Tutorial: Hardware & software options for experimenting with APRS™ networks

Abstract

In this session the audience will learn how to configure and use recently developed hardware and software for participating in amateur radio APRS™ (Amateur Packet/Position Reporting System) communication networks; How to use APRS to communicate with nearby correspondents without Internet or telephone connections; How to use APRS and similar amateur radio services in a community to save human lives and properties; How to contribute to weather observation (amateur radio meteorology) by participating in APRS; How to create a local AMUNET (AMateur radio University NETwork) and expand visibility of an academic institution.

Objectives, motivation, intended audience

What will the participants learn?

- Recent results in experiments with GPS technology in amateur radio mapping;
- Implementation of DMR (Digital Mobile Radio) in the amateur radio world;
- Exchanging e-mails without Internet and telephone connectivity;
- Choosing & operating proper modems, radios, antennas, and a computer;
- Wireless network security and privacy: Protect yourself against potential amateur radio 'pirates' (hackers);
- Test-bed and prototype implementation of amateur wireless services;
- Amateur radio as a technology and architecture model for rural communications;
- How to make the local AMUNET and how to link it to a neighboring one;

A significant percentage of school kids – being involved in the amateur radio – continue with education in areas of telecommunications, computing, mathematics, electronics and related disciplines. That aspect of amateur radio opens new possibilities for exploring at homes, work, and in educational environments. To mention just a few opportunities for implementing amateur radio, there are various types of hybrid LAN connections, network simulations, and use of Linux and open-source software. One of the most important roles of the amateur radio is to bridge communication gaps after natural disasters such as tornadoes, hurricanes, earthquakes, floods, etc. Therefore, the knowledge, skills & experience in radio amateurs as well as their equipment, have always been, is now, and will remain on duty in cases of emergency (several examples will be provided).

Intended audience: Teaching and managing personnel at academic level, high-grade technical and elementary schools; students of all levels of education; authorities and institutions in rural areas and developing countries; agencies and ministries of communications, science and education; humanitarian services (first aid etc), scientific expeditions organizers, non-for-profit societies and other technically-oriented practitioners, volunteers & professionals.

Instructors' biographies

Miroslav Skoric, a Senior Member of IEEE Austria Section, former secretary of SRV (Amateur Radio Union of Vojvodina province in northern Serbia). More than three decades of experience in computer network administration and system maintenance (Diploma in Business Computing) and voluntary practice in the amateur radio (licensed amateur since 1989, amateur radio call sign YT7MPB; ex-CN2MPB; ex-TO0MPB). He has been maintaining amateur radio bulletin board systems (MS DOS, Windows and Linux platforms) at VHF/HF radio frequencies and Internet inputs/outputs. Teaching experience includes classes in a local high-school amateur radio club; technical paper presentations in domestic and international events; tutorials & workshops on the amateur radio in engineering education, magazine/journal articles, five book chapters, and a web page featuring an amateur radio software. Social activities include memberships in IEEE Computer Society, IEEE Communications Society, IEEE Education Society, IEEE Antenna and Propagation Society, and others.

LinkedIn profile: https://www.linkedin.com/in/miroslavskoric/

Larbi Ouiyzme (amateur radio CN8FF), is a freelance consultant in systems, networks and cybersecurity, based in Morocco. Among the others, works in radio communication area: Study of private radio networks, installation and maintenance. Previously he worked as senior hardware & software development engineer for embedded systems with Union Telecom, Morocco, and before that as a service engineer in Customer Service and Operations with SICPA, Morocco & Switzerland. He is a Microsoft certified trainer & consultant, specializing in Microsoft technologies and various products. He possesses several certifications, and holds University Master in Systems Architectures Bac + 5 ENSEM, and is in progress for obtaining Specialized Master Cybersecurity Governance & Engineering Bac + 6 INSA Lyon. In his lab and office he uses various test infrastructure: Physical and virtual servers, VM virtual machines, routers & switches, Raspberry Pi, RF spectrum analyzer, RF frequency generator, ...

