

## Mobile VCE

innovation for the global communications industry

transforming lifestyles  
transforming business

user interaction

green radio

m-health

ubiquitous services

peered content

u-commerce

wireless enabled industry

p2p/m2m/a2a

personal environment

video conference

# Virtual Centre of Excellence

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***a unique company  
for a unique industry***

In two decades wireless personal communications has revolutionised telecommunications and impacted economies and societies around the world. Today more individuals have access to a cellphone than to a car, a television or the Internet. Yet, in what is only the second century of radio, there lies ahead huge untapped potential.

Information and communications transforms economies, individual lives and whole societies. The next wave of technological evolution will give ICT companies tools to support the world's 'big issues', with the creation of new industries, major changes to business models and personalised support for needs and lifestyles.



Mobile VCE offers a proven, highly leveraged framework for open innovation, enabling our industrial members to accelerate transformation of industry, business and lifestyles

Mobile VCE is a unique not-for-profit company, established in 1996 to undertake technology research to underpin and accelerate such visions. Global telecom operators, manufacturers and other players today use their membership of Mobile VCE to harness, direct and harvest the capabilities of the UK's world-renowned research Universities to identify new research approaches, accelerate their own technology developments and create new commercial opportunities. Many recently commercialised developments reflect early Mobile VCE pioneer research – which has subsequently become today's mainstream.

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## **objectives and success factors**

When established in 1996, it was intended that Mobile VCE should be Industry-led, should fully harness the research expertise of the UK's Universities, and should retain strong relationships with Government, to accelerate industry growth.

Mobile VCE was thus constituted as a not-for-profit company with the following objectives:

- To harness the research efforts of a selected group of UK universities into a cohesive world-class Centre of Excellence, focused on personal communications technologies and applications
- To influence the direction of long-term research through dialogue between industry and the academic community
- To carry out programmes of research with a particular emphasis on cross-disciplinary and well managed programmes
- To provide a mechanism for industry to work collectively with key universities to secure the necessary flow of the most skilled experts in the new technologies
- To secure international recognition

Mobile VCE exceeded these goals and transitioned quickly from an unproven initiative into a demonstrably effective instrument for delivering value to the global communications industry.

Mobile VCE's sustained success in delivering world class, industry relevant, research is globally recognised and derives from four key fundamentals:

- Strong and Sustained Industrial Leadership
- Commitment from the UK's Top Research Universities
- Research Excellence
- Global Perspective and Engagement

Mobile VCE's research outcomes are utilised by companies based in Europe, Asia and North America. They are recognised as having played a significant role in shaping the evolution of the wireless industry. Looking forward, they will enable the industry revolution that awaits us in the next few years.

### **Mobile VCE directors**



**Michael Walker**  
Vodafone



**Jonathan Leigh-Smith**  
BT



**Shaun Cairns**  
Alcatel - Lucent



**Stephen Hope**  
Orange



**Tao Cai**  
Huawei



**Rahim Tafazolli**  
Surrey University



**Peter Grant**  
Edinburgh University



**Hamid Aghvami**  
Kings College



In recent times a consensus has emerged regarding the opportunities presented by the next stage of evolution of wireless telecommunications, Internet and ICT. These opportunities will transform those industries that lend themselves to the application of

this rapidly evolving technology and will also create new business models.

The recently published report 'Digital Britain' (1) highlights the opportunities and outlines a strategy to ensure that *UK plc* benefits significantly from these opportunities. Mobile VCE will be at the forefront of the R&D that will enable this transformation and will be working with its members and partners to develop such opportunities. I hope that you will wish to join us on this exciting journey.

