Nuremberg, Germany

26.–28.2.2019

embeddedworld

Exhibition&Conference

...it´s a smarter world

CONFERENCE PROGRAM

www.embedded-world.eu

Organized by

DESIGN& ELEKTRONIK
KNOW-HOW FÜR ENTWICKLER

design-elektronik.de

NÜRNBERG MESSE

Conference Sponsors

Digi-Key ELECTRONICS · DSPECIALISTS Digitale Audio- und Messsysteme GmbH · Green Hills SOFTWARE · Mentor A Siemens Business · PARASOFT Automated Software Testing · pls Development Tools · WE WÜRTH ELEKTRONIK

7.4 MILLION+ PRODUCTS ONLINE | 750+ INDUSTRY-LEADING SUPPLIERS | 1,300,000+ PRODUCTS IN STOCK

The World's Largest Selection of Electronic Components Available for Immediate Dispatch™

FREE SHIPPING ON ORDERS OVER € 50 OR $60 USD*

TELEPHONE: 0800 180 01 25

DIGIKEY.DE

Digi-Key® ELECTRONICS

*A shipping charge of € 18.00 will be billed on all orders of less than € 50.00. A shipping charge of $22.00 USD will be billed on all orders of less than $60.00 USD. All orders are shipped via UPS, Federal Express, or DHL for delivery within 1-3 days (dependent on final destination). No handling fees. All prices are in euro or United States dollar. Digi-Key is a franchised distributor for all supplier partners. New product added daily. Digi-Key and Digi-Key Electronics are registered trademarks of Digi-Key Electronics in the U.S. and other countries. © 2018 Digi-Key Electronics, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA

eda MEMBER

embeddedworld
Exhibition&Conference
...it´s a smarter world

Prof. Dr.-Ing. Axel Sikora
Chairman of embedded world Conference

embedded world Conference 2019 – Embedded Intelligence

Now in its 17th year, the embedded world Conference takes up the title of one of its precursors from the 1990s. Back then "Embedded Intelligence" was rather a vision of the future but now it is increasingly becoming reality and shaping more and more systems: from autonomous vehicles over image recognition and embedded vision systems to preventive and demand-driven maintenance in Industry 4.0 systems, from small edge computers to high-performance cloud servers. These developments not only open up immense possibilities and business opportunities, but are also closely associated with many technical, economic, social and ethical issues.

With a program of high-quality and solution-oriented presentations, the embedded world Conference 2019 aims to contribute once more to the success of an industry that has now become an essential part of the technological future and, as such, a basis for our continued economic success.

The embedded world Conference 2019 is made up of 10 subject areas, which are clearly structured in the program and presented in different colors. These are: 1. Internet of Things, 2. Connected Systems, 3. Embedded OS, 4. Safety & Security, 5. Hardware Engineering, 6. Software & Systems Engineering, 7. Embedded Vision, 8. Autonomous & Intelligent Systems, 9. Embedded GUI & HMI, and 10. System-on-Chip. The solution-oriented presentations of each session build upon one another and examine questions from different perspectives. Discussion and an active exchange of ideas with the speakers as well as among conference participants are encouraged. The 30-minute presentations of the sessions will be complemented by 12 classes, which provide comprehensive basic information on selected topics in the form of condensed training courses.

It is not possible to describe all 250 presentations in detail here. You will find them fully explained on the following pages of this booklet.

The steering board of the embedded world Conference 2019 wishes all participants stimulating discussions about new ideas and solutions in order to be able to cope more easily and better with the immense challenges that lie ahead. You are welcome to gain great insights in a pulsating atmosphere.

Prof. Dr.-Ing. Axel Sikora
Chairman of embedded world Conference

CONFERENCE PROGRAM

	1. Internet of Things – Platforms & Applications	2. Connected Systems		3. Embedded OS			4. Safety & Security	
DAY 1: morning		Session 2.1: Communication I CAN	Session 2.2: Communication II Bluetooth	Session 3.1: OS Basics	Class 3.1: The Robert Berger Class: Embedded Linux – a Crash Course		Session 4.1 I: HW-based Security I	Session 4.2: Functional Safety
DAY 1: afternoon		Session 2.3: Communication III Realtime & TSN		Session 3.2: OSADL			Session 4.1 II: HW-based Security II	
DAY 2: morning	Session 1.1 I: IoT I	Session 2.4: Communication IV Wireless Physical & Design Aspects		Session 3.3: Linux	Class 3.2: Embedded Android Workshop		Session 4.3 I: Security Architectures & Hacking I	Class 4.1: The ESCRYPT Class
DAY 2: afternoon	Session 1.1 II: IoT II	Session 2.5: Communication V Wireless Multiprotocol		Session 3.4: Virtualization		Class 3.3: Linux Hands-on Workshop with BeagleBoard.org PocketBeagle	Session 4.3 II: Security Architectures & Hacking II	
DAY 3: morning	Session 1.2: IoT III	Session 2.6 I: NB-IoT & LPWA I	Session 2.8 I: Wireless Power I	Session 3.5: OS-Security	Class 3.4: The Mc Guire Class: Introduction to Linux Kernel Tools		Session 4.4 I: Securing IoT I	
DAY 3: afternoon	Session 1.3: IoT IV OPC UA I 4.0	Session 2.6 II: NB-IoT & LPWA II Session 2.7: Communication VI Wireless Localization	Session 2.8 II: Wireless Power II				Session 4.4 II: Securing IoT II	Class 4.2: Hands-on Side Channel Power Analysis

KEYNOTE-SPEAKERS

Jim Tung, MathWorks
Conference Keynote: **Developing Game-Changing Embedded Intelligence**
February 26th, 2019, 1:30 PM

Jim Tung is a MathWorks Fellow, focusing on business and technology strategy and working with key customers and partners. Jim has more than 35 years of experience in real-time systems, data acquisition, and technical computing, including 30 years at MathWorks. Jim was previously vice president of marketing and vice president of business development at MathWorks, and earlier held marketing and sales management positions at Lotus Development and Keithley DAS, a pioneering manufacturer of PC-based data acquisition systems.

