

Unwiring Universities

Carsten Bormann, cabo@tzi.de

Niels Pollem, np@tzi.de

... and a cast of dozens ...

Universität Bremen, FB3/Informatik Center for Computing Technology (TZI)

Objectives

- ◆ Transfer of computing technologies to applications through projects with customers
- ◆ Development of innovative application-oriented technologies
- ◆ Interdisciplinary cooperation projects
- ◆ Application-oriented classes and projects for students
- ◆ (and don't forget basic research)

Center for Computing Technology (TZI)

- ◆ 10 professors, ~ 100 researchers, lots of students
- ◆ The 5 sectors of the TZI:
 - BV Image processing
 - BISS Dependable systems
 - ISI Software ergonomics and information management
 - IS Intelligent systems
 - DMN Digital Media and Networks

TZI: Digital Media and Networks

Research Group for Computer Networks

- ◆ Prof. Dr.-Ing. Ute Bormann
- ◆ Dr.-Ing. Jörg Ott
- ◆ Researchers and student employees

Managing Director of this TZI sector

- ◆ Dr.-Ing. Carsten Bormann
- ◆ Assistant: Dipl.-Inf. Olaf Bergmann

Digital Media and Networks

Architectures, Protocols and Interfaces for computer-based communication and collaboration



- ◆ Digital Networks (infrastructure)
 - Internet technologies
 - Application: synchronous distributed groupware systems
 - special interests: teleconferencing and Internet Telephony
- ◆ Digital Media (content)
 - Structured document communication (XML/SGML technologies)
 - special interests: document transformation

◆ IETF / ITU-T / ETSI / IMTC standardization

Digital Media
and Networks

Prof. U. Bormann

Dr. C. Bormann
O. Bergmann

6WINIT – IPv6 Wireless Internet Initiative

- ◆ Validate the feasibility of running real applications for the wireless Internet using IPv6 and GPRS/UMTS & WLAN
 - Seamless mobility
 - Security
 - Multimedia communication over heterogeneous networks
- ◆ Providing wireless IPv6 based testbeds
 - Application focus: Healthcare
 - Development of network components and generic applications

Mobile Campus Bremen: Towards a Notebook University

- ◆ IT-Support of Teachers and Learners
- ◆ University as **non-territorial Workspace**
 - Teachers: Office, Classroom, Meeting room
 - Learners: Classroom, Student room, IT Pool
- ◆ IT Solution: **Notebook Computers**,
WLAN, Software, Qualification (!)
- ◆ Students buy/lease Notebook etc. on their own

Cornerstones of the Notebook University

1. **Wireless Network** (WLAN)
2. Basic Software, 3. Domain-specific Software
4. Training and Coaching Teachers
5. Digital Content: Texts, Media
6. Define standard configurations, e.g.:
Notebooks (Basis, Professional, High End):
7. Develop a financial model
8. Allow for Notebooks in all exams
9. Integrate IT as important element in all teaching
10. Offer Service Points

Other groups involved

- ◆ Zentrum für Netze (ZfN)
- ◆ Zentrum für Angewandte IT (ZAIT)
- ◆ Zentrum für Multimedia in der Lehre (ZMML)

- ◆ Departments (Fachbereiche):
 - FB1 (IKOM)
 - FB12 (Lehrerausbildung)

Wireless Network Access

- ◆ **Network** is prerequisite for using Multimedia Technologies in Teaching
 - ZfN: Campus network, Ethernet ports
- ◆ Put Cat5 sockets in all rooms?
 - Need to cover all seats
 - Hideously expensive
 - Way too inflexible

Mobile Devices	Fixed Installations
Wireless	Ethernet

no fiber!

