Investigators' Track Record

This proposal presents an interdisciplinary partnership between those who design 'end user' technology and interaction, and those who seek to realise future mobile services and network architectures to invent novel mobile services to promote awareness of carbon use amongst the general public. We bring together expertise in mobile services and interaction, extensive experience in the design of mobile services and infrastructure drawn from a broad portfolio of existing EPSRC Projects including the RCUK supported Horizon Digital Economy Hub.

University of Cambridge Computer Laboratory – Systems Research Group, Horizon DE HUB

The Systems Research Group has a well established track record in delivering novel network and operating systems realisations including its recent spinoff XenSource.

Professor Ian Leslie – has recently stepped down as Pro-Vice-Chancellor for Research with responsibility for carbon reduction strategy. He has led large multi-site research collaborations in communications and distributed systems, and now leads for Cambridge in the Tsinghua-Cambridge-MIT Low Carbon Energy University Alliance, which seeks to bring the research capacities of the participating universities to bear upon new deployments in China.

Professor Jon Crowcroft – has been active in opportunistic and social networking using smart handsets: a current project is concerned with tracking the spread of swine flu. He has also been working on home monitoring of energy use and the attribution of contributions by individual appliances and their human users.

Dr Steven Hand – is one of the principals in the Cambridge Horizon Hub, with considerable experience in networks and operating systems. He was the designer of the memory management system in Nemesis – the precursor to Xen – a developer of the Xen hypervisor, and a founder of XenSource. He is active in thinly distributed and redundant ("spread-spectrum") computing and in novel network architectures.

Nottingham University – Horizon Digital Economy Research Institute, Computer Science, Psychology, Energy Technologies Research Institute

Horizon is an Institute within the university of Nottingham focussed on Digital Economy Research; this is an interdisciplinary institute where computer scientists, psychologists, sociologists, engineers and experts in business collaborate to explore the potential of ubiquitous and mobile in the digital economy.

Professor Derek McAuley – is Director of Horizon with over twenty years experience in academia (Cambridge and Glasgow) and business, both in large established companies (Sun, Intel, Microsoft and Marconi), as well as in a series of successful start-ups (Nemesys, Atlantech, XenSource and Netronome). He has extensive experience in transforming research to real world systems. While directing the Intel Research lablet in Cambridge his collaborative research with the Xen team at Cambridge University was a key factor in Intel's early launch of the Intel VT technology – a case study in the value of open source.

Professor Tom Rodden – is exploring ubiquitous computing for everyday living, including in both the home and workplace. He has published widely in Ubicomp, HCI and CSCW and has acted as chair for the leading conferences in these areas. He directed the Equator IRC and has played a leading role in the establishment of UK Grand Challenge in Ubiquitous Computing. He holds an EPSRC senior fellowship to investigate new interdisciplinary approaches to ubiquitous computing.

Professor Claire O'Malley – is exploring the application of psychological theories in computer supported collaborative environments. She has published widely in the psychology and computing literature. She leads the Human Challenge within Horizon which aims to elaborate a multidisciplinary 'human-science' of ubiquitous computing that encompasses the theories and methods needed to analyse and design digital economy services.

Professor Mark Gillot – is co-director of the School of the Built Environment's Institute of Sustainable Energy Technology at the University of Nottingham and manages the Creative Energy Homes Project. He has expertise in energy monitoring and relating consumption to behaviour.

University of Exeter - Business School and Centre for Service Research

Professor Irene Ng – is Professor of Marketing Science and Director of the Centre for Service Research. She is on research leave from Exeter until September 2011 as an Advanced Institute of Management Research Services Fellow, visiting the Institute for Manufacturing at Cambridge. She was the Research Director of the EPSRC/BAE Systems Service Transformation Grant Consortium (S4T) (completed Dec 2009) and she has also recently been appointed the ESRC/NHS Public Sector Fellow studying complex service systems in Healthcare with Addenbrookes Hospital and the School of Clinical Medicine at the University of Cambridge. Her research experience is in service experience pricing, revenue management of services, value co-creation in services, mechanism design in service contracts and service capacity.

