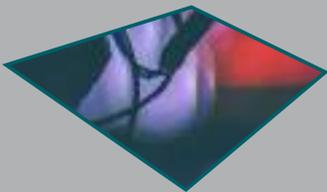


# INNOVATION SOUTH - A POWERHOUSE OF WORLD CLASS STRENGTHS IN DIGITAL ENABLING TECHNOLOGIES

A SCIENCE AND INNOVATION AUDIT REPORT SPONSORED BY THE DEPARTMENT FOR  
BUSINESS, ENERGY & INDUSTRIAL STRATEGY

REPORT 2017



Department for  
Business, Energy  
& Industrial Strategy

# INNOVATION SOUTH

SWITCHING ON OUR FUTURE

# ACKNOWLEDGEMENTS

## Message from Dr Mike Short, CBE FEng FIET, Chair, Innovation South Strategic Steering Group, VP Telefónica

This report is sponsored by the Department for Business, Energy and Industrial Strategy (BEIS) and produced on behalf of Innovation South, a consortium of over 120 private and public organisations from across Dorset, East & West Sussex, Hampshire, the Isle of Wight, Kent, Surrey, and the Thames Valley (see Annex D). The consortium's ongoing endorsement of this Science and Innovation Audit is most appreciated.

The report was primarily authored with the invaluable support and expertise of members of the Innovation South Strategic Steering Group (see below) and its Advisory group (see Annex D), to whom I am most grateful, and thank them for their time and dedication. Many thanks as well to Christine Doel and Ross Gill of SQW who expertly helped us make sense of a vast amount of evidence received and information gathered.

Thanks also to staff at Technopolis for their support and guidance as we navigated the process. During the preparation of this report around 200 people from business, academia and public services across the region attended workshops and/or submitted written evidence. Their contributions have been extremely valuable and highly appreciated.

Finally, I would like to thank Sue Littlemore as Project Manager and Editor, Lucy Crabtree for her support and unfailing organisational skills, and the Enterprise M3 Local Enterprise Partnership for its excellent leadership in the delivery of this substantial project.

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# FOREWORD



Innovation South is spearheading the UK's digital revolution. From better health care to safer transport and from adventurous immersive technologies to the design of super fast racing yachts, Innovation South is a

substantial region at the forefront of advances in digital innovations that are constantly improving our daily lives.

Spanning eight counties outside the M25, and across some of England's most beautiful areas of countryside and coastline, Innovation South is not only a very significant contributor to the whole of the UK economy, it is also a superb place to live and work.

This Science & Innovation Audit, sponsored by BEIS, is a timely and valuable opportunity to highlight the outstanding strengths of Innovation South in digital enabling technologies and the application of those technologies to make advances in several key sectors in the South: Digital, Biosciences, Marine & maritime and Advanced Engineering.

Close to London and Heathrow, this is a high performing region. The economic output of Innovation South is close, in scale, to that of Denmark. Exports and foreign investments are strong; much of the workforce is highly skilled; a dynamic stock of businesses, from huge multinationals to entrepreneurial scale ups, are working with the region's richly diverse and excellent universities to turn world class science in digital technologies into innovative products and services that will compete in global markets.

This report demonstrates Innovation South is a region in a good position to face challenges ahead. It also highlights opportunities that must be grasped if Innovation South is to maintain and enhance its valuable place as a regional success, and a major supporter to the broader UK economy, for London and beyond.

A number of recurrent themes were raised by businesses during the preparation of this report. A high tech innovative digital economy relies on a good supply of high tech, highly specialised digital talent. Fresh thinking on both stimulating that supply at home and maintaining access to talent abroad was a repeated demand. Other frequently identified barriers to innovation and improved productivity were the relatively high cost and limited availability of housing in the region, and the need to enhance the efficiency of transport links to London, west-east connections across the region and the ease of connection and transit to/from major air/sea ports.

The auditing process has brought together business people, entrepreneurs and academics, many of whom had never met before, and enabled them to focus clearly on how Innovation South really can be powerfully greater than the sum of its parts.

As the UK and Innovation South face future challenges and opportunities, there is a pressing need and a strong ambition to continue and extend levels of region-wide collaboration initiated during this Audit. That ambition, reflected in the recommendations at the end of this report, must be realised in order to unlock the vast commercial and exporting potential in the region's economy.

It is Digital Enabling Technologies that are the key drivers in advances in entertainment, communications, health, marine operations and transport. That is undisputed. More uncertain is which countries will capitalise on these opportunities. Innovation South is poised to deploy its outstanding expertise in partnerships with other regions to help ensure the nation which takes the lead in those advances is the UK.

**Dr Mike Short CBE FEng FIET, VP Telefónica & Chair, Innovation South Strategic Steering Group**



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# EXECUTIVE SUMMARY

In Autumn 2015, the UK Government announced regional Science and Innovation Audits (SIAs) to catalyse a new approach to regional economic development. SIAs enable local consortia to focus on analysing regional strengths and identify mechanisms to realise their potential.

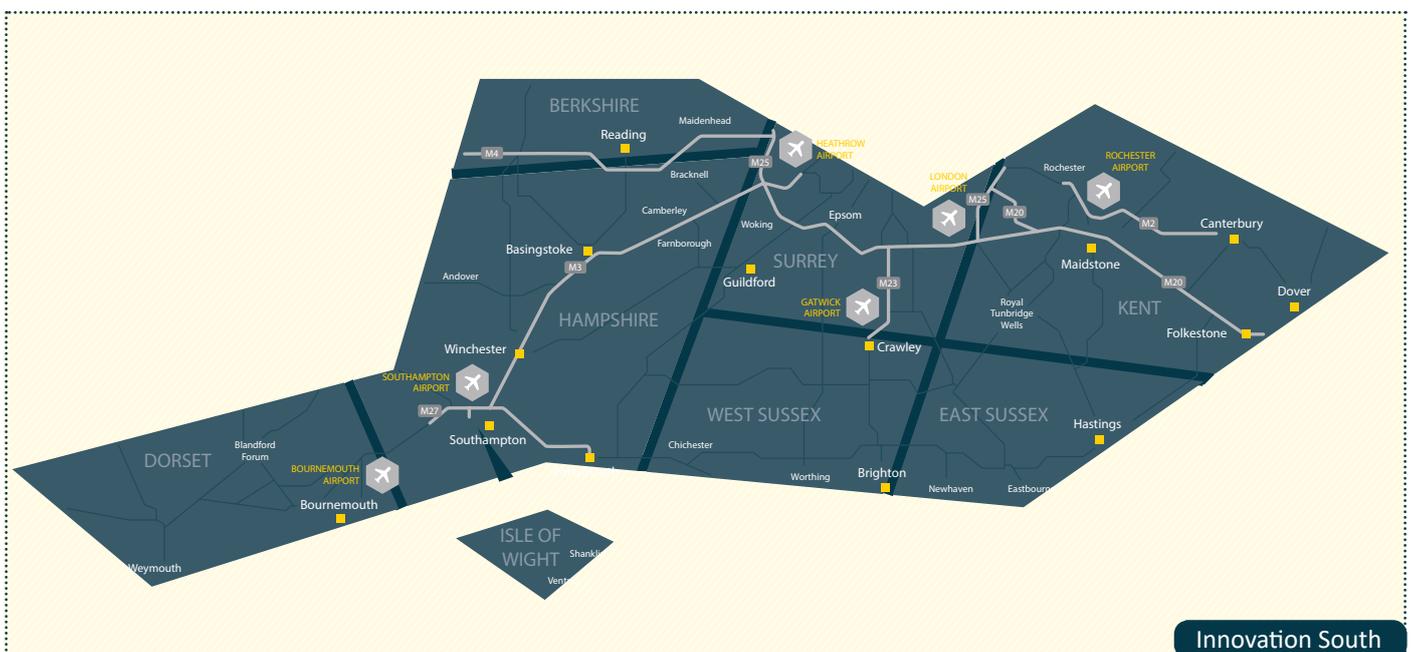
In the South of England, a consortium, “**Innovation South**”, was formed to examine the region’s capacity to commercially exploit its excellence in a portfolio of Digital Enabling Technologies<sup>1</sup>. Specifically, it examined the hypothesis that *while others may share strengths in individual technologies, Innovation South stands out for the number and breadth of digital enabling technologies, and their widespread application in four high-tech sectors: Connected Digital, Marine and Maritime, Bioscience, and Advanced Engineering*<sup>2</sup>.

This report presents the results, and includes broad-ranging analysis of Innovation South’s capabilities, the challenges and the substantial opportunities for future economic growth.

## INNOVATION SOUTH

Innovation South spans eight counties, two National Parks, and more than a thousand kilometres of England’s coastline. From Dorset to Kent and from the Isle of Wight to the fringes of London, it is home to more than a tenth of the UK population and supports an economy comparable in size to that of Denmark<sup>3</sup>.

The Innovation South Consortium embraces well over one hundred organisations from the region’s private (SME and corporate) and public sectors. They are united around an ambition to sustain and advance the findings and recommendations of this Science and Innovation Audit in order to maximise the region’s contribution to the UK’s global influence in the science and commercial application of Digital Enabling Technologies.



<sup>1</sup>Digital Communications (5G); Cyber Security; Big Data Analytics; Photonics; Quantum

<sup>2</sup>This hypothesis had been developed by the consortium and explained in an Expression of Interest which was accepted by BEIS and provided, effectively, the Terms of Reference for the SIA

<sup>3</sup>ONS, OECD



## A HIGH PERFORMING REGION

Innovation South has many economic advantages. Much of the workforce is highly qualified and good numbers of people work in science, research, engineering and technology. Average earnings are higher than England's and there are impressive levels of productivity in some parts of the region.

It's a dynamic region for business growth. Across most of the area, the concentration of start-up enterprises and the incidence of high growth firms are well above England's average. Business start-ups outnumber business deaths and the share of national companies is larger than the national average.

The success of Innovation South is significantly influenced by a close relationship with London. The region's proximity and connectivity to this dynamic and growing world city makes it an attractive business location; there are strong commuting flows in both directions and the links benefit both economies.

## A GLOBAL AND ENTREPRENEURIAL REGION

The Innovation South economy is intrinsically international. Export performance is strong and levels of foreign investment are impressive.

International ownership is high among the region's numerous large corporations; its labour market attracts high skilled international talent and there is very good access to international markets via the region's airports and ports.

The region is entrepreneurial and there is a strong track record of producing and commercialising world class and high quality research. The region benefits from 16 universities with a diverse range of expertise and capability which are playing a key role in spinning out and fostering new businesses.

Business expenditure on research and development in the Innovation South area is high, and according to a new analysis, the region "punches above its weight" for public investment in research into Digital Enabling Technologies.

## INNOVATION SOUTH: EXCELLENCE IN DIGITAL ENABLING TECHNOLOGIES

Digital Enabling Technologies can and are being deployed in an increasing number of sectors. They are critical to innovation, economic growth and global competitiveness for both Innovation South and the UK. Innovation South has world-class research strengths and innovation capabilities in a portfolio of five powerful Digital Enabling Technologies:



### Digital comms

including fifth generation (5G) wireless communications enabling a step change in the capacity, speed, stability and potential for innovation of internet systems.



### Cyber security

the protection of data from theft, damage or disruption. Arguably, the single largest challenge for the world's growing digital economy.



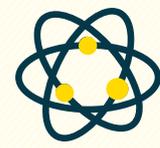
### Big data analytics

the process of collecting, organising, analysing, visualising and optimising large, complex and dispersed data.



### Photonics

involves manipulating light using lasers and optical fibres. It has revolutionised many areas including communications, medicine, aerospace and manufacturing. Fibre optic networks and developments in photonics will underpin all future communications, data and internet services.



### Quantum

quantum devices, components and systems are based on the ability to capture and manipulate single atoms and particles of light. They are critical to the long term "future-proofing" of digital enabling technologies, lower manufacturing costs and sustaining growth in computer processing speeds.

Digital Enabling Technologies

## ***Digital Communications - Regional Strength & National Asset***

The 5G Innovation Centre (5GIC), based at the University of Surrey, is the largest open innovation centre for 5G development worldwide. Key partners include major international corporates, and in 2016 5GIC was recognised by G7 nations as a global leader driving the growth and promotion of a digitally-connected world<sup>4</sup>.

This leading facility is a valuable asset not just for the South but, importantly, for the whole UK. There are plans to create regional and national test beds connected to the 5GIC core network. They include: Digital Greenwich (London); NE LEP (Northern Powerhouse); and Worcestershire LEP (Midlands Engine).

Within the region, partnerships include, investigations with Airbus and Portsmouth University to create a Satellite/5G and Big Data Innovation Centre; work with Enterprise M3 LEP to extend the 5GIC existing network of SMEs; and a DCMS-commissioned 5G network and mapping tool, involving Bournemouth Council, Dorset LEP, Ordnance Survey and the Met Office, ahead of the national roll out of 5G.

## ***Cyber Security: A global Industry; An Innovation South Speciality***

In the UK, three of the fourteen universities now recognised by Government as Academic Centres of Excellence in Cyber Security Research are in Innovation South: Royal Holloway, University of Southampton, and University of Surrey<sup>5</sup>.

Royal Holloway's Information Security Group, established in 1990, has long standing, expertise in Cyber Security research and education, endorsed by GCHQ.

## ***Big Data Analytics: Big Business; Deep Expertise***

Expertise in the South goes broad and deep: University of Reading's Institute of Environmental Analytics and partnership in Agrimetrics, the

world's first Big Data Centre of Excellence for the whole food system; Royal Holloway's specialisms in machine learning - British Gas is among its partners. The University of Portsmouth's Institute of Cosmology and Gravitation, IBM at Hursley and QinetiQ, and Dame Wendy Hall, Regius Professor of Computer Science at the University of Southampton, is jointly leading a government review of the UK's world-leading Artificial Intelligence technology.

## ***Photonics at Southampton - world-leading pioneers in lasers & optical fibres; transformers of billions of lives***

There is a concentration of photonics research expertise at several Innovation South universities, which is distinctive for its impact on everyday life and wider society. Researchers at the University of Southampton's Optoelectronics Research Centre (ORC) have been making ground-breaking discoveries in photonics throughout the centre's four decades. A device that led to the rapid expansion of the internet was developed in the 1980s, for example, and its numerous industry partners include BAE Systems, BMW, VW and Volvo. The Universities of Surrey, Kent and Sussex also have significant research strengths in photonics.

## ***Quantum***

The pursuit of quantum technologies is a national priority and universities across Innovation South are stepping up to the challenge, namely Southampton, Sussex and Royal Holloway. All are key collaborators in one or more of the four Quantum Technology Hubs.

The University of Sussex is leading work with Google and Aarhus on a breakthrough in developing a quantum computer; the University of Southampton is important in developing the industrial capacity and supply chain for quantum products and has particular expertise in the commercial exploitation of the technology with regional partners, the Government's Defence Science and Technology Laboratory (Dstl) and National Physical Laboratory (NPL), the UK's National Measurement Institute; The University of Surrey has close working links with the

<sup>4</sup>Joint Declaration by the G7 ICT Ministers, Takamatsu, Japan (April 2016).) See also notes from G7 ICT officials meeting, Brussels, 2nd December 2016 (meeting convened by Japan G7 Presidency. Chaired by Vice Minister Shigeki Suzuki and moderated by Yoichi Iida Director for International Research and Policy Coordination)

<sup>5</sup>EPSRC, Academic Centres of Excellence in Cyber Security Research scheme, <https://www.epsrc.ac.uk/research/centres/acecybersecurity/>

National Physical Laboratory (NPL). Together they formed the NPL South hub and aim to expand the quantum industry.

## DIGITAL ENABLING TECHNOLOGIES: THE OPPORTUNITIES AND THE CHALLENGES

The innovation and commercial opportunities that can flow from deploying digital enabling technologies are immense, and the UK government has clear ambitions for their development. These significant rewards will go to whichever regions and nations can address the important social, ethical, technological, economic and regulatory issues which need to be unlocked before digital enabling technologies deliver their full potential. Its outstanding industrial and research expertise, in a portfolio of five digital enabling technologies, places Innovation South in an extremely strong position to help ensure it is the UK that reaps those rewards.

## APPLYING DIGITAL ENABLING TECHNOLOGIES IN FOUR OF THE SOUTH'S KEY HIGH TECH SECTORS

### Connected Digital



The digital economy is a UK success story and the outstanding performance of the Connected Digital sector in Innovation South is essential to that. The South has a very strong concentration of large corporates within this sector, including significant international players such as Fujitsu, Huawei, Microsoft, and IBM. There are several significant and high profile clusters of digital companies, including areas with a notable concentration of high growth digital firms: Bournemouth & Poole, Brighton, and Guildford. The “prize” of a Digital Catapult located in Brighton is testimony to the area’s innovation culture. The region is demonstrating the vast opportunities to apply digital technologies across a raft of sectors and services, such as FinTech & HealthTech using cross cutting applications to diversify their business.

### Marine & Maritime



Innovation South is one of the strongest contributors to the UK’s marine and maritime industry, which, it is estimated, is similar in scale to pharmaceuticals and notably bigger than aerospace. According to the Government’s 2015 Maritime Growth Study, “The Solent’s...business base, skills, traditions, research and educational strengths, place it at the forefront of the national marine and maritime economy.” In this sector, digital enabling technologies are critical for future competitiveness, especially, robotics, sensors, big data analytics, smart ship autonomous systems, cyber and electronic warfare, human computer interaction and communication. This means together with the region’s outstanding industrial and research assets, including Lloyd’s Register, BAE Systems, QuinetiQ, Sunseeker, the National Oceanography Centre and the Marine Robotics Innovation Centre, the substantial growth opportunities in marine and maritime play extremely well to this region’s specialist strengths.

### Bioscience



Innovation in the use of digital technologies to improve health care, hospital/GP information systems, and food production and security are regional strengths. University Hospital Southampton achieved national recognition in 2016 as an IT Centre of Excellence and is improving ways of using patient data. The Kent, Surrey and Sussex AHSN<sup>6</sup> is participating in one of five national ‘test bed’ initiatives to assess the potential for new technology in health and social care, and devices have been tested at the 5G Innovation Centre.

There are around 500 Medical Technology businesses across Innovation South in disciplines ranging from medical imaging to oncology<sup>7</sup>. Prosthetics and Orthotics is a regional specialism. The global company, Blatchford, based at Basingstoke, developed the first commercially available microprocessor controlled prosthetic knee.

Technologies to control bacteria and pest threats, and the use of data and connectivity to ensure safe, efficient and sustainable food production are also being exploited by organisations such as University of Reading's Agrimetrics, the global life science companies, Bayer and Syngenta, and the Pirbright Institute.

In these areas there is significant regional and national benefit to be gained from maximising links between innovation activities.

### **Advanced Engineering**



The South has specialisms in the high-value, innovation-intensive end of engineering, and its advanced engineering capabilities are at the centre of the UK's defence and aerospace sector, where the UK has a strong comparative advantage. There are world-class and outstanding research strengths. Southampton and Surrey universities take the UK number one and two slots for particular fields of engineering research. Others are also high performers, including Greenwich, Portsmouth, and Sussex.

Innovation South has a concentration of internationally-significant engineering businesses, with a large number of aerospace & defence companies around Farnborough in Hampshire. Other types of leading-edge and research-intensive engineering firms are well-represented: Ricardo, in Shoreham supplies the McLaren Formula One team, based in Woking and there is a huge array of specialist engineering SMEs with high demand for Digital Enabling Technologies. At Bournemouth Aviation Park, for example, there is a concentration of aerospace and advanced engineering firms, including Cobham, Meggitt and Magellan Aerospace.

The South's world-class strengths in engineering research, are closely connected with the region's outstanding strengths in Digital Enabling Technologies. For example, Innovation South research organisations, TRL, the UK's Transport Research Laboratory and Thatcham Research, the motor insurance automotive research centre, are at

the cutting edge of the revolution in transport which is underpinned by connected digital and automated vehicle technologies.

## **CHALLENGES TO SUSTAINING GROWTH AND MAXIMISING INNOVATION**

This Audit confirms Innovation South has world class research and industrial capacity in a portfolio of five powerful digital enabling technologies. It also demonstrates these technologies are being deployed in four of the region's high performing sectors to drive innovation and growth. Innovation South currently has, in general, a high performing economy and is a significant asset to the national economy. It is in a strong position to step up to the challenges ahead.

Its global businesses, rooted here, its export trade, underpinned by its international transport connections, are a stand out feature of the success of Innovation South. Its labour market attracts, and currently relies on access to, high skilled international talent. As the UK reshapes its international relationships, it is critical every opportunity is seized to preserve and enhance each of these factors in the region's success.

However, this Audit has also emphasised future levels of competitiveness for both Innovation South, and its contribution to the wider UK, depend on realising a number of ambitions. This high skilled, high wage region is also high cost. Housing and commercial property prices and shortages hold back business growth in parts of the region, and national and local efforts to relieve this should continue to be a priority. Similarly, reliable and efficient road and rail connections with London (and the rest of the UK) and east-west across the South are necessary conditions for maximising the region's prosperity.

In a high cost, high value economy there is a relentless need to innovate to compete. This Audit shows that in each of Connected Digital, Marine & Maritime, Bio Science and Advanced Engineering, there is arguably an imperative and certainly great potential for Innovation South to deploy Digital Enabling Technologies to drive both cross-cutting and sector focused innovation. The preparation of

this Audit has sown the seeds of a stronger culture of regional collaboration and emphasised the value of this to maximise the region’s potential. It has been widely acknowledged that this collaboration must include businesses, universities, colleges and the public sector working more effectively together, to share ideas and resources which will make the most of the region’s advantages in digital enabling technologies and their application.

Five recommended opportunities have been identified to realise these aspirations and the Innovation South Consortium is ambitious to take these forward:

### OPPORTUNITY 1

### KNOWLEDGE-TO-MARKET ACCELERATOR



Enhancing collaboration between business, industry, universities, & other research expertise to maximise the commercial application of digital enabling technologies and ensure Innovation South is among global leaders in innovation in the digital, marine, health and life science and advanced engineering sectors.

### OPPORTUNITY 2

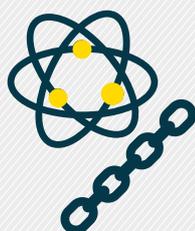
### LINKING INNOVATION HOTSPOTS



Complementing the first opportunity by enhancing, replicating and expanding the South’s excellent “innovation hotspots” (e.g. SETsquared, Wired Sussex and SinC) to develop a more powerful innovation network across the South driving new growth, underpinned by digital enabling technologies.

### OPPORTUNITY 3

### QUANTUM SUPPLY CHAIN INITIATIVE



Helping to build capacity and presence in the development of products using quantum technology in readiness for significant commercial demand. This project will not only improve the supply chain for current research into quantum technologies, but will also develop the industrial capacity needed to support the production of the first quantum products once the technologies are market-ready. The strength of defence-related activities in the region will provide an important foundation for this project.

## OPPORTUNITY 4

### DEVELOPING SME ENGAGEMENT WITH THE 5G INNOVATION CENTRE



Building the capacity and reach of the 5GIC even further, unlocking a new generation of high growth digital businesses in the South and other UK regions, fit for a global competitive market. This opportunity complements 1 & 2, and extends these facilities to SMEs and companies across the South and in other UK regions.

## OPPORTUNITY 5

### ADVANCED & SPECIALIST SKILLS IN DIGITAL TECHNOLOGIES

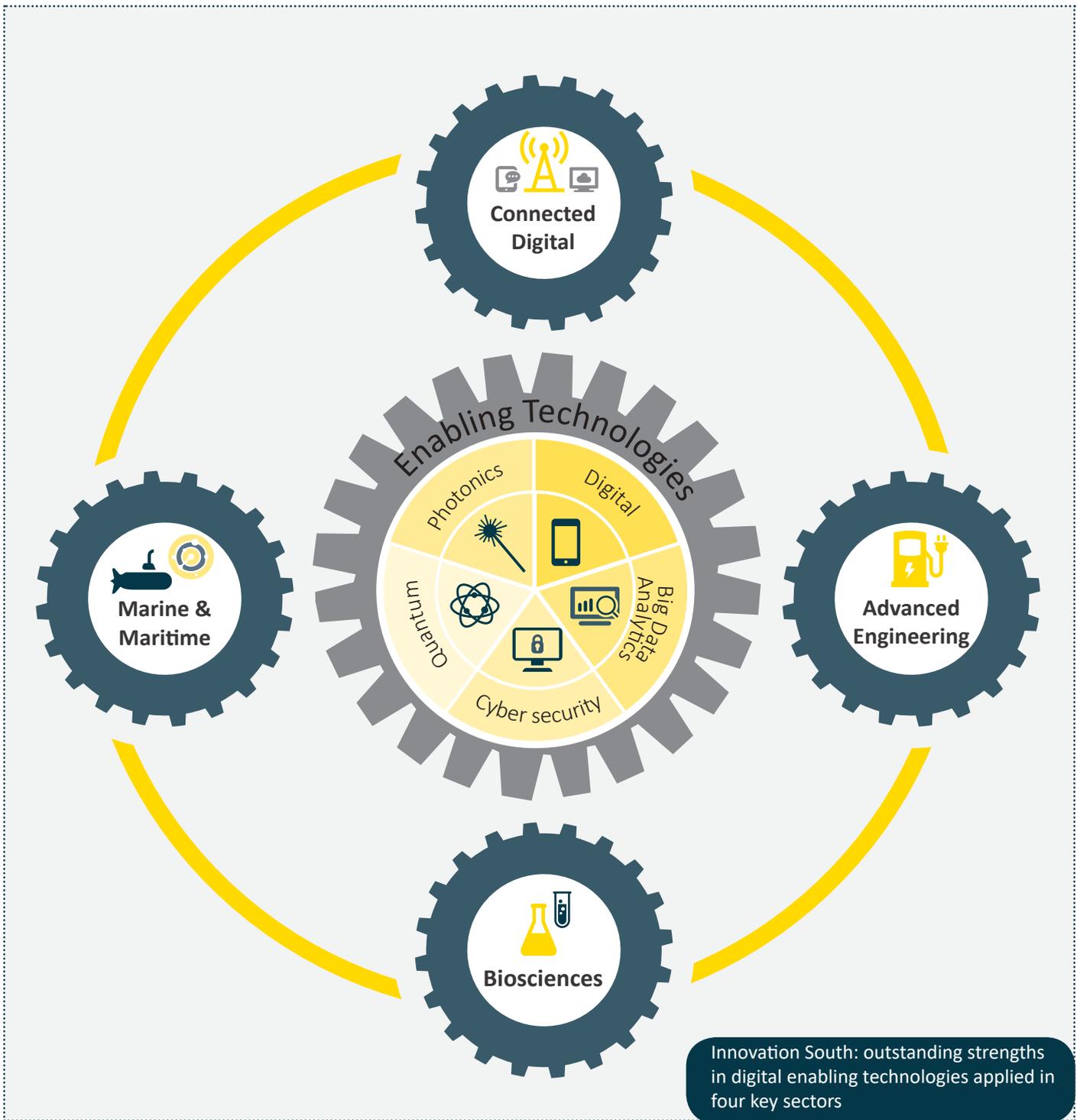


Securing a supply of high calibre digital talent which will be critical to realising the significant growth potential of applying digital enabling technologies. Fresh thinking is required to address the needs and responsibilities of employers, and ensure competition between providers does not frustrate the end goal. This project will champion and promote career opportunities linked with digital enabling technologies, provide a clearer skills evidence base which can be used by industry bodies, universities and further education, and offer a brokerage service, linking SMEs with new entrants to industry from the region's universities and further education colleges.

# 1. INTRODUCTION - INNOVATION SOUTH: A WORLD LEADER IN THE SCIENCE AND COMMERCIAL APPLICATION OF DIGITAL ENABLING TECHNOLOGIES

- 1.1 Innovation South<sup>8</sup> stands out in the UK for its expertise across a range of key digital enabling technologies. In this region, world class science in a suite of technologies, is blended with globally outstanding skills in digital creativity and design, and applied across a strong and diverse business base to drive marketable innovation. The result is already a high growth, high value, highly successful knowledge-based regional economy but the potential for further innovation and growth if all assets are successfully integrated is outstanding. Sustaining the success of Innovation South, and driving its innovation-led productivity even further, is critical to the success of the UK's digital economy and the nation's competitiveness in global markets.
- 1.2 This Science and Innovation Audit (SIA) has presented a golden opportunity to evidence and bring into sharp focus the defining strengths of Innovation South in digital enabling technologies; enhance an understanding of how those individual strengths could be consolidated to create step changes in capabilities; and to allow this insight to inspire conclusions and cost effective recommendations for taking the region and its outstanding assets further.
- 1.3 At every step, we have been wide and inclusive in our enquiries; always looking for proof, avoiding preconceptions and challenging assumptions. The Innovation South Science and Innovation Audit has been underpinned throughout by several guiding principles:
- To highlight the excellence of the science and innovation capabilities of Innovation South
  - To identify how the region's outstanding capabilities in digital enabling technologies are applied, and drive marketable innovation across every part of Innovation South
  - To demonstrate the positive impact and resonance of Innovation South on other UK regions/nations, and identify areas where new collaborations and partnerships could drive the UK's economic competitiveness. During this process, Innovation South has engaged with other Science and Innovation Audits, namely Leeds City Region on Med Tech, Glasgow Economic Leadership on Quantum, and Oxfordshire on transformative technologies. Informal engagement has been facilitated by South East LEP's direct interest in two Audits: East of England and Innovation South. These linkages are set out in more detail in Annex E.
  - To capitalise on the evidence collected and, looking forward, devise actions and interventions which will maximise the potential of Innovation South in line with the principles and ambitions set out above.
- 1.4 The specific focus of this Science and Innovation Audit report is the region's capacity to commercially exploit its excellence in a portfolio of five mutually supportive digital enabling technologies. The Audit tests the hypothesis that while others may share strengths in individual technologies, Innovation South stands out for the number and breadth of digital enabling technologies, and their widespread application. These are underpinned by world class research, supported by centres of excellence in digital creativity and adopted by a successful stock of regionally-based, innovative businesses in four high-tech sectors: Connected Digital, Marine and Maritime, Bioscience, and Advanced Engineering (see Figure 1 1).

<sup>8</sup> Innovation South covers much of southern England. The region extends along the south coast from Dorset to Kent and north to the edge of London. It is defined in terms of five complete Local Enterprise Partnership areas (Thames Valley Berkshire, Enterprise M3, Coast to Capital, Solent and Dorset) plus that part of South East LEP's geography which is south of the Thames (East Sussex and Kent & Medway).



1.5 It is testimony to both the entrepreneurial ambition of the region, and confidence in its potential, that the Innovation South Consortium embraces well over 100 individuals and organisations. The group's strength is notable for its diversity, coming from all parts of the region and public and private sectors. It includes a large body of businesses and enterprises from multinationals

through to SMEs, research organisations, including 16 universities, innovation and enterprise networks, local authorities and economic partnerships. All are bound by their commitment to Innovation South as a world leader in the science and commercial application of Digital Enabling Technologies for the benefit of the whole UK.

1.6 As of June 2017 a series of meetings have taken place with BEIS, regional LEPs and the Innovation Strategic Steering Group to discuss a) developing the profile of the Innovation South region and b) implementing the opportunities identified by the SIA. There is clear support and ambition to do both.

## WHAT ARE “DIGITAL ENABLING TECHNOLOGIES”?

1.7 Digital Enabling Technologies relate to the collection, processing, transportation, use and protection of data. In its report, “Technology and Innovation Futures 2017”, the Government Office for Science stated that:

• “the greatest future opportunities lie in enabling existing and emerging technologies to interact with each other... Our lives are being increasingly influenced by several closely related classes of technologies that allow us to sense, detect and measure what is happening around – and within – us; connect and collect the data that are being sensed or gathered from other sources; combine and mine this data to produce fresh understanding; and make this understanding accessible to inform both our individual and social activities”.

1.8 The Innovation South region has world-leading research strengths and innovation capabilities in five main Digital Enabling Technologies:



### Digital comms

including fifth generation (5G) wireless communications enabling a step change in the capacity, speed, stability and potential for innovation of internet systems.



### Cyber security

the protection of data from theft, damage or disruption. Arguably, the single largest challenge for the world’s growing digital economy.



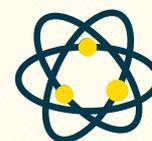
### Big data analytics

the process of collecting, organising, analysing, visualising and optimising large, complex and dispersed data.



### Photonics

involves manipulating light using lasers and optical fibres. It has revolutionised many areas including communications, medicine, aerospace and manufacturing. Fibre optic networks and developments in photonics will underpin all future communications, data and internet services.



