osmocom.org - FOSS for mobile comms

community based Free / Open Source Software for communications

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Outline

1. Researching communications systems
2. The Osmocom project
3. Non-osmocom projects

About the speaker

- Using + toying with Linux since 1994
- Kernel / bootloader / driver / firmware development since 1999
- IT security expert, focus on network protocol security
- Former core developer of Linux packet filter netfilter/iptables
- Board-level Electrical Engineering
- Always looking for interesting protocols (RFID, DECT, GSM)
- OpenEXZ, OpenPCD, Openmoko, OpenBSC, OsmocomBB, OsmoSGSN

Research in TCP/IP/Ethernet

Assume you want to do some research in the TCP/IP/Ethernet communications area,

- you use off-the-shelf hardware (x86, Ethernet card)
- you start with the Linux / *BSD stack
- you add the instrumentation you need
- you make your proposed modifications
- you do some testing
- you write your paper and publish the results

Research in (mobile) communications

Assume it is before 2009 (before Osmocom) and you want to do some research in mobile comms

- there is no FOSS implementation of any of the protocols or functional entities
- almost no university has a test lab with the required equipment. And if they do, it is black boxes that you cannot modify according to your research requirements
- you turn away at that point, or you cannot work on really exciting stuff
- only chance is to partner with commercial company, who puts you under NDAs and who wants to profit from your research

GSM/3G vs. Internet

- Observation
  - Both GSM/3G and TCP/IP protocol specs are publicly available
  - The Internet protocol stack (Ethernet/Wifi/TCP/IP) receives lots of scrutiny
  - GSM networks are as widely deployed as the Internet
  - Yet, GSM/3G protocols receive no such scrutiny!
- There are reasons for that:
  - GSM industry is extremely closed (and closed-minded)
  - Only about 4 closed-source protocol stack implementations
  - GSM chipset makers never release any hardware documentation

GSM is more than phone calls

Listening to phone calls is boring...

- Machine-to-Machine (M2M) communication
  - BMW can unlock/open your car via GSM
  - Alarm systems often report via GSM
  - Smart Metering (Utility companies)
  - GSM-R / European Train Control System
  - Vending machines report that their cash box is full
  - Control if wind-mills supply power into the grid
  - Transaction numbers for electronic banking

Osmocom / osmocom.org

- Osmocom == Open Soruce Mobile Communications
- Classic collaborative, community-driven FOSS project
- Gathers creative people who want to explore this industry-dominated closed mobile communications world
- communication via mailing lists, IRC
- soure code in git, information in trac/wiki
- http://osmocom.org/

OpenBSC

- first Osmocom project
- Implements GSM A-bis interface towards BTS
- Primarily supports sysmoBTS and ip.access nanoBTS
- Limited support for some Siemens, Ericsson and Nokia BTS models
- can implement only BSC function (osmo-bsc) or a fully autonomous self-contained GSM network (osmo-nitb) that requires no external MSC/VLR/AUC/HLR/EIR
- deployed in > 200 installations world-wide, commercial and research

First OpenBSC test installation (HAR 2009)

OpenBSC use cases

- can be used either as pure BSC (A-over-IP)
  - suitable for operators with existing core (MSC/VLR/HLR/AUC)
  - easy integration into existing infrastructure
- or as NITB (network in the box)
  - suitable for private / autonomous small networks (PBX style)
  - no dependency on any other external component
  - connect to the outside via ISDN or VoIP (using linux call router)
  - off-shore drilling rigs, underground mining, alternative to PMR

OsmoSGSN / OpenGGSN

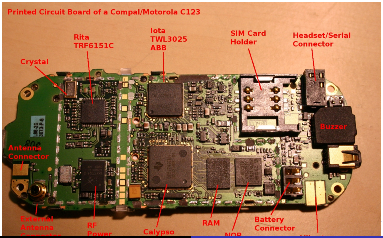
- extends the OpenBSC based network from GSM to GPRS/EDGE by implementing the classic SGSN and GGSN functional entities
- OpenGGSN existed already, but was abandoned by original author
- Works only with BTSs that provides Gb interface, like sysmoBTS or nanoBTS
- Suitable for research only, not production ready

OsmoSGSN / OpenGGSN use cases

- Testing of M2M devices using your own BTS+SGSN+GGSN
- Mobile malware research (analyze cellular data traffic of apps)
- Any type of GPRS related research
- Teaching, training on mobile data protocols/interfaces (RLC, MAC, LLC, SNDCP, BSSGP, NS, GTP, etc.)