**Dr Keith Baughan**  
Chairman, Mobile VCE

(1) 'Digital Britain', 2009, report to Parliament, led by Lord Stephen Carter, Minister for Communications, Technology & Broadcasting. Published by the Department of Culture, Media & Sport and the Department for Business, Enterprise & Regulatory Reform. ISBN: 9 78 010175 4828



Communications have evolved enormously since the mid-1990s when Mobile VCE began to pioneer Open Innovation, before that term had been coined. The opportunity to direct and harness world-leading research, with high financial leverage, today is valued worldwide. This is reflected in the

globalised industry membership of Mobile VCE and in independent assessments of the quality of its research.

Mobile VCE's research directions are building upon and beyond wireless and Internet, with green technology, flexibility, personalisation and cross-industry applications increasing in importance, in a service-driven era.

As you read, I am sure that you will glimpse something of the vision, dynamism, innovation and industry-relevance that drives Mobile VCE and its members.

**Dr Walter Tuttlebee**  
Chief Executive



Mobile VCE's research outcomes are utilised by companies worldwide. They are recognised as having played a significant role in the evolution of the wireless industry



## *world class, industry led, strategic research*

### **High quality**

Mobile VCE's research is funded by industry and financially supported by the UK Government. Independent audits for research quality and effectiveness have consistently assessed the research as 'Internationally Leading' and 'World Class'.

A substantial portfolio of granted patents has been generated over the past decade, available royalty free to our Industry members.

### **Industrially relevant**

Mobile VCE's industry members define the research challenges and meet regularly to oversee the resulting programmes - providing direction, reviewing progress and making decisions on patent filings and publications, thereby ensuring industrial relevance and research quality.

### **Strategic**

In today's fast moving industry companies still need access to strategic long term research, but find it increasingly difficult to undertake this alone. Recent commercial developments reflect Mobile VCE's early research, based on an IP core infrastructure. Tools, techniques and concepts from Mobile VCE programmes are used by member companies in different ways, reflecting their own strengths, roles and business models, leveraging in-house capabilities.

### **Performance**

Mobile VCE's reputation has been earned by a decade of effective delivery, evidenced by relevant outputs and objective assessment. This level of performance has been facilitated by the evolution of long-term relationships of mutual trust and respect amongst key players from the industrial and academic worlds.



Mobile VCE R&D Demonstration Day, hosted at BT Centre, 2008

Mobile VCE  
Ubiquitous Services  
R&D Demonstration Day

Virtual Centre of Excellence in  
Mobile & Personal Communications

## **exploitation by industry**

Industry exploits Mobile VCE's capabilities via three main mechanisms:

**Core research: 'seed and feed'** - Member companies enjoy explicit royalty-free access to all of Mobile VCE's core research. Companies use the core programme...

- to monitor technical opportunities and threats – a 'window on the future' of emerging research ideas
- to decide when to initiate new in-company activities
- to accelerate such in-house initiatives, or
- to leverage their existing (confidential) activities

Core research provides financial leverage of x40 or more and enables companies to stretch and focus their internal research budgets.

**Elective research** - Any company may initiate elective research. A summary of the proposed new activity is circulated. Interested companies meet to jointly scope and define a programme. Elective projects are funded by the participating companies, separately from their annual subscription, with royalty-free access available to participating companies.

The elective mechanism...

- provides financial leverage, typically x3 to x6
- allows companies to undertake important projects which might not make the budget line if one company alone had to fund the full cost
- can extend the breadth of the activity
- can result in subsequent commercial collaboration amongst industrial partners

**Directly commissioned research** - All members, through their involvement in the core programme, build relationships with, and good knowledge of, the capabilities of Mobile VCE's University members. When commercial requirements mandate confidentiality and/or full IPR ownership, Mobile VCE encourages our industry and academic members to establish direct one-to-one commercial relationships. Mobile VCE's role in such cases is one of facilitation upon request.