China Mobile

This academic team is complemented by key industrial research partners with a strategic research interest in the future of mobile services. China Mobile will play an active role in the work of the project dedicating research staff, equipment and access to empirical date to support the work of the project.

Henry Ge – is China Mobile's Chief Representative for Europe and Africa. Based in London, Mr Ge is responsible for business development in both Europe and Africa, focusing on maximising shareholder value through innovation, enhancing service levels to ensure greater end-user satisfaction, and developing closer partnerships with other operators. He was previously director within Development Strategy Department for China Mobile Communications Corporation overseeing strategic planning at the Group level.

Yan Hongyan – is Director of Industry and Market Research in China Mobile Research (Beijing). She established and directs a team of researchers in psychology, sociology, art, industrial design, data mining and market research. The team is focused on market research for innovative products, new business models, and user experience design. China Mobile's OPhone, an open mobile platform (Linux on ARM) adopted by over 20 manufacturers is a concept from her group.

Lai Jiangyang – is Director of Strategic Planning and Corporate Social Responsibility with responsibility for developing and monitoring indicators and standards for the sustainability performance of the China Mobile provincial companies., Department of Development Planning, China Mobile (Beijing). She has a rich experience in development strategy and innovation management within a number of provincial operating companies of China Mobile.

Case for Support

With the provision of smart buildings and location awareness, energy use in buildings (home and work) and in transport systems is rapidly becoming part of our *lifelong contextual footprint* - the idea that each of us, throughout our lifetimes, will lay down a digital trail that reflects our patterns of interaction with services, the contexts within which we choose to use them, and ultimately our reactions to them.

While a wide range of technologies for monitoring and presenting energy use are becoming available that add to this contextual footprint, in order to achieve global impact we must give consideration to the inclusion of 85% of the population outside "the West" who emit[1] 65% of the CO_2, where there are very pragmatic technical and economic limitations on the deployment of new technology solely for energy awareness. Arguably the primary physical mechanism through which a significant proportion of the population – both inside and outside "the West" – interact with information services, is the handheld mobile device; this infrastructure is truly global and will form a key component in any global solution for transforming energy demand.

We seek to understand how services based on quite modest monitoring technology in the home with a mobile device providing location, uploading of monitored data and user feedback can improve users' awareness of energy consumption and hence modify their energy demand.

While the study will focus on the user and behavioural modification through energy awareness, many of the user focussed services will in fact rely on the aggregate models developed from the "crowd-sourced" data that the users are implicitly and explicitly inputting to the system. There are three distinct motivations here: (i) the extent to which an energy supplier can derive economic benefit in planning and on the supply side is a key factor in making the systems economically viable; (ii) recognised collective behaviour is likely to reinforce positive individual actions; and (iii) transport decisions will be informed by aggregate behaviour.

Aggregation of information provides several challenges, particularly as the aggregator is unlikely to be the end application service provider. The aggregator is likely to be trusted implicitly by individuals, just as mobile operators are – indeed there is a case for mobile operators to provide aggregation services. In an open system of service provision, however, we imagine many service providers, each trusted only by their direct customers who are necessarily a subset of those whose information is usefully included in the aggregate. Aggregation requires an understanding of trust relationships, appropriate anonymization, business models and contractual relationships.

> ***The challenge being addressed by this proposal is the creation of new energy information services and corresponding business models based on emerging sensor technology, real time information aggregation techniques and opportunistic networking. The services must be functional and compelling both to the individual user and to the user collective based on social perceptions of energy reduction need. They must also provide viable revenue streams for mobile operators and end application service providers.***

In order to face this challenge, we have brought together a diverse team with a great deal of experience across a range of disciplines to conduct a feasibility study. We have also engaged with the largest mobile operator (by subscribers) in the world in the form of China Mobile who have made clear their willingness to explore business models with intermediate services (e.g. aggregation) in a system of open application service provision. A successful outcome of this project would be a programme of continued development leading to a a field trial of new services with China Mobile and/or one of its global partners.

