The most common way used to evaluate the effects of ECM systems is a test range that involves several ships or airplanes in an operational environment. This method is very expensive and most of the time real platforms are unavailable. On the other hand, using software simulation only, it is often not so clear the real effect of the ECM System Under Test on enemy Radars. In fact, only a “Hardware In the Loop” Simulation System can represent the reality with the appropriate reality. E-PRS open new perspectives to the Radar Simulation world for EW Systems evaluation and other technical and operative purposes.
Eldes Programmable Radar Simulator (E-PRS)

**Generals**
Since it is not possible in an Electronic Warfare Evaluation Test Range to assess the System Under Test (SUT) effects on real enemy radars, the only way to test the SUT is to use a "programmable radar simulator" capable to emulate them. This is done by the E-PRS using a real radar digital receiver, waveform generator and programmable signal and data processor. This method, unlike the SW simulation approach, takes in proper account the response and limitations of a real HW processing including non-linearity, distortion, saturation, etc. This approach is commonly defined as "Hardware in the Loop" (HWIL) simulation system. Moreover with this method it is possible to "play-back" the same simulation and analyze the data collected for making deep analysis on the jammer effectiveness or for training purposes.

The E-PRS can simulate ground based Radars, airborne and shipborne Radars, missile seekers (active and semi-active).

The supervisory control of the whole system and simulation, including also the Scenario Control is managed by a computer with adequate software and a physical interface which also provides the display and data analysis functionalities, as well as hosting the user programmed radar model data base.

Multiple SUTs can be tested at the same time with the proper HW and SW E-PRS configuration.

The E-PRS is also a valuable support for Radar System engineering to test the effectiveness of new radar and ECCM techniques.

E-PRS can be used both in a Laboratory environment and in an anechoic chamber or Open Air EW Test Range using different HW options.

**Operation principles**
The E-PRS TX pulse is generated by an arbitrary waveform generator; the waveform could be simple or complex to implement many types of pulse compression techniques (Chirp, Barker, etc.).

The SUT receives the pulses generated by the E-PRS, weighted by the simulated antenna pattern. Starting from this input, it generates the jammer signal (SPJ or SOJ) that, together with the target skin echo (from E-REG) is injected in the RF or IF input (according to the system architecture) of the E-PRS.

By means of the RX antenna simulator the receiving antenna weighting is applied and the signal goes to the digital receiver for the analog to digital and base-band conversions. The resulting signal is then processed through the user programmable matched filter that implements the proper filtering according to the actual TX waveform.

After the filtering, the signal samples are sent to an High Performance Computer (based on an array of Intel Xeon processors) that implement the desired radar signal and data processing according to the built-in or user generated algorithms library.

The receiver will react exactly as the one of a real radar (of the selected type) providing to the user all the data to evaluate the real effects of the SUT on Radar detection and tracking.

**System Architecture**
The E-PRS, see block diagram, is composed by the following functional blocks:
- Microwave receiver
- Digital receiver (4 or more channels)
- Microwave Transmitter
- Programmable Signal and Data Processors.
- Radar TX and RX Antenna Simulator
- RF/IF Target(s) / Chaff / Clutter Generator. (E-REG or others)
- Software Programming environment (Framework).
- Display and Data Collection/Analysis System

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![Diagram of EPRS](image-url)
Software Features

E-PRS Framework
An advanced programming mode to create radar models using a “friendly” high level graphic user interface called E-PRS Framework is available. With this tool the user can generate a radar model according to his needs, simply using the functional library provided with the system.

The other way to program a radar model is to write the algorithms using the C/C++ language. In this way the user can also extend the basic E-PRS library and then simulate all possible radars.

Using the framework, further to the platform and radar type, the operator can choose all the radar operational parameters like:
- Matched Filter: Barker, bi-phase and quad-phase, CHIRP.
- TX parameters (PRF, Pulse, Stagger, Jitter, MOP, CW, etc.)
- MTI-AMTI-MTD processing
- Target Glint
- SLB/SLC
- Doppler Channel
- PDI/CFAR, TWS, TAS
- Tracking Loops: Range, Angle, Velocity
- Ambiguity Resolver
- Antenna type and radiation pattern
- Pre-defined or User-defined ECCM Logics

The SW Framework which runs in the E-PRS host computer, has an open interface to add user defined radar model libraries. When a new library item is added it is then reusable like the standard ones.

