

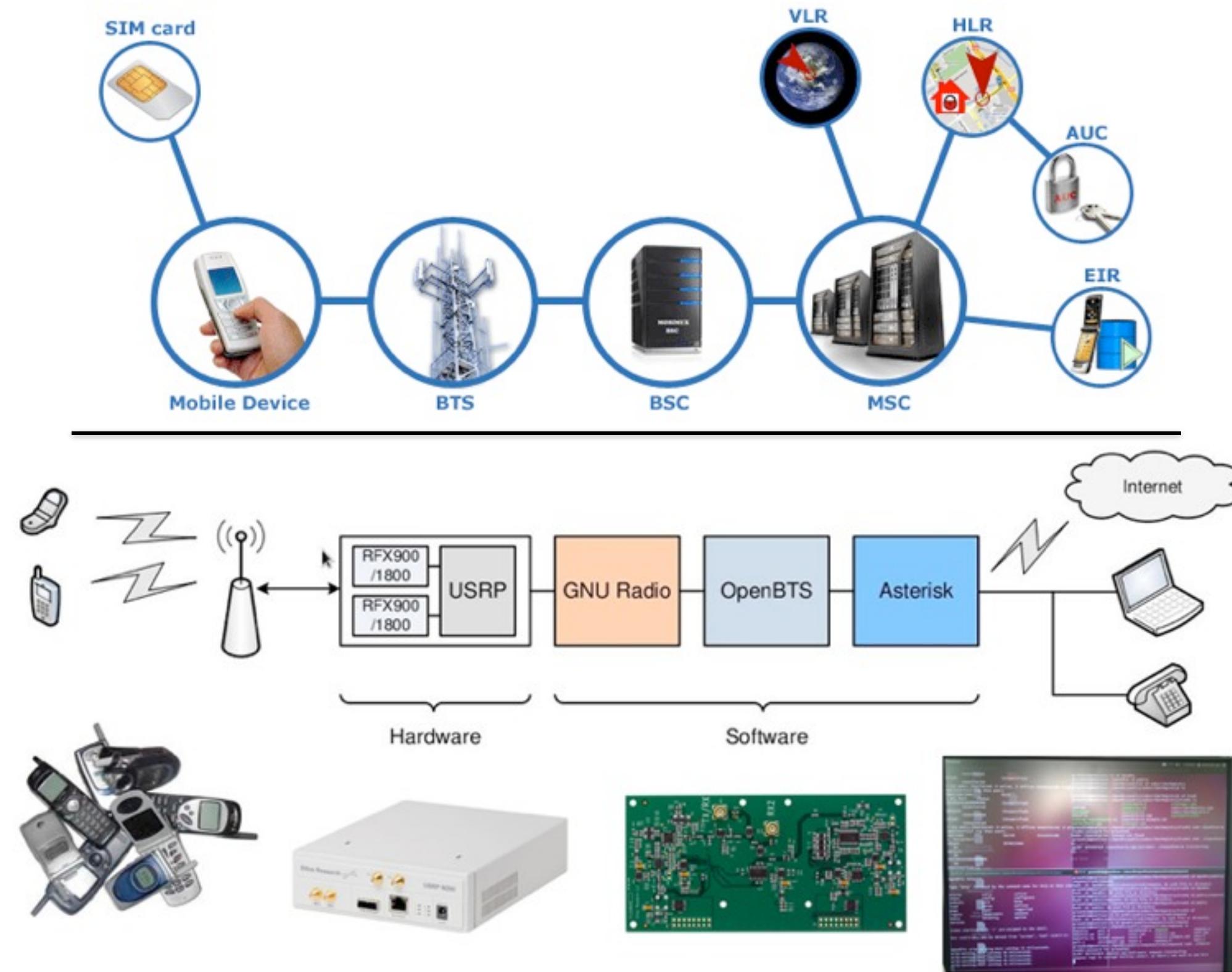


TOWERS OF POWER

OVERVIEW OF SDRs
& OPEN SOURCE BTS/BCS

1-801-9T0WERS (809377)