Research Objectives

We seek to investigate the feasibility of a ubiquitous set of applications that could enhance consumer awareness of carbon footprint. This requires at least three major challenges to be overcome:

1. The provision of applications that are *compelling* to users, that provide *comprehensible information* that make the consumers aware of the implications of their behaviour, and provide a useful baseline service when delivered onto the projected ecosystem of deployed handsets;
2. Ensuring that *privacy concerns are addressed*: Mobile devices can be enabled to monitor and report a great deal of information about an individual's energy use, by interaction with smart meters or smart plugs in the home or office, or through location information supplied to inference engines. Some of this information is useful in aggregated form to some agent or application, e.g. for the optimisation of transport, but the risk of disaggregation to individual behaviour needs to be analysed and mitigated.

[1] From Climate Analysis Indicator Tools (available at http://www.cait.wri.org)

3. Ensuring that a *viable business model exists* for those providing the infrastructure behind the applications: There will be a large volume of very small event descriptions, which will be passed between service providers with consumer and provider specific privacy constraints. Transaction costs will have to be microscopic but providers must receive some return. Innovation considerations demand that third party service providers be allowed to develop and operate applications: viability must therefore include both application service provision and the basic carrying and aggregation of information.

Background

There is a great deal of work being carried out to monitor and inform consumers about their energy use. These systems might be provided by energy suppliers or third party system providers (e.g. Green Energy Options) but thus far systems tend to be closed - the provider is responsible for specifying/providing sensors, communication infrastructure, application and presentation. Many claims have been made about the efficacy of these systems to alter behaviour with only anecdotal evidence. While it is clear that one has little hope of altering individual behaviour or understanding behavioural change without measuring and presenting energy consumption, this is a necessary condition, not a sufficient one. Our end goal here is not to produce an application which induces energy efficiency, but rather to work towards a commercially viable environment in which such applications will evolve.

History has shown that open architectures are far more robust, open to technical and business innovation, evolvable and economically resilient. The most rapidly embraced and evolvable applications – those often referred to as *viral* – will only be developed on open platforms.

While we can build on the current technology – sensors in particular – it is our aim to demonstrate the feasibility, both technically and commercially, of delivering rapidly evolving applications and services to users.

Our building blocks for this work are sensor networks, distributed systems, in particular the developments of event architectures for aggregating sensor data, opportunistic networking, the availability of open platforms for application development on mobile handsets, and, importantly, a mobile operator willing to explore new business models in order to drive innovation.

A number of the team (Leslie, Crowcroft, McAuley) have over the past 30 years witnessed the conflict between vertically integrated services and horizontal service provision in the telecommunications industry. We have consistently argued for openness, not merely in the sense of standard interfaces and interoperation of equipment, but in service provision. We have seen what we have regarded as the inevitable move in this direction sweep through traditional data networking in the early 90's, resistance by mobile operators ("walled gardens") at the beginning of this century, and then an opening up of platforms and service provision for mobile devices. The delivery of real time information required for transport and energy consumption to end service applications, independent of the telecommunication operator requires further progress on this path.

Key Research Themes

We propose a two-year feasibility study to investigate the business and services framework in which these challenges can be met and delivery of the analysis methodology. Our approach will be based upon:

1. The creation and evaluation of two prototype services accessed through applications based on handheld mobile devices, addressing the two largest contributors to personal energy consumption:
    a. Personal travel - real-time and reflective applications that communicate energy use in both regular and episodic travel;
    b. Home energy – basing our work on energy monitoring using smart sockets and meters communicating with passing mobile handsets rather than a separate infrastructure;
2. Investigation of aggregation, security and service model which enables the prototype services, provides clear privacy guarantees to users, and allows businesses to be created in a viable service supply chain;
3. Evaluation of consumers' value-in-use for the prototype services, and from the various dimensions of customer value, designing feasible contracts, incentives and value-centric business models for the sustainability of the business proposition.