**These three mechanisms reflect the requirements of member companies and are appropriate in different situations and circumstances; most members use all three mechanisms at different times.**



## 'seeding and feeding' innovation core research:

### Core research

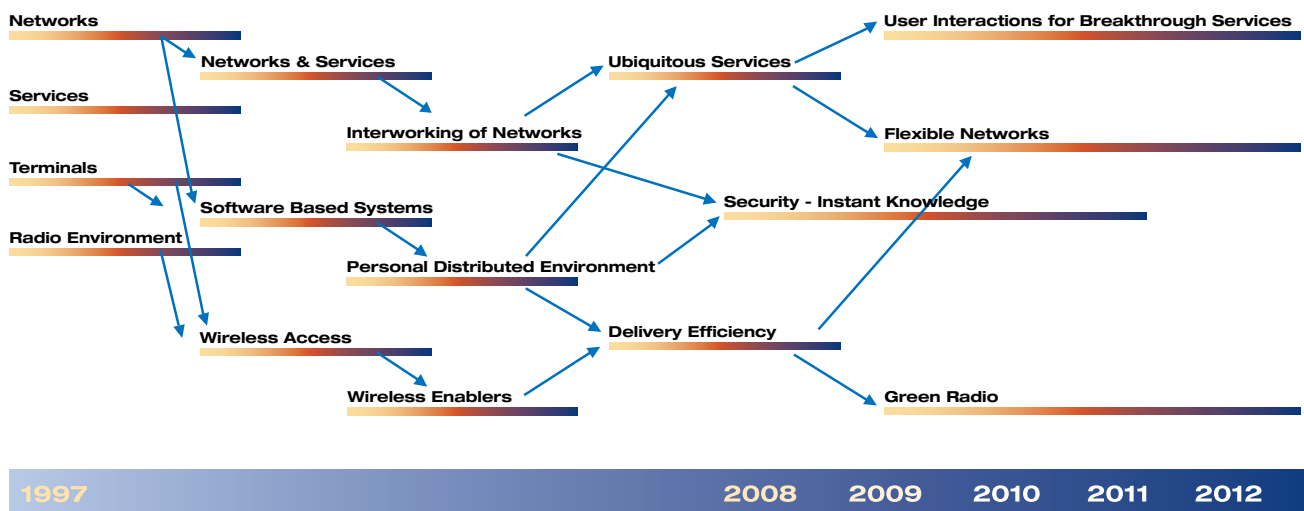
Mobile VCE undertakes as its primary activity a programme of core research – a substantial portfolio of typically three or four research streams, covering a wide range of technical activities. The core programme is evaluated and new streams defined by our industry members every three years or so – its historical evolution is shown below.

### 'Seed and feed' exploitation

Few companies today can afford to track all the emerging research topics of potential importance – R&D budget decisions require that many promising areas be postponed or shelved. Mobile VCE's core programme provides a way for member companies to maintain involvement in such areas at minimal cost, through participation in the relevant industry steering group. Companies can monitor and steer the research, receive detailed technical reports and ready access to relevant academic experts and researchers.

When a research area begins to blossom, or perhaps when a member company's own product or business ambitions move toward the area, the company can choose to leverage the core programme knowledge and expertise to 'seed' internal activities. In such circumstances it may initiate an in-company programme, building upon Mobile VCE's technical research reports and detailed knowledge, and with input from our research teams. This enables a company to move quickly – rather than starting from a blank page, it can hit the ground running. 'Seed' provides a way to accelerate new company R&D.

### Core Research Evolution



Often a company will participate in an industry steering group where the core research complements an in-house programme already underway. This is the ‘feed’ model, where a company uses its participation to better utilise their in-house budget, steering both its in-house work and Mobile VCE research to be synergistic and mutually supportive. *‘Feed’ provides a way to leverage the company R&D budget.*

Companies recruit trained researchers from the Mobile VCE team, another way to ‘feed’ internal capability. Whilst we encourage this, in practice such an employment transition works best for all parties towards the end of a core programme. Today ex-Mobile VCE researchers are employed in global companies in many nations around the world.