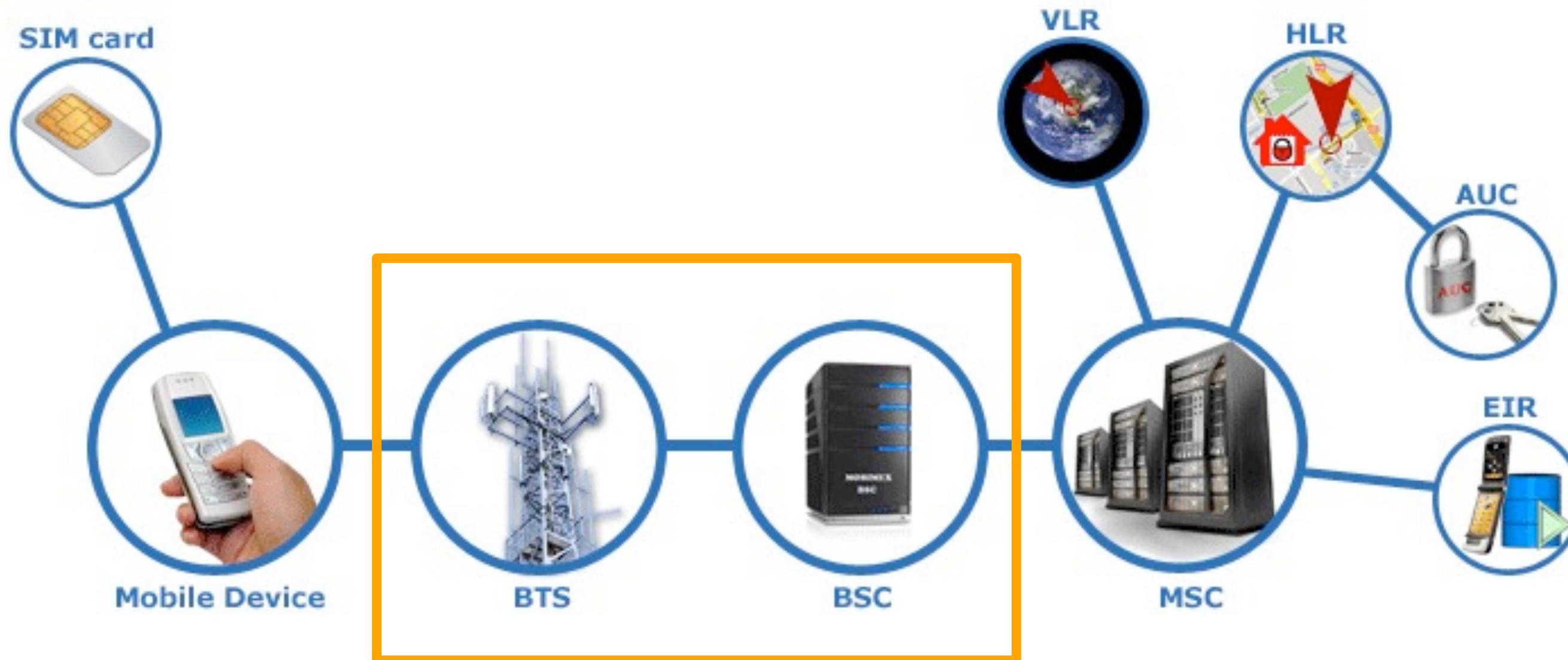
OPEN SOURCE GSM NETWORKS



MOBILE STATION SYSTEM

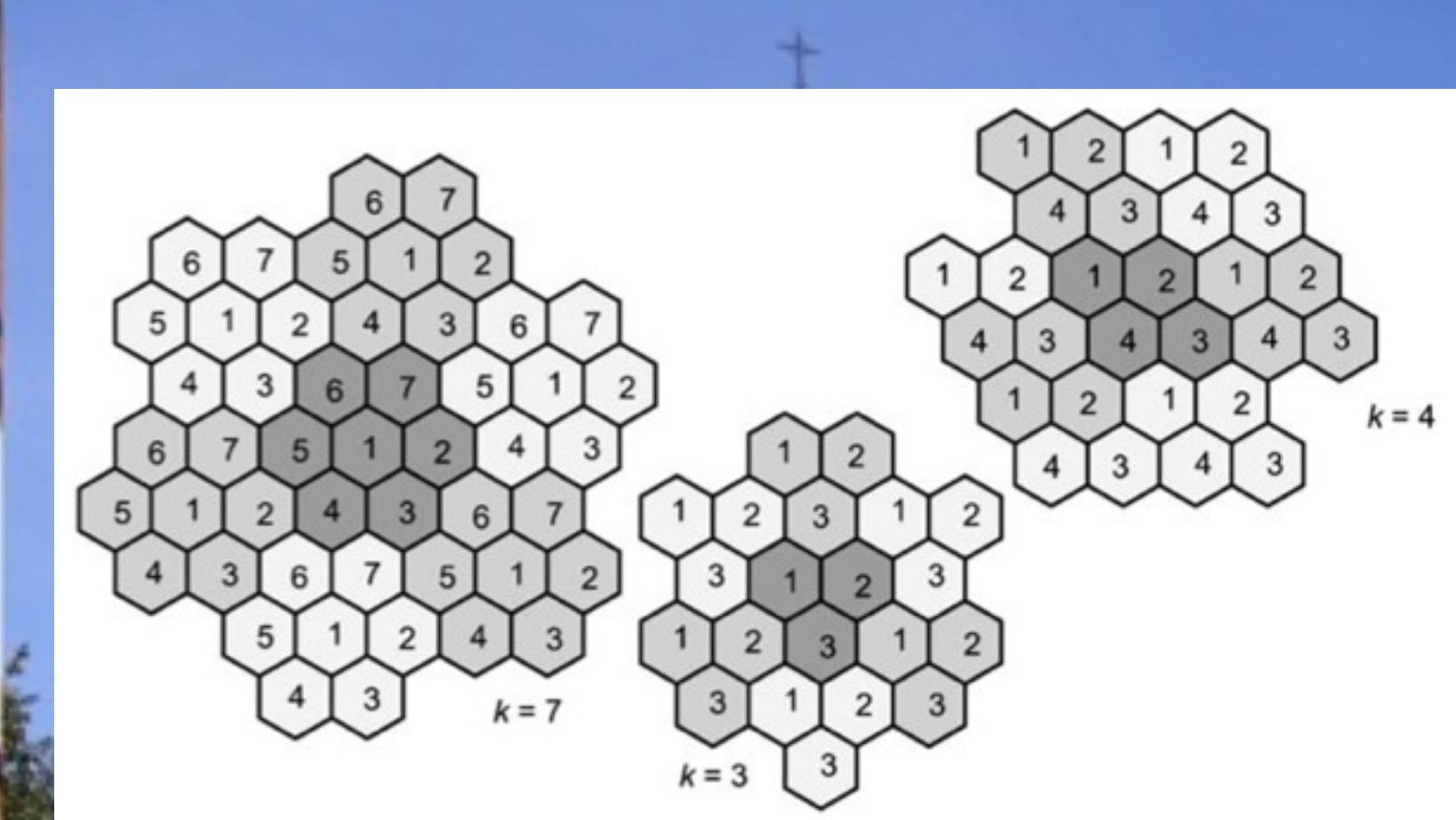


BASE STATION SUBSYSTEM

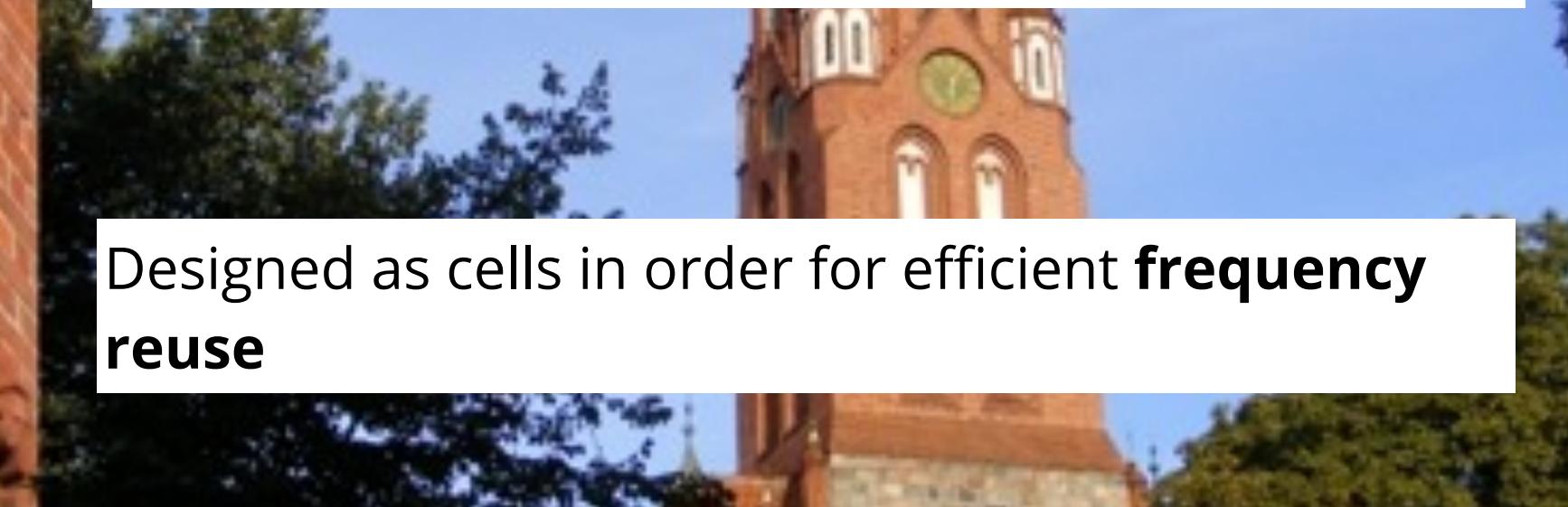


BASE TRANSCEIVER STATION

The Tower of Power



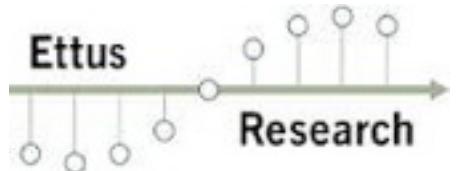
Designed as cells in order for efficient **frequency reuse**



