SAAB

RUSK™

MULTIDIMENSIONAL CHANNEL SOUNDER

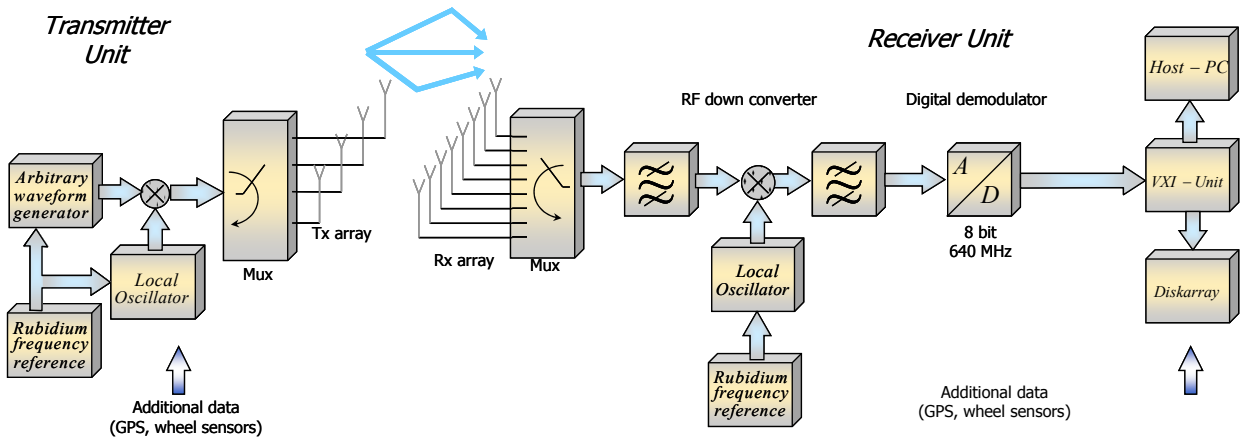
RUSK MIMO CHANNEL SOUNDER

RUSK MIMO is a real-time radio channel impulse response measurement system for multiple transmit and receive antenna element configurations. It is complemented by various antenna array architectures and software packages that meet all needs of research and development of wireless communication systems.

Highlights:

- Modular and flexible measurement setup
- 240 MHz measurement bandwidth
- Up to 1h continuous real-time storage
- Full programmable transmit signal
- Multiband and multiple sounder operation
- Switched MIMO antenna access
- High resolution antenna arrays
- Powerful post processing tools

Receiver Unit and Transmitter Unit
VXI design mounted in rugged portable 19“ racks



Block Diagram and Technical Data

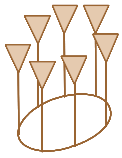
- 65536 antenna channels freely configurable for RX- and TX-multiplexing
- RF bands (e.g.):WLAN (5..6 GHz),UMTS (1.8..2.5 GHz)
- 640 MHz maximum sampling frequency
- Up to 240 MHz bandwidth
- 1 W / 2 W / 5 W / 10 W TX power (e.g.)
- Up to102.4 µs impulse response length
- Navigation data and optionally video data recording at TX and RX
- Remote operation by (W)LAN
- Optional feedback channel from RX to TX for test signal adaptation

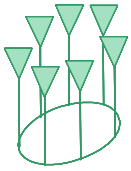
RUSK CHANNEL SOUNDING APPLICATION AREAS

Profound knowledge of radio propagation is a key for successful wireless system design. With the RUSK MIMO channel sounder you are capable to measure the radio channel characteristics in your potential system deployment environments.