Companies need not publicly present related in-house research when participating in industry steering groups. This enables a company to bring direction to the core programme without divulging its reasons or intent – although it is free to do so where it sees such action as beneficial. Industry steering is based upon technical competence and commercial relevance, both used together as the basis for development of consensus.

Most companies understandably choose not to divulge specific examples of exploitation of Mobile VCE core research, at least until significant time has elapsed. One such instance which is today within the public domain relates to Mobile VCE’s early work on multi-service networks.



A company uses its participation to better leverage their in-house budget, steering both its in-house work and Mobile VCE research to be synergistic and mutually supportive

#### **Example: Multi-Service Network Dimensioning**

Early mobile network dimensioning assumed circuit switched voice. By contrast Mobile VCE’s first core programme assumed an IP-based infrastructure and multiple service types, including web traffic and video services. The core programme delivered, inter alia, a GPRS network simulation tool subsequently used by Vodafone as part of its GPRS network rollout. The programme also delivered a statistically accurate online video traffic generator, applicable to 3G service dimensioning, eliminating the need to store and replay voluminous real-time traffic traces.

## ***opportunity to initiate elective research***

### **Elective research**

An Elective research programme is one in which a small number of industrial members choose (elect) to participate. The programme is funded by this subset of the Mobile VCE Industrial membership; those same companies are the only ones who share the benefits of involvement in the research. An elective programme is usually initiated by an Industrial Member who has identified a clear requirement or opportunity that his company wishes to explore.

Elective research may be a single- or multi-company activity, depending on the level of shared interest. Usually a single company will initiate a programme idea – Mobile VCE will then circulate the proposal and a group of interested member companies will emerge. Programme scope and size are determined entirely by these industrial participants, reflecting their needs.

The elective mechanism enables companies to commission a focussed, customised, programme of research and, subject to wider member company interest, to share the costs, thereby leveraging research budgets. Mobile VCE offers a rapid and efficient means of pulling partners together and placing the contracts.

Mobile VCE works with the participants to develop a detailed technical description and programme plan. When needed it can also assist in identifying a suitable University research team.



The elective mechanism enables companies to commission a focused customised, programme of research

**Example: Urban MIMO Propagation**

Mobile VCE was approached by a member company, proposing an experimental 2GHz urban MIMO propagation measurement campaign. The company was already undertaking related activities, and realised that an elective programme could be a cost-effective complement, of interest to other companies.

The programme brought varied benefits to the participants:

- an extensive propagation measurement database, including raw data, was provided to the companies, allowing independent in-company analysis
- channel models were derived and provided to the companies
- a method was developed to extrapolate the measurements to 3.5GHz, available to the companies for future work
- the companies requested a programme extension to analyse the behaviour of proposed IEEE802.16e algorithms under real world propagation conditions
- one of the companies subsequently recruited the lead programme researcher
- two participating companies subsequently began a related commercial collaboration



2x2 MIMO propagation measurements in an urban environment were made using laptop and handheld devices

## intellectual property

On joining, new members sign a deed of adherence to Mobile VCE's IPR Agreement, which provides confidentiality and protection for the research and a framework for exploitation. Proven over more than a decade, the Agreement is structured as a win-win for the IPR funders (member companies) and the IPR creators (universities).

### Key principles

- patent filing decisions made by industry steering groups
- patent ownership resides with the inventing university
- filing and maintenance costs borne by Mobile VCE
- member companies enjoy royalty-free exploitation

### A growing portfolio

Today's patent casebook exceeds 50 maintained cases. Periodic member-led reviews are convened to ensure effective portfolio management, providing recommendations to the Board. Patent and process decisions are regularly communicated to the membership, via industry steering groups, and general meetings.