### Quantum

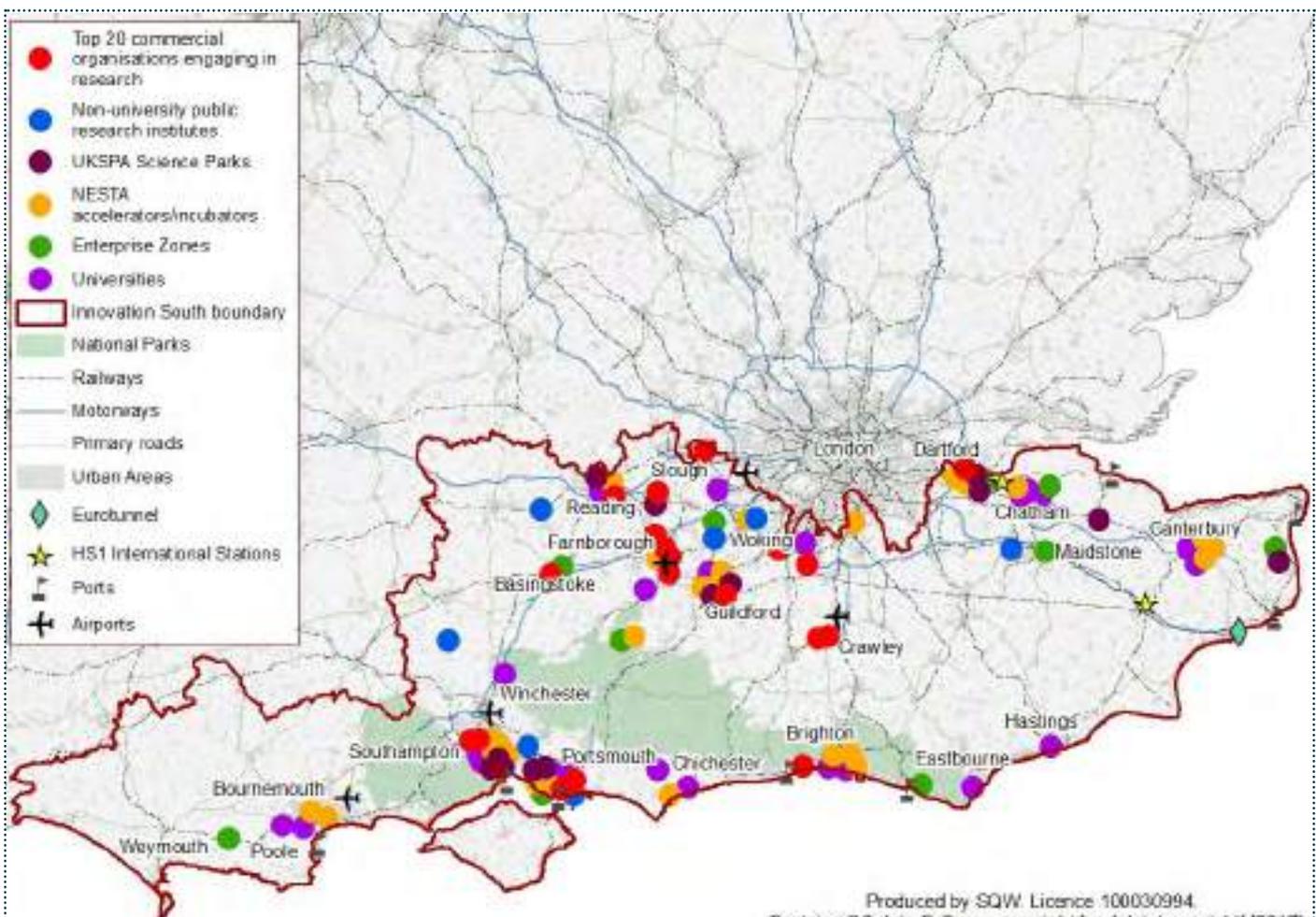
quantum devices, components and systems are based on the ability to capture and manipulate single atoms and particles of light. They are critical to the long term “future-proofing” of digital enabling technologies, lower manufacturing costs and sustaining growth in computer processing speeds.

Digital Enabling Technologies

## 2. INNOVATION SOUTH — ENGLAND'S GLOBAL REGION

### CHAPTER 2 — KEY MESSAGES

- Innovation South is a global region and a national asset
- Export performance is strong; levels of international ownership are high; its labour market attracts high skilled international talent
- The region benefits from good international and national connectivity
- Innovation South is a powerhouse of research strengths, matched by a strong culture and ethos of enterprise and innovation
- There are 16 universities and many high profile, internationally renowned research institutions
- Corporate investment in R&D in Innovation South is high
- The region is entrepreneurial and has a strong track record in commercialising research
- The South is a dynamic region for business growth with a highly skilled workforce whose productivity exceeds the national average
- There are challenges to rise to, risks to confront and opportunities to grasp in order to preserve, spread, and enhance the high performance of Innovation South both within the South and across the UK



Innovation South: Key assets

## INTRODUCTION

- 2.1 Stretching from Dorset to Kent and from Berkshire to the Isle of Wight, Innovation South covers a large part of southern England, and has a total economic output of £225.3 billion<sup>9</sup>. It is a sizeable economic area: to put it in context, it accounts for 13.7% of the UK's output<sup>10</sup> and in scale is almost equivalent to the whole of Denmark<sup>11</sup>. The region includes two National Parks and many Areas of Outstanding Natural Beauty, earning the South a reputation for a quality of life, which is a magnet for some businesses and their workforce.
- 2.2 It is a dynamic region for business growth. The concentration of active enterprises is well above England's average across most of the area<sup>12</sup>, as is the incidence of high growth firms<sup>13</sup>. It is also a location for numerous international corporations, which enjoy the advantages of the region's proximity and connectivity to London and access to international markets as well as access to international markets via the South's airports and ports, including Heathrow, Gatwick and Southampton.
- 2.3 With a population of over 8.6 million, more than one in ten people in the UK live here<sup>14</sup>. 5.3 million are of working age<sup>15</sup> and the region provides more than one in ten of the UK's jobs<sup>16</sup>. The Innovation South workforce is, in general, highly qualified<sup>17</sup> and the proportion of those working in science, research, engineering and technology is well above the national average<sup>18</sup>. Average earnings are higher than England as a whole<sup>19</sup>. In parts of the region, productivity levels are well above England averages<sup>20</sup>.

As this Audit demonstrates, the South contains world class science and innovation capabilities and there is vast potential and incentive to build on existing strengths for commercial exploitation. The economy is highly internationalised (as evidenced in, for example, international businesses maintaining global or European headquarters in the region), and benefits from its proximity to London and its infrastructure. There is a strong base of both corporates and SMEs. It is a high value economy meaning the costs of both employment and housing are also high<sup>21</sup> and these provide a strong incentive for relentless innovation, wealth creation and growth. This Audit finds good evidence that the South's capabilities in digital enabling technologies and their application are helping to drive commercial growth.

- 2.4 The Innovation South region and its economy are diverse. It encompasses six local enterprise partnership areas (Coast to Capital, Enterprise M3, Dorset, Solent, the Kent and East Sussex part of the South East, and Thames Valley Berkshire). There is no single dominant urban centre – although the region is shaped by a close relationship with London, and benefits from proximity to this dynamic and growing world city. There are strong commuting flows in both directions and London continues to be a major financial centre; the seat of UK Government; a business hub; and a focus for outstanding science in its own right. The strengths and potentials of the South are significantly influenced by its relationships with London, and the links benefit both economies.
- 2.5 Innovation South has a rich diversity of industry, business and enterprise. This diversity is a strength, which underpins a flexible and resilient economy. It is also a challenge in that expertise and innovation assets and activity are

<sup>9</sup>ONS, Regional and Sub-regional Productivity, based on NUTS3, 2015

<sup>10</sup>Ibid.

<sup>11</sup>OECD, Regional GDP, 2014

<sup>12</sup>ONS, Business Demography, 2016

<sup>13</sup>ERC Growth Dashboard data, high growth firm incidence rate (by LEP), 2012-15 (sourced via Technopolis core data)

<sup>14</sup>ONS, 2015 mid-year population estimates

<sup>15</sup>Ibid

<sup>16</sup>ONS, Business Register and Employment Survey, 2015

<sup>17</sup>ONS, Annual Population Survey, 2016

<sup>18</sup>ONS, Business Register and Employment Survey, 2015

<sup>19</sup>ONS, Annual Survey of Hours and Earnings, 2015

<sup>20</sup>ONS, Sub-regional productivity, 2016

<sup>21</sup>ONS, Annual Survey of Hours and Earnings, 2015; Land Registry, UK House Price Index, 2017

widely distributed. Interventions that aim to improve the connectivity between these assets and create greater scale and effective critical mass, which would unlock further growth in commercial innovation – are a key ambition of this Science and Innovation Audit and its outcomes.

2.6 There are strong links between businesses and the 16 universities across Innovation South. A diverse SME and corporate base benefit from an equally diverse group of excellent specialist research institutions and universities across the South as well as world-leading incubation and acceleration facilities. Together, these organisations share globally recognised excellence in scientific research; commercially adopted application of research and customer focused design; and industry accredited excellence in the delivery of high-level skills, including industry backed PhDs, pioneering digital degree apprenticeships, and specialist expertise in the creative industries. During the collection of evidence for this Audit, the frustrated desire of business and higher education stakeholders to further widen and strengthen collaboration was a recurring theme. It underlines the case for investment in action, which would facilitate a growth in working alliances to drive innovation.

2.8 There are around 4.3 million jobs within the South<sup>25</sup>. London is an important employment destination for many residents in the South and the “commuter class” pushes up the employment rates of the working population. Achieving growth in a relatively tight labour market is likely to reinforce pressures to innovate to increase productivity.

### ***The South has a highly skilled workforce***

2.9 The Innovation South workforce is educated to a higher level than the national average. Some 38% of the working age population in Innovation South is qualified to degree level or equivalent (NVQ4+), as opposed to 37% across England. 58% of the South’s workforce have at least 2 A’ Levels or equivalent; the England average is 56%. The region also has a lower than average proportion of its workforce with no qualifications<sup>26</sup>.

2.10 As Figure 2 2 illustrates, the distribution of higher workforce qualifications broadly reflects the distribution of higher productivity levels described above.

## **PRODUCTIVITY, BUSINESS AND INNOVATION IN THE SOUTH**

### ***Leading the way on productivity and talent***

2.7 In the South, overall productivity is ahead of the UK average<sup>22</sup>. The South has consistently maintained a productivity lead over the past decade, with growth rates tracking the national average. However, productivity rates diverge substantially across the region and do not all match the particularly high levels in Berkshire<sup>23</sup>, Surrey, West Sussex and north Hampshire. This level is reflected in higher than average wages in those areas<sup>24</sup>.

<sup>22</sup>Productivity, measured as gross value added (GVA) per hour worked, was £29.30 in the Innovation South area and £27.90 in the UK as a whole in 2015 (ONS Regional and Subregional Productivity, January 2017 release. Innovation South data based on NUTS 3)

<sup>23</sup>Berkshire GVA per hour worked was £36 in 2015

<sup>24</sup>ONS, Annual Survey of Hours and Earnings, 2015

<sup>25</sup>The overall jobs density ratio (i.e. the number of jobs available divided by the resident population aged between 16 and 64) of 0.81 (Technopolis core data). This is roughly the same as the national average

<sup>26</sup>ONS Population Survey via Technopolis

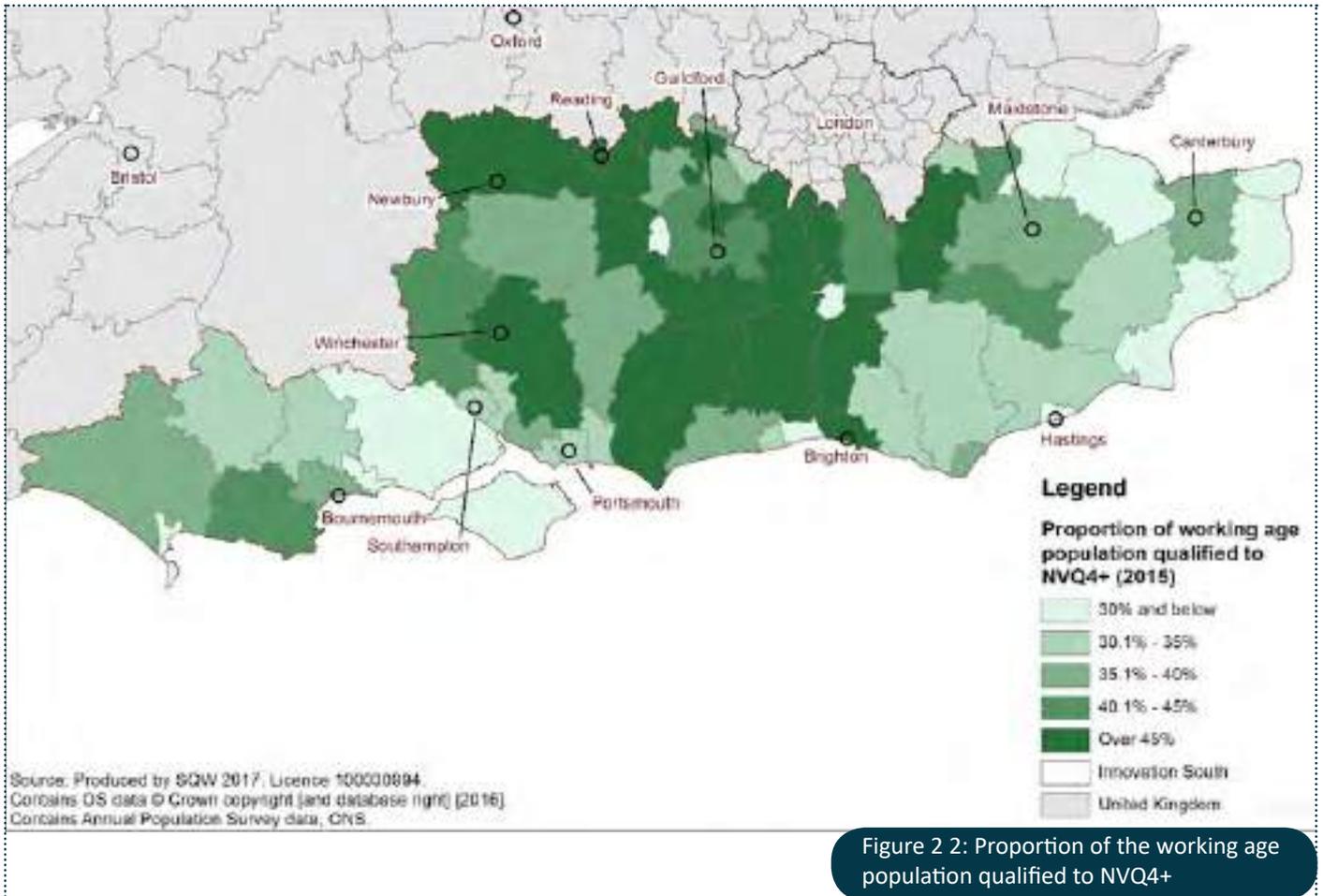


Figure 2 2: Proportion of the working age population qualified to NVQ4+

**The South has high levels of scientists, engineers and technology experts**

2.11 Across the South, around 6.7% of the workforce is employed in science, research, engineering and technology occupations, compared with around 5.4% nationally. Employment in these occupations is particularly high in Reading, where they account for around 15.8% of all employment, and in neighbouring parts of Thames Valley Berkshire<sup>27</sup>.

2.12 Qualitative evidence collected during this Audit through expert workshops and an open call for evidence suggests businesses underpinned by digital enabling technologies for their growth and innovation face particular challenges in finding the specialist skills they need. This, together with the regional variation in the prevalence of highly qualified employees, signals the need for a very targeted approach

to maintaining, spreading and enhancing the highly skilled workforce which is a hallmark of Innovation South.

**Innovation South - intrinsically international**

*The economy of the South is strongly 'internationalised', with impressive levels of foreign investment and a strong exporting culture*

2.13 The South has an internationally-focused economy. Historically, global businesses have chosen the region to locate their UK and European headquarters. Thames Valley Berkshire, for example, hosts a concentration of telecoms and IT companies, including Microsoft, Telefonica, Fujitsu and Oracle, which benefit from good transport connectivity and proximity to London.

<sup>27</sup>ONS Annual Population Survey, via Technopolis. Data relates to the proportion of the resident workforce employed in these occupations – some of whom will be employed in other locations.

2.14 Overall, the region has by far the largest share of FDI projects in the UK outside London. Over the five years to 2016, the South East region accounted for 1,029 FDI projects, around 11.5% of the UK total<sup>28</sup>. There is much variation within the geography of Innovation South: Thames Valley Berkshire performs very strongly and in 2012/13 had the highest number of FDI projects across any LEP area other than London (see also Box 2-1); but in the same year, the figure in Dorset placed it among the ten poorest performing LEP areas in England<sup>29</sup>.

2.15 There is a strong export culture among businesses. The South East accounted for £37.8 billion in exports in 2015, 14% of the UK's total exports<sup>30</sup>. However, the region's share of the UK's exporters is even higher, a little over 18%, reflecting a high propensity among businesses in the South East to export. Locally there is again some variation. Data from the LEP Network suggest that 41.7% of Solent LEP's market-based establishments with 10 employees or more exported in 2010 and the figure for Thames Valley Berkshire LEP was 36.3%, compared to a UK average of 33.0%; however it was lower for South East LEP (26.6%) and for Dorset (28.6%)<sup>31</sup>.

## BOX 2-1

## INWARD INVESTMENT INTO THAMES VALLEY BERKSHIRE

The north of the Innovation South region – particularly Berkshire – has long been a key focus for UK inward investment and is home to a large number of global ICT businesses.

Data gathered by Thames Valley Chamber of Commerce suggest that in 2015/16, there were 67 Foreign Direct Investment projects across Berkshire generating almost 1,800 new jobs – more than three times the number created in Oxfordshire through the same FDI process over the same period.

In its report, the M4 Corridor was identified as the preferred location for many of the world's most famous information technology and electronic communications businesses, notably Canon, Cisco, Computer Associates, Dell, Huawei, Microsoft, Telefonica and Vodafone. Several innovative disruptive technology firms – like Redwood Technologies, Bullitt Group, Reaction Engines, 3D Systems and Raw Talent – were also recognised. Slough was described as a “mega cluster” in recognition of the 22 datacentres located on SEGRO's industrial estate.

Looking ahead, the Chamber flagged the existing strength – and on-going investment – in connectivity. Heathrow Airport is key. In addition, Berkshire will benefit from investment in Crossrail (journey times from Maidenhead to Canary Wharf will be less than an hour); Western Rail Access to Heathrow; Smart M4; and £895m reinvestment into Reading railway station, which is helping to secure its position as a major rail hub.

[Source: *Inward Investment Results (2015/16)*, Thames Valley Chamber of Commerce Group (October 2016)]

<sup>28</sup>Department for International Trade (2016), FDI projects by UK region for 2011/12 to 2015/16. Note that the South East region covers the Innovation South area minus Dorset, plus Buckinghamshire, Oxfordshire and Milton Keynes. It is larger than the Innovation South area, but is the nearest geographical approximation for some data produced at regional level.

<sup>29</sup>Data from LEP Network Report, 2014 (sourced from then-UKTI)

<sup>30</sup>Department for International Trade (2017), Regional Goods Export Data

<sup>31</sup>Data from the LEP Network Report, 2014 (sourced from Harris, R (2013), *Inward Investment and Exporting in the LEPs: Report to BIS*, September 2013, based originally on the Community Innovation Survey, 2010)

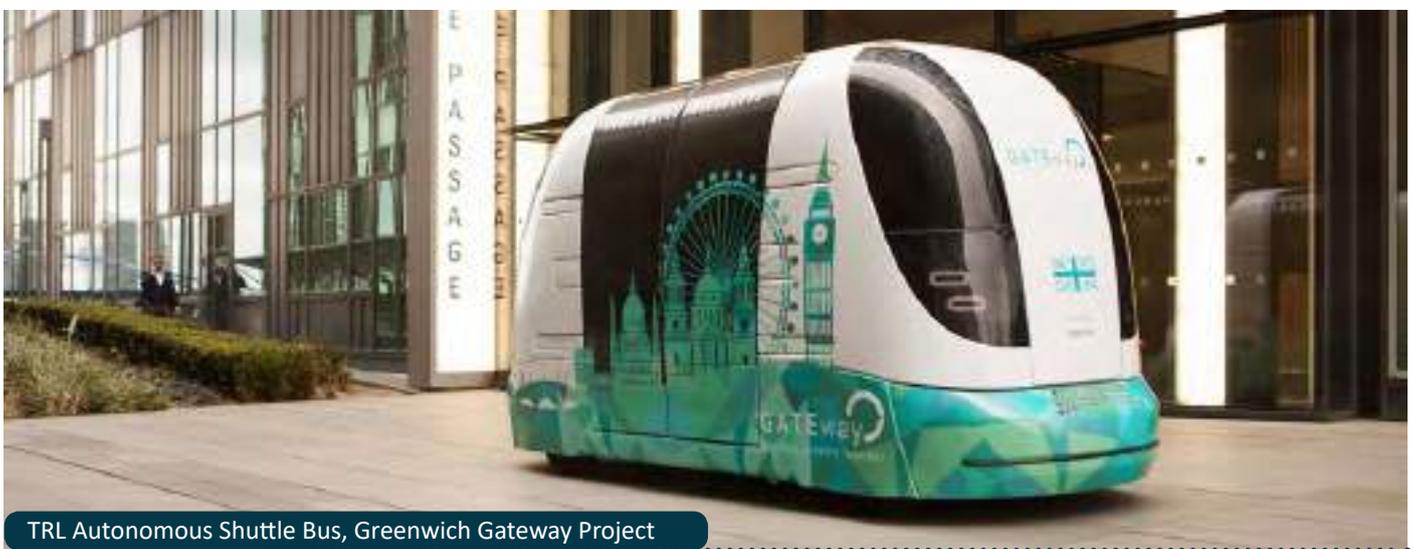
## ***Innovation South - place to set up business, grow and innovate***

*The South has strengths in science and innovation-intensive business activity*

- 2.16 There are around 391,000 active enterprises in the Innovation South area. This is equivalent to 45 enterprises per 1,000 residents, higher than the national average<sup>32</sup>. The numbers of businesses set up outweigh the numbers which fail. Start-up rates are higher than the national average in most parts of the South, and the proportion of high-growth firms within the business population is also higher than average<sup>33</sup>. Growth in the overall business stock has broadly followed the national trend over recent years.
- 2.17 Adding to the evidence of the region's outstanding capacity in digital enabling technologies, the South scores particularly highly on measures of relative concentration by business unit or employment (location quotients) in computer programming, consultancy and related activities; telecommunications; scientific R&D; and the manufacture of computer, electronic and optical products<sup>34</sup>.

## ***Innovation South universities are world class in important areas of scientific research***

- 2.18 The 2014 Research Excellence Framework, the latest official assessment of the quality and impact of university research, shows Innovation South includes universities conducting globally competitive research in science and technology. Analysis of university research activity rated 4\* (world class in terms of originality, significance and rigour) reveals high scores in areas including engineering, computer science and informatics and bioscience<sup>35</sup>.
- 2.19 The Innovation South area includes several specialist research institutions. Of particular relevance to this Audit are the National Physical Laboratory, managed in partnership with the University of Surrey; the Chilbolton Observatory at Stockbridge, owned by the Science and Technology Facilities Council; the Atomic Weapons Establishment at Aldermaston; TRL, the Transport Research Laboratory at Crowthorne; and several research facilities focused on plant and animal health, including the Pirbright Institute near Woking, the Animal and Plant Health Agency at Weybridge, and NIAB-EMR near Maidstone.



TRL Autonomous Shuttle Bus, Greenwich Gateway Project

<sup>32</sup>ONS business demography 2015. There are around 39 businesses per 1,000 residents in the UK as a whole.

<sup>33</sup>Technopolis core data

<sup>34</sup>BRES/ IDBR, analysed by Technopolis

<sup>35</sup>See Annex F

<sup>36</sup>Technopolis (2017), Innovation South: Analysis of research activity and main collaborations. For example, while institutions in the Innovation South area participated in just under 14% of all UK projects funded by the Research Councils, Innovate UK and European research programmes, they were engaged in 19% of cyber security projects.

2.20 According to analysis of publicly-funded research and innovation activity involving business and universities, the South ‘punches above its weight’ in winning backing for Digital Enabling Technologies innovation projects<sup>36</sup>.

### **Corporate investment in R&D is high**

2.21 In the South, many corporates are engaged in publicly-funded research activity. For example, in cyber security, recent analysis found that Hewlett Packard, Thales Group, BAE Systems, Intel, Cisco Systems and Microsoft had all participated in funded research and innovation activities in the region. In relation to quantum applied to advanced engineering, there have been publicly funded research collaborations with ARM, Dstl, QinetiQ, NXP Semiconductors and the National Physical Laboratory<sup>37</sup>.

2.22 Commercial business expenditure on research and development in the Innovation South area is high. The best available evidence is Government’s figures for the standard ‘South East’ region - the nearest approximation to Innovation South. With this in mind, the South East accounted for the highest level of business enterprise expenditure on R&D for any region or nation in the UK - a total expenditure of about £4.7 billion which is 22.5% of UK business enterprise expenditure on R&D in 2015<sup>38</sup>. Major commercial research and development facilities in Innovation South include those operated by QinetiQ at Farnborough, Ordnance Survey Ltd at Southampton, IBM at Fareham, BAE Systems and Surrey Satellite Technology Ltd (SSTL) at Guildford, Airbus Defence and Space at Portsmouth, Ricardo at Shoreham, NATS at Fareham, Thales UK in Reading and the many major ICT hardware and software firms (such as Fujitsu and Oracle) in the Thames Valley.

### **The region is entrepreneurial and has a strong track record in commercialising research**

2.23 The concentration of start-ups and high growth firms in Innovation South is well above average for England across most of the area<sup>39</sup>. There is also good evidence of businesses emerging from the region’s universities and research institutions to commercialise research. For example, at Surrey Research Park, technology firms such as SSTL and Detica (now BAE Systems Applied Intelligence) began as start-ups making use of university research, and have since grown into major international businesses, still carrying out their R&D in the South. The South also hosts the commercialisation arm of Dstl (Ploughshare Innovations, based at Stockbridge) and hosts a number of successful spin-outs.

2.24 The region contains an extensive innovation support infrastructure. A key – and distinctive – part of this is SETsquared, “the Global # 1 University Business Incubator”<sup>40</sup>. It has been operating for well over a decade and its work is widely applauded. It is focused around two of the region’s 16 universities, and has supported the process of spin-off and growth helping to create new generations of businesses, particularly in and around Guildford and Southampton.

2.25 The Sussex Innovation Centre (SinC) runs two incubation hubs in the South, one at the University of Sussex and one to support the fast-growing tech sector in Croydon. SinC plans to open another in Brighton soon and a Bio-Innovation Centre at Sussex University by 2019. The region contains six Enterprise Zones and 13 science parks and innovation centres supported by the UK Science Parks Association (UKSPA). Growth hubs supported by the LEPs add to the large and extended family of Innovation South business support organisations.

<sup>37</sup>Technopolis (2017)

<sup>38</sup>Data sourced through a study conducted for then-BIS found that Thames Valley Berkshire was the fourth highest ranking LEP area and Enterprise M3 was the seventh highest on “Business Enterprise R&D Expenditure (BERD) by Full Time Equivalent (FTE)” in 2013. Source: Mapping Comparative Advantages in Innovation – study by Liverpool John Moores University for the Department for Business, Innovation and Skills, March 2015

<sup>39</sup>ERC Growth Dashboard for LEPs, 2015 (via Technopolis core data)

<sup>40</sup>UBI Global Top University Business Incubator and Accelerator World Rankings 2015. UBI Global provides access to business incubation data & networks to help incubators and their partners benchmark themselves to become more efficient and competitive.

## BOX 2-2

## SETSQUARED

The SETSquared Partnership is an enterprise collaboration between the universities of Surrey, Southampton, Exeter, Bristol and Bath, established 15 years ago. The organisation is focused on the commercialisation of the universities' research and promoting entrepreneurial activities in them and their surrounding regions. SETSquared focuses on three areas:

- Student Enterprise – promoting entrepreneurship within the universities
- Research Commercialisation – promoting technology licensing, spin-out companies and research collaborations with partner companies
- Business Incubation and Acceleration – incubating spin-out companies and start-ups in the regions

Each of the five universities hosts a Business Acceleration Centre, providing physical space and entrepreneurial business support to early-stage technology ventures with high-growth potential. A fifth off the companies incubated are university spin-outs., and in its 15 years, SETSquared has assisted more than 1,000 high-tech, high-growth ventures, which have raised £1billion of investment and created 9,000 jobs.



**1,000**  
high-tech, high-growth ventures



**£1bn** investment raised



**9,000**  
jobs created

SETSquared created and is piloting the Innovation and Commercialisation of University Research (ICURE) program which enables market validation of research outputs and more rapid commercialisation of research. To date over 100 research teams from 30 UK universities have benefited.

SETSquared runs a number of open innovation activities engaging major corporations, the NHS and other stakeholder in using university research for the expansion of the UK economy and enrichment of society. In the most recent University Business Incubators (UBI) ranking of 3000+ business incubator worldwide, SETSquared is the Global #1.

An economic impact assessment completed by Warwick Economics and Development concluded that cumulative GVA of £306m could be attributed to SETSquared between 2002 and 2014, and 1,100 jobs in 2014<sup>41</sup>

## ***The South enjoys good connectivity - an important magnet for businesses and their staff***

2.26 The South is extremely well connected - a key factor in many business decisions to locate and grow here<sup>42</sup>. International connections are excellent, with good access to the main international transport hubs of Heathrow and Gatwick; as well as domestic and European airports at Bournemouth and Southampton and international rail via Ebbsfleet and Ashford. The region's ports, including Dover, Newhaven, Portsmouth and Southampton, and Eurotunnel via Folkestone are also significant gateways for freight and passengers.

2.27 Road and rail links to London are good and easy access to London, a highly valued source of customers, finance and two-way supply of skilled labour is a major asset. However, roads are often congested; trains are often overcrowded and, within the region, east-west connectivity is less efficient, both by road and rail. It is widely accepted that congestion, inhibiting the movement of people and goods directly affects productivity and growth<sup>43</sup>. The

map in Figure 2-3 below, showing desired improvements to the road and rail networks, was prepared in the region for the National Infrastructure Commission and illustrates some of the key transport investment priorities. Economic activity in Dorset (not represented on this map) is also hampered by poor infrastructure<sup>44</sup>. A focus on East West infrastructure is key to the highest performing integrated economy across the South and significant improvements to regional and national transport systems can be achieved by developments in digital technologies and advanced engineering, both subjects of this Audit.

2.28 The provision of digital infrastructure is somewhat better than in the rest of the UK: download speeds are, on average, marginally faster, and around 93% of premises are able to access broadband speeds of 30 mbps or greater<sup>45</sup>. However, substantial parts of the region – not all in rural or peripheral areas – still experience weaker broadband connectivity<sup>46</sup>.