Jean-Marc Chery, STMicroelectronics
Conference Keynote:
Embedded Intelligence for the Next Wave of Smart Systems – Opportunities and Challenges on the Edge
February 27th, 2019, 1:30 PM

Jean-Marc Chery is STMicroelectronics' President and Chief Executive Officer since May 31st, 2018. In July 2017 Chery had been appointed Deputy CEO of ST with overall responsibility for Technology and Manufacturing, as well as for Sales and Marketing operations. Before that, he had held a broad range of management positions across ST functions throughout his career. Chery currently chairs the board of directors of STS, ST's manufacturing joint venture in China, and is a board member of the European microelectronics R&D program AENEAS.

5. Hardware Engineering		6. Software & Systems Engineering				7. Embedded Vision	8. Autonomous & Intelligent Systems	9. Embedded GUI & HMI	10. System-on-Chip
Session 5.1: RISC-V I Overview	Class 5.1: Ultra Low Power	Session 6.1: SW-Engineering I Languages & Standards	Session 6.2 I: MISRA I	Class 6.1: The Bruce Douglass Class 1: Modeling		Session 7.1 I: Embedded Vision I	Session 8.1: Intelligent Systems I Applications		
Session 5.2: RISC-V II Security			Session 6.2 II: MISRA II			Session 7.1 II: Embedded Vision II	Session 8.2: Intelligent Systems II Hardware	Session 9.1: Embedded GUI & HMI	
Session 5.3: RISC-V III System									
Class 5.2: RISC-V Workshop I		Session 6.3: SW-Engineering II Design & Modeling	Class 6.2: The Bruce Douglass Class 2 Agile				Session 8.3: Intelligent Systems III Autonomous Driving		Session 10.1: SoC I Analog Circuits & Solutions
									Session 10.2 I: SoC II EDA I
Session 5.4: Power Supply		Session 6.4: SW-Engineering III SW-Quality I					Session 8.4: Intelligent Systems IV Development Methods		Session 10.2 II: SoC II EDA II
		Session 6.5: SW-Engineering IV Development Process	Session 6.7: SW-Engineering VI SW-Testing	Class 6.3: The Bruce Douglass Class 3 Safety & Security	Class 6.4: The Greg Davis Class C / C++				Session 10.3: SoC III Complex Ics & System Solutions
		Session 6.6: SW-Engineering V SW-Quality II	Session 6.8: SW-Engineering VII SW-Debugging						Session 10.4: SoC IV ICs & IPs

Frank Riemenschneider, Publication Chair

Registered participants of the ewC2019 will receive the conference proceedings with the papers of selected contributions free of additional charge after the conference. The proceedings of ewC2018 reached nearly 1,000 pages with more than 170 papers.

STEERING BOARD

back row (from left to right):
Dr. Bernd Hense,
Prof. Dr. Axel Sikora,
Dr. Klaus Grimm

front row:
Joachim Kroll,
Prof. Dr. Peter Fromm

	Session 2.1: Communication I CAN	Session 3.1: OS Basics	Session 4.1 I: HW-based Security I	Session 4.2: Functional Safety
09:30-10:00	**Troubleshooting in Embedded Networks Based on CANopen FD** Reiner Zitzmann, CAN in Automation	**Introduction to OpenAMP: An Open Source Standard and API for Asymmetric Multiprocessing Systems** Jeffrey Hancock, Mentor, A Siemens Business	**Hardware Security for Embedded Systems** Ben Boehman, Advanced Micro Devices (AMD)	**High Performance Distributed Mixed Criticality Systems to SIL2** Prof. Hans Dermot Doran, Zürich University of Applied Sciences
10:00-10:30	**Automated Node ID Assignment in CAN and CAN(FD) Networks** Christian Keydel, Olaf Pfeiffer, Embedded Systems Academy		**Techniques for Securing Low-Cost Embedded Devices** Josh Norem, Silicon Labs	**Integrating Functional Safety Enabled 3rd Party IP** Alexander Scheuermann, Texas Instruments
10:30-11:00	**Signal Improvement Concept for CAN FD Networks** Yao Yao, CAN in Automation	**42 Reasons Using FreeRTOS Should Scare Developers** Jacob Beningo, Beningo Embedded Group	**Transitioning from Software Based Security to Hardware Based Security – How to Make the Leap** Anthony Ambrose, Data I/O	**Modeling and Assessment of Safety Critical Systems** Thomas Barth, Hochschule Darmstadt
11:00-11:30	Coffee Break			
11:30-12:00	**Session 2.2: Communication II Bluetooth** **Bluetooth Evolution** Jim Katsandres, Bluetooth SIG	**How to Measure RTOS Performance** Colin Walls, Mentor, A Siemens Business	**Making Products Safer and More Secure with an MPU** Jean Labrosse, Silicon Labs	**Safety Critical RTOS: Adapting Across Applications** Andrew Longhurst, WITTENSTEIN high integrity systems
12:00-12:30	**Supercharging BLE Beacons with Bluetooth 5** Joe Tillison, Silicon Labs	**Home-grown or Commercial Linux: a Binary Choice?** Iisko Lappalainen, MontaVista Software	**Extend MCU Security Capabilities Beyond Trusted Execution with Hardware Crypto Acceleration and Asset Protection** Saurin Choksi, NXP Semiconductors	**Data and Control Coupling: Taint Analysis for Critical Embedded Applications** Mark Pitchford, LDRA
12:30-13:30	Lunch Break			
13:30-14:30	KEYNOTE 13:30	**Conference Keynote:** **Developing Game-Changing Embedded Intelligence** Jim Tung, MathWorks		
	Session 2.3: Communication III Real-Time & TSN	**Session 3.2: OSADL** powered by OSADL	**Session 4.1 II: HW-based Security II**	
14:30-15:00	**Real-time Control of Embedded Devices with OPC UA Pub/Sub w, w/o TSN** Heinrich Munz, KUKA	**Performance of Real-time Computing and Real-time Network Communication Using the Linux Mainline Kernel in the OSADL QA Farm** Dr. Carsten Emde, OSADL	**What Can You Do When You Don't Trust Your Processor?** Yoni Kahana, Nanolock security	
15:00-15:30	**TSN – a Pragmatic Approach** Michael Roeder, SILICA - Avnet EMG	**Safe and Secure Field Updates of Embedded Linux Systems** Enrico Jörns, Pengutronix	**Methods for Provisioning Security Features in a Cortex-M33 based MCU Using a Physically Unclonable Function** Rob Cosaro, NXP Semiconductors	
15:30-16:00	Coffee Break			
16:00-16:30	**Time Sensitive Networking for Industry 4.0 and Automotive** Dr. Dadmehr Rezaei, Intel	**Using Linux in Safety-critical Environments: Update on the SIL2LinuxMP Project** Prof. Nicholas Mc Guire, OpenTech EDV Research	**Securing Edge Devices with Hardware-based Security** Timo Grassmann, Infineon Technologies	
16:30-17:00	**Extending Time Sensitive Networking over Next Generation Wi-Fi** Ritu Sethi, Intel	**Basics of Copyright Law and Open Source Licensing: Fulfilling License Obligations is Easier Than You May Think** Dr. Carsten Emde, OSADL	**Leverage Security IP Embedded in MCU for New Connectivity Use Cases** Mayank Sharma, ARM	
17:00-17:30	**SPICE Simulation of 100Base-TX LAN-Transformer in an Ethernet Transmission Path** Simon Mark, Würth Elektronik eiSos	**OSS Compliance Tools** Dr. Michael Jaeger, Software Compliance Academy	**Secure Boot of a Complex Quad Core CPU** Ken Irving, Microchip Technology	
17:30-18:00		**How to Implement Appropriate Processes for License Compliance?** Dr. Catharina Maracke, Software Compliance Academy		