SOFTWARE DEFINED RADIOS



sysmocom

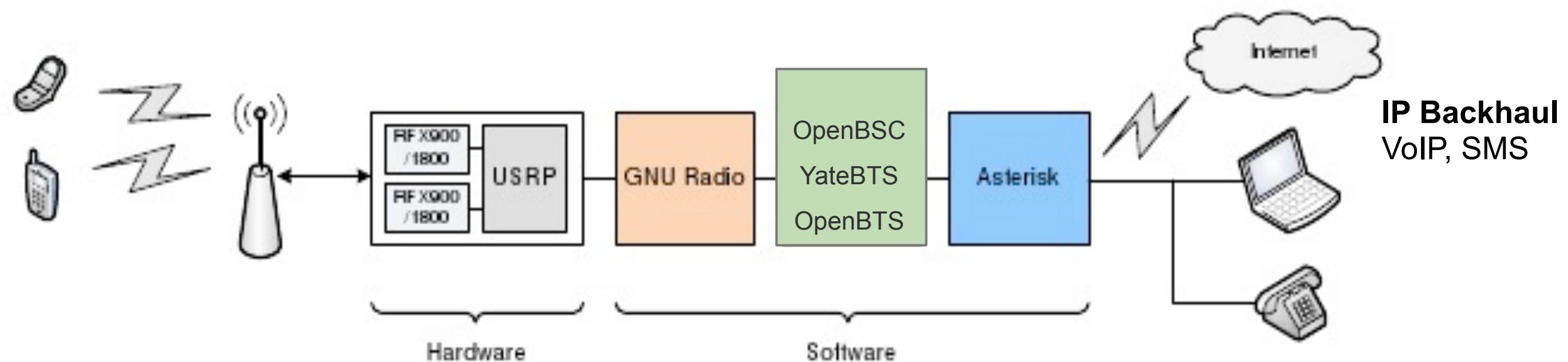


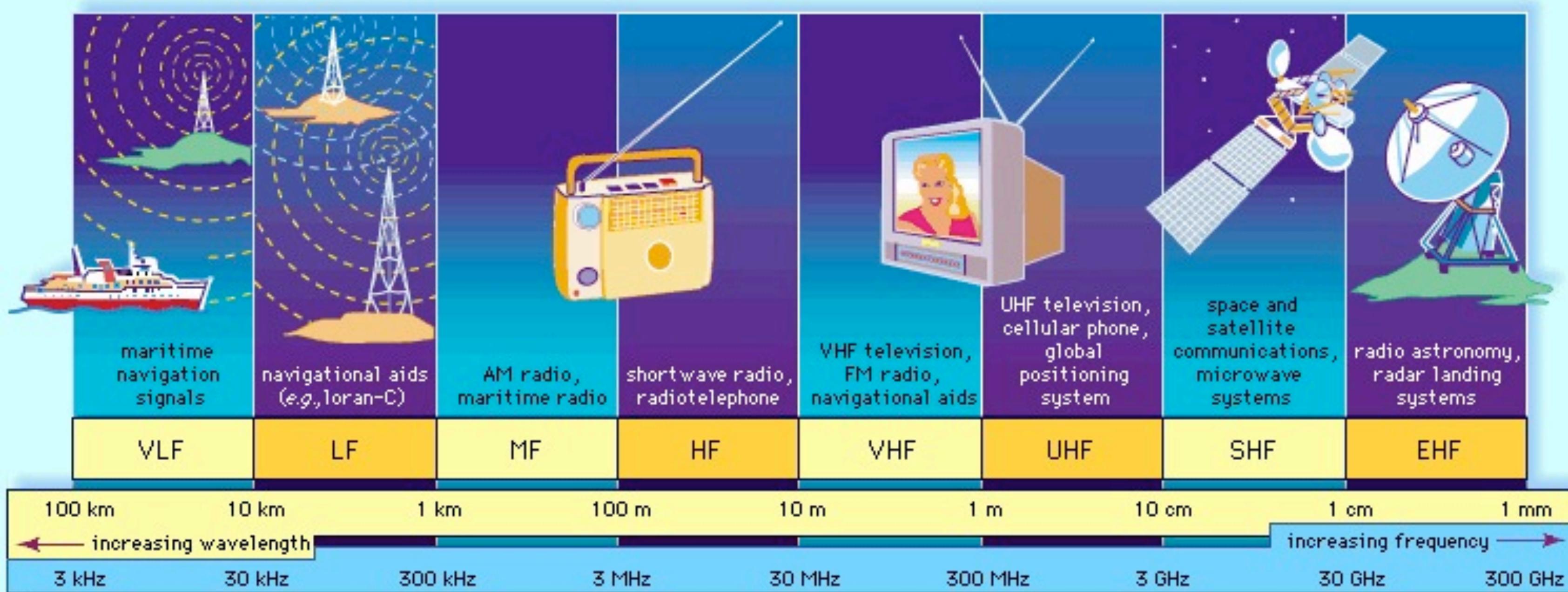
Range NETWORKS

fairwaves

**yate
BTS**

nu RAN
WIRELESS
Reaching Everyone, Everywhere





VLF - Very Low Frequency

LF - Low Frequency

MF - Medium Frequency

HF - High Frequency

VHF - Very High Frequency

UHF - Ultra High Frequency

SHF - Super High Frequency

EHF - Extremely High Frequency

SOFTWARE DEFINED RADIOS (<\$2K)



