Signals and Communication Technology

Ramjee Prasad (Ed.)

My personal Adaptive Global NET (MAGNET)

Springer

For other titles published in this series, go to
http://www.springer.com/series/4748

Ramjee Prasad (Ed.)

My Personal Adaptive Global NET (MAGNET)

Springer

Editor
Ramjee Prasad
Aalborg University
CTIF
Niels Jernes Vej 12
9220 Aalborg
Denmark
prasad@es.aau.dk

ISSN 1860-4862
ISBN 978-90-481-3436-6 e-ISBN 978-90-481-3437-3
DOI 10.1007/978-90-481-3437-3
Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2009942347

Cover design: eStudio Calamar S.L.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

To the Technical Managers of MAGNET and MAGNET Beyond

Juha Saarnio
Mikael Latvala
Karsten Vandrup
Liljana Gavriloska
Albena Mihovska (Deputy)

Preface

सहजं कर्म कौन्तेय सदोषमपि न त्यजेत् ।
सर्वारम्भा हि दोषेण धूमेनाग्निरिवावृताः ॥

saha-jaṁ karma kaunteya
sa-doṣam api na tyajet
sarvārambhā hi doṣeṇa
dhūmenāgnir ivāvṛtāḥ

Every endeavour is covered by some fault, just as fire is covered by smoke.
Therefore one should not give up the work born of his nature, even if such work is full of fault.

– The Bhagvad-Gita (18.48)

This book is the outcome of the research and development contributions of partners from three different continents, Asia, Europe, America, coming from universities, research centers, industrial partners and SMEs (Small and Medium Enterprise), all of them collaborating in MAGNET (My Adaptive Personal Global Net) and MAGNET Beyond project supported by European Commission within the Sixth Framework Programme (FP6). The project was focusing on a secure user-centric approach developing secure Personal Networks in multi-network, multi-device, and multi-user environments.

The innovative concept of Personal Network (PN), which was introduced and developed in MAGNET, finds in this book the first confirmation of the success that the future of wireless communications is bound to achieve. The importance of this book is not only related to being the first work on PNs, it also gives an overview of operation of a big project, like MAGNET, and in fact the organisation of the book reflects how then project itself has been structured.

The book summarize all the steps taken from the introduction of a user-centric perspective until the implementation of PN-Fs, outlining the applications and commercialisations of the new concepts carried out of the project. The starting point has been the concept of Personal Network coming out like an extension of the local scope of Wireless Personal Area Networks (WPAN) by addressing virtual personal environments that span a variety of infrastructures. The new element was that the composition, organisation, and topology of a PN have determined by its context and the geographical location, the time, the environment and the explicit wishes to use particular services determined which device and network element have been incorporated in a PN. The PN can be defined as a dynamics collection of personal nodes and device not only centered around a person, but also personal devices on remote locations. A PN is composed of multiple clusters, where the communication is between remote clusters that have a common trust relationship. To extend the PN solutions to enable interactions between multiple PNs, it have been introduced the concept of PN Federation (PN-F). A PN Federation can be defined as a secure cooperation between different PNs, making selected service(s) and resource(s) available to selected receiver(s) for the purpose of achieving a common goal.

The project started in January 2004, and was divided in two phases, in the first, named MAGNET (January 2004–December 2005), the objectives were to design, develop, demonstrate and validate the concept of a flexible Personal Network that supports resource-efficient, robust, ubiquitous service provisioning in a secure, heterogeneous networking environment for nomadic users. There were 37 partners, 13 industrial, 7 research centres, 14 universities, and 3 SMEs coming from 16 different countries around three different continents: Austria, Belgium, China, Denmark, Finland, France, Germany, Greece, India, Italy, Netherlands, Spain, Sweden, Switzerland, United States, and UK. In the second phase, MAGNET Beyond (January 2006–June 2008) the interest was concentrated on the interactions between multiple PN users with common interests for various services. MAGNET Beyond had 30 partners from 15 countries, the same involved in MAGNET except United States:

- Twelve Universities
- Seven Research Centres
- Nine Industrial Partners
- Two SMEs

The cooperation from several partners from all over world and from different organization was a hard task but, at the same time, the level of the discussions was always very high, and very interesting results were obtained. MAGNET/MAGNET Beyond had a significant influence in specifying the PN and PN-F, offering to the community patents, demo-platform, pilots and test bed useful for next industrial commercialization. This was possible because of the collaboration among all the partners, which coming from different organization highlighted different points of view and achieving results that led directly to the future wireless technologies known as 4G.

The intent of this book is to disseminate the concept of PN and PN-F among with the activities and achievements carried out in MAGNET/MAGNET Beyond to encourage new projects and academic initiatives toward personalized, ubiquitous communications. We tried to make our best to write each chapter as self-contained as possible in order to allow the reader to read them independently.

Any remarks to improve the text and correct any errors or typos would be highly appreciated.

Acknowledgements

The material in this book originates from the EU project MAGNET/MAGNET beyond. Therefore, the editor would like to thank all the colleagues involved in the project for their collaboration and dedication that made the success of the project and also helped to finalize this book. The editor also hopes that the personal relations established during these years will remain and make possible future collaborations.

In the first place, the editor would like to thank the Project Officer, Rémy Bayou, for his remarkable support to our work.

The editor would like to acknowledge the contributions from Aalborg University, Advanced Communications Research and Development S.A, ALCATEL Italia, Brunel University, Centre Suisse d'Electronique et de Microtechnique – Recherche et Development SA, Commissariat à l'Energie Atomique, Danmarks Tekniske Universitet, Delft University of Technology, France Telecom R&D, Fraunhofer Institut FOKUS, Forschungszentrum Telekommunikation Wien Betriebs GmbH, Groupe des Ecoles des Télécommunications – Institut National des Télécommunications, Institute of Communication and Computer Systems (ICCS) of the National Technical University of Athens, Interuniversitair Micro-Elektronica Centrum vzw, INTRACOM S.A. Hellenic Telecommunications and Electronics Industry, Lund University, National Institute of Informational and Communication Technology, NEC Europe Ltd., Nokia Corporation OYJ, NXP Semiconductors Netherlands B.V, Shanghai Institute of Microsystems and Information Technology/CAS, Tata Consultancy Service, TeliaSonera, Telefónica Investigación y Desarrollo Sociedad Anónima Unipersonal, Universidad de Cantabria, The University of Surrey, University of Rome "Tor Vergata", Technical Research Centre of Finland, Twente Institute of Wireless and Mobile Communications, University of Kassel.

Finally, the editor likes to express his special thanks to Antonietta Stango and Juan J. Sanchez for their patience and cooperation in freeing from the enormous editorial burden.

Contents

List of Partners in MAGNET and MAGNET Beyond

List of partners	Country	Magnet	Magnet beyond
Aalborg University	Denmark	*	*
Advanced Communication Research and Development, S.A.	Spain	*	*
ALCATEL Italia	Italy		*
Alcatel Sel Ag	Germany	*	
Beijing University of Posts and Telecommunications	China	*	
Brunel University	UK	*	*
Centre Suisse D'electronique Et De Microtechnique Sa – Recherche Et Development	Switzerland	*	*
Commissariat A L'energie Atomique	France	*	*
Danmarks Tekniske Universitet	Denmark	*	*
Eidgenoessische Technische Hochschule Zuerich	Switzerland	*	
Fraunhofer Institut FOKUS	Germany	*	*
Forschungszentrum Telekommunikation Wien Betriebs-Gmbh	Austria	*	*
France Telecom	France	*	*
Groupe Des Ecoles Des Telecommunications	France	*	*
Institute of Communication and Computer Systems – National Technical University of Athens	Greece	*	*
Interuniversitair Micro-Electronica Centrum Vzw	Belgium	*	*
Intracom S.A. Hellenic Telecommunications and Electronics Industry	Greece	*	*
Lucent Technologies Inc.	United States	*	
Lucent Technologies Nederland Bv	The Netherlands	*	

(continued)