Session 5.1: RISC-V I Overview

RISC-V; Practical Industry Approach to Getting Started with This Technology
Prof. Robert Oshana, NXP Semiconductors

How to Benefit from RISC-V Based Linux for Embedded Industrial Applications
Tim Morin, Microchip Technology

The Soul of a New SoC: Hands-on Experience with Embedding a RISC-V Core
Onno Martens, Trinamic Motion Control

Methodology for Implementation of Custom Instructions in the RISC-V Architecture
Larry Lapides, Imperas Software

Compliance Methodology and Initial Results for RISC-V ISA Implementations
Lee Moore, Imperas Software

Session 6.1: SW-Engineering I Languages & Standards

Declarative Programming for Cortex-M Class Embedded Devices
Andy Walter, macio

Navigating the Jungle of the Secure Coding Standards
Michal Rozenau, Parasoft

Session 6.2 I: MISRA I

The MISRA C Coding Standard: A Key Enabler for the Development of Safety- and Security-Critical Embedded Software
Roberto Bagnara, BUGSENG & University of Parma

MISRA C/C++ Situation Report
Andrew Banks, LDRA

Writing Reliable Code with MISRA C
Colin Walls, Mentor, A Siemens Business

Session 7.1 I: Embedded Vision I

Adding Intelligent Vision to Your Next Embedded Product
Radhika Jagtap, ARM

Implementation of Camera Based Driver Monitoring System Using Deep Learning
Nirmal Kumar Sancheti, AllGo Systems

Develop Multi-platform Computer Vision Solution with Intel Up Squared
Oluwatobi Oyinlola, Intel

High Image Quality for Embedded Vision Applications
Henning Haider, Allied Vision Technologies

Machine Learning for Embedded; a System of Software and Hardware Components
Prof. Robert Oshana, NXP Semiconductors

Session 8.1: Intelligent Systems I Applications

The Edge is Getting Smarter – AI in the IoT World
Amir Sherman, Arrow

Context-Aware Smart Home – Opening the Eyes of AI in the Home Through Sensors
Johan Pedersen, Silicon Labs

Ultra Low Power Key Phrase Detection at the Edge
Hussein Osman, Lattice Semiconductor

Embedded Deep Learning Healthcare Collaboration System
Chungyeh Wang, Intel

Motor Condition Monitoring for Predictive Maintenance in „Industrie 4.0“
Volker Rzehak, Texas Instruments

Coffee Break

Lunch Break

Conference Keynote:
Developing Game-Changing Embedded Intelligence
Jim Tung, MathWorks

Session 5.2: RISC-V II Security

Maintaining Security In a Heterogeneous and Changing World
Jon Geater, Thales
Cesare Garlati, prpl

A New Zero-Trust Model For Securing Embedded Systems
Chris Conlon, wolfSSL
Cesare Garlati, prpl

Session 6.2 II: MISRA II

Using MISRA C/C++ for Security and Reliability
Greg Davis, Green Hills Software

Avoiding Unsafe and Insecure Complex Software
Mark Richardson, LDRA

Session 7.1 II: Embedded Vision II

Deep Learning Versus Rule-based-configurable Vision Software on Embedded Devices
Christoph Wagner, MVTec Software

Sorting Through the Many Options for Machine Learning at the Edge
Markus Levy, NXP Semiconductors

Session 8.2: Intelligent Systems II Hardware

How to Implement Deep Learning on FPGAs
Robert Green, Asic Design Services

Machine Learning on Arm Cortex-M Microcontrollers
Dr. Naveen Suda, ARM

Session 9.1: Embedded GUI & HMI

Which Graphic Software Library Should I Use for My Embedded Device?
Aurindam Jana, The Qt Company

Coffee Break

Session 5.3: RISC-V III System

User Mode Interrupts: A Must for Securing Embedded Systems
Prof. Sandro Pinto, Uni do Minho
Cesare Garlati, prpl

Embracing a System Level Approach: Combining Arm & RISC-V in Heterogeneous Designs
Gajinder Panesar, UltraSoC

RISC-V Project: from Embedded Cores to Vision of Datacenter Processors
Dr. Zvonimir Bandic, Western Digital

Why Coding Standards and Implementing MISRA-C
Chris Hills, Phaedrus Systems

How Far Can You Trust Your Compiler?
Mark Pitchford, LDRA

Approaches for Improving Handling of Static Analysis Findings
Dr. Claude Bolduc, Rogue Wave Software

powered by MISRA

Enhance Human Vision with Intel Vision Technology
Pavani Kilari, Intel

Implementing Monocular Visual SLAM for Augmented Reality in Low-Power Embedded Vision Systems
Gordon Cooper, Synopsys

Bridging Embedded Vision and Machine Vision with a Hybrid Driver
Mark Schenk, Allied Vision Technologies

Accelerating Next Generation Deep Learning Algorithms – How to Choose FPGA or GPU?
Prof. Alok Gupta, Intel

Hardware Implementation of Deep Neural Networks – A Comparison Between FPGA and GPU
Marcus Rüb, Hahn-Schickard

Driving Deep Learning Performance Through Hardware Accelerators and Advanced Storage Technology
Muhammad Waqas Sadiq Jutt, Intel

Embedded Computer Vision Applications with Qt
Berthold Krevert, basysKom

3D GUIs for the Mass Market
Jason Williamson, Altia

The Usage and Benefits of Global Palettes in Embedded Graphics Applications
Kurt Parker, Microchip Technology

Want more? See page 12/13 for additional classes!