Nuand - bladeRF



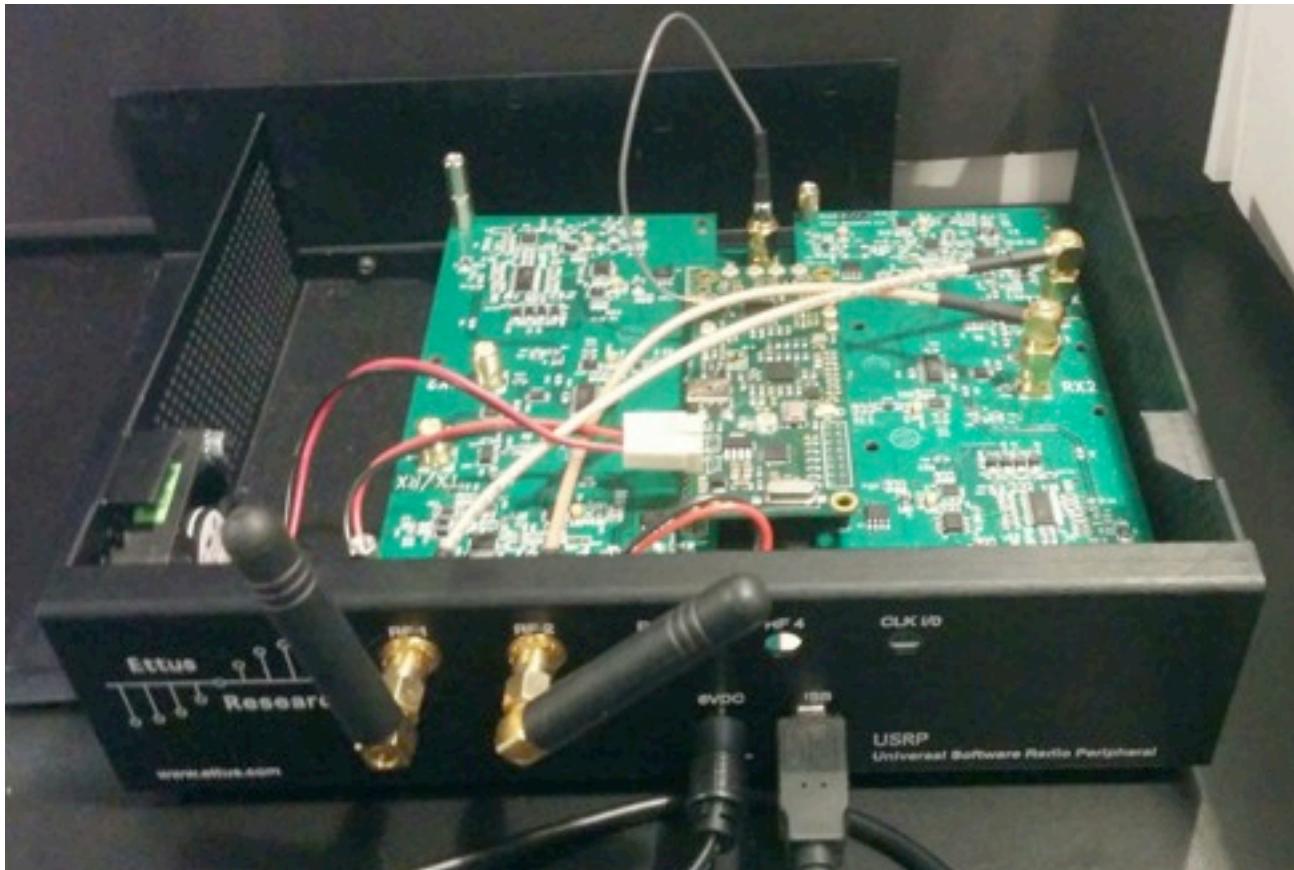
RP1



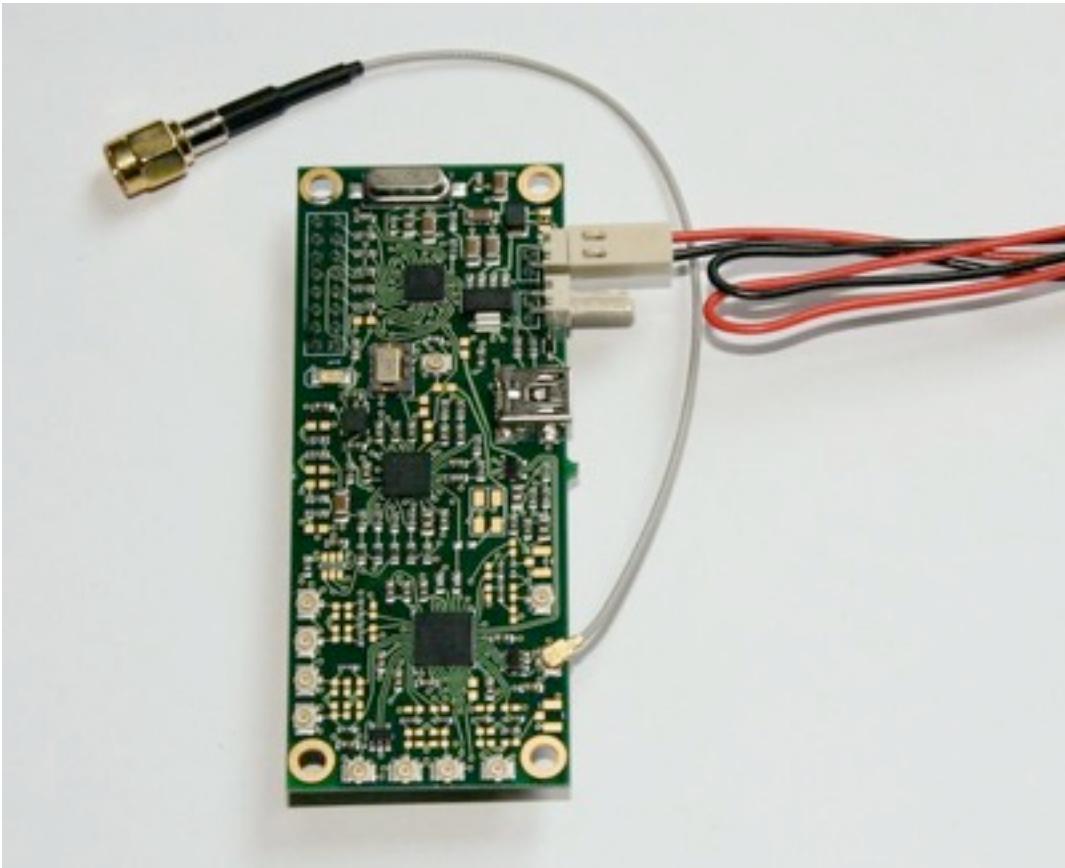
Ettus - B2xx



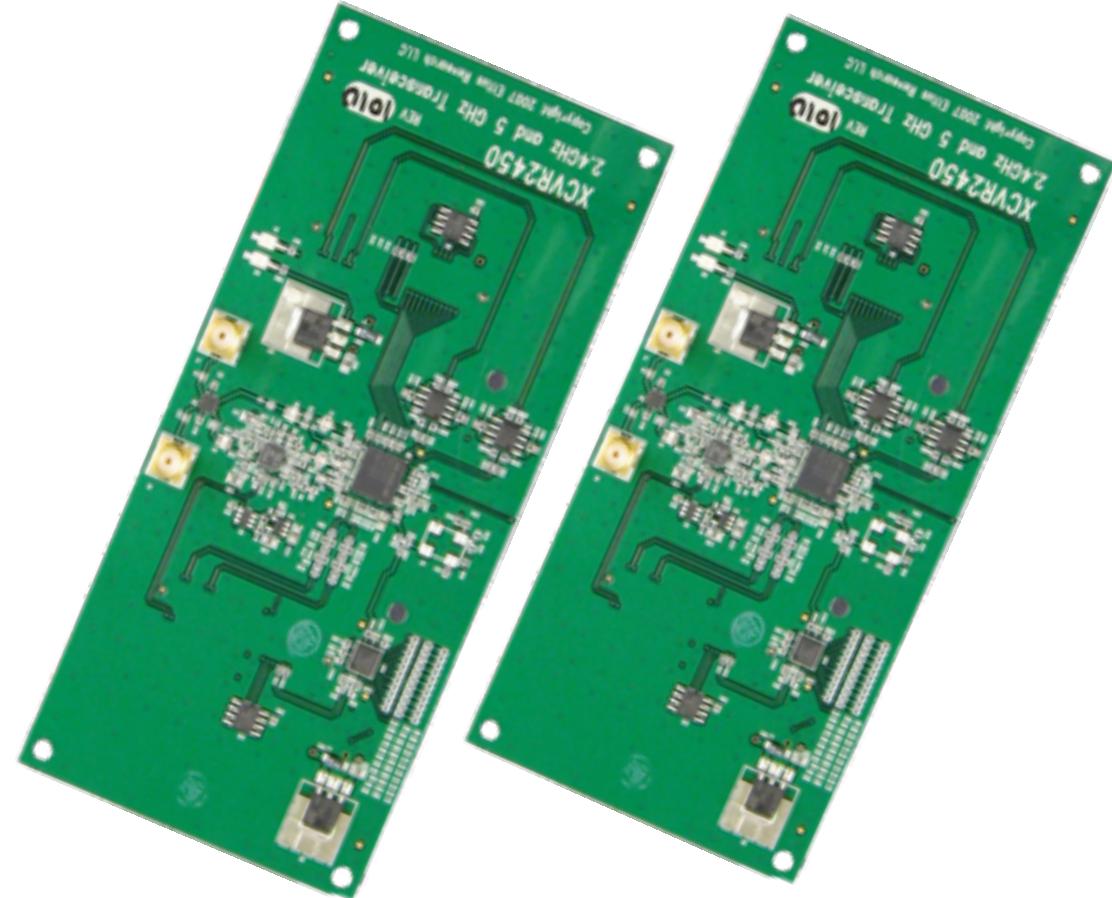
Ettus - USRP N2xx



Ettus - USRP1



ClockTamer



Transceiver Daughterboards



Antennas

ARFCN

1	Channel: 0;	Band: EGSM-900	Uplink: 890 MHz,	Downlink: 935 MHz
2	Channel: 1;	Band: GSM-900	Uplink: 890.2 MHz,	Downlink: 935.2 MHz
3	Channel: 2;	Band: GSM-900	Uplink: 890.4 MHz,	Downlink: 935.4 MHz
4	Channel: 3;	Band: GSM-900	Uplink: 890.6 MHz,	Downlink: 935.6 MHz
5	Channel: 4;	Band: GSM-900	Uplink: 890.8 MHz,	Downlink: 935.8 MHz
6	Channel: 5;	Band: GSM-900	Uplink: 891 MHz,	Downlink: 936 MHz
7	Channel: 6;	Band: GSM-900	Uplink: 891.2 MHz,	Downlink: 936.2 MHz
8	Channel: 7;	Band: GSM-900	Uplink: 891.4 MHz,	Downlink: 936.4 MHz
9	Channel: 8;	Band: GSM-900	Uplink: 891.6 MHz,	Downlink: 936.6 MHz
10	Channel: 9;	Band: GSM-900	Uplink: 891.8 MHz,	Downlink: 936.8 MHz
11	Channel: 10;	Band: GSM-900	Uplink: 892 MHz,	Downlink: 937 MHz
12	Channel: 11;	Band: GSM-900	Uplink: 892.2 MHz,	Downlink: 937.2 MHz
13	Channel: 12;	Band: GSM-900	Uplink: 892.4 MHz,	Downlink: 937.4 MHz
14	Channel: 13;	Band: GSM-900	Uplink: 892.6 MHz,	Downlink: 937.6 MHz
15	Channel: 14;	Band: GSM-900	Uplink: 892.8 MHz,	Downlink: 937.8 MHz
16	Channel: 15;	Band: GSM-900	Uplink: 893 MHz,	Downlink: 938 MHz
17	Channel: 16;	Band: GSM-900	Uplink: 893.2 MHz,	Downlink: 938.2 MHz
18	Channel: 17;	Band: GSM-900	Uplink: 893.4 MHz,	Downlink: 938.4 MHz
19	Channel: 18;	Band: GSM-900	Uplink: 893.6 MHz,	Downlink: 938.6 MHz