List of partners	Country	Magnet	Magnet beyond
Lund University	Sweden	*	*
National Institute of Information and Communications Technology	Japan	*	*
NEC Europe Ltd.	Germany		*
Nokia Corporation	Finland	*	*
Nokia Gmbh	Germany	*	
NXP Semiconductors Netherlands B.V	The Netherlands		*
Pcom: I^3 Aps	Denmark	*	
Rheinisch-Westfaelische Technische Hochschule Aachen	Germany	*	
Samsung Electronics (UK) Limited	UK	*	
Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences	China	*	*
Tata Consultancy Service	India		*
Tata Sons Limited	India	*	
Tata Sons Limited, Europe		*	
Technical Research Centre of Finland	Finland	*	*
Technische Universiteit Delft	The Netherlands	*	*
Telefonica Investigacion Y Desarrollo Sa Unipersonal	Spain	*	*
Teliasonera Sverige Aktiebolag	Sweden	*	*
The University of Surrey	UK	*	*
Twente Institute of Wireless and Mobile Communications	The Netherlands		*
Universidad De Cantabria	Spain	*	*
Universita Degli Studi Di Roma “Tor Vergara”	Italy	*	*
University of Kassel	UK		*

About the Editor

Ramjee Prasad is currently a Professor and Director of Center for Teleinfrastruktur (CTIF), and holds the chair of wireless information and multimedia communications. He was coordinator of European Commission Sixth Framework Integrated Project MAGNET (My personal Adaptive Global NET) and MAGNET Beyond. He was involved in the European ACTS project FRAMES (Future Radio Wideband Multiple Access Systems) as a project leader in Delft University. He was also project leader of several international, industrially funded projects of Technology. He has published over 700 technical papers, contributed to several books, and has authored, co-authored, and edited over twenty five books. His latest book is "*Introduction to Ultra Wideband for Wireless Communications*".

Professor Prasad has served as a member of the advisory and program committees of several IEEE international conferences. He has also presented keynote speeches, and delivered papers and tutorials on WPMC at various universities, technical institutions, and IEEE conferences. He was also a member of the European cooperation in the scientific and technical research (COST-231) project dealing with the evolution of land mobile radio (including personal) communications as an expert for The Netherlands, and he was a member of the COST-259 project. He was the founder and chairman of the IEEE Vehicular Technology/Communications Society Joint Chapter, Benelux Section, and is now the honorary chairman. In addition, Professor Prasad is the founder of the IEEE Symposium on Communications and Vehicular Technology (SCVT) in the Benelux, and he was the symposium chairman of SCVT'93. Presently, he is the Chairman of IEEE Vehicular Technology/Communications/Information Theory/Aerospace and Electronics Systems/Society Joint Chapter, Denmark Section.

In addition, Professor Prasad is the coordinating editor and editor-in-chief of the *Springer International Journal on Wireless Personal Communications.* He was the technical program chairman of the PIMRC'94 International Symposium held in The Hague, The Netherlands, from September 19–23, 1994 and also of the Third Communication Theory Mini-Conference in Conjunction with GLOBECOM'94, held in San Francisco, California, from November 27–30, 1994. He was the conference chairman of the fiftieth IEEE Vehicular Technology Conference and the steering committee chairman of the second International Symposium WPMC, both held in Amsterdam, The Netherlands, from September 19–23, 1999. He was the general chairman of WPMC'01 which was held in Aalborg, Denmark, from September 9–12, 2001, and of the first International Wireless Summit (IWS 2005) held also in Aalborg, Denmark on September 17–22, 2005. He was the General Chair of the First International Conference on Wireless Communication, Vehicular Technology, Information Theory and Aerospace and Electronic Systems Technology (Wireless VITAE) held on May 17–20, 2009 in Aalborg.

Professor Prasad was also the founding chairman of the European Center of Excellence in Telecommunications, known as HERMES and now he is the honorary chairman. He is a fellow of IEEE, a fellow of IETE, a fellow of IET, a member of The Netherlands Electronics and Radio Society (NERG), and a member of IDA (Engineering Society in Denmark). Professor Prasad is advisor to several multinational companies. He has received several international awards; one of this is the "Telenor Nordic 2005 Research Prize" (website: http://www.telenor.no/om/).

Abbreviations

3GPP	Third Generation Partnership Project
AAF	Anti-Aliasing Filter
ACL	Access Control List
ActCom	Activity Based Communication Concept
AES	Advanced Encryption Standard
AGC	Automatic Gain Control
AI	Air interface
AIPN	All-IP networks
AMC	Adaptive Modulation and Coding
AN	Ambient Networks
APF	All Pass Filter
API	Application Programming Interface
ARPU	Average Revenue Per User
ARQ	Automatic Repeat Request
AWA	Alternating Wireless Activity
AWGN	Additive White Gaussian Noise
BAN	Body Area Networks
BC	Business Card
BER	Bit Error Rate
BI	Beacon Interval
BiCMOS	Bipolar Complementary Metal Oxide Semiconductor
BMA	Berlekamp-Massey
BO	Beacon Order
BP	Beacon Period
CA	Certificate Authority
CA	Context Agent
CAC	Context Agent Controller
CAC	Context Aware Component
CALA	Context Access Language
CAM	Context Access Manager
CAN	Community Area Network
CAP	Contention Access Period
CASD	Context Aware Service Discovery

CASM	Context Aware Security Manager
CC/PP	Composite Capabilities/Preferences Profile
CCIB	Computational Complexity per Information Bit
CDMA	Code Division Multiple Access
CFP	Contention Free Period
CID	Cluster Identifier
CLH	Cluster Head
CMN	Context Management Node
CMOS	Complementary metal oxide semiconductor
CP	Control Point
CPFP	Certified PN Formation Protocol
CPNS	Converged Personal Network Service
CRC	Cyclic Redundancy Check
CSI	Channel State Information
CSMA/CA	Carrier Sense Multiple Access/Collision Avoidance
CTAP	Channel Time Allocation Period
DAA	Detect and Avoid
DAC	Digital Analog Converter
DDS	Direct Digital Synthesiser
DEV	Device
DEVID	Device ID
DH	Diffie-Hellman
DHCP	Dynamic Host Configuration Protocol
DHT	Distributed Hash Table
DME	Device Management Entity
DoS	Denial of Service
DQPSK	Differential Quadrature Phase Shift Keying
DSA	Data Source Abstraction
DSAL	Data Source Abstraction Layer
DSAM	DSA Manager
DSN	Data Sequence Number
EAP	Extensible Authentication Protocol
EC	European Commission
ECC	Elliptic Curve Cryptography
ECDH	Elliptic Curve Diffie-Hellman
ECDSA	Elliptic Curve Digital Signature Algorithm
ECMA	European Computer Manufacturers Association
ECMQV	Elliptic Curve Menezes-Qu-Vanstone
EEA	Extended Euclidean Algorithm
ESD	Electrostatic Discharge
ETSI	European Telecommunications Standards Institute
FCS	Frame Check Sequence
FCSL	Frame Convergence Sub Layer
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction

FER	Frame Error Rate
FFD	Full Function Device
FFT	Fast Fourier Transform
FIFO	First In First Out
FM	Federation Manager
FMC	Fixed Mobile Convergence
FM-UWB	Frequency Modulation Ultra Wide Band
FSB	Frequency-Spreading Blocks
FSK	Frequency Shift Keying
FSMC	Finite-State Markov Channel
FTD	Fixed Time Delay
GENA	Generic Event Notification Architecture
GF	Galois Field
GSM	Global System for Mobile communications
GSMA	GSM Association
GTS	Guaranteed Time Slots
GUI	Graphical User Interface
GUP	Generic User Profile
HCS	Header Check Sequence
HDR	High Data Rate
HTTP	Hyper Text Transfer Protocol
IAWA	Improved AWA
ICMP	Internet Control Message Protocol
IDFT	Inverse Discrete Fourier Transform
IdP	Identity Provider
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IF	Intermediate Frequency
IFS	Inter Frame Space
IMS	IP Multimedia Subsystem
IMT-A	International Mobile Communication-Advanced
INR	Intentional Name Resolver
INS	Intentional Naming System
IP	Internet Protocol
IPsec	IP security
ISM	Industrial, Scientific and Medical
ISO	International Organization for Standardization
ISO/IEC	International Organization for Standardization/ International Electrotechnical Commission
IST	Society Technology
ITU	International Telecommunication Union
KDF	Key Derivation Function
LAN	Local Area Network
LDC	Low Duty Cycle
LDR	Low Data Rate

