

Case Study Competition 2011

Keep pace with the future.
The future of radiomonitoring is in
your hands.

Kickoff: Topic introduction

Content

Rohde & Schwarz

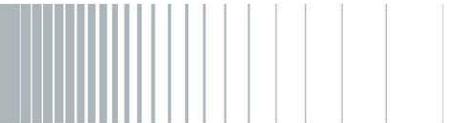
- | Introduction to Rohde & Schwarz in general
- | Introduction to the Radiomonitoring and Radiolocation Division

Our customers and their requirements

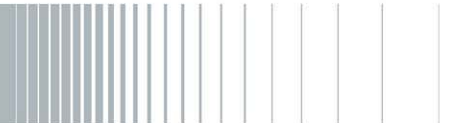
- | Customer group
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- | Radiomonitoring challenges
- | Radio methods
- | HF modems and their significance

Case study competition

- | Scenario
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- | Prerequisites
- | Sample exercises and practical tips



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Rohde & Schwarz Divisions

Test and Measurement



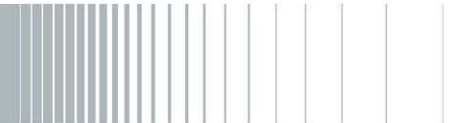
Secure Communications



Broadcasting



Radiomonitoring and Radiolocation



Radiomonitoring and radiolocation

Receivers



Radiomonitoring and radiolocation

Direction finders



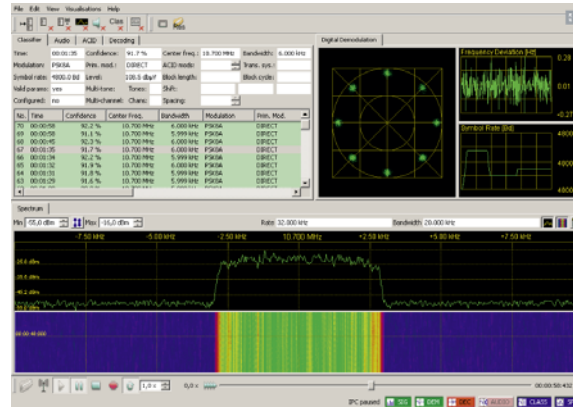
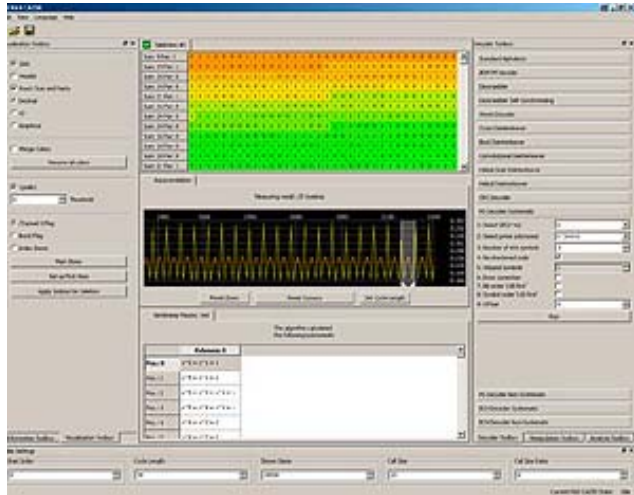
Radiomonitoring and radiolocation

Antennas



Radiomonitoring and radiolocation

Software and systems for signal analysis and signal monitoring



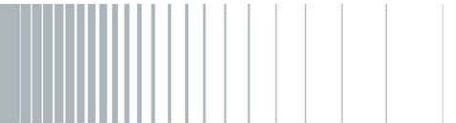
Our customers and their requirements

Who are the customers in the field of radiomonitoring and radiolocation?

- | Regulatory authorities
- | Police authorities
- | The military

What are our customers' objectives?

- | Compliance with specified frequency ranges and permissible bandwidths
- | Classification of utilized devices and methods
- | Tactical and strategic intelligence



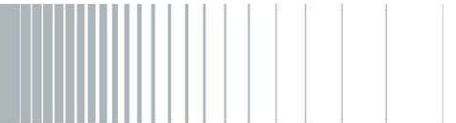
Our customers and their requirements

What HF radio methods and systems are of special interest to our customers?

- | Teletypewriters (Baudot, Sitor, ...)
- | Imaging systems (HF fax, SSTV, ...)
- | HF modems (Codan, Pactor, ...)

What is the significance of HF modems today?

- | Radio data transmission over large distances
- | Secure transmission even under poor conditions
- | High data throughput for complex services and applications
- | Worldwide usage, both in civil applications (radio amateurs, skippers,...) and in governmental areas (embassies, military facilities,...)



Our customers and their requirements

What radiomonitoring challenges do our customers face?