20	Channel: 19;	Band: GSM-900	Uplink: 893.8 MHz,	Downlink: 938.8 MHz
21	Channel: 20;	Band: GSM-900	Uplink: 894 MHz,	Downlink: 939 MHz
22	Channel: 21;	Band: GSM-900	Uplink: 894.2 MHz,	Downlink: 939.2 MHz
23	Channel: 22;	Band: GSM-900	Uplink: 894.4 MHz,	Downlink: 939.4 MHz
24	Channel: 23;	Band: GSM-900	Uplink: 894.6 MHz,	Downlink: 939.6 MHz
25	Channel: 24;	Band: GSM-900	Uplink: 894.8 MHz,	Downlink: 939.8 MHz
26	Channel: 25;	Band: GSM-900	Uplink: 895 MHz,	Downlink: 940 MHz
27	Channel: 26;	Band: GSM-900	Uplink: 895.2 MHz,	Downlink: 940.2 MHz
28	Channel: 27;	Band: GSM-900	Uplink: 895.4 MHz,	Downlink: 940.4 MHz
29	Channel: 28;	Band: GSM-900	Uplink: 895.6 MHz,	Downlink: 940.6 MHz
30	Channel: 29;	Band: GSM-900	Uplink: 895.8 MHz,	Downlink: 940.8 MHz
31	Channel: 30;	Band: GSM-900	Uplink: 896 MHz,	Downlink: 941 MHz
32	Channel: 31;	Band: GSM-900	Uplink: 896.2 MHz,	Downlink: 941.2 MHz
33	Channel: 32;	Band: GSM-900	Uplink: 896.4 MHz,	Downlink: 941.4 MHz
34	Channel: 33;	Band: GSM-900	Uplink: 896.6 MHz,	Downlink: 941.6 MHz
35	Channel: 34;	Band: GSM-900	Uplink: 896.8 MHz,	Downlink: 941.8 MHz
36	Channel: 35;	Band: GSM-900	Uplink: 897 MHz,	Downlink: 942 MHz
37	Channel: 36;	Band: GSM-900	Uplink: 897.2 MHz,	Downlink: 942.2 MHz
38	Channel: 37;	Band: GSM-900	Uplink: 897.4 MHz,	Downlink: 942.4 MHz
39	Channel: 38;	Band: GSM-900	Uplink: 897.6 MHz,	Downlink: 942.6 MHz
40	Channel: 39;	Band: GSM-900	Uplink: 897.8 MHz,	Downlink: 942.8 MHz
41	Channel: 40;	Band: GSM-900	Uplink: 898 MHz,	Downlink: 943 MHz
42	Channel: 41;	Band: GSM-900	Uplink: 898.2 MHz,	Downlink: 943.2 MHz