LIFS	LongIFS
LLC	Logical Link Control
LNA	Low Noise Amplifier
LOS	Line of Sight
LPF	Low Pass Filters
M C	Modulation and Coding
MAC	Message Authentication Code
MAC	Medium Access Control
MAGNET	My personal Adaptive Global NET
MAS	Medium Access Slots
MC-CDMA	Multi-carrier CDMA
MCDU	MAC Command Data Unit
MC-SS	Multi Carrier Spread Spectrum
MCTA	Management Channel Time Allocation
MFR	MAC Footer
MIC	Message Integrity Code
MIFS	Minimum Inter Frame Space
MIMO	Multiple-Input and Multiple-Output
MITM	Man-in-the-Middle
MLME	MAC (sub)Layer Management Entity
MMC	Multi Media Card
MMS	Multimedia Messaging Service
MNO	Mobile Network Operator
MOD	Modality environment
MOPED	Mobile Grouped Device
MOS	Metal Oxide Semiconductor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MPDU	MAC Protocol Data Unit
MPEG	Moving Picture Experts Group
MSDP	MAGNET Service Discovery Platform
MSDU	MAC Service Data Unit
MSMP	MAGNET Service Management Platform
MUP	MAGNET User Profile
NAT	Network Address Translation
NF	Noise Figure
NGN	Next Generation Networks
NGWS	Next-Generation Wireless Systems
NIC	Network Interface Card
NoC	Network on Chip
OA	Output Amplifier
OFDM	Orthogonal Frequency Division Multiplexing
OMA	Open Mobile Alliance
OSAL	Operating System Abstraction Layer
OSGi	Open Service Gateway initiative
OSI	Open Systems Interconnection

OSS	Operation Support System
OWL-DL	Ontology Web Language – Description Logics
P S	Processing and Storage
P2P	Peer to Peer
PAC	Authenticated Channel
PACWOMAN	Power Aware Communications for Wireless Optimised Personal Area Network
PAN	Personal Area Network
PDA	Personal Digital Assistant
PDE	Personal Distributed Environment
PE	Policy Engine
PeP	Personalization Provider
PER	Packet Error Rate
PFP	PN Formation Protocol
PGZ	Peterson-Gorenstein-Zierler
PHY	Physical Layer
PIP	Personal Identity Provider
PKI	Public Key Infrastructure
PLL	Phase Lock Loop
PMH	Personal Mobile Hub
PN	Personal Network
PNC	Piconet Coordinator
PNCA	PN Certificate Authority
PNDS	Personal Network Directory Service
PN-F	Personal Network Federation
PNID	Piconet Identifier
PNM	Personal Network Management
POS	Personal Operating Space
P-PAN	Private Personal Area Network
PTAT	Proportional to Absolute Temperature
PU	Processing Unit
PUCC	The P2P Universal Computing Consortium
QoS	Quality of Service
RAF	Repository Access Function
RD	Radio Domain
RDF	Resource Description Framework
RF VCO	Radio Frequency Voltage-Controlled Oscillator
RFC	Request for Comments
RFD	Reduced Function Devices
RFID	Radio Frequency Identification
RI	Radio Interfaces
RPC	Remote Procedure Call
RRM	Radio Resource Manager
RS	Reed Solomon
RTP	Real Time Protocol

SAM	Slot Allocation Matrix
SAN	Service Assistance Node
SAP	Service Access Point
SB	Stuff Bits
SCE	Service Creation Environment
SCIM	Service Capability Interaction Manager
SCM	Service Control Module
SCMF	Secure Context Management Framework
SCP	Sub Carrier Processing
S-CSCF	Serving-Call Session Control Function
SD	Superframe Duration
SD	Service Discovery
SDAL	Service Discovery Adaptation Sub-layer
SDM	Service Discovery Module
SGN	Service Gateway Node
SGSN	Serving GPRS Support Node
SHA	Secure Hash Algorithm
SHAMAN	Security for Heterogeneous Access in Mobile Applications and Networks
SIFS	ShortIFS
SIG	Signature
SiGe:C	Silicon Germanium:Carbon
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SK	Secret Key
SLA	Service Level Agreement
SLEE	Service-Logic Execution Environment
SLP	Service Location Protocol
SME	Small and Medium Enterprise
SMMM	Service Mobility Management Module
SMN	Naming System Service
SMN	Service Management Node
SMS	Short Message Service
SNR	Signal to Noise Ratio
SO	Superframe Order
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOCM	Service Orchestration and Composition Module
SORM	Service Ontology and Reasoner Module
SP	Service Proxy
SPN	Service Provider Network
SR	Service Ranker
SRC	Source
SSCS	Service Specific Convergence Sublayer
SSDP	Simple Service Discovery Protocol

SSID	Service Set Identifier
SSL	Secure Sockets Layer
SSMM	Service Session Management Module
STF	Special Task Force
TCP	Transmission Control Protocol
TDMA	Time Division Multiple Access
TISPAN	Telecommunications and Internet converged Services and Protocols for Advanced Networking
TLS	Transport Layer Security
TTP	Trusted Third Party
UAProf	User Agent Profile
UCL	Universal Convergence Layer
UDN	Unique Device Name
UDP	User Datagram Protocol
UI	User Interface
UMA	Unlicensed Mobile Access
UML	Unified Modelling Language
UMTS	Universal Mobile Telecommunication System
UPnP	Universal Plug and Play
USIM	Universal Subscriber Identity Module
UWB	Ultra Wide Band
VB	Virtual Badge
VBR	Variable Bit Rate
VID	Virtual Identity
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
W3C	The World Wide Web Consortium
WAN	Wide Area Network
WCDMA	Wideband Code Division Multiple Access
WHERE	Wireless Hybrid Enhanced Mobile Radio Estimators
WLAN	Wireless Local Area Network
WP	Work Package
WPAN	Wireless Personal Area Network
WWAN	Wireless Wide Area Network
WWRF	Wireless World Research Forum
XCAP	XML Configuration Access Protocol
XDM	XML Document Management
XML	Extensible Mark-up Language

List of Figures

List of Tables

Chapter 1
Introduction

Ramjee Prasad

This book builds on the achievements of the EU-funded projects MAGNET and MAGNET Beyond in the area of personal area networks and related technologies. Wireless connectivity has already enabled computer users to profit from a new convenient mobile lifestyle. Consumers are now demanding the same simplicity throughout their homes, connecting personal computers (PCs), personal digital recorders, MP3 recorders and players, and every kind of digital and electronic devices to each other in versatile domestic wireless personal area networks (WPAN) and also the possibility to be connected with any body area networks (WBAN) if needed. However, current wireless local area network (WLAN) and WPAN technologies cannot yet meet the needs of tomorrow's connectivity for the host of emerging consumer electronic devices that offer full mobility while requiring low power, quality of service (QoS) and security. So, as computing, communications and consumer applications converge to provide domestic consumers with extensive new services in an intelligent ambient environment, there is an urgent need to develop short-range user-centered wireless networks. This challenge was undertaken by the EU-funded IST projects MAGNET and MAGNET Beyond.

1.1 The Concept of Personal Networks

The concept of PAN (Personal Area Network) refers to a space of small coverage around the person where ad hoc communication occurs. To extend the local scope of PANs a new kind of network has been developed: Personal Network. The concept of the Personal Network (PN) goes beyond the concept of a PAN by addressing virtual personal environments that span a variety of infrastructures (as well as ad hoc networks) [1].

