1st International P-NET Conference

Truck Systems

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0. Contents

1. Introduction

An increasing number of truck operating companies are considering the use of electronic equipment for the following tasks

- measured data acquisition (volume, weight, temperature, pressure, speed,..)
- control and surveillance (protection against fraud, crossover protection)
- automatization of time-consuming manual processes
- replacement of logbooks and similar tasks for the driver
- route optimization
- invoice printing
- interface to other systems (radio-link, mobile phone modem, ...)

Typically, the importance of the above points depends strongly on the customer's "philosophy" and many other factors:

- degree of automatization already being achieved in the office
- operational cost of truck/driver
- legal aspects

Consequently, the market asks for a modular system to be able to fulfil the customer's immediate needs and still keep all possibilities for future expansion of the on-board electronics.

2. Milk trucks

Ultrakust is in the business of truck automatization systems since more than 10 years. It all began with a Microprocessor-based rack-type system consisting of plug-in cards.
The size of the system was so that one wonders today how all the equipment could fit into the driver's cabin.

Application Example: **Truck Systems** *[by ULTRAKUST electronic gmbh, Dr. Rainer Decker]*

Two centimetres thick cables led from the central system to the peripheral equipment (encoder, display, indicators and so on). It was a two-day job for two persons to mount all the equipment for a typical milk truck.

Approximately 4 years ago, the CMOS microprocessor (SCMP, nobody seems to know that brand today, though it was the first CMOS 8-bit processor available worldwide) used in our system was due to be replaced: a high-level language was not and would probably never be available due to the architecture of the chip (no stack!).

We decided to try a modular approach, using a serial data bus as the backbone of the truck system.Individual components were designed which could be mounted anywhere on the truck. They should be connected through a thin cable carrying the supply voltage and a serial data link for data exchange between the components. Fortunately, at that time we learned about the new magnetic flowmeter of Proces Data, Silkeborg, which was already available with a serial data port, called P-NET interface. After some comparison of the bus protocols being on the market at that time, we decided to use P-NET as the general protocol for all electronic components on the truck. The "MAK-3001" system was born.

Today, ULTRAKUST is able to deliver milk truck automatization systems also to the most exotic needs of our customers. The specific tasks on milk trucks:

- quantity measurement (calibratable, mostly with magnetic flowmeters)
- on-line temperature and pH-value measurement
- reading in supplier number from special magnetic data "block"
- control of pump, valves and other equipment on the truck
- "sorting" milk into different containers according to recent statistical information about the quality and/or the actual measurement results (temperature, pH)
- sampler device, consisting of stepper-motor driven peristaltic pump (speed depending on average quantity of the individual suppliers)
- error-proof assignment of sample bottle (bar-coded) to supplier number
- supervision of valves, degasser contents, manholes (protection against fraud)
- gathering of additional info, e.g. distance travelled, speed, ...
- backflow of information (e.g. lab results to supplier)

Currently, more than 1000 milk trucks are equipped with Ultrakust systems worldwide. Of course, we also deliver the components and software necessary to establish the data link to diaries and milk labs. In nearly all applications, our ruggedized semiconductor memory cartridge is used to transport the data from and to the truck.
All these features are, however, achieved with a single-master subset of the P-NET protocol (as I have to confess sadly). There are typically 3-4, but up to 8 P-NET slave devices connected to the system-master, which contains the main control software. The slaves typically are identical through all systems (soft- and hardware). More complex ones are automatically configured by the master via P-NET after power-up.

At 1986, when the system specification was discussed, we could hardly imagine that there is really a need for multimaster capabilities in such a small environment as a truck. Thus, we saved about 2 cm² of board space, 20 DM worth of electronic components per module and some weeks of software development effort. Today we know that this decision was definitely wrong: meanwhile we had to invest much more effort than we "saved" to implement certain features, which had not been foreseen at 1986. P-NET folks, be warned ....

3. Heating Oil Trucks

In 1989, a TV-report about selling hot (up to 45 °C!) heating oil to households caused German authorities to consider legal prescriptions to protect customers against such methods.

Though a national law turned out to be possible only in close coordination with the European authorities in Bruxelles, which would probably take five to eight years, an agreement between all large mineral oil companies is now being negotiated and will become valid from next year on. The agreement means that heating oil distributors will have some important commercial advantages when selling **temperature-compensated fuel** to their clients.