- Design, optimization, and performance evaluation of B3G air interfaces
- Smart antenna systems
- Antenna and polarization diversity
- Design of multiple-input multiple-output (MIMO) transceivers
- Parametric channel modelling including TDOA, Doppler, DOA and DOD
- Realistic MIMO link-level simulation based on measurements

Mobile Terminal (MT) Antenna Arrav





Access Point (AP) Antenna Array

MIMO WLAN for industrial applications

SAAB MEDAV TECHNOLOGIES CHANNEL SOUNDING SOLUTIONS

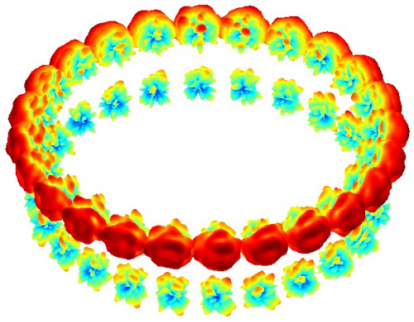
- **RUSK MIMO** customization
- High resolution antenna arrays incl. calibration and parameter estimation software
- RUSK rental service
- Measurement service
- MIMO measurement data in relevant 4G deployment scenarios (indoor and outdoor)
- MATSYS – RUSK data analysis software
- Database oriented statistical analysis software
- Software for supporting measurement based channel simulation and emulation

HIGH RESOLUTION MULTIPATH PARAMETER ESTIMATION

Advanced channel modelling approaches for multi-antenna system designs are based on geometrically distributed scatterers for the characterization of the multipath propagation. Design, verification and parameterization of geometrical channel models for real field scenarios are possible by RUSK measurements and the respective parameter estimation.

Saab Medav Technologies provides:

- Highly optimized MATLAB software for multidimensional path parameter estimation by the **RIMAX** algorithm
- Interactive MATLAB software for result visualization
- Antenna arrays optimized for high directional resolution
- Pre-processed antenna reference data measured in an anechoic chamber



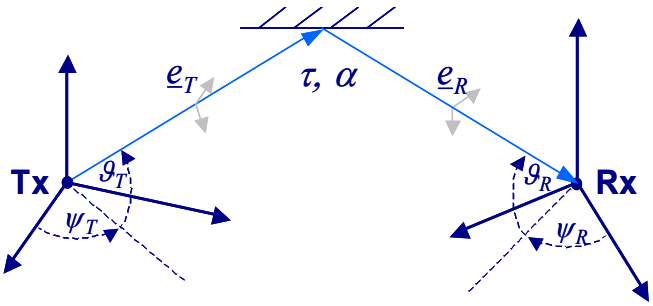
Measured 2D antenna patterns for V and H polarizations

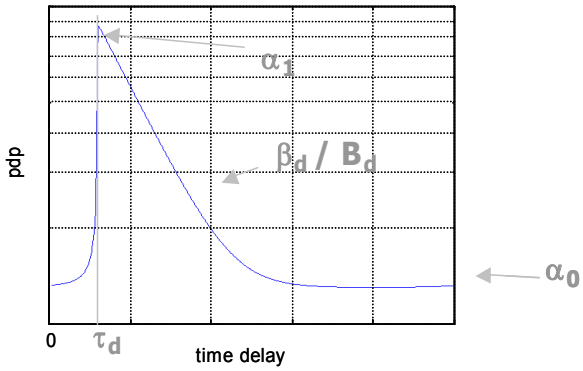
RIMAX ALGORITHM

The RIMAX algorithm is an iterative maximum likelihood parameter estimation framework which is based on expectation maximization and on gradient based nonlinear least squares (Gauss-Newton/ Levenberg-Marquardt). The estimation results are the deterministic multidimensional parameters of the specular propagation paths as well as the parameters of a simplified model for the diffuse scattered (dense) multipath components. The estimator features robust adaptive model order control, high resolution performance of closely spaced coherent propagation paths in all dimensions and provides reliability information of the estimated parameters.

Parametric Channel Model with:

Multidimensional Specular Components & **Dense Multipath Components**





Parameters:

Doppler shift, delay, Rx azimuth and elevation, Tx azimuth and elevation, and the complex polarization-resolved path weights (number of directional dimensions and polarizations is antenna dependent)

Parameters:

Base delay $_d$, normalized coherence bandwidth $_d$, maximum power $_1$ and noise level

HIGH RESOLUTION ANTENNA ARRAYS

Depending on the geometrical dimensions to be resolved, the desired resolution, and the need for polarization information a large variety of antenna array solutions can be provided. The antenna arrays are optimized to achieve best performance for the direction estimation. All arrays are measured in an anechoic chamber to collect the appropriate antenna calibration reference data.

