

2004 International Symposium on Signals, Systems, and Electronics (ISSSE'04)

Johannes Kepler University Linz, Austria
August 10-13 2004



Johannes Kepler University



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Welcome to ISSSE'04

We warmly welcome you to the International Symposium on Signals, Systems and Electronics '04 (ISSSE'04), which aims at bringing together researchers from the areas of signals, systems, and electronic devices and circuits. The ISSSE is an international symposium held once every three years and is sponsored mainly by the International Union of Radio Science (URSI) Commissions C and D. Historically, Commission C represented signal-, system-, and software-oriented technology, while Commission D represented device- and hardware-oriented technology. In recent years, however, a strong cooperation between these areas has become increasingly important. We are sure, that the ISSSE'04 will be a great opportunity for showing latest research both from within each area as well as from interdisciplinary work, thus giving the participants the possibility to share their views with colleagues from around the world. The tutorials, invited plenary sessions in the mornings, poster presentations and three sets of parallel sessions will give you plenty of opportunities to discuss current and future research work.

We greatly appreciate the enthusiastic team effort of our Organizing Committee. We would also like to thank all the authors for their contributions making possible a strong and vibrant symposium. Enjoy every minute of ISSSE'04 and Linz!

Kurt Schlacher & Robert Weigel
Co-Chairmen

Gernot Kubin & Andreas Springer
Program Co-Chairmen

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University of Linz, Austria



Professor Dr. Robert Weigel,
University of Erlangen-Nuermberg, Germany

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- Ke Wu, Ecole Polytechnique de Montreal, Canada
- B. Zagar, University of Linz, Austria
- J. Zehenter, University of Prague, Czech Republic

ISSSE'04 SCHEDULE

Tuesday August 10, 2004

13:00-18:00 Room: K009D	Registration
14:00-18:00	Tutorial 4 <i>Ch. Kuhnert, Ch. Waldschmidt, W. Wiesbeck</i> Smart Antennas and MIMO
18:15	Welcome Reception

Wednesday August 11, 2004

08:00-16:00 Room: K009D	Registration			
08:45-09:00	Opening Remarks			
09:00-10:00	Plenary Talk: "Cross Layer Design - An Equivalence Class Approach", <i>M. T. Ivrlac, J. A. Nossek</i>			
10:00-10:20	Break			
10:20-12:20 Morning Sessions	Session 1 Modulation & Equalization	Session 2 Optical Devices and Link Analysis	Session 3 Circuit Modeling and Design	
12:20-13:30	Lunch break			
13:30-15:30 Afternoon Sessions	Session 4 Multi Carrier and CDMA Systems	Session 5 Optical Receivers	Session 6 Special Session on Solar Power Satellite Systems with Device and Circuit Aspects	Poster Session
15:30-16:00	Break			
16:00-18:00 Afternoon Sessions	Session 7 Advanced Communication Systems	Session 8 Power Amplifiers	Session 9 SAW Sensors & Devices	
18:15	Banquet			

Thursday August 12, 2004

08:00-12:00 Room: K009D	Registration		
09:00-10:00	Plenary Talk: "On the Role of Software Defined Radio in Advanced Spectrum Management", <i>F. Jondral, T.A. Weiss</i>		
10:00-10:20	Break		
10:20-12:20 Morning Sessions	Session 10 Wireless Networks	Session 11 Integrated Mixers	Session 12 Signal Processing and Smart Antennas
12:20-13:30	Lunch break		
13:30-15:30 Afternoon Sessions	Session 13 Embedded Systems Design	Session 14 Frontend Modules and Integrated Antennas	Session 15 A/D & D/A-Converters
15:30-16:00	Break		
16:00-18:00 Afternoon Sessions	Session 16 Hardware/Software Co-Design	Session 17 System Analysis & Design	Session 18 Antenna Systems

Friday August 13, 2004

Post Conference Tours to Vienna or Salzburg

Tuesday, August 10 2004

Tutorial

14:00 - 18:00 *Tutorial 4*
Room: K034D

Smart Antennas and MIMO

Ch. Kuhnert, Ch. Waldschmidt, W. Wiesbeck

Presently, communication systems do not properly exploit the spatial component of the mobile radio channel. Mobile communication systems radiate and receive either with no antenna gain or low gain. The propagation channels especially in urban and indoor areas exhibit a rich multipath propagation. Two major problems in this environment occur. Present day mobile communication systems either use only a very small portion of the radiated energy. Second, they are interfered by signals from other systems or communication links.

The solution to these problems is simple: collection of all available energy from the selected transmitter and elimination of any interference from others. The system solution to this problem is Smart Antennas and MIMO. The term Smart Antennas means antennas that are able to form RF beams in order to focus on the selected communication channel and to blind out interference. MIMO systems (multiple input, multiple output systems) aim at the simultaneous usage of beamforming and multiplex transmission of several signals and at the same time at suppressing interference. The tutorial starts with a demonstration of the problem area and an overview of possible solutions. Based on this, several dedicated Smart Antenna system configurations are detailed. SDMA (Space Division Multiple Access) is addressed as well. In the same way MIMO system configurations of major interest are explained. The advantages and disadvantages of special structures and the required system characteristics for example channel state information (CSI) are discussed. The tutorial closes with a recommendation for MIMO system concepts, that can be integrated into small hand-held devices.

Wednesday, August 11 2004

Plenary Talk

9:00 - 10:00 **Cross Layer Design - An Equivalence Class Approach**
Room: HS 7 *M. T. Ivrlac, J. A. Nossek*

A cross layer design method is presented which is built upon the idea of equivalence classes of key-parameters of several layers in the protocol stack of a communication system. An equivalence class is composed of all key-parameter tuples which fulfill a desired quality of a given service. Since different parameter tuples are usually associated with different costs (e.g. transmit power), a cross-layer design can select the most cost-efficient parameter tuple. In order to keep both inter-layer information exchange and computational complexity low, the key-parameters are divided into so called operating-points and operating-modes. The optimization with respect to operating-modes is independent of service and quality of service and allows for pre-computations. Only the optimization with respect to the operating points takes service and quality into account. packet-size, interleaver-length, buffer-size, air-time, SDMAgrouping, type of packet scheduling and its parameters, application-specific parameters (e.g. source data rate for a streaming media application).

Session 1: Modulation & Equalization

Chair: H. Witschnig

10:20 - 10:50 **Virtual Subcarrier Assignment (VISA) for Spatial Filtering of OFDM Signals**
Room: HS 5 *Y. Jia, S. Hara*

We have proposed a novel spatial filtering technique named "Virtual Subcarrier Assignment (VISA)" for OFDM signals, which colours OFDM signals with different virtual subcarrier positions in the spectrum to enable adaptive array antenna at the receiver to accept the OFDM signals selectively. In this paper, following the brief introduction on the principle of VISA, we present its application to an IEEE802.11abased system, where we propose a weight control algorithm and a channel estimation algorithm to support VISA without changing the signal burst format of IEEE802.11a standard. We investigate the effect of angle spread and that of antenna element spacing on the performance of the proposed system employing VISA. Furthermore, we evaluate the system performance by computer simulation using a realistic spatiotemporal indoor channel model.

10:50 - 11:20 **Error Performance of an Energy Sequence Estimation Receiver for M-ary FSK on Frequency Selective Fading Channels**
Room: HS 5 *K. Nakano, Y. Iwanami, E. Okamoto, P. H. Wittke*

This paper proposes a novel sequence estimation scheme of M-ary FSK signals with noncoherent energy detectors under static multipath fading channels. A new metric criterion for MFSK with energy detection has been given in order to extend as well as improve the results in [3], [4] where only 2FSK is available.

11:20 - 11:50 **Frequency Domain Equalization of Low PAPR Linear Modulation Schemes**
Room: HS 5 *M. Huemer*

Single carrier transmission with frequency domain equalization (SC/FDE) is a promising technology for broadband transmission over ISI (Intersymbol Interference) channels. In this paper we investigate the low PAPR (Peak to Average Power Ratio) linear modulation schemes OQPSK (Offset QPSK) and $\pi/4$ -DQPSK (Differential QPSK) in combination with SC/FDE. We discuss options how the baseband signal processing of QAM-SC/FDE may be adapted to meet the requirements of these two modulation schemes. Finally we present performance results and comparisons with QPSKSC/FDE transmission, considering the implementation loss due to channel estimation and due to carrier frequency offset tracking procedures.

11:50 - 12:20 **CDMA Concepts for a Single Carrier System with Frequency Domain Equalization**
Room: HS 5 *H. Witschnig, R. Stuhlberger, A. Springer*

In this work we investigate the possibilities of combining Code Division Multiple Access techniques (CDMA) with a Single Carrier System with Frequency Domain Equalization (SC/FDE), as future transmission concepts will also be judged by their possibilities to be combined with concepts of multiple access techniques. In particular it will be pointed out in this work that the main elements of a classical CDMA receiver (despreading and Rake-receiver) may be implemented in frequency domain advantageously – allowing a low complexity, efficient, and powerful receiver structure in the frequency domain. Besides that the necessary extension by efficient equalization strategies will be demonstrated for the case of multipath propagation and in particular for multiuser detection.

Session 2: Optical Devices and Link Analysis

Chair: K. Schneider

10:20 - 10:50 **Spatially Unsteady Optical Wireless Link**
Room: HS 6 *O. Wilfert, Z. Kolka*

Optical wireless links (OWL) have found many applications due to their specific properties. One of interesting applications is a 10Mb/s optical link connecting train wagons. The link design has to take into account instability of mutual position and orientation of transmitter and receiver. The paper deals with analysis of extreme deviations, design, and modelling of transmitting and receiving optical systems for the *Infotrain* project.

10:50 - 11:20 **Adaptive Electronic Equalization for Multigigabit Optical Communication Systems**
Room: HS 6 *P. P. Monteiro, L. M. R. Teixeira, M. Violas, R. Ribeiro, A. Teixeira, J. F. da Rocha*

This paper describes the use of electrical transversal filters as chromatic dispersion compensators in partially compensated light-wave systems for 10Gbit/s and 40Gbit/s transmission rates. A particular case of a five-tap transversal filter is considered, and its performance evaluated based on the quality factor of the signal at the receiver.