<sup>42</sup>TVB, EM3, OxLEP, Bucks Thames Valley (2013), London Heathrow Economic Impact Study

<sup>43</sup>DfT (2016), An introduction to the Department for Transport's road congestion statistics

<sup>44</sup>Dorset LEP (2014), Transforming Dorset: Strategic Economic Plan, p.36

<sup>45</sup>ThinkBroadband, via Technopolis core data

<sup>46</sup>ThinkBroadband, 2016

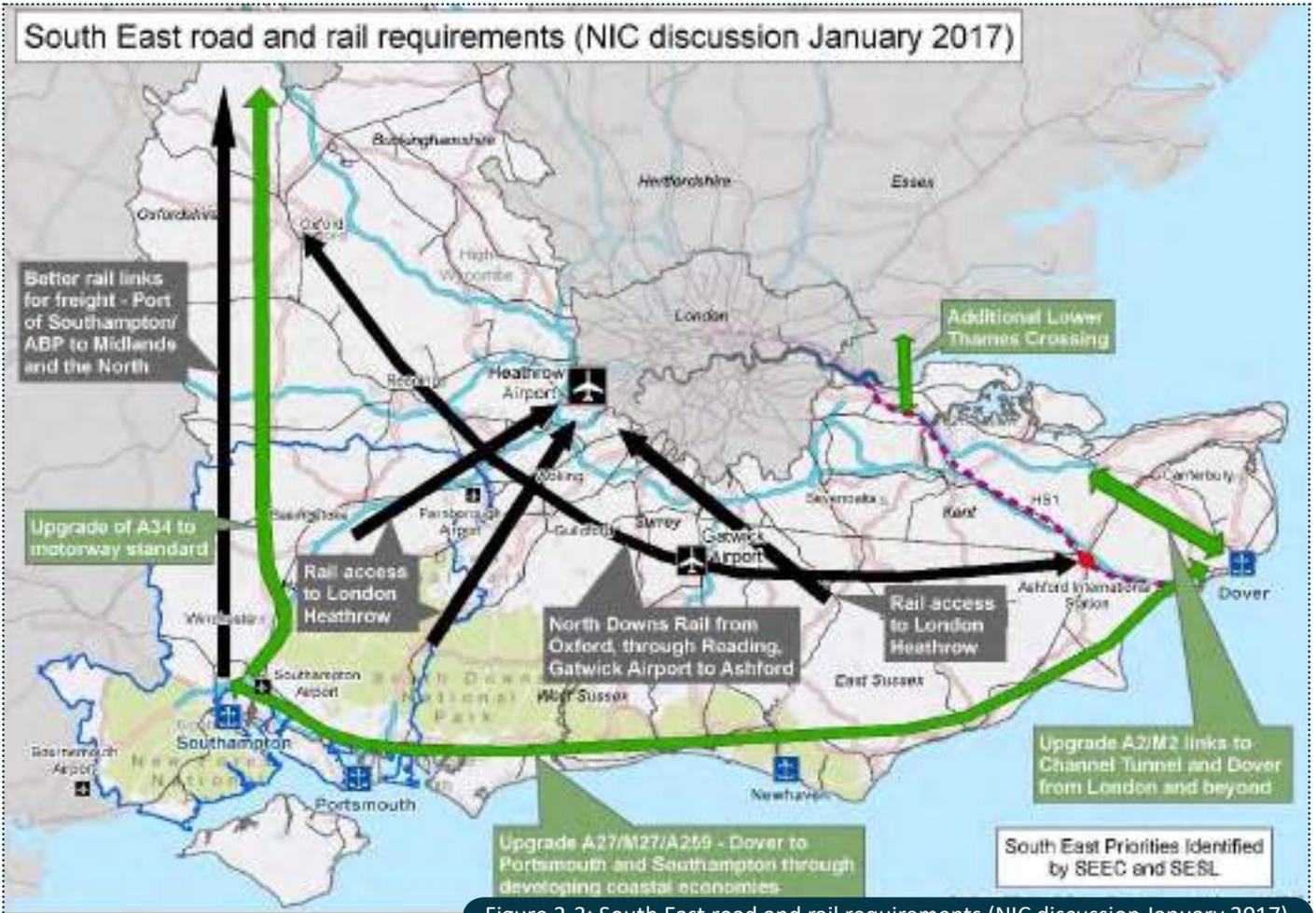


Figure 2-3: South East road and rail requirements (NIC discussion January 2017)

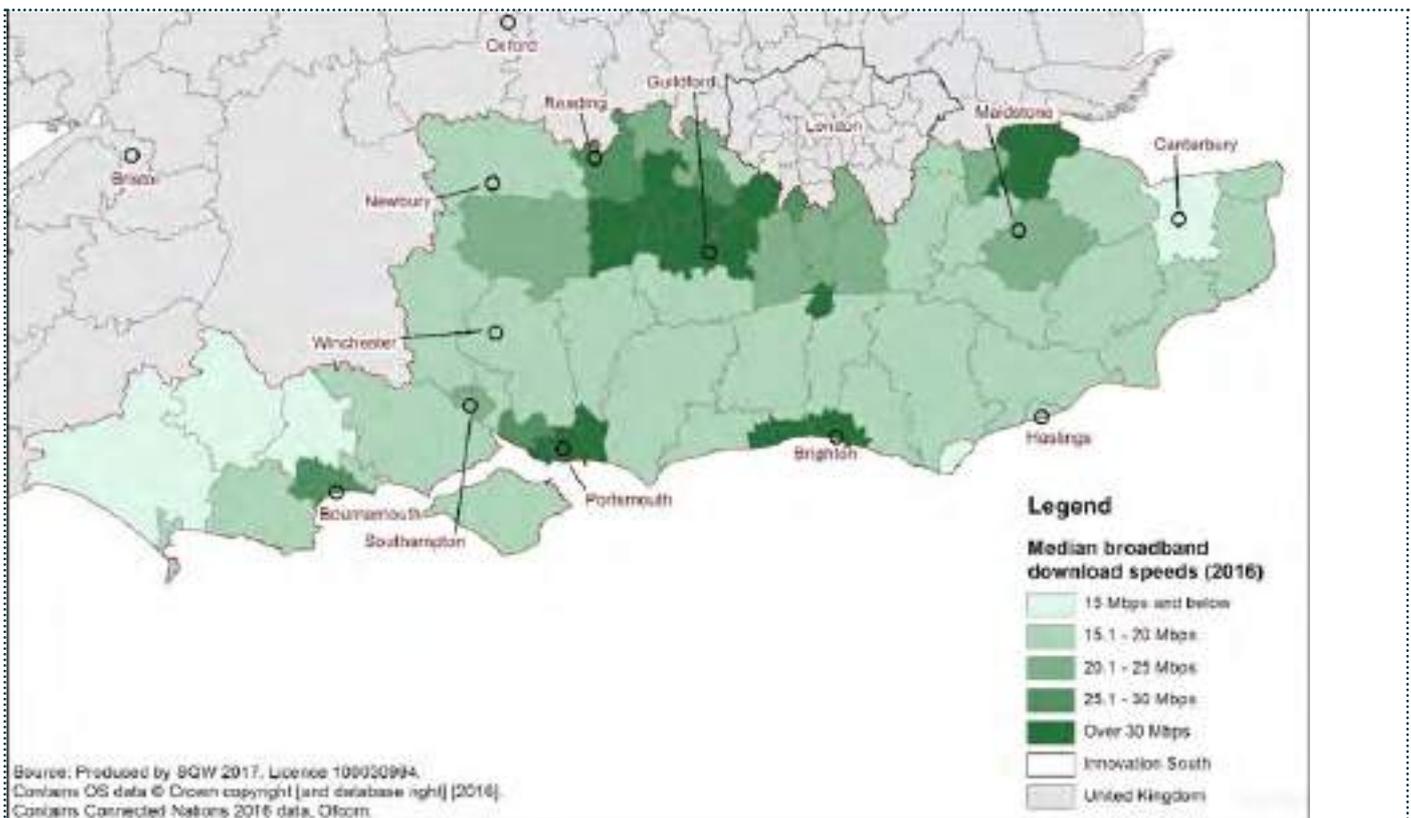


Figure 2-4: Average broadband speeds

## LOOKING FORWARD

2.29 This ‘snapshot’ of the South’s economy highlights a region that is internationally-focused with high commercial engagement in research and development and a highly skilled workforce. These factors, combined with good connections to London contribute to levels of productivity and GVA per capita that are higher than the national average. The evidence so far already points to areas where the region’s capacity to innovate might be enhanced: facilitation of wider collaboration; stronger connection between innovation support networks; a specialist skills strategy, fit for the region’s focus on digital technologies.

2.30 What further evidence supports the region’s strengths and will help create even clearer routes from research to commercialisation? Our Audit assumes the region’s expertise in Digital Enabling Technologies, both within academic research and industry, will enable the South to take advantage of the disruptive impact their development will have on many high-tech sectors thriving in the region. The following chapters test this – focusing first on the technology and the South’s strengths in developing it, and second on its impact in the connected digital, marine and maritime, bioscience and advanced engineering sectors.



<sup>42</sup>TVB, EM3, OxLEP, Bucks Thames Valley (2013), London Heathrow Economic Impact Study

<sup>43</sup>DfT (2016), An introduction to the Department for Transport’s road congestion statistics

<sup>44</sup>Dorset LEP (2014), Transforming Dorset: Strategic Economic Plan, p.36

<sup>45</sup>ThinkBroadband, via Technopolis core data

<sup>46</sup>ThinkBroadband, 2016

### 3. SCIENCE AND INNOVATION STRENGTHS IN DIGITAL ENABLING TECHNOLOGIES

#### CHAPTER 3 – KEY MESSAGES

Innovation South has world class credentials in relation to a suite of Digital Enabling Technologies relating to the collection, processing, transportation, use and protection of data

It has outstanding research strengths in universities, research institutions and in the commercial sphere in each of photonics; digital communications (including 5G); cyber security; and quantum

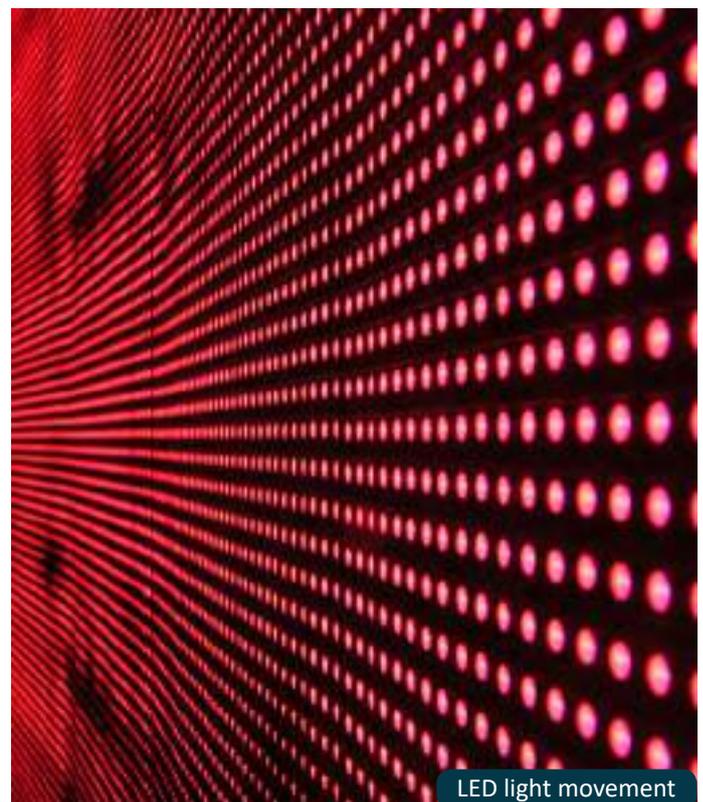
This combination of pioneering science in a range of Digital Enabling Technologies blended with outstanding skills in digital creativity and design makes Innovation South an exceptional asset for the UK

These research strengths are being successfully commercialised and over the next decade they can transform many aspects of social and economic life including the delivery of public services and industrial productivity

The advance of the global digital economy brings with it many challenges ranging from ethical issues around data to technical challenges linked to security. Organisations in the Innovation South region are leading the development of responses to those global challenges.

#### INTRODUCTION

- 3.1 Innovation South has world-class credentials in a suite of Digital Enabling Technologies (see definitions in paragraph 1.7 above). These technologies are underpinning a revolution which will transform almost every sphere of economic, cultural and social life.
- 3.2 These credentials – and the over-arching priority attached to Digital Enabling Technologies by Innovation South – are consistent with UK government priorities, as summarised below.



LED light movement

The UK government has clear ambitions about how Digital Enabling Technologies should develop and these are articulated in several policies including the green paper, *Building our Industrial Strategy* (published in January 2017), and in the *UK Digital Strategy 2017* (published in March 2017), *Next Generation Mobile Technologies – A 5G Strategy for the UK* (published in March 2017), and in the latest *Technology and Innovation Futures* report (published January 2017). Main points include:

- **Identifying digital technology enablers to drive long-term economic growth and productivity.** The latest *Technology and Innovation Futures* report concludes that “The greatest future opportunities lie in enabling existing and emerging technologies to interact with each other”.
- **Building World Class Digital Infrastructure.** The UK has good broadband and mobile infrastructure given its size and the nature of geography. However, some gaps need to be addressed. The roll-out of superfast broadband is on-going and will reach 95% household coverage by the end of 2017. However, the UK is far behind other developed nations in the deployment of fibre to premises. The National Infrastructure Commission is looking at the most advantageous approach to broadband technology deployment. Digital infrastructure is also seen as critical to other sectors so the digitalisation of the railway signalling system is a priority.
- **Improving the data infrastructure.** Physical infrastructure is insufficient to allow the digital economy to flourish. The communications over that infrastructure need to be safe and secure. This will give people the confidence to be part of the digital world, as well as giving the UK a significant competitive advantage. The Government has set up the National Cyber Security Programme to facilitate secure digital interaction.
- **Widespread access to digital Skills.** Shortage of digital skills is a constraint not just on digital industries but on most sectors that use digital technologies intensively (banking and finance, creative industries, transport, retail, etc.). An across the board improvement is needed in STEM (science, technology, engineering and mathematics) subjects, specific digital skills such as coding, and developing understanding and skills throughout business to allow sophisticated business to business digital transactions that will greatly improve efficiency in the economy.
- **Industrial Digitalisation.** Juergen Maier (UK CEO of Siemens) will undertake a review of industrial digitalisation to consider how the UK can benefit from the accelerated adoption of digital technology across advanced manufacturing.
- **Commercial opportunities for Artificial Intelligence.** This review, led by Professor Dame Wendy Hall FRS FREng, Regius Professor of Computer Science, University of Southampton and, Jérôme Pesenti, CEO of BenevolentTech, will consider how to capitalise on the UK’s world leading status in the science underpinning AI.
- **Encouraging digital business.** This is a two-pronged approach with support being put in place for new digital businesses to start and grow. The Government also wants to support the deployment of appropriate digital technologies across all businesses.
- **Focus on key digital areas.** The Government has identified supercomputing, advanced modelling and 5G networks as areas where the UK has strengths and which should be supported to ensure world class-performance in these areas continues.

- **Maintaining the position of the UK government as a world leader in digital government.** Initiatives such as gov.uk have dramatically improved the way that citizens and organisations interact with government. Whole rafts of interaction from tax returns to passport applications have been digitised making the process less expensive and more efficient. Government procurement has also been transformed with digital methods opening up significant government contracts to many more SMEs than was previously the case.

## INNOVATION SOUTH'S SCIENCE AND INNOVATION STRENGTHS IN DIGITAL ENABLING TECHNOLOGIES

• *“The analysis using national and international research funding data over the past ten years shows the Innovation South area has above UK average concentrations of research and innovation activity in the areas of Marine & maritime, Connected Digital and Advanced engineering, and in the enabling technologies of Cyber Security, Photonics, Big data, and Digital communications (5G). To that end, Innovation South can be viewed as “punching above its weight” in comparison to the UK as a whole...”* Technopolis Group, March 2017

3.3 On jobs, GVA, population – Innovation South accounts for approximately 13% of the UK economy. This is a reasonable benchmark to assess the strength of its asset base in Digital Enabling Technologies. The analysis suggests that:

- Over the period from 2004-2016, organisations in the Innovation South area accounted for £147m of **UK Funding Councils’ research funding** targeted at “*information and communication technologies*” (12% of the UK total); and £31m focused on “*optics, photonics and lasers*” (14% of the UK total)<sup>47</sup>
- Organisations within the geography of Innovation South accounted for 15% of **European Commission funding (through Horizon 2020) received in the UK** linked to the ICT programme; in absolute terms, this

amounted to 31.3m euro from 2014-2017<sup>48</sup>

- Organisations within Innovation South accounted for 20% of the **innovation grants (by value) offered by Innovate UK across the UK** in the digital domain; and 15% under the heading of ICT<sup>49</sup>
  - Inventors within the geography of Innovation South were responsible for 16% of **UK patents** in the sphere of “*digital communication*”<sup>50</sup> This demonstrates that the region accounts for a significant share of the entire UK asset base, particularly in those elements relating to invention and innovation.
- 3.4 Innovation South is a big region. On key metrics, its share of science and innovation assets within the ambit of the Audit is, in general, bigger again.

## DIGITAL COMMUNICATIONS

• *“The development of 5G presents a significant economic opportunity and this world-leading centre will position the UK at the forefront of research into the next generation of communications technology”* Minister for Science, Jo Johnson, at the formal opening of the 5G Innovation Centre at the University of Surrey, 15 September 2015

- 3.5 In the domain of digital communications, the region stands out particularly, in terms of the pioneering work led by the 5G Innovation Centre (5GIC). Based at the

<sup>47</sup>Source: Gateway to Research

<sup>48</sup>Source: E-Corda

<sup>49</sup>Source: Innovate UK

<sup>50</sup>Source: European Patent Office data, PATSTAT.

University of Surrey, the 5GIC currently houses over 170 researchers, making it Europe's largest academic research group in mobile communications and future internet. In 2016, 5GIC was recognised by G7 nations as one of the global leaders driving the growth and promotion of a digitally-connected world. G7 ICT ministers highlighted the centre for its real potential to maximise the benefits of ICT to drive economic growth and employment across the world<sup>51</sup>.

3.6 The 5GIC is based on a close collaboration between major international corporates and academic researchers. In the view of SIA workshop participants, this mix of corporate interest and academic expertise is one that can be most successfully achieved in the South due to the ideal balance of corporate and SME/start up activity in the region. The 5G Innovation Centre provides a model of how

to fuse cutting edge science and research activities with industry and companies (large and small) to generate commercial ideas as well as the role of a local enterprise partnership (in this case Enterprise M3) in bringing together public, private and HE partners. Key regional partners in addition to Enterprise M3 LEP are: Digital Greenwich (London); NE LEP (Northern Powerhouse); and Worcestershire LEP (Midlands Engine). Also, Surrey is already collaborating with a number of other Universities with expertise in 5G and 5G applications in key sectors including health, transport, and creative industries. Current relationships include, Bristol, Kings, Warwick, Newcastle and Queens Belfast, with more collaborations planned. This broader network of activity will help maximise the benefit and impact of this investment for the UK. A synopsis of the 5GIC is provided below.

## BOX 3-2

## 5G INNOVATION CENTRE

Formally opened in September 2015, the 5G Innovation Centre (5GIC) in Guildford is a £75m industry-academic partnership. Key partners include EE, Huawei, O2, Vodafone, HEFCE, Enterprise M3 LEP, TEOCO Corporation, BBC, BT, Cobham, Anite, Ascom, Digital Catapult, Fujitsu, Rohde & Schwartz, Samsung, Roke, McLaren Applied Technologies, Ofcom, Imagination Technologies, ITRI, MYCOM OSI, Three and Ordnance Survey.

The 5GIC provides practical experimental facilities for researchers working on emerging 5G technologies covering mobile and wireless communications, the Internet of Things and connected cars<sup>52</sup>. As part of the University of Surrey's Institute for Communication Systems, 5GIC is the largest academic research group in mobile communications and future internet in Europe, with over 170 researchers, 25 contributing members and a network of 50 communication technology SMEs<sup>53</sup>.

Based around a 4km<sup>2</sup> 5G testbed, the centre also has dedicated laboratories which provide specialist facilities for network testing and management, and communication electronics<sup>54</sup>. In December 2016, 5GIC launched the 5G mobile network emulator at the Basing View innovation hub in Basingstoke in partnership with SETsquared, Basingstoke and Deane Borough Council and high-tech start-up Gematech, with funding from Enterprise M3 LEP. The emulator will allow start-ups and businesses working on mobile applications to develop systems capable of operating on the 5G system and will be accessed through SETsquared's digital hubs as part of its Digital Business Acceleration Hub programme<sup>55</sup>.

<sup>51</sup>See G7 Opportunities for Collaboration – available at [http://www.japan.go.jp/g7/\\_userdata/common/data/000416960.pdf](http://www.japan.go.jp/g7/_userdata/common/data/000416960.pdf). See also notes from G7 ICT officials meeting, Brussels, 2nd December 2016 (meeting convened by Japan G7 Presidency. Chaired by Vice Minister Shigeki Suzuki and moderated by Yoichi Iida Director for International Research and Policy Coordination)

<sup>52</sup>University of Surrey 5G Innovation Centre response to Innovation South Science and Innovation Audit Call for Evidence, March 2017

<sup>53</sup>University of Surrey 5G Innovation Centre website, 'About Us' (accessed via: <https://www.surrey.ac.uk/5gic/about>). Note that over the next 12 months, the plan is to increase the number of SME members to more than 100

<sup>54</sup>University of Surrey 5G Innovation Centre website, 'About Us' (accessed via: <https://www.surrey.ac.uk/5gic/about>)

<sup>55</sup>SETsquared website, 'Pioneering mobile tech facility opens following Chancellor's call to make UK a world leader in 5G' (accessed via: <http://www.setsquared.co.uk/news/201612/pioneering-mobile-tech-facility-opens-following-chancellor%E2%80%99s-call-make-uk-world-leader-0>)

On a national basis, the 5GIC is working closely with DCMS, Treasury, the Engineering and Physical Sciences Research Council and other partners to develop a national framework to provide large-scale 5G demonstrators in sectors such as Transport, Health, Cyber security and Agritech. Government has allocated approximately £175m from 2017/18 through to 2020/21 to support this activity and 5GIC will play an active role in its delivery.

5GIC is currently the world's largest open innovation research and development facility.



5G Innovation Centre, University of Surrey, Guildford

### ***Surrey's 5GIC – supporting growth and innovation North, East, West and South***

- 3.7 Having established this world leading 5G facility the next phase of development will focus on the creation of regional and national test beds connected to the 5GIC core network. These test beds will range from small facilities in business incubation centres to allow direct access by SMEs to large scale programmes in other regions and cities to demonstrate applications in key market sectors. This will facilitate the exchange of ideas in different locations around the country. Key partners in addition to Enterprise M3 LEP are: Digital Greenwich (London); NE LEP (Northern Powerhouse); and Worcestershire LEP (*Midlands Engine*).
- 3.8 Within the South, there are discussions with Airbus and Portsmouth University on the creation of a Satellite/5G and Big Data Innovation Centre at Portsmouth. The 5GIC will work to extend its existing network of SMEs to approximately 100 with an increasing focus on supporting company scale-up opportunities with the regional digital economy as part of an Enterprise M3 Scale-Up programme. In addition, the 5GIC is already in a formal partnership with the Digital Catapult Hub in Brighton and will be working closely with the Creative/Gaming sector there.
- 3.9 One specific example which will be launched in July 2017 is the world's first 5G Digital Gaming support facility. This will provide

### BOX 3-3

### BOURNEMOUTH'S 5G TEST BED WITH ORDNANCE SURVEY

Ordnance Survey, Britain's mapping agency and digital business is headquartered in Southampton. It has been commissioned by the Department of Culture, Media and Sport to develop a 5G network planning and mapping tool together with the Met Office and the 5G Innovation Centre at the University of Surrey. This is being piloted in Bournemouth in preparation for the national rollout of 5G.

Mobile network planners need to take into account the location of things that are likely to weaken or block the signal from their masts - trees, buildings, lamp-posts, for example. This is going to be particularly important for 5G, which uses high-frequency radio waves that do not travel as far as those used for 4G.

Ordnance Survey's tool will allow 5G planners to construct a virtual network to test broadcast range and reliability through the seasons and over the coming years. Weather conditions, tree foliage, vegetation life cycles, and details of future building projects are included in the model's intelligence.

To make the project a success, Bournemouth Council has forged a close working partnership with Ordnance Survey, and with Dorset LEP on how local authorities can work together to trial a 5G network. The Council are seizing the opportunity to work with Ordnance Survey to understand the different applications of the 5G tool to support the delivery of public infrastructure. AS one of the first areas to deploy a 5G network into the UK is also expected to attract more technology companies into Bournemouth, helping it to build on its success as home to the largest number of high-growth digital businesses in the UK.

Guildford and Aldershot's digital gaming cluster with unique access to the latest mobile internet technologies. 5GIC members have already committed an additional £5m to this programme.

## CYBER SECURITY

- 3.10 Cyber Security has become a global industry. In the UK, it is shaped by the government's National Cyber Security Strategy entitled "*Protecting and promoting the UK in a digital world*". Three of the fourteen universities now recognised by Government as Academic Centres of Excellence in Cyber Security Research (ACE-CSR) are in Innovation South: Royal Holloway, University of Southampton (through "Cyber Security Southampton"), and the University of Surrey (through the Surrey Centre for Cyber Security). A brief synopsis of the credentials of Royal Holloway's renowned Information Security Group are provided below.

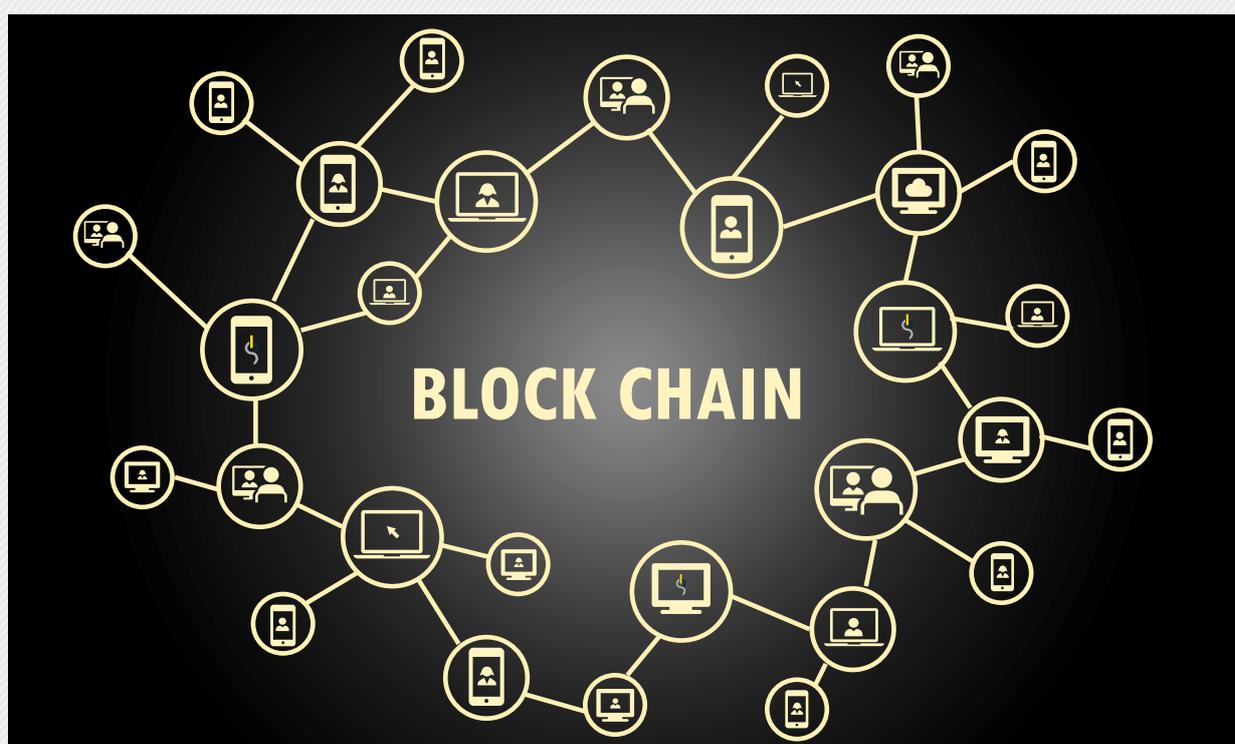


## BOX 3-4

## ROYAL HOLLOWAY INFORMATION SECURITY GROUP

Royal Holloway Information Security Group Founded in 1990, the Royal Holloway Information Security Group (ISG) is a GCHQ/EPSRC recognised Academic Centre of Excellence for Cyber Security Research (ACE-CSR). It hosts one of only two UK, National Cyber Security Centre (NCSC) supported Centres for Doctoral Training in Cyber Security (CDT), and its MSc in Information Security (launched 1990) is recognised by GCHQ/NCSC.

The ISG has 20 permanent research-active members of academic staff, 10 visiting professors and numerous consultants. ISG research areas include, conventional and post-quantum cryptography; computer and software systems security; IoT and vehicular security; critical infrastructure security and testing; human aspects and privacy; smart cards, smartphone, hardware and embedded systems security; network, communications, access and cloud security; blockchain<sup>56</sup> and big-data integrity and privacy.



ISG research facilities include the Smart Card and IoT Security Centre, founded in 2002 with support from Giesecke & Devrient, and Vodafone, which researches into security issues associated with smart cards, mobile devices, RFID, near field communication and general embedded/implementation systems<sup>57</sup>. The Systems Security Research Lab (S2RL) was founded in 2014 and researches into novel techniques and community tools to protect systems from a broad range of threats, particularly from malicious software. S2RL has received support from EPSRC, Intel and EU-FP7.

The ISG also works with many industry partners and governments on sponsored research and consultancy, for example a recent project with GE Aviation to identify security requirements for wireless avionics, and an interdisciplinary project sponsored by GSK to investigate why employees click on phishing links<sup>58</sup>.

<sup>56</sup>Blockchain technology is viewed as one of the key building blocks for the global economy. Encryption used on blockchains like Bitcoin and Ethereum is industry standard and has never been broken. They are 'cryptographically auditable', which means you can be mathematically certain that their entries have not been forged. Also because blockchains are copied across thousands of computers they are incredibly robust. Even if a large number of individual computers were taken offline, the records would remain accessible and the network could rebuild itself.

<sup>57</sup>ISG Smart Car and IoT Security Centre website (accessed via: <http://scc.rhul.ac.uk/>)

<sup>58</sup>Royal Holloway Information Security Group response to the Innovation South call for evidence, March 2017

## BIG DATA ANALYTICS

3.11 Big data – datasets that are so large and complex that conventional data processing software is unable to manage them – is itself a *consequence* of the explosion of digital enabling technologies, as data are generated by mobile devices, wireless sensors, virtual reality applications, and so on. While data volumes have, according to McKinsey, doubled in three years, storage capacity has greatly increased and storage costs (through the advent of cloud computing) have fallen<sup>59</sup>. Potential gains from the effective use of the data apply to all parts of the economy, both those highlighted in this Audit and sectors (such as retail) which have been quick to spot the commercial potential of the increased volume of customer data.

3.12 The South has considerable depth of expertise in this field. Academics at the University of Southampton were integral to the formation of the Open Data Institute; the University of Southampton also hosts the Administrative Data Research Centre for England<sup>60 61</sup>; the University of Reading has particular expertise in agrimetrics and has the Institute of Environmental Analytics; Royal Holloway has specialisms in machine learning; and the University of Portsmouth has the Institute of Cosmology and Gravitation. In addition, the corporate sector has significant depth of expertise – IBM at Hursley and QinetiQ are two examples.

### BOX 3-5

### DEPARTMENT OF COMPUTER SCIENCE, ROYAL HOLLOWAY

Royal Holloway's Department of Computer Science is one of the UK's leading centres for research into algorithms and complexity, distributed and global computing, machine learning, and software language engineering. This research profile allows the Department to offer a full spectrum of activity from cloud physical infrastructure and middleware through to machine learning-based data analytics and artificial intelligence, which has been generating many collaborations with industry and organisations, an example of which is the partnership with Centrica established in 2013.

Research in Machine Learning at Royal Holloway started in the 1990's. Since then, the Department has developed both fundamental theory and practical algorithms that have fed into the analytics methods and techniques that are in use today – for example, several patents granted to Google and other companies cite Royal Holloway publications.

Examples of industrial applications include automated target identification (with QinetiQ), fault diagnosis (with Marconi Instruments/FRI), biomarker discovery (with CIPHERGEN Biosystems), anomaly detection (with Thales UK), missing values and imputation (with Office for National Statistics), abdominal pain treatment (with Western General Hospital, Edinburgh), smart meter analysis (with British Gas).

More recently, strong collaborations have also been established with Facebook, Google, IBM and NASA in areas such as concurrency control, large-scale and cloud-based systems, cognitive and autonomous agents, and automated planning, scheduling and domain-independent search control with applications in surveillance operations, disaster response missions, and space operations.

<sup>59</sup>Nicolaus Hencke et al (2016), The Age of Analytics: Competing in a data-driven world, McKinsey Global Institute

<sup>60</sup>The Administrative Data Research Centre for England is led by the University of Southampton and run in collaboration with the Institute for Fiscal Studies, the London School of Hygiene and Tropical Medicine, the Office for National Statistics, and University College London

<sup>61</sup>This combines exceptional physical facilities with high performance computer platforms to provide knowledge and evidence to help develop, implement and evaluate public policy and future research. The organisations that make up the Centre are leaders in linking data and have world-class expertise in using and analysing administrative data from the education, health, crime, environment, economic and welfare sectors.

Royal Holloway's Machine Learning Group (principally Gannerman, Vovk, Luo, Kalnishkan and Watkins) have received regular funding from EPSRC often in collaboration with the Department of Information security (e.g. current funding of £604K has Cavallaro (ISG) as PI) but in recent years European funding has become equally important as has funding from industry and other research councils where machine learning is applied to interdisciplinary problems. Significant funding (>£3.5million) has been attracted from the EPSRC, EU, BBSRC, MRC, Veterinary Laboratories Agency, the Leverhulme Trust, and industry over the last ten years.

The Department has also been making substantial contributions to the development of skills in the critical area of data analytics: former MSc and PhD students are pursuing successful careers at leading companies and organisations such as Amazon, Centrica, EY, Google, Facebook, Microsoft, Office for National Statistics, QuintilesIMS, Rolls-Royce, Shell, UBS, VMWare and Xerox; others are enabling smaller companies to thrive in this competitive market. The recent launch of an MSc in The Internet of Things, the first in the UK, will extend the scope of the Department's contribution to skill development in this fast expanding area.

3.13 Accenture estimates Artificial Intelligence could add up to £654bn to the UK economy by 2035. Regius Professor of Computer Science at the University of Southampton, Dame Wendy Hall, also Executive Director of the Web Science

Institute, has been chosen by Government to lead a review of the UK's sector with Jérôme Pesenti, CEO of BenevolentTech and a world-leading pioneer in the commercialisation of AI.



Machine Learning

## BOX 3-6

## WEB SCIENCE INSTITUTE

The Web Science Institute is an entrepreneurial not-for-profit research institute at the University of Southampton<sup>62</sup> which was launched in 2013.<sup>63</sup> It is highly inter-disciplinary in nature, and has as its broader aims the maximisation of social, cultural, economic and developmental impacts of Web technologies.<sup>64</sup> It realises these aims through conducting research and providing intelligence to government, the business world and civil society that can lead to insightful decisions in these realms. Its mission is to bridge the state of evolving technology with patterns of social and organisational behaviour, creating an integrated picture of these two dimensions.

Given the realms it aims to influence, in addition to research and educational endeavours, the Web Science Institute pursues enterprise initiatives.<sup>65</sup> In aiming for highly relevant societal impact, the Institute has generated research that has led to applicable commercialisation of knowledge and spin-out businesses, which include: Garlik, which protects consumers from identity theft and fraud,<sup>66</sup> The Open Data Institute, W3C PROV Working Group, E-Prints Services.<sup>67</sup>

The Institute was led by Web Science pioneers, Professor Dame Wendy Hall and Professor Sir Nigel Shadbolt (now at University of Oxford). Professor Dame Wendy Hall led a team, just before the Web emerged, to create Microcosm, a system that allowed users to browse collections of hypermedia information from text to sound and video.<sup>68</sup>



Professor Dame Wendy Hall

## PHOTONICS

- 3.14 The concentration of expertise in photonics research at several Innovation South universities is outstanding.
- 3.15 Photonics is the physical science of light (photon) generation, detection, and manipulation through emission, transmission, modulation, signal processing, switching, amplification, and detection/sensing. Its most important application has been combining high

speed lasers and optical fibres to enhance the capacity of communications links. Great strides have been made in the capacity of optical fibres as communications channels with rapid transmission speeds (well into the multiple Tbit/s speed range) over a single fibre by using wave division multiplexing (which means sending simultaneous signals over the same fibre at different frequencies). Optical fibre and optical device technologies will provide the essential backbone for future mobile and internet communication networks.