64 URA
Uniform rectangular array

8x CUBA
Circular uniform beam array

24x2 PUCPA
Dual polarized uniform circular patch array

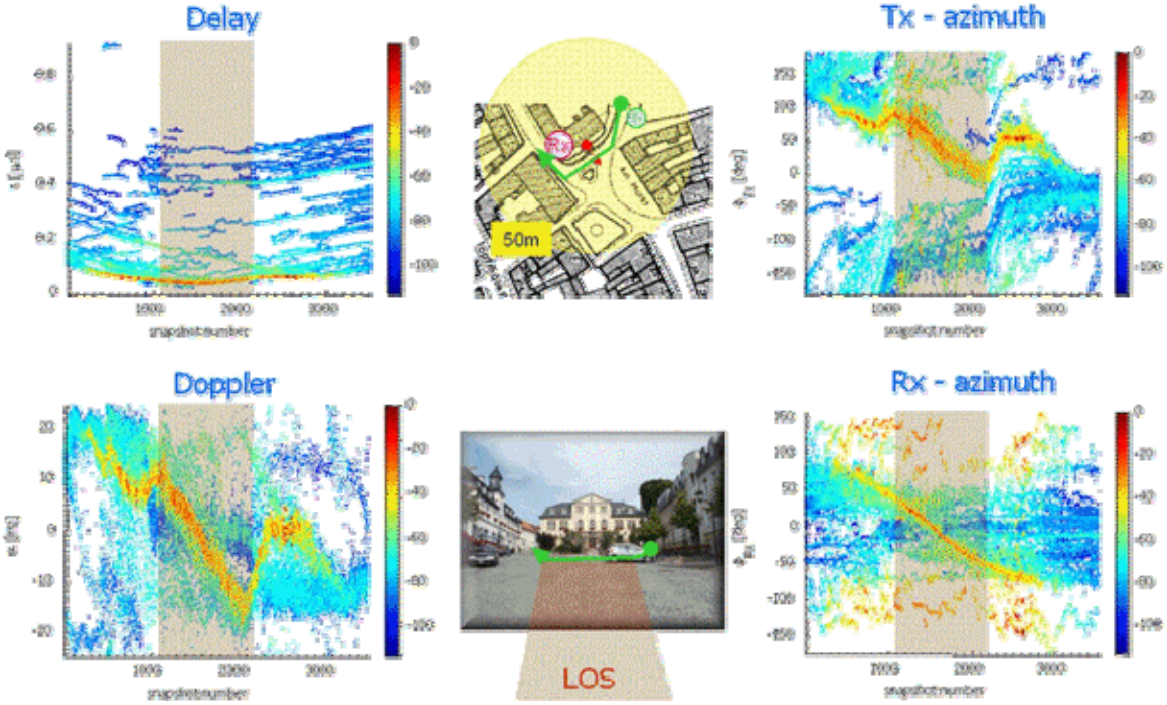
4x24x2 SPUCPA
Stacked polarimetric uniform circular patch array

32 UCA
Uniform circular array

8x2 PULA
Dual polarized uniform linear patch array

RIMAX ESTIMATION RESULTS

The figure presents RIMAX parameter estimation results along a measurement route in a public access scenario. Each estimated multipath component is represented by a dot in the four jointly estimated parameter dimensions, with the colour indicating the path's magnitude.



MEASUREMENT DATA AND SERVICE

Saab Medav Technologies offers measurement data for exclusive measurement scenarios. This includes a measurement documentation and basic characterization of the measurement data. For custom specific scenarios Saab Medav Technologies offers measurement service according to the customer's conception. The measurement campaign is defined, prepared and carried out jointly with the customer.

4 x 8 MIMO measurements for largely varied antenna spacing at a motorway bridge

MATSYS

MATSYS is a MATLAB® based software package for offline analysis of RUSK measurement data. MATSYS offers an easy to use graphical user interface as well as a MATLAB command line interface for all analysis functions.