This requires that the truck has to be retrofitted with a temperature probe and an electronic calculating device which simultaneously measures the volume (using conventional mechanical meters) and the temperature of the liquid. Knowing the thermal coefficient of expansion of the fuel, it is possible to compute the volume *as if the oil had a temperature of 15 °C*. Thus, the price to be paid by the customer is now independent of the fuel temperature.

Already having a device which was capable to measure the volume and temperature of milk, it is evident that it is only necessary to write some software to do the volume compensation for mineral oil (at least if you neglect the problems of the "real world", like for example obtaining the PTB certificate for legal transactions, which took us about 18 months ...). In 1989, we decided to develop such an electronic system, which we are successfully selling today in ever-increasing quantities. Of course, the hardware is nearly exactly the same as for the milk-trucks. Currently, more than 100 systems are installed in the field (only Germany).

It turned out quickly that also on oil-trucks a modular system like MAK-3001 (here called Petro-Dat) could be of great *additional* use to the truck operator. Having all the measured values available in an on-board computer, one could use these, for example, to print an invoice immediately on the truck. Some of our customers estimated that alone the saved mailing cost and the speed up of cash-flow would pay for the total retrofitting cost within two years. Since it takes some time (typically at least half a year!) to prepare the office computer-software to deliver the data (customer’s name and address, for example) and - more complicated - to accept the data delivered back by the truck, it is advantageous to first install the electronic volume compensation first and retrofit the additional components (P-NET devices, of course) later, when the data link becomes available.

4. Future aspects

There are several aspects which will lead to an increasing need for electronic systems on trucks (and -of course - not only on trucks!):

- Quality (ISO 9000 and similar concepts require more data)
- Economy (optimization of time, distance travelled, protection against fraud ..)
- Ecology (e.g. protection against handling errors)
- European market (stronger competition --> tighter control)
- Legal prescriptions (become more complicated --> tighter control)
- "EDP-islands" will be linked together

All these needs can only be satisfied in an economically feasible way if the systems are open for extension.

Since *P-NET systems are open by definition* (of the standard) and can be *extended limitless*, we at ULTRAKUST strongly believe in a bright future of the P-NET idea.

5. Company Profile

Ultrakust was funded in 1939 in Berlin and moved to Bavaria into a completely non-industrialized region (Bavarian Wood) in the last years of World War II. The name is derived from "ultrasonic" and "acoustics", since the business dealt with ultrasonic devices at that time.

In the fifties, Ultrakust developed (among other things like a washing machine) the first hand-held, fairly-priced and accurate electronic thermometer (called THERMOPHIL), which we are still manufacturing today, though mainly for nostalgic (and not commercial) reasons.

In the seventies, humidity measurement devices were added to the product line (based on the psychrometric effect, which requires only the precise measurement of two temperatures).

Three months ago, the company moved to a completely new building (only 3 km away from the previous location, thus keeping the same telephone-number and postal-code). The building automatization is a big P-NET project by itself (under way!), being described in another contribution to this conference.

Today, the company has about 200 employees and annual sales are about 27 Million DM. Much more than 50% of those sales are based on P-NET products - including PD products. Since two years, nearly all new developments deal with P-NET devices.

The product line of the company mainly consists of:

- temperature sensors
- Infrared (contactless) temperature sensors
- humidity sensors
- all kinds of electronic devices needed for the above sensors (indicators, regulators, strip-chart recorders, transmitters, including those with P-NET interface and so on)
- data collection system for trucks (see above) and industrial use, nearly 100% of them based on P-NET

Meanwhile, a lot of P-NET devices have been developed in addition to the PD product line, many of which are commercially available today:

- "heavy-duty" humidity measurement system for industrial use
- digital "I/O-Box" (8 relays, 16 digital inputs)
- barcode reader
- P-NET to Centronics converter
- P-NET to 2 x RS-232 converter
- 4 different types of printers (thermal paper, metal paper, standard EPSON fx-line printer with integrated P-NET interface; all of them calibratable)
- infrared temperature sensors and sensor arrays (e.g. for measurement of temperature distributions)
- universal off-line and on-line data collection systems MEDAT and STOR

Since 1990, ULTRAKUST is participating in a so-called "Verbundprojekt" funded by the German ministry of research and technology with about 4 million DM. The goals of the six companies and three institutes and universities are

- further miniaturization of sensors (temperature, humidity, distance)
- development of additional P-NET links (infrared, radio)
- P-NET interface to standard PLC’s (starting with Siemens PLC’s)
- practical tests and further developments of the P-NET standard
- EMC-tests of P-NET devices

Application Example: **Truck Systems** *[by ULTRAKUST electronic gmbh, Dr. Rainer Decker]*