<sup>62</sup>Web Science Institute, University of Southampton, Available at: <http://www.southampton.ac.uk/wsi/about/index.page?>, accessed on 24.04.2017

<sup>63</sup>University of Southampton, 'New Web Science Institute to explore how the Web will shape our future', published 8 November 2013, available at: <http://www.ecs.soton.ac.uk/news/4365>, accessed on 24.04.2017

<sup>64</sup>UK Parliament, Parliamentary Digital Service Blog, available at: <https://pds.blog.parliament.uk/2016/11/14/building-networks-of-support-visiting-the-web-science-institute-at-university-of-southampton/>, accessed on 24.04.2017

<sup>65</sup>University of Southampton, 'New Web Science Institute to explore how the Web will shape our future', published 8 November 2013, available at: <http://www.ecs.soton.ac.uk/news/4365>, accessed on 24.04.2017

<sup>66</sup>Naomi Atkinson, 'University of Southampton – Web Science', The impact made by UK Academic Computer Science Research, available at: <http://cs-academic-impact.uk/the-web/>, accessed on 24.04.2017

<sup>67</sup>Web Science Institute, University of Southampton, Available at: <http://www.southampton.ac.uk/wsi/about/index.page?>, accessed on 24.04.2017

<sup>68</sup>Naomi Atkinson, 'University of Southampton – Web Science', The impact made by UK Academic Computer Science Research, available at: <http://cs-academic-impact.uk/the-web/>, accessed on 24.04.2017

3.16 Nationally, REF 2014 includes 56 impact case studies relating to photonics. Twelve of these came from universities within Innovation South, and the University of Southampton alone accounted for seven: the largest number of photonics-related impact case studies<sup>69</sup> from any university in the UK. The University of Surrey and the University of Kent both contributed two, while the University of Sussex contributed one.

3.17 This points to both the concentration of research expertise in the South, and its application. The University of Southampton's Optoelectronics Research Centre (ORC) has a strong reputation in photonics research with groups focused on optical materials, optical fibres, light generation and manipulation, optical networks and systems, biophotonic microsystems and fundamental photonics. A more detailed account is provided in Box 3-7 below.

### BOX 3-7

### PHOTONICS AT THE UNIVERSITY OF SOUTHAMPTON

Photonics research has a strong tradition at the University of Southampton. It has a strong and successful industry focus and is mainly conducted in two multi-disciplinary research centres:

- The Zepler Institute is the largest photonics and electronics institute in the UK.<sup>70</sup> It has over 350 researchers with more than 100 laboratories.<sup>71</sup>
- The Optoelectronics Research Centre, formed in 1989, leads photonics research spread across 30 multi-disciplinary research groups, with more than 200 staff and student researchers.<sup>72</sup>

Both centres are characterised by a strong industry-orientated approach to their research. The Zepler Institute generates, on average, 15 patents a year, while the Optoelectronics Research Centre typically files around 20 patents a year.<sup>73</sup> Both centres have also been a source of at least ten spin-off businesses.<sup>74</sup>

Photonics research carried out at the Optoelectronics Research Centre was judged to be outstanding through the Research Excellence Framework (REF 2014)<sup>75</sup> Researchers publish over 250 papers and give 25 plenary talks at conferences a year on average.<sup>76</sup> The Zepler Institute displays a strong research component, generating on average 372 publications per year.<sup>77</sup>

Harnessing the University of Southampton's expertise in this field, the Zepler Institute, is to link up with the EPSRC National III-V Centre at the University of Sheffield to form the Future Photonics Hub, a £10million future manufacturing research centre funded for the next seven years.<sup>78</sup> Using photonics research and applications, the hub aims to boost the UK's manufacturing industries by the rapid commercialisation of emerging technologies.<sup>79</sup>

<sup>69</sup>Impact case studies were submitted as part of the 2014 Research Excellence Framework (REF). Broadly, the case studies outline changes and benefits to the UK economy, society, culture, public policy and services, health, the environment and quality of life and impacts in these sectors beyond the UK

<sup>70</sup>Zepler Institute, available at <http://www.zeplerinstitute.ac.uk/about-us>, accessed on 13.04.2017

<sup>71</sup>Ibid.

<sup>72</sup>Optoelectronics Research Centre, available at <http://www.orc.soton.ac.uk/community.html>, accessed on 13.04.2017

<sup>73</sup>Zepler Institute, available at <http://www.zeplerinstitute.ac.uk/facts-and-figures>, accessed on 13.04.2017; Photonics Research, Optoelectronics Research Centre, University of Southampton, Available at: <http://www.orc.soton.ac.uk/research.html>, accessed on 12.04.2017

<sup>74</sup>Zepler Institute, available at <http://www.zeplerinstitute.ac.uk/facts-and-figures>, accessed on 13.04.2017; Photonics Research, Optoelectronics Research Centre, University of Southampton, Available at: <http://www.orc.soton.ac.uk/research.html>, accessed on 12.04.2017

<sup>75</sup>Ibid

<sup>76</sup>Ibid

<sup>77</sup>Zepler Institute, available at <http://www.zeplerinstitute.ac.uk/facts-and-figures>, accessed on 13.04.2017

<sup>78</sup>The Future Photonics Hub, available at: <http://photonicshubuk.org/capability/>, accessed on 13.04.2017

<sup>79</sup>'Southampton to lead £10 million national Manufacturing Hub', University of Southampton, Published 24 November 2015, Available at: <http://www.southampton.ac.uk/news/2015/11/future-photonics-hub.page>, accessed on 12.04.2017

## QUANTUM

- 3.18 The pursuit of quantum technologies is a national priority and a “*National Strategy for Quantum Technologies*” was launched by the EPSRC in 2015. Scientific expertise in relation to quantum technologies is distributed widely across universities nation-wide, but the University of Southampton, University of Sussex and Royal Holloway are among those universities stepping up to the national challenge.
- 3.19 Four Quantum Technology Hubs have received substantial research funding nationally – and the universities of Southampton and Sussex, and Royal Holloway, are key collaborators. One Hub in sensors and metrology (led by the University of Birmingham) involves the University of Southampton and University of Sussex. Both universities are collaborators in a second Hub which is focused on information technologies (led by the University of Oxford). Royal Holloway is a collaborator in a third Hub which focuses on communications technologies (led by the University of York).
- 3.20 There is a new “*National Centre for Superconducting and Hybrid Quantum Systems*” in the process of being set up at Royal Holloway with funding from EPSRC and a second EPSRC project at the University of Surrey. The University of Sussex is leading on the design of Quantum Computers.
- 3.21 Innovation South is well represented among the 106 impact case studies recorded in REF 2014. Each of the universities referenced above has between two and four submissions linked to quantum technologies. The University of Surrey contributed a further two.
- 3.22 There are several research institutions that are developing substantial expertise in this field. A profile of one – the National Physical Laboratory – is provided in Box 3-8 below.
- 3.23 As recently reported in the Economist, “*According to McKinsey, in 2015 about 7,000 people worldwide, with a combined budget of about \$1.5bn, were working on quantum-technology research*”. While some applications, such as universal quantum computing, remain a long way from commercialisation, others are far closer to realisation. Secure quantum communications systems are already being installed, and new opportunities in sensors will likely see deployment within five years. However, there is a strong consensus that quantum technologies will be a game changer. Fifty years ago, Gordon Moore from Intel coined his famous “*Moore’s Law*”, which stated that the capacity of silicon devices would double every year. However, silicon technology is now approaching the limits of the laws of physics and industry is therefore beginning to look more seriously toward Quantum technologies to form the basis of a new generation of super-devices. Innovation South research institutions are well-placed to lead on the first applications of such technology.
- 3.24 Quantum technologies will develop rapidly over the coming years. Most experts expect the technology to develop within the research community, and with early adopters in defence and security, secure telecoms, finance and large scale computing. In parallel, sensors and imaging technology will likely spread into civil engineering, healthcare and aerospace, and in the longer term, into mass market consumer goods. The newly announced EU Flagship with 1bn Euro will play a significant role.

## BOX 3-8

## NATIONAL PHYSICAL LABORATORY

The National Physical Laboratory (NPL) has acted as the UK's National Measurement Institute for more than 100 years, developing the UK's primary measurement standards. In this way, the NPL both relies on new and innovative measurement science and technology research, and encourages its application to the benefit of real-world problems. Beneficiaries of new measurement solutions are generators of commercial research and development, where these can support business innovation. NPL employs over 500 scientists and is home to a 36,000 square-metre, purpose-built laboratory which hosts 388 measurement science laboratories.<sup>80</sup>

The NPL has close working links with the University of Surrey, and jointly they have formed the NPL South hub, specialised in research of key metrology areas, in particular, regarding technologies including 5G, Satellite sensing, and Quantum technologies.<sup>81</sup> The hub also acts as a focal point for the region's industry to access measurement innovation and research conducted by the two centres.<sup>82</sup>

NPL also collaborates with government and a broader network of businesses to extend the impact of its work. This approach is set in the most recent government strategy which encourages the exploitation of NPL work for driving enterprise, business and innovation. From this perspective, the hub of strategic partners, NPL and the University of Surrey aims to:

- expand the quantum industry, and subsequent development of new products. This work will be led at the Advanced Quantum Metrology Laboratory, currently under construction, in Teddington.
- as a partner in the 5G Innovation Centre, conduct research on measurement issues for 5G implementation and develop and provide standardisation and validation for 5G ready technologies.
- increase the hub capabilities in satellite sensing and the development of low cost satellite solutions, refining instruments to international standards

### RESEARCH EXCELLENCE IN DIGITAL ENABLING TECHNOLOGIES GOES DEEP & WIDE

3.25 There is good evidence that the South has substantial and significant research strengths across all Digital Enabling Technologies.

3.26 These are linked, most directly, to the University of Southampton, University of Surrey, University of Sussex and Royal Holloway. However, Digital Enabling Technologies are dispersed across a range of academic disciplines ("units of assessment" in REF terms) and many of the universities across the South are making a contribution. These institutions are Bournemouth, Canterbury Christ Church and Solent Universities and the Universities of Brighton, Chichester, Greenwich, Kent, Portsmouth, Reading and Winchester.

3.27 What is also apparent is the inherently interdisciplinary nature of research strengths linked to Digital Enabling Technologies. The description of Cyber Security Southampton, for example, refers to 12 research groups within the University, one of which is the Optoelectronics Research Group, at the core of its photonics excellence. Different Digital Enabling Technologies are therefore being developed together, and this is a further source of strength.

3.28 The Audit has revealed research excellence in Digital Enabling Technologies also exists within businesses in the South, and some of it is being advanced through international collaborations. One important example is provided below.

<sup>80</sup>National Physical Laboratory, available at <http://www.npl.co.uk/about/what-is-npl/>, accessed on 13.04.2017

<sup>81</sup>National Physical Laboratory response to Innovation South Science and Innovation Audit Call for Evidence, April 2017

<sup>82</sup>ibid

## BOX 3-9

### IBM EMERGING TECHNOLOGY (HURSLEY) AND THE INTERNATIONAL TECHNOLOGY ALLIANCE

IBM Emerging Technology is based at IBM's major site in Hursley, Hampshire. Hursley is the company's main R&D lab in the UK with the Emerging Technology team comprising around 50 members of staff with strong links to IBM Research. The team has expertise in a range of disciplines including Internet of Things, encryption and cognitive computing, and its focus is on bridging the gap between work conducted in IBM Research and its application into "real world" situations.

As stated on its website, Emerging Technology "*collaborate with customers from a huge variety of industries, ranging from aerospace to retail and healthcare to security*"<sup>83</sup>. Part of its business is therefore client-facing and the team is concerned essentially with finding innovative applications for digital enabling technologies.

In addition, the Emerging Technology team is involved in large scale and long term research programmes, generally working with academic and industry partners. This has included the **International Technology Alliance in Network and Information Sciences (NIS-ITA)**, initiated by the Ministry of Defence and the US Army Research Laboratory<sup>84</sup>. Its purpose was to produce fundamental advances in network and information sciences. This in turn was designed to provide a scientific basis for new agile and flexible networking systems to support capabilities like information delivery and decision making, especially in uncertain and unstable environments at the edge of the network (e.g. with limited bandwidth, mobile devices and limited battery).

The programme ran from 2006 to 2016 and it involved 16 academic partners and 10 industrial organisations from across the UK and US. In the UK, it was led by IBM Emerging Technology and other partners included Royal Holloway, University of Southampton, Airbus UK and Roke Manor Research (based in Hampshire). Another programme – **International Technology Alliance in Distributed Analytics and Information Sciences (DAIS-ITA)** – was launched in September 2016. This too will run for 10 years and it is being led in the UK by IBM Emerging Technology. Other UK partners include the University of Southampton, Airbus and BAE Systems.

The ITA programmes are substantial and long term. Although funded through defence budgets, they are concerned with fundamental research at the core of digital enabling technologies. Partners from across the geography of Innovation South are playing leading roles in this transatlantic initiative.

## THE COMMERCIALISATION OF DIGITAL ENABLING TECHNOLOGIES

3.28 The market for Digital Enabling Technologies in themselves is niche and limited. The market for the current and future application of Digital Enabling Technologies is huge, extremely wide-ranging and exciting. It relates to every aspect of economic, social and cultural life.

3.29 Innovation South is a region where excellent research can and is being translated into excellent business innovation research. The route, though, from laboratory to commercial markets is often complicated and usually requires considerable navigation at both a business level and more generally.

<sup>83</sup>See <http://ets.mybluemix.net>

<sup>84</sup>See <http://nis-ita.org>

## *Challenges surrounding the commercialisation of Digital Enabling Technologies - the perspective of individual businesses*

3.30 The case study below is significant because it takes Digital Enabling Technologies, where the science is demonstrably world class, but

the journey to commercial impact still needs to be navigated. Here the wider innovation infrastructure found within the South comes into play. Although AccelerComm is a spin-out from the University of Southampton, the 5G Innovation Centre based at the University of Surrey and SETSquared ICURe are also critical.

### **BOX 3-10**

### **CASE STUDY: ACCELERCOMM**

The origins of AccelerComm can be traced to the Southampton Wireless Research Group at the University of Southampton. With backing from the EPSRC, Dr Rob Maunder found a way of significantly improving the throughput and latency of turbo decoders, one of the most complex components used in mobile phones and basestations. With support from the ICURe (Innovation to Commercialisation of University Research) programme, run by SETSquared, a second phase of development was instigated. The award of an Innovate UK grant provided the commercial foundation for a new business which was set up as an independent spin-out in early 2016.

AccelerComm is now an IP company, based on the Chilworth Science Park, close to Southampton which supplies designs for error correction hardware to the manufacturers of components for mobile phones and basestations. AccelerComm's patented turbo decoder solution is unique and meets all the requirements for the latest version of 4G. The company is also developing solutions for polar coding, which is a relatively new error correction code that has been selected for 5G. AccelerComm aims to be the first to market with commercial-grade IP in polar encoding and decoding, which will find first application in test and measurement equipment for 5G.

AccelerComm has developed a strong sales pipeline, but it faces the challenge of selling new and complex technology. Its main customers are major corporates – like Huawei, Ericsson and Intel – and the key applications besides mobile phone and basestations include satellites and defence. The market for AccelerComm's products is global. The major corporates have a huge impact on the development of the technology and the market, and it is challenging for a start-up business to “be seen” and for confidence in its product to be developed. In order to address this, AccelerComm has contributed unique expertise to 5G standardisation technical meetings, which has significantly raised its profile and led to partnerships and opportunities with several large corporates. Recently, AccelerComm successfully demoed their turbo decoder technology at Mobile World Congress (MWC), which has led to several more significant opportunities.

It is – in part – also for this reason that AccelerComm's links to the 5G Innovation Centre at the University of Surrey are seen as very important. AccelerComm is one of over 40 “small enterprise tech members” of the 5GIC, and it considers that membership brings with it two very important benefits:

- access to the 5GIC's testbed facilities – described as “amazing” and are likely to be replicated in Basingstoke (which will be helpful for the Southampton-based firm)
- networking and promotional benefits consistent with a facility that is well known by UK Government and has profile internationally: when the AccelerComm is seeking to break into the major corporate market, the associated visibility is extremely important.

AccelerComm's goal is to become the leading supplier of Intellectual Property (IP) cores for 4G and 5G error correction codes on the market, and thereafter expand their portfolio throughout the core pieces of the physical hardware layer of mobile phones and basestations. AccelerComm has globally unique products that are protected by patents, which are enabling the business to grow quickly, and is very confident about its prospects. Accelercomm's journey encapsulates the strength of Innovation South's support ecosystem for exciting, innovative new companies working in the field of Digital Enabling Technologies.

### ***Challenges surrounding the commercialisation of Digital Enabling Technologies for the South more broadly***

3.31 Table 3 1 below highlights some of the other broader challenges to be faced and they are, in part, the focus for this Audit.

**Table 3 1: Social, technological, economic and regulatory challenges linked to the further adoption of Digital Enabling Technologies**

<b>Overarching challenges</b>	<b>Innovation South Enablers</b>
Regulatory challenges linked to the development of Digital Enabling Technologies...	→ Connecting SMEs and start-ups to regulatory bodies and frameworks through standard organisations and networking with corporate partners
Technological challenges relating to the adoption of Digital Enabling Technologies...	→ There are significant technological challenges that will need to be overcome relating, ultimately, to cyber security. Cyber crime is likely to be one of the biggest societal challenges in future years. Innovation South has a world class academic base in Cyber security as well as strong connections to national resources such as GCHQ. Via the Universities and other research establishments in the region, SMEs have excellent access to scientific and technological resources and the established incubation and spin out processes established by SETsquared
Challenges related to the social acceptability of Digital Enabling Technologies...	→ There are growing ethical concerns about the 'free' services which people use in exchange for their personal data. In response, the Council for Big Data, Ethics and Society was formed in collaboration with the National Science Foundation in 2014. This produced a comprehensive white paper in 2016. It was entitled "Perspectives of Big Data, Ethics and Society". The societal impact of digital technologies is a strong focus of the Universities, for example, the Web Science Institute, whose Directors include Dame Wendy Hall, at the University of Southampton; and work at the University of Sussex on ethical issues related to artificial intelligence and automation; and will be a major strand running through future technological development activity within the region.

**Table 3 1: CONTINUED**

<b>Overarching challenges</b>	<b>Innovation South Enablers</b>
Economic challenges linked to the full development of Digital Enabling Technologies...	→ Communications services can always be provided more cost-effectively in areas of high population density. To achieve ubiquitous, reliable high speed connectivity whether stationary or travelling at speed will require a suite of new digital enabling technologies. Some of this technology will be provided by existing communications companies but many of the really innovative breakthroughs will come from agile smaller companies and start-ups. Innovation South has optimum, balanced ecosystem of small and large technology companies to support a thriving ecosystem for such developments.
3.32 AccelerComm’s journey neatly encapsulates the real challenges facing innovative, bright new companies entering a highly competitive and challenging digital global market. It also illustrates the significant strides in the commercialisation of leading-edge Digital Enabling Technologies already underway within the Innovation South region.	3.33 In the future, the successful businesses/sectors in the South are likely to be the ones that navigate these effectively. Innovation South is in an extremely strong position to provide the support infrastructure needed. Looking forward, ensuring the most effective business support is felt across the region will be key to making the most of the South’s advantages in Digital Enabling Technologies in a global market.

**How does the evidence in Chapter 3 help us capture the full economic potential of Digital Enabling Technologies?**

- Innovation South has outstanding research strengths in a range of Digital Enabling Technologies. However, the challenges of the commercialisation process must be recognised and addressed
- Some of the region’s research strengths in Digital Enabling Technologies (e.g. quantum, 5G) are some way from full commercial application and there is a need to gear up for the opportunities that lie ahead

## 4. APPLYING DIGITAL ENABLING TECHNOLOGIES — IN “CONNECTED DIGITAL”

### CHAPTER 4 — KEY MESSAGES

- Connected Digital is a UK success story largely underpinned by the outstanding performance of the connected digital sector in Innovation South
  - The South has a major concentration of large corporates, including international businesses such as Fujitsu, Huawei, Microsoft and IBM, with UK/European Headquarters in the Thames Valley, Surrey and Hampshire.
  - These are major employers, ensuring the South’s position as a globally-significant and globally-connected region
- There are several significant and high profile clusters of digital companies
  - Some are achieving national and international acclaim: the gaming sector in and around Bournemouth, Brighton, and Guildford, the “Hollywood of Videogames”<sup>85</sup>
  - Almost half the UK games industry is in London and the South East<sup>86</sup>
  - The “prize” of a Digital Catapult located in Brighton is testimony to the area’s innovation culture
  - The South has growing credentials in the Internet of Things (IoT) and the closely linked “internet of place”
- The application of digital technologies across a raft of sectors and services, e.g. FinTech & e-government, is spearheading the digital revolution.

### “CONNECTED DIGITAL”, AND ITS PRESENCE IN THE SOUTH

- 4.1 The Connected Digital Economy is driven by digital sectors focused on the supply of digital infrastructure and applications that generate output and wealth in their own right. As well as the ‘core’ digital sectors, they are transforming other sectors across the economy to create emerging fields such as EdTech, FinTech, and HealthTech where the UK is already leading the way. They also include the increasingly significant Creative Digital sector.
- 4.2 Connected Digital businesses are often at the heart of the development of Digital Enabling Technologies and are using them to improve the performance and reach of the systems and solutions they are delivering to support other industries, including the other themes of this Audit: marine and maritime, biosciences and advanced engineering.
- 4.3 Nationally, “*connected digital*” sectors are increasingly driving economic growth and are performing strongly. Analysis by DCMS distinguishes the “digital sector” from “telecoms” but suggests that in both sectors, GVA (current prices) increased by over 20% between 2010 and 2015 and that together they account for about 9% of the UK economy.
- 4.4 Between 2010 and 2014, exports in the digital sector increased from £23.0bn to £31.8bn (14% of all UK service exports); in telecoms, the percentage increase was 47%<sup>87</sup>.

<sup>85</sup>“All hail Guildford- the Hollywood of video games”, The Guardian, 2014 <https://www.theguardian.com/technology/2014/jun/04/guildford-uk-video-game-industry-ubisoft-little-big-planet-hollywood>

<sup>86</sup>“A Map of the UK Games Industry, Nesta 2014. The South East is the nearest approximation to Innovation South. It excludes Dorset and includes Buckinghamshire; Oxfordshire; Milton Keynes.

<sup>87</sup>DCMS Sectors Economic Estimates, August 2016

4.5 Within the South, the “connected digital” sector is large and a significant source of employment. Official figures suggest there are over 200,000 jobs in directly related sectors<sup>88</sup>. This is 50% more jobs than would be expected if the South simply replicated the national pattern (a location quotient – region-wide – of 1.5). Locally, the concentrations of employment are much higher again. For example, large parts of Thames Valley Berkshire have employment location quotients in excess of 3.5.

4.6 TechNation Report, 2017, gives some insight into different digital economies within the region. For the incidence of high growth digital firms, Bournemouth and Poole is ranked the highest of 30 clusters surveyed for the report at 26%. Reading’s digital economy appears to score perform phenomenally well on productivity, (although there may be a distorting effect on the figures because of large company accounts). Table 4-1 highlights the place-based digital sector in some parts of Innovation South, although, it should be noted that some key local examples such as Guildford/Aldershot and Basingstoke are missing from the survey.

**Table 4 1: Insights into the connected digital sector across hubs within Innovation South – from TechNation, 2017**

	Bournemouth & Poole	Brighton	Reading	Southampton	London
No of digital jobs	15,763	12,614	45,269	22,737	300,169
Digital GVA	£352m	£580m	£5.5bn	£1.1bn	£30bn
<i>Implied GVA/job</i>	<i>£22.3k</i>	<i>£45.9k</i>	<i>£121,5k</i>	<i>£48.4k</i>	<i>£99.9k</i>
High Growth Firms	26 % [the highest national figure]	19%	18%	10%	20%
Start-up Births	199	218	605	270	7,682
Average advertised digital salary	£39,508	£44,608	£53,255	£45,633	£61,803
<i>Indexed against London</i>	<i>0.64</i>	<i>0.72</i>	<i>0.86</i>	<i>0.73</i>	<i>1.00</i>
Tech Sector Growth Potential	91%	92%	n/a	n/a	n/a
Other observations	National Centre for Computer Animation and Visual Effects at University of Bournemouth New accelerator – First Bourne “Ordnance Survey and Bournemouth Council testing a 5G mapping and planning tool”	Wired Sussex – a “hub and initiator for the digital community” “Brighton is awash with hackathons, skills swaps and meetups” “Gaming sector going from strength to strength”	“Close to, yet cheaper than, London and within each reach of Heathrow” “Many multinationals are based on Green Park” “ConnectTVT <sup>89</sup> goes from strength to strength”	“University of Southampton has produced 27 spin-outs since 2000” “The city has excellent international connections – a 2015 FedEx report singled out Southampton as a “export epicentre”	

[Source: Based on data presented in TechNation, 2017]

<sup>88</sup>These relate to employment jobs identified through BRES on the basis of a rolling average from 2013-2015. Note that this estimate excludes most self-employment jobs. These are a significant feature of the digital economy and the inference is that total employment in the sector is understated here

<sup>89</sup>ConnectTVT was formed in 2014 to “put Thames Valley back on the tech and digital cluster maps”. Subsequently it has encouraged networking, innovation and skills development in the area.

4.7 There are different “layers” in the region’s “connected digital” sector. Some of it is well-established, equally, there are new and emerging elements which are growing quickly and changing the region’s digital landscape. Although there is a good deal of overlap, as the diagram below illustrates, there are four key elements:

- the major ICT corporates which have a substantial presence in the north west of the region, particularly through the Thames Valley, but also in parts of Surrey and Hampshire; this includes the likes of Vodafone, Oracle, Microsoft, Telefonica, Huawei and IBM
- the digital businesses that have emerged in response to other established regional specialisms; and the emerging, localised, clusters of predominantly SME and micro businesses relating, for example, to gaming and creative digital media in and around Brighton, Guildford and Bournemouth
- the businesses/organisations that are deploying Digital Enabling Technologies with respect to Internet of Things (IoT) and the associated “Internet of Place”
- the businesses/organisations in many different sectors which are increasingly part of the “connected digital” sphere: the European HQ of American Express in Brighton and LV and JP Morgan in Bournemouth are examples of FinTech, and SSE in the utilities sector is based in Havant.

## INNOVATION SOUTH’S FOUR OVERLAPPING ROLES IN SPEARHEADING “CONNECTED DIGITAL”

### *Innovation South as a hub for global corporates in the digital sphere*

4.8 Innovation South is the UK centre for global digital corporates. Many of these firms arrived in the 1970s and they have been the subject of significant academic study. One influential account concluded that “rather than being responsible for the development of the high-tech concentration, these multinational corporations have taken advantage of a

location that had already been established indigenously”<sup>90</sup>. However, over the last 40-50 years, the major corporates have had a formative influence on Innovation South, not least as major employers.

4.9 An example is Chinese-owned Huawei, now the biggest telecommunications equipment manufacturer in the world. Its UK Headquarters – and principal employment hub – is at Green Park on the edge of Reading. Although it has research centres in Cambridge, Bristol and near Ipswich, it regards the Reading-Guildford area as the main UK locus for international ICT businesses. As the case study below demonstrates, Huawei attaches considerable significance to research excellence within the geography of Innovation South – here, particularly the Universities of Surrey, Royal Holloway and Southampton.

4.10 These corporates are now strongly embedded within the South. Whilst proximity to Heathrow Airport continues to be of great significance, other aspects of these corporates’ characteristics and behaviours are evolving quickly. The analysis completed by Hall et al (referred to above) commented on their overwhelmingly American ownership. Over the last 20 years, the ownership pattern has become very much more varied; Huawei bears this out and the influence of Asian investment appears to be growing rapidly.

4.11 For these corporates, the relationship with London is extremely important. An analysis completed in 2016 for Thames Valley Berkshire Local Enterprise Partnership highlighted the growing importance of drawing on the London labour market, especially younger “millennials”<sup>92</sup>, through reverse commuting. An earlier piece of work noted that two major firms – Cisco and Telefonica – had established incubators to support young people to develop innovative ideas into new businesses. In both cases the corporates provided co-working space free of charge, mentoring and some financial support for a period of six months to a year, and in both cases “these incubators are

<sup>90</sup>Western Sunrise: The genesis and growth of Britain’s major high tech corridor, Hall, P, Breheny, M, McQuaid, R, Hart, D (1987). London: Allen and Unwin

in central London, because that is where most innovative young people want to be”<sup>93</sup>.

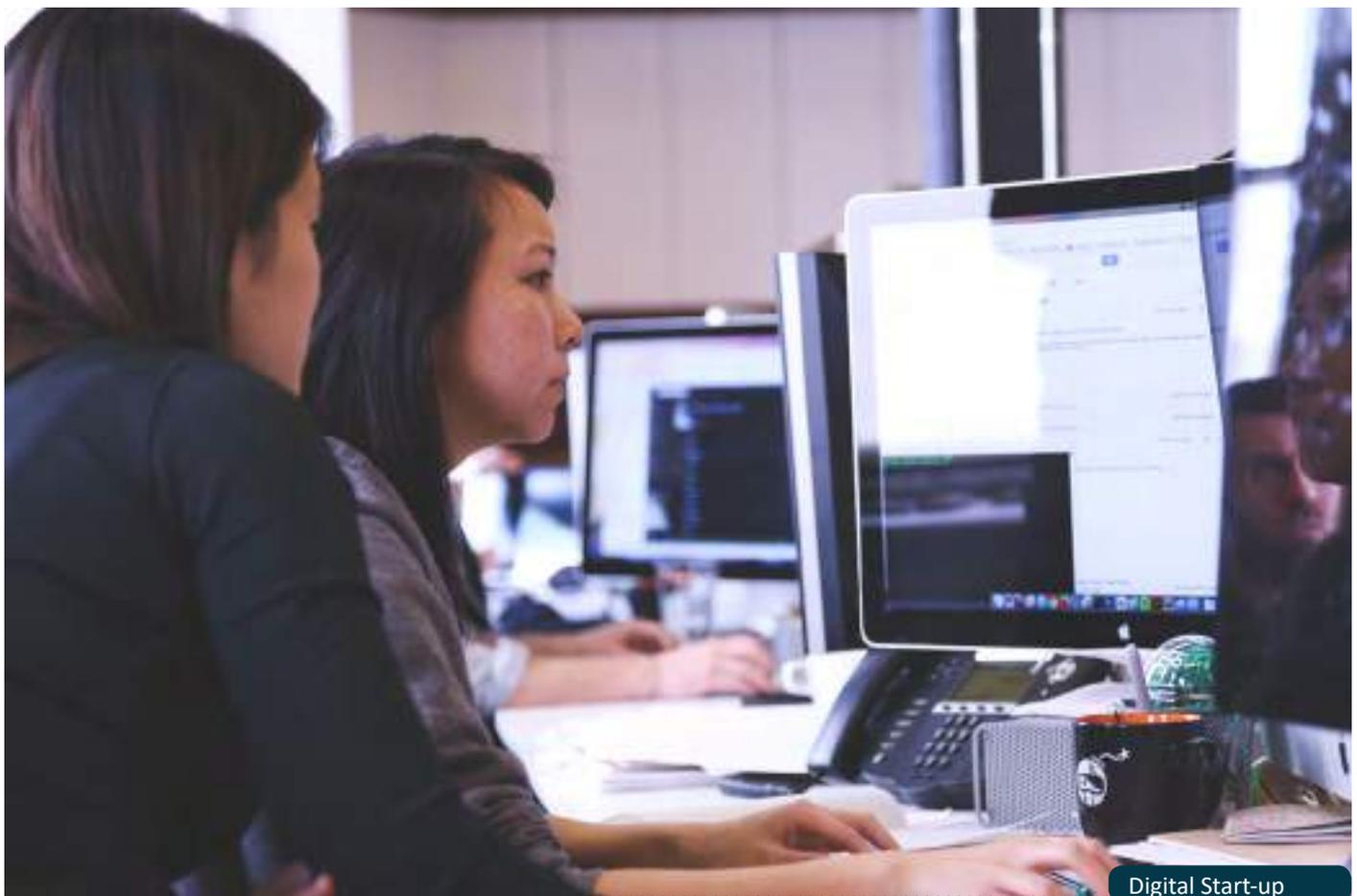
4.12 This example adds to the view that an effective digital skills strategy for Innovation South must be tailored and underpinned by a profound understanding of the drivers of the local and regional economy. These include the importance of links with London and an awareness of the demands of different types of digital employers and how these connect into the wider international supply chain, taking advantage of existing links with, for example, the Digital Catapult.

### ***Innovation South - generator of digital start-ups and digital clusters***

4.13 Over the last two decades, Innovation South has seen a profusion of digital start-ups. Some of these should be understood as part

of localised clusters. These are found across different areas within Innovation South (consistent with the analysis in Table 4 1 although that list is not exhaustive).