	Session 1.1 I: Internet of Things I	Session 2.4: Communication IV Wireless Physical & Design Aspects	Session 3.3: Linux	Session 4.3 I: Security Architectures & Hacking I
09:30-10:00	**Session Keynote: Digital Transformation: A Catalyst for Changing the Embedded Development Paradigm** Dr. Gareth Noyes, Wind River Systems	**Model Based Approach for Wireless Network Design and Implementation** Marco Roggero, MathWorks	**ARM SoCs in the Mainline Linux Kernel** Arnd Bergmann, Linaro	**Lessons to be Learnt from the World's Most Lethal Cyber-Attacks** Anyck Turgeo, IBM
10:00-10:30	**Think Local: How to Migrate Intelligence from the Cloud to Embedded Devices at the Edge** Chris Shore, ARM	**Robust Software Defined COFDM-Modem for Embedded Applications** Andreas Bayer, A.R. Bayer DSP Systeme	**Status of the Embedded GPU Space** Robert Foss, Collabora	**Quantum Computers Just Broke My Crypto – What Now?** Kris Chaplin, Intel
10:30-11:00	**The Future of IoT: Edge Intelligence, Distributed Processing and Data Orchestration** Olivier Pauzet, Sierra Wireless	**From DC to Daylight: Single Chip RF Solutions for Wired, Wireless and High Frequency Applications** Glenn Steiner, Xilinx	**XDP for Embedded Networking** Luka Perkov, Sartura	**Breaking Security: Power Analysis & Fault Injection Attacks** Dr. Colin O'Flynn, NewAE Technology/Dalhousie University
11:00-11:30	Coffee Break			
11:30-12:00	**Where the Cloud Meets the Edge** Brad Cole, Digi International	**How a Software-defined Radio Enables Diversity in IoT Endpoint Design** Dan Clement, ON Semiconductor	**Software Defined Peripherals in Linux Using Zephyr and RPMsg** Marek Novak, NXP Semiconductors	**Developing a Mixed-critical AUTOSAR Adaptive ECU with Safety and Security by Design** Dr. Sergey Tverdyshev, SYSGO
12:00-12:30	**Distributed Database Systems and Edge/Fog/Cloud Computing** Steve Graves, McObject	**Introduction for Bluetooth5 IoT Device – RoKi Sensor Node** Koki Okada, ROHM Semiconductor	**Linux Containers on a Small Device – a Good Idea?** Valter Minute, Toradex	**Enabling TPM2.0 with an Open Source Software Stack for Industrial and Automotive Applications** Dr. Florian Schreiner, Infineon Technologies
12:30-13:30	Lunch Break			
13:30-14:30	KEYNOTE 13:30	**Conference Keynote:** **Embedded Intelligence for the Next Wave of Smart Systems – Opportunities and Challenges on the Edge** Jean-Marc Chery, STMicroelectronics		
	Session 1.1 II: Internet of Things II	**Session 2.5: Communication V Wireless Multiprotocol**	**Session 3.4: Virtualization**	**Session 4.3 II: Security Architectures & Hacking II**
14:30-15:00	**Databases at the Edge – ObjectBox for Devices and Gateways** Markus Junginger, Objectbox	**The Benefits and Challenges of a Common Software Platform for IoT Development** David Egan, Silicon Labs	**Virtualization Impact on the Performance in Embedded Systems** Marcus Nissemark, Green Hills Software	**Secure Boot, Chain of Trust and Data Protection** Akshay Bhat, Timesys
15:00-15:30	**End-to-End Streaming Data Management Using Streaming Analytics Framework and Visual Data Management System** Dr. Wendy Siew Wen Chin, Intel	**Radio Scheduling in Dynamic Multiprotocol Applications** Marius Munder, Silicon Labs	**On the Road Towards Autonomous Driving – Simplifying AI with Virtualization Technologies** Dr. Ciwan Gouma, OpenSynergy	**Chains of Trust: Building Security into Today's Digital World** Gil Bernabeu, GlobalPlatform
15:30-16:00	Coffee Break			
16:00-16:30	**Streaming Analytics Framework (SAF)** Dr. Shao-Wen Yang, Intel	**Low Power WiFi for IoT Devices** Asaf Even-Chen, Texas Instruments	**The Automotive GPU gets Virtual** Kristof Beets, Imagination Technologies	**Sidestepping Side Channel Attacks Through Separation & Virtualization** Arun Subbarao, Lynx Software Technologies
16:30-17:00	**Towards a Greener World with ECMA-393 Network Proxying: A Practical Guide To Support Multi-Protocols Network Presence** Boon Leong Ong, Intel	**Manage Thousands of Nodes Through Secure Commissioning with Thread 1.2 Network Protocol** Robert David, NXP Semiconductors	**Handling Mixed Criticality on Modern Multi-core Systems: the HERCULES Project** Dr. Paolo Gai, Evidence	**Securing all Network Layers of CAN (FD) Communication** Olaf Pfeiffer, Embedded Systems Academy Andreas Walz, HS Offenburg
17:00-17:30	**Applying Cognitive Systems Engineering to Shape a Good Developer Experience of IoT Solutions** Dr. Jongsoon Park, Intel	**Taking Mesh Networking Mainstream** William Hart, Particle Industries	**New Development Paradigms for Smart IoT** Loïc Minier, Canonical	**Simplifying Product Returns Through Device Security** Øivind Loe, Silicon Labs

