

Wireless Networking in the Developing World

Second Edition

**A practical guide to planning and building low-cost
telecommunications infrastructure**

Wireless Networking in the Developing World

For more information about this project, visit us online at <http://wndw.net/>

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About This Book

This book is part of a set of related materials about the same topic: Wireless Networking in the Developing World. The WNDW project includes:

- Printed books, available on demand
- Several translations, including French, Spanish, Portuguese, Italian, Arabic, and others
- A DRM-free PDF and HTML version of the book
- An archived mailing list for discussion of the concepts and techniques described in the book
- Additional case studies, training course material, and related information

For all of this material and more, see our website at <http://wndw.net/>

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The website will include additional case studies, currently available equipment, and more external website references. Volunteers and ideas are welcome. Please join the mailing list and send ideas.

The training course material was written for courses given by the Association for Progressive Communications and the Abdus Salam International Center for Theoretical Physics. See <http://www.apc.org/wireless/> and <http://wireless.ictp.trieste.it/> for more details on those courses and their material. Additional information was provided by the International Network for the Availability of Scientific Publications, <http://www.inasp.info/>. Some of this material has been incorporated directly into this book. Additional material was adapted from *How To Accelerate Your Internet*, <http://bwmo.net/>.

Credits

This book was started as the BookSprint project at the 2005 session of WSFII, in London, England (<http://www.wsfii.org/>). A core team of seven people built the initial outline over the course of the event, presented the results at the conference, and wrote the book over the course of a few months. Throughout the project, the core group has actively solicited contributions and feedback from the wireless networking community. Add your own feedback and updates to the WNDW wiki at <http://wiki.wndw.net/>.

- **Rob Flickenger** was the lead author and editor of this book. Rob has written and edited several books about wireless networking and Linux, including *Wireless Hacks* (O'Reilly Media) and *How To Accelerate Your Internet* (<http://bwmo.net/>). He is proud to be a hacker, amateur mad scientist, and proponent of free networks everywhere.
- **Corinna “Elektra” Aichele**. Elektra’s main interests include autonomous power systems and wireless communication (antennas, wireless long shots, mesh networking). She made a small linux distro based on slackware geared to wireless mesh networking. This information is of course redundant if one reads the book... <http://www.scii.nl/~elektra>
- **Sebastian Büttrich** (<http://wire.less.dk/>) is a generalist in technology with a background in scientific programming and physics. Originally from Berlin, Germany, he worked with IconMedialab in Copenhagen from 1997 until 2002. He holds a Ph.D. in quantum physics from the Technical University of Berlin. His physics background includes fields like RF and microwave spectroscopy, photovoltaic systems, and advanced maths.

He is also a performing and recording musician.

- **Laura M. Drewett** is a Co-Founder of Adapted Consulting Inc., a social enterprise that specializes in adapting technology and business solutions for the developing world. Since Laura first lived in Mali in the 1990s and wrote her thesis on girls’ education programs, she has strived to find sustainable solutions for development. An expert in sustainability for ICT projects in developing world environments, she has designed and managed projects for a diversity of clients in Africa, the Middle East and Eastern Europe. Laura holds a Bachelors of Arts with Distinction in Foreign Affairs and French from the University of Virginia and a Master’s Certificate in Project Management from the George Washington University School of Business.
- **Alberto Escudero-Pascual** and **Louise Berthilson** are the founders of IT +46, a Swedish consultancy company with focus on information technology in developing regions. IT +46 is internationally known for promoting and implementing wireless Internet infrastructure in rural areas of Africa and Latinamerica. Since 2004, the company has trained over 350 people in 14

countries and released over 600 pages of documentation under Creative Commons License. More information can be found at <http://www.it46.se/>

- **Carlo Fonda** is a member of the Radio Communications Unit at the Abdus Salam International Center for Theoretical Physics in Trieste, Italy.
- **Jim Forster** has spent his career in software development, mostly working on operating systems and networking in product companies. He has experience with several failed startup companies in Silicon Valley, and one successful one, Cisco Systems. After a lot of product development work there, his more recent activities involve projects and policies for improving Internet access in developing countries. He can be reached at jrforster@mac.com.

- **Ian Howard**. After flying around the world for seven years as a paratrooper in the Canadian military, Ian Howard decided to trade his gun for a computer.

After finishing a degree in environmental sciences at the University of Waterloo he wrote in a proposal, "Wireless technology has the opportunity to bridge the digital divide. Poor nations, who do not have the infrastructure for interconnectivity as we do, will now be able to create a wireless infrastructure." As a reward, Geekcorps sent him to Mali as the Geekcorps Mali Program Manager, where he led a team equipping radio stations with wireless interconnections and designed content sharing systems.

He is now a consultant on various Geekcorps programs.

- **Kyle Johnston**, <http://www.schoolnet.na/>
- **Tomas Krag** spends his days working with *wire.less.dk*, a registered non-profit, based in Copenhagen, which he founded with his friend and colleague Sebastian Büttrich in early 2002. *wire.less.dk* specialises in community wireless networking solutions, and has a special focus on low-cost wireless networks for the developing world.

