With significant population growth in cities, there is growing pressure on infrastructure and resources and this affects quality of life, impacts the environment and limits economic growth. On the other hand, the increasing availability of real-time information from a myriad of mobile and embedded sensors (e.g. smart phones, energy/water meters, roadside monitoring units, vehicles, buildings etc.), combined with high bandwidth network connectivity, creates the potential for the deployment of innovative software services that manage cities’ infrastructure and resources more effectively. However, a key challenge to enabling the development of such software services is to cater for the inherently dynamic nature of the underlying infrastructure environment from multiple dimensions. An infrastructure supporting software services must cater for resource-constrained and possibly mobile devices that are likely to be heterogeneous and geographically dispersed. Services must be interoperable across city domain silos, and it should be possible to compose them, for the provision of higher-order services, dynamically and in a timely manner.

My research expertise is in software engineering, and I have a strong sense of the significant shortcomings in the methods and techniques available to software engineers who are tasked to build software services to execute reliably in such an urban environment. In my early career, I published highly influential work on the use of “aspects” in software modelling, called Theme/UML, which provided new techniques to improve the modularisation and composition of software models, designed to be generally applicable to a range of domains operating in stable environments. However, the fundamentally challenging nature of emerging computing systems is such that assumptions related to centralised knowledge of software services’ availability, representation and interoperability are invalid. This makes existing software applications useless in such environments, significantly limiting the potential for addressing global challenges in urban sustainability.

My research goal within this wholly under-researched area is to provide new service-oriented software engineering techniques that enable the development of dynamically adaptable applications, using innovative run-time service composition algorithms that support resilient service provisioning even in the face of a dynamically adapting network of potentially heterogeneous service providers. Enabling such services-based development requires a combination of new techniques, and my research group within the School of Computer Science and Statistics has published work on predicting potentially damaging emergent behaviour that may affect future quality of service; registering and discovering the “right” services at the “right” time in the “right” place; and a self-organising, goal-driven approach to dynamically composing and re-composing services. Funding for this work has come primarily from Science Foundation Ireland.

Enable will develop new technology to improve the way we manage our cities to benefit people, communities and the environment.

Siobhán Clarke received her BSc and PhD degrees from Dublin City University. She joined Trinity in 2000, and is Professor in Computer Science. She was elected Fellow of Trinity College Dublin in 2006 and is Director of the Trinity Future Cities Research Centre. She has published 170 peer-reviewed papers, and leads the Enable SFI Spoke on Connecting Communities. She is co-PI of the Connect, Insight and Lero SFI Research Centres. Her research focus is on engineering dynamic software services in urban-scale environments.

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Smart environments. Connected communities — Sustainability of our cities also requires finding new ways to enable behavioural change, the solutions to which are inherently multi-disciplinary.

I lead a large-scale (€12m) SFI Spoke project, called Enable, which leverages expertise from the Connect, Insight and Lero Research Centres. Enable is a multi-disciplinary collaboration between 20 PIs from 7 HEIs, 28 companies and Dublin and Cork City Councils, and is the first national collaboration between companies, academia and public bodies in the area of smart cities. Enable will develop new technology to improve the way we manage our cities to benefit people, communities and the environment. Sensors and mobile devices will be linked in large, well-managed networks. The focus is on making better decisions from the data gathered, providing up-to-date information for people in towns and cities, while keeping personal data private and the networks secure. We aim to enable smarter transport services, reduce pollution, improve our workplaces and allow everybody to take part in the decisions.

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