Personal Networks is a concept that supports the professional and private activities of users without being obtrusive and while safeguarding their privacy and

R. Prasad (✉)
Aalborg University - CTIF, Niels J. Vey 12, Aalborg 9220, Denmark
e-mail: prasad@es.aau.dk

R. Prasad (ed.), *My Personal Adaptive Global NET (MAGNET)*, Signals and Communication Technology, DOI 10.1007/978-90-481-3437-3_1,

security. A PN may operate in both ad hoc and infrastructure-based networks and is dynamic and diverse in composition, configuration and connectivity depending on the time, place and circumstances as well as the required resources [2–17].

PNs comprise potentially "all of a person's devices capable of network connection in the real or virtual vicinity". In PNs, users interact with various companion-, embedded-, or invisible computers not only in their close vicinity but potentially anywhere. They also need to interact with other persons having their own PNs, leading to group communication and federation of PNs to achieve particular tasks. PNs constitute a category of distributed systems with very specific characteristics. This requires major extensions of the present Personal Area Networking.

The PN concept has been researched by various groups and from different perspectives. Examples are found in "Scenarios for Ambient Intelligence in 2010" [12], "The Book of visions – Visions of the Wireless World" [13], "Telecom Scenarios in 2010" [14], and the vision of the Association of Computing Machinery (ACM) in "The Next 1000 Years" [15]. EU-funded IST projects such as the projects PACWOMAN [16] and MOBILIFE [17] addressed users and the wireless vision in different ways. The projects MAGNET and MAGNET Beyond [2] exercised a different approach in order to identify and represent user requirements in the PN-development process, which would provide a better design and identify the path towards novel business models speeding up their adoption and successful deployment. In MAGNET the methodology to describe and develop understanding for the implementation of an efficient PN-solution in a heterogeneous multimodal environment has been carried out involving 'technology', 'user needs' and 'economics' requirements. A key element of 'user needs' was the perceived QoS associated with given private or business activities and its relation to the technical solutions. Furthermore, the user requirements were derived from real user involvement in the process in all stages.

The actual introduction, implementation, and commercialisation of PN services derived a unique and enhanced understanding of the combination between user requirement and technology developments, business models, market strategies and socio-economic aspects that are necessary to give a holistic picture of the PN concept and its possibilities to secure the European communication needs in the future.

PNs are configured in an ad hoc fashion, as the opportunity and the demand arise to support a person's private and professional applications. These applications may run on a user's personal device, but also on foreign devices. PNs consist of communicating clusters of personal digital devices, possibly shared with others, and connected through various suitable communications means. This is shown in Fig. 1.1. Unlike PANs, with a limited geographically coverage, PNs have an unrestricted geographical span, and may incorporate devices into the personal environment regardless of their geographic location.

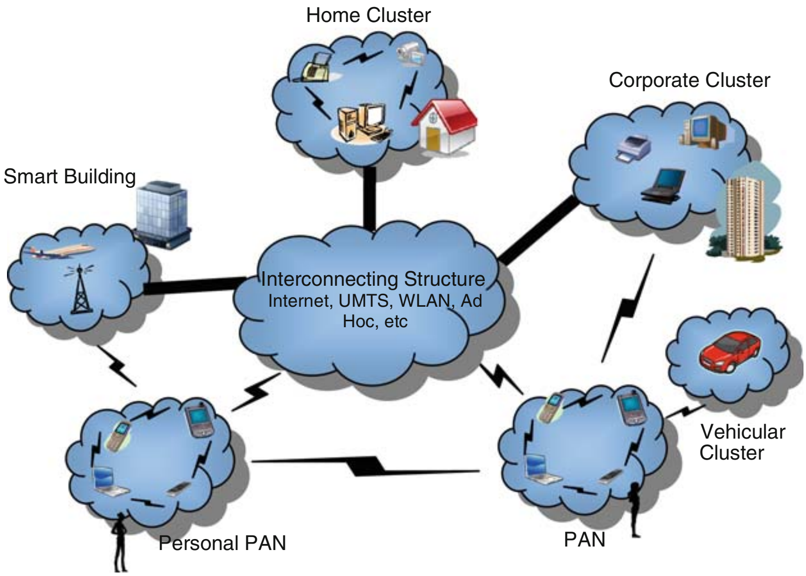

Fig. 1.1 The PN concept

1.1.1 PN Networking

Current radio technologies offer, up to a certain extent, self-organisational capabilities at the link layer:

- IEEE 802.11 provides link-level self-organisation
- Bluetooth networks organise themselves by forming pico-nets or even scatternets

Self-organisation at the network layer is also receiving a lot of attention in the context of mobile networks (e.g., ad hoc, MANETs, cooperative communications), in which nodes need to cooperate to organise themselves and to provide network functionality, due to the absence of any fixed infrastructure or simply to provide for autonomic resources. However, in the context of PNs, the problem has a completely different dimension, as self-organisation spans over multiple network technologies and strongly builds on the concept of trust between the personal nodes and devices.

The field of mobile ad hoc networks has seen a rapid expansion due to the proliferation of wireless devices, witnessed by the efforts in the IETF MANET working group [18]. A lot of attention has been given to the development of routing protocols, with the MANET group working on the standardization of a general reactive and proactive routing protocol, and, in a lesser extent, to address Internet connectivity [19].

When analysing the characteristics of a PN and its communication patterns, a number of similarities with mobile ad hoc networks can be observed. A PN should be self organising and self maintaining, handling mobility and, thereby, providing its own addressing and routing mechanisms for its internal communication. So, similar to ad hoc networks, PNs require self organizing and self maintaining networking capabilities that can deal with their dynamic behaviour. Therefore, developing PN networking solutions can be considered an extension of ad hoc networking techniques and concepts. However, existing solutions for mobile ad hoc networks cannot be adopted as is, due to the specific nature and the context of PNs. A PN has a specific wireless/wired geographically dispersed network topology, which, to a certain extent, can rely on the fixed infrastructure (e.g., edge routers), for providing networking solutions. Also, PNs are built around a specific trust relation concept, on which higher layer protocols can rely, which is absent in traditional ad hoc networks. The architecture developed for the PN concept and described further in this book is a novel one and a step further than the traditional concepts.

As PNs support mobility of individual devices, mobility of complete *clusters* of devices and splitting and merging of these clusters, efficient solutions are needed when dealing with these types of mobility. Worth mentioning in this context are the activities on mobile networks within the Mobile IP Working Group [20] of the IETF, the work on extensions of mobile IP for mobile ad-hoc networks interconnection [21] and the work within the NEMO working group that is concerned with the mobility of an entire network [22]. Mobility solutions for PNs can borrow from this work, but should be adapted to fit the proposed PN architecture and addressing schemes.

1.1.2 Service and Context Discovery

Routing is one of the main processes on the networking abstraction level, which is responsible for the finding and establishment of the routes among the communicating nodes. Current ad hoc routing protocols inherently trust all participants. Most ad hoc routing protocols are cooperative by nature and depend on neighbouring nodes to route packets. This simple trust model allows malicious nodes to paralyze an ad hoc network by inserting erroneous routing updates, replaying old messages, changing routing updates or advertising incorrect routing information. None of the protocols such as AODV, DSR, Ariadne, ARAN, SAR, SRP, etc. provide a solution to the requirements of certain discovery, isolation or Byzantine robustness.

The routing process must be shielded by solutions that grant the integrity and the availability of the networking procedures.

The capability to provide secure context transfer is essential in achieving fast performance in a wireless environment. Secure fast context transfer in handovers between heterogeneous access technologies/network types is needed. Furthermore, providing context-aware, adaptive and personalised services to the user, poses many opportunities, challenges and risks. Perhaps the greatest challenge is the ability to offer secure, intuitive and easy to use solutions for accessing contextual services that have to be location-aware and time-sensitive; personal preference and network bandwidth aware, and finally, device-capability aware.

Self organisation and routing aspects are fundamental aspects in the PN point of view, requiring investigation in order to provide schemes for devices and services discovery.