11:20 - 11:50 **Optical Narrow-Band Amplifier Without Resonances**
Room: HS 6 *G. Wolf, U. Barabas*

In contrast to conventional wide-band semiconductor optical amplifiers (SOA), a novel architecture of a narrow-band SOA is presented. The effect of filtering is not based on resonances like used in DFB structures, but is achieved by interferences of different wave paths. A pair of gratings with slanted grating lines is used. The calculated results of an amplifier with 5000 grating lines are shown. The amplifier can be used in WDM/DWDM systems with channel distances down to 0.2nm for selecting one channel and amplifying its signals simultaneously.

Session 3: Circuit Modeling and Design

Chair: T. Itoh, E. Schmidhammer

10:20 - 10:50 **The Ultra Wideband Transfer Function Representation of Complex Three-Dimensional Electromagnetic Structures**
Room: HS 7 *Y. Kuznetsov, A. Baev, F. Coccetti, P. Russer*

The network-oriented ultra wideband transfer function representation of complex three-dimensional electromagnetic structures is investigated. The transfer function is consisting of two parts: entire function and rational or pole function. The system identification approach in time-domain by using Pencil-of-Function method is presented and the criterion of choice the order of this method is introduced. The presented method may yields considerable reduction of the computational effort and generates compact models of electromagnetic systems.

10:50 - 11:20 **Lumped Skin-Effect Model for Interconnects**
Room: HS 7 *A. E. Engin, W. Mathis, W. John, G. Sommer*

In this paper, internal impedance of arbitrary conductors is approximated with a non-rational function, which provides a good accuracy even near the skin-effect transition region for the resistance and internal inductance. Lumped models, which can be used in generic SPICE circuit solvers, are presented based on the realizations of this non-rational impedance.

11:20 - 11:50 **Wideband Suppression of Spurious Responses Realized by Microstrip Resonators Loaded with Dielectric Rods**
Room: HS 7 *R. K. Pokharel, K. Wada, O. Hashimoto, T. Takahashi*

A new type of microstrip resonator which is loaded with dielectric rods between a resonator strip and the ground plane, is proposed. Dielectric rods to be inserted have higher relative permittivity than that of the substrate, and this can be realized by Low Temperature Cofired Ceramics (LTCC) technique. Analysis shows that spurious responses have been completely suppressed or partially controlled in the frequency range of interest, and on the other hand, reduction in resonator's length has been achieved about 60% compared to a basic $\lambda/2$ microstrip resonator.

11:50 - 12:20 **A Complete Substrate Integration of Waveguide Diplexer and Antenna for Low-Cost Millimeter-Wave Module**
Room: HS 7 *D. Deslandes, K. Wu*

The complete integration of an antenna and a diplexer is presented on the basis of the Substrate Integrated Circuits (SICs) concept. In this work, small-size dual-mode filters are used to provide good isolation with a small number of poles. A four-element linear slot array is designed and implemented to provide 120° radiation coverage. In the complete integrated diplexer circuit, return loss for the lower frequency filter is better than 13 dB while 18 dB is achieved for the higher frequency filter. The isolation is better than 22 dB. This module can be used as a first RF part of LMDS front-end transceiver.

Session 4: Multi Carrier & CDMA Systems

Chair: **M. Huemer**

13:30 - 14:00 **Transmission Characteristics and Optimization of Continuous Walsh Code in the diffCDMA System**
Room: HS 5 *W. Ke, K. Yin, M. Kishi*

The diffCDMA system with continuous Walsh code has been analyzed in detail from the frequency usage efficiency point in reference[1]. In this paper, we mainly discuss the coherent detection ability of the CDMA system with continuous Walsh code, which is not involved in reference[1], but it is very important for CDMA system because the multiple access interference may aggravate with the orthogonality of Walsh code descending, when the continuous Walsh code is adopted as spreading spectrum code. The relation between the coherent detection ability and transient duration ratio of smoothing function[1] shows the effect of continuous Walsh code in diffCDMA through simulations over such two-ray Rayleigh fading environment. We also select optimal parameter of the transient duration ratio through simulations to illustrate the system capability, where the bandwidth and coherent detection ability is considered as a whole.

14:00 - 14:30 **Performance of Multi-Carrier Spread-Spectrum Systems with Spatial Diversity and Pre-Equalization**
Room: HS 5

I. Cosovic, M. Schnell, A. Springer

In this contribution, the benefit of applying channel knowledge at the transmitter is investigated for multi-carrier spread-spectrum (MC-SS) systems. Two different MC-SS systems are observed, namely uplink multi-carrier code-division multiple-access (MCCDMA) and spread-spectrum multi-carrier multiple-access (SSMC-MA). The latter system is considered for both down- and uplink transmission. Pre-equalization as well as spatial diversity techniques based on transmit selection diversity and maximum ratio combining are evaluated as transmit diversity techniques which utilize channel knowledge at the transmitter. It is shown that the considered MC-SS systems can provide very promising performance with low hardware complexity.

14:30 – 15:00 **Field Experiments on Throughput Performance Above 100 Mbps in Forward Link for VSF-OFCDM Broadband Wireless Access**
Room: HS 5

H. Atarashi, Y. Kishiyama, N. Maeda, N. Miki, K. Higuchi, M. Sawahashi

This paper presents throughput performance over 100 Mbps based on field experiments using the implemented Variable Spreading Factor-Orthogonal Frequency and Code Division Multiplexing (VSF-OFCDM) transceiver with a 100-MHz bandwidth in an actual multipath fading channel. In the experiments, a van equipped with a mobile station (MS) is driven at the average speed of 30 km/h along four different measurement courses that are approximately 1500 m away at maximum from the base station (BS), which has the antenna height of approximately 50 m.

Field experimental results show that, by applying 16QAM data modulation and turbo coding with the coding rate of $R = 1/2$ to a shared data channel together with two-branch antenna diversity reception, the throughput over 100 Mbps is achieved when the average received signal-to-interference plus noise power ratio (SINR) is approximately 6.0 dB. Furthermore, the location probability for achieving over 100-Mbps throughput becomes approximately 60 to 90% in these measurement courses when the transmission power of the BS is 10W with a 120-degree sectored beam transmission.

15:00 - 15:30 **Enhanced Detection Through Signal Space Diversity for a Coded MC-CDMA System**
Room: HS 5

R. Raulefs, A. Dammann, S. Sand, S. Kaiser, G. Auer

Signal space diversity defines a multidimensional signal constellation. The spread data symbols in a CDMA based transmission system, also called data chips, define a multidimensional signal constellation. However, this multidimensional signal constellation is ambiguous. The ambiguity is avoided by applying rotated spreading. In this paper we investigate an MC-CDMA system with rotated spreading. The higher signal space diversity is exploited at the receiver by a multiuser detector. The possible gains at desired bit error rates depend on the minimum Hamming distance of the used channel code. The minimum Hamming distance of the chips rises by increasing the length of the spreading sequence. Furthermore, it is shown that the enhanced signal space diversity scheme does not increase the requirements on the analog-digital converter at the receiver.

Session 5: Optical Receivers

Chair: R. Weigel, G. Wolf

13:30 - 14:00 **An Alexander Half-Rate Phase Detector for 80 Gb/s**
Room: HS 6 *J. Sundermeyer, N. Michel, N. Weber, J. Sauerer*

A half-rate alexander phase detector for 80 Gb/s data signals was developed and produced in a 0.1 μm -HEMT technology with an f_t of 200 GHz. Measurements with reduced data rates indicate its functionality at 80 Gb/s. Challenges on clock and data distribution are discussed in detail. Special solutions for data input buffer and clock input buffer were developed to reduce the influence of the disadvantageous source followers. Measures to avoid voltage breakdown of the transistors are presented and are discussed concerning high speed.

14:00 - 14:30 **Low-Noise Transimpedance Amplifier for Optical Receiver in 120nm CMOS Technology**
Room: HS 6 *K. Schneider, H. Zimmermann*

A three-stage transimpedance amplifier (TIA) as preamplifier for optical receivers in passive optical networks (PON) designed in a digital 120nm CMOS technology with a supply voltage of 1.5V is presented. An external ternary pin photodiode with a responsivity of 0.85A/W and a capacitance of 1.2pF is used to detect the 1.3 μm light being used for upstream in PON. The open-loop gain of the transimpedance amplifier can be varied by a factor of 115 to enable various transimpedances for a wide input-current range without stability problems. Sensitivities of -31.3dBm at 622Mb/s and -28.6dBm at 1.25Gb/s with a bit error ratio (BER) of 10^{-10} and a pseudo random bit stream (PRBS) of $2^{31}-1$ are achieved. A wide dynamic optical input power range of more than 27dB can be processed.

14:30 - 15:00 **A High-Speed Optical Front-End with Integrated Photodiode in 90nm CMOS**
Room: HS 6 *C. Hermans, P. Leroux, M. Steyaert*

This work presents the integration of a high-speed photodiode with a transimpedance amplifier in a standard 90nm CMOS process. A fast diode response is obtained by using substrate contacts to eliminate the slowly diffusing carriers. For 850nm light, the front-end achieves a sensitivity of -10.4dBm at 400Mbit/s and a sensitivity of -8dBm at 500Mbit/s. The power consumption is only 9mW.

15:00 - 15:30 **Compensated Feedback Network for Highly Sensitive Optical Receivers**
Room: HS 6 *C. Seidl, J. Knorr, H. Zimmermann*

Amplifiers with high bandwidth and high sensitivities are required for digital versatile disk (DVD) applications. The presented single-stage transimpedance amplifier (TIA) is integrated together with a pin photodiode in a 0.6 μm BiCMOS process. The TIA achieves a transimpedance of 183.5k Ω and a bandwidth of 267MHz with a simple compensated feedback network. Compared to the same TIA with an ordinary polysilicon feedback resistor an improvement by a factor of 4 is observed for the bandwidth.

Session 6: Special Session on Solar Power Satellite Systems with Device and Circuit Aspects

Chair: T. Itoh

13:30 - 14:00
Room: HS 7 **Overview of Microwave Power Transmission Technologies and Space Solar Power System (SPS) - Part I**

H. Matsumoto

From 1980's, the microwave power transmission (MPT) and a space solar power system (SPS) studies are started in Japan. In early 80's, plasma physics as propagation of microwave from space to ground and development of rectenna was mainly studied in Japan. After 90's, some important innovation of the MPT occurred in Japan. New microwave tubes, active integrated antenna, rectennas are developed and applied for the SPS. SPS system studies are also being conducted in the light of the recognition of SPS significance by the Japanese government. The SPS will be a very important milestone for the sustainable world as a promising solution to the environmental and energy issues.