I Blind reception of radio transmissions

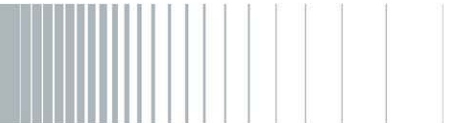
- Location-dependent problems (obstacles, etc.)
- Little previous knowledge of the radio systems and methods to be monitored
- Problems with automatic repeat requests (ARQ) and other bidirectional processes (since it may only be possible to receive in one direction)

I Channel coding

- Analysis varies in complexity depending on the cascading/process

I Encryption

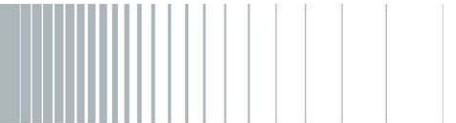
- Today's systems often use encrypted transmission, but keys or type of encryption are unknown



Case study competition

Scenario

- I You are a development engineer in the field of radiomonitoring and radiolocation
- I Your task is to develop a competitive HF modem and a concept for monitoring the operation of this class of modems
- I You will create an overview of the currently available data transmission methods and corresponding HF modems, and analyze the system parameters of these devices
- I You will present your results to the customer and convince them that your modem and operation monitoring concept meet their requirements



Case study competition

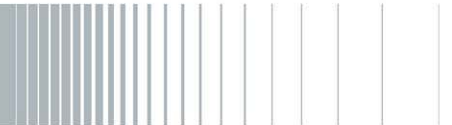
Summary of main points

- I Product analysis and comparison (devices will be specified)

- I Design of a competitive HF modem
 - Multichannel methods
 - Digital modulation modes
 - Interleaving
 - Channel coding

- I Operation monitoring concept
 - Technical parameters
 - Content recovery

- I Presentation of results



Case study competition

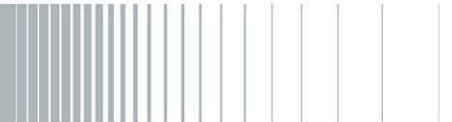
Prerequisites

I Hard skills

- Good general technical education/background
- Basic knowledge of system theory
- Basic knowledge of digital signal processing
- Basic knowledge of linear algebra
- In-depth knowledge of telecommunications theory

I Soft skills

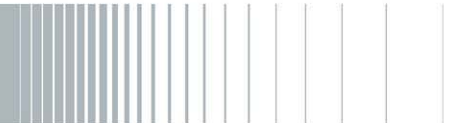
- Structured approach to work
- Creativity
- Solid team player
- Professional presence and ability to convince



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Sample exercises (theory basics)

- | Why do state-of-the-art HF modems often use multiple channels to transmit data? *(1 point)*
- | Possible answer: To increase the data rate.
- | Why is it not possible to pack the channels very closely together? *(4 points)*
- | Possible answer: Each individual channel has a certain bandwidth that depends on the modulation mode and the symbol rate. If channels are packed too closely together, the interchannel interference (ICI) increases drastically and the demodulation error rate rises.
- | How can ICI be counteracted in order to still achieve relatively high spectral efficiency? *(2 points)*
- | Possible answer: By pulse shaping/prefiltering the individual channel or by using OFDM.



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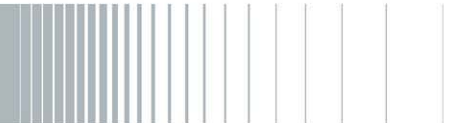
Sample exercises (practical)

I Let's take a look at a 7-channel transmission system with PSK8 modulation and a symbol rate of 75 baud per channel. (2 + 4 + 2 points)

- Calculate the system's maximum data transmission rate in bit/s.
- A Reed-Solomon code is to be used. Narrowband interference causes one of the 7 channels to fail. Determine a possible set of parameters for the RS code that will ensure error-free transmission even though one of the channels has failed.
- How should the RS code words be transmitted in this 7-channel system?

I Possible solution approach

- PSK8: 3 bit/symbol \Rightarrow 3 bit/symbol * 75 symbol/s * 7 = 1.575 kbit/s
- (n,k,f) RS code sought: $GF(2^3) \Rightarrow$ code word length $n = 7$ symbols
correction capability $f = (n-k)-1 \Rightarrow$ information length = 5 symbols
 \Rightarrow redundancy length = 2 symbols
- Each channel should transmit exactly one code symbol of a code word per timeslot. If a channel is impaired at a point in time t , then the other 6 unimpaired channels will ensure complete error correction.



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Concluding tips on solving the exercises

- | Any necessary documentation and resources will be provided in a suitable form
- | The goal is not to perform complex mathematical calculations, even though they are important
- | The goal is to demonstrate that you understand the many facets of radiocommunications and how they interact, and that you can develop viable solution approaches