In a PN world, trust, identity management and privacy need considerable effort if we want to talk about an end-to-end security. Thus, a mechanism of enabling extension of the trust between personal nodes needs to be defined. Also, protection of user location, identity and privacy need to be considered. The user's location, identity and privacy requirements must be taken into account by the mobility procedures. The precise nature of these requirements may have a considerable impact on the mobility procedures. The PN world should bring concepts of anonymity and pseudonymity. Also privacy, resistance to denial of service and performance requirements is a crucial issue that needs to be considered. The project MAGNET starts with this considerations developing new concepts for service and context discovery.

1.1.3 Advances in the State of the Art of PNs

Commercially viable PNs were enabled by the joint efforts of a number of key academic and industrial players organized in the frames of the EU-funded project MAGNET and MAGNET Beyond [2]. The developed concept enabled attractive, affordable and beneficial for end users PN services in their everyday life. The MAGNET Beyond project constituted a system approach to what is expected to be one of the most important telecom related growth markets of the future, the Personal Area Network style networking. The main achievement of MAGNET Beyond was that it produced concepts and technologies that did not treat the PAN networking in isolation: the concept was extended into that of a PN by interconnecting PANs with other networks and, in particular, with wireless wide area networks to access the rich services available on and through these networks, including the interconnection to other PANs.

The following advances were made in relation to the PN:

- Research-based, comprehensive, short-term and long-term solutions for the technologies and protocols needed to build Personal Networks that meet the user requirements, in particular in terms of the quality, security, and trust requirements
- Technology roadmaps for the evolution of PNs
- System specification for first generation PNs
- Effective platforms that optimally and cost-effectively meet the short- and long-term communication requirements for personal devices
- A pilot PN system and pilot services
- An assessment of the market potential of the PN based on PN services usage, usability and acceptation tests

The project MAGNET Beyond introduced pilot services, obtained real-market and user feedback and provided the basis for the business of personal services over PNs. This had helped promote the PNs and related technologies and provided input and recommendations to standardisation and regulatory bodies and fora.

Wireless personal and body area networks are set to play an increasing role in applications such as health, personal safety, secure wireless data exchange or home entertainment. The PN concept addresses the challenge to deliver the next generation of ubiquitous and converged network and service infrastructures for communication, computing and media. It provides a new type infrastructure that can overcome the scalability, flexibility, dependability and security bottlenecks of current ones and permits the emergence of dynamic and, pervasive and robust new communication technologies. This is achieved by the extension of the PN to the concept of the PN-Federation (PN-F).

1.2 The Concept of the PN-Federation

In order to extend their reach, PNs need the support of infrastructure-based, and also ad-hoc networks. The cooperation between PNs belonging to different people in a federation is shown in Fig. 1.2.

In PN-Fs, PNs of different users cooperate for a certain purpose by sharing information and services. The daily life of persons does not involve their personal network only, but persons also need to communicate and collaborate with groups of people. Figure 1.2 shows how constituents from various PNs are federated in overlays to establish trusted groups and communities.

In such a scenario of networking of people, the needs in collaborative working, resource sharing or common interest groups such as family members, friends,

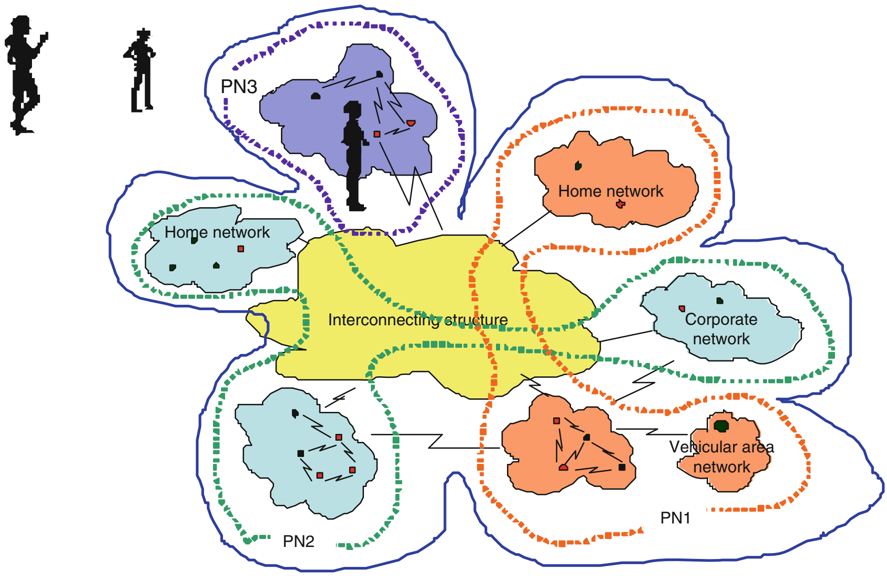

Fig. 1.2 The concept of the PN-F

kids at school, colleagues or public servants are all addressed. In such contexts, networking and security are confronted with far greater challenges. Designing enablers for user-centric personal networking and for creating a secure architectural framework suitable and viable for PN services become essentials.

To this end the concept of the long term or permanent trust relation between personal devices belonging to a single user should be extended to group trust between personal services shared by a group of users. In contrast to the single-user PN-concept, where secure communication exists between all personal devices constituting the PN, secure communication needs in the PN-F need to be established between a subset of personal devices belonging to different PNs, hereby creating a multi-user virtual private network overlay in a federation of multiple co-operating PNs.

A PN Federation as introduced by MAGNET Beyond is meant for a well defined goal and sets certain rules and policies for participation in the federation, defined by the creator of the Federation. Key management issues at PN Federation level for different scenarios can be supported by means of the PN-F Formation Protocol (PNFFP) [23].

1.3 Optimised Air Interfaces for PAN, PN and PN-F Communications

The PAN as a basic component of the PN relies on suitable air interfaces to ensure the communication process. Even though wireless has exploded in the last decade, wireless standards are dominated by a few protocol types. For example, most cellular networks use fixed-capacity channels, while data networking standards (e.g., IEEE802.11, IEEE802.15) are often contention-based so they can exploit statistical multiplexing of traffic. The use of simple, traffic-specific protocols has helped the rapid growth of mobile networks, but it stifles innovation and has lead to inefficient spectrum use. Today, basically, three wireless technologies, besides satellite communications, have made an impact: WLANs, WPANs, and wireless wide area networks (WWANs).Work in that direction is on-going in the various standardisation activities supported by the European Telecommunication Standardisation Union (ETSI) and the Institute of Electrical and Electronic Engineers (IEEE). Currently, the standardized WPAN technologies are BLUETOOTH, HIPERPAN and IEEE 802.15. These technologies are used for short distance ($\sim$10 m) with low data rates for different QoS requirements. It is envisaged that the WPANs will exist in all mobile terminals in the near future. The WPAN standards, IEEE 802.15.3 and 3a have developed and work is ongoing for paving the way towards broadband WPANs with envisioned data rates up to about 1 Gbps. IEEE 802.15.4 is focusing on very low data rate solutions, which will work at a few or a few hundred Kbps, which is the first step towards body area networks (BANs). Ultra wideband (UWB) schemes are considered for both IEEE 802.15.3 and IEEE 802.15.4. The working group IEEE 802.15.3a proposed direct-sequence (DS) UWB for low and medium data rates and multiband orthogonal frequency-division multiplexing (OFDM) for high data rates.

The latter is based on a transmission over 14 overlapping OFDM channels each having a bandwidth of 528 MHz for 128 subcarrier signals.

The specifics of the PAN radio environment (i.e., user proximity, user dynamics, radio co-existence with legacy and emerging communication systems, terminal/device sizes and their use cases), affect the choice of a proper channel model and consequently the air interface configuration. Appropriate and accurate radio channel and radio interference models, based on previous results and from new investigations, were investigated in the context of PNs with the objective to approximate the real time varying PAN radio environment. The proposed MAGNET PAN radio access solutions were taken as a basis for the optimisation of the air interfaces for typical PAN scenarios to ensure a favourable trade-off between user satisfaction (QoS) and system complexity.