14:00 - 14:30
Room: HS 7 **Overview of Microwave Power Transmission Technologies and Space Solar Power System (SPS) - Part II**

H. Matsumoto

From 1980's, the microwave power transmission (MPT) and a space solar power system (SPS) studies are started in Japan. In early 80's, plasma physics as propagation of microwave from space to ground and development of rectenna was mainly studied in Japan. After 90's, some important innovation of the MPT occurred in Japan. New microwave tubes, active integrated antenna, rectennas are developed and applied for the SPS. SPS system studies are also being conducted in the light of the recognition of SPS significance by the Japanese government. The SPS will be a very important milestone for the sustainable world as a promising solution to the environmental and energy issues.

14:30 - 15:00
Room: HS 7 **Retrodirective Magnetron Array for SPS using Spread Spectrum Pilot Signal**

N. Shinohara, K. Hashimoto, H. Matsumoto

For satisfying both requirement of high efficiency and beam control for a space solar power system (SPS), we propose a phased array with a phase and amplitude controlled magnetron (PACM).

The PACM is developed with an injection locking technique and PLL feedback to an anode current for frequency/phase control and to an external coil current in order to control magnetic field for amplitude control. In Kyoto University, we also developed phased array with phase controlled magnetron with a retrodirective system with spread spectrum (SS) in order to detect a target. The retrodirective with the SS has possibility to use a single frequency SPS-MPT for both monochromatic power transmission and a carrier of the pilot signal.

15:00 - 15:30
Room: HS 7

Wide Bandgap Semiconductor Transistor Amplifiers for High Power Microwave Transmitters

R. J. Trew, G. L. Bilbro, W. W. Huang

The development of solar power satellites will require the development of compact RF transmitters that can generate high RF output power with high power-added efficiency. Amplifiers constructed using field-effect transistors fabricated from wide bandgap semiconductors, such as AlGaIn/GaN, are a very attractive approach. These devices have demonstrated the potential to develop RF output power an order of magnitude greater than can be obtained from devices fabricated from traditional materials such as Si and GaAs. RF output power density on the order of 30 W/mm of gate periphery has been reported from an AlGaIn/GaN HFET. This compares very favourably with the 1-2 W/mm of gate periphery available from GaAs power FET's. However, the AlGaIn/GaN HFET's currently are hindered by a series of physical effects that are limiting their development and utilization. The physical effects are associated with device structure and high operating voltages and currents at which these devices operate. The physical effects that limit RF performance are reviewed in this paper, and possible solutions surveyed.

Session 7: Advanced Communication Systems

Chair: **A. Wolf**

16:00 - 16:30
Room: HS 5

PSSS - Parallel Sequence Spread Spectrum Application in RF Communication

H. Schwetlick, A. Wolf

PSSS – Parallel sequence spread spectrum provides a physical layer for RF data communication. It is based on an overlap of cyclically shifted binary spreading sequences modulated with M-ary PAM, QAM and PSK. Coding, modulation and channel equalization can be integrated and allow a flexible tradeoff between data rate, energy efficiency and multipath fading resistance at a low electronic complexity. This paper describes the principles of the transmission procedure including the spreading, overlap and modulation. Some results are shown from AWGN-channels with different modulation procedures.

16:30 - 17:00
Room: HS 5

Efficient Near-Optimum Decoding of Space-Time Linear Dispersion Codes Using a Modified Sphere Decoder

H. Artes

We investigate a computationally efficient algorithm for near ML decoding of space-time *linear dispersion* (LD) codes. The problem of optimally decoding LD codes is usually more challenging than optimal detection for spatial multiplexing systems since the singular values of the equivalent real-valued channel occurring in the context of LD codes do not fade individually, but rather in groups. Our algorithm is based on a priori pruning (excluding) of branches from the search tree arising in the *sphere decoding* (SD) algorithm. The choice of the branches to be pruned relies on geometrical reasoning which is in turn based on a simplified channel model designed to capture the effect of this groupwise fading. The remaining search tree after pruning can be processed by the conventional SD algorithm with a strongly reduced complexity as against scanning the complete tree.

Simulation results show that despite the pruning near ML results can be obtained.

17:00 - 17:30 **A Sinusoidal Model using Adaptive Analysis Segmentation**
Room: HS 5 *K.-H. Kim, I.-H. Hwang, J.-H. Yoon*

The sinusoidal model has been applied to speech/audio signal coding, analysis/synthesis, modification, and various other fields. However, one drawback of this model is that the analysis segmentation length is generally fixed in analyzing the signal. As a result, optimal spectral resolution cannot be guaranteed to each sinusoidal component. In this paper, in order to overcome this drawback and to estimate the sinusoidal components more accurately, we propose a sinusoidal model using an adaptive analysis segmentation length. In the proposed scheme, the analysis segmentation length is varied based on the coarse and refined pitch characteristics. Experimental results have shown that the proposed model can achieve better performance than that of classical and filter bank sinusoidal model.

17:30 - 18:00 **Adaptive Ordered Layer Receiver in MIMO-MCCDMA Systems**
Room: HS 5 *W. Yin, C. C. Tsimenidis, B. S. Sharif*

In recent years, multiple-input-multiple-output (MIMO) systems have attracted increasingly research attention due to the performance gains obtained in high data rate transmissions and their robustness in mitigating inter-symbol interference (ISI). Vertical Bell Layered Space Time (VBLAST) is a technique which can improve the performance of a MIMO system dramatically. In this paper, the performance of a MIMO-VBLAST system employing Multi-Carrier Code Division Multiple Access (MCCDMA) is evaluated by means of simulations and compared with open and close-looped schemes of optimal and uniform power allocation. From the simulations it can be seen that closed-looped VBLAST schemes can achieve optimal performance, i.e. high data rate transmission and spectral efficiency, with reasonable computation complexity.

Session 8: Power Amplifiers

Chair: **A. Springer**

16:00 - 16:30 **Reconfigurable GaAs FET Dual-Mode Amplifier**
Room : HS 6 *Y. Chung, T. Itoh*

This paper presents a 2.12 GHz GaAs FET dual-mode amplifier, employing new 1:1/1:0 power routing schemes. The power router is realized by utilizing coupled-line couplers and mode control switches. It provides two different operating modes, two-way Wilkinson equal-split power divider or one-way signal path which directs all input power to one output port in a power divider case. By switching the operating mode, better overall efficiency and linearity performance of an amplifier has been achieved. The measured results of the implemented dual-mode amplifier were compared with those of an amplifier structure with the conventional Wilkinson power divider/combiner and a single-ended reference amplifier.

16:30 - 17:00 **Distortion in Supply Voltage Modulated CMOS RF Power Amplifiers**
Room : HS 6 *P. Reynaert, M. Steyaert*

This paper investigates the influence of low-pass envelope filtering in a linearized amplifier. The degradation of the Error Vector Magnitude versus envelope bandwidth is given. Furthermore, a digital solution to overcome most of the generated distortion is presented. The influence of AM-AM and AM-PM distortion is also described. For these nonlinearities, a comparison is made between two-tone intermodulation distortion and the Error Vector Magnitude.

17:00 - 17:30 **Simulation of Power Compression in GaAs and GaN MESFETs**
Room : HS 6 *K. Horio, Y. Kazami, D. Kasai*

Two-dimensional transient simulations of GaAs and GaN MESFETs are performed in which substrate traps or surface states are considered. Particularly, turn-on characteristics are simulated as a parameter of the on-state drain voltage. Quasi-pulsed I - V curves are derived from the turn-on characteristics. It is shown that the drain currents in the pulsed I - V curves are much lower than those for the steady (DC) state. It is concluded that both the substrate traps and surface states could be a cause of so-called power compression in GaAs and GaN MESFETs.

17:30 – 18:00 **Three-port Noise Analysis for the Investigation of Feedback on Two-port Noise Parameters**
Room : HS 6 *F. Chen, R. J. Weber*

A MOSFET is a three-port device not considering the body contact. In order to predict its two-port noise parameters with respect to a source-degeneration inductor, three-port approaches should be used. This paper utilizes a three-port noise matrix to model the noise behaviour of a MOSFET. An explicit formulation is given for its noise transformation from a three-port to a two-port circuit with source feedback and the result is verified with circuit simulations. This approach can be extended to a general case of an n -port-to-two-port noise transformation where n is greater than two for the investigation of feedback on two-port noise parameters.

Session 9: SAW Sensors and Devices

Chair: **A. Stelzer, C. Ruppel**

16:00 - 16:30 **Inductively Coupled Excitation and Reading of Crystal Resonators for Wireless Temperature Sensing**
Room: HS 7 *D. A. Eisele, L. M. Reindl*

Temperature sensing is widely-used in industrial instrumentation, but entirely passive wireless solutions are limited. As discussed in literature some possible solutions are SAW sensors or sensor technology based on bulk acoustic resonators and microwave signals. This paper illustrates a new approach for close-coupling systems using low frequency crystal resonators and inductively coupled coils. We discuss in detail the energy and signal transmission for the excitation and reading duty cycle and consider our system performance.

16:30 - 17:00 **S-FSCW-Radar Based High Resolution Temperature Measurement with SAW Sensors**
Room: HS 7 *S. Scheiblhofer, S. Schuster, A. Stelzer, R. Hauser*

In this paper, we present a system for wireless temperature measurement with surface acoustic wave (SAW)-based sensors. After a short overview of standard interrogation methods, a new switched FSCW (S-FSCW) approach is proposed to reduce the requirements on dynamic range of the used analog-to-digital converter. Signal processing methods for achieving high temperature resolution are illustrated and compared with respect to their performance when applied to the presented measurement system.

17:00 - 17:30
Room: HS 7

A Wireless SAW-Based ID System for Harsh Environment

R. Hauser, R. Fachberger, G. Bruckner, G. Knoll, R. Reicher, W. Smetana, G. Hofbauer, W. Randeu

A radio frequency identification (RFID) system operating in the ISM band at 2.45 GHz is presented. Much effort was placed in the development of a high temperature resistive transponder comprising of both a surface acoustic waves (SAW) device and a patch antenna stable up to 400 °C. For the reader unit the FMCW principle was employed. The developed system allows for tagging of objects exposed to harsh environments.