LinkedIn profile: https://www.linkedin.com/in/larbi-ouiyzme-12596b75/

A description of the technical issues that the tutorial will address, emphasizing its timeliness

Witnessing natural disasters, radio amateurs quickly establish their communications to replace temporary-down governmental- and commercial-based links. This tutorial takes attention to emergency communications and email services (such as *Winlink 2000*) and related hardware & software requirements, focusing on geo-locating and position mapping of radio operators and valuable objects, so that the *APRS* network participants could get awareness on their surrounding – particularly in unfamiliar locations, rural areas, and foreign countries.

APRS is "the IoT of amateur radio", where sensors of all sorts automatically report information that humans can use to make informed decisions about things such as which road to use in a new state/country when travel, or to avoid directions where bad weather occurs. APRS is also the text-messaging service of amateur radio where humans can keep others informed in real time of things such as traffic

accidents (incl. injuries and need for ambulance), incidental/bad road conditions, (missing/available) parking places for incoming group gatherings or in cases of emergency, technical experiments & research (E.g. 'ballooning' - sending weather balloons), and so on. And to do all of that without any Internet or cell telephony coverage: Only amateur radio stations are used. US-based radio amateurs consider cell phones as not being a reliable form of communication across a fairly large part of the country: Outside of large cities and a mile or two off the 'interstates' is a much different world than most of the population are acquainted to. APRS offers opportunities for general hobbyists to transport small data packets of all types from geographically separated locations – many without Internet service. Next, it enables networking-oriented enthusiasts to inexpensively build APRS infrastructure to benefit others, as well as makers to produce IoT-like appliances and sensors of all sorts. Canadian amateur radio operator Nick, VA3NNW, informs that his radio club used APRS tracking of vehicles, volunteers and supplies, and also "added extra items to the map" for a local marathon (the route, water stations, first aid locations, first/last runners). The resulting maps were useful to non-amateur participants too.

Public services and emergency communication groups like RACES and ARES can add situational awareness data to first respondents of all types thankfully to APRS. Having in mind that amateur radio and APRS has been doing it since before the Internet existed, it will continue to provide those services when disaster takes the Internet offline - even on a local basis. For example, in Puerto Rico, after Hurricane Maria, one of the most prized information asset was a map of passable and impassable roads. It was gathered by 'hams'. According to US-based operator Craig, KH6CP, amateur radio was the only communication post-Maria in Puerto Rico for six weeks. He adds that local radio amateurs in Hawaii had demonstrated how APRS could quickly pinpoint such problems by using hand-held radio stations.

Outline with tentative schedule

- Computer-driven radio communications (focused on 'packet-radio' & APRS)
  - Direct link between two correspondents
  - Splitting information to smaller 'packets'
  - Indirect link over a repeater (incl. 3D simulation)
  - Security and privacy in the amateur radio digital networks
- Hardware for the amateur computer-related communications
  - Computers (PC XT, AT, i386, i486, Pentium, non-PC, etc.)
  - Radio stations (types, output capabilities, power supply, etc.) – *practical demo*
  - Antennas – *personal low-cost experience*
  - Radio modems & interfaces (several examples related to overall types, data throughput, connectivity etc.)

1st - 2nd hour

- Hardware for the amateur computer-related communications *(cont.)*
  - GPS receivers – *practical demo*
  - Implementation of sound-cards and various interfaces – *practical demo from a 'kitchen table'*

- Software solutions
  - Server side (DOS, Windows, Linux systems) – several examples
  - Client side (OS-included software, other software) – several examples
  - Installing 'factory-made' software, or compiling it by yourself? - advantages of Linux & open-source solutions
  - Repeaters' programs
- Foreign experience
  - Universities in some countries (examples on what they have been doing with the amateur radio)
  - Humanitarian role of the radio amateur communications: Examples on disasters in the USA where the amateurs voluntarily helped to the local communities, etc.
  - Winlink 2000 – a global emergency email service (how to join it – *examples*)
- Networking opportunities
  - AMUNET – Amateur University Network (local area, MAN etc)
  - APRS™ – Automatic Packet/Position Reporting System – *practical demo*
  - Widening the network (surrounding countries, global connections)
  - Scientific expeditions to remote and developing areas
  - Connecting with scientists at the International Space Station, ship crews, etc.
  - Interconnections to/from the TCP/IP world ('gatewaying' with the Internet)

3rd - 4th hour

Possibility of and suitability for a virtual presentation of the tutorial

Having in mind technical display, practical parts of the tutorial & experimental demo, the proposed program is **not** suitable for a virtual presentation.