Technology: Wireless LANs

- ◆ Wireless Local Area Networks (WLANs)
 - Wireless equivalent of **Ethernet**
 - Unlicensed: ISM Band (2.4 GHz)
- ◆ Base stations (APs): Connect to Ethernet
- ◆ Laptop Cards:
 - Drivers for Windows, Linux, MacOS



WLANs in the TZI

- ◆ WLAN-Technologies in use since 1998
 - in projects, first
 - TZI/DMN ➡ TZI ➡ Informatik ➡ FB3
- ◆ Converging to IEEE 802.11b (**WiFi**) since 1999
 - 11 Mbit/s, range up to 300 m/30 m
- ◆ www.dmn.tzi.de/wlan/

WLAN Project Bremen (1)

- ◆ Phase 1: supported by **bmb+f**
 - Objective: Apply WLAN in Teaching
- ◆ Project group: TZI, IKOM, **ZMML**, ZfN, ZAIT, ...
- ◆ >400 APs, Cisco
 - Goal: Good coverage in covered buildings (!)
 - Goal: Future-proof infrastructure

WLAN Project: Rolling it out

- ◆ Base: Fixed network on campus
 - (oops: ATM, Fiber)
 - Remote Power not an Option at the time
- ◆ Cisco 342 (and a few 350s with antennae)
- ◆ Actual roll-out: hit squads (staff+students)
 - Problem: Electricity – solvable
 - Problem: Physical security → Boxes

WLAN-Project: Making it useful

- ◆ Application scenarios:
 - Pilots for later
 - Use WLAN inside and outside class
 - Laptop-assisted classes
 - Cater for independent **student work**
- ◆ Formally evaluate scenarios

WLAN Project: Status

- ◆ Most important buildings networked
 - ➔ Staff and Students can use network everywhere!
 - ➔ Oops, fiber-contaminated buildings...
 - ➔ Access workgroup networks, IT services, Internet...
 - Just like in the campus fixed network
- ◆ Objective: Sustain **campus coverage**
 - Standard component for all future construction
 - + Add hotspots: Schools, Polytechnics, ...

WLAN Project: Support

- ◆ Technology alone is not sufficient
 - Train support technicians
 - Train users
 - Teachers and learners
 - Support structure
 - In each building: First-line
 - ZfN/ZAiT: Second-line

Notebook University:
Involve the Vendors!

WLAN: Use at home

- ◆ Base stations for home network:
- ◆ E.g., Apple Airport (~ € 300)
 - Includes Modem
 - Oops, no ISDN...
 - Ethernet
 - For other PCs
 - for T-DSL (PPPoE)
 - NAT/DHCP (multiple PCs)



How safe is a WLAN?

1) For the humans

➔ **Safety**

2) For the data

➔ **Security**

Safety

- ◆ WLANs approved by RegTP (up to 100 mW)
 - EN60950, EN50361, DIN VDE 0848, BImSchG, ...
- ◆ 2.4 GHz:
 - Non-ionizing electromagnetic waves
 - Parameters: Power Density (limit: 1 W/m²)
 - WLAN: way below limits, large safety margins
- ◆ Cisco: 30 mW ➡ total **per channel** (AP + Laptops)

Safety and the staff council

- ◆ Rolling out WLANs creates a perceived threat
 - UMTS discussion in 2000 didn't help
- ◆ Get the details to the staff council early
 - Bremen: started with “trial”
 - Get measurements (from independent lab)
- ◆ ➡ Agreement Staff Council/Chancellor

Security (1)

- ◆ Objectives:
 - Secure against eavesdropping
 - Accountability
(access for university members only)
- ◆ Interim: WEP
 - **Shared** secret 40-bit key (oops)
 - Can “burn” key on cisco WLAN cards (write-only)
 - Secures only against external eavesdropping
 - Unfortunately: cryptographically useless

