

# A multipurpose microcontroller-based data acquisition system for meteorological measurements

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# COMMERCIAL DAQ SYSTEM

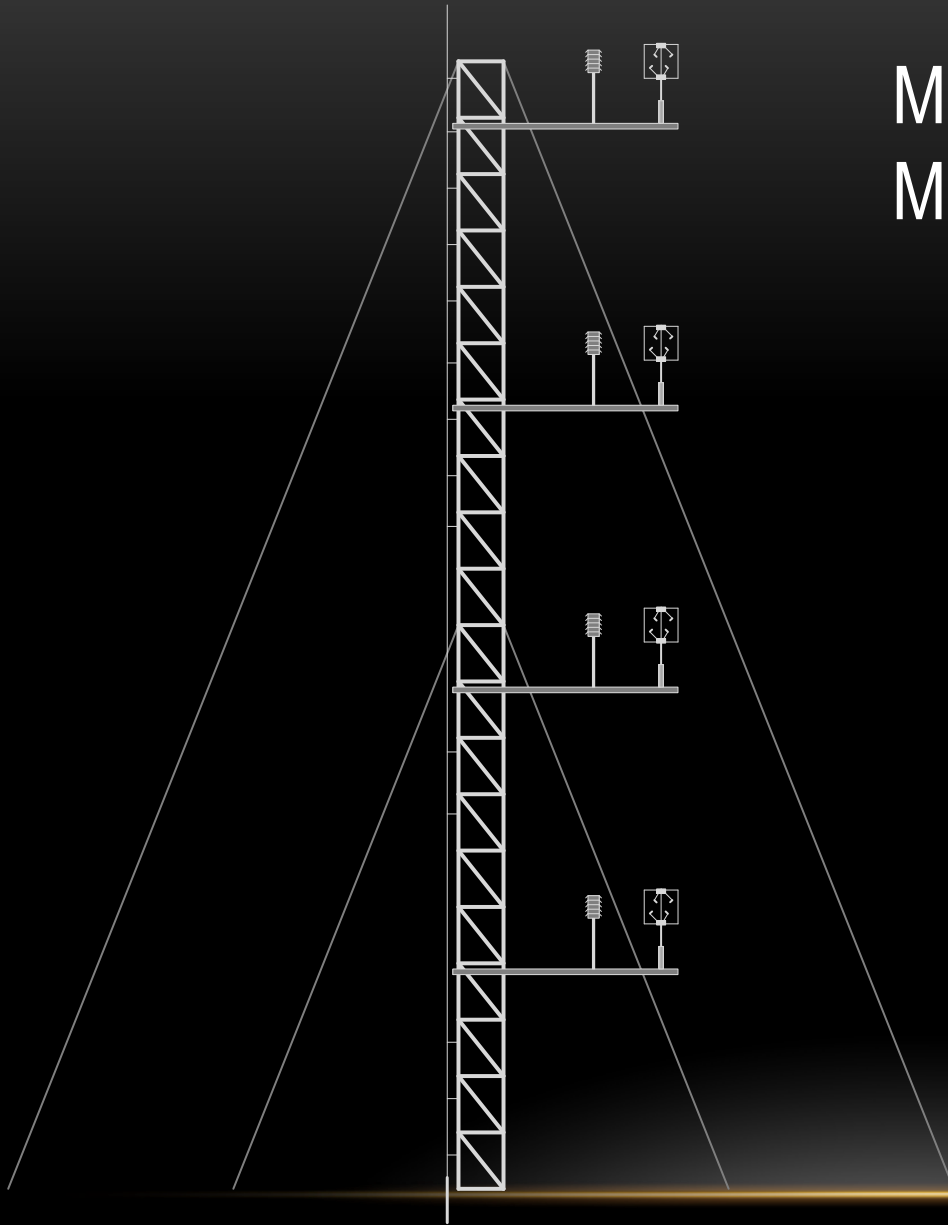
- A large selection of different products is available on the market
  - Campbell Scientific
  - National Instruments
- Useful for everyday measurement applications:
  - Electrical measurements (voltage, current, power quality, ...)
  - Environmental measurements
  - **Meteorological measurements** (wind speed/direction, humidity, solar irradiance ...)