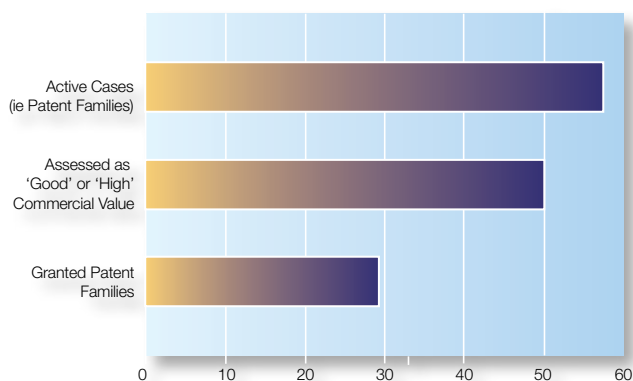
### External licensing

As the portfolio has matured, an independent company – Camitri Technologies – has been engaged to enable Mobile VCE to secure revenue income through external licensing. This benefits Mobile VCE members in several ways:

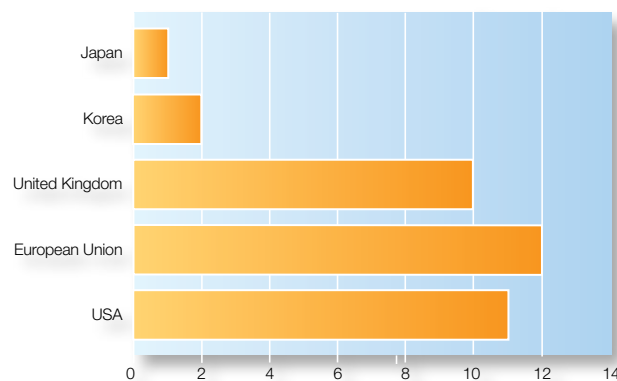
- licensing income offsets IPR maintenance costs thereby increasing research funding
- new companies appreciate the benefits of membership and may join, increasing the funds available for new research
- member companies are alerted to the true value of the portfolio, encouraging more effective exploitation

Member companies enjoy significant IPR benefits over non-members, notably being able to define and steer the research programmes in directions relevant to their own interests, royalty free access and much earlier awareness of, and ability to build upon, resulting innovations.

**Professor Peter Grant receives an award on behalf of Edinburgh University, in recognition of one of Mobile VCE's first granted patents**



Patent Portfolio (January 2009)



Granted Patents by Jurisdiction (January 2009)

## ***directly commissioned research***

Mobile VCE's IPR model ensures explicit royalty-free access to all its members or, in the case of elective programmes, those members who elect to participate in the programme.

In circumstances where companies require full IPR ownership, and perhaps confidentiality over the existence of a research activity, member companies commission research directly with Mobile VCE member Universities.

In many instances such arrangements develop naturally, without the need for any Mobile VCE involvement – we see this as a success in our fundamental mission of strengthening commercial exploitation of UK academic research. On request, however, Mobile VCE can assist in identifying a suitably qualified UK academic partner, which may be an academic member of Mobile VCE or otherwise.



We see this as a success in our fundamental mission of strengthening commercial exploitation of UK academic research



## *sharing vision*

A founding principle of Mobile VCE was that sharing long-term perspectives on industry evolution would benefit all its member companies, through the creation of a strategic research programme, an enabler of new markets for all. As Mobile VCE has evolved, this approach has deepened and effective methodologies have been developed to define the key future research challenges.

**Global synergies** – the environment, market and drivers in Asia, Europe and America have similarities and differences. Mobile VCE draws inputs from member companies in all three regions, providing opportunities to explore synergies, omissions and fresh opportunities.

**Across the value web** – the same environment can look quite different from a different part of the value web. Market maturity means that operator perspectives vary, as do those of handset and infrastructure vendors, software suppliers, broadcasters, etc. Sharing these helps identify win-win ideas from which all can benefit.

**Working cross-industry** – involving players from telecommunications, broadcasting, defence and Internet stimulates creativity and new concepts that would otherwise go unexplored. Increasingly Mobile VCE is reaching out to application industries which communications has the potential to transform - transport, healthcare, education, etc.