OsmocomBB

- Full baseband processor firmware implementation of a mobile phone (MS)
- We re-use existing phone hardware and re-wrote the L1, L2, L3 and higher level logic
- Higher layers reuse code from OpenBSC wherever possible
- Used in a number of universities and other research contexts



OsmocomBB use cases

- Applied security research on Infrastructure
  - Fuzzing / exploiting of protocol parsers on network side
  - RACH denial of service
  - Check if networks use random padding
  - Detect IMSI catchers or other fals base stations
  - Assess GSM network (operator) security level
- Study + learn how a GSM stack / phone work
- Protocol tracing of your own transactions with the network

OsmoBTS

- OpenBSC/OsmoNITB takes care of BTS and higher elements
- OsmoBTS implements a BTS with A-bis/IP back-haul to OpenBSC
- Developed primarily for sysmoBTS hardware
- Support for other hardware is ongoing in the community

OsmocomTETRA

- SDR implementation of a TETRA radio-modem (PHY/MAC)
- Rx is fully implemented, Tx only partial
- Can be used for air interface interception
- Accompanied by wireshark dissectors for the TETRA protocol stack

OsmocomTETRA use cases

- Analysis/assessment of TETRA network security
- Learn how TETRA works on teh lowest levels (L1, MAC, L3)
- Protocol analysis / sniffing / intercepting unencrypted networks

OsmocomGMR

- ETSI GMR (Geo Mobile Radio) is "GSM for satellites"
- GMR-1 used by Thuraya satellite network
- OsmocomGMR implements SDR based radiomodem + PHY/MAC (Rx)
- Partial wireshark dissectors for the protocol stack
- Reverse engineered implementation of GMR-A5 crypto
- Speech codec is proprietary, still needs reverse engineering

OsmocomGMR use cases

- Analysis/assessment of GMR/Thuraya security (there is none)
- Learn and understnad how satellite telephony L1 and protocol work
- Actual interception of SMS + data
- Voice still difficult due to proprietary undocumented codec

OsmocomDECT

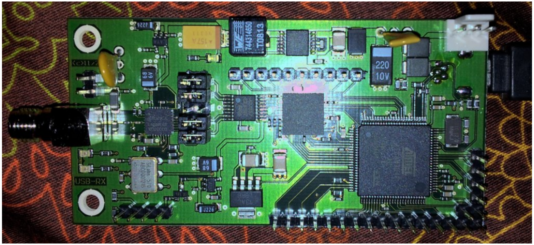
- ETSI DECT (Digital European Cordless Telephony) is used in millions of cordless phones
- deDECTed.org project started with open source protocol analyzers and demonstrated many vulnerabilities
- OsmocomDECT is an implementation of the DECT hardware drivers and protocols for the Linux kernel
- Integrates with Asterisk

OsmocomOP25

- APCO25 is Professional PMR system used in the US
- Can be compared to TETRA in Europe
- OsmocomOP25 is again SDR receiver + protocol analyzer
- Use cases like OsmocomTETRA

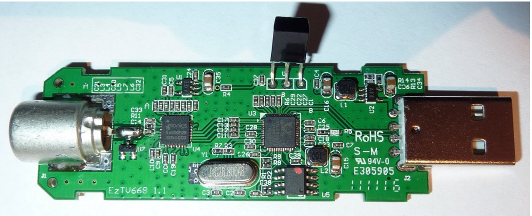
OsmoSDR

- small, low-power / low-cost USB SDR hardware
- higher bandwidth than FunCubeDonglePro
- much lower cost than USRP
- Open Hardware
- Developer units available



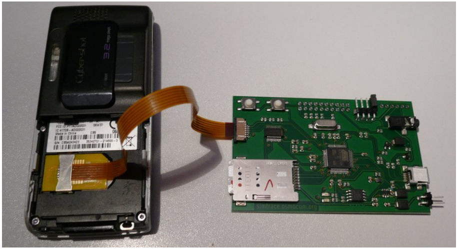
rtl-sdr

- re-purpose a USD 20 DVB-T USB dongle based on Realtek chipset
- deactivate/bypass DVB-T demodulator / MPEG decoder
- pass baseband samples via high-speed USB into PC
- no open hardware, but Free Software