DCA (Data Collection and Analysis)
This software tool, supplied with E-PRS, allows the user to collect all the main events during the simulation and retrieve the information on success/not success of the ECM generated by the SUT. The DCA records all the macro events (i.e. Tracking, track-lost, tracking errors, etc….) in addition to the scenario and target info.

All the simulation can be eventually played-back for training purposes using different display modes (PPI, A, B, C scope).
### Technical specifications of standard version (customized versions are available upon request):

#### Transmitter:
- **Frequency Range (4 channels):** 0.5 - 18 GHz (optionally 0.05-0.5 and 26-40 GHz bands are available)
- **Frequency Agility band (Operational Bandwidth):** ≤ 62.5 MHz (0.05-0.5 GHz); ≤ 125 MHz (0.5-2 GHz); ≤ 250 MHz (2-5 GHz); ≤ 500 MHz (5-8 GHz); ≤ 1 GHz (8-40 GHz) - pseudo random, linear, sinusoidal, user defined, groups.
- **Waveforms:** Not coded, Barker codes (all), Bi phase code modulation, Quad phase code modulation, Linear FM modulation Chirp, Continuous wave, Other arbitrary waveforms
- **Intra Pulse bandwidth:** ≥ 20 MHz (wider bandwidth available upon request)
- **Pulse Repetition Frequency (10 Hz – 1 MHz):** Fixed, Staggered (pulse to pulse), Group stagger, Jitter (pseudo random)
- **RF Output Power:** ≥ 0 dBm

#### Receiver:
- **Type:** Analog Front-end. Band: 0.5 - 18 GHz (optional 0.05-0.5 and 26-40 GHz bands); Four or Eight Channels Digital Receiver (options for more channels upon request) with 16 bits A/D Converter (> 120 MHz sampling frequency).
- **Range sampling:** 12.5 to 2000 m. (user programmable, optionally down to 6.25 m.)
- **Instantaneous Bandwidth / Dynamic Range:** ≥ 20 MHz (optionally higher bandwidth) / ≥ 90 dB (with IF AGC-STC on 1 MHz bandwidth)
- **Signal Processing and Data Processing:** Matched Filter using FPGA, Libraries with algorithms of typical Radar Processing techniques on multi-processor multi core server PC. Scalable Computational power starting from 450 GFlops

#### Antenna:
- **Simulated Antenna types:** Monopulse: SUM, Delta Az, Delta El, Omni. Electronic scan, Frequency scan, LORO scan, Sector scan, Raster scan, Circular scan, Helical scan, Conical scan, Spiral scan. Single or Stacked Beams
- **User Defined Antenna Pattern:** Main-lobe & Sidelobes 0.5 – 10 deg. beamwidth (angular Resolution 0.088 deg.)

#### Radar Display:
- **Display modes:** Plan Position Indicator – PPI, A – Scope, B – Scope, C – Scope (dual trace mode available)

#### Radar Standard Library:
- **Signal and Data processing techniques:**
  - TX Pulse Width and Type (not coded, Barker, bi-phase, quad-phase, linear FM);
  - TX Pulse Repetition Interval and type (fixed, group of stagger, jitter);
  - TX frequency and type (fixed, group of fixed, random, agile);
  - MTI/AMTI of first, second and third order;
  - Doppler channel for PD radar; Doppler channel for MTD (clutter map);
  - CFAR (cell average, log-CFAR, order statistic CFAR, bi-dimensional CFAR);
  - Ambiguity resolver (Doppler or Range) for PD radar;
  - Angle, Range and Doppler Tracking Loops; Leading Edge Range Tracking; Track While Scan
- **Radar Types:** Search, Track, Seeker, Multifunctional, Airborne, FCR

#### Generals:
- **Control e communications:** FAST Ethernet (GB) on optic fibers and Reflective Memories
- **PC Workstation:** MS- Windows Xeon multi core
- **Number of simultaneous Systems Under Test:** 1 or more according to the HW configuration
- **Number of simultaneous Antenna Beams:** 1 or multiple according to the HW configuration
- **Width/Height/Depth (typical E-PRS + E-REG):** 2 cabinets, each: 830 mm / 1000 mm / h 1910 mm (Note: dimensions subject to change)

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