Examples of analysis capabilities:

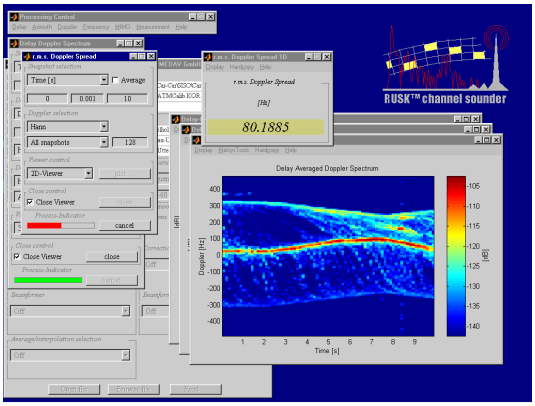
Rx power, delay window, SNR, dynamic

Doppler, Doppler spread, coherence time

Delay spread, coherence bandwidth

Azimuth, azimuth spread, Eigen-values

Joint delay-Doppler/azimuth spectra



Options:

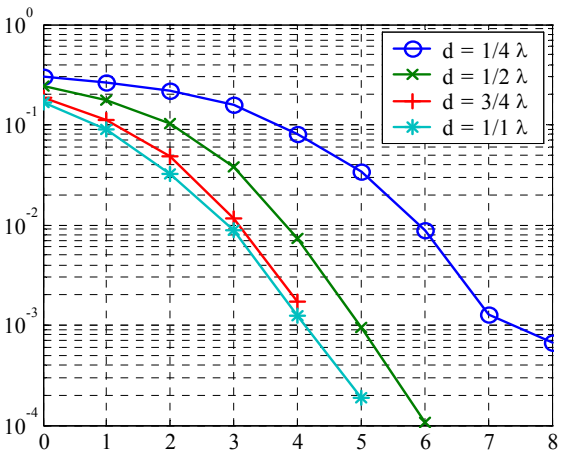
MATSYS Parallel Processing. This option provides dynamic configuration of various MATLAB computers within a heterogeneous network structure for enhanced processing speed.

Super resolution Parameter Estimation

Multidimensional ESPRIT algorithm for joint estimation of the channel parameters: time delay, Doppler, direction of arrival (DoA), direction of departure (DoD) for specific antenna array configurations.

MEASUREMENT BASED MIMO CHANNEL SIMULATION

RUSK MIMO channel sounder data can be used for realistic simulations of wireless transceiver designs. Real field performance can be verified in an early development stage. In this way a bridge can be built between theoretical simulations and field trials. The risks and the expenditure of prototyping can be reduced.



Bit error rate versus antenna element distance

- Link level simulations employ a simulation model of the transmitter as well as the receiver processing. The channel model itself is fed by measured propagation data.
- System level simulations rely on statistical propagation parameters for a specific radio network design that can be distilled from channel sounder measurements.
- Saab Medav Technologies provides suitable measurement data, software solutions for the data handling and simulation expertise.

SAAB MEDAV TECHNOLOGIES CONTRIBUTION TO THE WIGWAM PROJECT

WIGWAM

www.wigwam-project.com

WIGWAM – Wireless Gigabit With Advanced Multimedia Support – is a recent German research project of 10 partners targeted to develop a system concept to achieve 1 GBit/s overall throughput in a bandwidth of 100 MHz within the 5 GHz band, making the use of MIMO technology mandatory. Dedicated measurement campaigns using RUSK MIMO are carried out. Sophisticated data analysis results provide a solid base for the channel models of the WIGWAM system.

WIGWAM measurement campaign at Munich main station jointly with Siemens Communications

Research radio propagation

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FG Elektronische Messtechnik
Helmholtzplatz 2
98684 Ilmenau, GERMANY

http://www.tu-ilmenau.de/it-emt/

RF components

KMDC Dresden
Zur Bleiche 15
01279 Dresden, GERMANY

http://www.kmdc.de

High speed AD/DA conversion

WMT-Elektronik GmbH
Werksstraße 15
45527 Hattingen, GERMANY

http://www.wmt-elektronik.de

Antenna design

IRK – Dresden
Bismarckstr. 56
01257 Dresden, GERMANY

http://www.irk-dresden.de

Saab Medav Technologies is the overall system provider for RUSK channel sounders. Competent cooperation partners contribute their expertise to complete highly sophisticated measurement technique.

www.channelsounder.de

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