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Edited by Wolter Lemstra, Vic Hayes and John Groenewegen

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## The Innovation Journey of Wi-Fi

*The Road to Global Success*

Wi-Fi has become the preferred means for connecting to the Internet – at home, in the office, in hotels and at airports. Increasingly, Wi-Fi also provides internet access for remote communities, where it is deployed by volunteers in community-based networks, by operators in ‘hotspots’ and by municipalities in ‘hotzones’. This book traces the global success of Wi-Fi to three key events: the landmark change in radio spectrum policy by the US Federal Communications Commission in 1985; the initiative by NCR Corporation to start the development of wireless local area networks; and the drive for an open standard IEEE 802.11, released in 1997. It also singles out and explains the significance of the initiative by Steve Jobs at Apple to include wireless LAN in the iBook, which moved the product from the early adopters to the mass market. The book explains these developments through first-hand accounts by industry practitioners, and concludes with reflections and consideration of the implications for government policy and firm strategy.

WOLTER LEMSTRA is Senior Research Fellow in the Department of Technology, Policy and Management at the Delft University of Technology and Senior Lecturer at the Strategy Academy, Rotterdam, the Netherlands. He has twenty-five years of experience in the telecommunications sector, at Philips, AT&T and Lucent Technologies.

VIC HAYES is Senior Research Fellow in the Department of Technology, Policy and Management at the Delft University of Technology. He is the recipient of eight awards, including *The Economist* Innovation Award 2004, the Dutch Vosko Trophy, the IEEE Hans Karlsson Award and the IEEE Steinmetz Award.

JOHN GROENEWEGEN is Professor of the Economics of Infrastructures at the Delft University of Technology. He is also a research fellow at the Tinbergen Institute in the Rotterdam School of Economics, Erasmus University Rotterdam.

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## Preface

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In 2003 the Dutch Ministry of Economic Affairs commissioned a study to assess the position of the Netherlands with respect to information communications technology (ICT) knowledge and ICT innovation. This project was awarded to a consortium led by Capgemini, in cooperation with the Strategy Academy and Zenc. As I was associated with the Strategy Academy, and in recognition of my experience in the telecommunication industry, I was invited to carry out a series of interviews with experts in the communications technology sector. A wide range of firms was being targeted, from start-ups to well-established companies, manufacturers and service providers, covering multiple technologies and applications. The list included Bruce Tuch, the director of technology strategy and standards at Agere Systems, leading the Wi-Fi efforts from the Utrecht Systems Engineering Centre, in the Netherlands.

At Lucent Technologies I had been involved with the WaveLAN product line to explore business opportunities in the public communications sector, but I was not aware of the genesis and development of Wi-Fi and the role NCR, AT&T and later Lucent Technologies had played, or, for that matter, the role of the Engineering Centre. The enthusiasm that Bruce Tuch conveyed in relaying the innovation story of Wi-Fi was captivating. I became convinced that this narrative had to be recorded and shared. When attending the ‘Creative capital’ conference in Amsterdam the following spring I observed that the TV series *Big Brother* was being presented by a government official as an important example of Dutch innovation. Clearly, Wi-Fi was not yet recognised as an applicable case example. Something had to be done. In the autumn I attended a seminar organised by the Royal Institute of Engineers featuring Vic Hayes on the topic of IEEE 802.11. For ten years Vic had been the chairperson of the working group responsible for the standardisation of wireless local area networks, to become commonly known as Wi-Fi. I learned that Vic was about to retire; this was the moment.

I persuaded Vic to join me as senior research fellow at the Delft University of Technology so that we could start a project together to document the ‘innovation journey of Wi-Fi’. This book is the result of our efforts and those of many others, from the academic community and the communications industry. Vic, John and

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I have been in a very fortunate position in that our longitudinal case study could to a large extent be based on personal accounts of individuals who have been instrumental in the development of Wi-Fi. This includes Michael Marcus, who in 1980, while working at the US Institute for Defense Analyses, proposed the public use of spread-spectrum technology to the chief scientist of the US Federal Communications Commission; and, most importantly, Bruce Tuch and Cees Links at the Utrecht Systems Engineering Centre, which passed from NCR to AT&T, to Lucent Technologies and, finally, to Agere Systems. We would like to acknowledge the contribution of the many scholars and industry representatives who have made this project possible. Without their efforts, which included painstaking searches of archives in attics, this undertaking would not have been feasible. It has been their enthusiasm and willingness to share in the aim of this project that has made it a reality.

As authors and editors we would like to acknowledge the valuable feedback received during the many seminars in which early versions of the contents of the book were presented. A special ‘thank you’ is due to Frank van Iersel, Michael Marcus, John de Waal and Eric van Heesvelde, who took the trouble to review the typescript in full, and to Donald Loughry and Daniel Tijink, who reviewed particular chapters; they have all provided extremely valuable feedback. We would also like to thank the publishing team at Cambridge University Press: Paula Parish, Philip Good, Andy Woodfield, Sarah Roberts, Michelle Leblanc and Mike Richardson. In addition, we would like to acknowledge the funding provided by the Delft University of Technology for carrying out our Wi-Fi research project through its Senior Research Fellowship Programme.

Our aim has been to provide an accurate account of the innovation journey of Wi-Fi; where we have fallen short of this objective the responsibility is ours. The usual disclaimers also apply.

*Delft, 2010*

WOLTER LEMSTRA, WITH VIC HAYES  
AND JOHN GROENEWEGEN