Discover the Experience

Bring the Wireless Battlefield Conditions into Your Lab With EB Propsim Radio Channel Emulators

This product overview provides a brief outlook on how the EB Propsim radio channel emulators can be used in testing of modern wireless devices, systems and applications in the aerospace, defense and military area.

EB Propsim radio channel emulators are tools for air interface testing, replacing the real-world radio channel between a transmitter and a receiver. The EB Propsim product family of radio channel emulators provides realistic and repeatable test conditions for air interface testing in your lab. You can test and verify the performance and functionality of your receiver and transmitter designs, and wireless systems against the deployment environment.

EB offers industry-standard, high performance radio channel emulators for demanding industry leaders. In addition to the product offering, EB offers such tailored consulting services as radio channel modeling and training based on the vast experience in radio channel standardization, modeling and emulation.

Key words

- *Military communications*
- *Terrestrial communications*
- *Airborne communications*
- *Satellite and aerospace communications*
- *Naval and Maritime communications*
- *Software Defined Radio testing*
- *Receiver performance testing*
- *Mobile Ad hoc NETwork testing*
- *Scenario based real-time channel emulation*
- *Virtual Drive testing*
- *MIMO testing*
- *Over-the-Air testing*
- *Radar Sensor testing*
- *Beam forming testing*
- *Jamming scenarios*
- *System calibration*
- *Independent of waveform*
- *Channel emulation from HF to Microwave frequencies*
- *Interference and noise generation*

Background

The research and development of modern wireless devices and communication systems for aerospace, defense and military is very challenging due to the integration of multiple radio waveforms and network topologies in a demanding RF signal propagation environment.

The radio signal propagation environment is ranging from space to underground. There is a variety of systems utilizing the radio channel, e.g. point-to-point, point-to-multipoint voice and high speed data applications, broadcasting applications, a set of different radar applications, radar jamming and communication jamming and platform control communications, to name a few.

The common challenges to implement these devices, systems and applications:

- How to ensure the functionality of a critical communication link in any circumstances?
- How to verify the requirements for such a communication system?
- How to perform realistic and accurate evaluations?
- How to test and verify the functionality of the communication system under real scenario conditions without having the possibility of a test run in the real scenario?
- How to ensure the smooth interoperability of radios and applications between and over different systems?
- What is the optimal test set to cover the toughest performance requirements?
- How to ensure quality of service?
- How to implement products and systems cost-effectively with proper quality?

Key to success - Test and verify right things with proper methods and tools

In order to guarantee the wireless product performance for operation in the field, the testing methods should mimic real-life use case scenarios as closely as possible.

The wireless products can be field tested in a test setup that matches the intended use scenario. This could include for example performing drive testing with a measurement device through a coverage area of a radio network or measurements on different operational areas of RF sensors. Field testing is an essential part of wireless product, wireless system and applications development.

It is a known fact that field testing is generally a labor-intensive, time-consuming and expensive process - and sometimes even impossible to perform in advance with wireless equipment operating in some locations. When performing testing in the field, the testing of different environments requires physically moving the testing equipment to another geographical location. Field testing results are specific to the environment, location and time. They are non-repeatable, even under the exact same test setup, location and test scenario conditions. This is due to the fact that with field testing there is no real control over the natural environment or the radio channel effects.

A more sophisticated approach to testing wireless products compared to field tests is to emulate the radio channel in a controlled laboratory environment. With this approach the radio channel is replaced with a radio channel emulator, which takes all the radio channel phenomena into account. The radio channel emulator is a test and measurement device connected between the transmitter and the receiver. The transmission passes through the emulator, which recreates e.g. path loss, shadowing, multipath fading, delay spread, Doppler spread, angle spread and polarization effects as well as provides the option for the addition of noise and interference. Figure 1 illustrates the principle of radio channel emulation testing.

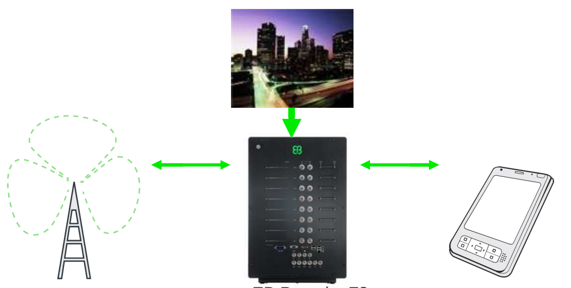

Figure 1. Typical test setup with a stand-alone radio channel emulator and transceivers under testing

The benefit of radio channel emulation is that it enables accurate, controllable and fully repeatable test runs to be performed in a laboratory environment. Testing through radio channel emulation can be used to complement – or in some cases even replace – traditional field testing. Emulator testing significantly reduces the testing time and cost for a variety of standard and specific radio environments. With a radio channel emulator it is possible to test product performance during one test session in any environment such as indoor, metropolitan, highway, rural or mountainous areas. Faster testing cycles lead to shorter development cycles with reduced costs and with the excellent performance, maturity and reliability of the wireless product, systems and applications.