Poster

12:20 - 16:00
Hall D

Design, Simulation and Synthesis of 2D-DCT Algorithm for Image Compression VLSI Chip

Md. S. Islam, M. Othman, M. S. Beg

This paper describes the use of Electronic Design Automation (EDA) for implementing On-Chip 2D-Discrete Cosine Transform (DCT) image compression algorithm. The design flow starts from the system specification to implementation on silicon and the whole process is carried out using an advanced EDA tools for digital signal processing. The software allows a bit-true analysis to be performed at all level to ensure that the designed VLSI chip satisfies the required (Behavioral, RTL etc) specifications.

12:20 – 16:00
Hall D

Improvement of Blocking Probability of Channel Assignment in Microcellular Mobile Systems

W. Park, M. Bae, J. Ahn

The model proposed treats the CBR (Call Blocking Rate) of traffic model as a function of the cell load and the availability of a neighbor cell that is less loaded. The model assumes the basic process of soft handoff zone, wherein the subscriber is assigned to both the donor and recipient cell. The channel assignment to the recipient cell is assumed to take place in no time, upon crossing the soft handoff zone. The issues to be dealt with are:

1. The CBR of new calls that are generated within the soft handoff zone
2. The CBR for roaming calls
3. The priority of (2) over (1).

The proposed model assumes uniform density within each cell, uniform rate of birth and an average uniform speed, leading to an average uniform rate of crossing the boundary. The novelty proposed by the model is evaluated call arrival model between tow cells with non-uniform traffic load, as a means of analyzing the CBR.

12:20 - 16:00
Hall D

System-C Modeling of GSM/UMTS Baseband Architectures for Rapid Simulation of Multimedia Applications

A. Füreder, C. Tröbinger, E. Eidenberger, F. Eibensteiner, H. Dietl, M. Huemer, H. Heigl, H. Margiol, T. Lüftner

In consideration of increasing complexity in mobile phone baseband ICs, it becomes impossible to optimise the overall chip-architecture on the basis of estimations. To handle this situation, adequate tools are necessary, which allow the simulation, exploration, verification and optimisation of common architectures in a convenient way. In this contribution we present a SystemC based simulation platform, which allows a rapid verification of architecture concepts as well as module concepts of dedicated (e.g. multimedia-) subsystems. The designed modules can be connected very quickly in an arbitrary way for reassembling new system architectures. The goal is to simulate a specific, modular, cycle-accurate multimedia subsystem, which delivers quantitative and qualitative information regarding behaviour and data transfer. Thus, it is possible to obtain early information about the efficiency of the system, data traffic, and chip area estimation. The simulation environment is also able to support HW/SW split decisions.

12:20 - 16:00
Hall D

Performance Estimation of Secret Key Agreement System Exploiting an ESPER Antenna and a Received Signal Strength Indicator

H. Mori, H. Sasaoka, T. Ohira

For a countermeasure against eavesdroppers on wireless communication, we have proposed secret key agreement system exploiting an ESPAR antenna and a received signal strength indicator. It is predicted that the proposed method cannot achieve key agreement due to disagreement in keys between regular users if influence of noise become large. Consequently, this paper estimates the probability (key agreement rate) that key agreement could be attained between regular users against the influence of noise. Moreover, this paper also estimates the key agreement rate with key disagreement correction.

12:20 - 16:00
Hall D

A Class of Jointly Power and Bandwidth Efficient Digital Modulation Schemes for Single Carrier Transmission with Frequency Domain Equalization

T. Buzid, L. Reindl, M. Huemer

The increasing use of radio spectrum in a wide range of public and private communication systems is putting severe strain on the availability of this rare resource. Another important issue for many wireless applications is the power efficiency of appropriate transceivers. One possibility of a careful utilization of the available spectrum is the use of a class of jointly power and bandwidth efficient digital modulation schemes with constant amplitude [1]. Continuous phase modulation (CPM) signals have already been implemented very successfully in narrowband wireless systems like GSM and DC1800. Due to their constant envelope characteristics CPM signals relax the constraints concerning the linearity of the power amplifier stage, and therefore they provide the possibility to implement power efficient transmitter stages. In this paper we investigate broadband CPM transmission combined with a cyclically extended block structure at the transmitter and frequency domain equalization schemes at the receiver. Finally we present performance results and comparisons with QPSK transmission.

12:20 - 16:00 **Hardware Software Cooperation in Embedded Communication Devices**
Hall D *J. Langer*

In many embedded communication devices drivers have to be designed, which are supposed to be efficient and fast, and to need little energy. Furthermore the drivers often have real time requirements. Thus timeliness is an important issue. There are many constraints in timing, which have to be evaluated, calculated and tested. Evaluation of timeliness and performance of the total system should take place in the early stages of the design process. Only a coordinated cooperation of hardware and software can achieve excellent results. When developing in embedded communication systems, some constraints are not exactly known at the beginning. Therefore it is necessary to evaluate certain behavior of the hardware, the processor and used real time operating system (RTOS). It will be shown which parameters and items in a hardware/software system have to be evaluated and how these parameters and items can be measured. An example of a combined hardware-software analysis is given

12:20 - 16:00 **Novel Method for Computation of Frequency Characteristics of**
Hall D **Semiconductor Lasers**
I. Safonov, A. Shulika, I. Sukhoivanov, A. Kublik, P. Ivanov

Existent methods of semiconductor lasers frequency characteristics computation and novel method with small computation time and high accuracy are considered.

12:20 - 16:00 **Applying Self-Consistent Cosimulation to the Design and Analysis of a 10**
Hall D **GB/s Semiconductor Laser Transmitter**
D. Crawford, M. Rehse, A. Ebberg, D. Reznick

Multiple analysis methods have been selfconsistently applied within a single design environment to analyze a semiconductor laser transmitter for operation at 10 GB/s. The model includes a non-linear circuit for the laser chip that accounts for below and above threshold electro-optical performance. A three-dimensional model of the package is included along with the test fixture, which allows valid comparison of the simulation with measurement. The finite element method [1] is used to obtain wide-band s-parameters for the electrical interconnects and package, while Spice based analysis is used from the same simulation environment to determine the operating point of the device. The analysis demonstrates that multiple methods must be applied self-consistently within a single model to accurately predict the performance of the device.

12:20 - 16:00 **Digitally Controlled RF Predistortion Based on Vector Modulator**
Hall D *I. Teikari, J. Vankka, K. Halonen*

In this paper a digitally controlled RF predistortion system based on signal envelope and phase detection and vector modulator is presented. The RF predistortion eliminates the need for quadrature demodulator in the feedback loop and does not require access to the baseband signals which makes the implementation less complex. Unlike most of the previous RF predistortion methods the presented method uses the comparison of power amplifier input and output envelopes and phases in time domain for lookup table update. Experimental results show that the implemented predistorter was able to reduce the gain variation from 1.39 dB to 0.3 dB and the phase variation from 1.74° to 0.37° over 20 dB input range and reduced the first upper adjacent channel power of a 420 MHz 18 ksym/s 0.3 roll off factor RRC filtered $\pi/4$ -DQPSK signal from 40 dBc to 58 dBc

12:20 - 16:00
Hall D **Numerical Analysis of Nonlinear Distortion Generated from Anti-Series Schottky-Barrier Diode Pair**

M. Akaike, T. Ohira, K. Inagaki, Q. Han

This paper analyses higher-order harmonic distortions generated from a pair of Schottky-barrier diodes which are so connected that they are in anti-series in the high-frequency signal circuit and in parallel in the low-frequency bias circuit. In such a diode pair, the magnitude of the nonlinear terms in current-voltage and capacitance-voltage characteristics is suppressed in the high-frequency circuit. It is shown that the even-number-order harmonic distortions are completely eliminated and that the odd-number-order harmonic distortions are drastically decreased compared with a conventional standard circuitry in which a single diode is connected in both the high-frequency and low-frequency circuits.

12:20 - 16:00
Hall D **A Radar Signal Recognition Algorithm Based on the Wigner-Ville Distribution and the RBF Probability Density Function Estimation**

Y. Grishin, K. Konopko

The radar signal recognition can be carried out by exploiting the individual modulation features of a radar signal. These features are the result of slight variations of a radar components and acts as an individual signature of the radar. The paper describes a DSP implementation of a classification algorithm using the Wigner-Ville distribution and the RBF neural network estimator of the probability density function.

12:20 - 16:00
Hall D **Development and Operating Experience of 36 GHz and 95 GHz Magnetron Based Cloud Radars**

D. Vavriv, V. Volkov, V. Vynogradov, R. Kozhyn, O. Bezvesilniy

A review is given of recent activities undertaken in the Institute of Radio Astronomy of the National Academy of Sciences of Ukraine for the development of mm-wave meteorological radars. Both, 36 GHz and 95 GHz magnetron based Doppler polarimetric radars have been developed and produced. The radars are capable to perform real-time, high-resolution measurements of cloud and precipitation parameters. The set-up of these instruments is discussed. The results obtained during measurement campaigns are presented as well.

Thursday, August 12 2004

Plenary Talk

9:00 - 10:00
Room: HS 7 **On the Role of Software Defined Radios in Advanced Spectrum Management**

F. Jondral, T. A. Weiss

This paper starts with a discussion about the necessity for the introduction of advanced spectrum management strategies. Then an introduction to spectrum pooling is given and results of this new field are presented. Finally, the major role that software defined radios are going to play in future mobile communications systems is emphasized.

Session 10: Wireless Networks

Chair: G. Stromberg, G. Kubin

10:20 - 10:50 **Using Adaptive TDMA Protocols in WDM Passive Star Networks with Fixed Transmitters and Tunable Receivers**

Room: HS 5

G. I. Papadimitriou, M. S. Obaidat, A. S. Pomportsis

An adaptive TDMA protocol for WDM Passive Star Networks using fixed transmitters and tunable receivers is presented. The proposed Optical Adaptive TDMA (OATDMA) protocol is capable of operating efficiently under bursty and correlated traffic. According to the proposed protocol, the stations, which are granted permission to transmit at each time slot, are selected by taking into account the network feedback information. In this way, the number of idle slots is minimized and the network performance is significantly improved. Furthermore, although the traffic parameters are unknown and time-variable, the portion of the bandwidth assigned to each station is dynamically adapted to the station's needs.