Theme 1: User focused prototyping

Work within this theme uses the well-developed methodologies of user-centred design and evaluation for innovative applications on mobile platforms (Rodden, Crowcroft). Understand the real world needs of users lies at the core of this proposal consequently we will undertake a strongly iterative user centred approach to development. Initial application will be developed in co-design sessions with users using a variety of lo-fi prototyping techniques. Once initial concepts have been developed a process of formative evaluation where users assess emerging prototypes in a variety of real world settings will be used to refine prototypes. This will build upon the considerable experience of interactive prototyping at Nottingham across a number of domains.

Applications will emerge through a series of focus group sessions where the needs of particular user groupings will be discussed. Sessions will be seeded using a number of provocative examples of the sorts of

applications and services that may be developed. Applications will range from everyday mundane endeavours to the more playful and ludic. Elements of gaming and competition, a key strength at within the Mixed Reality Laboratory (Rodden), will be introduced, targeted at making behavioural change a fun and shared experience. Prototyping will be supported through a range of toolkits developed within the MRL that support the rapid construction and assembly of applications directly by users under supervision and guidance from researchers.

The work in this proposal also aims to extend beyond these to investigate the ways in which the emergence of cloud based computing and on-line application stores allows us to consider how to scale up these techniques to directly engage with larger user communities and to help users shape the nature of applications through their use. Consequently, we wish to consider how we might adopt "crowd sourcing"style approaches to the iterative refinement and shaping of applications. Building upon previous experience of *technology probes*[2] we would develop a series of initial mobile prototypes with feedback facilities build into the applications. These applications could then be realised to large communities using on-line applications stores and the interactive feedback used to refine the application. Our mobile applications would be made freely available for download onto standard platforms (e.g. Android) and deploy the service in "the Cloud" (e.g. Amazon EC2, S3 and SimpleDB).. Again this generic approach to large scale user centred development is being adopted within Horizon and the necessary infrastructure to enable it will be provided by that project.

As part of this work we will explicitly seek to understand users reactions to mobile applications that capture significant information about their everyday endeavours. We will extend out our work on social, moral and cultural perspectives of ubiquitous computing explored within Horizon and as part of the Rodden Senior Fellowship. This project offers a unique experience to understand the cultural differences associated with the acceptance and uptake of new mobile services and their views on critical issues such as climate change.. Societies worldwide are concerned about global warming and energy consumption, and our work here will focus on applications designed to allow users to comprehend and share energy information enabling engagement in a dialogue with others and behavioural comparisons around energy consumption. Given the difference of perspectives between western views(e.g. North America, Europe) on climate change and those within emerging and developing nations (e.g. India, China, Brazil) a crucial issue will focus around the broad societal acceptance of the need to reduce energy consumption. This work will feed in the work of theme 3.

Theme 2: Elaborating Security and Service Models

Horizon is developing a service infrastructure and toolkit for building applications based on crowd-sourcing information (McAuley, Crowcroft, Rodden); while this infrastructure provides generic services that allow the recording of personal data and enables controlled sharing of data derived with varying degrees of anonymization with various different social groups depending on the context and application, each specific data type has associated semantics that must be understood to provide the appropriate anonymization while leaving enough domain specific information to enable useful services.

The overall structure of the generic architecture involves personal mobile devices storing activity information in a per user private data store; based on some policy defined by the user, application/service specific "plug-ins" operate on this data to transform it into the anonymous form suitable for sharing and data mining; applications, including analytical tools can then be developed that combine the personal user data, the federated database formed from the aggregation information and whatever other sources of information the applications need, to generate new and innovative services.