The EB Propsim radio channel emulators provide unique emulation capabilities from HF to Microwave frequencies enabling users to implement and run the test scenarios in realistic environments under laboratory conditions with the highest accuracy and repeatability available.

Receiver performance and application testing

Figure 2 shows the received signal amplitude as a function of time in an urban environment. The total signal can be divided and categorized into a *path loss* component, *shadowing effects* (corner effects or toggling between Line Of Sight and Non-Line Of Sight states between transmitter and receiver) *and fast fading* effects (sum of multipath signals between mobile transmitter and receiver).

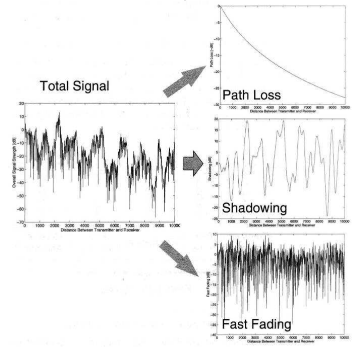

Figure 2. Example of multipath signal received in mobile radio receiver in a typical urban environment.

Typical items to be tested and measured with the supported waveforms of the receiver are:

- Receiver sensitivity level
- AGC
- Intersymbol/Intercarrier Interference
- Channel Estimation algorithms
- Diversity/MIMO DSP Algorithms
- Synchronization
- Min/max delay-Doppler
- SNR
- Interference mitigation

All these functions of the receiver should be tested and verified against realistic phenomena that are occurring in the real wireless environment, where the receiver is to be exposed. Figure 3 shows the signal path inside a typical digital receiver.

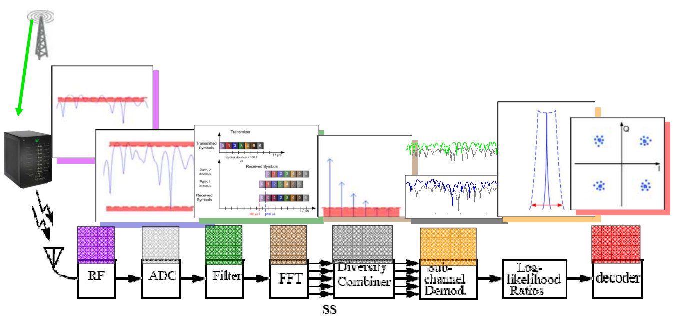

Figure 3. Signal processing in a typical digital receiver.

The air-to-ground link (broadcast or communication) includes both terrestrial and satellite environments and therefore the receiver must handle the characteristics of both of them. E.g. phase continuous delay/Doppler with extremely high velocities, path delay, path loss, rain effects, multipath fast fading, shadowing and Doppler due to terrestrial environment. See Figure 4.

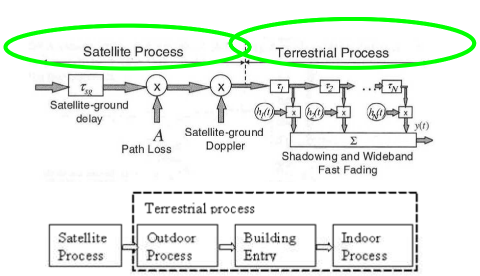

Figure 4. Air-to-ground channel emulation process.

For the testing of air-to-ground links a proper radio channel emulator with excellent radio channel modeling and emulation capabilities is needed.

Network level system and application testing

Today the communication network in defense and military is the so-called Mobile Ad hoc NETwork (MANET), where multiple radios are communicating with each other. See Figure 6 (on next page).

The radios in this type of network are called Cognitive radios. Figure 5 describes the main features of Cognitive radios and communication systems.

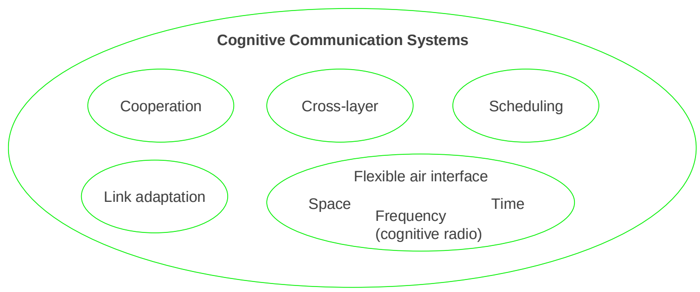

Figure 5. Features of a cognitive communication system

A cognitive radio is an intelligent radio, which can change its transmission or reception parameters to communicate efficiently avoiding interference with undesired signals. Cognitive systems have several items (not only frequency) to be cognitive, e.g. adaptive modulation and coding, retransmission, cross-layer optimization, awareness of user requirements (QoS, throughput etc.), adaptive scheduling, etc. Most of them are related to the radio channel conditions.

With EB Propsim real-world radio channel emulators the cognitive radios are easy and efficient to develop and test in laboratory conditions.