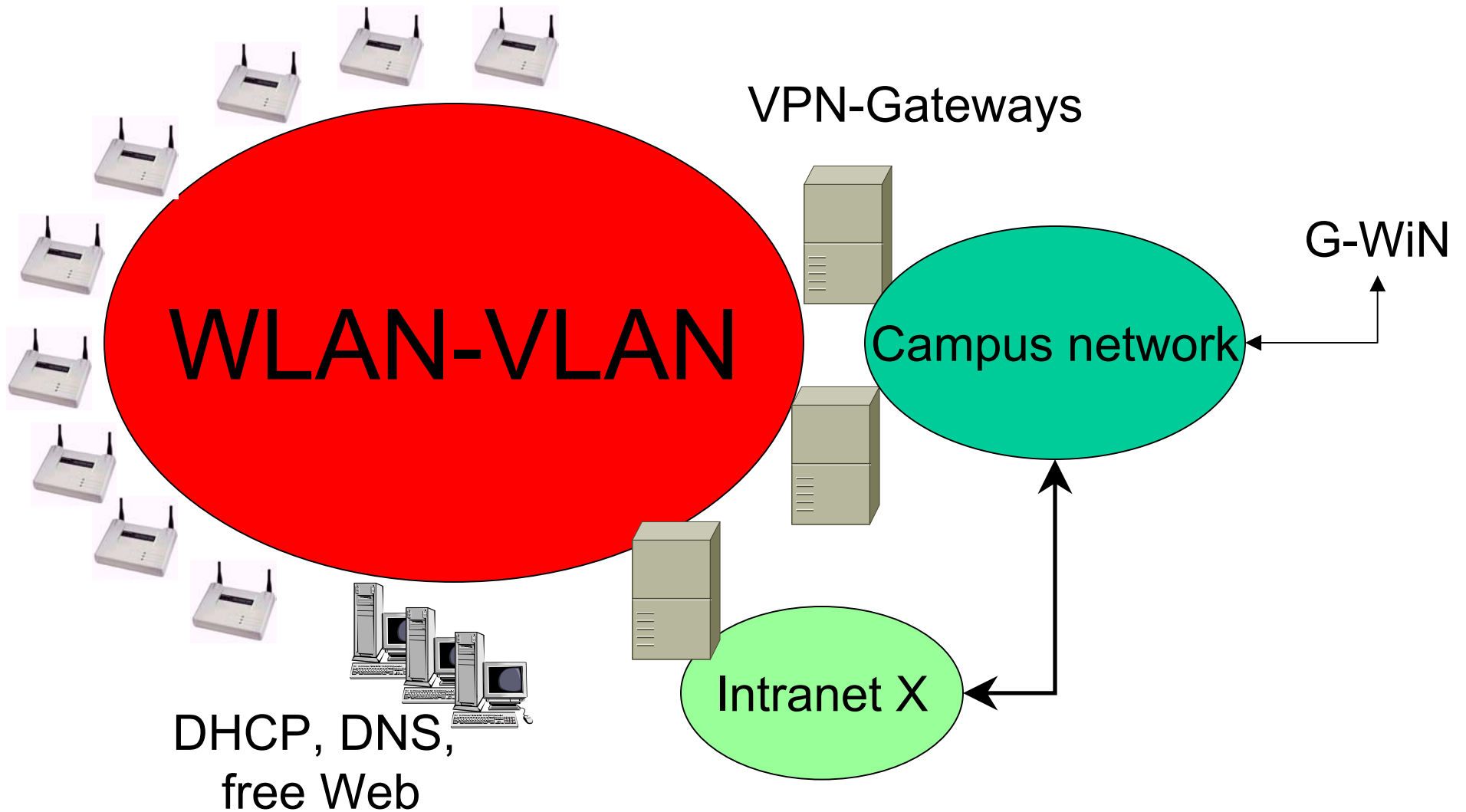
Security (2)

Since October 2001:

- ◆ Integrate WLAN Islands ➡ „Roaming“
 - Can use seamlessly everywhere
- ◆ Authenticate by user/password
 - Decentralized Administration, VPN Gateways
 - Cryptographically secure
 - User is identified at login: Accountability

WLAN: Standard Architecture

- ◆ All APs are in one L2 network (VLAN, Bridges)
 - RFC1918 network (e.g., 10.x.y.z), no Routing
- ◆ VPN-Gateways into the relevant networks
 - Campus network, networks behind Firewalls
- ◆ Infrastructure within WLAN-VLAN:
 - DHCP, DNS, „free Services“ (internal WWW)
- ◆ Now in use at many universities in Germany



WLAN: VPN solution with PPTP

- ◆ Initial Solution: **Point-to-Point Tunneling Protocol** (PPTP)
 - MPPE (Microsoft Point-to-Point Encryption)
 - MS-CHAPv2 (Challenge-Handshake Auth. Protocol)
- ◆ Increasingly vulnerable, but widely available: „It works.“
- ◆ Clients for Windows (built-in), Linux, MacOS 8.6, 9.x, X
- ◆ Next Step: **IP Security** (IPSec)
 - standardized by IETF
 - transparently integrated in Layer 3
 - Offer in parallel to PPTP, additional Gateway

VPN Solution: Decentralize!