**Helpful heresy** – thinking the unthinkable and challenging accepted views is a normal part of discussion at our industry steering groups. Many companies discover that today's heretics may be their company's future saviours, as business models inevitably change.

**Visions Group** – industrial members active in international fora participate in Mobile VCE's Visions Group, sharing views, leveraging thinking and challenging each others' perceptions. The group works with the wider membership by organising Futures Days, preparing Vision Papers and online consultations.

**From vision to research** - As industry consensus emerges around the vision and research priorities, embryonic industry steering groups are created. These begin to work with relevant pan-University teams to define promising innovative approaches that will deliver the required solutions.



Industry Futures Day



## *a proven research approach*

Just as shared vision amongst industrial companies can yield clarity on the key challenges, so shared knowledge and debate amongst academic leaders can yield innovative approaches to deliver solutions to these challenges.

### **Global technology and research**

Mobile VCE's academic teams are well connected globally, through international cross-university initiatives and conferences. The leading academics in Mobile VCE are internationally renowned research pioneers with global exposure. As such, although Mobile VCE research is undertaken solely by UK universities, it benefits fully from the latest in international research and partnerships. The majority of our researchers are recruited from Asia, America and Europe through these links.

### **Robust debate**

Substantial benefits result from the early interaction in programme definition between academics and industrial members. Because the priority is not winning external funding, but rather defining a programme that will deliver commercial benefit to their companies, this interaction results in robust questioning, refining and exposing the weaknesses in initial technical proposals. This means that programmes start from a strong foundation.

### **Business Model Neutral**

The variety of Member Companies is reflected in their business models which, in today's environment, are changing. For these reasons a principle of our approach is to pursue solutions that neither mandate nor preclude a specific business model. This 'toolbox not architecture' approach circumvents complex and political standardisation requirements, reducing time-to-exploitation and allowing different companies to use outputs in different ways. Companies do not have to take 'all or nothing', but can use the 'Seed & Feed' exploitation model described earlier.

### **Quality control**

Once the programmes are underway, the industry players review progress and steer the research through quarterly meetings. In addition, during each programme, they undertake a comprehensive review of the performance and contribution of each of the participating Universities.



A principle of our approach is to pursue solutions that neither mandate nor preclude a specific business model

## industrial membership ...why companies join

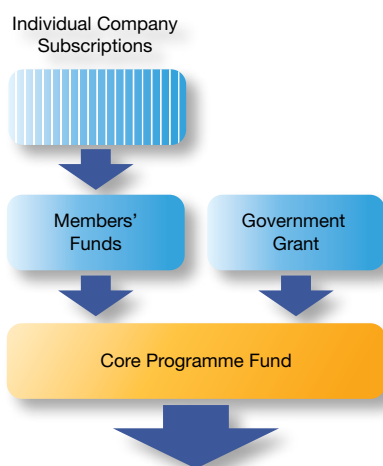


Mobile VCE's member companies are all different. They have differing objectives, varying size and role in the value chain, and diverse internal strengths and cultures. They therefore value differently the various benefits available to them through membership which, in broad terms, are summarised below.

Mobile VCE's unique operating model brings financial benefits to our member companies in ordinary times, and even more so in economically challenging ones. However, the benefits of membership extend significantly beyond this.

### Ensuring the Future

When research budgets are under pressure to focus on the short term, important research priorities can drop below the funding threshold – yet these are *strategic seed for the future*. Awareness of new technology opportunities and threats preserves competitive edge. Mobile VCE's financial model enables companies to secure financial leverage in excess of x40, and thereby visibility of, and IPR access to, a broad range of key emerging technologies – a vital window on the future – for a modest annual fee less than the cost of a single engineer.