After examining the details of energy consumption information within this architecture, we will apply energy domain specific analysis to understand the trade off between privacy and utility. In the context of our energy consumption in personal travel, this will drawn on the well established work of mixing zones, spatial degradation, noise injection etc. from the geospatial and location aware computing field, but the subtleties of adding energy consumption data and hence the possibilities for re-identification need to be investigated.

For home energy, even with the simplistic smart meters currently fielded in some countries within private homes (e.g. only capable of reporting average power consumption over 15 minute intervals), privacy issues have already resulted in legislation to mandate their installation being stalled. As we add devices within higher measurement precision, matters will only become worse. We require a detailed study of the "latent semantics" within the energy data to ensure that services offer access to only the information intended and are not open to further mining for more personal information. A key part of this work is understanding the human trade off in exchanging privacy for value (O'Malley).

Theme 3: Service Evaluation

Each service postulated must come equipped with a delivery plan that estimates the communication, processing and storage capacities required per user, and hence revenue requirement, to achieve a useful

[2] See Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hansen, H., Roussel, N., and Eiderbäck, B. 2003. Technology probes: inspiring design for and with families. In Proceedings of CHI '03., 17-24. DOI= http://doi.acm.org/10.1145/642611.642616

level of service. From data to service, we need to identify all the key intermediaries. For example, in addition to using infrastructure as a service model (IaaS), we can provide specific software development tools and infrastructure using the model of platform as a service (PaaS), which provide, as a service, hardware and development environments to allow cloud applications to be developed, rendered, and offered as software.

Against this cost model must be placed the consumers' view of value (Ng); whether financial, social or otherwise. These various dimensions of customer value enable service providers to consider a range of product offerings designed around different incentives and revenue models based on understanding different market sectors defined by user behaviour and cost sensitivity. Revenue and contract mechanism design models are powerful tools that can elicit favourable or unfavourable behaviours in the market as consumer exploit that which is free and are tight-fisted with that which needs to be paid. In today's modern service economy, there is currency in our time, our 'eyeballs', our effort, our loyalty which has infused itself into a myriad of business models.

The mobile application, service, equipment and retail market supply chain is complex, in many countries deliberately so by legislation which aims to deliver better competition for the consumer. The team (Ng) brings expertise of value co-creation in complex service systems and the experience of China Mobile is critical to the evaluation of the feasibility of the services considered under current or possibly new regulatory regimes.

Our work within this theme is particularly aimed at developing a methodology for such analysis through case studies of the two applications to be developed in conjunction with the intermediate aggregation service.

The Programme of Work

The work plan consists of six work tasks: Sensor Technology and Connectivity; Application Development; Application Evaluation; Aggregation and Privacy; Business Modelling; and Dissemination and Project Management. Because of the nature of the project, the interaction between these tasks is of particular importance to ensure that a holistic and fundable development plan is produced at the end of project. As the project will take place over two years, we have organised this to a relatively fine level of detail with each subtask corresponding to a deliverable due at the end of the subtask time slot.

Temporally, the programme is structured around 4 project milestones: *Set Up (*month 3*); Application Selection* (month 7)*; First Evaluation* (month 13)*; Second Evaluation* (month 22); and *Follow Up Proposal* (month 24). These milestones provide co-ordination points across the work tasks. This provides some structure to development/evaluation iterations, recognising that there may in fact be more iterations.

Work Task 1 Sensor Technology and Connectivity (Guillot, McAuley, Crowcroft, Yan Hongyan)

This work task will be responsible for selecting appropriate sensor technology for the prototype system. There will have to be interaction with the application development work task concerning the type of information that can be provided and with the aggregation work task with regard to connectivity to mobile networks. The aim is not to develop new sensor technology, but to survey and select what is readily available. Some work may have to be carried out to provide connectivity to mobile network through gateway devices – China Mobile already have done some work in this area. This work task delivers early into the project at month 12. However, there are further useful investigations which do not impact the rest of the programme but could inform follow up activity: (i) tracking sensor development for future deployment; and (ii) establishing the feasibility of *profiles* so that: behaviour can be inferred without the need for sensors to be deployed everywhere, further anonymity can be provided since behaviour is inferred rather than observed, and comparability between profiles can be made so that users might better understand the impacts of their behaviour.

