

# Cyber Physical Systems Integration for Induction Heating Technologies



A. IVANOV<sup>1</sup>, V. BUKANIN<sup>1</sup>, A. ZENKOV<sup>1</sup>  
<sup>1</sup>SPB. ELECTROTECHNICAL  
UNIVERSITY (LETI)  
ST. PETERSBURG, RUSSIA



V. VOLOGDIN<sup>2</sup> AND VL. VOLOGDIN<sup>2</sup>  
<sup>2</sup>FREAL&CO LTD.

ST. PETERSBURG, RUSSIA

*presented at MECO'2020 and CPSIoT'2020, Budva, Montenegro*



CPS&IoT

# Problem definition

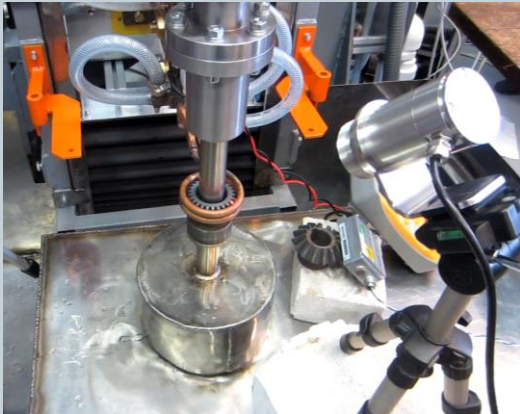


## Common problems

- The revolutionary progress in cyber and cyber-physical systems (CPS) has affected many applications of technical systems, as it is mentioned in previous MECO conferences, including the sphere of induction electro-heating
- For example the state-of-the-art thyristor or transistor power supplies with induction heating block have the built-in control systems with microprocessors and numerous sensors that allows them to operate normally and safely

# State of the art

- The control systems of heating process use a variety of temperature sensors to measure temperature, which transmit the required information in order to adjust parameters of the power supplies.



# Problem definition



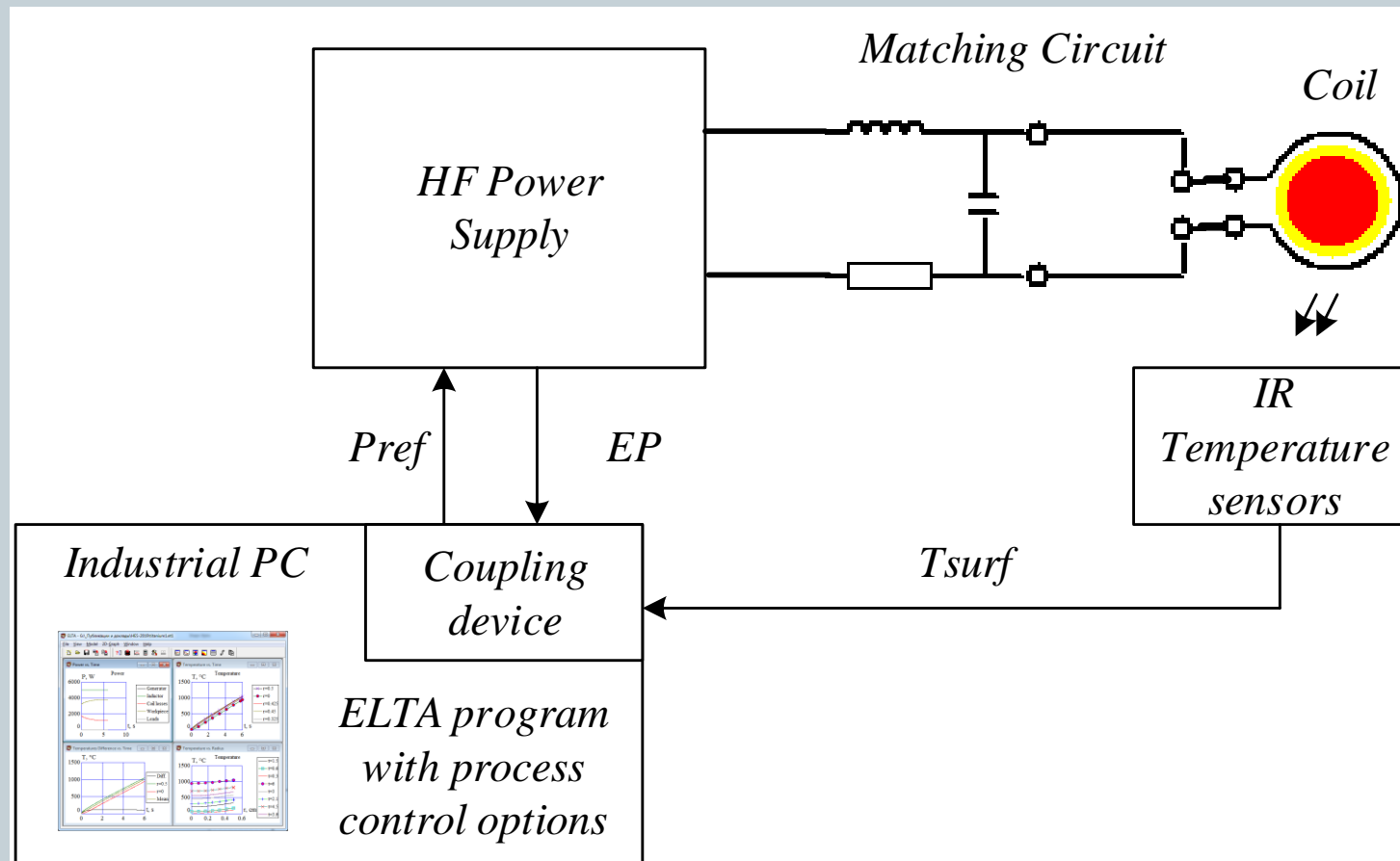
Problems to be solved are:

- Possibility to find the required but hidden from sensors several technological parameters (Temperature distribution, Heat Sources density inside the load, etc.) for a future control of product quality
- Optimization in real-time mode the heating process, a continuous monitoring and fixing of all necessary parameters by the use of an algorithm and a program embedded in a smart power supply with one board industrial PC

# Methods/Approach



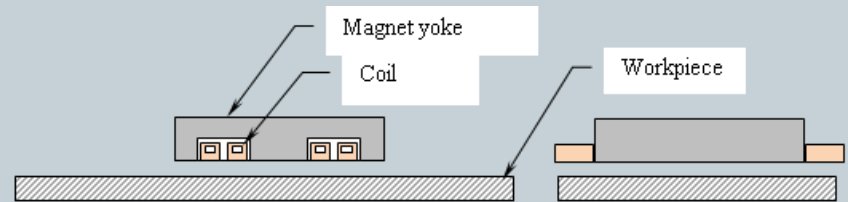
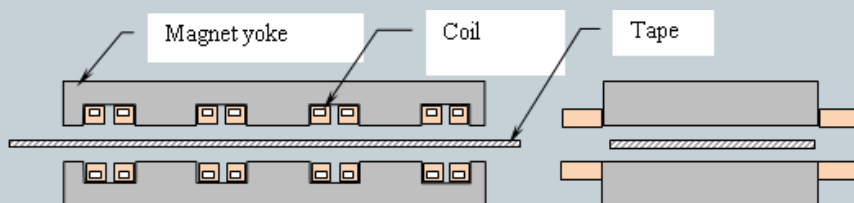
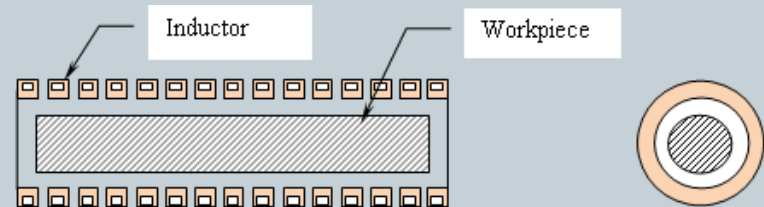
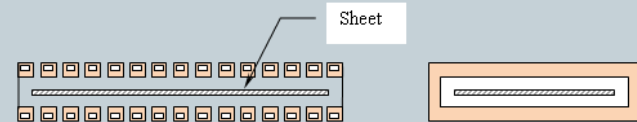
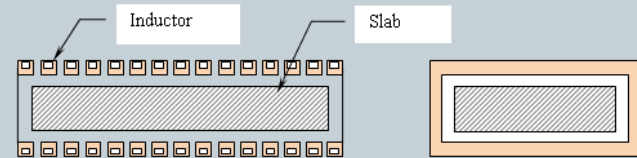
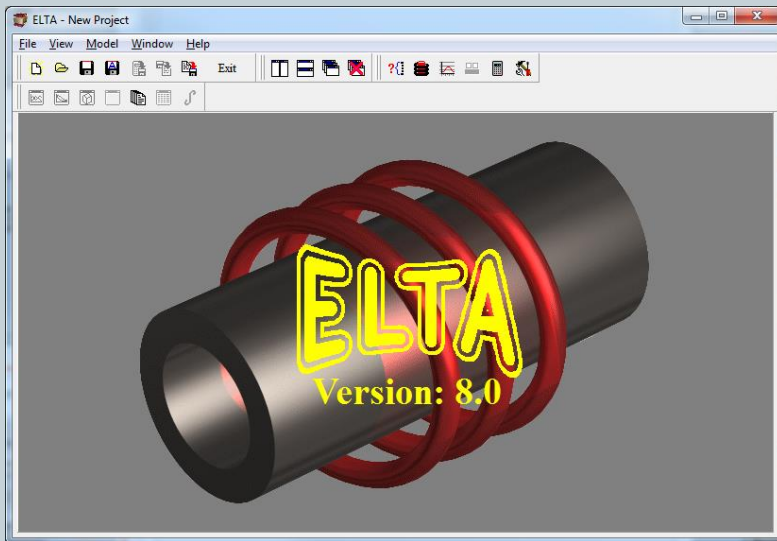
## Structure of the CPS system for Induction Heating applications