10:50 - 11:20 **An Embedded System Architecture for UPnP Compatible Wireless Control Networks**

Room: HS 5

D. Bichler, S. Borbely, M. Fachberger, Y. Gsottberger, M. Huemer, R. Knauseder, H. Linde, E. Naroska, M. Pfaff, P. Schramm, X. Shi, G. Stromberg, T. F. Sturm, W. Weber

In this paper, we present a system architecture called Sindrion which allows to create a cheap, energy-efficient, wireless control network. Its focus is to integrate small embedded sensors and actuators into one of the most established middleware platforms for distributed semantic services, namely Universal Plug and Play (UPnP). To meet rigid constraints regarding cost and power consumption, complex data processing is sourced out from the sensor or actuator nodes to dedicated computing terminals, which establish a proxy in the UPnP network. The structure of the network and the hardware architecture of the Sindrion nodes allow dedicated networking protocols, which lead to a significantly lower power consumption of the Sindrion system compared to existing solutions.

11:20 - 11:50 **Inter-Vehicle Peer-to-Peer Communication**

Room: HS 5

T. Nishida, K. Eguchi, Y. Okamoto, T. Warabino, T. Ohseki, T. Fukuhara, K. Saito, K. Sugiyama

It is expected that inter-vehicle peer-to-peer type applications are going to be used in ITS in the near future. This paper explains our developed inter-vehicle peer-to-peer communication experimental system, which has a capability of selecting suitable communication medium out of inter-vehicle adhoc communication, cellular phone, and road-to-vehicle communication according to circumstances. This paper also reports results of our outdoor wireless-LAN connection experiments that we conducted to verify the applicability of wireless-LAN ad-hoc mode for inter-vehicle peer-to-peer communication.

11:50 - 12:20 **Galileo/GPS Receiver Architecture for High Sensitivity Acquisition**

Room: HS 5

G. Heinrichs, N. Lemke, A. Schmid, A. Neubauer, R. Kronberger, G. Rohmer, F. Förster, J. A. Avila-Rodriguez, T. Pany, B. Eissfeller, H. Ehm, R. Weigel

The location requirements for emergency callers and location-based services (LBS) outside urban areas can hardly be fulfilled without Global Navigation Satellite Systems (GNSS). The new European satellite navigation system Galileo will undoubtedly further expand and improve applications for users in many fields by allowing combined use with GPS in hybrid receivers. This paper describes the main concept of a future large-scale integrated combined Galileo/GPS receiver chipset for consumer applications with particular attention to high sensitivity acquisition.

Session 11: Integrated Mixers

Chair: R. Weigel

10:20 - 10:50 **Phase Conjugation Mixers for Retrodirective Array Application**
Room: HS 6 *J.-Y. Park, M. DeVincentis, K. M. K. H. Leong, T. Itoh*

In this paper, three phase conjugation mixers developed by the authors' group are presented for retrodirective array applications. The three circuits include an active phase conjugation mixer with MESFETs, an IF-based phase conjugation mixer with a self-heterodyne direct conversion receiver, and a 2nd harmonic phase conjugation mixer with anti-parallel diode pairs (APDPs). They are demonstrated for use in retrodirective array element and bistatic RCS measurements are shown to validate retrodirective characteristics.

10:50 - 11:20 **Linear Front-End ICs for TETRA/TETRAPOL Handhelds using SiGe Technology**
Room: HS 6 *F. Gruson, S. Hettich, A. Trasser, H. Schumacher*

A pair of linear receive ICs for TETRA / TETRAPOL handhelds has been developed using a 45 GHz – f_{max} SiGe-BiCMOS technology. The ICs consist of a switched-gain low-noise amplifier (LNA) and a passive FET mixer. Due to the low channel spacing in TETRA and TETRAPOL, both LNA and mixer need to have very high IP_3 values at a very low tone-spacing of 50 kHz. In order to achieve this, active low frequency termination is used in the LNA. The LNA features 17 dB gain and 1.5 dB NF with an IIP_3 of 5 dBm while consuming 6 mA from a 2.7 V supply. The FET mixer including LO buffer draws just 4 A at 400 MHz and 6 mA at 800 MHz, respectively, while providing a conversion loss of 7.5 dB and an IIP_3 of +20 dBm.

11:20 - 11:50 **On The Simulation Of The Non-Linear Behavior Of I/Q-Modulators**
Room: HS 6 *G. Strasser, J. Platz, H. Jäger, L. Maurer, A. Springer*

This paper deals with the modelling of non-linear effects in a quadrature modulator. It will be shown that the widely used polynomial model is not suited for such purposes. Instead we propose a cosh-type limiter model. It will be shown that this model predicts the intermodulation distortions sufficiently accurate and therefore, allows for a fast and simple assessment of the behavior of non-linear building blocks.

Session 12: Signal Processing and Smart Antennas

Chair: P. Russer, T. Itoh

10:20 - 10:50
Room: HS 7 **Field Experiments on Autocorrelation Characteristics of Shadowing Variation for Broadband OFCDM Wireless Access in Forward Link**

A. Morimoto, S. Abeta, M. Sawahashi

This paper investigates time-variation characteristics of the received signal level due to shadowing variations based on field experiments in cellular environments using the implemented Orthogonal Frequency and Code Division Multiplexing (OFCDM) transceiver with a 100-MHz bandwidth. Field experimental results clarify that autocorrelation of the received signal level due to shadowing between two separated locations exhibits the same characteristics as that of Gudmundson's model [3], when the distance between the two locations is less than 30 m, and that the autocorrelation due to the shadowing variation is not subject to the channel bandwidth. Furthermore, we clarify that the distance with which the autocorrelation becomes 0.5, which indicates the speed of time-variations due to shadowing, is approximately 10 to 25 m when the antenna height of the base station is 50 m and the maximum cell radius is approximately 1.5 km.

10:50 - 11:20
Room: HS 7 **Resolution Properties of Spectral Estimators Applied to Multiple Frequency Bands**

U. Siart, S. Tejero, J. Dettlfsen

The paper is related to a method for coherent combination of radar information that has been collected in distant subbands by means of mutually incoherent measurements. We used real measurement data from X-, K-, and V-Band to show that mutual coherence can be established on the basis of autoregressive (AR) signal modelling. This avoids the necessity of a common local oscillator which would involve unacceptable expenditure for commercial radar systems. It is possible to relate the phase information from different subbands to each other as if they were collected coherently with one single TX/RX-system [6]. The resolution properties are discussed in this paper.

11:20 - 11:50
Room: HS 7 **Mapping from the Reactance Set to the Equivalent Weight of a Reactance-Loaded Parasitic Element Array Antenna and Its Application for DoA Estimation**

M. Taromaru, T. Ohira

Mapping from the loading reactance set of the ESPAR (Electrically Steerable Parasitic Array Radiator) antenna to the equivalent weight of the array elements is theoretically analyzed and discussed. The study shows that the mapping from a loading reactance value to the weights is conformal and a bilinear transform and the trajectories of the weights draw circles. The performance of DoA (direction of arrival) estimation and adaptive beam forming with an ESPAR affected from the weight vector is also discussed and it is concluded that the performance should be good when using an equivalent weight vector set forming an orthogonal basis, or a hi-rank and distant angle basis to the greatest degree possible.

11:50 - 12:20
Room: HS 7

Adaptive Antenna Array-Beam Forming with Simultaneous Received Path Timing and DOA Estimations Based on Two-Dimensional Power Profile in Broadband CDMA Reverse Link

T. Kataoka, H. Taoka, K. Higuchi, M. Sawahashi

This paper proposes an adaptive antenna array-beam forming (AAABF) receiver that employs simultaneously received path timings and the direction of arrival (DOA) estimations for Rake combining based on a two-dimensional power profile that takes advantage of directive beam reception in the broadband CDMA reverse link. In the proposed AAA-BF receiver, we compare two antenna weight generation methods: independent weight generation to each path based on DOA estimation (hereafter path-independent weight generation) and common weight generation to all paths based on the average DOA or the maximum signal power after Rake combining (hereafter path-common weight generation). Computer simulation results show that the path-independent weight generation method exhibits superior performance to the path-common weight generation method because it achieves almost a constant required average received signal energy per bit-to-noise power spectrum density ratio (E_b/N_0) value irrespective of the angle spread among paths up to 20 degrees. The simulation results also show that the required average received E_b/N_0 in a three-user environment (i.e., two-interfering users with the same average received power exist) using path-independent weight generation with eight antennas is almost identical to that in the single-user environment due to the effect of multiple access interference (MAI) suppression by the AAA-BF receiver.

Session 13: Embedded Systems Design

Chair: **M. Pfaff, M. Huemer**

13:30 - 14:00
Room: HS 5

An Improved Hardware Architecture Design for Video Motion Estimation

R. Gao, D. Xu, I. French

This paper presents an improved parallel hardware architecture design for MPEG-4 video motion estimation. The architecture possesses the dual characteristics of lowcost and low-power dissipation and is, thus, suitable for hand-held and mobile applications. In order to accelerate computation, the architecture uses parallel-pipeline processing elements, incorporating dual-register/buffers to reduce the number of preload and alignment cycles. A content-based full-search block-matching algorithm has been mapped onto the architecture using a 16-PE array. This has the ability to calculate the motion vectors of a 20fps QCIF video sequence in real time using an 8.2MHz clock. Power dissipation using a Xilinx Spartan II FPGA is 36.76mw.

14:00 - 14:30
Room: HS 5

Non-Preemptive Execution Support for Critical and Hard Real-Time Applications on Embedded Platforms

M. V. Micea, V. Cretu

The problem of providing a fully predictable execution environment for critical and hard real-time applications on embedded and DSP-based platforms is studied in this paper, from the viewpoint of system architecture and operation. We introduce a set of homogenous models for time, signals and tasks, which will further serve as a basis for describing the architecture and operation of a particular hard real-time kernel – "HARETICK". The kernel provides support for concurrent operation of hard real-time tasks (the HRT execution environment), using non-preemptive scheduling algorithms, along with soft real-time tasks (the SRT environment), using classical, preemptive, prioritybased scheduling algorithms.