MAGNET Beyond proposed air interfaces for high data rate (HDR) and low data rate (LDR) applications. The HDR applications are enabled by a multi-carrier spread spectrum (MC-SS) air interface solution. The only other available solution with similar capabilities at the moment is WiMedia, a radio platform standard for high-speed UWB wireless connectivity. For LDR applications, a low-power, low-complexity frequency modulation based UWB (FM-UWB) air-interface solution was proposed compatible to standards such as BLUETOOTH, ZigBee, and WiBree. The medium access control (MAC) of these two is based on the IEEE 802.15.3 and IEEE 802.15.4 standards. The FM-UWB approach was adopted after being studied and compared with other solutions like ZigBee and Bluetooth. Accordingly, the MC-SS scheme was compared to the orthogonal frequency-division multiplexing (OFDM) based UWB PHY scheme in a WiMedia system. Results are reported in details in and show that the developed air interfaces fulfil the requirements for next generation technologies.

Broadband wireless access is the third wireless revolution, after cell phones and Wi-Fi. The broadcast nature of wireless transmission offers ubiquity and immediate access for both fixed and mobile users, clearly a vital element of next generation quadruple play (i.e., voice, video, data, and mobility) services. Unlike wired access (copper, coax, fiber), a large portion of the deployment costs is incurred only when a subscriber signs up for service. An increasing number of municipal governments around the world are financing the deployment of multi-hop wireless networks with the overall aim of providing ubiquitous Internet access and enhanced public services. Broadband wireless access is an inherent feature of next generation communication systems. Therefore, PAN and PN solutions as proposed by the projects MAGNET and MAGNET Beyond will be the additional component together with IMT-Advanced (International Mobile Communication-Advanced) candidate systems that would complete the equation for the realisation of the next generation communication systems. In Fig. 1.3 is shown the overall structure of the wireless telecommunications, including the past and the future.

Efficient implementation of the transceivers for PANs is a key driver for enabling low cost, low power portable hand-held devices. The efficiency of the implementation relies on architectural choices. For example, most of the power in a transceiver, especially for LDR, are consumed in the RF part. An intensive research activity is

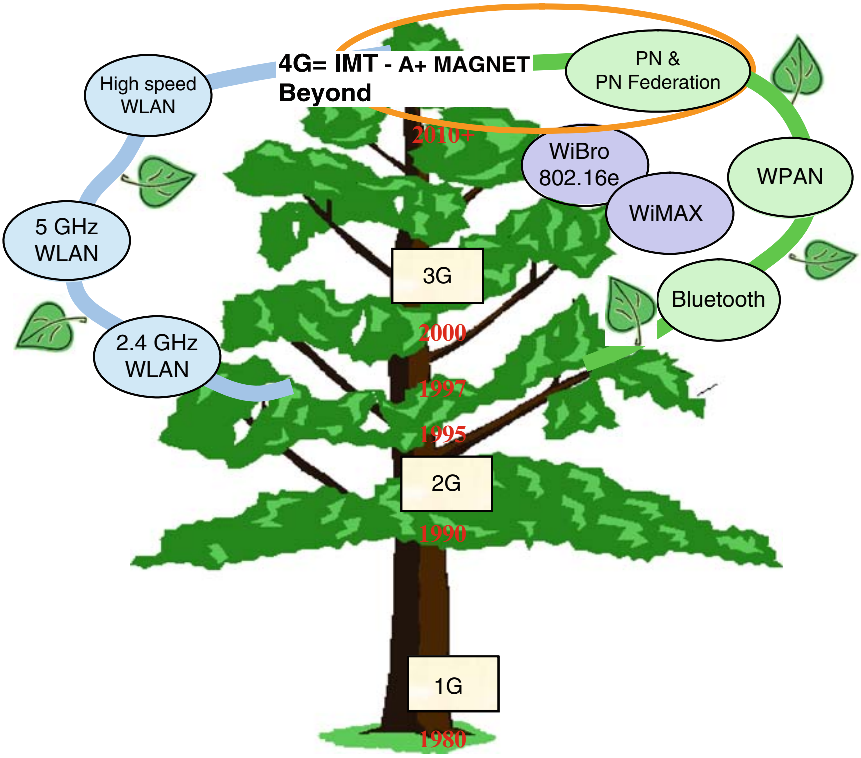

Fig. 1.3 Tree of communication standards evolution towards next generation systems

required in order to optimise the power figures. This is particularly true for UWB solutions, on which designers have less background than on the classical narrow-band systems. New architectures using high data rate digitiser have been introduced recently. They open the door to a software defined radio (SDR) approach where the RF section is reduced to a low noise amplifier (LNA) and fast sampler. Since all processing is then performed in the digital domain, reconfigurability can be introduced more easily. On the other hand more analogue solutions can bring some interesting features in terms of complexity and power consumption figures for LDR air interfaces [24–28]. For HDR, new architectures such as *networks on chip (NoC)* have been applied to MC-CDMA techniques [28–30]. This kind of architecture can be promising for the PAN HDR air interfaces that need more computational power than LDR solutions. Such schemes were evaluated and compared to more classical *system on chip (SoC)* approaches to propose the optimal compromise between flexibility and power consumption figures. Besides, the use of deep submicron technology may enable the design of monolithic approaches for the mass market target transceiver using the resulting advanced architectures.

Figure 1.4 proposes a roadmap for the realisation of the PAN-optimised air interfaces. Currently, as a result of the research and development effort put forward

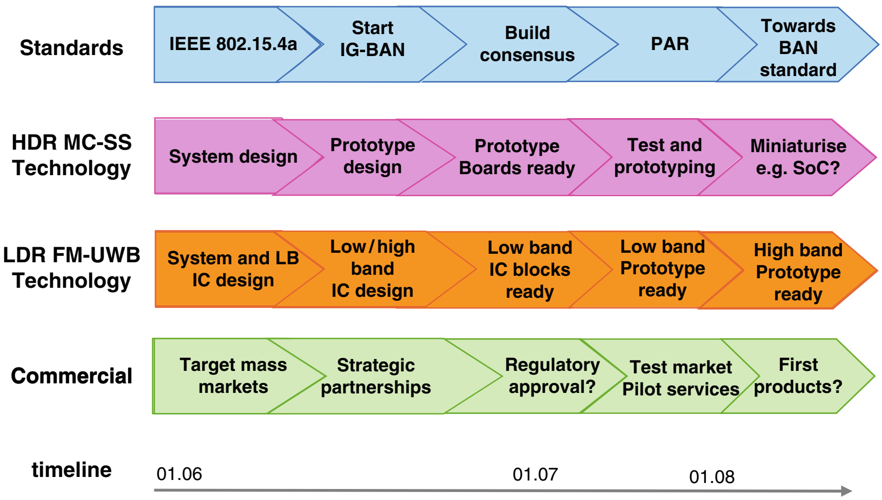

Fig. 1.4 Proposed roadmap for commercialization of the PN concept

by the consortium members of the projects MAGNET and MAGNET Beyond, the integrated prototypes for the two air interface solutions are a reality. These have been also fed into the standardisation activities of the ETSI and IEEE802.15 bodies.

1.4 Security, Privacy and Trust

Security, availability, and reliability are three key requirements for the successful deployment of the MAGNET Beyond concept. With a multitude of wireless standards in use, it is very important to ensure the dependability of the connections established by means of PNs and PN-Fs. One of the reasons why PNs can support a large variety of applications is that in PNs different types of access technologies can work hand in hand to deliver services to the users. The PN in Fig. 1.5 is configured in ad ad-hoc fashion, as the opportunity and the demand arise to support personal applications.

It consists of communicating clusters of personal and foreign devices, possibly shared with others, and connected through various suitable communication ways.

In order to access a device or service, the user needs to provide an identity that can be authenticated and authorised by the PN components. The provision of such an identity needs to be user friendly. In addition it should be possible to exchange the identity between service providers without affecting the privacy of the user. Concepts of anonymity and pseudonymity must be adapted to the PN and PN-F architecture to develop a coherent identity management solution, which is interoperable with the existing addressing, naming and identity management systems. Scalable and efficient methods for protection of user identity must be defined.