# METROLOGICAL MEASUREMENT TOWERS

- Department of geophysics at Faculty of Science, University of Zagreb, Croatia
  - High speed measurement
    - wind speed and direction
  - Low speed measurements
    - air temperature
    - relative humidity
    - atmosphere pressure
    - insolation
  - High precision time stamping of measurement data
  - High capacity storage for storing measurement data
  - Desirable wireless data transfer to central data storage
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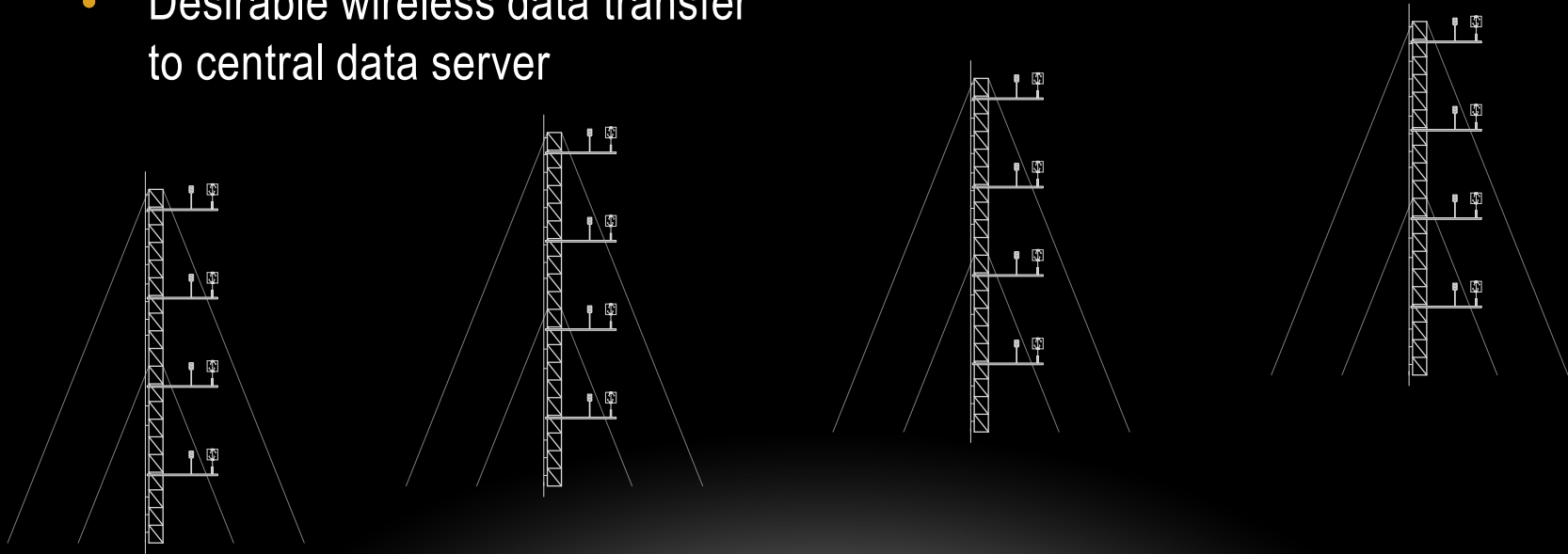
# METEOROLOGICAL MEASUREMENT TOWERS



- Ultrasonic anemometers (*digital RS232/RS485*)
- Temperature sensors (*analog*)
- Humidity sensors (*analog*)
- Atmospheric pressure sensors (*analog*)
- Insolation sensor (*analog*)
  
- **TOTAL:**
- 4 digital sensors (*50 Hz sampling rate*)
- 16 analog sensors (*5 Hz sampling rate*)
- Up to 1 GB of data per day

# METEOROLOGICAL MEASUREMENT TOWERS

- Local storage for measurement data for  $\geq 1$  month autonomy
- Needed space  $> 32$  GB / tower
- Desirable wireless data transfer to central data server
- Time synchronization of multiple meteorological towers
- Needed precision  $< 100 \mu\text{s}$



# OUR SOLUTION PROPOSAL

- **NOVEL GENERAL-PURPOSE DATA ACQUISITION SYSTEM**
  - New system developed on Department of Measurements at Faculty of electrical engineering and computing, Zagreb, Croatia (**FEE guys**)
  - Main goals:
    - High speed
    - High precision
    - Time synchronisation
    - Wireless data transfer
    - Developed on newest microprocessor technology
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# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- System diagram

## 4 DIGITAL INPUTS

RS232/RS485  
100 S/s/ch max

## CPU

NEW ARM Cortex M4  
32-bit 120 MHz

## TIME SYSTEM

w/o GPS  $\pm 2$  min/year  
w GPS  $< 1 \mu\text{s}$

## 16 ANALOG INPUTS

1000 S/s/ch max  
24-bit, 5 V – 80 mV

## CONNECTIVITY

Ethernet, USB,  
RS232

## DATA STORAGE

2 x SD cards  
up to 32 GB

# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- **Digital inputs**
    - 4 channels
    - High sample rate up to **100 S/s/ch** (20 B packets)
    - Time stamp accuracy  **$\pm 1 \mu\text{s}$**
    - RS232 / RS485 software selectable
    - Programmable serial interface characteristics (baud rate, data bits, parity, stop bits)
    - RS232 hardware flow control (RTS and CTS)
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# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- **Analog inputs**
    - Very low noise 24-Bit ADC
    - 16 channel single ended / 8 channels differential
    - High speed sample rate up to **1000 S/s/ch**
    - Dynamic ranges: from 0-5 V to 0-78 mV
    - Noise-free resolution (0-5 V range)
      - 23,0 bits for 2,5 S/s
      - 20,9 bits for 100 S/s
      - 19,0 bits for 1000 S/s
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# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- **Time system**
  - All data samples are time stamped
  - Resolution  $1 \mu\text{s}$
  - What is **time keeping accuracy**?
    - *Integrated Extremely Accurate RTC/Crystal*
    - Time keeping system accuracy  $\pm 2 \text{ min/year}$
    - Integrated GPS receiver
    - With GPS signal available – absolute time accuracy  $< 1 \mu\text{s}$

# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- **Data storage**
    - 2 SD cards up to 32 GB
    - Double storage capacity (up to 64 GB)
    - Uninterrupted data logging while transferring data to PC
  - **Samples of data**
    - Export data formats?
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# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- **Connectivity**
    - Local configuration
    - USB / RS232 port
      - Local configuration
    - Ethernet port
      - Local / remote configuration and data transfer over network
  - **Power**
    - Wide input voltage range 10-30 V
    - Low power consumption < 100 mA
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# GENERAL-PURPOSE DATA ACQUISITION SYSTEM

- **Future plans**
  - beta prototype exist...
  - testing prototypes available until Christmas 2014.

# DISCUSSION

**What is your application?**

We would like to hear your needs & opinion!

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