- ◆ Divide based on user communities (FB1, FB3, ZfN)
 - One service box (does DNS, DHCP, Web) for each
 - DNS and DHCP are on redundant servers
- ◆ Users build Tunnels via appropriate Gateway
 - Can have one or more tunnel endpoints per community
 - Load sharing via Round-Robin-DNS
 - Load on campus backbone negligible

VPN Solution: Getting access

- ◆ Prerequisite: existing Account in one community
- ◆ Issue: MS-CHAPv2 vs. crypt (Unix)
 - Passwords must be stored on server in cleartext
- ◆ Solution: Webserver with SSL on service boxes
 - Access via SSL („https://...“)
 - Create separate WLAN password
 - Never goes over network in clear
- ◆ Future: solve by PKI (yeah, right)

WLAN: VPN Gateway Box

- ◆ All Infrastructure runs Linux
 - Low TCO, well-understood, easy integration
 - RedHat 7.1, Kernel 2.4.10 plus MPPE patches
- ◆ pptpd (PoPToP 1.0.1)
- ◆ PPPd (2.4.1, MPPE plus patches for MacOS clients)
- ◆ Installation was simple, good docs
 - MacOS support was hard, though (Patch für PPPd)
- ◆ Athlon 1400 MHz, 512 MB, 2x Ethernet 100 Mbit/s

WLAN: Use in “Fachbereich 3”

- ◆ Infrastructure is stable, not yet approaching load limit
 - 250 users, about 40 in parallel
 - Can be used by externals
- ◆ Strong snowball effect:
 - 500 registered users on Campus in total
 - Access network (WLAN-VLAN) available in wired sockets
 - WLAN-VLAN slowly percolates into science park