4.14 A study completed by Nesta found that about half of the companies which make up the UK games industry are located in London and the South East, and identifies established “games hubs” in Brighton and Guildford<sup>94</sup>. A more recent interactive map produced by a gaming industry representative body, UKIE, pointed to 69 games companies in and around Brighton; 37 in Guildford; 15 in Southampton; and 14 in Bournemouth<sup>95</sup>. Some of the businesses are global players, for example Creative Assembly, founded in 1987 and employing 300 people in Horsham. The sector as a whole is growing quickly and the South is extremely well positioned.



Digital Start-up

Figure 4 1: Understanding Innovation South’s unique assets and opportunities relating to “connected digital”



### Huawei in the UK

Huawei is the largest telecommunications equipment manufacturer world-wide. It has grown rapidly since it was founded in 1987 in Shenzhen, Guangdong (China). Globally, it now has about 180,000 employees of whom around 80,000 are focused on research and development. Its global annual R&D spend is in the order of US\$11bn. In 2016, its revenue globally was US\$75.1bn and its profit was US\$5.3bn<sup>91</sup>.

Huawei operates through three main business groups. These are concerned with telecommunications carrier networks (digital infrastructure); enterprise (supporting businesses/ organisations/ cities in the use of digital infrastructure); and devices.

Currently, around 1,000 of Huawei's UK staff are based at its UK Headquarters in Green Park, Reading. This includes all sales and marketing functions, operational project managers and engineers.

According to an Oxford Economics economic impact study in 2015, Huawei made a contribution of £956m to UK GDP over the three years 2012-2014 and supported 7,400 jobs either directly or through its supply chain.

### Key collaborations across the Innovation South area

Although its own R&D centres are outside Innovation South, Huawei has a series of significant local research collaborations. Three are seen as particularly important:

- Huawei is a major corporate sponsor of the 5G Innovation Centre (5GIC), based at the University of Surrey, and has invested approximately £5m in the facility. Huawei regards the 5GIC as a venture of global significance, and its decision to get involved was taken outside of the UK. Huawei's particular contribution is the installation of a 4-5G testbed. It is seeing this used extensively and is very positive about its potential, including its relation to the community of small businesses that is being attracted by and nurtured through it.
- Huawei is working very closely with the University of Southampton on a number of different projects. It regards the Optoelectronics Centre at the University of Southampton as a world class asset – and certainly the best in Europe.
- Within the region, its third major collaborative research partner is Royal Holloway. It has very strong links in the field of cyber security and regards Royal Holloway as a leading research institution in this sphere.

Particularly in relation to the Universities of Southampton and Surrey, Huawei also recognises the role played by SETSquared, in supporting early stage businesses with expertise in digital technologies. The commercialisation process is often difficult – particularly with very new technologies – and SETSquared is making a difference.

More broadly, Huawei recognises the Guildford-Reading area as the “locus” for the digital sector with others at Southampton and Brighton. Tech City (London) is key in relation to tech start-ups and Cambridge is very important for research, but this part of Innovation South is where many of the major corporates are located, Huawei included. The significance of Heathrow Airport cannot be underestimated in terms of international technology cooperation. The sector is intrinsically global and international connectivity is crucial.

<sup>91</sup>Huawei Investment and Holding Co Ltd, 2016 Annual Report: Building a Better-Connected World – page 8

### Early days and the evolution of 22cans

22cans, a computer games company based in Guildford, is the latest studio to be established by Peter Molyneux, who has been active in the games industry for over 30 years.

In the 1980s, Peter was running a small import-export business in Guildford. After an offer of free Amiga PCs from Commodore International, Peter designed a successful Amiga database program and with the proceeds, established Bullfrog Productions in 1987. Bullfrog was subsequently sold to the American video games company Electronic Arts in 1995. Electronic Arts' UK headquarters remains in Guildford. Subsequently, Peter established Lionhead Studios in 1997, acquired by Microsoft Studios in 2006. 22cans was created in 2012, based on Surrey Research Park and released its first game later that year.

### The explosion and transformation of the games industry

The story of the games industry is one of both expansion and transformation, driven by the advance of new technology. In the early days of the industry, video games could be developed by small teams with a small budget - the budget for Peter's first game was around £1,000. The transformation of computing power and the range of devices available to consumers have transformed the scale of the industry: at its peak, Lionhead Studios employed about 300 staff, and games development budgets reach around \$90 million.

Increasingly, "games companies are becoming like film companies" in the budgets they require, the markets they reach and the product quality demanded by consumers. It is therefore becoming increasingly challenging for start-up businesses to get into the market.

### The future

Future product development will depend on the exploitation of new technology, such as augmented reality, on increasingly connecting players, and on developing products in all formats. In market terms, the Chinese market is becoming increasingly important, currently accounting for around 50% of the world games market and offering great potential for expansion.

### Why the South?

Why has Guildford become such a major centre for the games industry? Peter Molyneux was already based in Guildford when he developed his first game. However, the pattern of new company formation and consolidation, and relationships between key people within the sector, makes an element of clustering "inevitable".

The UK is a good base partly because of a cultural acceptance of risk and innovation within the entertainment industry, and the UK's leading role. However, the sector is highly internationalised: a third of 22cans' staff are nationals of other EU states - increasingly they are recruited directly from abroad – and most games products are developed for global markets.

4.15 The creative design and digital technologies developed for the gaming industry are increasingly finding new markets through innovative applications in other sectors - private and public. So-called “Gamification” or “Serious Gaming” represents vast potential

for new products and services. In Innovation South there are many good examples where the region’s outstanding strength in creative digital is driving innovation in other areas of competency.

### BOX 4-3

#### BOURNEMOUTH UNIVERSITY’S ORTHOPAEDIC RESEARCH INSTITUTE & NATIONAL CENTRE FOR COMPUTER ANIMATION

The Orthopaedic Research Institute (ORI) at Bournemouth University (BU), has invested heavily in staff and state of the art equipment and facilities, including a gait lab and a virtual reality surgical training simulator. The ORI unit is working across BU with the National Centre for Computer Animation (NCCA) and the SciTech Games Technology Group to produce training and diagnostic scenario-games in virtual reality.

Co-operation between these two globally-recognised centres enables surgeons to do orthopaedic training and achieve expertise before performing “live” treatments and allows the gait lab to provide walking and running scenarios that assess the root of orthopaedic ailments in patients.

Being able to assess the results of surgery accurately and train surgeons without “learning on the patient” has generated huge interest at home and abroad. ORI is already working with a multinational company on a multi-centre clinical trial and with a software company on virtual clinics. abroad – and most games products are developed for global markets.

### BOX 4-4

#### CHILD PROTECTION – SERIOUS GAMING AT THE UNIVERSITY OF KENT

The Centre for Child Protection at the University of Kent is a centre of excellence and innovation in research, training and practice, aimed at the full range of professionals involved in child protection. The Centre was established following the Munro Review (2011), which stressed that Continuing Professional Development is crucial for professionals working to safeguard and protect children.

The Centre offers participants a chance to reflect on their practice skills within complex scenarios using virtual reality technology. These child protection simulations are widely used, award-winning and unique to the sector. Scenarios include a simulation of a benign situation rapidly developing into a case of child sexual abuse; a simulation of online grooming and the radicalisation process, designed for school age students; and interactive avatars used in advocacy for supporting the UK’s ageing population.

The Centre is licensing the technology to Police Forces across the UK as well as District Authorities.

These are outstanding examples of digital enabling collaboration between academic and applied disciplines allowing technologies to cross from one sector to another with productivity enhancing results. They demonstrate the scope for adding economic value to a range of practical health and social care requirements through the application of creative digital technology and offer a blueprint for further cross-sector and cross-technology innovation.

## ***Innovation South as an innovator in “Internet of Place” / Internet of Things (IoT)***

4.16 A third element of the “connected digital” sector is smaller currently, but appears to be an emerging specialism within the South. It focuses on the IoT and “internet of place”, and is the use of Digital Enabling Technologies to make “places work better”. It links to the smart cities agendas, but on a much smaller scale, and reflects the way towns and cities are scattered across the South, with no single dominant regional centre.

4.17 The region currently hosts a number of testbed projects. Driven by the Digital Catapult Centre Brighton (see Box 4-7 below), Brighton is leading the way in associated Smart City developments. As reported, the aim is to:

*use the internet of place to improve the way the city manages its infrastructure, including transport systems, and the 11 million tourists who visit each year. There could be apps to direct drivers away from the most congested areas and help them find free parking spaces. Improving public transport and encouraging visitors to use park and ride facilities will address concerns over traffic and air pollution<sup>96</sup>.*

## ***Innovation South as a pioneer in the widespread application of Digital Enabling Technologies***

4.18 The fourth main component of “connected digital” is the application of digital sector technologies to other industries that are becoming increasingly digital in their operations for example FinTech and online retail. One example – from financial services – is provided below.

### **BOX 4-5      LV=**

#### **The background to LV=**

Formed in 1843, LV= is a financial Mutual Society owned by, and run for the benefit of its members. In 1996, its Head Office moved to Bournemouth. LV= is now the third largest car insurer nationally. Its turnover is in the region of £3bn and it has about 5.8m customers. It employs about 6,200 people - roughly double the figure five years ago. About half of its staff are based in its Bournemouth Head Office, and there is a second major site in Croydon.

#### **LV= as a digital organisation**

Especially over the last five years, LV= has become a digital organisation. This has transformed how insurance is marketed and sold; how it is priced and underwritten; and how the Society interacts with its customers and members.

Looking ahead, this process of transformation is expected to continue. The emphasis will shift to using data & analytics for preventative purposes to reduce insurance claims and improve customer engagement. In the domain of car insurance, this will include using telematic data to alert drivers to when they are driving in “high risk” areas and it will also help to identify any safety issues linked to the car itself. This suggests that the full impact of Digital Enabling Technologies will continue to grow through the ambit of insurance.

#### **LV='s developing expertise in Digital Enabling Technologies**

LV= has committed to invest over £100m over three years in digital capabilities. Some of this will be developed in-house and some will involve working with a wide range of specialist partners and collaborators.

<sup>96</sup>“Brighton: The seaside resort that wants to be the smartest digital city in England” The Guardian, 20th May 2015

## BOX 4-5

## CONTINUED

In-house, LV= has an “Innovation Laboratory” at its site in Bournemouth. This has about 12 staff and its focus is long term (5-10 years) and developmental. In addition, the Society employs around 200 specialist digital professionals (based in Bournemouth and Croydon) who focus on more immediate digital projects and applications.

LV=’s external collaborators are many and varied. They include major international IT systems and applications specialists (like Accenture, Oracle and IBM), together with leading digital performance marketing agencies (such as iProspect). LV= is increasingly working with smaller, local, firms. Examples include Greenwood Campbell and Experience UX, two (of many) digital agencies which have started to emerge in and around Bournemouth.

### LV=’s views on the digital sector in Bournemouth

LV= recognises the growth in Bournemouth’s digital sector (reported in TechNation, 2017). It describes this in terms of large numbers of small digital agencies and also in terms of the activities of major financial services businesses/organisations. In addition to LV=, JP Morgan (investment banking) and Vitality (health insurance) are recognised to be the major digital businesses locally. It appears the financial services sector is itself helping to drive the growth of a wider digital sector.

### Wider challenges and opportunities looking ahead

LV= has undertaken substantial recruitment in the Bournemouth area over recent years, much of it concerned with securing digital skills. It has developing links with both Bournemouth University and Bournemouth and Poole College; specifically, it has developed what it regards as an important and effective digital apprenticeship programme.

In the past, it recruited new, local, graduates who would stay for a year or two and then leave to work in London. Increasingly, it is instead focusing on recruiting 30-35 year olds from either financial institutions or marketing/digital agencies in London who are looking to return to the south coast. With this change in focus, recruitment is working well and Bournemouth is seen as a “good place” in which to be a digital employer.

## “CONNECTED DIGITAL” SCIENCE AND INNOVATION ASSETS IN THE SOUTH

4.19 Particularly for the smaller businesses, networking and cluster groups can play a key role in de-risking the process of enterprise and

innovation. Wired Sussex – profiled below – is one of the most established and successful support groups in the region. Focused on Brighton and Sussex, it has been working with businesses in the digital sphere for over a decade. It is also one of the partners involved in the Digital Catapult Centre Brighton.

## BOX 4-6

## WIRED SUSSEX

**Wired Sussex** is a membership organisation for companies and freelancers engaged in the digital, media and technology sector. It was founded in 2006 by a group of businesses. The organisation currently has a membership base of 2,856 companies and freelancers. Wired Sussex aims to contribute to the progress and development of a regional digital cluster. It does this through a number of services, initiatives and networks, addressing six critical areas: recruitment and skills, business and growth, work spaces, a shared voice, supporting local networks, and investment and trade.

**BOX 4-7****DIGITAL CATAPULT CENTRE BRIGHTON (DCCB)**

Focusing on innovation of technologies associated with the Internet of Place, **Digital Catapult Centre Brighton (DCCB)** provides opportunities for SMEs, larger businesses, public sector organisations and academia to collaborate and maximise the value of their products and services. Led by the Coast to Capital LEP in collaboration with the University of Brighton and Wired Sussex, the centre aims to convert university-led R&D into market opportunities that are prototyped by small companies in the Creative Digital and IT sector.

DCCB hosts 12 resident start-ups and SMEs and is partnered with more than 270 local businesses, with its activities focused on 5 core themes (covering health and care, transport networks, data science (including 5G), future retail and augmented/virtual reality). The centre provides business support advice – including product and service development, access to finance and access to specialist facilities and expertise – and collaboration opportunities with university researchers, which can consist of workshops, sandpits information days and hackathons.

DCCB is part of the larger Digital Catapult initiative, which was established by the Department for Culture, Media and Sport and receives core funding from InnovateUK. DCCB is contributing to a programme of work that aims to accelerate sustainable growth and encourage a culture of collaboration through digital innovation. Following the UK Government's 5G strategy, DCCB has been selected to deliver a national 5G testbed for businesses to explore how their existing products operate under 5G conditions.

4.20 A particular strength for Innovation South is its fusion of digital and creative skills, both of which underpin innovation across different sectors. The region is a powerhouse for the creative industries, accounting for one quarter of creative clusters identified within the UK<sup>97</sup>, including hotspots in East Sussex: Hastings and Eastbourne's TechResort. It is home to two universities uniquely focused in this field: The University for the Creative Arts (with two campuses in Kent and two in Surrey) and Arts University Bournemouth. Both universities have a strong track record of developing industry-ready graduates. Alumni from both universities, as well as the Bournemouth University, have gone on to work on major blockbuster films, including Oscar- and BAFTA-winners. UCA also counts among its alumni a winner of the Turner Prize.

4.21 Many of the South's universities are in the top 30 in the UK for research power related to connected digital, with Sussex and Bournemouth in the top 5<sup>98</sup>. The National Centre for Computer Animation (NCCA) at Bournemouth University, which supplies roughly 50% of graduates working in the UK's VFX and Computer Games industries<sup>99</sup>; the Centre for Insight, Design and Innovation at the University of Winchester, which focuses on design thinking and offers expertise in augmented reality, web design and Computer Aided Design; and TIGA<sup>100</sup> award-winning gaming courses at the University of Portsmouth.

<sup>97</sup>The Geography of Creativity in the UK, July 2016, NESTA and Creative England

<sup>98</sup>See Annex F

<sup>99</sup>Next Gen.: Transforming the UK into the world's leading talent hub for the video games and visual effects industries, February 2011, by Ian Livingstone and Alex Hope for NESTA

<sup>100</sup>The trade association representing the UK video games industry

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## CONCLUSION

4.22 The outstanding performance of the connected digital sector in Innovation South is a major factor in the success of the UK's Digital economy. It is a significant contributor to the GVA, growth and jobs in the South. The Innovation South region is the UK hub for many global digital corporates which have effective university connections. The region also enjoys a high level of digital start-ups, many within the rapidly developing creative digital media sector.

4.23 These businesses are developing Digital Enabling Technologies and using them to improve the performance of the infrastructure and applications that support existing and new industry models. Connected Digital is a UK success story largely underpinned by Innovation South businesses and the associated research of its Universities.

### How does the evidence in Chapter 4 help us capture the full economic potential of Digital Enabling Technologies?

- In relation to the connected digital sector, the strengths of the South are clear, but the “heat map” is uneven. The vibrancy of the larger urban areas needs to be shared region-wide, and core regional assets – like 5GIC – can be developed further
- The pace with which Digital Enabling Technologies find their way into the connected digital sphere will impact on regional competitive advantage and this “supply chain” – from research through to innovation – needs to be sustained and encouraged

## 5. APPLYING DIGITAL ENABLING TECHNOLOGIES – IN MARINE AND MARITIME

### CHAPTER 5 – KEY MESSAGES

- Home to the Navy, the UK's number one vehicle-handling port and an extensive coastline, science and innovation in Marine & Maritime have deep roots in the South
- There is a well-established marine and maritime cluster which has grown up around international ports and/or harbours
- Digital Enabling Technologies are having a transformative impact on the marine and maritime sphere, particularly in operations that could, otherwise, be “dull, dirty and dangerous”; and, led by growth in China and India, the sector as a whole is seeing rapid global growth. Autonomous platforms – based on the extensive use of sensors – are changing the sector profoundly, and within the South, there are significant scientific strengths and downstream innovation in this domain
- There are substantial research assets in both marine science and maritime engineering; the cross-disciplinary Southampton Marine and Maritime Institute (SMMI) and the National Oceanographic Centre (located on Southampton Waterfront) are especially important, but there are many other research centres too
- A Marine Robotics Innovation Centre has been established with the aim of taking the disciplines of robotics into the marine sphere and this is seeing innovative, small companies playing a crucial role in the commercialisation process
- The role of large commercial companies is significant – including Sunseeker International (in the leisure market), Lloyd's Register (a classification society) through to BAE Systems (in defence-related maritime systems)
- Models of innovation in marine and maritime are changing. The profile attached to Land Rover BAR (Ben Ainslie Racing), based in Portsmouth, is creating an innovation model that is closer to Formula One, and the South is leading the way

### MARINE AND MARITIME SECTOR, AND ITS PRESENCE IN THE SOUTH

5.1 The South is home to the Navy at Portsmouth, the UK's number one vehicle-handling port at Southampton and has a long heritage in the marine leisure and tourism sectors. There is exceptional research and industrial capacity in the business of marine and maritime in Innovation South; and, along its extensive coastline, clusters of specialist industrial and academic activity have grown around the South's numerous significant ports and/or natural harbours – from Dover and Ramsgate

in the east, through Newhaven, Brighton, Shoreham, Portsmouth, Southampton and Poole, to Weymouth in the west.

5.2 Nationally, it has been estimated that the maritime and marine sector contributed £11bn GVA in 2012, a figure that was similar in scale to pharmaceuticals and notably bigger than aerospace<sup>101</sup>. Estimates suggest it accounted for 367,000 direct jobs in 2011/12 and 703,000 in total (including indirect and induced jobs), roughly one job in every 45 nation-wide. Significant science and technology underpins the industry.

<sup>101</sup>Maritime Growth Study – keeping the UK competitive in a global market, Department for Transport, 2015

5.3 In terms of its scale, the South Coast Marine Cluster has estimated that the South East (GOR) accounts for about a third of the “UK Leisure, superyacht and small commercial marine industry” (9,300 jobs). Although one element only of the wider marine and maritime sector, it does signal the region’s relative pattern of specialisation. On a broader definition, it has been estimated that approximately 40,000 jobs are provided by the sector in Solent, accounting for 20.5% of GVA and supporting over 3,000 businesses locally<sup>102</sup>. The Bournemouth/Poole and Weymouth areas are also very significant local hubs.

- extended use of composites and other novel materials
- design and manufacture of specialist vessels for support of the offshore energy and naval sectors
- through-life operation and insertion (including refits and conversions) to improve vessel efficiency
- decision support systems – including integrated voyage optimisation to deliver just-in-time arrival at port at lowest cost, secure situational awareness and next-generation command and control systems.

## DIGITAL ENABLING TECHNOLOGY DRIVERS AND CHALLENGES...

5.4 Marine and maritime is a sector which will be transformed by Digital Enabling Technologies. *The 2015 Marine Industries Technology Roadmap*<sup>103</sup> drew on inputs from over 70 experts and it alighted on seven overarching priorities. These may be summarised as:

- whole-vessel integration to deliver more affordable and optimised running with reduced staff and minimised through-life costs
- design, integration, manufacture and operation of autonomous vessels and systems
- design, manufacture and refit of superyachts, high-end powerboats and high-end sailing yachts

5.5 The importance of Digital Enabling Technologies is confirmed through a study completed by the Southampton Maritime and Marine Institute. This identified technologies that are likely to be transformational within the marine and maritime sphere. In the table below, these are divided into two columns – those which might be described as Digital Enabling Technologies and “other”, although many of the latter will themselves have a strong Digital Enabling Technologies element. The notion of “high value digitally enabled design” is also key here. Many of these drivers need to be integrated into complex systems requiring multidisciplinary design tools, often enabled by high performance computing. It is also important to note that exploitation of these technologies will require a change in the skills mix within the sector, including attracting more graduates from electronics and computer science programmes.

**Table 5 1: Technology drivers within the marine and maritime sector – identified by Southampton Marine and Maritime Institute**

Technology drivers linked to Digital Enabling Technologies	Other Technology drivers
<ul style="list-style-type: none"> <li>• robotics</li> <li>• sensors</li> <li>• big data analytics</li> <li>• smart ship</li> <li>• autonomous systems</li> <li>• cyber and electronic warfare</li> <li>• human–computer interaction</li> <li>• communication</li> </ul>	<ul style="list-style-type: none"> <li>• propulsion and powering</li> <li>• advanced materials</li> <li>• advanced manufacturing</li> <li>• sustainable energy generation</li> <li>• shipbuilding</li> <li>• carbon capture and storage energy management</li> <li>• marine biotechnology</li> <li>• deep ocean mining</li> <li>• human augmentation</li> </ul>

[Source: Based on *Global Marine Technology Trends 2030*, QinetiQ, Lloyd’s Register, University of Southampton, 2015]

<sup>102</sup>Making Waves: Solent’s Marine and Maritime Sector, Solent LEP, 2015

<sup>103</sup>UK Marine Industries: Technology Roadmap 2015 – produced by IfM, University of Cambridge, for UK Marine Industries Alliance, supported by Innovate UK, DEIS and KTN

5.6 Marine autonomy has been identified as “a truly disruptive technology that has the potential to replace traditional ship-based alternatives for equipment inspection and other marine monitoring operations”. In practice, this links together many of the technological specialisms outlined above and is an area of regional strength. Particularly for “dull, dirty and dangerous” operations – which are increasingly unaffordable (due to price sensitivities and labour costs) and also under regulatory pressure – marine autonomous platforms (both above and below the surface) can potentially be fitted with application-specific sensors to capture whatever data is required for a given location. This is an area of work in which the South has particular strengths, and an embryonic sub-cluster has been defined in these terms<sup>104</sup>. The existing South Coast Marine Cluster has designated 2017 its “Year of Autonomy” with companies such as Qinetiq among the key partners.

5.7 There are particular regulatory barriers to the full deployment of marine autonomy. Marine expertise in the South is playing a critical role in the global leadership required to address these obstacles. The UK Maritime and Coastguard Agency, headquartered in Southampton, has been active in work to

recognise these challenges, sponsoring a paper to the International Maritime Organisation. Lloyd’s Register, at Southampton University, is a leading international provider of marine classification and compliance services. It has introduced provisions for progressive autonomy and unmanned units with the classification requirements to help ensure this disruptive technology is deployed in a safe manner.

### ***Other trends and drivers in the marine and maritime sector***

5.8 The marine and maritime sector is being transformed by market changes. Shipping is seeing a drive towards greater efficiency and further automation of vessels, with opportunities in the manufacture of marine equipment, ship design and classification. In the commercial sphere, the rise of China and India – both in the production of ships and in dictating patterns of demand for world shipping – is changing the economics of the sector; while in the military sphere, the continuing pre-eminence of the USA is apparent. In addition, there is increasing deep sea exploration and operation which presents opportunities<sup>105</sup>.



Land Rover Ben Ainslie Racing, Portsmouth

<sup>104</sup>Marine Autonomous Systems; An Embryonic Cluster with high growth potential. Smart Specialisation Hub Innovation Review Workshop – Southampton, 19th January 2016

<sup>105</sup>Maritime Growth Study: keeping the UK competitive in a global market, Department for Transport, 2015

## BOX 5-1

## GLOBAL MARINE TRENDS, 2030

A summary of global trends across the principal marine sectors is provided below, based on a report entitled “*Global Marine Trends, 2030*” prepared by QinetiQ, Lloyd’s Register, University of Strathclyde with expert input from the University of Southampton. The report points to significant international changes and major productivity increases, driven by technology in general and Digital Enabling Technologies in particular.

### Commercial shipping, fleet ownership and shipbuilding

- The volume of seaborne trade will double from nine billion tonnes per annum to 19-24bn tonnes by 2030.
- China will play a key role in 2030 as the emerging maritime superpower in shipping, followed closely by India.
- The total deliveries of bulk carriers, tankers, LNG carriers and container ships across the world will remain at around 2010 levels.

### Naval sector

- The US Navy will be dominant in 2030, both in scale and technology.
- Naval power will double in 2030, although navies will only maintain and refresh the numbers of platforms and personnel, rather than expanding them. *This points to growth opportunities for the naval sector in systems capability rather than platforms or people. The growth of automation, sensor integration, cyber security and related technologies will help to determine the nature of naval power in 2030.*

### Offshore Energy

- Advances in technology, underpinned by innovation, research and development will be the keys to meeting the growing demand for energy from more diverse sources.
- The number of offshore platforms and renewable energy devices required to meet global demand will grow significantly.

[Source: Based on *Global Marine Trends 2030*, QinetiQ, Lloyd’s Register, University of Strathclyde (2013)]

## MARINE AND MARITIME SCIENCE AND INNOVATION ASSETS IN THE SOUTH

### Universities

5.9 Within the South, there are outstanding, high-ranking research strengths in marine and maritime – both in marine science, focusing on the environment, and maritime engineering.

5.10 Headline data from the Research Excellence Framework are presented below. In “earth

systems and environmental sciences” – which includes marine science but is broader – the University of Reading and the University of Southampton are ranked 3 and 4 in the UK respectively.

5.11 Maritime engineering is wrapped up with more general engineering disciplines, and the Universities of Southampton and Surrey are outstanding. In two areas of engineering, Southampton’s research power is unrivalled in the UK.

5.12 In addition, it is important to note the University of Southampton has established the cross-disciplinary Southampton Marine & Maritime Institute (SMMI). This brings

together expertise in various related fields including big data and cyber security; robotics and autonomous systems; and energy and resources.

**Table 5 2: UK rank on “research power” in units of assessment that are relevant to marine and maritime across a selection of universities in the South**

	Marine environments			Maritime engineering					
	Biological Sciences	Earth Systems and Environmental Sciences	Geography, Environmental Studies and Archaeology	Aeronautical, Mechanical, Chemical and Manufacturing Engineering	Chemistry	Civil and Construction Engineering	Electrical and Electronic Engineering, Metallurgy and Materials	General Engineering	Physics
Royal Holloway, University of London	31	21	24	-	-	-	-	-	27
University of Greenwich	-	-	-	19	36	-	27	51	-
University of Portsmouth	-	24	46	16	-	-	-	-	36
University of Reading	35	3	29	-	28	-	23	-	-
University of Southampton	26	4	14	-	8	-	1	1	17
University of Surrey	-	-	-	-	-	-	2	14	24
University of Sussex	17	-	28	-	32	-	-	43	30

[Source: REF, 2014]

### Other research and innovation assets

5.13 The National Oceanography Centre is the UK’s Centre of Excellence for oceanographic sciences. Located on Southampton Waterfront, it has a remit to provide national capability and leadership for big ocean science. Whilst it works particularly closely with the University of Southampton, it is independent as one of six research centres funded by NERC.

5.14 The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) is based in Weymouth. It is a world leader in marine science and technology, collecting, managing and interpreting data on the aquatic environment, biodiversity and fisheries. Lloyd’s Register is based at the University of Southampton at the purpose built Boldrewood Innovation Campus - the single biggest academic-industrial development so far in the UK, and, with data and digital technologies at the heart of its strategy, LR has strong links

to high performance computing capability. The UK Defence Solutions Centre (UKDSC), based at Farnborough, works closely with the Department for International Trade, industry

and academia to drive innovation and exports. It leads a Maritime Community of Interest and works with the Royal Navy to stimulate autonomous systems contracts for UK Industry.

## BOX 5-2

### THE NATIONAL OCEANOGRAPHY CENTRE AND MARINE ROBOTICS INNOVATION CENTRE

The National Oceanography Centre (NOC) in Southampton is a multi-disciplinary research centre with activities covering marine geoscience, marine physics and ocean climate, systems modelling, ocean biogeochemistry and ecosystems, and ocean technology and engineering. The origins of NOC may be traced back to the 1940s and the formation – in Surrey – of the National Institute of Oceanography. This moved to Southampton in the 1990s and it became the Southampton Oceanography Centre. It merged with Proudman Oceanographic Laboratory in 2010 to become, formally, the National Oceanographic Centre.

As one of six centres supported by the Natural Environmental Research Council, NOC contributes to the UK's national capabilities in long term science through research programmes covering sustained ocean observation, ocean and ecosystem model development, and integrated sea floor and habitat mapping. The centre is home to about 520 research scientists and staff, with more than 700 undergraduate and postgraduate students also based at the site in partnership with the University of Southampton's Ocean and Earth Science Department<sup>106</sup>.

In 2015, NOC opened the £3.5m Marine Robotics Innovation Centre (MRIC), which provides a collaborative space for companies developing technologies that aid oceanographic research, with the Marine Autonomous and Robotics Systems (MARS) team also based at the site. To date, MRIC has worked in partnership with 8 companies and has 11 associate members, with £8m of R&D projects underway<sup>107</sup>. The centre is based around a 317m<sup>2</sup> open-plan office space, with a range of smaller, enclosed spaces and private meeting rooms also available.

Airbus has a long-standing involvement with the National Oceanography Centre (NOC) in the field of remote sensing techniques to support the marine environment. This has enabled the development of new technologies for monitoring of the maritime environment which are at the leading edge of research in this domain.

NOC operates large scale research infrastructure – with the Royal Research Ships Discovery and James Cook, and a fleet of autonomous underwater vehicles (including the recently commissioned Boaty McBoatface) all based in Southampton – and houses the UK National Oceanographic Library, the Discovery Collections and the British Ocean Sediment Core Repository at the British Ocean Sediment Core Research Facility<sup>108</sup>.



Boaty McBoatface

<sup>106</sup>National Oceanography Centre website, 'Our History' (accessed via: <http://www.noc.ac.uk/about-us/our-organisation/our-history>)

<sup>107</sup>National Oceanography Centre response to the Innovation South Science and Innovation Audit call for evidence, presentation titled 'Marine Robotics Innovation Centre; a hub for MAS Innovation', March 2017

<sup>108</sup>National Oceanography Centre website, 'Our History' (accessed via: <http://www.noc.ac.uk/about-us/our-organisation/our-history>)

5.15 The South is leading the ambition to bring home the America's Cup with the location of Land Rover BAR (Ben Ainslie Racing) in Portsmouth. This is generating new opportunities for science and innovation; for showcasing commercial opportunities in the South and the UK, and for inspiring a new generation of high tech engineers by demonstrating how powerful technology is behind "spectacle" events such as high level competitive yachting, where the purpose of innovation is different. As with Formula One, the goal is simply to win; and this – rather than downstream opportunities for commercialisation, etc. – drives priorities (and timescales) for innovation. As explained in the national Maritime Growth Study:

*Government has also supported Sir Ben Ainslie's America's Cup team. This will provide a good platform to demonstrate the UK's technologies and skills to a wider audience at home and abroad, replicating the success achieved by UK based Formula 1 teams. Over £4m was invested in a Centre for Maritime Intelligent Systems. Industry is diversifying*

*out of defence to provide offerings into the commercial sector (e.g. energy, marine science, safety and security) internationally. Both of these initiatives are based in the Portsmouth area to ensure the area's shipbuilding skills are retained in new areas of technology.*

### **Commercial**

5.16 A range of businesses – some established, some new and small – are active in the field across the Innovation South region. Examples include: ASV Global Ltd, BAE Systems, Hydroid and Saab Seaeye, MOST, Sonardyne, Lloyd's Register, Planet Ocean, Airbus, QinetiQ, Chelsea Instruments, Roke Manor Research Ltd, GRP and Sunseeker International. The formation and growth of these businesses has frequently occurred as part of wider clusters which are anchored by the universities and specialist institutions outlined above. The Case Study below describes the growth of two small companies and demonstrates the positive commercial impact of the South's wider assets and potential.

## **BOX 5-3**

## **PLANET OCEAN AND ECOSUB ROBOTICS**

### **Early days – and the formation of Planet Ocean**

Planet Ocean was established as a marine science and technology company in 2004 with a focus on developing and commercialising aids to navigation.

Planet Ocean's location in Surrey owes much – historically – to the legacy provided by the Institute of Oceanographic Science (IOS), which was based in Wormley, Surrey. It relocated to Southampton and it became the National Oceanography Centre, but it "left behind" a significant hot spot in Surrey/North Hampshire, consisting of a large number of oceanographic companies.

Planet Ocean's early business was as an agent for overseas manufacturing businesses which were seeking market entry into the UK and Ireland. Gradually, however, its role evolved to develop its own marine systems and branded products. Fourteen years on, Planet Ocean employs seven people and it represents 23 different manufacturing businesses.