Session 6.3: Software Engineering II Design & Modeling	Session 8.3: Intelligent Systems III Autonomous Driving	Session 10.1: SoC I Analog Circuits & Solutions
Migrating Legacy Software Applications to Model-Based and AUTOSAR: an Introduction to a Programmatic Approach Roberto Agnelli, Teoresi	**Law and Innovation – a Difficult Relationship?** Susanne Meiners, NewTec	**A Programmable Analog Computer on a Chip** John Milios, Nicolas Clauvelin, Sendyne
Emerging MultiCore Development Paradigms Greg Davis, Green Hills Software	**Performance Profiling and Optimization for Autonomous Driving Workload** Yang Wang, Intel	**Mission Impossible? If an Embedded Antenna Needs a Ground Plane of 100mm, How Can it Perform Brilliantly within an IoT Device with a Very Small PCB?** Colin Newman, Antenova
Coping with Complexity in Mobility by Connected Model-based Systems Engineering – An Insight Look Into Successful Projects Andreas Korff, Parametric Technology	**A Machine Learning Environment for Evaluating Autonomous Driving Software** Jussi Hanhirova, Aalto University	**Protect the Ports!** George Slama, Wurth Elektronik eiSos
Coffee Break		
Software Quality, Systemic Failure and Dual Modular Redundancy Mark Pitchford, LDRA	**Power Efficient AI Processors for Perception and Decision Making in Autonomous Vehicles** Lazaar Louis, Cadence	**Session 10.2 I: SoC II EDA I**
Design Cycle Acceleration for Hardware/ Software Co-Design with Renode Dr. Greg Sullivan, Dover Microsystems	**Understanding the Safe Move to Intended Functionality in Autonomy** Joe Dailey, Mentor, A Siemens Business	**Using Models for SoC Hardware/ Software Co-design** Baruch Mitsengendler, MathWorks
		Matlab Simulink for FPGA-Design Dr. Baltasar Trancón Widemann, aicas
Lunch Break		

Conference Keynote:

Embedded Intelligence for the Next Wave of Smart Systems – Opportunities and Challenges on the Edge

Jean-Marc Chery, STMicroelectronics

Session 5.4: Power Supply	Session 6.4: Software Engineering III Software Quality I	Session 8.4: Intelligent Systems IV Development Methods	Session 10.2 II: SoC II EDA II
PoE: The Power Oriented Era Jairo Bustos Heredia, Würth Elektronik eiSos	**Semantic Static Analysis of IoT Software** Dr. Pietro Ferrara, JuliaSoft	**Efficient Workflow for Designing, Training and Deploying Deep Learning Models with MATLAB** Marco Roggero, The MathWorks	**An Open Source Framework for Rapid Application Development for Complex SoCs** Anton Krug, Microchip Technology
Extending the Abilities of Battery-Powered End Nodes Through Better Power Supply Design Josh Norem, Silicon Labs	**Static Analysis of Finite State Machines with Zero False Alarms** Dr. Daniel Kästner, AbsInt Angewandte Informatik	**Accelerating Embedded Inferencing** Russell Klein, Mentor Graphics	**Delivering Real Time and Determinism with Zynq Ultrascale+ MPSoC A53 Clusters Using Advanced Cache Management, Jailhouse and Xen Hypervisor** Dr. Giulio Corradi, Xilinx
Coffee Break			
OP-TEE – A Intro to a Trusted Execution Environment Andreas Schuler, Missing Link Electronics	**Machine Learning for Finding Programming Defects and Anomalies** Dr. Paul Anderson, GrammaTech	**Benchmarking the Intelligent Edge – A Framework to Measure Embedded AI Performance** Bruno Zimmermann, ZHAW InES	**System-Level Modeling of Heterogeneous Compute Architectures for NVMExpress Protocol Acceleration** Cedrik Bock, Missing Link Electronics
Harvesting Energy from RS232 Data Signals to Power a Wired to Wireless Converter Prof. Dr. Marcel Meli, ZHAW InES	**How to Find Concurrency Issues in C and C++** Dr. Frank van den Beuken, Perforce Software	**Designing Intelligent Systems Using Resource Constrained Edge Devices** Jacob Beningo, Beningo Embedded Group	**Shifting-Left Together – Enabling the Ecosystem with Virtual Platforms** Dr. Jakob Engblom, Intel
Ferrite for EMC – What Do I Need to Know? George Slama, Wurth Elektronik eiSos	**Automating Code Reviews by Writing Your Own Program Analysis Rules** Prof. Dr. Ralf Huuck, Synopsys	**Safety in Cooperative Automated Systems** Dr. Daniel Schneider, Fraunhofer IESE	**Shift Left for Software Development Using Virtual Platform Emulation Hybrids** Frank Schirrmeister, Cadence Design Systems

Want more? See page 12/13 for additional classes!

	Session 1.2: Internet of Things III	Session 2.6 I: NB-IoT & LPWA I	Session 2.8 I: Wireless Power I	Session 3.5: OS-Security
09:30-10:00	**IoT Platforms: Selection and Pitfalls** Jan Rodig, tresmo	**What 5G Can Help for Industrial IOT** Yongbin Wei, Qualcomm Technologies	**Market and Future of the Global Wireless Power Transfer Industry** Jörg Hantschel, Würth Elektronik eiSos	**The LTS Kernel is a Barrier to Building a Global Secure IoT Platform** George Grey, Foundries.io
10:00-10:30	**Benchmarks: the Good, the Bad, and the Ugly** Diego Buitrago, Ben Boren, Intel	**DECT-5G: Enhancing the DECT and ULE Standards to Embrace the Requirements of 5G (IMT-2020)** Daniel Hartnett, DECT Forum	**Qi Versus NFC: Evaluating NFC as a New Wireless Charging Solution for Small Battery Powered Devices** Peter Schmallegger, NXP Semiconductors Austria	**How Should an RTOS Works in a TrustZone for Armv8-M Environment?** Joseph Yiu, ARM
10:30-11:00	**How the Use the IIC's IICF to Select the Best IIoT Connectivity Technology** Brett Murphy, Real Time Innovations	**Evaluating NB-IoT Technology for Industrial Communication** Kofi Atta Nsiah, Hahn-Schickard	**EMF: Requirements, Directives and Measure Method in Europe** Werner Grommes, DGUV/IFA	**Designing a Secure and Reliable OTA Update Mechanism for IoT Endpoints** Nick Lethaby, Texas Instruments
11:00-11:30	Coffee Break			
11:30-12:00	**IoT Device Lifecycle Management – Update. Control. Secure. The Keys to IoT Device Best Performance and Secure Data-to-cloud Connections** Francis D'Souza, Gemalto	**LoRa LoRaWAN a Technologie Used in Industrial Application** Michael Fink, Semtech Germany	**15W Inductive Wireless Power Transfer with Integrated Data Communication** Cem Som, Würth Elektronik eiSos	**Android Security Internals** Karim Yaghmour, Opersys
12:00-12:30	**Improving Reliability of Industrial IoT Systems** Edwin de Jong, Real Time Innovations	**The 20 Cent IoT is Coming** Aurelius Wosylus, Sigfox Germany	**Boosting Contactless Charging to 40W** Francois Ricodeau, Semtech	**A Future-proof Performance Enhancement for Secure MCUboot** Derek Atkins, SecureRF
12:30-13:30	Lunch Break			
	Session 1.3: Internet of Things IV OPC UA I4.0	**Session 2.6 II: NB-IoT & LPWA II**	**Session 2.8 II: Wireless Power II**	
13:30-14:00	**Open Source OPC UA Pub/Sub Over TSN: Current Status and Implementation Plans** Julius Pfrommer, Fraunhofer IOSB	**Revolutionizing Worker Safety with Innovative IoT and LPWAN Solutions** Albert Behr, Behr Technologies	**Regulatory Requirements for Devices Using Wireless Power Transfer Technology** Niels Jeß, CETECOM	
14:00-14:30	**OPC UA Application Development with Open62541** Frank Meerkötter, basysKom	**Unified Test Environment for LPWA and Cellular IoT** Jubin E. Sebastian, Offenburg University of Applied Sciences	**Wireless Power Transfer Safety Test Toolkit: An Automated Tool for Compliance Testing of WPT Systems Including Implant Safety** Dr. Ilaria Liorni, IT'IS Foundation	
14:30-15:00	**Dynamic LWM2M Data Model Mapping to OPC UA** Dovydas Girdvainis, Hahn-Schickard		**Wireless Power Transfer in Rotating Assemblies** Jelena Mijuskovic, Würth Elektronik eiSos	
15:00-15:30	Coffee Break			
15:30-16:00	**Securing the IoT** Dorian Knoblauch, Fraunhofer FOKUS	**Session 2.7: Communication VI Wireless Localization** **Introduction to UWB Network Topologies and Applications** Kenneth Dwyer, Decawave	**Wireless Power Transmission: High Efficient Solution Based on Resonance Effects with High Power Density for Long Transmission Distances** Günther Trautzl, WPT Systems	
16:00-16:30	**Assistance Systems for Industrial 4.0 Environments** Bjoern Barig, IMMS	**Distance Estimation Using Narrow-band Wireless Time of Flight** Carlos Neri, NXP Semiconductors	**Cost Optimization in Wireless Power Systems** Christian Wern, etatronix	