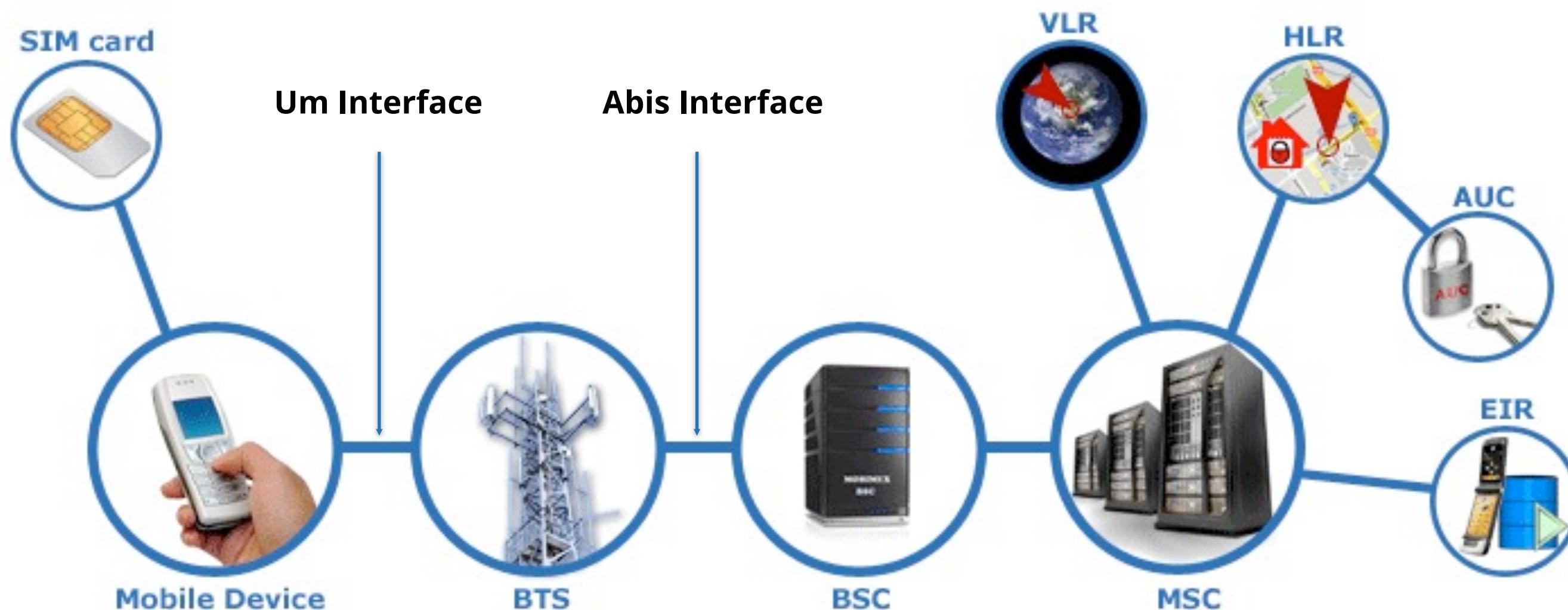
ABSOLUTE RADIO-FREQUENCY CHANNEL NUMBER

BASE STATION CONTROLLER

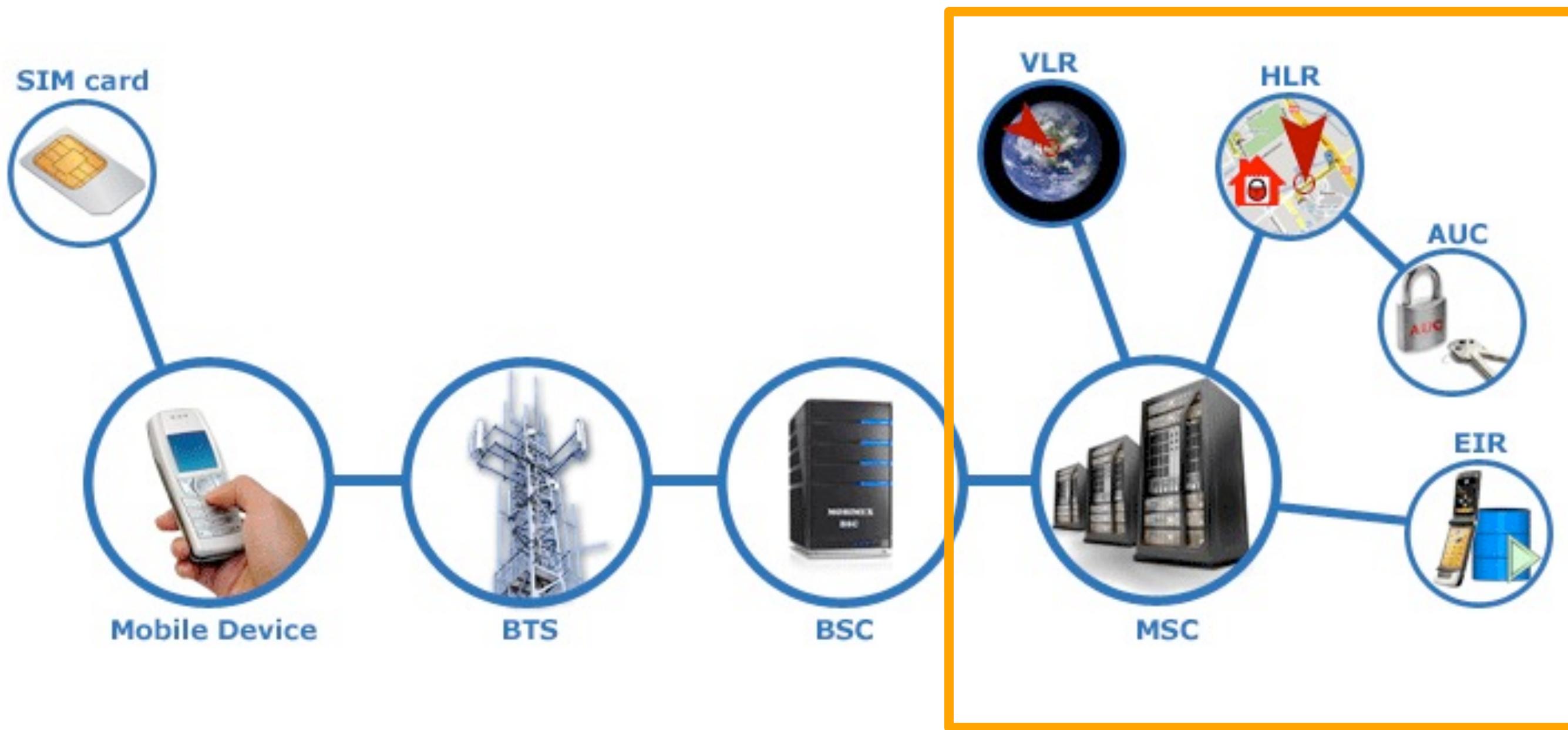
The *intelligence* of the BTS



INTERFACING



NETWORK SUBSYSTEM



OPENBTS SYSTEM



+



+

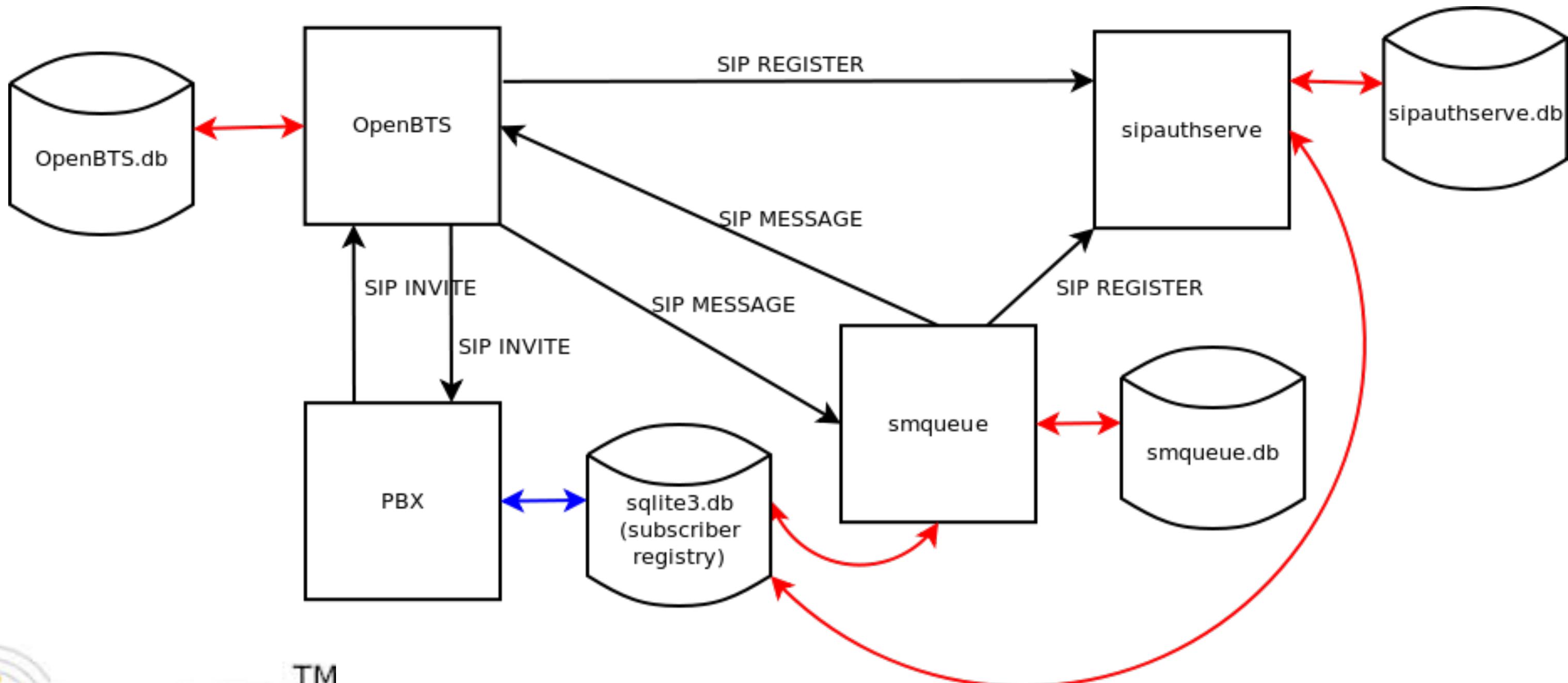


is the software that replaces
dedicated circuits in the hardware
with software processing blocks

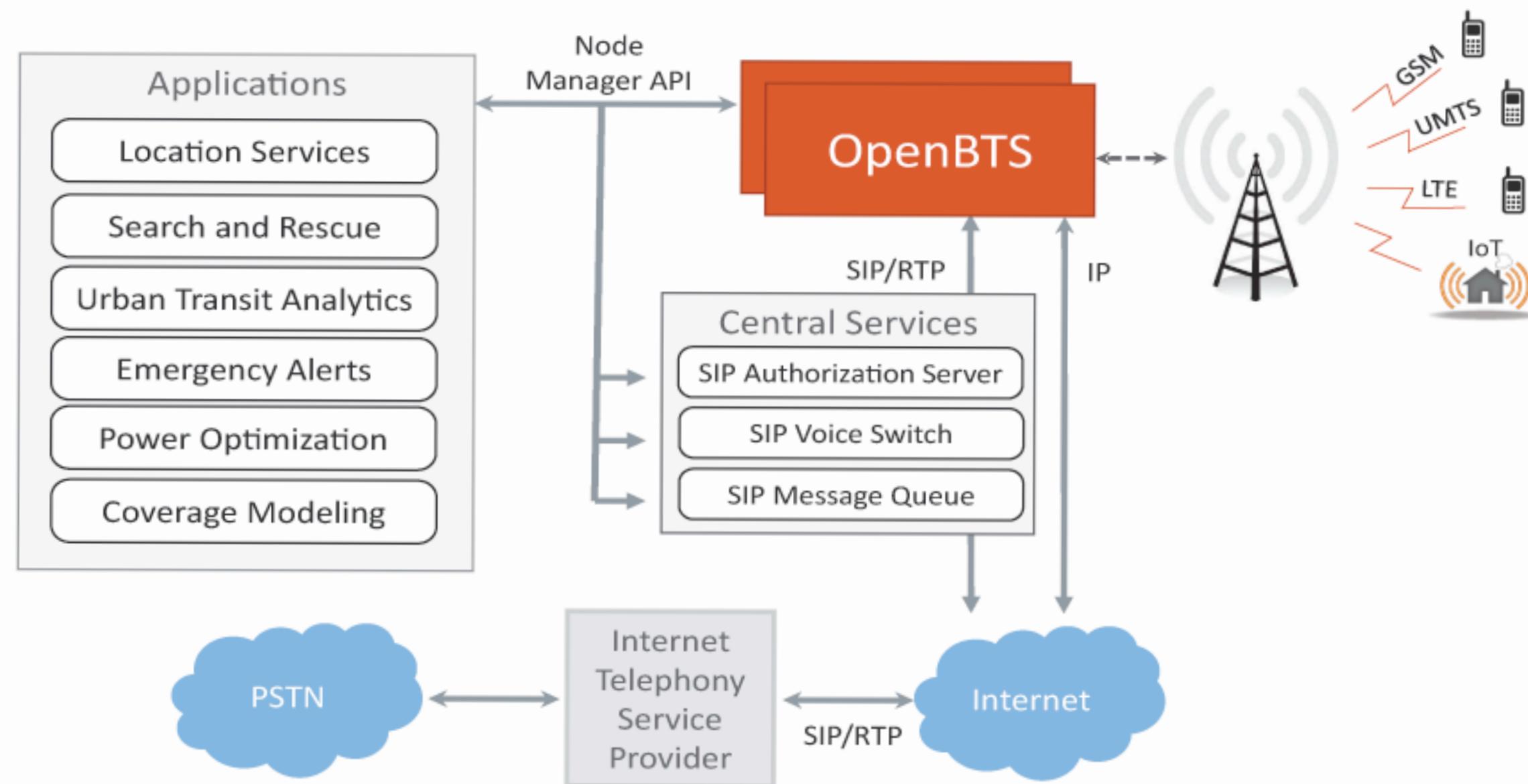
is a Unix application that uses a
software radio to present a GSM air
interface to standard 2G GSM
handset and uses a SIP soft-switch or
PBX to connect calls