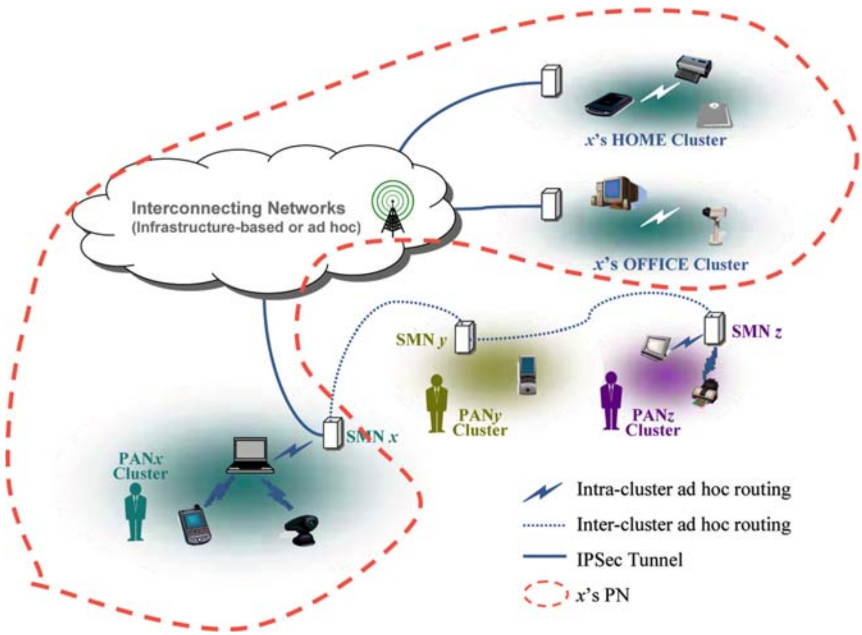

Fig. 1.5 Secure communications in a PN [31]
.

The vision of MAGNET Beyond of PNs combines two types of trust relationships: a priori *trust* inside the PN, which is managed by the user, which is ensured through proper authentication based on credentials; and the hand trust between PNs, which is an a posteriori *evolutionary* trust, as authentication (and identities) schemes in such a scenario are meaningless.

Methods to protect user privacy, including investigation of use of virtual identities protection of location of user and devices must also be developed. Protection of disclosing mobility behaviour, would, for example, require solutions for identity management, trust and privacy in PNs.

Communication with low-weight devices like sensors will obviously play a major role in the upcoming important market of PNs and on the background of the vision defined for the Future of Internet by the European Commission. For example, one such area is the application of mobile health in body area networks in which people will be equipped with several biosensors to continuously monitor their medical data such as glucose level, blood pressure and temperature. In these scenarios, these external devices are rather resource scarce in terms of processing and communication capabilities and it is necessary to support them with light-weight key exchange mechanisms.

MAGNET Beyond proposed novel solutions for physical encryption applicable to the PN-F security architecture. The solutions included an efficient hybrid protocol that secures the federation. Further, a physical layer encryption mechanism for both LDR and HDR was designed.

In the PN level a new key agreement protocol (i.e., the Certified PN Formation Protocol (CPFP)) was introduced. CPFP is based on the Elliptic Curve Cryptography (ECC) and the personal public key infrastructure (Personal PKI) in which instead of global certificates issued by a trusted third party, the local certificates issued by PN certificate authority (PNCA) can be applied. CPFP has two different stages, in the first stage all the PN devices get imprinted with PNCA, i.e., equip to its signature public key as the PN root key and get a certificate on their long term public key. In the second stage, PN nodes use their certificates to authenticate each other and establish pairwise keys based on the ECMQV protocol. CPFP is scalable to larger PNs and provides an enhanced level of authentication and non-repudiation with ease of the key revocation and key update.

1.5 PN Platforms

The concept of a flexible PN that supports ubiquitous service provisioning in a secure heterogeneous networking environment for mobile users was a challenging objective for MAGNET. PNs, apart from link level platforms, involve several heterogeneous networking and security components that must cooperate in order to make a reality such a concept.

The validation of such a concept cannot be provided only by simulations and it was necessary to implement a real testbed where the validity of this concept could be tested by users and industry. This testbed was the support for the real pilot services developed and specified within the frames of the project MAGNET Beyond. Testing as well as the identification of future optimisations that could be achieved by enhancing the collaboration between the different components comprising the whole system were another development activity in this context.

Well deployed operating system embedded platforms are key for supporting the PN networking components functionalities as introduced in the previous sections.

1.6 Preview of This Book

Figure 1.6 shows the collaboration of the various PN technologies described above in the scope of the IST project MAGNET Beyond that are also the basis for the organization of this book.

The organization of the book depends also on the division of the tasks among the Work Packages (WPs) involved in the projects. Every chapter is the summary of the achievements earned from the WPs, highlighting the efforts and the collaborations necessary to reach the excellent result obtained.

This book is organized as follows.

Chapter 2 discusses in details the concept, challenges and solutions for the provision user-centric personalised communications. In particular it describes

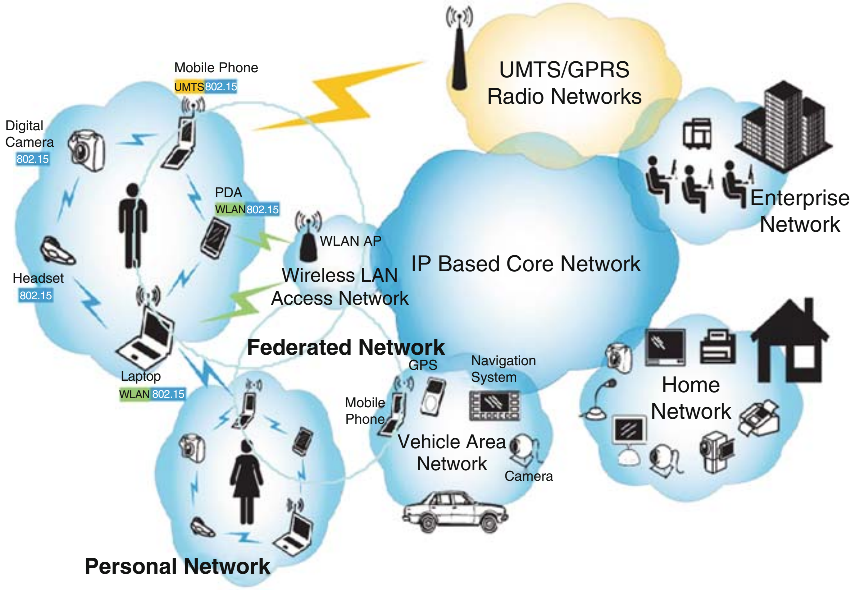

Fig. 1.6 Collaboration of MAGNET Beyond Technologies for realising a number of personalised applications

the user requirements to be considered, including requirements related to the user-friendliness of the personal device, the management of user profiles and the required business models for the successful deployment of personalised communications. Further, it proposes evaluation scenarios for the validation of the proposed requirements and business models.

Chapter 3 discusses in details the concept and advances in the area of PNs and PN-Fs. In particular, it proposes solutions for the realisation of self organisation at the network level (e.g, the network overlay approach), solutions for PN-aware service discovery and life cycle management, and it discusses the topic of user collaboration. Here, the focus is on the establishment of networking and services when joining of PN-Fs.

Chapter 4 proposes connectivity solutions for PNs and PN-Fs. In particular, it proposes advanced air interfaces for low and high-data rates (LDR and HDR, respectively), optimized for user-centric communications and provides benchmarking results as a proof-of-performance. Further, novel concepts related to interference mitigation and spectrum efficiency are proposed in support of the communication process. Issues such as multi-mode operation and PAN-to-PAN communications are also discussed.

Chapter 5 proposes solutions related to security, privacy and trust challenges in PNs and PN-Fs. In particular, the proposed solutions relate to the secure communication between personal nodes, the encryption and encoding for PAN air interfaces, and the architecture for management and enforcement of security policies.