Tomas is also an associate of the Tactical Technology Collective <http://www.tacticaltech.org/>, an Amsterdam-based non-profit "to strengthen social technology movements and networks in developing and transition countries, as well as promote civil society's effective, conscious and creative use of new technologies." Currently most of his energy goes into the Wireless Roadshow (<http://www.thewirelessroadshow.org/>), a project that supports civil society partners in the developing world in planning, building and sustaining connectivity solutions based on license-exempt spectrum, open technology and open knowledge.

- **Gina Kupfermann** is graduate engineer in energy management and holds a degree in engineering and business. Besides her profession as financial controller she has worked for various self-organised community projects and non-profit organisations. Since 2005 she is member of the executive board of the development association for free networks, the legal entity of freifunk.net.

- **Adam Messer.** Originally trained as an insect scientist, Adam Messer metamorphosed into a telecommunications professional after a chance conversation in 1995 led him to start one of Africa's first ISPs. Pioneering wireless data services in Tanzania, Messer worked for 11 years in eastern and southern Africa in voice and data communications for startups and multinational cellular carriers. He now resides in Amman, Jordan.
- **Juergen Neumann** (<http://www.ergomedia.de/>) started working with information technology in 1984 and since then has been looking for ways to deploy ICT in useful ways for organizations and society. As a consultant for ICT strategy and implementation, he has worked for major German and international companies and many non-profit projects. In 2002 he co-founded www.freifunk.net, a campaign for spreading knowledge and social networking about free and open networks. Freifunk is globally regarded as one of the most successful community-projects in this field.
- **Ermanno Pietrosemoli** has been involved in planning and building computer networks for the last twenty years. As president of the Latin American Networking School, Escuela Latinoamericana de Redes “EsLaRed”, www.eslared.org.ve, he has been teaching wireless data communications in several countries while keeping his base at Mérida, Venezuela.
- **Frédéric Renet** is a co-founder of Technical Solutions at Adapted Consulting, Inc. Frédéric has been involved in ICT for more than 10 years and has worked with computers since his childhood. He began his ICT career in the early 1990s with a bulletin board system (BBS) on an analog modem and has since continued to create systems that enhance communication. Most recently, Frédéric spent more than a year at IESC/Geekcorps Mali as a consultant. In this capacity, he designed many innovative solutions for FM radio broadcasting, school computer labs and lighting systems for rural communities.
- **Marco Zennaro**, aka *marcusgennaroz*, is an electronic engineer working at the ICTP in Trieste, Italy. He has been using BBSes and ham radios since he was a teenager, and he is happy to have merged the two together working in the field of wireless networking. He still carries his Apple Newton.

Support

- **Lisa Chan** (<http://www.cowinanorange.com/>) was the lead copy editor.
- **Casey Halverson** (<http://seattlewireless.net/~casey/>) provided technical review and suggestions.
- **Jessie Heaven Lotz** (<http://jessieheavenlotz.com/>) provided several updated illustrations for this edition.
- **Richard Lotz** (<http://greenbits.net/~rlotz/>) provided technical review and suggestions. He works on SeattleWireless projects and would like to take his node (and his house) off the grid.
- **Catherine Sharp** (<http://odessablue.com/>) provided copy edit support.

- **Lara Sobel** designed the cover for WNDW 2nd Edition. She is an artist currently living in Seattle, WA.
- **Matt Westervelt** (<http://seattlewireless.net/~mattw/>) provided technical review and copy edit support. Matt is the founder of SeattleWireless (<http://seattlewireless.net/>) and is an evangelist for FreeNetworks worldwide.

About the solar power guide

The source material for the Solar Power chapter was translated and developed by Alberto Escudero-Pascual. In 1998, the organization Engineering without Borders (Spanish Federation) published the first version of a handbook titled "Manual de Energía Solar Fotovoltaica y Cooperación al Desarrollo". The handbook was written and published by members of the NGO and experts of the Institute of Energy Solar of the Polytechnical University of Madrid. By curiosities of life, none of the members of the editorial team kept the document in electronic format and more editions were never made. They have passed almost ten years from that very first edition and this document is an effort to rescue and to extend the handbook.

As part of this rescue operation Alberto would like to thank the coordinators of the first original edition and his mentors in his years at University: Miguel Ángel Eguido Aguilera, Mercedes Montero Bartolomé y Julio Amador. This new work is licensed under Creative Commons **Attribution-ShareAlike 3.0**. We hope that this material becomes a new departure point for new editions including new contributions by the community.

This second and extended edition of the solar power guide has received valuable input from Frédéric Renet and Louise Berthillon.

Special thanks

The core team would like to thank the organizers of WSFII for providing the space, support, and occasional bandwidth that served as the incubator for this project. We would especially like to thank community networkers everywhere, who devote so much of their time and energy towards fulfilling the promise of the global Internet. Without you, community networks could not exist.

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