is the platform to create
communication/telephony
applications

OPENBTS SYSTEM



OPENBTS SYSTEM



OSMOCOM



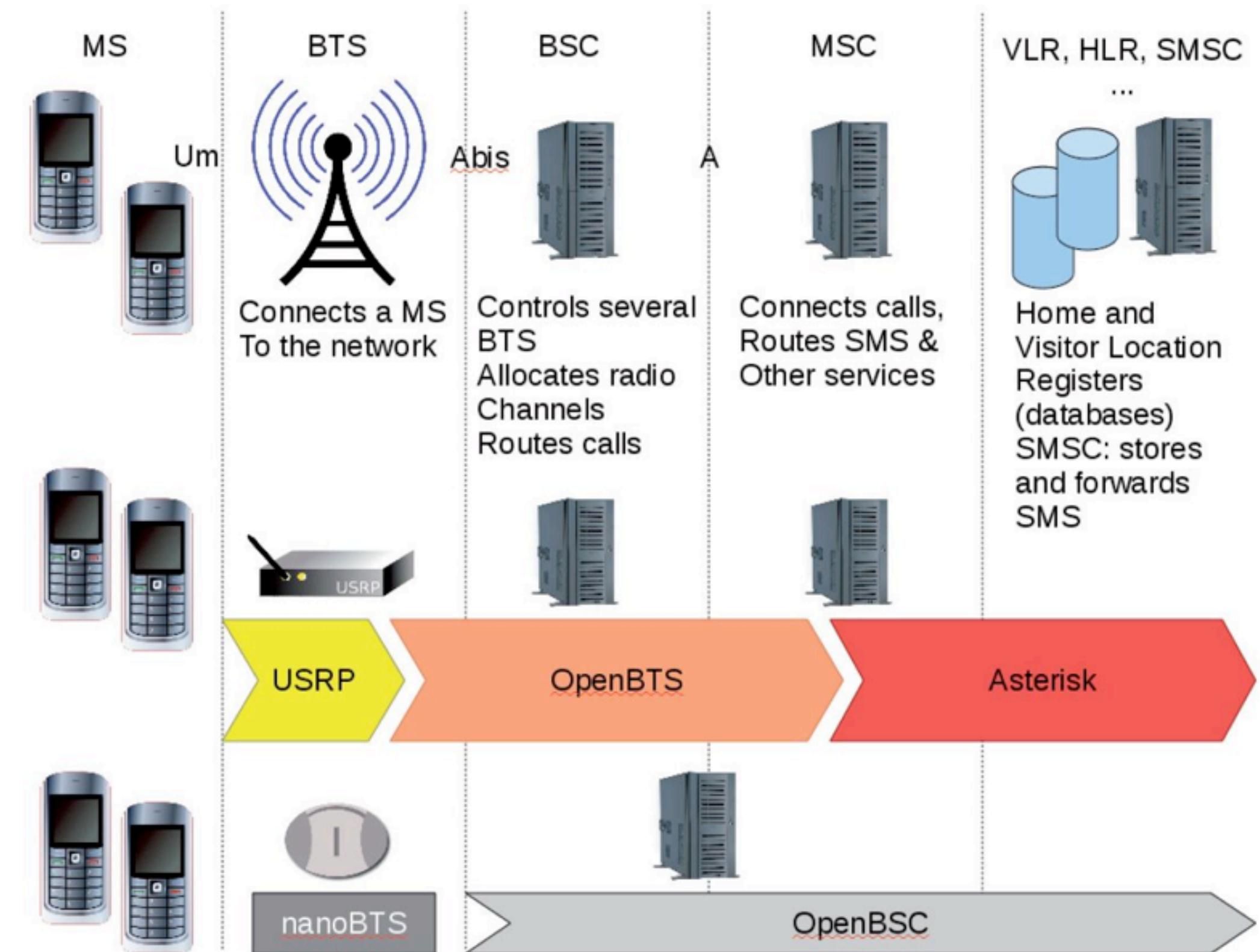
Harald Welte is a hacker/programmer who reversed engineered the BTS station.

- **Osmocom**
<http://osmocom.org/>
Family of projects regarding
Open source mobile communications
- **OpenBSC**
GSM network in a box software,
implementing the minimal
necessary parts to build a small,
self-contained GSM network.

