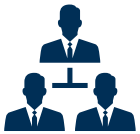
- UK government departments (including the Department for Business, Energy & Industrial Strategy and the Ministry of Defence)
- Research councils (including the Engineering and Physical Sciences Research Council (EPSRC))
- Innovate UK
- Industry (including the automotive, healthcare and transport sectors)
- European Union

The coordinators

- EPSRC Robots and Autonomous (RAS) network (academia focus)
- Innovate UK's Knowledge Transfer Network via its RAS Special Interest Group
- Catapults – specifically High Value Manufacturing and Transport Systems

The researchers

- Research institutes
- Universities
- Industry
- International



The influencers

- Policymakers and parliamentarians
- Learned societies (including the Royal Academy of Engineering)

2 What happens?

Stages of research activity

Description of research	Basic	Applied	Translational
Purpose of research	**Knowledge expansion** – asks questions about robotics and autonomous systems. Research is approached as a scientific study rather than to address specific needs	**Solutions-focused** – research is concerned with finding a solution to a specific question or problem	**Product development** – takes the findings from basic or applied research and uses them to develop new products and treatments
What is involved?	Experiments by academics and researchers at university laboratories or research institutions	Testing and observation at demonstrator site facilities	Development of new products at demonstrator site facilities
Funders include	research councils; government departments	Innovate UK; National Institute for Health Research; industry; EU	Innovate UK; industry; EU
Examples of successes	Research into advanced control algorithms and flight dynamics has helped drones to fly level and straight.	**Eye surgery** – ongoing clinical trials are testing the use of robotics in surgical procedures (phased trials but early successes).	**Autonomous underwater vehicles** have been developed and brought into use for purposes such as collecting data and inspecting underwater oil and gas equipment.
Examples of current programmes and projects	EPSRC collaborative project with academia and industry to develop robotics technologies capable of operating autonomously and effectively within hazardous environments such as nuclear facilities. The project will look to overcome issues about the current limitations of smaller robots, while also developing systems able to improve issues around grasping and manipulation, computer vision and perception.	**Driverless cars** – Innovate UK is making funding available to projects that target develop and test autonomous car technology, e.g. safety improvements.	**Agricultural robotics** – the development of robotics in agriculture to replace manual labour in tasks such as harvesting and handpicking.

3 How much is spent?

Who are the principal funders of robotics and autonomous systems research?

- Government has invested or plans to invest over **£300 million in robotics and autonomous systems (RAS) research since 2012**. Investment comes from various funders within government departments and agencies. Total investment in RAS research is not reported consistently or in one place, which makes it difficult to calculate an accurate figure.
- Government funding includes a joint £100 million government/industry programme to support driverless cars in the UK, £100 million of research council grants, £25 million of Innovate UK funding for RAS-related innovation projects, and £32 million for research into unmanned aerial vehicles.
- The UK has been very successful in securing EU funding for robotics research – the Council for Science and Technology estimated that 80% of funding for UK RAS research came from the EU.

Forward look at RAS funding opportunities:

- Investment of £93 million from the **Industrial Strategy Challenge Fund** (ISCF) towards activities in the area of Robotics and Artificial Intelligence for extreme environments was announced in April 2017. The Engineering and Physical Sciences Research Council will award grants to universities to drive the translation of fundamental science in this area. The ISCF will also support a £35 million innovation programme and a £16 million demonstrator programme.

4 What did we find?

Some evidence of coordination mechanisms but an absence of strategic leadership

Many different parts of government invest in RAS but there is not a strategic, joined-up approach to investment and there is no evidence of any top-down action to set, coordinate or align priorities. The cross-cutting nature of RAS makes coordination difficult. But effective leadership and coordination across funders would help government to develop a coherent investment strategy and ensure that investment is targeted where it most needed.

The RAS Special Interest Group (a group of experts from industry and academia) is funded by Innovate UK through the Knowledge Transfer Network and has played an important role, leading work to identify opportunities for investing in RAS, including:

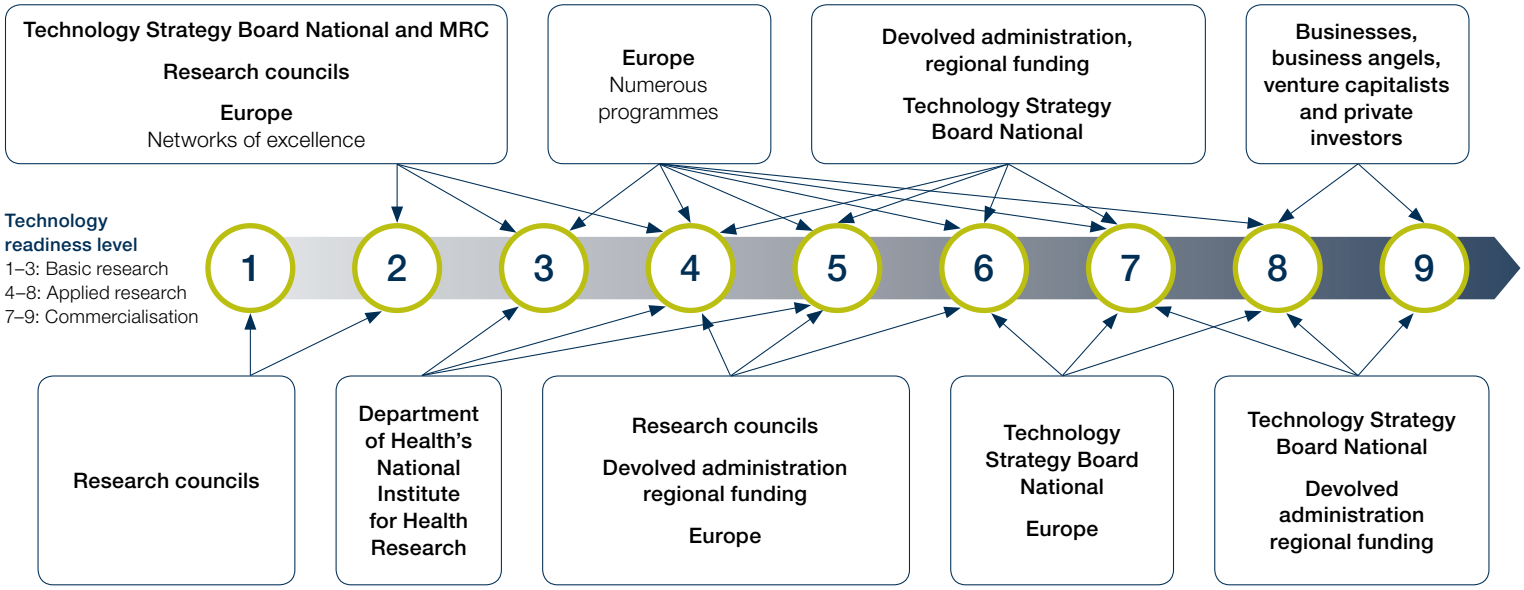
- publishing a national strategy to coordinate the development of assets, challenges, clusters and skills;
- mapping investment activity to identify gaps and highlight the translation problem;
- analysing the impact that RAS could have in three types of process: producing goods; providing services; and delivering goods and resources; and
- identifying 'hot spots' for investment, including aerospace, agriculture, automotive, energy, health, manufacturing, marine, nuclear and transport.

4 What did we find? *continued*

Consolidated information to support decision-making is at an early stage of development

The RAS Special Interest Group mapped out public sector research investment activity across the spectrum, from basic research to commercialisation, to highlight gaps in investment.

Mapping investment activity on the commercialisation spectrum



Note

1 Technology Strategy Board (TSB) was Innovate UK's predecessor.

2 Each of the funders shown on this chart uses various instruments of investment depending on the technology readiness level of the research being funded.

Source: A more detailed chart is included in RAS Special Interest Group, *RAS 2020 Robotics and Autonomous Systems* which is the information source for this abridged version of the chart.

4 What did we find? *continued*

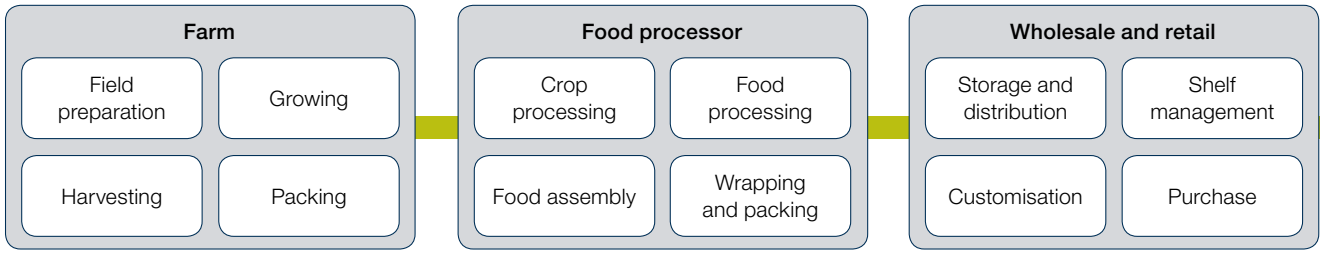
Consolidated information to support decision-making is at an early stage of development

The RAS Special Interest Group produced analysis to demonstrate the impact that RAS could have on three types of process – producing goods; providing services; and delivering goods and resources – within various industry sectors. For each sector, diagrams were developed to show the typical chain of tasks and to identify the opportunities and impact of RAS.

The analysis demonstrates the breadth of impact associated with RAS, and its wide ranging applications (the application of RAS in food production is shown opposite).

Analysis could be developed further to quantify benefits and outcomes and help make the case for further investment in translational research.

Outcomes for the application of RAS in food production



On the farm

The advantages of RAS on the farm are considerable: reduced pesticide use, less ground compaction, selective application of fertilisers, selective weeding, per plant processing, early pest detection, precise data on crop condition, and selective harvesting at the optimal time.

All of these will increase yield and reduce environmental impact while lowering costs.

Disruptive logistics

RAS based processing on the farm for delivery direct to the consumer. Daily on demand delivery of food means a reduced need for fridges and freezers.

Pizza, salads and sandwiches can be customised at the retail outlet based on customer demand.

In-store automated shelf restacking that can dynamically respond to demand and the weather.

RAS will disrupt the agri-food supply chain.

Source: Robotics and Autonomous Systems Special Interest Group, *The UK landscape for robotics and autonomous systems*, 2015

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