### Cost Sharing & Partnership

Companies can outsource and contain R&D costs by initiating shared-cost 'elective research', funded alongside other members, on topics of mutual interest outside the Core programme. Recent examples are focussed programmes on Ad Hoc Low Latency Wireless Communications and Fundamental Capacity Limits of Wireless Networks; at typical costs to a company of £20k-£50k these have offered x4-x6 financial leverage. Mobile VCE removes much of the organisational overhead normally associated with the commercial and contractual arrangements, saving time, cost and hassle, as well as facilitating new industrial relationships, which often endure after the research has been completed.

### People and Expertise

R&D capability is hard to build but easy to lose. Many of our researchers are subsequently recruited by our member companies. Membership offers companies a low cost, effective, way to identify high calibre researchers of known capability, a valuable future recruitment option. Mobile VCE can also provide advice to member companies seeking academic consultancy, to complement the direct relationships they build with our university teams, facilitating rapid and reliable access to expert consultancy and direct commercial R&D contracts with full IPR ownership.



Financial leverage in excess of x40...for a modest annual fee less than the cost of a single engineer

## effective industry engagement

Despite differing objectives, varying size and role in the value chain and diverse internal strengths and cultures, there are critical success factors key to securing the benefits of membership, which are common to all member companies.

### Strategic perspective

Membership of Mobile VCE is a strategic decision. By focusing on the scale of the overall research activity, £2-3m pa, rather than the much smaller annual subscription, member companies can ensure that potential value is realised, ensuring that research outcomes are fed through to the key departments, people and programmes that can exploit them.

### The gatekeeper role

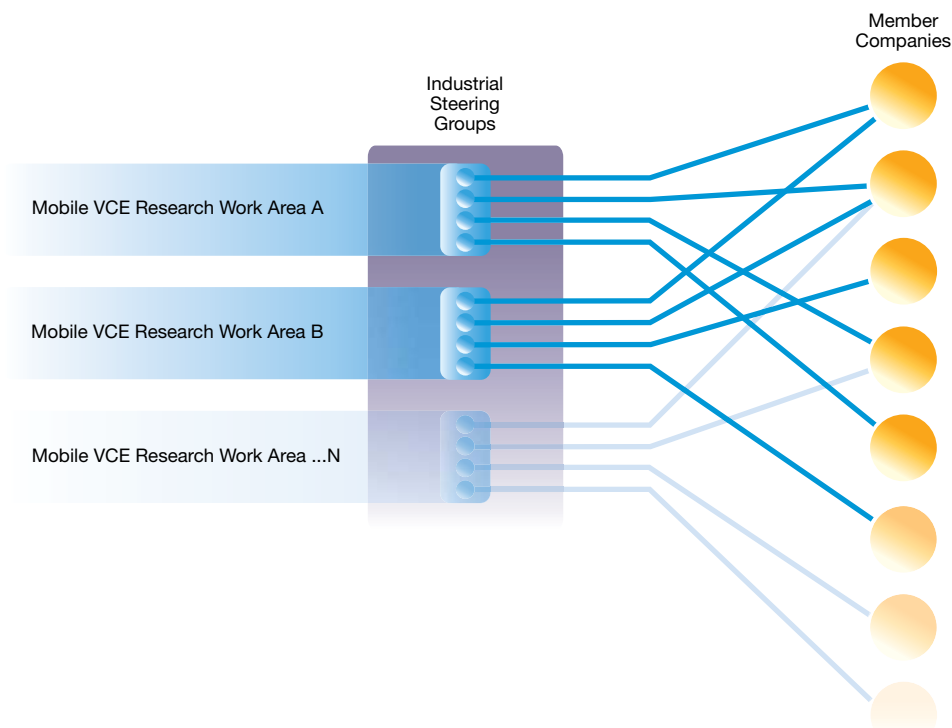
It is important for the company to identify the right individuals to represent them at Industrial Steering Groups. These individuals are gatekeepers and should ideally have a deep and broad technical capability, good visibility of in-house R&D programmes and adequate time to ensure communication to the relevant people in the company.