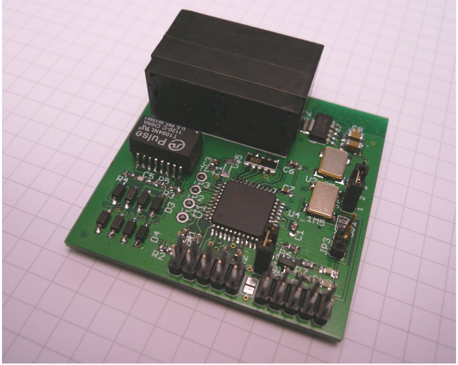
OsmocomSIMTRACE

- Hardware protocol tracer for SIM - phone interface
- Wireshark protocol dissector for SIM-ME protocol (TS 11.11)
- Can be used for SIM Application development / analysis
- Also capable of SIM card emulation and man-in-the-middle attacks



Osmo-E1-Xcvr

- Open hardware project for interfacing E1 lines with microcontrollers
- So far no software/firmware yet, stay tuned!



osmo_ss7, osmo_map, signerl

- Erlang-language SS7 implementation (MTP3, SCCP, TCAP, MAP)
- SIGTRAN variants (M2PA, M2UA, M3UA and SUA)
- Enables us to interface with GSM/UMTS inter-operator core network
- Already used in production in some really nasty special-purpose protocol translators (think of NAT for SS7)

osmo_ss7, osmo_map, signerl use cases

- Implement GSM/3G core network elements (HLR, SCF, etc.)
- Applications that interact with GSM/3G core network elements
- Mostly useful for small MVNOs or other operators who have requirements that cannot be fulfilled with off-the-shelf proprietary equipment.

More Osmocom projects

- Have a look at http://git.osmcoom.org/
- 79 public git repositories / projects at this point
- way too many to cover here in this talk
- Often RTFS, no manual/docs

The OpenBTS Um - SIP bridge

- OpenBTS is a SDR implementation of GSM Um radio interface
- directly bridges to SIP/RTP, no A-bis/BSC/A/MSC
- suitable for research on air interface, but very different from traditional GSM networks
- work is being done to make it interoperable with OpenBSC

airprobe.org

- SDR implementation of Um sniffer
- suitable for receiving GSM Um downlink and uplink
- predates all of the other projects
- more or less abandoned at this point

UmTRX

- SDR hardware, specifically for GSM Um air interface
- can be used with OpenBTS and soon: OsmoTRX / OsmoBTS
- Oepen Hardware Design
- http://code.google.com/p/umtrx/

xgoldmon

- extract all GSM/GPRS and even 3G protocol messages from your Samsung Galaxy 2, Galaxy 3, Note 2, Nexus phone via USB
- feed them into your PC running xgoldmon
- forward them from xgoldmon via GSMTAP into wireshark
- https://github.com/2b-as/xgoldmon

sysmocom GmbH

systems for mobile communications

- small company, started by two Osmocom developers in Berlin
- provides commercial R&d and support for professional users of Osmocom software
- develops + sells products like sysmoBTS (inexpensive, small-form-factor, OpenBSC compatible BTS)
- runs a small webshop for Osmocom related hardware items like SIMtrace

Where do we go from here?

- Dieter Spaar has been working with 3G NodeBs (Ericsson, Nokia) to be able to run our own RNC
- Research into intercepting microwave back-haul links
- Research into GPS simulation / transmission / faking
- Port of OsmocomBB to other baseband chips
- Low-level control from Free Software on a 3G/3.5G phone
- Re-using femtocells in creative ways
- Proprietary PMR systems

Call for contributions

- Don't you agree that classic Internet/TCP/IP is boring and has been researched to death?
- There are many more communications systems out there
- Never trust the industry, they only care about selling their stuff
- Lets democratize access to those communication systems
- Become a contributor or developer today!
- Join our mailing lists, use/improve our code
- for OsmocomBB you only need a EUR 20 phone to start

Thanks

I'd like to thank the many Osmocom developers and contributors, especially

- Dieter Spaar
- Holger Freyther
- Andreas Eversberg
- Sylvain Munaut
- On-Waves e.h.f

Thanks

Thanks for your attention. I hope we have time for Q&A.