WLAN: aktuelle Entwicklungen

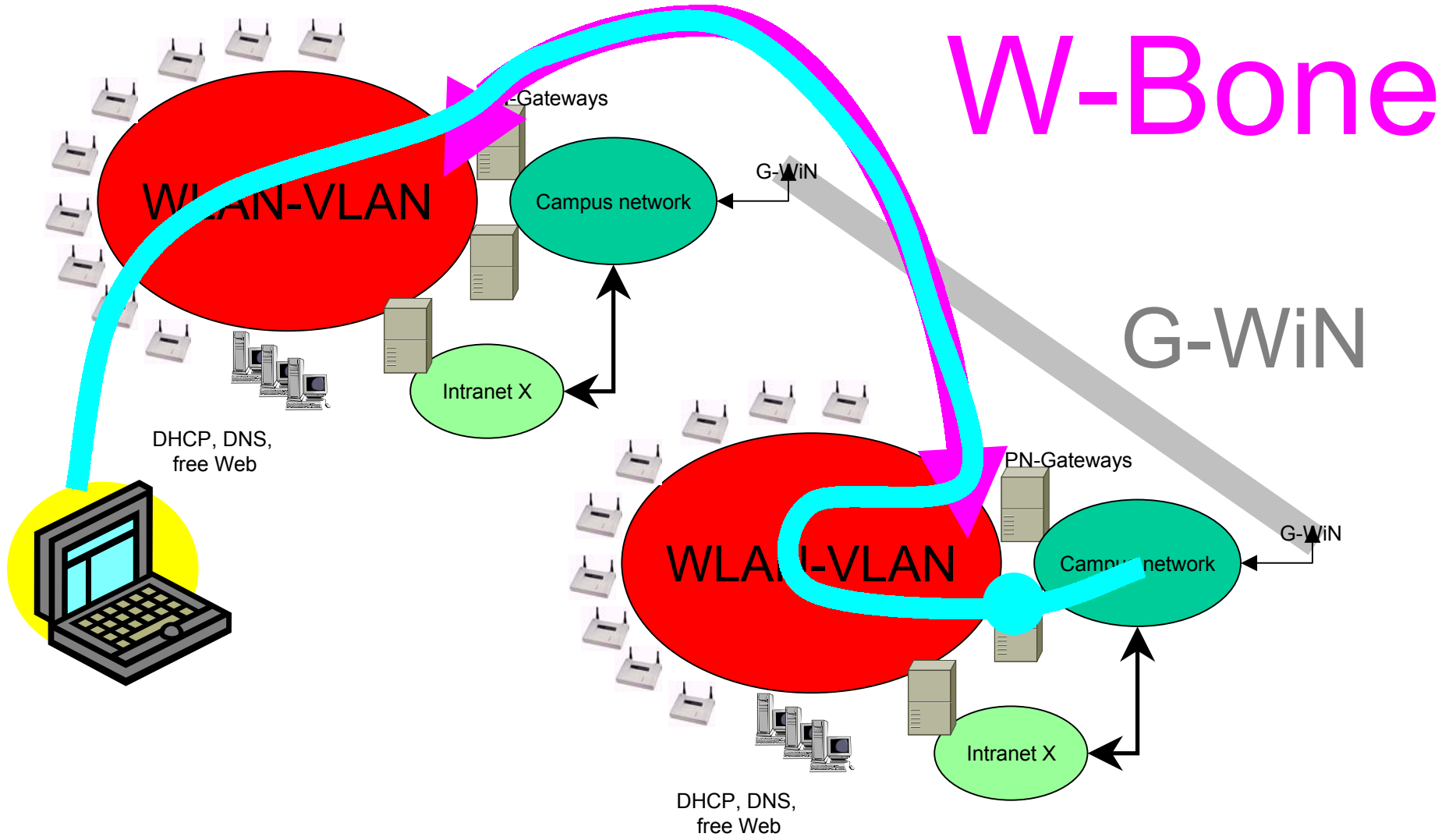
- ◆ zeitnah 22 bzw. 54 Mbit/s über 802.11a/h, 802.11g
 - entsprechende Ausstattung an Schwerpunkten
- ◆ Location-based Services (LBS) deutlich sichtbar
 - ideale Infrastruktur: flächendeckendes WLAN
- ◆ Multimedia-Kommunikation über drahtlose netwerke
 - TZI: Arbeiten zu fehlertoleranter Übertragung
 - IP-Telefonie: nahtloses Roaming zu Mobilfunk



New: Roaming

Initiative by HB, GÖ, KA, HRO

- ◆ Why not use a Bremen user account to work in Karlsruhe?
- ◆ Authentication/Authorisation in Home VPN-GW
- ◆ To do: Interconnection of the WLAN-VLANs
 - Address coordination
 - Routing (Tunneling, OSPF)
- ◆ coordinate MAC-„Authentication“ (where needed)



DFN-WRX: WLAN Roaming Exchange

- ◆ Interconnection of WLAN VLANs: „W-Bone“
 - Tunnel Management, Routing Coordination
- ◆ DFN-wide **Support in WRX**:
 - Authorize network access, where needed
 - Integrate configuration tables
- ◆ Supporting information for the users
 - SSID Tables, integrated coverage maps, ...

WRX-Roaming in Practice

- ◆ Before travelling:
 - Register MAC Address (once)
 - Get SSID used by destination network
- ◆ At destination:
 - Configure local SSID, DHCP -> DNS -> VPN

WRX: Vision (2003)

- ◆ WRX as a standard service in DFN core network
 - „W-Bone“ becomes (separate!) Part of G-Win
 - Robust Management infrastructures
- ◆ Include relevant **companies, providers**
 - Park WLANs, Hotspots, ...
 - Wide Area Mobility (GPRS/UMTS)

<http://www.dmn.tzi.de/wlan/>
wlan@tzi.de

Das Campus-WLAN der Universität Bremen

Carsten Bormann <cabo@tzi.org>

Niels Pollem <np@tzi.org>

Q&A