A description of the past/relevant experience of the speaker(s) on the topic of the tutorial

M. Skoric noticed a significant interest in technically-oriented audiences in many countries towards new approaches in unofficial, non-governmental, and non-commercial communications like proposed amateur radio topics. The amateur radio session in the most recent IEEE RADIO 2019 opened new perspectives for regional collaboration across the countries surrounding Indian Ocean, related to using amateur radio weather-monitoring facilities in multi-national early warning systems. A similar facility could be planned for Morocco and other countries across Atlantic.

A description of previous tutorial experience of the speaker(s), and past versions of the tutorial

Half-day, full-day, and multi-day conference tutorials were performed by M. Skoric in IEEE-EESTEC Technical Conference 2004 (Rende-Cosenza, Italy), WSEAS CSCC 2006 (Athens, Greece), IEEE EUROCON 2007 (Warsaw, Poland), WSEAS EE 2008 (Heraklion, Greece), IARIA ICWMC 2008 (Athens, Greece), TELFOR 2008 (Belgrade, Serbia), IAENG IMECS 2009 (Hong Kong, China), WSEAS EE 2009 (Rhodes, Greece), IEEE ICACT 2010 (Phoenix Park, Korea), DIRF NDT 2010 (Prague, Czech Republic), IAENG IMECS 2011 (Hong Kong, China), SDIWC ICIEIS

2011 (Kuala Lumpur, Malaysia), SDIWC DICTAP 2012 (Bangkok, Thailand), SNDS'12 (Trivandrum, India), SDIWC EBW 2013 (Bangkok, Thailand), IEEE ISPCC 2013 (Solan, India), ICCS-2013 (Burdwan, India), SDIWC WCIT 2014 (Kuala Lumpur, Malaysia), IEEE WOCN 2014 (Vijayawada, India), SDIWC ICCTIM 2015 (Batu Pahat, Malaysia), IEEE COMCAS 2015 (Tel Aviv, Israel), CN 2016 (Brunow, Poland), ICRCICN 2016 (Kolkata, India), CN 2017 (Ladek Zdroj, Poland), ICISCT 2017 (Tashkent, Uzbekistan), ICMCS'18 (Rabat, Morocco), IEEE RADIO 2019 (Reunion Island, France), and IEEE ANTS 2019 (Goa, India).

1/2/3/4/5-day seminars & workshops have been conducted by M. Skoric in India with BMSCE (Bangalore), TINJRIT (Udaipur), IIT-BHU (Varanasi), SVNIT (Surat), SRM University (Chennai), ABES Engineering College (Ghaziabad), Science and Technology Museum (Trivandrum), GMRIT (Rajam), RCC Institute of Information Technology (Kolkata), Thapar University (Patiala), UEM (Jaipur), MUJ (Jaipur), and BTKIT (Dwarahat); in Thailand with Bangkok University; in Malaysia with IIUM (Kuala Lumpur); in Poland with Rzeszów University of Technology (Rzeszów); and in Uzbekistan with TUIT (Tashkent).

Supplementary materials

The audiovisual support for this tutorial is designed in Linux LibreOffice Impress format (compatible to Microsoft Office PowerPoint). The course program includes 250+ slides and short videos. M. Skoric uses a Linux-based laptop (standard VGA connectivity to a wall projector), as well as some electronics for practical demo (portable VHF/UHF radio transceivers, modems, sound-card interfaces, GPS receivers, and a temperature & humidity sensor). Tutorial notes in form of a 20-page PDF brochure will be provided.

L. Ouiyzme and local radio amateurs will establish an ad-hoc radio facility at the conference venue to give the audience an opportunity to see & hear more amateur radio signals and get familiar with high-quality transmitting equipment.

An extension of this tutorial (3-5 days) can be made in form of a satellite event throughout the DDP 2021 conference week.

Multi-day, pre/post-conference seminars are also possible at local universities.

No prior experience in radio technology is necessary for this tutorial. An awareness of some basic computer networking concepts would be helpful.