ECCS-Related Research Activities Department of Automation, TU Vienna

U. Schmid
Technical University of Vienna
Department of Automation 183/1
Treitlstraße 3, A-1040 Vienna
Email: s@auto.tuwien.ac.at

July 19, 1994

The Department of Automation at the Technical University of Vienna was established in 1988 by appointing Prof. G.-H. Schildt to the departments chair. Its primary research and teaching activities are devoted to all computer science aspects of automation systems. The broad field of research actually covered is structured internally by means of more or less independent research groups working on several dispersed projects.

Some of our projects belong to the ECCS area, but there are of course several other groups at TU Vienna working on related projects. Note that a working group evaluating possible major computer science research topics to be pursued at TU Vienna is currently evaluating *distributed systems engineering* as one of four major activities for the next five years.

Two ongoing research projects and one large mid-term activity at our department are primarily concerned about engineering large automation systems:

1 Project SynUTC — Synchronized Universal Time Coordinated (UTC) for Distributed Real-Time Systems

Keywords: Clock validation, universal time coordinated (UTC), clock synchronization, fault-tolerant distributed real-time systems.

Project head:	Ulrich Schmid Department of Automation 183/1 Treitlstraße 3, A-1040 Vienna. Email: s@auto.tuwien.ac.at FAX: +43-1-563260
Cooperation with:	Dept. of Computer Technology, TU Vienna
Co-workers:	4+3
Starting date:	July 1994
Duration:	2 years

Project description: The project SynUTC is devoted to the problem of how to establish a common notion of time that also relates to an external time standard, in particular, *universal time coordinated* (UTC), in a distributed fault-tolerant (real-time) system.

During the past few years, much research has been conducted towards a mutually consistent view of time in fault-tolerant distributed systems so that the problem of *internal synchronization*, i.e., keeping local clocks within well-defined bounds of each other, is relatively well understood. The nature of the problem, however, radically changes when the requirement of a mutually consistent global time is extended with a global time that also relates to some external time standard like *universal time coordinated* (UTC). Thus, as observed by prominent researchers like F. Cristian, the problem of fault-tolerant *external synchronization* constitutes a research topic in its own right.

Taking into account that real-time systems are becoming more and more prevalent in our daily life, e.g., as integral part of more general information processing systems, where UTC is the only common (and official/legal!) notion of time, it is obvious that systems employing their own idea of time might be of questionable use for future applications. Promising sources of UTC are readily available now, most notably the NAVSTAR *global position system* (GPS). Consequently, we felt that it is high time to focus on the problem of how to provide a global time accurately synchronized to UTC for large-scale, fault-tolerant, distributed real-time systems.

In our project SynUTC, we are primarily exploiting the promising features of our novel *clock validation technique* that solves the problem of fault-tolerant external synchronization. The underlying idea is to validate time information of external time sources like GPS-receivers against a global time maintained by the local clocks in the system. The mainstreams of our work are:

- Development of an "engineered" implementation of a particularily promising clock validation algorithm ICV.
- Providing a full (average case) analysis of our algorithm's behavior, relying on a probabilistic rather than a deterministic failure model.
- Development of an ASIC (UTCSU) supporting our algorithm by hardware.
- Planning of an elaborate experimental performance evaluation testbed comprising M68030 VMEbus-CPUs equipped with a 802.3 network coprocessor and our UTCSU.

- Investigation of availability and failures of GPS-receivers with respect to our failure model.
- Systematic exploration of the theory of external synchronization and investigation of other clock validation algorithms.

Selected paper(s):

U. Schmid. Synchronized UTC for Distributed Real-Time Systems, to appear in Proc. 19th IFAC Workshop on Real-Time Programming WRTP'94 (Reichenau/Germany, June 1994), 1994.

2 Project Versatile Timing Analyzer (VTA) for Distributed Real-Time Systems

Keywords: Monitoring, distributed real-time systems, timing analysis, distributed event recognition, object orientation, visualization.

Project head: Ulrich Schmid
Department of Automation 183/1
Treitlstraße 3, A-1040 Vienna.
Email: s@auto.tuwien.ac.at
FAX: +43-1-563260
Co-workers: 5+6
Starting date: August 1991
Duration: 3 years

Project description: The project VTA[1] aims at the development of a flexible monitoring system (the *Versatile Timing Analyzer* VTA) assisting in observing the external and internal (timing-)behaviour of a distributed real-time system.

Apart from "classical" monitoring purposes like experimental performance evaluation, a monitoring system may also be used to support theoretical modelling. In fact, any modelling of real-time systems in case of more general event arrival patterns requires realistic information about existing real-time systems. A flexible and powerful monitoring system is needed to facilitate the process of gathering such information. Moreover, a monitoring system is almost the only means for discovering errors in system specifications, and also well-suited as a test tool for checking timing violations by measurement, in particular for today's *ad hoc* real-time systems. Finally, there are applications in the system tuning area as well. Since accurate worst-case execution time predictions for modern processors are quite difficult to obtain, one may employ monitoring to improve predicted bounds considerably.

Given such requirements, flexibility and extendability are two inevitable features of a suitable monitoring system. The main streams of effort in our project VTA are:

[1]Supported by the Austrian Science Foundation (FWF) under contract P8390-TEC.

- Sound theoretical foundation, including formal semantics of the monitoring systems operation.
- Flexible primitive event management featuring full on-line monitoring and also maximal target system independence.
- High-performance, fully distributed event recognition.
- Powerful yet easy-to-use object-oriented monitor programming language.
- Flexible data analysis and visualization capabilities.

Selected paper(s):

U. Schmid, Monitoring Distributed Real-Time Systems, Real-Time Systems 7, 1994, p. 33–56.

3 Description IUCCIM — Interuniversitary Center for Computer Integrated Manufacturing

Keywords: CIM, expert systems, automated guided vehicles.

Head: Gerhard-Helge Schildt
Department of Automation 183/1
Treitlstraße 3, A-1040 Vienna.
Email: schi@auto.tuwien.ac.at
FAX: +43-1-563260

Project description: The Interuniversitary Center for 'Computer Integrated Manufacturing' (abbreviated as IUCCIM) was founded in 1990 in cooperation of several institutes of the technical and the economical university of Vienna. It has mainly the following three topics as its aims:

- research and development in the field of CIM
- practical education for students
- interuniversitary courses for people from industry

A demonstrative factory was founded by the IUCCIM in cooperation with the industry. Its structure corresponds to an average, medium-sized austrian enterprise. Here a model of the Ferrari Testarossa is fully automatically manufactured to a scale of 1:18, using most moderntechnical equipment. All CIM-relevant components as PPS, CAD, CAE, CAP, CAM and CAQ are integrated into the producing processes.

From the moment, an order comes in, to the final endproduct all courses in the factory should go off under computer control and fully automatically. In the demo factory technologically superior production machines are used, like a laser cutting machine, an injection moulding machine, automated guided vehicles, CNC-machines, a tool grinding machine. Most of the handling machines in the production lines are designed and constructed by students. All these components are integrated into a data network, that is based on the profibus-standard.

The IUCCIM also is a platform for industrial projects, who are connected with computer integrated manufacturing. The equipment in the demo factory and the competence of the people working in the IUCCIM are the ideal basis for solving problems of the industry.

The institute for Automation specialized in the following topics:

- CAE-electronics
- expert systems for PPS
- ultra-high precision measuring of drillings
- enterprise informational systems