Session 4.4 I: Securing IoT I	Session 6.5: Software Engineering IV Development Process	Session 6.7: Software Engineering VI Software Testing	Session 10.3: SoC III Complex ICs & System Solutions
Common Pitfalls in IoT Security Implementations and How to Avoid Them Brent Wilson, Silicon Labs	**Agile in Development Regarding Safety** Frank Poignée, infoteam Software	**Self-testing in Embedded Systems** Colin Walls, Mentor, A Siemens Business	**Next Generation 7nm FPGA Architecture Enables Machine Learning for Edge and Cloud Computing** Manoj Roge, Achronix Semiconductor
Security on IoT Devices with Secure Elements Tobias Schläpfer, ZHAW Institute of Embedded Systems	**Adopting Agile/DevOps ALM in Automotive & Safety-critical Development** Peter Haller, Intland Software	**Testing Strategies for Asymmetric Environments** Jeffrey Fortin, Vector Informatik	**Design Space Exploration for Convolutional Neural Networks on a 22nm FD-SOI SoC** Nicolai Behmann, Leibniz Universität Hannover
Finding the Right Security Level for Your IoT Application Dr. Lars Lydersen, Silicon Labs	**How to Balance Traceability and Compliance With Agile Development** Robert Riccetti, Gerhard Kruger, Perforce Software	**Testing Safety Critical Software Using Automated Fault Injection** Michael Wittner, Razorcat Development	**High Performance Thermal Management Using Miniature Low Cost Microfluidics Heat Sink** Philippe Soussan, IMEC
Coffee Break			
Optimizing Threat Modelling to Create Robust IoT Security Solutions Suresh Marisetty, ARM	**Open Source Software and Mission-Critical Embedded Systems – Like Oil and Water** Andrew Banks, LDRA	**Hardware in the Loop Test in Combination with Continuous Integration** Dr. Kristian Trenkel, iSyst Intelligente Systeme	**400G+ Hyperscale Data Centers with 56G Ethernet PHY IP** Manmeet Walia, Synopsys
Secure Device Management for the Internet of Things Geert-Jan Schrijen, Intrinsic ID	**Bug-killing Using Best-practice Development Techniques** Mark Richardson, LDRA	**Consistent Test Reuse Across MIL->SIL ->HIL in a Model-Driven Development Workflow** Lance Brooks, Mentor, A Siemens Business	**SSD SoC Microcontroller with Embedded Neural Network for 3D NAND Flash Memories** Dr. Lorenzo Zuolo, Microsemi
Lunch Break			
Session 4.4 II: Securing IoT II	**Session 6.6: Software Engineering V Software Quality II**	**Session 6.8: Software Engineering VII Software Debugging**	**Session 10.4: SoC IV ICs & IPs**
Make Your IoT Project Secure in 5 Steps Dr. Shawn Prestridge, IAR Systems	**The (Software) Doctor is in...Software Vital Signs for Managing the Development of Your Embedded Software** Prof. Robert Oshana, NXP Semiconductors	**Tips and Tricks for Debugging** Greg Davis, Green Hills Software	**RADAR Signal Processing on an Embedded System Using the Xilinx Zynq Platform** Prof. Frank Kesel, Hochschule Pforzheim
A Major New IoT Security Certification Scheme with Innovative Trust Signals – PSA Certified Robert Coombs, ARM	**Miscompilation – A Thing of the Past** Dr. Daniel Kästner, AbsInt Angewandte Informatik		**Lowering Software Development Costs by Using Arm Cortex-M Processors in an FPGA** Phillip Burr, ARM
Secure and Scalable FW Upgrade Mechanisms in the IoT Domain Frank Audun Kvamtrø, Nordic Semiconductor	**Uncovering Real-Time Bugs with Specialized RTOS Tools** Jean Labrosse, Silicon Labs	**Simplify Multi-core Debugging in Your SoC Development Workflow** Dr. Shawn Prestridge, IAR Systems	**Custom RF SoC Have Never Been this Easy** Edel Griffith, Adesto Technologies
Coffee Break			
Security and Licensing for IoT Devices Guenther Fischer, Wibu-Systems	**Safety, Security, and Compiler Bugs** Greg Davis, Green Hills Software	**Connectivity, Complexity & the Role of Enhanced Debugging** Trish Messiter, Clarinox Technologies	**Virtual Digital Sensor for Analog Signal Processing on SoCs** Vinay Bansal, Faststream Technologies
Why Should an IoT Sensor Maker Care About the Blockchain? Mark Hebbel, Basler	**The AMASS Approach for Assurance and Certification of Critical Systems** Gaël Blondelle, Eclipse Foundation Europe		**High Speed Communication: Everything Serial** Dirk van den Heuvel, Topic Embedded Products

Program is subject to change (as at 05.12.2018)

Want more? See page 12/13 for additional classes!