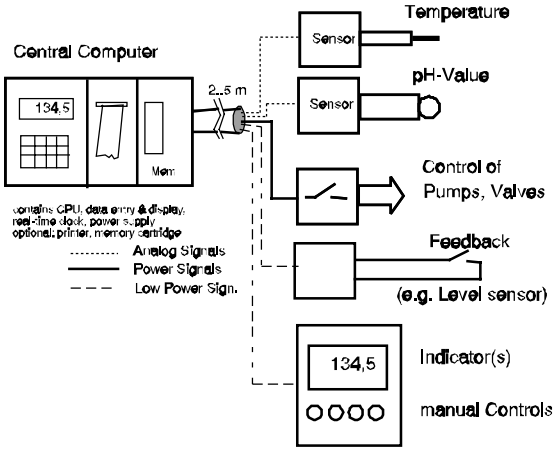
Some of the contributions on this conference already report about the activities of this project, which is on half of it's way now - and which may well lead to a breakthrough of P-NET as a *de-facto standard* in Germany and - who knows? - also in Europe.

Tasks for Truck Systems

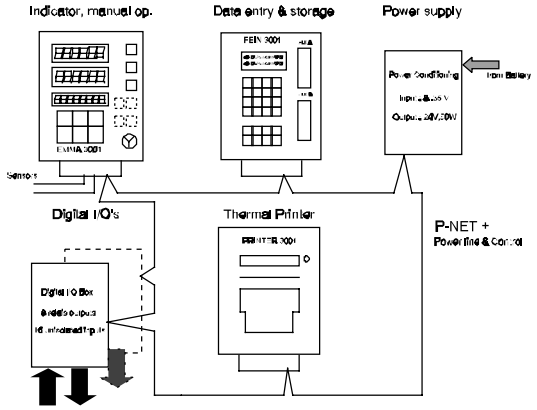
- measured data acquisition (volume,temperature,speed,...)
- automatization of manual tasks
- control and surveillance (protection against fraud and operator errors)
- route optimization
- printing invoices/delivery papers
- "automatic logbook"
- interface to other equipment (credit card reader, barcode, radio data-link, service station...)

Layout of MAK-3000 Truck System

(developed 1981)



P-NET based Truck System today



Specific Tasks on Milk Tankers

- Quantity measurement (calibrated)
- Quality factors (temperature, pH)
- Supplier code (magnetic code)
- Control of pumps, valves, ...
- Sorting of milk according to quality
- Control of sampling device
- Assignment sample-bottle/supplier
- Evaluation & registration of status signals (error conditions, fraud,..)
- Printing of tickets, lab results, ...
- additional information (distance travelled, speed, rest-times, ..)

Specific Tasks on Heating Oil Trucks

- Quantity measurement (calibrated)
- Temperature compensation (cal.)
- Controls (e.g. overspill protection, quantity preset, hose selection,...)
- Supervision (e.g. crossover protection, sealed parcel delivery)
- printing of delivery papers and / or invoice
- registration of error conditions and additional data (distance, speed,..)
- interface to credit card reader, radio link modem, ...

ULTRAKUST electronic gmbh The product line:

- Sensors ('dumb' & 'intelligent')
  - Temperature sensors
  - Infrared temperature sensors
  - Humidity sensors
- Electronic indicators, regulators, strip chart recorders for the above
- Data collection and automatization systems for
  - Milk Trucks
  - Heating Oil Trucks
  - Industrial applications
  - Quality control

Available P-NET modules:

- humidity sensor (industrial)
- universal on-line and off-line data collections systems
- Digital "I/O box" (8 relais, 16 inputs)
- Barcode decoder (2/5 interleaved)
- Centronics converter
- RS-232 converter
- Printing devices
  - Thermal print head (few moving parts)
  - Metal paper (special national requirement)
  - Epson fx-850/1050, integrated interface
- Infrared sensor transmitter
- Infrared sensor array transmitter

Verbundprojekt GENIS

- funded by German ministry of research and technology with approx. 4 mill. DM
- Cooperating Partners:
  - Fachhochschule Landshut
  - six "SMI" (Small & Medium Industries)
  - Physico-Technical Institute Jena
  - Technical University Dresden
- Project goals
  - miniaturization of intelligent sensors
  - using microsystem technologies (micro-structuring, hybrid circuitry, ..)
  - additional P-NET links (infrared, radio)
  - interface to standard PLC's (Siemens)
  - EMC tests
  - Interoperability tests