14:30 - 15:00 **Implementation of Real-Time-Control-Systems with Embedded Operating Systems**
Room: HS 5 *S. Burglechner, S. Silber, H. Grabner, M. Kaiserseder, M. Huemer, W. Amrhein*

Present control-systems which are addressed by digital fixpoint processors should include the ability to adapt and to reconfigure a system at anytime. Usually this leads to very long flashing routines that can cause heavy problems due to local conditions. Nowadays this should be carried out via a bus system. The presented concept offers the possibility to design a control system graphically. The designed system is loaded down via a bus system to a target hardware. The same bus system can be used to enhance the performance of the application by proper adaption of each single control parameter.

15:00 - 15:30 **DSP in Dedicated Hardware: Raising Value Abstraction for Fixed Point Implementation**
Room: HS 5 *W. Pauli, M. Pfaff, S. Reichör*

This abstract presents an arithmetic package for digital signal processing purposes that may be used with synthesizable VHDL code. This package provides means to raise the level of abstraction of a VHDL description without sacrificing the quality of synthesis results. No changes to the hardware description language itself are needed to achieve the desired effects, resulting in compatibility with existing simulation and synthesis tools. Higher levels of abstraction enable a designer of dedicated hardware for digital signal processing to work more efficient and make fewer mistakes at the same time.

Session 14: Frontend Modules and Integrated Antennas

Chair: **A. Springer**

13:30 – 14:00 **Advanced Characterization and Modeling of Power Amplifier and Transmit Front-End Modules**
Room: HS 6 *Y. Tkachenko, S. Boerman, P. DiCarlo, M. Gerard, J. Gering, J. Hu, P. Reginella, S. Sprinkle, C. Wie*

This paper reviews a number of advanced characterization and modeling techniques employed in the development of highly integrated, multi-band power amplifier and transmit front-end modules (TX-FEM's). Non-invasive waveform probing, in-situ IR imaging and electro-thermal modeling techniques described provide valuable insight into operation of these highly complex systems and serve as powerful tools in their design and optimization. An example of applying these techniques to design of a quad-band (UGSM/EGSM/DCS/PCS) TX-FEM, which integrates two power amplifiers, a PA controller, T/R switches, a switch controller, a dual-band directional detector/coupler, a diplexer, matching networks and harmonic filters in a single, 50 Ω input and output, 9x10x1.5mm package is demonstrated. The module employs InGaP/GaAs HBT, Al-GaAs/InGaAs/AlGaAs PHEMT, GaAs Schottky/passive, and Si Schottky/bipolar/CMOS semiconductor technologies and features 34dBm Pout with 45% PAE GSM and 31dBm Pout and 36% PAE DCS/PCS performance, while meeting a VSWR>20:1 open loop ruggedness spec.

14:00 - 14:30 **LTCC-Based Frontend for the HIPERLAN Band**
Room: HS 6 *L. Pergola, U. Göbel, P. Nüchter, R. Vahldieck*

The design of a HIPERLAN frontend based on LTCC technology is reported. The frontend is part of a 16 element array of active antenna modules for a channel sounder. The operative band is between 5.15 GHz and 5.875 GHz. The active antenna modules include the antenna, an LNA, a band pass filter for the image rejection and a mixer; a directional coupler is also incorporated for calibration purposes. Measured and simulated results are shown.

14:30 - 15:00 **A Planar Broadband Antenna for Applications in WLAN and 3G**
Room: HS 6 *O. Klemp, M. Schultz, H. Eul*

To support the steady increase of standardized frequency bands in mobile transmission systems the telecommunications industry is being required to develop structurally more compact and wide-band air interfaces. For the suppression of the multipath conditioned polarization fading in typical applications of portable radios, primarily antenna modules with polarization-invariant transmission behaviour are to be used. A suitable representative for the realization of wideband antenna structures is the logarithmically-periodic antenna, which can be favourably used in transmission systems with the characteristic of polarization diversity provided it offers a specific geometrical structure. Based upon the definition of certain basis geometry functions logarithmically-periodic antennas can be realized with almost arbitrarily polarizable transmission characteristics over a wide band of frequency use.

Session 15: A/D & D/A Converters

Chair: **T. Ostermann**

13:30 - 14:00 **Time-Interleaved ADCs in the Context of Hybrid Filter Banks**
Room: HS 7 *C. Vogel, G. Kubin*

In recent years the popularity of hybrid filter bank technologies for analog-to-digital conversion (HFB ADC) has increased and they have found their way from the academic world to industrial applications. Hybrid filter bank designs are based on an established mathematical framework for optimized converter designs. Time-Interleaved ADC (TIADC) technologies have a much longer history; nevertheless, a complete mathematical framework for the investigation of TIADCs has not yet been established. This is particularly remarkable, since an HFB ADC can be thought of as a generalization of a TIADC. Based on the mathematical framework of HFB ADCs, we introduce a complete framework for treating TIADCs and show advantages of this unified description.

14:00 - 14:30 **Analysis of G_mC and RC Filters for High-Speed Continuous Time Sigma-Delta A/D Conversion**
Room: HS 7

R. Schoofs, M. Steyaert, W. Sansen

This paper presents an analytical comparison between high-speed, single-bit continuous time modulators using G_mC and RC filters based on their power consumption. Mathematical expressions for harmonic distortion and thermal noise for both kinds of filters are derived and interpreted. Proposed design choices are verified by numerical simulations. It is shown that the minimal current consumption of a RC filter is determined by harmonic distortion constraints. These require an integrator closed loop gain-bandwidth equal to the sampling rate. For a G_mC filter, the current is determined by both thermal noise and harmonic distortion suppression. For this type of filter, it is also shown that transistor noise can become dominant over resistance noise due to source degeneration and technology scaling. However, for the same harmonic distortion and thermal noise suppression specifications, a RC filter proves to consume more power than its G_mC equivalent.

14:30 - 15:00 **Comparison of Different Class-D Power Amplifier Topologies for 1-bit RF Band-Pass Delta-Sigma D/A Converters**
Room: HS 7

J. Sommarek, A. Virtanen, J. Vankka, K. Halonen

The suitabilities of different class-D power amplifier architectures for 1-bit bandpass $\Delta\Sigma$ D/A converters operating with RF signals are compared. The objective is to find out which architecture provides the best efficiency. The architectures considered are two-transistor voltage-mode class-D amplifier, H-bridge voltage-mode class-D amplifier, Transformer-coupled voltage-mode class-D amplifier, Transformer-coupled current-mode class-D amplifier and two-transistor current-mode class-D amplifier. These architectures are compared by APLAC simulation for discrete GaAs MESFET realisations.

Session 16: Hardware/Software Co-Design

Chair: **B. Knerr, A. Springer**

16:00 - 16:30 **Mobile Reception Characteristics of Software Defined Radio Receiver for Digital Terrestrial Television Broadcasting**
Room: HS 5

Y. Endo, M. Maeda, M. Saitou

In Japan, digital terrestrial television broadcasting services started in 2003. ISDB-T (Integrated services Digital Broadcasting-Terrestrial) system that is the standard for digital terrestrial television broadcasting in Japan has various functions to improve mobile reception characteristics. There are increasing demands to receive digital terrestrial television broadcasting services in a high-speed vehicle. To meet these demands, we developed a software defined radio receiver for ISDB-T and two demodulation algorithms for improving mobile reception characteristics. The mobile reception characteristics are discussed in this paper.

16:30 - 17:00 **Modern Hardware-Software Co-design for Radar Signal Processing**
Room: HS 5 *R. Gessler, T. Mahr, M. Wörz*

This paper presents novel hardware-software co-design methods used in radar signal processing. First of all the hard- and software design strategies are described separately. The software section focuses on an architecture which decouples application from operating system and hardware, which is a precondition for the use of COTS products during the life cycle of a radar system. The hardware section focuses on design flow methods based on the efficient use of MATLAB/Simulink and SystemC; both generate VHDL code for FPGA designs. Signal processing algorithms like FIR filter or FFT are used to benchmark and compare both design flows. The binding for a possible co-design is SystemC, MATLAB/Simulink, and UML. On the other hand MATLAB/Simulink with System Generator supports the integration of different IPs and soft cores for SOC on FPGA.

17:00 - 17:30 **A New Addressing Method for Look-up Table Based Digital Predistortion Linearizers**
Room: HS 5 *N. Ceylan, J.-E. Mueller, R. Weigel*

Linear power amplifiers are essential for the new generation frequency efficient mobile communication systems, which have non-constant modulation signal envelopes. Digital predistortion is a reliable linearization method used for power amplifier linearity improvement. However, this method requires some additional digital circuitry capable of fast real time digital signal processing. The required clock frequency depends on the bandwidth of the modulation signal, the oversampling ratio and the complexity of the predistorter. In this paper a new addressing method is proposed for look-up table (LUT) based digital predistorters, which makes the addressing very fast and reduces the power consumption in digital circuitry.

17:30 – 18:00 **Advanced UMTS Receiver Chip Design using Virtual Prototyping**
Room: HS 5 *B. Knerr, M. Holzer, P. Belanovic, G. Sauzon, M. Rupp*

Development of complex System on Chip (SoC) for modern communication systems has become more and more challenging. A designer has to bridge the gap between the requirements of the system at algorithmic level and its cycle true hardware description; the latter being synthesised for an Application Specific Integrated Circuit. This development requires numerous sub-steps, i.e., several intermediate descriptions on different abstraction levels of the same system. One of those levels can be an architecture level description implemented purely in software in form of a Virtual Prototype. This paper shows how Virtual Prototyping has been integrated in a design flow by a consistent design methodology and what advantages in terms of design efficiency have been gained.

Session 17: System Analysis & Design

Chair: **W. Mathis**

16:00 - 16:30 **Some Remarks on Modal Solutions for Second and Third Order Time-Varying Systems**
Room: HS 6 *P. van der Kloet, F. L. Neerhoff*

For linear time-varying systems modal solutions are obtained. This process needs a triangularization of the statespace matrix. This involves a set of Riccati differential equations, which generalize the characteristic equations for timeinvariant systems. As examples third and second order systems are treated.

16:30 - 17:00
Room: HS 6

Model Order Reduction of FIR Filter for Audio Amplifier

L. Radic, W. Mathis

In this paper we will discuss the application of three different model order reduction methods for discrete state space system: Balanced Model Order Reduction (BMR), Singular Perturbations Model Reduction (SPR) and Optimal Hankel-Norm Approximation (OHA) for FIR filters. A reduced filter is designed by applying these model reduction methods and results in a 78% lower filter order compared to the original FIR filter. The most important characteristic of FIR filter: linear phase is preserved in pass-band. Furthermore, ideas for a hardware implementation of low sensitive IIR filters will be discussed.