TUESDAY, FEBRUARY 26, 2019

	Class 3.1: The Robert Berger Class – Embedded Linux	Class 5.1: Ultra Low Power Class	Class 6.1: The Bruce Douglass Class 1 – Modeling
09:30-10:30	**Embedded Linux a Crash Course** Robert Berger, Reliable Embedded Systems	**Ultra Low Power Hands-on Workshop** Herman Roebbers, Altran	**Model-Based Interface Control Documents**
10:30-11:00			**Improving System Requirements with Use Case Models**
11:30-12:30			**Everything you Always Wanted to Know About Flowcharts and Activity Diagrams**
14:30-15:30			**Advanced Behavioral Modeling with State Machines**
16:00-17:00			**Data Modeling for Systems Engineering and System Specification**
17:00-17:30			**The Tao of SysML** Dr. Bruce Douglass, IBM

WEDNESDAY, FEBRUARY 27, 2019

	Class 3.2: Embedded Android Workshop	Class 3.3: Linux Hands-on Workshop with BeagleBoard.org PocketBeagle	Class 4.1: The ESCRYPT Class
09:30-10:30	**Embedded Android Workshop** Karim Yaghmour, Opersys		**The ESCRYPT Class – Security for a Globally Connected Vehicle** ESCRYPT, et.al.
10:30-11:00			
11:00-11:30			
11:30-12:00			
12:00-12:30			
14:30-15:30		**Getting Started with PocketBeagle from BeagleBoard.org – A Hands-On Coding with Embedded Linux Workshop** Jason Kridner, Texas Instruments & BeagleBoard.org Foundation	
15:30-16:00			
16:00-17:30			

THURSDAY, FEBRUARY 28, 2019

	Class 3.4: The Mc Guire Class: Introduction to Linux Kernel Tools	Class 4.2: Hands on Side Channel Power Analysis	Class 6.3: The Bruce Douglass Class 3 Safety & Security
09:30-10:15	**OSADL: Introduction to Linux Kernel Tools** Prof. Nicholas Mc Guire, Markus Kreidl, OSADL		**Safety Analysis for Embedded Systems Development**
10:15-10:30			
10:30-11:00	powered by OSADL		**Safety Design for Embedded Systems Development**
11:00-11:15			
11:30-12:00			**Model-Based Systems Engineering for Cybersecurity** Dr. Bruce Douglass, IBM
12:00-12:30			
13:30-16:30		**Hands on Side Channel Power Analysis** Dr. Colin O'Flynn, NewAE Technology/Dalhousie University	

embedded world Conference 2019 – Embedded Intelligence

Classes:

In the embedded world Classes, reputed experts speak on special topics for half a day or a full day. This format is aimed primarily at participants who want to familiarize themselves thoroughly and efficiently with a specific topic. Straightforward and concise dialogues with the experts help to answer many questions and are an excellent opportunity of quickly expanding your current expertise. The classes aim at maximum learning goals.

With these equally compact and concentrated classes, the embedded world Conference covers a broad range of substantial aspects of embedded systems in detail to offer developers competent technical groundwork.

Be sure to register now!

Class 5.2: RISC-V Workshop	Class 6.2: The Bruce Douglass Class 2 Agile
How to Build a RISC-V Embedded System In Just 30 Minutes Cesare Garlati, prpl Foundation	**Agile Systems Engineering**
How to Secure a RISC-V Embedded System In Just 30 Minutes Don Barnetson, Zorlu Ventures Cesare Garlati, prpl Foundation	
	Agile for Safety Critical Systems: Design Practices
Trusted Execution Environments: A System Design Perspective Boran Car, Hex Five Security Cesare Garlati, prpl Foundation	
	Agile for Safety Critical Systems: Quality Assurance Practices
	Agile for Safety Critical Systems: Evidence-Oriented Practices Dr. Bruce Douglass, IBM

Class 6.4: The Greg Davis Class C / C++
Writing Reliable and Portable C/C++ Code
Understand Shared Memory in the C/C++ Standards
Porting C Code to C++ Code
Hack-Proofing Your C/C++ Code Greg Davis, Green Hills Software

embeddedworld
Exhibition&Conference
...it´s a smarter world

Venue: NürnbergMesse
Messezentrum NCC Ost
90471 Nuremberg, Germany

Details and Registration:
www.embedded-world.eu

Please tick:

CLASSES
embedded world Conference 2019

		Tuesday, Feb 26, 2019		Wednesday, Feb 27, 2019		Thursday, Feb 28, 2019	
		am	pm	am	pm	am	pm
Class 3.1:	The Robert Berger Class: Embedded Linux – a Crash Course	☐					
Class 3.2:	Embedded Android Workshop			☐			
Class 3.3:	Linux Hands-on Workshop with BeagleBoard.org PocketBeagle				☐		
Class 3.4:	The Mc Guire Class: Introduction to Linux Kernel Tools					☐	
Class 4.1:	The ESCRYPT Class			☐			
Class 4.2:	Hands on Side Channel Power Analysis						☐
Class 5.1:	Ultra Low Power Class	☐					
Class 5.2:	RISC-V Workshop			☐			
Class 6.1:	The Bruce Douglass Class 1 Modeling	☐					
Class 6.2:	The Bruce Douglass Class 2 Agile			☐			
Class 6.3:	The Bruce Douglass Class 3 Safety & Security					☐	
Class 6.4:	The Greg Davis Class C / C++					☐	

Class Fees	**Early Rate until January 17, 2019**	**Late Rate from January 18, 2019**
Half Day Class	EUR 380,–	EUR 440,–
Full Day Class	EUR 570,–	EUR 650,–

Conference Fees	**Early Rate until January 17, 2019**	**Late Rate from January 18, 2019**
1 Conference Block	EUR 325,–	EUR 370,–
2 Conference Blocks	EUR 445,–	EUR 500,–
3 Conference Blocks	EUR 560,–	EUR 640,–
4 Conference Blocks	EUR 660,–	EUR 750,–
5 Conference Blocks	EUR 745,–	EUR 845,–
Full Conference (Classes excluded)	EUR 790,–	EUR 910,–

All fees plus 19% VAT

* Please note: In order to be registered you have to fill in all required fields marked with an asterisk (*). (A confirmation email will be sent to you.)
If yot want to state a different billing-address: Please register online.