Chapter 6 proposes design solutions for the PN connectivity concepts proposed in the preceding chapters. The design and prototyping of the LDR and HDR interfaces are described in detail down to the basic components. Results are represented related to the measured performance.

Chapter 7 describes the realization of the complete PN and PN-F testbed as a proof-of-concept of the proposed theoretical solutions. In particular, this chapter provides the description of the required components with high-and low-level specifications, and the integration of the pilot services onto the platform.

Chapter 8 discusses advances in the area of standardization of WPANs and BANs. In particular, the effort of MAGNET towards advancements in the IEEE.802.15 and ETSI are described.

Chapter 9 concludes the book and outlines the future challenges for PNs and PN-Fs.

References

1. R. Prasad, Personal network, Guest Editorial Telektronikk (Jan 2007)
2. IST Project MAGNET and MAGNET Beyond (2004–2008), www.ist-magnet.org
3. J. Saarnio, N.R. Prasad, *Foolproof Security Mechanisms and Challenges Within*, Int. J. Wireless Pers. Commun. (Kluwer, the Netherlands, 2004)
4. N.R. Prasad, A novel secure multi hop routing protocol for personal networks. WPMC 2004, Abano Therme, Italy, 12–15 Sept 2004
5. J. Lilleberg, R. Prasad, Research challenges for 3G and paving the way for emerging new generalisation. Wireless Pers. Commun. **17**, 355–362 (2001)
6. R. Prasad, M. Ruggieri, *Technology Trends in Wireless Communications* (Artech House Publishers, Boston, MA, 2003), ISBN 1-58053-352-3
7. S. Hara, R. Prasad, *Multicarrier Techniques for 4G Mobile Communications* (Artech House Publishers, Boston/London, 2003), ISBN 1-58053-482-1
8. R. Prasad, L. Munoz, *WLANs and WPANs Towards 4G Wireless* (Artech House Publishers, London), ISBN 1-58053-090-7
9. I.G. Niemegeers, S.M.H. de Groot, *From Personal Area Networks to Personal Networks: A User Oriented Approach*, Special issue J. Wireless Pers. Commun. (Kluwer, Hingham, MA, May 2002)
10. I.G. Niemegeers, S.M.H. de Groot, Research issues in ad-hoc distributed personal networking. Special issue Wireless Pers. Commun. **26**(2–3), 149–167 (2003)
11. I.G. Niemegeers, S.M.H. de Groot, FedNets: Some ideas for applying concepts of cognitive networks. Dagstuhl Seminar on Cognitive Networks and Radios, Dagstuhl, Germany, 18–21 Oct 2004, http://www.dagstuhl.de/04431/Materials/
12. K. Ducatel et al., Scenarios for Ambient Intelligence in 2010. IST Advisory Group (ISTAG), European Commission, Brussels, www.cordis.lu/ist/istag.htm, 2001
13. W. Mohr et al. (eds.), The book of Visions 2000 – Visions of the wireless world. Version 1.0, Wireless Strategic Initiative (Nov 2000), www.wireless-world-research.org
14. J. Zander et al., Telecom Scenario's in 2010. PCC, KTH, Sweden, 1999
15. ACM, The next 1000 years. Special issue Commun. ACM **44**(3), 50–52 (Mar 2001)
16. IST PACKWOMAN, http://www.imec.be/pacwoman
17. IST MOBILIFE, http://www.ist-mobilife.org
18. IETF MANET Working Group, http://www.ietf.org/html.charters/manet-charter.html
19. J. Hoebeke, I. Moerman, B. Dhoedt, P. Demeester, An overview of mobile ad hoc networks: Applications and challenges. J. Commun. Netw. **Part 3**, 60–55 (July to Sept 2004)

20. IP Routing for Wireless/Mobile Hosts, http://www.ietf.org/html.charters/mobileip-charter.html
21. U. Jönsson, F. Alriksson, T. Larsson, P. Johansson, G.Q. Maguire Jr., MIPMANET – Mobile IP for mobile ad hoc networks, in *Proceedings of the IEEE/ACM Workshop on Mobile and Ad Hoc Networking and Computing*, Boston, MA, Aug 2000
22. Network Mobility (NEMO), http://www.ietf.org/html.charters/nemo-charter.html
23. IST-027396 MAGNET/WP4/D4.2.1, First solutions for implementation of key management and crypto techniques (Dec 2006)
24. K. Marsden et al., Low power CMOS re-programmable pulse generator for UWB systems. IEEE Conference on UWB Systems and Technologies, Reston, VA, Nov 2003, pp. 443–447
25. S. Bagga et al., A PPM Gaussian monocycle transmitter for ultra-wideband communications. By IEEE Joint International Workshop of UWBST and IWUWBS, May 2004, pp. 130–134
26. T. Tong, T. Larson, Concept and architecture of integral receiver for Low Data Rate Ultra-Wide-Band System, in *Proceedings of Magnet Workshop*, Shanghai, China, 11/12 Nov 2004
27. J.F.M. Gerrits, J.R. Farserotu, J.R. Long, UWBFM: A low and medium data rate constant envelope UWB communications system with localisation potential, in *Proceedings of Magnet Workshop*, Shanghai, China, 11/12 Nov 2004
28. U. Hanke, A. Bøifot, J. Gamag, F. Bekkadal, Integrated reconfigurable radio front-end technology, URSI/COST 284 (2004)
29. S.B. Slimane, A low complexity antenna diversity receiver for OFDM based systems. IEEE ICC2001 **4**, 1147–1151 (2001)
30. K. Strohmenger, M. Laugeois, D. Noguet, B. Oelkrug, K. Seo, Architectures for digital physical layer implementation in multi-mode 3G terminals, IST-SUMMIT'04
31. A. Mihovska, N. Prasad, Adaptive security architecture based on EC-MQV algorithm in a personal network (PN), in *Proceedings of PERNETS'07*, Philadelphia, PA, Aug 2007

Chapter 2
Users, Pilot Services and Market

Knud Erik Skouby, Lene Sørensen, Henning Olesen, Allan Hammershøj, Anders Henten, and Iwona Windekilde

2.1 Introduction

Working within the overall purpose of MAGNET/MAGNET Beyond one of the specific challenges that is elaborated on in this chapter has been to represent and include a direct and clear user centred focus. The user centricity was firmly agreed to be ever present both in the development process in the focus areas of the project and as direct involvement of users at different stages in the systems development process. The basic idea has been to identify and build up relevant user requirements as the basis for formulation of systems requirements.

The MAGNET system focuses in particular on the user concept in five categories: user requirements, user case studies, user scenarios and use cases, evaluation and business models. The links between the five categories and the rest of MAGNET are illustrated in Fig. 2.1.

1. *User Requirements*. The user requirements elicitation process is part of the overall project synthesis process running from identifying preliminary user themes over selected themes or cases to establishment of user workshops, user scenarios and expert workshops all contributing to the identification of user requirements.
2. *User Case Studies*. Through idea generation based on work with selected themes or cases, initial user scenarios has been created as input to user workshops and expert workshops. These resulted in identification of a number of user cases relevant for demonstration of the MAGNET idea.
3. *User Scenarios and Use Cases.* Out of the user cases two user cases were selected to clearly demonstrate the MAGNET concepts and elements: MAGNET.Care and Nomadic@work. Idea creation as basis for scenario writing took place differently in the two cases. For the MAGNET.Care case, workshops were carried out in a lab while in the Nomadic@work case, a cultural probe was used to capture the nomadic perspectives of the users. In both cases, however, the result was elaborate story board-based scenarios outlining potential use situations challenging the MAGNET system to deliver relevant services to the users. A new approach

K.E. Skouby (✉), L. Sørensen, H. Olesen, A. Hammershøj, A. Henten, and I. Windekilde
CMI/Aalborg University, Lautrupvang 15, Ballerup 2750, Denmark
e-mail: skouby@cmi.aau.dk

R. Prasad (ed.), *My Personal Adaptive Global NET (MAGNET)*, Signals and Communication Technology, DOI 10.1007/978-90-481-3437-3_2,