17:00 - 17:30
Room: HS 6

Optimization and Implementation of FIR Filter Pre-Emphasis for High-speed Backplane Data Transmission

M. Li, S. Wang, Y. Tao, T. Kwasniewski

FIR filter pre-emphasis has been used to counteract intersymbol interference (ISI) in high-speed backplane data transmission. A MATLAB program has been developed for optimization of FIR filter under Least Mean Square (LMS) criterion. The optimized FIR filter is then implemented in 0,18 μ m CMOS technology. The HSPICE simulation further verifies the results obtained in MATLAB optimization. An eye-opening of 0,78UI is achieved for 34" FR4 backplane.

Session 18: Antenna Systems

Chair:

J. Zehentner, R. Sorrentino

16:00 - 16:30
Room: HS 7

Slotted Waveguide Active Phased Arrays for Mobile Satellite Terminals

R. Sorrentino, R. Vincenti Gatti

In the next few years we will see the birth of several new Ka-band satellite communication systems, based on a constellation of Geostationary Earth Orbit (GEO) satellites to provide a global coverage. A key part of these systems is the mobile satellite terminal, which has to satisfy several requirements, such as: ability to scan the beam, high gain, compact design and low cost. A survey of the recent advances in antenna technology for mobile satellite terminals is presented in this paper. Among those solutions, a new active antenna is presented, consisting of a slotted waveguide array electronically scanning in the elevation plane. This solution combines the high performance of an active phased array with the low cost of a passive fixed beam slotted waveguide array.

16:30 - 17:00
Room: HS 7

A Low-Cost Smart Antenna Demonstrator for the 2.4GHz ISM Band

J. Heubeck, H. H. Fröhlich, C. Prieto-Burgos, S. Lindebnner

In order to provide a smart antenna demonstrator system for laboratory and field tests, research on calibration of the components and the overall system is discussed in this publication. Therefore effects of amplitude and phase mismatch of the demonstrator system are simulated, measured and discussed with the intention to develop a calibration strategy.

17:00 - 17:30
Room: HS 7

Active Phased Array Antenna with High Gain for Mobile Satellite Communication and Broadcasting

H. S. Noh, U. H. Park, K. H. Lee, S. H. Son, S. I. Jeon

In this paper, Tx/Rx dual microstrip array antenna system for mobile satellite communication and broadcasting is de-signed. This antenna consists of 24 subarrays, and each subarray consists of 8x1 unit elements. The unit element of the proposed subarray consists of three stacked patches and Tx/Rx feeds. In the subarray, patch elements have higher gain and wider impedance bandwidth than single or two-stacked patch array antenna by using the three-stacked layer structure. Moreover because of Tx/Rx direct feed circuits arranged on the same layer, it is very convenient to assemble our array antenna. The proposed antenna has a vertical po-larization for Tx band and a horizontal polarization for Rx band. To verify the practicality of this antenna system, we fabricated an active phased array antenna composed of 24 subarrays and measured the radiation pattern. From the measured results, we can see that this array antenna system has a good performance.

17:30 - 18:00
Room: HS 7

Mutual Impedance Extraction and Varactor Calibration Technique for Electronically Steerable Parasitic Array Radiator Antennas

Q. Han, B. Hanna, K. Inagaki, T. Ohira

This paper proposes an extraction and calibration technique that allows Electronically Steerable Parasitic Array Radiator (Espar) antennas to achieve high efficiency and precision in antenna elemental current predictions. This is important because the currents play an important role in understanding the array's performance. The proposed technique is based on a reactive-near-field probing. We present a formulation that needs only two-round current measurements to successfully extract the mutual impedance. Currents are predicted for the arbitrary combinations of bias voltages that are used to control the reactance of varactor diodes directly integrated with the antenna's parasitic radiators. These predicted currents are verified by conducting an experiment with a 4-element Espar antenna. Using the proposed technique, number of measurement is decreased to approximately 1/431 for a 4-element Espar antenna with 21 step bias voltages. Root mean square error in currents is 1.48%, relatively normalized by the fed-element current.

Social Events

Welcome Reception: Tuesday August 10, 2004
18:15 in the Representation Room A at the Johannes Kepler University Linz

Banquet: Wednesday August 11, 2004
18:15 Departure (Johannes Kepler University of Linz)
19:00 Showing over the Monastery St. Florian
19:45 Organ recital on the Bruckner-organ
20:15 Dinner
23:00 Return to Johannes Kepler University and Hotel Sommerhaus

Post Conference Tours: Friday August 13, 2004
Tour to Salzburg:
08:00 Departure (Johannes Kepler University Linz)
09:30 Guided Tour
Sightseeing of "Schloss Mirabell", the cathedral of Salzburg, Mozart's Birthplace, Getreidegasse, Festival Halls,
12:30 Lunch Break
13:30 "Hohensalzburg" Fortress (Euro 7,40)
15:30 Journey home, via the lakes "Fuschlsee" and "Wolfgangsee".
Stop in Bad Ischl for a Coffee break in the famous "Café Zauner"
18:00 Arrival in Linz

Tour to Vienna:
08:00 Departure (Johannes Kepler University Linz)
10:15 Arrival at the Vienna University of Technology
10:30 Introduction of the Faculty of Electrical Engineering and Information Technology
11:00 Tour of Sensor Laboratory
11:30 Tour of Laser Laboratory
12:00 Introduction of FTW
Alternative Program: (10.30-12.30)
Castle of Schönbrunn
12:30 Lunch Break at the Vienna University of Technology
14:00 Sight-Seeing Tour across Vienna, finishing at the Technical Museum
17:00 Journey home
19:30 Arrival in Linz

Meeting of the International Steering Committee: Tuesday August 10, 2004
19:30-22:00 at Wirtshaus Auhof, Altenbergerstr. 70

Registration

2004 International Symposium on Signals, Systems and Electronics

August 10 - 13, 2004 in Linz (Austria)

REGISTRATION FORM

To register, mail or fax this form to:

Johannes Kepler University Linz
Institut für Nachrichtentechnik, Dr. A. Springer
Altenbergerstr. 69, A-4040 Linz, Austria
Fax: +43-70-2468-9712

Registration by email will be refused without notification.

SECTION A: PARTICIPANT

PLEASE PRINT OR TYPE IN CAPITAL LETTERS

Mr / Ms Last name > _____ First Name > _____ Date of birth > _____

Title (Prof./Dr.) > _____ Dept. > _____

Institution > _____ Country > _____

P.O.Box/Street > _____ Zip/Postal Code > _____ City > _____

E-Mail > _____ Phone > _____ Fax > _____

Accompanying Person: Mr / Ms Last name > _____ First Name > _____

SECTION B: REGISTRATION FEES

Registration Package Nr. (please fill in numbers from registration fee information form)

Registration and Payment by July 1st, 2004

Registration or Payment after July 1st, 2004

_____	€ _____,--	€ _____,--
_____	€ _____,--	€ _____,--
Total:	€ _____,--	€ _____,--

SECTION C: PAYMENT OF FEES

Payment in Euro (€) is required. Registration without proper payment or credit card authorization will be refused.

In case of prevention we offer the possibility to substitute the participant without additional costs. Refunds for the Conference are only made in response to written requests to ISSSE '04 at the above address, postmarked or faxed (+43-732-24689712) before July 1st, 2004. After July 1st, 2004 a charge of 80% of the registration fee will be imposed for cancellation. No refund is available after August 1st, 2004.

Bank transfer

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Bank: **Raiffeisenlandesbank OÖ** Bank code: **34000**
Account name: **Inst. f. Nachrichtentechnik, ISSSE 2004,**
Account number: **2624773**
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2004 International Symposium on Signals, Systems and Electronics

August 10 - 13, 2004 in Linz (Austria)

REGISTRATION FEE INFORMATION

Nr.		Registration and Payment by July 1 st , 2004	Registration or Payment after July 1 st , 2004
1	Symposium Full Registration Members	€ 300,-	€ 325,-
2	Symposium Full Registration Non-members	€ 350,-	€ 375,-
3	Symposium Student Registration	€ 100,-	€ 125,-
4	Tutorial Half Day	€ 50,-	€ 60,-
5	2 Half Day Tutorials	€ 75,-	€ 85,-
6	Extra Lunch Ticket (per day)	€ 10,-	€ 10,-
7	Extra Banquet Ticket	€ 70,-	€ 70,-
8	Additional Symposium CD-ROM	€ 15,-	€ 15,-

Full registration includes: Plenary, Technical Sessions, Exhibition, Coffee breaks and Lunch on August 11-12, Conference Banquet, Welcome reception, and CD-ROM Record.

Student registration includes: Plenary, Technical Sessions, Exhibition, Coffee breaks, Lunch on August 11-12, Welcome reception, and CD-ROM Record. For registration as a student a confirmation from the university or supervisor must be sent together with the registration form.

Tutorial registration includes tutorial handouts and lunch.

PLEASE NOTE:

1) For each accepted paper/poster at least one of the authors must register for the symposium before July 1st, 2004 and present the paper/poster. Otherwise the paper/poster will NOT be published in the symposium proceedings!

2) For the conference tours there will be an extra registration form available!