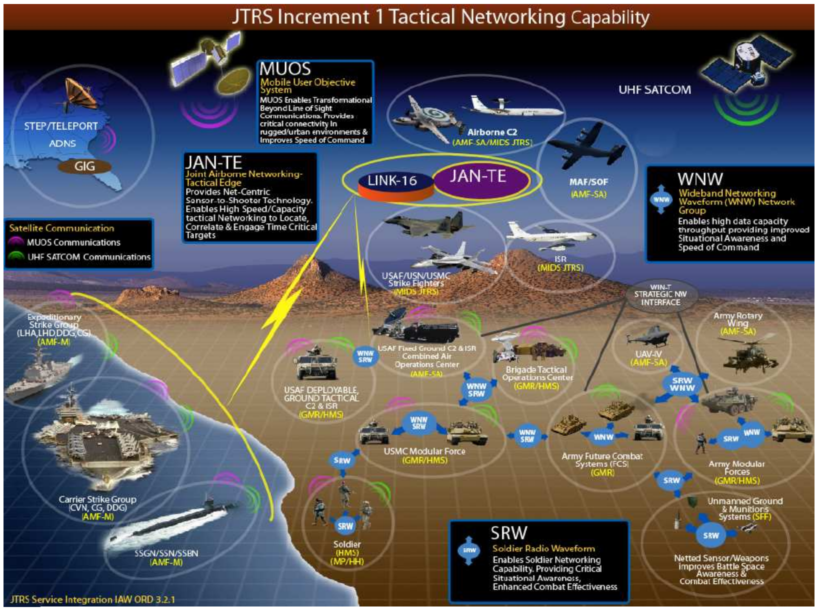

Figure 6. Mobile Ad hoc NETwork scenario in a battlefield (source: http://jpeojtrs.mil/)

Figure 7 shows on general level the example test setup for MANET testing in laboratory conditions – Hardware-In-a-Loop testing. The maximum number of radios and the needed connections between radios in testing define the number of emulation channels and emulators needed.

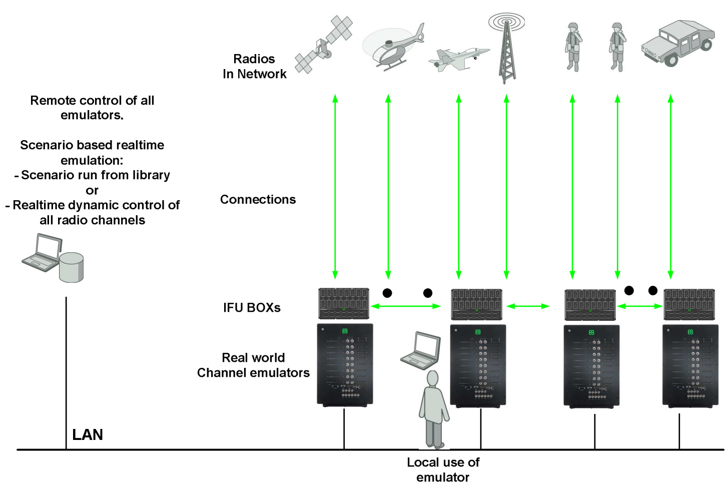

Figure 7. Example on MANET test setup in laboratory conditions – Hardware-In-a-Loop testing.

The physical connection of radios to the emulation channels is done via interfacing unit(s) (IFU) provided by EB. Each emulator can be used locally or all emulators can be remote controlled with control scripts or by a software application that is running on an external PC over a LAN network.

Scenario runs can be based on a set of pre-defined emulation files that can be loaded from the user library. Alternatively the scenario runs can be based on the real-time dynamic control of the parameters of each emulation channel: e.g. attenuation, multipath properties, velocities etc., interference and noise levels can be controlled in real-time.

Channel model definition for the scenarios could be based on field measured data (GPS data, loggers, scanners, test receivers, channel sounders) if available or on pure synthetic or standard channel models or profiles.

There are multiple 3rd party tools that can be utilized in the definition of the scenarios and the channel model library. As an example most ray tracing simulation software or application specific scenario planning tools can be utilized in the definition of the scenario data for the real-world radio channel emulation.

Brief summary of other testing capabilities for aerospace, defense and military

EB Propsim emulators support **MIMO transceiver testing.** The MIMO technology can be used for improved performance, either as extended coverage or as higher data throughput. The actual MIMO gain is dependent on the propagation environment; therefore the ability to test against realistic environment models is essential. EB Propsim emulators support MIMO topologies from 2x2 up to 8x4 or even beyond that.

EB Propsim emulators support testing of **beam forming and anti-jamming techniques** in a realistic radio channel environment. One EB Propsim F8 supports the testing of up to 8 antenna elements. By cascading multiple units as a single radio channel emulator, a higher number of antenna elements can be supported (the number of antennas is not limited by the emulator hardware).

EB Propsim emulators support **Over-the-Air (OTA) testing in an anechoic chamber**. OTA testing is especially needed when the antenna installation of the radio should be included into the radio testing.

EB Propsim emulators can be used in **radar sensor testing** and in radar calibration. Static and dynamic test scenarios can be created – e.g. testing of a radar altimeter, radar ranging, creation of moving targets for radar, anti-jamming features, passive radar sensors etc.

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For further information please refer to EB Propsim product datasheets at: http://www.elektrobit.com/what_we_deliver/wireless_communications_tools or contact us by emailing rcpsales@elektrobit.com.