Task	Months	Description	Deliverable
1.1	1-3	Survey of monitoring devices	Potential devices for applications
1.2	4-12	Procurement, set up and connection	Prototype monitoring infrastructure
1.3	13-24	Understanding feasibility of profiles	Potential contribution to Final Report

Work Task 2 Application Development (Rodden, Crowcroft, O'Malley, Hand)

This work task will produce the prototype applications. The Set Up phase will select and procure the application platform for the project, at this stage presumed to be the Android platform. Interaction with the application evaluation work task for the selection, evaluation and refinement of tasks will be a continual iterative process, but we have structured this as a series of milestones to ensure that progress can be monitored closely.

Task	Months	Description	Deliverable
2.1	1-3	Select and procure development platform	Development platform
2.2	1-6	Nominate applications	Potential applications

2.3	7-12	Develop applications	Apps for evaluation one
2.4	13-22	Refine applications	Apps for evaluation two
2.5	23-24	Application commentary for followup	Final Report

Work Task 3 Application Evaluation (O'Malley, Rodden, Yan Hongyan, Ng)

Work task 3 is concerned with the evaluation of applications from a user point of view. This requires usability analysis, an assessment of likely impact of information on user behaviour, an assessment of the potential for (positive) viral behaviour, and an assessment of perceived user value, incorporating the latest thinking around value co-creation in multi-stakeholder service systems. This task draws on the breadth of skills within Horizon at Nottingham to deliver both traditional HCI design and usability analysis for the applications themselves and the social psychological study of the behavioural changes achieved by the specific application interventions. The Centre for Service Research at Exeter's Business School combined with China Mobile's pragmatic business experience will concentrate on developing the techniques to trace the user value in the specific applications. Furthermore China Mobile already has extensive experience of the study of communication cliques within its subscription base, which will be linked with Horizon's ongoing work involving "crowd-sourcing", to enable the investigation of the socio-technical issues underlying the emergence of large scale and viral applications. Within this work task there is both a sustained sub task to develop evaluation methodologies, and punctuated subtasks which align with other work task development.

Task	Months	Description	Deliverable
3.1	1-4	Application Criteria	Application criteria for selection
3.2	7	Application selection	Selected applications for prototyping
3.3	13	Evaluated applications for further development	Refinement guidelines
3.4	1-23	Development of evaluation methodology	Final Report

Work Task 4 Aggregation and Privacy (McAuley, Leslie, Hand, Crowcroft)

There are a number of systems which aggregate information; Cambridge has experience of the event architecture used the TIME-EACM project[3] [Pietzuch] and China Mobile are developing a Machine to Machine (M2M) architecture with similar properties. Here we are concerned to produce an agregration layer which can form the basis of a service in which subscribers (application services) are shielded from detail but have considerable control over what is aggregated. (Note that subscriber may also be able to capture disaggregated information for their direct customers.)

We do not plan to create an aggregation service from scratch, but rather intend to build on existing schemes with particular attention to mitigating the potential for obtaining sensitive information through disaggregation, for example by adding noise which has no material impact on the aggregation's intended use.

This work task will move through stages of development from candidate systems, providing an initial system to the application services, to a system with some privacy protection and on to a final report. There will be a need to interact with WT5, Business Modelling, in order that viable service level agreements can be formulated. There is security expertise in the Computer Laboratory outside the project that can be consulted.