### **ecoSUB Robotics – a spin-out business from collaborative R&D**

In 2016, a new company – ecoSUB Robotics – was spun out from Planet Ocean as a result of its longstanding relationship with the National Oceanography Centre in Southampton. In 2015, Planet

Ocean led a bid – involving the Marine Autonomous Robotics Systems (MARS) group at NOC, ASV Global Ltd (Porchester) and the University of Southampton – for a collaborative R&D project, part-funded by Innovate UK and DSTL. The aim of the project was to develop a micro-AUV (Autonomous Underwater Vehicle) launch and recovery system from an USV (Unmanned Surface Vehicle) for applications including defence, oil spill monitoring and science. The project also required the design of the low-cost micro-AUV.

As of spring 2017, the project is nearing completion. ecoSUB Robotics Ltd is co-located with the National Oceanography Centre in Southampton within the Marine Robotics Innovation Centre. Some early adopters are very interested in its product and it expects to become financially self-sustaining in 2018. ecoSUB Robotics is developing through a strong network of relationships. Links to NOC and University of Southampton are key but there are relationships developing with other universities (e.g. the University of Sussex in relation to quantum sensors) and advanced manufacturers (e.g. specialists in 3D printing and composites (on the Isle of Wight)).

### **The significance of Digital Enabling Technologies in the marine and maritime sector**

Although its “sector” is formally “marine and maritime”, Planet Ocean considers itself to be – first and foremost – a digital business. Its entire growth trajectory has been premised on Digital Enabling Technologies – initially simply the use of the internet, and now more sophisticated technologies and applications. The core challenge for the business surrounds data – how they are generated, how they are stored, how they are shared (in challenging marine environments), how they are protected and how they are used. There are huge volumes of data, and the challenge – increasingly – is to distinguish between “data” and “information”; the latter is a processed and condensed variant of the former, and it is core to the value generated by the business.

### **Plans for the future – and key challenges**

Looking ahead, Planet Ocean expects to grow steadily. ecoSUB, however, could grow very quickly. ecoSUB is facing the challenges faced by all tech start-ups – around early stage finance, fast-developing technologies and new markets. For both businesses, however, there are overarching challenges relating to recruitment. Both companies require robotics engineers with foremost software skills and a deep understanding of oceanography – and this combination is very hard to find. Recent recruitment rounds have yielded no real interest from within the UK and instead, recent recruits have come from elsewhere in Europe (France, Germany). Currently non-UK-nationals comprise half of the two firms’ workforce.

### ***Evidence of innovation - partners in high value digitally enabled design***

5.17 The marine and maritime sector in the South is innovative. Some evidence of this is provided by an analysis of Innovate UK’s database of grant awards from 2010/11 to 2014/15. Over this period – in disciplines relating to

“transport” (which overlaps with, but is not synonymous with, marine and maritime) – participants in the South were awarded grants totalling over £30m, some 14% of the UK total.

5.18 Exploring these data further provides insight into the range and type of innovation projects which are linked more closely to

“marine and maritime”. Selected examples are provided in the table below. There is a striking breadth in the range of participants from within the Innovation South region - large firms, SMEs, universities and research institutions –and the mix of collaborators from elsewhere universities e.g. Cranfield University, corporates e.g. Rolls-Royce and specialist marine and maritime businesses e.g. Pendennis Shipyard in Cornwall.

5.19 Most of the individual projects listed involve the development of complex systems, requiring a strong element of multidisciplinary design, which in turn is often enabled by digital technologies, such as advanced numerical methods running on high performance computers. The projects draw on a highly-developed research and innovation ecosystem with strong roots in the South and a network of links country-wide.

**Table 5 2: UK rank on “research power” in units of assessment that are relevant to marine and maritime across a selection of universities in the South**

Project	Participants from within Innovation South	Other participants from elsewhere in the UK
Marine applications of electric turbo-compounding for waste heat recovery	Bowman Power Group Limited*, Lloyds Register EMEA	Rolls-Royce plc, University College London
Unmanned Safe Maritime Operations Over The Horizon (USMOOTH)	Autonomous Surface Vehicles Limited*	Cranfield University
Robust Machine Executable Collision Regulations at Sea	Lloyds Register EMEA, Southampton Solent University, Atlas Elektronik UK Ltd	Rolls-Royce plc*, Queen’s University of Belfast
Autonomous Surface / Sub-surface Survey System	Autonomous Surface Vehicles Limited*, Sonardyne International Limited	SeeByte Limited, NERC
High Efficiency Marine Energy (HEME)	Energy Solutions (UK) Limited	Pendennis Shipyard Ltd*, Triskel Marine Limited, Bruntons Propellers Limited
Marine Energy Efficiency, Transformation and Reporting (MEETR)	Azurtane Ltd*	Codel International Limited, Pole Star Space Applications Limited, Inmarsat Global Limited
GLEAMS- Glycerine fuel for Engines and Marine Sustainability	Marine South East Limited*, Lloyds Register EMEA, Aquafuel Research	Gardline Marine Sciences Limited, Redwing Environmental
Holistic Vessel Performance and Routing System	University of Southampton	Fugro GEOS Limited*, Triskel Marine Limited
Supercritical CO2 Waste Heat Recovery for Marine Gas Turbines	Meggitt (UK) Ltd T/A Heatric	Rolls-Royce plc*, Cranfield University
Wave Augmented Foil Technology (WAFT) for manned vessels	Marine One Stop Technologies Ltd, Seaspeed Marine Consulting Limited	Rolls-Royce plc*
Automated in service and permanent prevention, removal and detection of vessel hull fouling using a sparse network of guided ultrasound sensors (VESSEL CLEAN)	Denval Marine Consultants Limited	Applied Inspection Limited*, Pancom LTD, Tube Tech International Limited, Newton Montgomery Limited, TWI Limited
Performance and safety monitoring system for workboat fleet operation	CJR Propulsion Limited*	Avenca Limited, Callen-Lenz Associates Limited, Estuary Services Limited

[Key: \* lead partner in the collaboration. Source: Innovate UK ]

## BOX 5-4

## RNLI'S TECHNOLOGY PARTNERSHIPS

The Royal National Lifeboat Institution (RNLI), HQ in Poole, is the charity that saves lives at sea. RNLI has had an Advanced Technology Partnership with the University of Southampton since 2004, which develops technology focused on aspects of naval architecture and human-factors engineering. Over the past six months the RNLI has engaged over 40 different organisations exploring the future of Search and Rescue (SAR) Communications and Calling for Help and more recently, how the UK may be using Unmanned Aerial Systems and Space assets to enhance SAR operations. The RNLI ran a Design Challenge with the Royal College of Art, exploring how it can make the Thames the safest stretch of river in the World by 2030. Prototypes created include autonomous unmanned surface vehicles and smart bollards that collect data on river usage whilst nudging behaviours through lighting. Bournemouth University are producing a computer-animated film for the RNLI that will show a future design possibility for launching small lifeboats.



RNLI small lifeboat

## Skills and talent

5.20 Innovation South has very significant assets relating to the provision of skills in the marine and maritime sectors. Several of the regions' Universities offer relevant high quality degree programmes in maritime science and engineering. However, while science and engineering offer exciting and well-paid careers to graduates, maritime-related careers can be less attractive to graduates than other higher-profile engineering sectors (e.g. aerospace, automotive and the technology sector) as well other sectors, particularly the financial sector.

5.21 Solent University's Warsash Maritime Academy has earned a global reputation for education, training, consultancy and research services to the international shipping, commercial yacht, and offshore oil and gas industries over 70 years. Warsash's core business, of deck officer training, has itself become highly

dependent on digital enabling technologies, through highly sophisticated simulators for ship operations. The University of Portsmouth is home to the Institute for Marine Science. Further Education Colleges, such as Bournemouth and Poole College Marine and STEM Centre, Weymouth College; and the Marine Skills Centre at Southampton City College universities and University of Southampton add to this significant regional strength.

## Networks and networking

5.22 There is a close working collaboration between the region's marine sector and the industry's national "voice" Maritime UK<sup>109</sup>. Within the region, Marine South East is an active networking group with a high level of industry membership. It actively engages in innovation in its own right. A synopsis is provided below.

### BOX 5-5

### MARINE SOUTH EAST

Founded in 2005 and based in Southampton Science Park, Marine South East is a business-led consortium of marine sector organisations. The organisation aims to promote productivity-led growth in the marine sector through innovation, supply chain analysis, the promotion and encouragement of marine sector clusters, and the delivery of business support services to businesses traditionally in the South East of England, but also in other strong UK and European maritime regions<sup>110</sup>.

Since 2010, Marine South East has received funding from Innovate-UK for four projects covering information management systems, glycerine fuel research, monitoring for operational vessel efficiency and hybrid electric propulsion systems<sup>111</sup>.

Marine South East also provides consultancy services to a network of 2000 maritime organisations around the themes of offshore and marine energy, maritime resource efficiency, ports and marine operations and skills and workforce development. The consortium has also worked on projects funded by the ERDF Interreg programme, the European Framework 7 Programme (predecessor to Horizon 2020) and the Carbon Trust<sup>112</sup>.

<sup>109</sup>Marine UK : <https://www.maritimeuk.org/about/about-us/>

<sup>110</sup>Marine South East website, 'background' (accessed via: <http://www.marinesoutheast.co.uk/Background/>)

<sup>111</sup>InnovateUK, 'database of funded projects from 2010/11 financial year to 1st March 2017

<sup>112</sup>Marine South East website, 'projects' (accessed via: [http://www.marinesoutheast.co.uk/Current\\_Projects/](http://www.marinesoutheast.co.uk/Current_Projects/))

## CONCLUSIONS

- 5.23 Digital Enabling Technologies, especially autonomous solutions, are having a transformational effect – particularly in areas of the maritime industry which are “dull, dirty and dangerous” and facing operational and regulatory cost pressures.
- 5.24 The Innovation South Marine and Maritime sector operates as an effective cluster – albeit over a dispersed geography. There is a network of businesses, research institutions and universities with clear and strong inter-connections, and this is given additional focus with reference to the marine environment. The sector as a whole is evolving quickly and is global in its reach.
- 5.25 Looking ahead, one of the challenges for marine and maritime relates to recruitment. There is demand for highly specialist skills (as illustrated by the case study of Planet Ocean and ecoSUB Robotics). However, the belief is the sector “loses out”, particularly to other rapidly evolving digitally-enabled sectors, such as aerospace and automotive. In this context, the impact of the America’s Cup – and the

commitment to Land Rover BAR (Ben Ainslie Racing) – could help to change the image. Ensuring that the changing needs of innovative businesses are fully reflected in skills provision will be important more generally, and was a recurrent theme of the evidence gathered for this Audit.

- 5.26 Beyond this, the imperative will be to ensure that small, innovative firms are able to contribute to and benefit from the wider growth dynamic which is shifting quickly. Innovation South is facing competition from elsewhere – countries such as Singapore, Norway, Japan, S. Korea and China have invested significantly in maritime clusters. In terms of opportunities associated with exploration and understanding of the maritime environment, San Diego and Cape Cod have been identified as hubs of particular note<sup>113</sup>. In mass production shipping, and routine ship design, Innovation South is unlikely to be able to compete – and it is unlikely to want to try. However, its knowledge-rich offer can compete with the best in the world at the technologically-sophisticated end of the spectrum.

### How does the evidence in Chapter 5 help us capture the full economic potential of Digital Enabling Technologies?

- In the marine and marine sector, a supply of high calibre digital and engineering talent will be critical to realising the significant growth potential. Fresh thinking is required to address the needs and responsibilities of employers, and ensure competition between providers does not frustrate the end goal
- Maximising the full potential of Digital Enabling Technologies is the route to global competitiveness in the sector and the right conditions for their deployment must be in place
- Longer term – given links to defence – the marine and maritime sector is one in which Quantum technologies might start to be adopted and it will be important that the region is ready to respond

## 6. APPLYING DIGITAL ENABLING TECHNOLOGIES — IN BIOSCIENCE

### CHAPTER 5 — KEY MESSAGES

- Within bioscience, Digital Enabling Technologies are profoundly influencing the development of medical data, devices, pharmaceuticals, and agrimetrics which are, in turn, transforming the delivery of health, social care and food security
- The South has research strengths in both human and animal health. Corporate partners like Syngenta and Bayer have a strong research base in the region as do research organisations like the Pirbright Institute and Leatherhead Food Research
- Bioscience in the wider South East<sup>114</sup> is seeing strong organic growth in med tech, particularly amongst SMEs and the South East boasts one fifth of the UK workforce (compared to 6% for London and 11% in the Midlands)<sup>115</sup>.
- Many of these businesses are using Digital Enabling Technologies in the healthcare domain, an area where there is substantial growth potential

### BIOSCIENCE AND ITS PRESENCE IN THE SOUTH

6.1 The direct contribution of the life sciences industry to the UK economy was valued at £14.5 billion in 2015<sup>116</sup>. Productivity (measured by GVA per employee) is estimated to be more than double the average for all industries, and the sector generates a trade surplus of around £1.1 billion per year<sup>117</sup>.

6.2 'Bioscience' and 'life science', often used interchangeably, are diverse and complex fields benefitting from several Innovation South sectors: Data analytics and security, 5G, advanced engineering and robotics. By assessing our regional activity this Audit delivers bioscience strengths in:

- **Med tech:** the development and production of medical devices and equipment, employing around 93,600 people nationally<sup>118</sup>. The Office for Life Sciences highlights the growth of two areas of increasingly important activity:
  - **digital health:** products reliant on digital technologies and content, including hospital and GP information systems and medical data analytics and visualisation, as well as medical devices which have a

significant digital component essential for their functionality and/or deliver health related data.

- **genomics:** the sampling, sequencing, analysis, interpretation and application of human genomic information to improve clinical services. Along with digital health and data harvesting, genomics form the foundation of personalised and precision medicine, a burgeoning opportunity in health delivery.

- **Biopharmaceuticals:** the development and production of human, animal and plant therapeutics, estimated by the OLS to employ around 62,000 people nationally
- **Plant and animal health:** the development of technologies to detect, control and monitor pathogens and pest threats.
- **Food research, security and agrimetrics:** increasingly data and connectivity lie at the heart of safe, efficient and sustainable food production, delivery and determining or tracking provenance.

6.3 Across Innovation South, there are around 500 businesses active in med tech and biopharmaceuticals<sup>119</sup>. The four 'core' sub-sectors identified above also have close

<sup>114</sup>Official South East data do not reflect Dorset. These statistics do include the rest of Innovation South, plus Oxfordshire, Bucks and Milton Keynes

<sup>115</sup>UK Medical Technology Sector Strength & Opportunity 2015 compiled by UK Govt

<sup>116</sup>PwC/ ABPI/BIA/ABHI/ BIVDA (2017), The economic contribution of the UK life sciences industry

<sup>117</sup>Association of the British Pharmaceutical Industry, Pharmaceutical trade in the UK

<sup>118</sup>Office for Life Sciences (2016), Strength and Opportunity 2016: The landscape of the medical technology and biopharmaceutical sectors in the UK

<sup>119</sup>Office for Life Sciences (2016), Strength and Opportunity 2016: The landscape of the medical technology and biopharmaceutical sectors in the UK database estimates 430, which compares with around 260 in Oxfordshire. The University of Southampton Institute for Life Sciences counted 557.

scientific links with other activities concerned with the use of biological resources, including industrial biotechnology.

## DIGITAL ENABLING TECHNOLOGY DRIVERS AND CHALLENGES...

### *Digital Enabling Technologies are at the heart of the transformation of bioscience<sup>120</sup>:*

- First, a new market is developing in **connected medical devices**. This includes ‘smart assistive technology’, devices helping people perform tasks made harder by their condition, and, when enabled with sensors, help the user, or medical professionals, monitor performance. Aggregate data from the widespread use of these devices contribute to wider medical research. Sensor technology in the form of ‘smart pills’ can transmit data on the patient’s response to medication, and the development of relatively cheap, accurate and connected diagnostic equipment is leading to hospital-standard diagnosis at home<sup>121</sup>. Linked with this, production costs for personalised devices are likely to fall through the development of 3D printing techniques<sup>122</sup> and should harness design and usability expertise.
  - Second, at an operational level, much of the scope for **digitisation in the health sector** has yet to be realised. At a very basic level, health service digitisation is often seen as improving transactional processes (booking appointments online, receiving information, and so on) as well as the digital hospital. But the mainstream use of ‘machine learning’ to support clinical decisions will lead to greater advances in care, and the potential to analyse and visualise multiple patient records<sup>123</sup>. The UK has a fantastic opportunity to gain economically from health service digitisation through the integrated NHS and its potential for robust data collection.
  - Third, **computing ability is driving down the cost, and increasing the effectiveness, of drug discovery**, as the potential to screen multiple samples and analyse complex data increases. The cost of sequencing a single person’s genome has fallen to around \$1,000, so the potential to gather and analyse population-level medical databases will increase substantially. This impacts on the nature of medical research (broadly speaking, increased data analysis and less biological or chemical experimentation) and opens up commercial opportunities for smaller research-driven businesses, freed from the high capital costs once borne by the big pharmaceutical firms.
  - Fourth, digital technology offers a new opportunity to **develop a more integrated approach to plant and animal health science**. The UK’s strategy for animal and plant health science research highlights an aspiration for a ‘UK Animal and Plant Health Internet of Things’ enabling faster detection and analysis of animal and plant health risks<sup>124</sup>. This should deliver significant productivity gains for the UK’s food production sector, as well as developing the agricultural market for Digital Enabling Technologies. As a facet of the digital and genomic technologies migrating from health care, simpler and economic tracking of the food chain from producer to consumer is possible.
- 6.4 While digital technology makes it easier to capture, process and share data, securing public ‘**trust in data**’ (particularly as it relates to human health) and confidence in its security and use is vital in realising the economic benefits<sup>125</sup>. This means that public confidence in **data regulation** will be key – but securing that confidence in ever more sophisticated systems will mean increased demand for **cyber security** products, as well as changes in information governance.

<sup>120</sup>This section is partly drawn from Cosima Gretton and Matthew Honeyman (2016), The Digital Revolution: Eight technologies that will change health and care, The King’s Fund <https://www.kingsfund.org.uk/publications/articles/eight-technologies-will-change-health-and-care>

<sup>121</sup>Michael Montalto (2015), Hospital in the Home, The King’s Fund <https://www.kingsfund.org.uk/audio-video/dr-michael-montalto-hospital-home-victoria-australia>

<sup>122</sup>Deloitte (2017), Deloitte 2017 Global Healthcare Outlook <https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/global-health-care-sector-outlook.html>

<sup>123</sup>Matthew Honeyman, Phoebe Dunn and Helen McKenna (2016), A Digital NHS? An introduction to the digital agenda and plans for implementation, The King’s Fund;

<sup>124</sup>BBSRC (2016), A vision and high-level strategy for UK animal and plant health research to 2020 and beyond

<sup>125</sup>Stakeholder Workshop 5 (see Annex 1); Honeyman et al, p.21

## OTHER TRENDS AND DRIVERS IMPACTING ON THE BIOSCIENCE SECTOR

6.5 Three other drivers are relevant to the future of bioscience in the South:

- First, **regulation influences the structure of the sector and informs location decisions**. Relatively rapid and predictable approval processes (compared with the United States) have been cited as important in supporting the growth of the European medtech and pharma sectors, and influencing decisions to locate in the UK<sup>126</sup>.
- Second, the **ageing population** is changing the nature of demand for healthcare. By 2030, around 20% of the UK population will be aged over 65<sup>127</sup>. While older people are enjoying active, healthy lives for longer, they are more likely to live with complex conditions, requiring long-term management, increasingly personalised and within the community, rather than within hospital settings<sup>128</sup>. This is leading to rising demand for innovative medical devices that can be used remotely from the home.
- Third, in biopharmaceuticals, the **structure of the industry – and the way in which innovation takes place - have changed significantly**. For many years, the big pharmaceutical firms, such as Pfizer, GSK and AstraZeneca, absorbed rivals

and worked through large research campuses. However, faced with looming patent expiries and a need to cut costs, big pharma has sought to outsource R&D and acquire smaller biotech firms<sup>129</sup>. Large corporate research campuses have closed (such as, in the South, Pfizer's R&D facility at Sandwich) and the sector has shifted to more research being done through specialist SMEs and universities. By focusing on our areas of specialism, such as digitally-enabled med tech, Innovation South is in a good position to benefit from this trend.

## BIOSCIENCE SCIENCE AND INNOVATION ASSETS IN THE SOUTH

### *University research strengths*

6.6 Across the range of subject areas related to biosciences, in at least one subject area, five universities in the South are ranked in the top 20 institutions nationally for research power (Reading, Southampton, Surrey, Sussex and Greenwich) and five by 'grade point average' (Reading, Southampton, Surrey, Sussex and Royal Holloway). Kent and Canterbury Christ Church are among the top 30 institutions nationally for research power and "grade point average" in at least one bioscience area.



Biopharmaceutical

<sup>126</sup>Wendy Atkins (2012), 'Europe takes medtech lead', Financial Times FDI Magazine, Aug/ Sep, 70-1 [http://www.medtecheurope.org/sites/default/files/resource\\_items/files/10082012\\_Financial%20times\\_Europe%20takes%20medtech%20lead\\_Background.pdf](http://www.medtecheurope.org/sites/default/files/resource_items/files/10082012_Financial%20times_Europe%20takes%20medtech%20lead_Background.pdf)

<sup>127</sup>House of Lords (2013), Ready for Ageing? Select Committee on Public Service and Demographic Change. Report of Session 2012-13, Paper 140

<sup>128</sup>David Oliver, Catherine Foot and Richard Humphries (2014), Making our health and care systems fit for an ageing population, London: The King's Fund [https://www.kingsfund.org.uk/sites/files/kf/field/field\\_publication\\_file/making-health-care-systems-fit-ageing-population-oliver-foot-humphries-mar14.pdf](https://www.kingsfund.org.uk/sites/files/kf/field/field_publication_file/making-health-care-systems-fit-ageing-population-oliver-foot-humphries-mar14.pdf)

<sup>129</sup>Taylor, David (2015), 'The pharmaceutical industry and the future of drug development', Pharmaceuticals in the Environment 41, 1-33. In 2010-12, Pfizer lost 41% of its revenue, solely due to patent expiry. <http://pubs.rsc.org/en/content/chapterhtml/2015/bk9781782621898-00001?isbn=978-1-78262-189-8>

**Table 6 1: Research Excellence Framework: Institutions ranked within the top 30 nationally**

Institution rank (of all UK institutions)		
Subject area	Research power	Grade point average
Clinical medicine	Southampton (13)	Southampton (28)
Biological sciences	Sussex (17) Southampton (26) Kent (29)	Sussex (10) Kent (23) Southampton (29) Portsmouth (30)
Allied health professions, dentistry, nursing and pharmacy	Surrey (7) Southampton (24)	Southampton (3) Surrey (8) Brighton (27) Sussex (27)
Psychology, psychiatry and neuroscience	Sussex (13) Reading (15) Southampton (18) Kent (24) Royal Holloway (28)	Royal Holloway (6) Sussex (10) Southampton (22)
Public health, health services and primary care	Southampton (28)	Southampton (9)
Agriculture, veterinary and food science	Reading (4) Greenwich (17) Canterbury Christ Church (27)	Reading (6) Greenwich (23) Canterbury Christ Church (27)

[Source: Research Excellence Framework, 2014 ]

6.7 In addition to the cross-cutting assets in Digital Enabling Technologies highlighted in Chapter 3, key bioscience research assets include the Institute for Life Sciences at the University of Southampton. The Institute has a particular focus on the development of engineering, physical and chemical science as well as mathematical and data solutions to address health challenges, with collaborative links to

the University Hospital Southampton Trust. The University is a core partner in the new Rosalind Franklin Institute at Harwell, which will fuse physical science, engineering and life sciences to drive disruptive solutions to health challenges. The University of Southampton also has significant strengths in informatics which are important in relation to bioscience.

**BOX 6-1**

**DIGITAL ENABLING TECHNOLOGIES AT UNIVERSITY HOSPITAL SOUTHAMPTON**

**Innovation in informatics is good for our health and our NHS:** Innovation in the way health professionals and researchers can collect, store, retrieve, analyse and use information about patients, their health and their treatments can improve patient care, NHS productivity and reduce costs. Better, faster and more “human-centred” healthcare IT systems have resulted in a 10% improvement in professional productivity. That translates into at least £50M of equivalent savings or efficiency gains from more productive staff in the **local** health wage bill, or £7 Billion across the NHS human capital estate.

In September 2016, University Hospital Southampton (UHS) achieved national recognition as an IT Centre of Excellence and Global Exemplar for Clinical Informatics development. At least two things

have been essential to the success of the UHS Informatics Strategy: putting the clinician and health professional - the users - at the heart of any design; **and collaboration with innovative, flexible SMEs**, who offer good value for money, rather than contracting with large IT companies.

As an example, this approach is now proving its value in the challenging process of digitising all historic and future medical records held by UHS, more than 2 million, by the end of 2017.

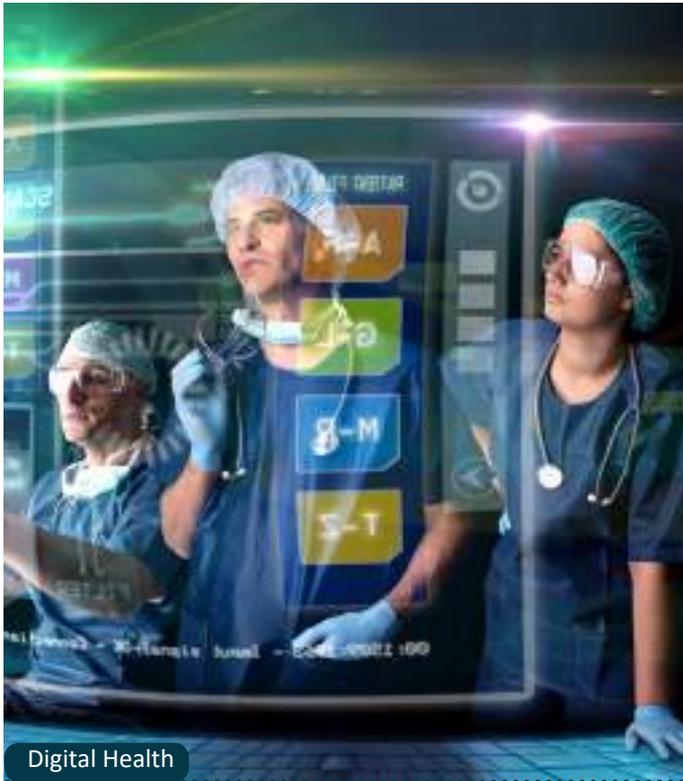
***UHS Lifelines - a new global electronic record interface at UHS:*** It is essential that clinicians and health professionals can visualise a patient's entire clinical record in a simple way, before drilling down into key clinical details and facts. The interface is highly adaptable as new data streams become available, or new tools such as "hover over" visualisation. It represents a major advance in speed over "list mode" access to PDF documents and electronic record sheets. Lifelines also allows the clinician to zoom down into an area of interest, and filter out unwanted material.

The Lifelines concept has its origins in the 1990s in a university laboratory in the United States. The idea was never turned into a practical clinical system then and to date the UHS Lifelines data visualisation methodology is unique in practical use in commercial and NHS clinical informatics systems. It illustrates the power of agile, iterative, ground upwards development by a small team - one clinician, one systems consultant and one IT Manager at UHS - to produce innovation at minimal cost within a public sector organisation to clear end user specifications.

There is considerable potential for further contributions from public, commercial and SME partnerships to drive nationally significant developments of Digital Enabling Technologies across Healthcare. Internationally, through Lifelines, there is collaboration with the **Hyland Corporation of Cleveland Ohio** on a ground-breaking project to manage the fast transition from paper to global digital record storage and access.

***Digital Health has educational and job creation opportunities:*** In recognition of the need to build the skill sets among programmers who also understand the complexities of clinical systems, the UHS IT team has started an informal partnership with the **School of Media Arts and Technology at Southampton Solent University** to develop interest among undergraduates in health care programming and visualization. Electronics and Computing Sciences at the University of Southampton (ranked 8<sup>th</sup> in the REF) are working with medicine and the Institute for Life Sciences to scope out undergraduate courses in digital health. An educated workforce will fuel our SMEs and export potential.

The Southampton Trust is also one of 11 NHS Genomic Medicine Centres, and in 2016, launched a project to process the genomic data of cancer patients to help clinicians deliver personalised treatment.



- 6.8 The School of Life Sciences at the University of Surrey also maintains a bioinformatics core facility, providing data analysis and computer simulation capabilities for use by commercial researchers, and academics.
- 6.9 There are also significant research strengths in areas relating to plant and animal health. The University of Reading is a leading centre for the study of food, health and the environment, with strong expertise in data science and modelling. It is one of 4 partners, including Rothamsted Research, in Agrimetrics - the world's first Big Data Centre of Excellence for the whole food system. At the core is a big data science platform, which includes software tools that make the integration of data according to users' needs possible. At its launch, then Life Sciences Minister George Freeman MP said: "We are investing in the use of data in agriculture to transform the way crops and livestock are grown and bred. Using data, we can identify new genetic traits, spray only crops with disease, and use less water and energy for modern lower input farming. The expertise we're supporting at Agrimetrics will position the UK a world leader in this fast-emerging

field and improve agricultural sustainability and productivity."

- 6.10 The **Natural Resources Institute** at the University of Greenwich, Medway, focuses on agricultural pest and disease management, particularly with application to the developing world.

#### **Non-university research institutions**

- 6.11 The South contains a number of nationally-significant bioscience research institutes associated with food research as well as animal and plant health. These include:

- The **Pirbright Institute** at Woking, one of the eight National Institutes of Bioscience<sup>130</sup>. The Pirbright Institute focuses on the prevention and control of viral diseases in livestock. The Institute is publicly funded via the BBSRC, with support from the Wellcome Trust, the Bill and Melinda Gates Foundation and industry, and is developing an Animal Health Innovation Hub to support future commercial collaborations<sup>131</sup>.
- The **Animal and Plant Health Agency**, near Weybridge, operates nationally as an executive agency of Defra. APHA undertakes 'applied' research into disease and pest control and maintains a commercial arm (APHA Scientific), providing testing and data analysis to scientists in the UK and internationally<sup>132</sup>.
- **NIAB-EMR**, at East Malling near Maidstone, a horticultural research institute focused largely on the development and protection of fruits.
- **Kew Gardens Millennium Seed Bank**, at Wakehurst Surrey houses the largest wild plant seed bank in the world.
- **The Leatherhead Research Institute** at Epsom, largely funded by industry, provides expertise and support to the global food and beverage sector.

- 6.12 There are strong links between the South's agricultural research institutions and the university base in the utilisation of Digital Enabling Technologies, evidenced by current collaboration between APHA, Pirbright and the University of Surrey:

<sup>130</sup>The Pirbright is the only National Institute of Bioscience in the South (the others are located in Cambridge, Norwich, Hertfordshire, Aberystwyth and Edinburgh).

<sup>131</sup>Pirbright Institute, [www.pirbright.ac.uk](http://www.pirbright.ac.uk)

<sup>132</sup>Defra/ APHA (2015), Science Strategy 2015-20 <https://www.gov.uk/government/publications/apha-science-strategy-2015-to-2020>

## BOX 6-2

### DIGITAL ANIMAL HEALTH: COLLABORATION WITH THE UNIVERSITY OF SURREY SCHOOL OF VETERINARY MEDICINE

Opened in April 2016 in collaboration with the animal health company Zoetis, vHive<sup>133</sup> is using digital technologies – including wearables, apps and sensors – to explore applying Big Data and the Internet of Things to animal health<sup>134</sup>. vHive – the veterinary Health innovation engine – involves three centres of excellence within the University of Surrey – the new School of Veterinary Medicine, the 5G Innovation Centre and the Centre for the Digital Economy (CoDE), part of the Surrey Business School. Its aim is to drive innovation in animal health to create new opportunities for research and business in the region and nationally. The project involves Zoetis – the global leading animal pharmaceutical company. vHive was launched at the end of April 2016.

Founded in October 2015 as part of the Faculty of Health and Medical Sciences, the £45m School of Veterinary Medicine is a strategic partnership between the University of Surrey and external partners including The Pirbright Institute, the Animal and Plant Health Agency, Surrey Wildlife Trust and Marwell Wildlife<sup>135</sup>.

#### Commercial

6.13 Within the **med tech** sector, larger firms include Roche Diagnostics (based at Burgess Hill) and Elekta, a Swedish-owned producer of radiotherapy equipment and software based at Crawley. Both of these form part of the West Sussex Health and Life Science Cluster, described below. Other significant med tech firms include Philips Electronics at Guildford, which develops wearable health monitoring devices and Hallmarq Veterinary Imaging in Guildford that develop and market internationally (23 countries) MRI machines for standing horses. An SME of 30 employees they are now the recipients of two Queens Awards for Enterprise.

6.14 Specifically within the **digital health** sub-sector, there are 54 businesses on the Office for Life Science's database, all of which are SMEs, with the exception of two larger providers of health and social care management software (Hospedia, based in Slough, and System C, a US-owned firm based in Maidstone).