I am ☐ **Exhibitor** ☐ **Student** ☐ **Co-Speaker (with** _____**)**

Company

Mr./Ms./Title*First Name*Last Name*

Street/No.*Department

ZIP-Code*City*Country*

Phone*E-Mail*

Date/Signature*

Exhibition-Ticket included!

Register online: www.embedded-world.eu
or send this fax registration form to + 49 (0) 89 / 255 56 – 0155

Please make sure that you are sending both pages!

Please tick:

SESSIONS
embedded world Conference 2019

		Tuesday, Feb 26, 2019		Wednesday, Feb 27, 2019		Thursday, Feb 28, 2019	
		Block 1 am	Block 2 pm	Block 3 am	Block 4 pm	Block 5 am	Block 6 pm
Session 1.1 I/II:	Internet of Things I/II			☐	☐		
Session 1.2:	Internet of Things III					☐	
Session 1.3:	Internet of Things IV OPC UA I4.0						☐
Session 2.1:	Communication I CAN	☐					
Session 2.2:	Communication II Bluetooth	☐					
Session 2.3:	Communication III Real-Time & TSN		☐				
Session 2.4:	Communication IV Wireless Physical & Design Aspects			☐			
Session 2.5:	Communication V Wireless Multiprotocol				☐		
Session 2.6 I/II:	NB-IoT & LPWA I/II					☐	☐
Session 2.7:	Communication VI Wireless Localization						☐
Session 2.8 I/II:	Wireless Power I/II					☐	☐
Session 3.1:	OS Basics	☐					
Session 3.2:	OSADL		☐				
Session 3.3:	Linux			☐			
Session 3.4:	Virtualization				☐		
Session 3.5:	OS-Security					☐	
Session 4.1 I/II:	HW-based Security I/II	☐	☐				
Session 4.2:	Functional Safety	☐					
Session 4.3 I/II:	Security Architectures & Hacking I/II			☐	☐		
Session 4.4 I/II:	Securing IoT I/II					☐	☐
Session 5.1:	RISC-V I Overview	☐					
Session 5.2:	RISC-V II Security		☐				
Session 5.3:	RISC-V III System		☐				
Session 5.4:	Power Supply				☐		
Session 6.1:	SW-Engineering I Languages & Standards	☐					
Session 6.2 I/II:	MISRA I/II	☐	☐				
Session 6.3:	Software Engineering II Design & Modeling			☐			
Session 6.4:	Software Engineering III Software Quality I				☐		
Session 6.5:	Software Engineering IV Development Process					☐	
Session 6.6:	Software Engineering V Software Quality II						☐
Session 6.7:	Software Engineering VI Software Testing					☐	
Session 6.8:	Software Engineering VII Software Debugging						☐
Session 7.1 I/II:	Embedded Vision I/II	☐	☐				
Session 8.1:	Intelligent Systems I Applications	☐					
Session 8.2:	Intelligent Systems II Hardware		☐				
Session 8.3:	Intelligent Systems III Autonomous Driving			☐			
Session 8.4:	Intelligent Systems IV Development Methods				☐		
Session 9.1:	Embedded GUI & HMI		☐				
Session 10.1:	SoC I Analog Circuits & Solutions			☐			
Session 10.2 I/II:	SoC II EDA I/II			☐	☐		
Session 10.3:	SoC III Complex ICs & System Solutions					☐	
Session 10.4:	SoC IV ICs & IPs						☐

Terms and Conditions:

1. The attendance fee includes participation on the booked conference days, proceedings, refreshments and free admission to the embedded world 2019 Exhibition. If morning and afternoon blocks/classes are booked, lunch is also included for that day.
2. You will receive a confirmation of your conference registration along with your invoice.
3. Cancellations received in writing before or on February 05, 2019 will be subject to a service charge of EUR 50 for one-day registrations and EUR 100 for several-days registrations. For all cancellations received after February 05, 2019 the full conference fee remains payable. Substitutions within the same company are welcome at any time.
4. The organizers reserve the right to make changes in the program and/or speakers or to cancel sessions/classes if conditions beyond its control prevail. Please check www.embedded-world.eu for the latest conference information.
5. Students are granted a 50 % reduction, student ID required. Please submit by fax to + 49 (0) 89 / 255 56 - 0155 or by email to JHeger@weka-fachmedien.de.
6. Exhibitors or Co-Speakers will receive a discount of 50 % limited to one person.
7. For registrations of five persons and more from one company, please contact our conference department for special rates.
8. On-site-registration: Please register in advance. For on-site-registration a surcharge of EUR 70 per attendee will apply.

DESIGN& ELEKTRONIK
KNOW-HOW FÜR ENTWICKLER

design-elektronik.de

Contact: Ms. Juliane Heger
Phone: +49 (0) 89 / 255 56 - 1155
Email: JHeger@weka-fachmedien.de
WEKA FACHMEDIEN GmbH
Richard-Reitzner-Allee 2
85540 Haar, Germany

An Excellent **Duet!**

WÜRTH ELEKTRONIK

© eSos

#INDUCTORDUET

WE speed up the future

TEAM WORLD CHAMPION
FIA FORMULA E 2017/2018

Coupled Inductors

The WE-MCRI is an innovative molded coupled inductor with fully automated bifilar winding process. It offers an almost ideal coupling coefficient up to 0.995. The WE-MCRI features a soft saturation behavior with its crystalline core structure and distributed air gap. The coupled inductor range includes high voltage isolation versions up to 2 kV, low profile types and versions with various turns ratios.

For further information, please visit: **www.we-online.com/coupled**

- Up to 0.995 coupling coefficient
- Up to 2.0 kV isolation
- Soft saturation
- Up to 120 A I_{SAT} and 48 A I_R
- Large portfolio

High Coupling	High Voltage	Various Turns Ratios	Low Profile	High Current	High Saturation Current
WE-MCRI	WE-CPIB HV	WE-EHPI	WE-TDC	WE-CFWI	WE-DCT