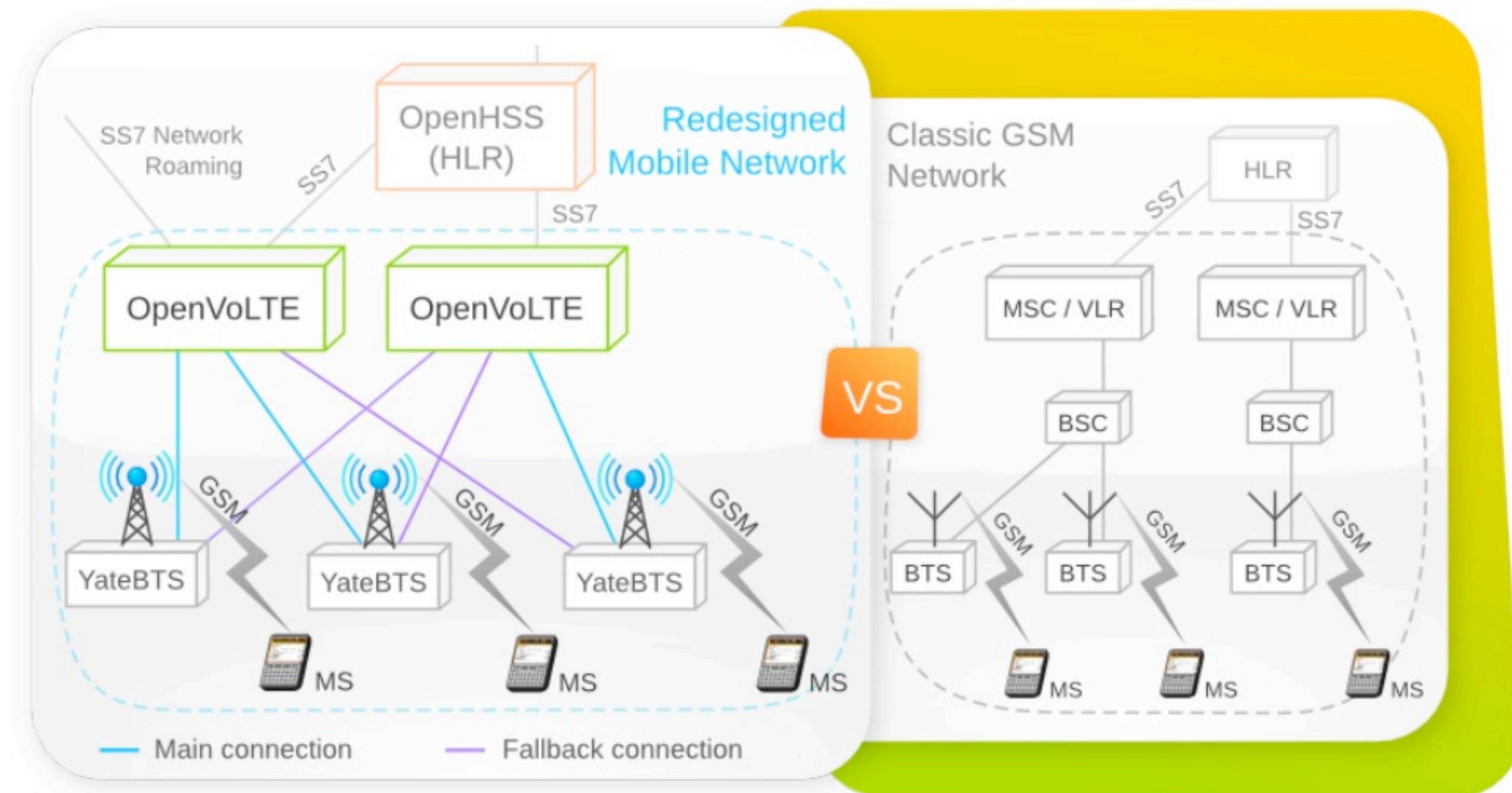


Harald Welte

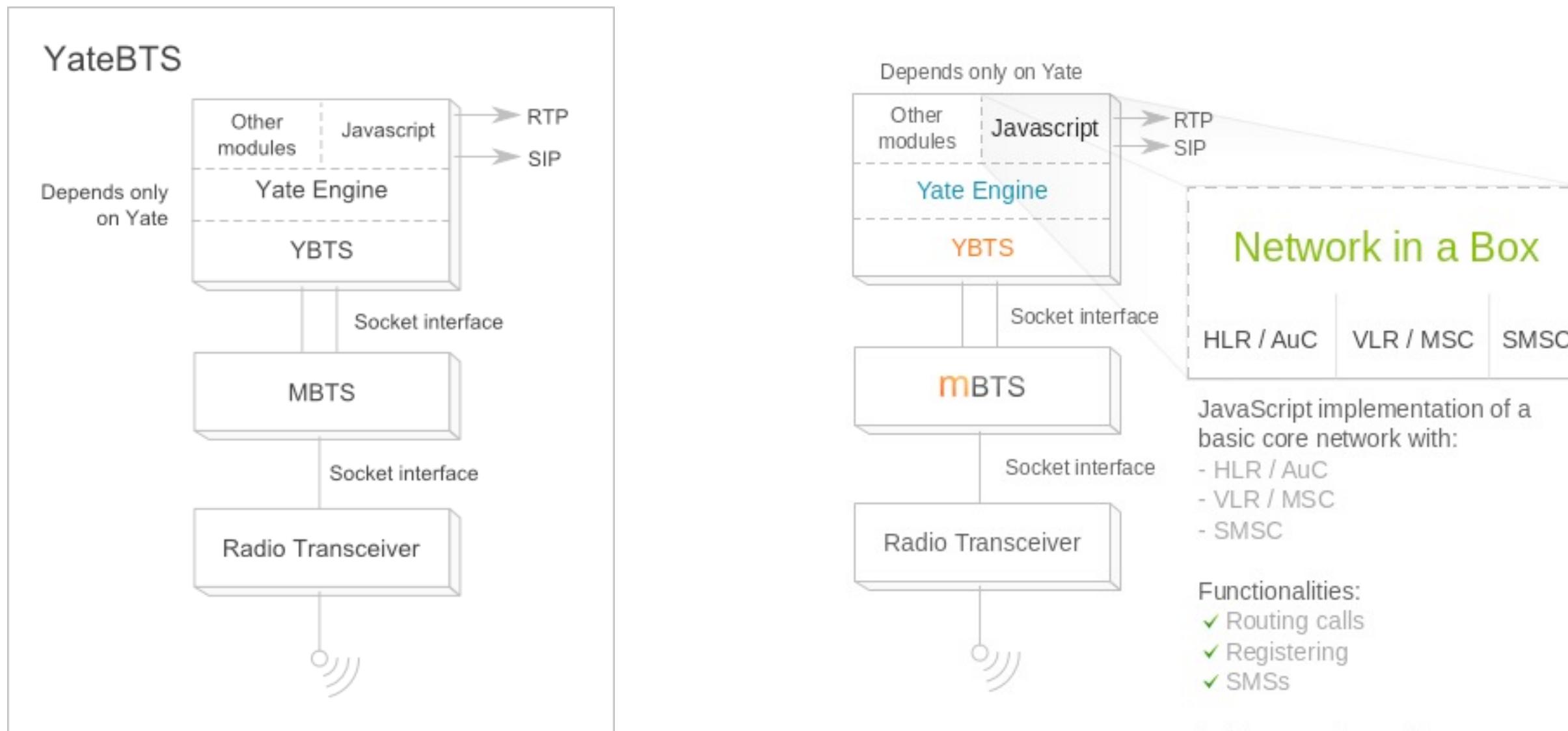
OPENBSC NITB



YATE - YATEBTS



YATE - NIB



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About

Legba was founded in October 2013 by David Burgess, the originator of [OpenBTS®](#), to create new all-software, open source radio access network products. We have offices in the US and Romania.

What's in a name?

In Haitian Vodou, [Papa Legba](#) serves as the intermediary between the spirit world and humanity. He is always the first and last spirit invoked in any ceremony, because his permission is needed for any communication. The radio access segment of the mobile network serves a similar function, as the intermediate link between the subscriber and the services of the core network.

Meet the team



Mihaela Blanaru
FPGA Developer



David Burgess
CEO



Daniel Condrea
Hardware Engineer



Gratiela Dumitrica
Marketing Specialist



Aurelian Florea
Developer



Mihai Gospodaru
Developer



Andrei Marghioala
Developer



Mihaela Moraru
Developer



Cristian Neacsu



You!

BE THE PHONE COMPANY.

No more waiting for coverage: now you can build cellular networks yourself.

[Learn More](#)

Endaga empowers anyone to build their own independent, profitable cellular networks, even in the most remote, sparsely populated places on Earth.



Our Story

We've been working on rural communications for a long time. We started as researchers in UC Berkeley's Technology and Infrastructure for Emerging Regions (TIER) group, where we developed the initial technology that would become Endaga.

In TIER, we took a multidisciplinary look at the problem of building rural cellular networks, drawing on our experience in computer science, design, and international development. The idea of *Community Cellular* emerged from this environment: locally-owned, small-scale, independent cellular networks, run by and for rural communities.

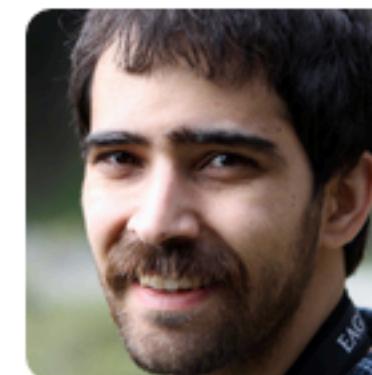
We built the first community cellular network in a rural village in Papua, Indonesia, in early 2013, with support from USAID and the Blum Center for Developing Economies. That first network is still running today, and today we continue to add new networks, constantly bringing connectivity to new users and communities worldwide.

Interested in solving communications problems in some of the most challenging environments on the planet? [We're hiring.](#)

Our Team



Kurtis Heimerl CEO, Founder



Shaddi Hasan CTO, Founder



Kashif Ali VP Eng., Founder

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RHIZOMATICA
Mobile Communications for All

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About



According to the ITU, 2-3 billion people around the world lack affordable mobile telephone services that facilitate critical communications and access to information. Due to market saturation in developed countries, mobile telephony is often too expensive for the poor in developing countries.

OUR MISSION

Rhizomatica's mission is to increase access to mobile telecommunications to the over 2 billion people without affordable coverage and the 700 million with none at all.

OUR APPROACH

We support and promote technologies that reinforce community values like cooperation,



Mobile phones for remote Mexico village

Source: CNN ↗

Added on 0022 GMT (0822 HKT) December 10, 2013



RANGE NETWORKS



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**Cellular networks should be software and IP.
Now they are.**

Internet simplicity,
Internet flexibility,
Internet costs for:

Enterprise
communications



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OpenBTS Dev Kits

Run your own GSM network

[VISIT OPENBTS.ORG](#)

The Range Networks Professional Development Kit is a fully functional GSM "network-in-a-box" designed for



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Customer Cases

Antarctica

This case study highlights how Range Networks equipment is being used to extend a private network and increase safety in the most remote and challenging conditions.



Papua, Indonesia

A remote village, four hours away from the nearest cellular tower, now has its own local calling and global SMS. Powered by a small hydro-electric generator, the network was deployed in one day.



Southern Zambia

In just two days, a two cell network was deployed to a rural village in Southern Zambia. The network serves as proof of concept for additional deployments in Zambia and other rural areas.



07.22.2014

OpenBTS APIs & 5.0 Preview

Now Available!

[Go Get 'Em!](#)

o o

OpenBTS.org is an open source software project dedicated to revolutionizing mobile networks by substituting legacy telco protocols and traditionally complex, proprietary hardware systems with Internet Protocol and a flexible software architecture. This architecture is open to innovation by anybody, allowing the

Latest News

["Getting Started with OpenBTS" e-book released, free download](#)
O'Reilly Media has published "Getting Start [...]"
[OpenBTS-UMTS 1.0 for data available for download!](#)

Upcoming Events

No Events Found
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GSM-reinvented. Profitable mobile networks anywhere.

Fairwaves helps mobile operators radically widen subscriber base and boost profitability in low-income regions. With a minimal initial budget, you could quickly roll-out your network and launch profit-generating services. Fairwaves sells equipment and provides private cloud core based network for mobile operators.

At Fairwaves, we believe that communications should be affordable for everyone and mobile networks could be profitable anywhere. We bet on a network of proven partners, the power of open-source and the latest IC technology.

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Our partners deploy fairwaves equipment in a variety of usage scenarios. Here we tell stories of some of them. We hope to see your story here as well.

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Meta



**NEXT UP: HOW TO MAKE YOUR OWN
GSM CAPABLE HARDWARE !
(OR YOUR OWN CELLPHONE)**

BUT NOW LET'S CAMP SOME PHONES!