6.15 The South has particular strengths in prosthetics and orthotics, with Blatchford,

based at Basingstoke and employing 800 people globally, a major innovator in lower limb prosthetic and orthotic products. In 1990, Blatchford developed the first commercially available microprocessor controlled prosthetic knee; its latest products offer complete microprocessor-controlled lower limb systems. Their Lynx limb system, designed and manufactured by Blatchford, has been selected as a finalist in the Rehabilitation and Assistive-Technology Products category of the 19th Annual Medical Design Excellence Awards in the US. Dr David Moser, Head of Research at Blatchford, was awarded the prestigious George Murdoch medal by the International Society of Prosthetics and Orthotics UK in 2016.

<sup>133</sup>vHive Animal Health website, 'About' (accessed via: <http://www.vhiveanimalhealth.com/>)

<sup>134</sup>University of Surrey response to the Innovation South Science and Innovation Audit call for evidence, March 2017

<sup>135</sup>University of Surrey website, 'School of Veterinary Medicine' (accessed via: <http://www.surrey.ac.uk/school-veterinary-medicine>)

**BOX 6-3****MEDTECH IN WEST SUSSEX**

Around 500 businesses across the South are engaged in the development of medical devices and the design and manufacture of technologies used to identify and test for diseases. In West Sussex, the County Council has mapped the local med tech sector, highlighting a number of examples of innovation, particularly in relation to imaging technology with applications in oncology:

**Elekta** is a Swedish-owned company specialising in equipment and software used to improve, prolong and save the lives of people with cancer and brain disorders. Elekta's global oncology business is headquartered in Crawley, with around 350 of the site's 900 staff employed in R&D. Work is underway to develop the new Cornerstone Hub, Elekta's international innovation campus, adjacent to its existing site in Crawley, which will open in December 2017<sup>136</sup>.

The technology being developed by Elekta include the world's first high-field MR linac, a targeting system using novel software to capture detailed images of tumours during treatment, supporting improved therapy plans.

Also based at Crawley, **Toshiba Medical Systems** is a leader in developing the diagnostic capabilities of medical imaging technology, including CT and MRI systems and x-ray devices. **Tesla Engineering**, based at Storrington, designs and manufactures specialised magnets for use in MRI systems and cancer therapy (among other uses)<sup>137</sup>.

Alongside these large and well-established businesses, some 70% of the enterprises in West Sussex's medtech cluster are SMEs, according to the County Council's analysis. The county's business base is supported by medical and scientific assets including the University of Brighton and the University of Sussex's **School of Life Sciences**, which utilises and develops advanced imaging and data analysis software at its Genome Damage and Stability Centre. Recently, the University of Sussex has received new investment into the forthcoming Wolfson Centre for Biological Imaging, to drive research into cancer and neuroscience<sup>138</sup>.

6.16 The major international **pharmaceuticals** firms maintain a significant presence in the South. Examples include Eli Lilly at Basingstoke, Sanofi Aventis (Guildford and West Malling), GSK (Crawley, Worthing, Maidenhead, Slough and Weybridge), Novartis (Camberley), Merck (Maidenhead), and Pfizer (Walton Oaks, Sandwich and Maidenhead).

firms. However, the legacy of historic investments remains important, and concentrations of largely SME-focused activity have emerged on former single-occupier research parks, such as Discovery Park near Sandwich (see case study below).

6.17 Global changes in the structure of the pharmaceutical industry have reduced employment within the major life science

<sup>136</sup>Elekta Cornerstone Hub, [www.cornerstonehub.net](http://www.cornerstonehub.net)

<sup>137</sup>West Sussex County Council, West Sussex Health and Life Science Cluster, 2016

<sup>138</sup>University of Sussex, press release, 25 April 2017

### Early days – and the formation of Venomtech

In his work at Pfizer based at Sandwich, East Kent, molecular biologist, Steven Trim, developed expertise in both animal venom and drug discovery, a rare combination. In 2010, having left Pfizer, Steven used his own resources to start up Venomtech, initially in rented premises in a pet shop in Ramsgate, and later at the Enterprise Hub on the University of Kent campus at Canterbury.

When Pfizer sold its Sandwich facility, the site was re-purposed as Discovery Park, a multi-occupancy science park focused on life sciences. Venomtech moved there in 2012, attracted initially by its high-quality facilities, convenient location and the opportunity to network with other drug discovery researchers. Most finance has been secured through angel investors and crowd funding.

### Venomtech today

Current offers include anti-coagulants and diabetes medication, with customers including Pfizer and AstraZeneca. Around 60% of sales are for export, especially to the United States and more recently Japan. In spring 2017, it launched its first product for sale to the cosmetics industry, opening up a new market. This past year, the firm has recruited its first full-time director of business development.

### The impact of Digital Enabling Technologies...

Venomtech's new cosmetic product has been developed through the analysis of multiple public sources of data to identify protein patterns in animal venom that could then be replicated synthetically. Accessing and analysing data on this scale has only recently been possible.

### ... and the value of the Discovery Park ecosystem

In principle, Venomtech could have located anywhere – the reason for choosing East Kent related to Steven's original place of residence and that of the first staff. But being based within a community of life science businesses has contributed to Venomtech's growth: Discovery Park offers a community of like-minded businesses and "*people who have bought into that community understand you*". Links between businesses on the Park are proactively supported by the Park's management, and this has been important in helping to overcome what can be a 'lonely existence' as a small young company in a very specialised market. Several of Venomtech's projects have involved collaboration with other researchers based at Discovery Park, and there is a concentration of businesses within the firm's supply chain (such as a specialist pharmaceutical packaging and dispatch company). The PhD student employed by Venomtech is based at Canterbury Christ Church University's Industry Liaison Lab at Discovery Park, and the firm has also employed apprentices via East Kent College's Discovery Park site.

Relationships with Canterbury Christ Church have grown over time. Currently, Venomtech participate in final-year undergraduate programmes at the University, and Steven offers lectures at the University – 'spinning in' commercial drug discovery expertise.

### The future

Venomtech has promising opportunities in both cosmetics and drug discovery and has a growing range of markets – and is on course to achieve £1 million turnover by 2019.

6.18 There are also significant commercial assets in the **food, plant and animal health** sector. Syngenta, a global agribusiness, maintains its largest R&D centre at Jealott’s Hill near Bracknell. Combined with Tozer Seeds, UK Head Office in Surrey, they oversee the majority of seeds grown for crop production in the UK. Both work closely with Royal Holloway. Syngenta also works closely with Reading and Southampton Universities. Syngenta deploys digital technologies by coupling big data analytics with drone monitoring to tackle weed growth. Bayer’s UK and Ireland operations (including animal health and pharmaceuticals) are based at Reading. In distribution, Bracknell, Berkshire is home to **Waitrose** a chain of British supermarkets, which forms the food retail division of Britain’s largest employee-owned retailer, the John Lewis Partnership.

**Evidence of innovation**

6.19 The bioscience sector is inherently innovative – although the future economic and commercial benefit of the early stage research driving breakthroughs often goes unrecognised. As a recent industry report notes, in the long

term, the contribution to growth can be very significant, often after the original innovation has been commercialised by the major pharmaceutical companies<sup>139</sup>.

6.20 Opportunities to co-locate small research businesses with larger corporates (such as at Discovery Park) has been highlighted by participants in the development of this Audit as important in enabling them to secure investment and the commercialisation of their research<sup>140</sup>.

6.21 The distribution of Innovate UK grants in bioscience provides a way of looking at innovation within the sector. Innovation South institutions have won 10 per cent of those in recent years. Between 2010 and 2017, grants to the value of £36.7 million were allocated in the Innovation South area within the bioscience, healthcare and agri (broadly, plant and animal science) – 10% of total UK grants allocated to these themes. The majority of these were directed towards SMEs; some examples including Digital Enabling Technologies are:

**Table 6 2: Examples of Innovate UK grants in bioscience**

Lead partner	Description
Rescon Ltd, Hart	Development of a low-profile microphone system to detect heart abnormalities
Siemens, Surrey Heath	Development of an online allergen sensor to detect allergen materials in processing equipment
University Hospital, Southampton	Integrated digital platform for the management of chemotherapy in hospital
University of Reading	Tackling barriers between the development of assistive living products aimed at older adults and their take-up by target groups
University of Southampton/ Oxford Gene Technology	Tumour profiling based on next generation sequencing of genes and variants
OptiSense Ltd, Horsham	Development of a system for rapid detection of hazardous bacteria in foodstuffs
Fruition PO Ltd, Canterbury	Developing a vision system to enhance phenotyping in apples
Lucite International, Southampton	Genome-scale metabolic modelling to optimise biomanufacturing (in partnership with Cambridge University)

<sup>139</sup>PricewaterhouseCoopers (2017), The economic contribution of the UK life sciences industry, p.14

<sup>140</sup>SQW, interview with Centauri Therapeutics, April 2017.

## Networks and clusters

- 6.22 The network of Academic Health Science Networks (ASHNs) exists to bring NHS health providers, bioscience companies and academic researchers together to develop practical solutions to health and social care problems. In the Innovation South area, the Kent, Surrey and Sussex ASHN is participating in one of five national 'test bed' initiatives, sponsored by NHS England to assess the potential for the introduction of new technology into health and social care. The **Technology Integrated Health Management (TIHM)** project links the ASHN with University of Surrey, Royal Holloway University of London, Surrey and Borders NHS Trust, the Alzheimer's Society and ten technology companies to provide patients and carers with wearable sensors and monitors to increase their ability to live independently.
- 6.23 The TIHM project highlights the potential to build links between the South's digital innovation capabilities and the healthcare system. For example, the first phase of the project saw the devices tested at the 5G Innovation Centre in Guildford before they were rolled out across a network of 350 homes. It also highlights how **Digital Enabling Technologies are blurring traditional sector boundaries**: of the companies involved in the project, some (such as Docobo, based at Leatherhead) are established specialists in digital health; others (such as Arqiva, a major communications infrastructure company based at Winchester) are using their wider range of digital capabilities to develop applications specific to personalised care<sup>141</sup>.
- 6.24 Other networks include **FortisNet**, supported by the Institute for Life Sciences at the University of Southampton, which links med tech businesses engaged in developing solutions to musculoskeletal difficulties with clinicians, academics and patients.

- 6.25 FortisNet is part of a growing body of evidence of significant med tech business and innovation activity in the South. Research carried out for the University of Southampton identified over 300 med tech companies in the Solent and Enterprise M3 areas, many of which were involved in product innovation, but which may not have previously appeared on the radar of the innovation support agencies<sup>142</sup>. In West Sussex, the County Council has facilitated the creation of the West Sussex Health and Life Sciences Cluster; so far around 140 related companies have been identified<sup>143</sup>. Further east, Discovery Park operates as a cluster, underpinned by Pfizer's continuing presence. The recent initiative to develop the **Biogateway** network aims to extend links between business and academia to the wider life science sector in Kent, while the **OBN life science network** has a substantial membership base around Reading and the Thames Valley<sup>144</sup>, where there is also a cluster of health-related contract research organisations.

## Skills and talent

- 6.26 The bioscience industry is highly research-intensive, and increasingly so. Skills required by the industry tend to be quite highly specialised and increasingly driven by the need to manage and interpret data. As a recent report by the main biopharmaceuticals industry body highlights: "new medicines are now less likely to have been identified through high-throughput screening of banks of compounds, and are more likely to have been created following mining of data... These changes will have greatly influenced the skills required by the industry"<sup>145</sup>. Broadly, the report calls for a greater emphasis on mathematics skills at all levels.

<sup>141</sup>Surrey and Borders Partnership NHS Foundation Trust, TIHM for dementia <http://www.sabp.nhs.uk/tihm/partnership>

<sup>142</sup>University of Southampton Institute for Life Sciences, Enterprise activities in the life sciences (presentation submitted through call for evidence)

<sup>143</sup>Stakeholder Workshop 5

<sup>144</sup>OBN, [www.obn.org.uk](http://www.obn.org.uk)

<sup>145</sup>Association of the British Pharmaceutical Industry (2015), Bridging the skills gap in the biopharmaceutical industry: Maintaining the UK's leading position in life sciences, p. 5

## CONCLUSIONS

6.27 Bioscience is an industry in which the UK has global strengths. The way in which the sector works has been transformed in recent years, partly due to a wave of significant corporate restructuring over the past decade, and partly due to the impact of new technology, both on the products that can be brought to the market (such as connected medical devices) and on the way in which research is carried out (with the creation and management of complex data increasingly central to the research process).

6.28 In the South, bioscience is a significant, and high-value, sector. There is strong representation from the larger bioscience businesses and the region has particular capabilities in med tech, and digital health applications linked to changing demand for

health and social care and plant and animal health. In biopharmaceuticals, the way in which the life science industry in the South has ‘bounced back’ from the shock of restructuring (for example in the transformation of Discovery Park) is impressive.

6.29 More specifically to the core theme of this Audit, there are opportunities to link the South’s strengths in Digital Enabling Technologies with the growth of the sector. There is evidence that this is happening – for example, in the case of the Technology Integrated Health Management project highlighted above – and there are likely to be wider opportunities in the security and management of data as well as in the development of new products and services. The challenge for Innovation South is to bring about the optimum conditions to enable that growth.

### How does the evidence in Chapter 6 help us capture the full economic potential of Digital Enabling Technologies?

- Disruptive innovation in bioscience shows how Digital Enabling Technologies are blurring traditional sector boundaries – this process must be supported in order to fully exploit opportunities for further innovation
- The bioscience industry will only transform important areas of daily life – health/social care and food security, for example – if the high level digital skills needed are in good supply
- It will be important that public confidence is built in the use and security of data and the range of benefits that might follow is fully articulated and understood
- There will be a need to ensure that clusters and innovation “hotspots” are supported and collaborative linkages stimulated

# 7. APPLYING DIGITAL ENABLING TECHNOLOGIES – IN ADVANCED ENGINEERING

## CHAPTER 7 – KEY MESSAGES

- The South has an outstanding depth of expertise in relation to advanced engineering, much of it stemming originally from the defence sector – and the assets within and around Farnborough/Fleet and in the Solent need to be recognised fully
- Research strengths in advanced engineering are considerable and go deep and wide across the region. Institutions like the University of Surrey and the University of Southampton have some of the strongest engineering research in the UK. Several smaller, younger universities (e.g. University of Portsmouth, University of Brighton and University of Greenwich) are also ranked very highly in relation to aspects of advanced engineering. It is a region-wide competence and asset with considerable depth
- The South is the chosen location for a number of the UK’s leading engineering businesses, such as BAE Systems, Airbus, QinetiQ, Roke/Chemring and Jankel which are predominantly defence-related. Other types of leading-edge and research-intensive engineering firms are well-represented too: Ricardo (based in Shoreham), for example, supplies the McLaren Formula One team (based in Woking) and there is a huge array of specialist engineering SMEs.
- The relationship between advanced engineering and Digital Enabling Technologies is symbiotic. Advanced engineering disciplines are key to unlocking leading-edge Digital Enabling Technologies and digital enabling technologies are the key to future innovation in advanced engineering. In the region, there are many examples of this relationship, and business growth is following
- The current success of the sector is self-evident but the potential for greater innovation and growth is considerable if the disparate areas of expertise in digital enabling technologies can be harnessed in an integrated fashion

## ADVANCED ENGINEERING AND ITS PRESENCE IN THE SOUTH

- 7.1 Advanced Engineering is the application of knowledge and advanced technologies to solve industrial problems and create wealth. It underpins all industrial sectors that involve manufacturing, design and technology-based services. It translates creativity and ideas into physical realities and new products.
- 7.2 Advanced engineering harnesses digital enabling technologies and at the same time is transformed by them. The combination of advanced engineering and new digital technologies is driving the next wave of industrial revolution, commonly referred to as Industry 4.0<sup>146</sup>. In the future “industry 4.0” world, the creation of value is focused on the manipulation of data for the designs of systems, processes and products all of which can be digitally transmitted to the most appropriate and cost effective manufacturing locations and/or operational centres as

<sup>146</sup>Cornelius Baur and Dominik Wee (2015), Manufacturing’s Next Act, McKinsey

needed. The elements of the supply chain will be connected in an internet of everything, where all dependencies are considered, waste is minimised, and competitive advantage goes to the owner of the most innovative product designs with the most integrated systems for the delivery of the product or service. The impact of this to the intellectual economy of the UK will be significant.

- 7.3 Nationally, the contribution of advanced engineering to innovation and productivity growth is significant. The manufacturing sector alone accounts for 68% of business expenditure on research and development and has a high propensity to export (around 25% of output is exported), while over the past decade, productivity (measured in GVA per hour worked) has grown around three times faster than in the economy generally<sup>147</sup>. Over the long term, general manufacturing employment has declined substantially as the UK's role in mass production has reduced – but employment in advanced engineering is rising and as a consequence, average manufacturing earnings are substantially above those in the economy overall<sup>148</sup>. Increasingly, digitally-enabled advanced engineering activities are located away from sites of production, with R&D taking place in different locations to the physical output.
- 7.4 The South is a powerhouse of UK advanced engineering R&D, historically driven by a concentration of defence interests and civil marine, telecoms, automotive and aerospace industries. It has **major innovation assets** - leading universities, research and innovation institutes, established blue chip **national and multinational engineering companies** with a proud record of nurturing engineering start-up businesses supported by an extensive **network of business parks and enterprise centres**<sup>149</sup>. The data show 113,500 people work in advanced engineering across the region (15% of England total) with strong concentrations of advanced engineering employment in Solent and North Kent (both traditional centres of

manufacturing), Thames Valley Berkshire, Surrey and North Hampshire<sup>150</sup>. Three of the South's local enterprise partnership areas are in the top ten nationally for manufacturing GVA per worker<sup>151</sup> and this reflects the importance of the South's concentration of advanced engineering activity in driving manufacturing productivity elsewhere in the UK.

## DIGITAL ENABLING TECHNOLOGY DRIVERS AND CHALLENGES...

- 7.5 Advanced engineering is increasingly dependent on the utilisation of digital technologies to maintain competitiveness in the global marketplace. Engineering design is largely digital with modelling and simulation capable of allowing complex products to be developed, manufacturing planned, and products tested and certified without numerous stages of prototyping and physically testing.
- 7.6 Manufacturing, quality inspection, maintenance, monitoring of products and reliability is all dependent to varying degrees on the use of robotics, sensors, on-line telemetry and simulation. A combination of big data sets, machine learning and artificial intelligence allows process optimisation, cost reduction, enhanced reliability and improved supply chain logistics. The internet of everything<sup>152</sup> allows data to be transmitted across the supply chain between companies and within companies, linking machinery to the design studio, the materials supplier to the recycling facility.
- 7.7 Products can be monitored in real time remotely. Simple feedback loops used to control machinery and adjust processes are now replaced by predictive algorithms. Rolls-Royce knows how each of its aero engines is performing at any one time and can take pre-emptive action to address performance problems; car companies can predict when a

<sup>147</sup>EEF (2016), UK manufacturing 2016/17: The facts

<sup>148</sup>ONS, ASHE (2015). Mean gross annual pay in manufacturing in 2014 was around £31,500, compared with around £27,600 across the economy.

<sup>149</sup>ONS, BRES (2015)

<sup>150</sup>ONS, BRES (2015)

<sup>151</sup>Coast to Capital LEP (2016), Advanced Manufacturing and Engineering: Sector Report, p.20

<sup>152</sup>The Internet of Everything has become a catch-all phrase to describe adding connectivity and intelligence not only to almost every device but to people, processes and data as well in order to give them special functions. Also see cisco FAQs

body press is going to go out of specification beforehand allowing down times to be scheduled; McLaren monitors its formula 1 cars continuously using advanced telemetry to dynamically determine race tactics. As the link between a product and its suppliers is maintained over time, the business models for advanced engineering companies is evolving to embrace the supply of a service rather than on just the manufacture of a product – a process that is critically dependent on digital enabling technologies.

### 7.8 Key technology driven catalysts for the future<sup>153</sup>:

- **Flexible manufacturing** – the introduction of 3D printing (additive manufacturing) which allows rapid changes in product design (no tooling needed) and the distribution/dispersion of manufacturing sites.
- **The internet of things** applied to industrial processes linking the entire supply chain, facilitating Industry 4.0 and prioritising data as the key value asset. For businesses producing high-value products, such as BAE Systems, services now contribute around 50% of revenues<sup>154</sup>.
- **Advances in robotics** – resulting in greater human-machine interactions and machine learning. This will result in robots engaging in more complex tasks to reduce cost, increase precision and reliability. The consequence being to reduce the need for semi-skilled labour but increasing the need for technical skills in the workforce.
- **Developments in new materials** – which can result in sensors, nanostructures, designer composites are tools that facilitate new product concepts, underpin the practical realisation of technologies such as autonomous systems but may require high precision manufacturing<sup>155</sup>.
- The need to protect **digital supply chains** – the emergence of a digital engineering landscape makes critical processes vulnerable to attack, increasing the need for enhanced cyber security for IOT devices, especially advanced technologies, such as autonomous vehicles and connected cars.



Robotic Arm

7.9 Advanced engineering is particularly susceptible to cost and competitive pressures and this affects the nature of the South particularly, because it is a high-cost location. Continual innovation and disruption is a core constituent of growth within this sector and this comes from the R&D facilities which dominate the South.

7.10 Government support within the South for this sector is most strongly impactful in the area of defence procurement and the approach taken by Government to the commercialisation of defence-related innovation. As well as impacting on overall demand for final products, Government purchasing policy also affects the way in which Digital Enabling Technologies are deployed, with prime manufacturers cautious about investing in untested technologies (such as some applications of quantum technologies) until demand is reflected in the procurement process. The Government should be aware of the investment in R&D made by the intellectual assets and the businesses located in the South and the impact on GVA, job security etc. which results in this activity.

<sup>153</sup>This section is partly drawn from The Manufacturer (November 2016), Five trends reshaping manufacturing; Stephanie Shipp et al (2012), Emerging global trends in advanced manufacturing, Alexandria, Virginia: Institute for Defence Analyses; Marian Mueller et al, (2017), 2017 Industrial Manufacturing Trends, PricewaterhouseCoopers

<sup>154</sup>Aston Business School (2014), Servitisation Impact Study

<sup>155</sup>Bill O'Neill (2014), 'Small is beautiful: Why ultra-precision manufacturing is such a big deal', Institute for Manufacturing Review 1

## ADVANCED ENGINEERING INNOVATION ASSETS IN THE SOUTH

### Universities

7.11 The South has some outstanding university research assets, which are judged as world-class. In the field of electrical and electronic engineering, metallurgy and materials, the University of Southampton is the highest-ranked university in the UK by research

power, according to the Research Excellence Framework, while the University of Surrey is the second highest ranked university. In general engineering, Southampton is again the UK's highest ranked university by research power. Overall, the South contains five institutions ranked in the top 20 nationally in relevant research areas (Greenwich, Portsmouth, Southampton, Surrey and Sussex), and a further four ranked in the top 30:

**Table 7 1: Research Excellence Framework, 2014: Institutions ranked within the top 30 nationally**

Institution rank (of all UK institutions)		
Subject area	Research power	Grade point average
Aeronautical, mechanical, chemical and manufacturing engineering	Portsmouth (16) Greenwich (19) Brighton (21)	Greenwich (14) Brighton (17) Portsmouth (18)
Chemistry	Southampton (8) Reading (28)	Southampton (12)
Electrical and electronic engineering, metallurgy and materials	Southampton (1) Surrey (2) Reading (23) Greenwich (27)	Southampton (6) Surrey (14) Reading (23)
General engineering	Southampton (1) Surrey (14)	Southampton (15) Surrey (25) Sussex (26)
Physics	Southampton (17) Surrey (24) Royal Holloway (27) Sussex (30)	Southampton (11) Surrey (21) Portsmouth (24) Kent (29)

7.12 The South's strengths in Digital Enabling Technologies are directly relevant to its research strengths in advanced engineering. Examples of university research centres include the Rolls-Royce University Technology Centre for Computational Engineering, the Microsoft Institute for High Performance Computing, applied to Engineering, and the Zepler Institute, the UK's largest photonics research institute, at the University of Southampton<sup>156</sup>; and the Centre for Automotive Engineering at the University of Surrey, which has research links with McLaren (based at Woking) as well as the major automotive manufacturers. At the University of Brighton, partnership with Ricardo plc (a technical engineering

consultancy and certification company based at Shoreham) has led to the establishment of the Sir Harry Ricardo Laboratories at the University's Advanced Engineering Centre, specialising particularly in low carbon internal combustion systems. Building on this, the University has recently become the internal combustion 'spoke' for the UK Advanced Propulsion Centre. Reflecting the importance of the defence sector in the South, the University of Brighton's Vectronics Research Centre is also the only academic centre of excellence conducting research in vehicle electronics sponsored by the Ministry of Defence.

<sup>156</sup>The University of Southampton also has strategic partnerships with both Network Rail and the National Grid, focused on high-voltage work, infrastructure and distributed electrical systems.

<http://www.southampton.ac.uk/news/2016/07/green-electrics.page>

[http://www.southampton.ac.uk/engineering/research/themes/geomechanics\\_and\\_environmental\\_geotechnics.page](http://www.southampton.ac.uk/engineering/research/themes/geomechanics_and_environmental_geotechnics.page)

<http://www.highvoltage.ecs.soton.ac.uk/research/conditionMonitoring.php>

### **Early days – and the formation of Ricardo**

Ricardo plc is a global engineering and environmental consultancy business. Founded by Sir Harry Ricardo in 1915, the company has a long history of innovation, starting in the First World War with the development of the first British-designed tank engine to be mass produced. From the 1920s onwards, Ricardo was a leader in automobile engine design, with a significant presence in the motorsports industry. In 2010, this included collaboration with McLaren on the design and development of the M838T engine. Ricardo also has a long history of innovation in the elimination of waste and the efficient use of natural resources, as well as in the supply of technology to the defence industry.

Ricardo now employs over 2,700 engineers, scientists and consultants worldwide.

### **The significance of Digital Enabling Technologies**

Ricardo Rail's range of 'Intelligent Rail' software uses data to continually monitor rail track conditions. Ricardo Software offers simulation and analysis tools for engineering in a range of industries. While not a *manufacturing* business, Ricardo uses digital technologies to add significant *engineering* value.

### **Key collaborations**

Firms working with Ricardo on engineering solutions include McLaren, Volkswagen-Audi Group, Jaguar Land Rover, Ford, Aston Martin and Toyota; in addition, the business acts as an advisor to several governments and runs the UK's National Atmospheric Emissions Inventory.

After placing test equipment at the University of Brighton in 1995, the Sir Harry Ricardo Laboratories were established in 2006, linked with the part-funding of a Brighton academic post<sup>158</sup>.

### **Plans for the future – and key challenges**

Ricardo's foresighting and analysis of future trends particularly focus on the impacts of digital technology. The firm's current focus is on energy and infrastructure; the use of advances in online technologies and autonomous vehicles to relieve the pressure on transport networks; and waste minimisation.

## **Defence, Space, Satellite & Sea**

7.13 Linking engineering and data science, the South has particularly strong capabilities in space-enabled technology. Whilst civilian space assets tend to be coordinated from the Satellite Applications Catapult in Harwell, military space assets and R&D are provided by a number of defence organisations in the South, including Airbus, Lockheed Martin, Serco, L3-ASA, SSTL and a large number of

SMEs. For example, the University of Surrey has pioneered research into small, low-cost space mission since the 1970s, leading to the establishment of SSTL (see case study 7-1 below).

7.14 Currently, Surrey Space Centre conducts research into satellite design, control and application, with close continuing collaboration with SSTL. The Satellite Applications Catapult also supports the South Coast Centre of

<sup>157</sup>Drawn from [www.ricardo.com](http://www.ricardo.com) and [www.ricardo100.com](http://www.ricardo100.com)

<sup>158</sup>University of Brighton, Case study: Sir Harry Ricardo Laboratories at the University of Brighton

Excellence in Satellite Applications, based at the University of Portsmouth: reflecting the cross-sectoral nature of digital enabling technologies. Key market areas for the use of satellite data and technology developed by the Centre include the marine sector as well as manufacturing. Surrey also maintains the Surrey Technology for Autonomous Systems and Robotics (STAR) Lab, which builds on the University's expertise in 'small sat' engineering to develop autonomous systems and robotics for space.

7.15 Surrey Research Park is a university-backed asset within the region that is particularly relevant to the development of advanced engineering. As the case study below highlights, the Park has been successful in incubating and developing a number of companies operating at the interface between advanced engineering and Digital Enabling Technologies, some of which have gone on to become genuinely internationally significant and which remain based within the region:

## BOX 7-2

## SURREY RESEARCH PARK

### *Early days – and the formation of Surrey Research Park*

In the 1970s, the University of Surrey decided to extend its scope to work closely with industry by developing a new science park, to lower the barriers for entry to new, technology-focused businesses. From the outset, the Research Park aimed to facilitate the commercialisation of research, moving beyond simple 'technology transfer'.

### *Surrey Research Park today*

The Park is currently home to around 500 businesses, around 300 of which are broadly ICT-related. To date, over 90% of the Park has been developed. By 2015, the University had invested around £52 million (although the Park had contributed over £96 million in unrestricted independent income for reinvestment by the University), and around 4,000 people were employed on site.

### *Successes in Digital Enabling Technologies*

These include:

- **IDBS**, established in 1989 by two entrepreneurs with a biochemistry background and is now a leading provider of advanced software for research organisations to capture, manage, share and exploit structured and unstructured data. Headquartered at the Research Park, it now operates globally, with offices in the US, Europe and Japan
- **Surrey Satellite Technology (SSTL)**, established by the University of Surrey in 1985 as a spin-out company to commercialise the University's success in demonstrating that small and inexpensive satellites could be developed to perform complex missions. Currently, SSTL has around 40% of the world's small satellite export market. Now employing around 600 people, and still based at the Research Park, Airbus acquired a 99% stake in SSTL from the University in 2009, enabling it to expand further.
- **BAE Systems Applied Intelligence**, established as Smith Associates in the 1970s and subsequently renamed Detica. Based at Surrey Research Park since 1986 and benefiting in its early days from a loan from the University, Detica became a leader in cyber security and communications intelligence and was acquired by BAE Systems for a reported £531 million in 2008. Re-branded as BAE System Applied Intelligence, the company remains based at the Research Park, where it employs around 1,000 staff

## **Non-university research institutions**

7.16 Within the defence sector, the South has several Government scientific research establishments, which form part of an important defence-related cluster in the region. These include the Atomic Weapons Establishment (AWE) at Aldermaston, near Reading, and the Defence Science and Technology Laboratory (Dstl) at Alverstone near Gosport and Portsdown West near Fareham. As well as its core mission to deliver technical support and research to the Ministry of Defence, Dstl has a mandate to develop commercial applications from its intellectual property, and in 2005, established a company, Ploughshare Innovations, to manage investments in spin-outs. Ploughshare is based in Stockbridge, and a number of successful spin-outs have been developed – and remain – in the South, building on their historic links with Dstl and exploiting Digital Enabling Technologies. Examples include Esroe (based at Fareham), which produces software for military use, and Subsea Asset Location Technologies (SALT), based at Portland. Dstl has a significant SME engagement and R&D outreach programme, which attracts a number of businesses to the South where they can be close to customer and supply chain/ partnering engagement opportunities.

### **Commercial – rooted in Innovation South; resonating throughout the UK**

7.17 The South has a concentration of internationally-significant engineering businesses, with a large number of aerospace & defence companies around Farnborough, such as QinetiQ, headquartered in Cody Technology Park, Farnborough (and with other sites in the South such as Alverstone, Chertsey and Fort Halstead, near Sevenoaks); Thales UK, in Reading; BAE Systems, also headquartered in Farnborough has operations in Surrey, Hampshire, Dorset and Kent; Airbus UK, whose defence and space operations are based at Farnborough and Portsmouth; and Lockheed Martin UK.

7.18 This area of the South has strong functional and operational links with other parts of the UK, for example with defence, aerospace and security related activities in the West of England and the North West. This creates a cohesive interdependent workforce and supply chain located within a relatively small geographic area within the South.

7.19 The scale of activity around Farnborough, including the International Airshow which in 2014 attracted orders and commitment over \$204bn<sup>159</sup>, has led to the development of Farnborough Aerospace Consortium, the longest established aerospace and defence trade body in the UK. FAC primarily exists to facilitate supply chain links between the large global ‘primes’ located in the region and SMEs, through a series of programmes focused on technology transfer and skills and training. Currently, FAC supports around 300 businesses located within the South<sup>160</sup>.

7.20 Focused at Bournemouth Aviation Park, there is also a concentration of aerospace and advanced engineering firms in Dorset, including Cobham, Meggitt and Magellan Aerospace who play an important role a national and international supply chain.

### **Space + 5G technologies - “A golden opportunity for Innovation South & the UK to lead the world”**

7.21 The Innovation South region has a particularly strong space industry. In the report “The Size and Health of the UK Space Industry 2016”, the South East region was top for the number of organisations engaged in space-related activities, and second only to London for space industry income for 2014/15. The South East<sup>161</sup> also had the second highest number of people employed in the space industry.

7.22 This strength in the space sector, combined with the Innovation South assets in digital enabling technologies in the telecommunications sector, enables a golden opportunity for the region to exploit the emerging 5G infrastructure ecosystem.

<sup>159</sup>2015 study by Repucom on behalf of Farnborough International Ltd. See link to media release

<sup>160</sup>Farnborough Aerospace Consortium

<sup>161</sup>South East figures are the closest proxy for Innovation South. Official South East data do not reflect Dorset. They do include the rest of Innovation South, plus Oxfordshire, Bucks and Milton Keynes. Any additional numbers for Dorset will be included in figures for the whole of the South West

Innovation South has the opportunity to become the global lead for 5G infrastructure development by developing this integrated terrestrial/space ecosystem in the region.