Task	Months	Description	Deliverable
4.1	1-3	Survey aggregation models (eg TIME-EACM, China Mobile M2M)	Candidate aggregation models
4.2	4-6	Develop prototype aggregation for use by prototype applications	Aggregation infrastructure (with no privacy features)
4.3	6-12	Enhance aggregation infrastructure	Aggregation with privacy features
4.4	12	Evaluation for follow up	Final Report

Work Task 5 Business Modelling (Ng, Lai Jiangyang, Yan Hongyan, McAuley, Leslie)

While we have taken the view that open platforms are the only way of supporting the development and evolution of the services we seek, we have not satisfied ourselves that we understand how to create viable business models for ubiquitous intermediate level services, such as aggregation, particularly where there are diverse stakeholders that derive value from the overall provision and consumption of such a service. This work task will initially develop a generic model for intermediate services, and engaging with WT 4 on Aggregation to deal with the implications of a large number of small events.

[3] See, e.g., Pietzuch, P.R., Shand R., and Bacon, J.M. "Composite Event Detection as a Generic Middleware Service", *in IEEE Network, Special Issues on Middleware Technologies for Future Communication Networks* 18(1), pp44-45, Jan/Feb 2004.

After these initial subtasks, the work task will explore service level agreements for the aggregation service – implicit in this will be a judgement on whether aggregation must necessarily be performed (at least at the lowest layer) by the operator.

Business modelling will also be used in the selection and evaluation of the demonstration applications, interacting with WT3, but more importantly will be developing a business model framework for future applications which will be a critical part of the Final Report.

Task	Months	Description	Deliverable
5.1	1-3	Generic intermediate service model	Guidelines on business viability of intermediate services
5.2	4	Evaluate candidate aggregation models	Input into selection
5.3	5-18	Develop aggregation service level agreements and business model	Prototype service level agreements
5.3	7	Evaluate candidate applications	Input into selection
5.4	13	Evaluate prototyped applications	Input into refinement
5.5	19-22	Develop business model for refined applications	Prototype business model
5.6	13-24	Business Feasibility Report for follow up	Final Report

Work Task 6 Dissemination and Project Management (Leslie, McAuley, Ng, Ge)

While we expect normal academic dissemination of the results of this work, our primary focus will be on the project's Final Report which will be in essence a proposal for further development of the platform and systems which are produced by the project. China Mobile and their global partners will be the most important audience for this. (See following.)

Project Management

The project will build upon extensive experience across the consortium in multi-site interdisciplinary research projects. The project will be overseen by a group made up of a member from each participant: Leslie, Ng, McAuley and Henry Ge (China Mobile). Given the nature of the project, that is, as a feasibility study, the principals will be meeting regularly as part of the technical working of the project; it is expected that project management will require little logistical overhead. We propose to a formal management meeting every three months (aligned with milestones where appropriate) to review progress against plan and to oversee plans for follow on work; such meetings are likely to coincide with technical meetings of the principals.

Dissemination and Exploitation

Dissemination of results will be through three distinct channels: (i) normal academic publication through journal publications and participation in workshops and conferences; (ii) through China Mobile, its partners and stakeholders; and (iii) in the case of user centric application development, through the Horizon Digital Economy Hub to its 40 commercial partners involved in regular dissemination events.

China Mobile have recently signed a comprehensive MoU with the University of Cambridge, and plans are already in hand for a series of workshops with senior China Mobile General Managers for novel applications for mobile communication directed at sustainability (in a general sense, going beyond the remit of this proposal). China Mobile, in turn, through their global partners, and through their stakeholders in China, and through their participation in global fora on Corporate Social Responsibility, will disseminate results more widely.

Inline with Horizon's "open-innovation" model, the technologies and methodologies developed will be openly available with Horizon able to support further exploitation through its Transformation Programme – this programme focuses on knowledge exchange, public involvement, the incubation of new endeavours and capacity building, and is supported by a dedicated Transformation Manager and two knowledge transfer officers. Together they manage Horizon's partnerships with partners and a number of agencies with expertise in entrepreneurship, innovation, enterprise, business development and technology transfer, including the The East Midlands Development Agency, the Location and Timing and the Creative Industries Knowledge Transfer Networks (KTN), the Ingenuity Programme and the University's Research Innovation Services