Accommodation

<p>Hotel Sommerhaus</p> <p>Julius-Raab-Straße 10 A-4040 Linz, Austria Tel +43 (732) 24 57376 Fax +43 (732) 245739 Prices: Single room: € 31,- Double room: € 62,-</p>	<p>Hotel Ibis</p> <p>Kärntner Strasse 18-20 A-4020 Linz, Austria Tel +43 (732) 69401 Fax +43 (732) 694019 Prices: Single room: € 56,- Double room: € 71,- Breakfast buffet: € 9,-</p>	<p>Hotel Steigenberger Maxx</p> <p>Am Winterhafen 13 4020 Linz, Austria Tel: +43 (732) 78990 Fax: +43 (732) 789999 Prices: Single room: € 71,- Double room: € 95,- Breakfast buffet: incl.</p>
<p>Hotel Courtyard Marriott</p> <p>Europaplatz 2 A-4020 Linz, Austria Tel: +43 (732) 6959 8403 Fax: +43 (732) 6959 8555 Prices: Single room: € 75,- Double room: € 75,- Breakfast buffet: incl.</p>	<p>Hotel Arcotel Nike</p> <p>Untere Donaulände 9 4020 Linz, Austria Tel +43 (732) 7626 1318 Fax +43 (732) 7626 2 Prices: Single room: € 86,58 Double room: € 114,16 Breakfast buffet: € incl.</p>	<p>Austria Trend Hotel Schillerpark</p> <p>Schillerplatz 1 4020 Linz, Austria Tel +43 (732) 6950 102 Fax +43 (732) 6950 9 Prices: Single room: € 121,- Double room: € 163,- Breakfast buffet: € incl.</p>

Transportation

by TRAIN - Main Station: Linz Hauptbahnhof

Info: <http://www.oebb.at>

Linz is a major train stop between Vienna and Salzburg. All Eurocity (EC) and Intercity (IC) trains stop here. There are also good train connections to Graz, to Germany and Hungary. The connection to/from Prague is straightforward but rather slow. The easiest and fastest way to the University of Linz is taking a taxi at the Main Station (Linz Hauptbahnhof)! Approximately costs 15,- EUR. You also can travel to the Universität of Linz by public transport.

by PLANE - Airport Linz Hörsching

Info: <http://www.flughafen-linz.at>

Passenger Service Counter

Business hours: daily from 5.00 am-11.00 pm

Parking administration, hotel reservation, currency change and general information.

Tel: ++43 +7221-600225

Fax: ++43 +7221-600100

In case of need an airport bus leaves from airport Linz Hörsching to the Main Station and "Göthekreuzung" from 6.00 am until 9.00 pm and is free of charge.

Airport	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00
Main Station	6:19	7:19	8:19	9:19	10:19	11:19	12:19	13:19	14:19	15:19	16:19	17:19	18:19	19:19
Göthekreuzung	6:23	7:23	8:23	9:23	10:23	11:23	12:23	13:23	14:23	15:23	16:23	17:23	18:23	19:23
Göthekreuzung	5:23	6:34	7:34	8:34	9:34	10:34	11:34	12:34	13:34	14:34	15:34	16:34	17:34	18:34
Main Station	5:27	6:38	7:38	8:38	9:38	10:38	11:38	12:38	13:38	14:38	15:38	16:38	17:38	18:38
Airport	5:45	6:57	7:57	8:57	9:57	10:57	11:57	12:57	13:57	14:57	15:57	16:57	17:57	18:57

Please call for a bus transfer: 0800/206600 (free of charge inside Austria), or ask at the Service Counter at the airport.

Outside the main entrance of the airport you can find a taxi rank. Those taxis offer a fixed price for the distance between the airport and the centre of the city. Taxi services can be contacted under the following telephone numbers. Taxi fares from the airport to the centre of Linz: approx. 22,- EUR.

Taxi Hötzenborfer: 07221-72387

Willy's Reisen: 0732-341095

Taxi Vondrak/Pöstinger: 07221-1712

Taxi Zitta: 07229-600

Taxi Jakober: 07229-70100

Taxi Haas: 07221-1718

Taxi Kirchmeir: 07221-72108

by CAR

Attention: Please mind that you need a so called "Vignette" to pay your toll for the high ways in Austria. You get them at the border, petrol stations or at any automobile club.

From Vienna, Salzburg, or Graz (via Autobahn A1):

From the Autobahn A1 exit at 'Knoten Linz' and continue on Autobahn A7 (direction north towards Linz/Prag). Stay on the A7 for about 10 kilometers, crossing through the entire city (watch the 100/80km speed limits!). Still on the A7, you cross over the Danube river (stay in one of the two left lanes). After about 1 more kilometer, take Exit Dornach/Universität.

PUBLIC TRANSPORT

Info: <http://www.linzag.at>

Public transport in Linz contains bus and tramways. Tickets include using them both. You can buy your ticket at automatic ticket machines at any station. Attention! Not all ticket machines have change!

Fares:

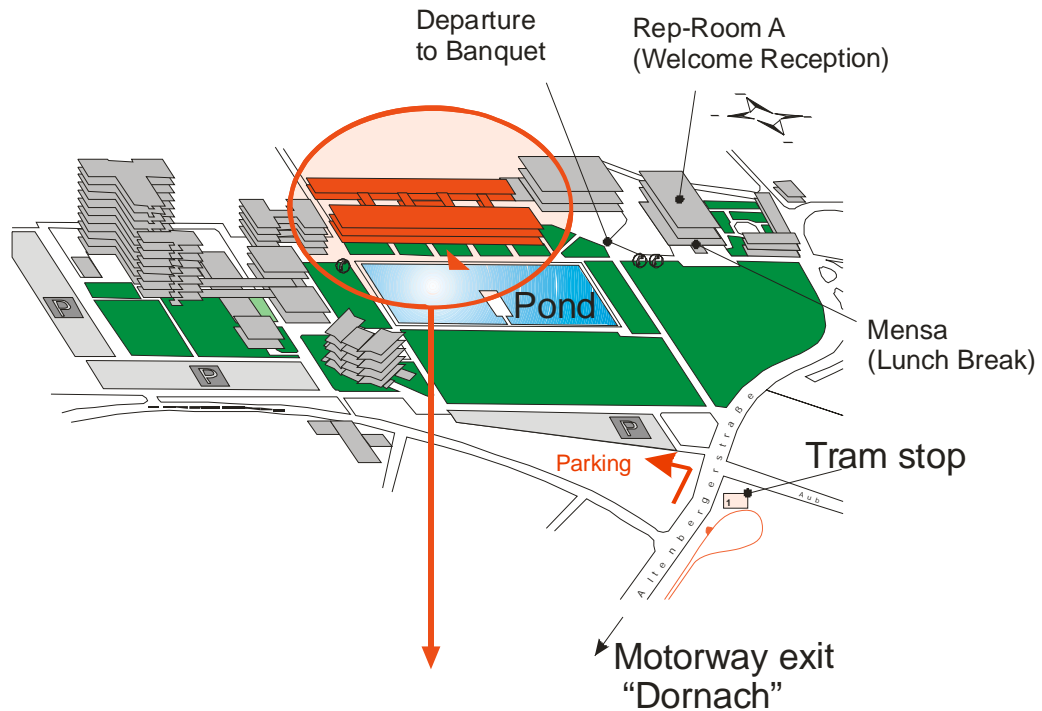
- 0,70 EUR (only 4 stations / long distance students)
- 1,40 EUR (long distance / one-day-ticket students)
- 2,90 EUR (one-day-ticket)

For visitors who arrive per train or take the bus from the airport Linz:

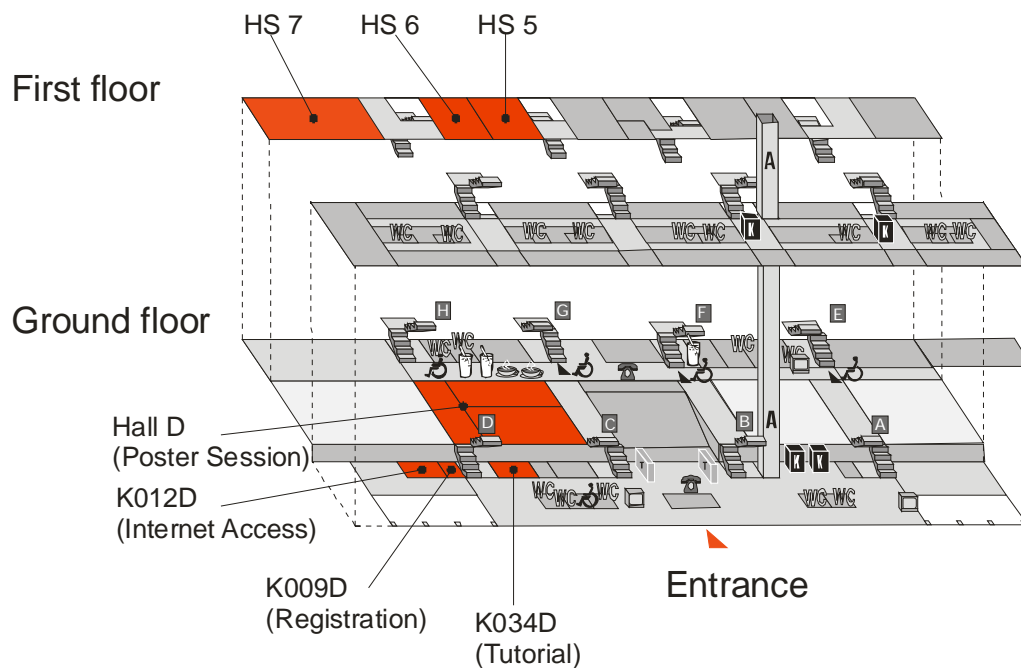
When you get off the train in Linz you find yourself at the Main Station ('Hauptbahnhof'). From there get on a Tram Nr. 3 (thick red line), which stops right in front of the station (only one direction to go). Get off Tram Nr. 3 at the Main Square ("Hauptplatz") and switch to a Tram Nr. 1 or 2 heading the same direction. (There are only two tram lines in Linz - Nr.1, 2 and 3 - so there is not much you can do wrong.) While waiting, you may enjoy the scenic view of the Hauptplatz. Take Tram Nr.1 or 2 and get off at 'Universität' (which is the last stop).

Map of the Conference Site

Campus Johannes Kepler University Linz



Detail: Kepler building



Tourist Information

The conference will be held at the Johannes Kepler University in Linz, Austria. Linz, the capital city of Upper Austria, combines history, modern business and state-of-the-art technology in a most pleasant way. The Old Town in the heart of Linz features many historical buildings as well as great possibilities for shopping. A variety of museums guide visitors through many periods of history, from the ancient Romans into the future of technology in the Ars Electronica Center. Linz also provides a vibrant cultural life with theaters, a famous concert hall and galleries. Besides its variety of own places of interest, Linz is the ideal starting point for tours into the Mühlviertel in the north and the famous Salzkammergut with its beautiful lakes in the south. The famous cities Vienna and Salzburg are reachable from Linz within 2 hours or less by train. August is the perfect time for visiting all attractions in Linz and its surrounding.

Further information under <http://www.linz.at>



The famous monument behind the yellow train, reminds of the black disease in the middle ages.

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