### In-company dissemination

Mobile VCE has various mechanisms in place to assist members, such as steering group presentations and audio recordings available over the web. Other mechanisms such as webinars and dial-in facilities for overseas staff are used and in development, to support today's geographically distributed industrial teams. Technical reports are made available over the web, as they are completed. In addition, an electronically-searchable Annual Technical Report Library is published on CD-ROM, which members are encouraged to upload to their company Intranet.

### Creating opportunities

Mobile VCE can be a vehicle for members to get things done quickly and differently. By thinking laterally, companies can quickly create new collaborations, respond to external opportunities or indeed create them. As a small and flexible organisation, Mobile VCE has the ability to act outside-of-the box and to quickly explore opportunities across our membership base, Government and overseas partners.



## *international and other collaborations*

Mobile VCE has established relationships and MoUs with peer research organisations across the world. These include the National Institute of Information and Communications Technology (Yokosuka Research Park, Japan), the National Science & Technology Programme for Telecommunications (Taiwan), Yonsei University (Korea), the Shanghai Research Centre for Wireless Communications (China), the Software Defined Radio Forum and the Wireless World Research Forum. These relationships have resulted in and benefited from research staff secondments, jointly organised conferences, international technical workshops, high level delegation visits and numerous industrial missions

Mobile VCE enjoys support from, and works closely with, many branches of UK Government - including the Department for Business, Enterprise & Regulatory Reform, the Engineering & Physical Sciences Research Council, the Technology Strategy Board, UK Trade & Investment - as well as with national bodies such as the Digital Communications Knowledge Transfer Network, innovITS (Intelligent Transportation) and the UK regulator Ofcom. Mobile VCE is also invited to participate from time to time in relevant inter-Governmental meetings.



**Lord Stephen Carter**  
Minister for Communications, Technology & Broadcasting

As well as international quality research, Mobile VCE provides excellent networking mechanisms between industry, university and Government - one of the real successes of Foresight. These capabilities position us well as we move forward to implement Digital Britain

## **vision, challenge, excellence**

Three words characterise the Virtual Centre of Excellence...

### **Vision**

Industrial members from Europe, Asia and America share varying perspectives on future industry evolution and research priorities, through a structured vision process. Mobile VCE adds further value through identifying synergies and omissions, and asking the 'heretical questions'. Mobile VCE's Visions Group – industry players active in international fora – works with the full membership to renew such visions, organising 'Industry Futures' days, which help define the next phase of research challenges. The resulting research programmes stimulate and catalyse new industry opportunities.

### **Challenge**

Profound change is at the heart of the technical and societal revolution enabled by wireless connectivity and the Internet. We do not seek simply to extend the present – we actively seek fresh challenges to create a new future – challenges that stretch our researchers and facilitate fresh industry growth. This requires challenging accepted assumptions – such is the calibre of researcher who we seek and the nature of the targets we encourage our industrial members to set us.

### **Excellence**

Research excellence is the watchword of Mobile VCE – Quarterly review of specific research progress by the Industrial Steering Groups is complemented by periodic review – again by our industry members – of the wider contribution of each university team against criteria encompassing quality of staff, supervision, collaboration, communications, delivery, etc, as well as basic technical excellence. The effectiveness of these mechanisms is attested by our publication and patent record and by the international acclaim that Mobile VCE has increasingly enjoyed during its lifetime.



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#### **Industrial Members**

Alcatel-Lucent  
BBC  
BT  
Fujitsu  
Huawei  
Hutchinson '3'  
NEC  
Nokia Siemens Networks  
Nortel  
Orange (France Telecom)  
Samsung  
Thales  
Toshiba  
Turner  
Vodafone

#### **Academic Members**

University of Bristol  
University of Edinburgh  
King's College, London  
University of Southampton  
University of Strathclyde  
University of Surrey

#### **Academic Associate Members**

University of Bath  
University of Glasgow  
Royal Holloway College  
Imperial College  
London School of Economics  
University of Swansea

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