7.23 For example, space technology is an ideal candidate for resolving capacity and coverage issues faced by the cellular network evolution

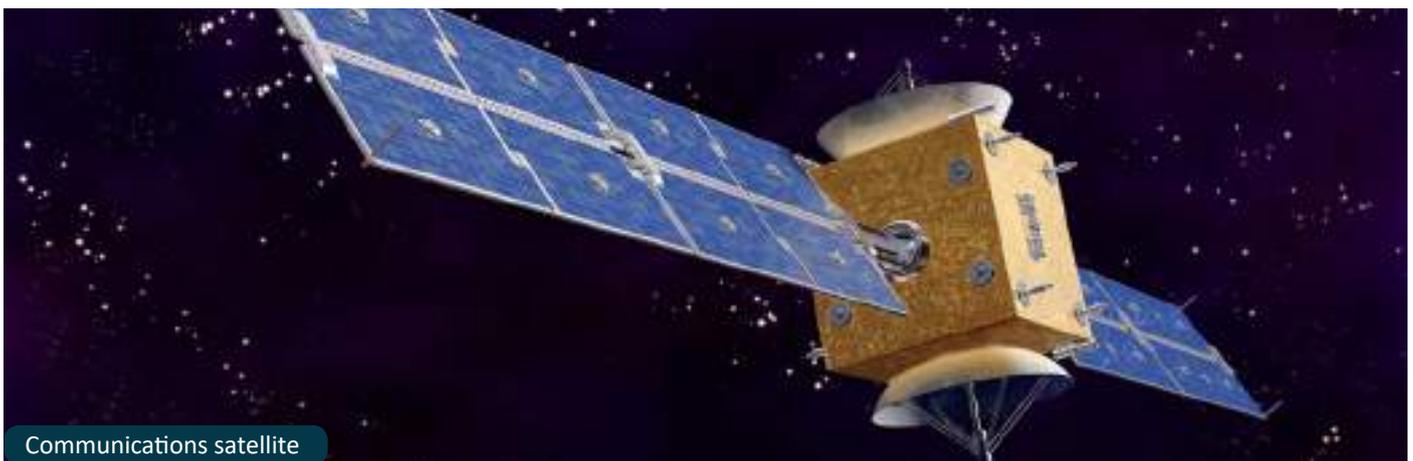
towards 5G, particularly in areas where it will prove very challenging to do so terrestrially (e.g. dense city centres and rural areas). The 5GIC facility is already providing leadership for terrestrial 5G, and Airbus Defence & Space has an established working relationship with the University of Surrey.

### BOX 7-3

### QUANTUM SATELLITE<sup>162</sup> CASE STUDY

Quantum is an innovative advanced telecommunications spacecraft designed to provide a flexible in-orbit reconfigurable payload for GEO satellite applications. Quantum is being implemented in a public-private partnership between ESA, Airbus Defence & Space and Eutelsat.

- Quantum is a pioneering mission that will influence how telecom satellites are procured and built in Europe by offering a new, generic payload design. It is intended to be more flexible, faster and cheaper
- The first Quantum satellite will be delivered in 2018 and operated by Eutelsat to serve government, mobility and data markets. Airbus DS will be the prime contractor, using a new platform from Surrey Satellite Technology Limited (SSTL). Both developments are supported by the UK Space Agency.
- This approach will have a far-reaching effect on European competitiveness in the commercial flexible communication payloads market across a large range of payload sizes.



Communications satellite

7.24 Beyond aerospace and defence, the South also has commercial strengths in the development of technologies for the automotive sector. The region hosts Rolls-Royce Cars, at Goodwood, McLaren at Woking, Gordon Murray Design at Shalford, Alexander Dennis (Bus Chassis) at Guildford and Delphi (diesel systems) at Gillingham, all of whom are involved in the

design of advanced automotive systems.

7.25 There are automotive companies in the South that are seizing opportunities for disruptive innovation by deploying their expertise in digital enabling technologies and diversifying into other lucrative sectors. A good example is McLaren:

**BOX 7-4****APPLYING TECHNOLOGIES ACROSS SECTORS: MCLAREN<sup>163</sup>**

McLaren Technology Group is a high-technology company based in Woking. Best known for the development of Formula One racing cars and (more recently) a range of luxury high-performance sports cars, McLaren Applied Technologies uses the Group's R&D and technical expertise to improve innovation in a range of other industries.

McLaren's strengths draw on its particular expertise in data collection and analysis, high performance design and the development and manufacture of advanced electronic control systems. In McLaren's historic 'core business' of motorsport, this has involved developing a standard set of Formula One electronics and linking complex electronic and mechanical components with embedded software to support new racing car and bike design.

Beyond the automotive sector, McLaren is using its digital technology strengths to address challenges in health, wellbeing and energy. McLaren's experience in installing advanced sensors in racing cars, and its success in collecting and analysing data has led it to work with GlaxoSmithKline to develop wearable technologies. Recently, these have been used to monitor patients recovering from strokes and managing neurological disorders and in improving sports safety standards.

In the energy sector, McLaren is also working with a large operator in the Ekofisk oil and gas field in the North Sea, developing a computer model that takes real-time data direct from the drilling head to provide constant insights to support decision-making. Building on this, McLaren is working on a new project to build a drilling simulator. Simulation technology is also the focus of a partnership with the National Air Traffic Control Service (based at Swanwick), developing a system that enables air traffic controllers to optimise the flow of air and ground traffic. Using high performance design expertise, the firm is also collaborating with IO, one of the world's largest data centre technology companies, to improve data centre design.

These examples take McLaren into fields very different from those envisaged by Bruce McLaren when he developed his first Formula 1 car in 1966. But they illustrate how the combination of engineering expertise and digital technologies are blurring conventional sector boundaries - enabling some of the South's most innovative businesses to address a wide range of challenges.

7.26 A revolution in mobility is taking place through the introduction of connected and automated vehicle technologies with the promise of safe, cleaner and more efficient movement of people and goods. Research organisations in the Innovation South region are at the cutting edge of this revolution. TRL (the UK's Transport Research Laboratory) based at Wokingham is highly prominent in developing how automated vehicles will deliver an improved transport system. Having worked in automated vehicles for more than 50 years, TRL is leading the £8m GATEway (Greenwich Automated Transport Environment) project, investigating

public trust and acceptance of automated vehicle technologies through real world demonstrations and trials. This is one part of a current portfolio of project work in this area with value exceeding £50m. BAE Systems also have a long history in automated vehicle development and are contributing to the £8m Venturer project to demonstrate automated vehicles in Bristol. Thatcham Research, located near Newbury, the motor insurance automotive research centre, is heavily engaged with the car manufacturers (particularly Volvo) in developing the standards for automated vehicle safety, operation and repair. Another

<sup>163</sup>Drawn from [www.mclaren.com/appliedtechnologies](http://www.mclaren.com/appliedtechnologies)

key regional asset is Ricardo plc, based at Shoreham, with strengths in the development of systems for autonomous vehicles, through Ricardo Agent Drive, simulation software to test complex driving situations for autonomous road vehicles<sup>164</sup>.

- 7.27 Key university contributors to autonomous vehicle research include the University of Southampton with work on driver behaviour and the University of Sussex on ethical issues related to artificial intelligence and automation. The University of Surrey's 5G centre is playing a critical role in determining how connected and autonomous vehicles communicate with one another and with infrastructure as part of an integrated transport system using high speed, large bandwidth and low latency networks. Cyber security will be essential in such networks and the region is well placed to address this issue with resources such as Royal Holloway's Information Security Group (ISG) and industrial concerns such as Thales, based at Crawley.
- 7.28 The marine and maritime and med tech sectors have been highlighted earlier but it is notable that the Universities of Southampton, Solent and Portsmouth are both recognised for their work in autonomous marine systems.
- 7.29 The physical location of test facilities for connected and autonomous vehicles defined by the UK government has a degree of overlap with the Innovation South region, including the A2-M2 corridor and the offices of TRL and the University of Surrey. Furthermore, it is clear from the expertise and capabilities highlighted above that organisations outside of the defined region yet within Innovation South can provide significant technical input to the test activities undertaken there – for example, modelling and simulation input from University of Southampton or cyber security input from Thales at Crawley.

## **Skills and talent**

- 7.30 Despite the nationally-significant concentration of advanced engineering activity around Farnborough and the M3 corridor, industry members, who contributed anecdotal evidence in Audit discussions, considered that engineering is 'less visible' in the South than in other regions such as the North West<sup>165</sup>. This may reflect the fact that traditionally, the South (with exceptions, such as North Kent) has not been seen primarily as a manufacturing location, and has a generally buoyant service sector.
- 7.31 This appears to have impacts on the ability to recruit new entrants to the workforce, given the general strength of the labour market in the South; and the competition for people with strengths in Digital Enabling Technologies for advanced engineering up against the "glamour" of rapidly growing media-related sectors, such as gaming. Responding to perceived STEM-related skills gaps, considerable efforts are being made to expand the higher education teaching offer in support of the economic opportunities associated with advanced engineering. Notably, the University of Chichester is developing an Engineering and Technology Park (due to open in 2018), including a School of Engineering and Applied Design. Canterbury Christ Church University has also recently secured funding for a similar facility, based on extensive involvement from engineering employers in East and North Kent.
- 7.32 Royal Holloway University of London has just launched an Engineering School with a new Department of Electronic Engineering at its Egham campus where it is stressing the creative element of engineering in order to attract more women into the field. The University of Winchester is one of the pioneering institutions in the UK for the design and development Degree Apprenticeships, and in partnership with employers, CGI, Fujitsu and SMEs has established a portfolio of degree apprenticeships in Digital and Technology Solutions. The Isle of Wight College has opened

<sup>164</sup>Ricardo plc (2016), White Paper: Key enablers for the fully autonomous vehicle, [www.ricardo.com/connected](http://www.ricardo.com/connected)

<sup>165</sup>SIA Stakeholder Workshop 3

a specialist education Centre of Excellence for Composites, Advanced Manufacturing and Marine (CECMM).

## CONCLUSIONS

- 7.33 The South's advanced engineering capabilities are at the centre of the UK's defence and aerospace sector, an area in which the UK has a strong comparative advantage; serves as the base for several major engineering corporates and contains a substantial stock of smaller engineering firms with high demand for Digital Enabling Technologies.
- 7.34 While the South does not, generally, contain major production facilities, it is a significant location for the innovation in design and

manufacturing, and this is underpinned by evidenced world-class strengths in engineering research, which are closely connected with, and regularly inseparable from, the region's strengths in Digital Enabling Technologies.

- 7.35 Given the South's specialism in the high-value, innovation-intensive end of engineering, sustaining its position depends on maintaining its 'leading edge' in a highly competitive international market, and being able to recruit high quality engineers. In the view of the Innovation South consortium the development of strategies for rising to these challenges would be a highly valuable outcome of this Audit.

### How does the evidence in Chapter 7 help us capture the full economic potential of Digital Enabling Technologies?

- The cross-cutting deployment of digital enabling technologies has great potential for innovation across sectors. The region should cultivate an environment which maximises these opportunities
- Advanced Engineering is an important sector region-wide and is increasingly dependent on digital technologies to maintain global competitiveness. Businesses need the engineering and digital skills to match
- In the future, collaboration is likely to be increasingly important: Digital Enabling Technologies will be both a catalyst and a requirement and the sector (which has been quite disparate) will need to respond
- In encouraging the growth of smaller businesses, appropriate links to the region's network of innovation centres and incubators will be important
- With an existing R&D market – given links to defence – the advanced engineering sector is one in which Quantum technologies will start to be adopted and it will be important that the region is ready to respond, as these technologies mature one after another over the next couple of decades.

## 8. CONCLUSIONS, KEY FINDINGS AND GAP ANALYSIS

### INTRODUCTION

8.1 This Audit confirms Innovation South is a region with outstanding strengths in the Science and Innovation of Digital Enabling Technologies. It demonstrates a high performing “commercialisation chain” and shows the South is intrinsically equipped to compete in international markets.

8.2 The examination of the commercial application of Digital Enabling Technologies, in four of the South’s high tech, sectors: (Advanced Engineering, Bioscience, Connected Digital and Marine & Maritime), shows current performance and potential opportunities are vast.

8.3 This Science and Innovation Audit demonstrates how these strengths and its high-performance position Innovation South as a UK-wide national asset. The evidence builds a robust and timely case for ensuring the strengths of Innovation South reach every part of the South; impact across the UK and are maximised and sustained.

### OPPORTUNITIES IN INNOVATION SOUTH’S FOUR KEY SECTORS

8.4 Following the trail of evidence in this Audit, there are clear signposts mapping ways to maximise the region’s strengths in the application of digital enabling technologies in the four chosen sectors. Innovation South has a proven “culture of commercialisation” of its science and technology; and outstanding capabilities in the support of business growth to match.

8.5 The intrinsically collaborative nature of the 5G Innovation Centre and the track record of SETSquared, as evidenced in this report, are just two of many shining examples. The Audit process has galvanized a strong regional ambition to maximise and spread best practice in collaboration, commercialisation and growth support.

8.6 The opportunities to build on existing networks and forge new ones are clear. The innovative creative digital community in Brighton, and the cohesiveness of the high tech marine and maritime sector on the South Coast are exemplars. There is a substantial “innovation, productivity and growth prize” to be won by forging new networks and greater connectivity in biosciences in the South, specifically focused on taking full advantage of the region’s digital technologies.

8.7 The South specialises in high-value, digitally enabled, innovation-intensive activity. This regional distinction is the route to globally competitive growth in each of our themes: advanced engineering and design, bioscience, connected digital and marine & maritime. A specialist economy provides great opportunities to those with the specialist skills to match - the supply of that talent is key.

8.8 Further analysis of the key findings and opportunities for Innovation South are set out below.

## KEY FINDINGS & OPPORTUNITIES

- The evidence gathered through this Science and Innovation Audit of Innovation South leads to three overarching conclusions:
  1. Although there are local variations, the economy is intrinsically international, underpinned by valuable connectivity and a highly-qualified workforce
  2. The relentless drive for higher value – which is imperative within the South – means that Digital Enabling Technologies are crucial for future competitiveness
  3. The South has demonstrable excellence in producing and developing Digital Enabling Technologies, and it has vast potential to apply and commercialise them
- To unlock and accelerate this process, five opportunity areas are identified, and all five should be advanced. These are:
  1. Knowledge-to-Market Accelerator – to augment the commercialisation process region-wide
  2. Linking Innovation Hot Spots – to ensure the infrastructure to support the process of innovation is consistently excellent region-wide
  3. Developing the 5G Innovation Centre – to build the capacity and reach of the 5GIC even further, unlocking a new generation of high growth digital businesses in the South and other UK regions, fit for a global competitive market
  4. Quantum supply chain initiative – focused on the research market in anticipation of the full commercial application of quantum technologies
  5. Advanced skills in Digital Enabling Technologies – led by the private sector to ensure digital businesses operating across all sectors in the South are able to recruit the workers they need

## OVERARCHING CONCLUSIONS

8.9 From the preceding analysis, three overarching conclusions stand out:

***The South's economy is intrinsically international, underpinned by valuable connectivity and a highly-qualified workforce***

8.10 The international connectivity which characterises the economy of the South has been demonstrated in this Audit through high level data relating to exports, foreign direct investment and patterns of company ownership<sup>166</sup>. Looking across the themes and sectors under examination, the international nature of individual firms' workforces is evidenced; as is the extent to which technology-based businesses in the South – even very small ones – are developing commercial links with customers around the world.

8.11 This underlying pattern of global connectivity equips the region's digitally-enabled economy to compete in global markets, and many businesses in the Innovation South region are performing strongly internationally. The challenge is to maintain and increase this number.

8.12 Brexit carries potential opportunities and risks, not least in the supply of high skilled labour. Knowledge-based businesses which are nurtured and grown within the South must be recognised as a part of a global economy and they need access to a global labour market: on that basis, they will fail or thrive.

8.13 Costs are a challenge – particularly during the early stages of the commercialisation process. Across much of the South: labour, housing and employment sites/premises are relatively

<sup>166</sup>As noted in Chapter 2, there are local variations in relation to this overall picture. On most indicators, Thames Valley Berkshire stands out in terms of international activity. Performance is more variable elsewhere within Innovation South

expensive. Along with major issues around infrastructure and congestion, they pose challenges. Advancing the process of commercialisation - always difficult and uncertain - in a relatively high cost environment adds pressure. The positive upshot is these high costs - to some extent, inevitable consequences of a strong economy - provide powerful incentives to pursue extra growth and innovation.

***The relentless drive for higher value means Digital Enabling Technologies are critical for future competitiveness***

- 8.14 It is because the South is a relatively high cost location that the imperative to achieve gains in productivity is relentless. Resources must be used well. This in itself is a driver for the adoption of Digital Enabling Technologies region-wide.
- 8.15 In marine and maritime, for example, digital solutions need to be found for the “dirty, dangerous and dull” elements of the sector, and the South is leading the way. In bioscience and healthcare, the possibilities surrounding digital health are particularly important for a sector that is struggling with recruitment and, as elsewhere, has an ageing population.
- 8.16 Although there are societal, regulatory and other barriers linked to the fuller adoption of Digital Enabling Technologies (see Table 3 1), the possibilities for the South are vast. The effectiveness with which these challenges are navigated will fundamentally shape the region’s well-being for decades to come, as much in relation to the overall quality of life, as to more immediate processes of wealth creation.

***The South has demonstrable excellence in producing and developing Digital Enabling Technologies, and it has vast potential to apply and commercialise them***

- 8.17 The main finding from this Audit is that Innovation South has an outstanding asset

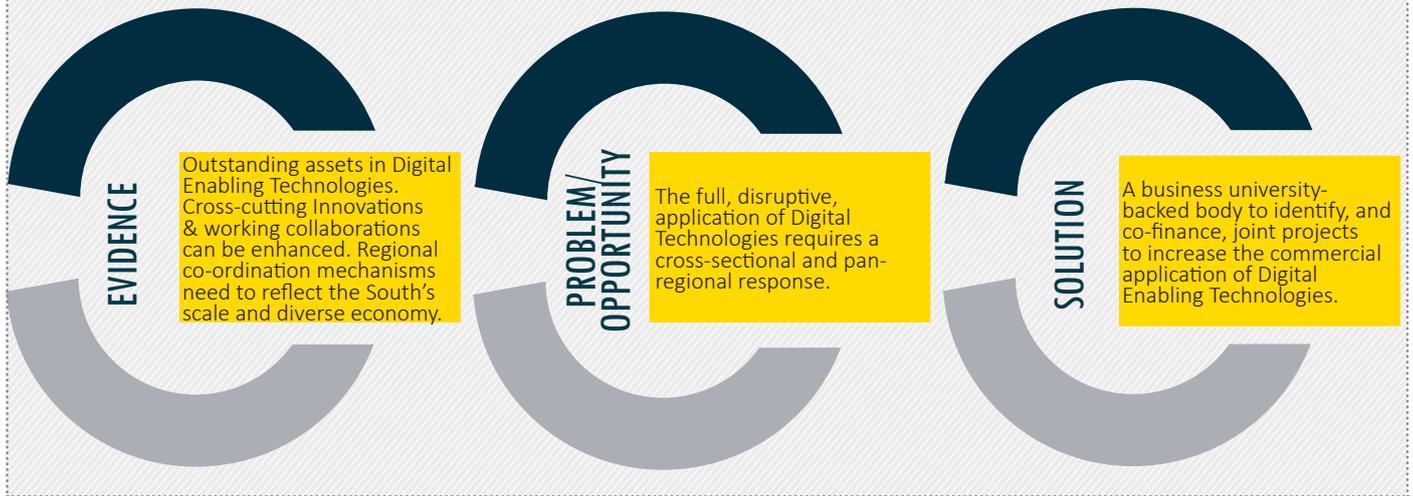
base and competence in relation to Digital Enabling Technologies. This can be seen throughout the “commercialisation chain” – from the science in the region’s universities and research institutions, through the early application of that science in research-intensive businesses, to its wider deployment downstream. The process of translation is challenging and the South benefits from a generally effective supporting infrastructure. As a global region, it must rise to the challenge of benchmarks that are both high and rising incessantly.

## OPPORTUNITY AREAS

- 8.18 The evidence of this Audit and its conclusions highlight areas of opportunity to ensure the region’s Digital Enabling Technology capabilities are nurtured and harnessed such that they appropriately shape the economy of the South over the decades ahead. Highlighting areas of opportunity – and returning to the initial hypothesis set out in paragraph 1.4 – the question that follows is what more could and should be done.
- 8.19 Five responses stand out. All five are grounded in the evidence of specialist strengths, assets and opportunities in the five areas identified for examination in the Innovation South Audit. While all address market failures and are likely therefore to require some level of public subsidy, partners across the South – in the universities, research institutions, local enterprises and local authorities – are prepared to commit their own resources to driving them forward. The expectation also is that the private sector will play a very substantial role (in cash or in kind) in advancing them.
- 8.20 The five opportunity areas are summarised (in no particular order) in the paragraphs below. In each case, a more detailed high level outline business case is presented in Annex A.



## KNOWLEDGE-TO MARKET ACCELERATOR



8.21 The purpose of the proposed Knowledge-to-Market Accelerator is, fundamentally, to harness the region's outstanding research assets in relation to Digital Enabling Technologies with applications across the four key sectors, highlighted in this Audit, and beyond, to effect greater levels of collaboration – both among research institutions across the South, and between researchers and the wider

business community (including both SMEs and corporates). This will lead to more systemic innovation, probably of a disruptive form. It will be seeded through small-scale innovation projects within the region, overseen by a body which will morph out of the Innovation South Science and Innovation Audit stakeholder partnership.

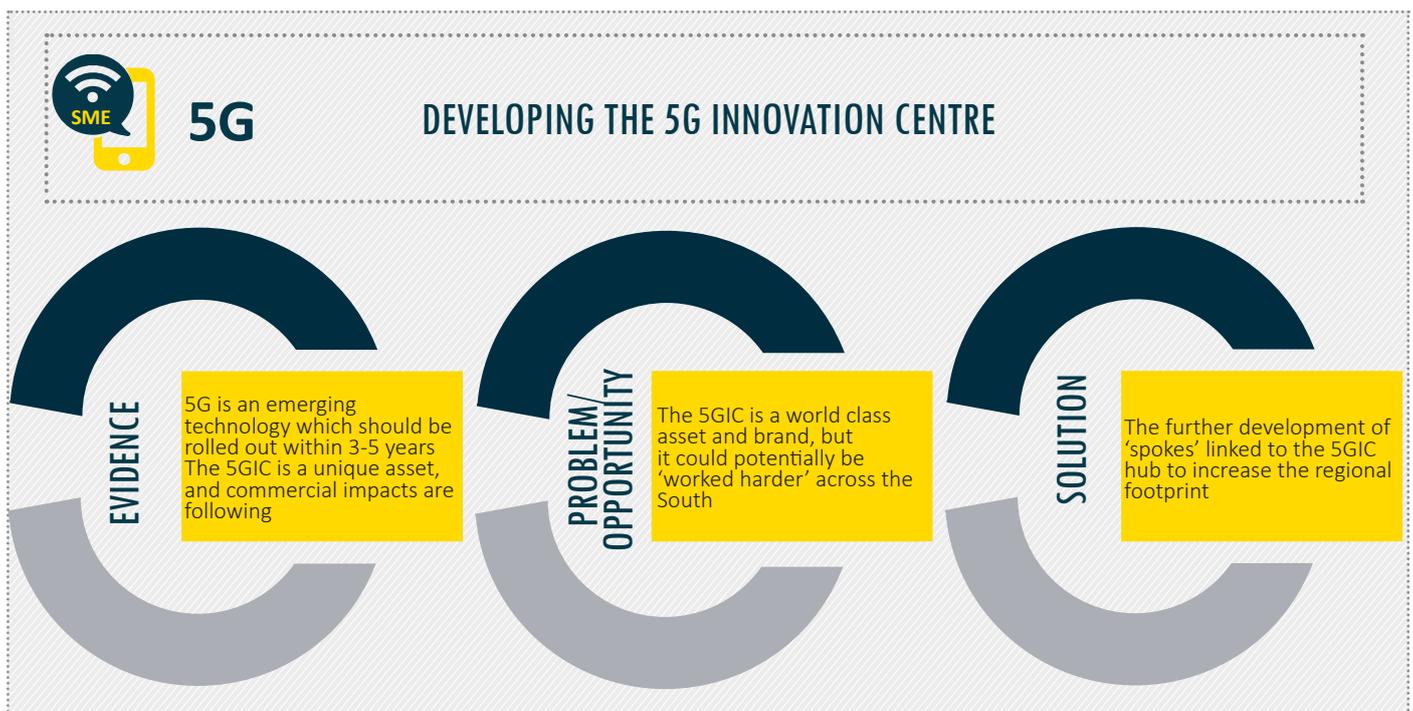


## LINKING INNOVATION HOTSPOTS



8.22 The South can claim some of the most effective systems of support for small, innovative businesses anywhere in the UK; in this context, the work of SETsquared and the model it has developed has been widely applauded<sup>167</sup>. However, it is also true to say that region-wide, patterns of provision are very variable. SETsquared itself works through the University of Southampton and the University of Surrey – but there are 14 universities in the region in total. Elsewhere, approaches to the support of early stage businesses tend to be more ad hoc, both within the ambit of the universities

and beyond. The inference is opportunities are being lost and innovative small businesses are not being supported on a consistent basis. The aim of this intervention is to remedy this by exploiting the underpinning science asset base more fully, and to create stronger innovation clusters across the theme areas of this Audit. There is a particular need to link the innovation hot spots more effectively in Bioscience, although the ambitions for this intervention would include all the sectors studied in this Audit and, longer term, beyond.



8.23 As described in Chapter 3, through the 5G Innovation Centre, the South has a major resource in developing the full potential of 4G and 5G, and businesses like AccelerComm are leading the way. From its base at the University of Surrey, the 5GIC has recently invested in a demonstrator in Basingstoke, providing firms engaged in 5G applications access to the latest technology. The intention

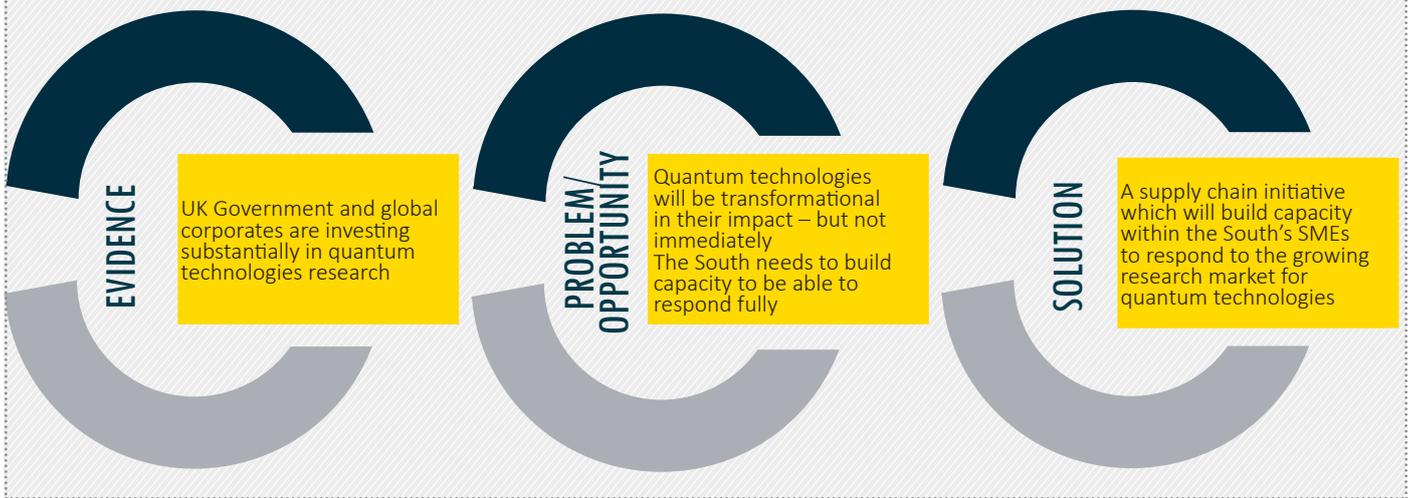
is to develop this network of “spokes” more fully across (and potentially beyond) the geography of Innovation South.

8.24 Potentially, this venture could connect with “Linking Innovation Hotspots” to provide a region-wide infrastructure for small businesses seeking to commercialise and use world-leading Digital Enabling Technologies.

<sup>167</sup>This was considered in Box 2-2. See also the discussion in Chapter 2



## QUANTUM SUPPLY CHAIN INITIATIVE



8.25 Quantum technologies will be transformational, and the South has great potential to take advantage of this. However, while much of the underpinning science is understood, end-applications are generally some way from full commercial application and the need for research funding will continue for some time. It is likely that defence applications will be the first to come forward, but the major defence companies (such as BAE Systems, Thales and QinetiQ, all of which have a strong presence in the South) are unlikely to invest until there are strong procurement signals from Government. In short, there is likely to be a huge commercial market in the future, but this is still developing – although the cluster in the South is well placed to respond.

8.26 The scale of pure investment into the science is creating an immediate and significant opportunity to sell into the research market. The South has existing commercial strengths in this area<sup>168</sup>, and this market is likely to grow. This will be important for the South's – and the UK's – ability to build a presence in quantum devices when their wider commercial application takes off. New applications, especially in advanced engineering and marine and maritime, will require a supply chain, and an existing stock of expertise will help to attract future investment. So how can we build a quantum supply chain based on existing

research demand in preparation for the longer term expansion of commercial opportunities?

8.27 The Government recognises the need to bridge the gap between the potential of quantum technologies and their commercialisation – for example, the National Quantum Technologies Programme aims to make the UK “a leading player in the global quantum technologies supply chain”<sup>169</sup>. In the South, there is an opportunity to take a lead in this, complementing scientific research investment. This might take the form of a “Quantum Technology Park”, acting as a hub for an inclusive region-wide network to deliver the following objectives:

- Enable start-up and scale-up SMEs to utilise the outstanding facilities held with the region's universities and Government labs to accelerate, for example, prototype device manufacturing, digital design, and testing
- Provide targeted financial and advisory assistance to quantum technology SMEs, where they are seeking to enter new markets in the UK or overseas
- Facilitate stronger links between SMEs and primes, particularly in the advanced engineering and marine and maritime (especially defence-related) sectors.

NB There is synergy between this and the “Innovation Hotspots” initiative.

<sup>168</sup>For example, Covesion (based at Romsey), which supplies non-linear optical crystals; Fibercore (based at Southampton), which is a major producer of optical fibres; and MSquared (based at Guildford), which develops and manufactures lasers and photonic instruments

<sup>169</sup>EPSRC, UK National Quantum Technologies Programme



## FUTURE SKILLS IN DIGITAL TECHNOLOGIES



8.28 The South benefits from a well-qualified working age population and high employment rates compared with the rest of the UK. However, a strong supply of high-level skills in digital enabling technologies is critical to future competitiveness in the South's high-value economy, where substantial growth will depend on innovation. Significant skills shortages and gaps threaten the full development and exploitation of digital enabling technologies. In the SIA workshop discussions, a theme emerged that finding advanced digital skills is challenging, particularly in less "visible" sectors. Gaming is very successful in the South and it generates much interest from young people, but embedded software for example, perhaps within the maritime sector or within an advanced manufacturing firm, is a less immediately-attractive proposition, and these sectors – which are important in the South – find recruitment especially difficult. Potentially, the labour market could tighten if there is greater difficulty in recruiting from overseas, further strengthening the case for commitment to home-grown talent.

8.29 The supply of skills is a shared responsibility between the private (corporates and SMEs) and public sectors at the national, regional and local levels. The full advantages of digital enabling technology will not be realised unless there is a workforce outside the immediate research base to take up the innovations. There are two broad areas of action where we believe regional leadership can make a difference in the South.

8.30 First, inspiring the next generation of technologists – and ensuring that they are aware of the scale and range of opportunities in digital enabling technologies – is vital. Major events in the South, such as the Farnborough Airshow, Land Rover BAR (Ben Ainslie Racing) and the Goodwood Festival of Speed, are important opportunities to inspire young people. There is an ambition to link the region's major corporates and smaller businesses in a coordinated programme to promote and champion the South's digital future and the exciting employment and business opportunities it will bring.

8.31 Second, in a tight labour market and with strong competition for talent, businesses and providers share a mutual interest in stimulating the supply of advanced level digital skills. This is critical to the future competitiveness of the key sectors identified in this Audit. The process of developing the Science and Innovation Audit has already opened up new dialogue between businesses and universities. Looking to the future, we would like to build on this and develop a more sophisticated approach to skills demand aggregation to help address skills gaps. One way we propose to address this is through a brokerage programme backed by universities and industry.

## MOVING FORWARD

8.32 The Innovation South Science and Innovation Audit has generated substantial local enthusiasm and commitment. Through the workshops that were at the centre of our evidence gathering process – and through five meetings of a Strategic Steering Group and wider Advisory Group – connections between businesses (both SMEs and corporates), universities, research institutions, local authorities and local enterprise partnerships from across the Consortium have been developed and strengthened. Substantial momentum has been generated and the Consortium is committed to driving forward the agenda set out in this report. It will now devote its own time and resources to furthering this venture. In addition, it is keen to work closely with Government in seeking to unlock fully the opportunities and potential linked to the region's Digital Enabling Technologies both for the benefit of Innovation South and the whole of the UK economy.