# Methods/Approach

Software for realization of the algorithm

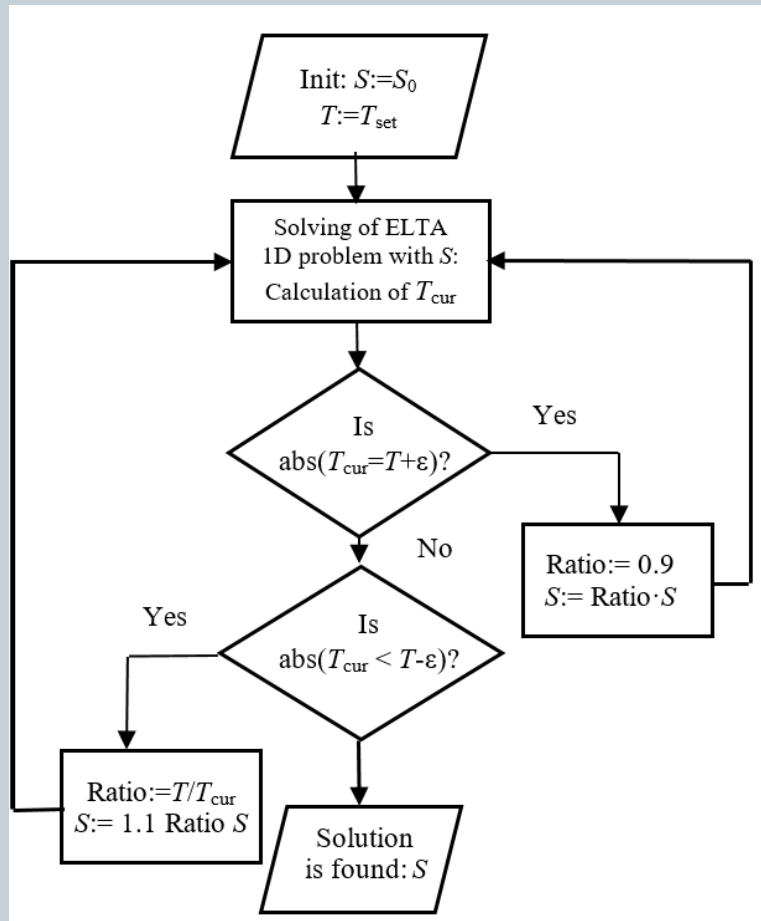
ELTA is a powerful program for a preliminary study of processes in a wide range of applications



# Methods/Approach



## Algorithm of built-in single-objective optimization

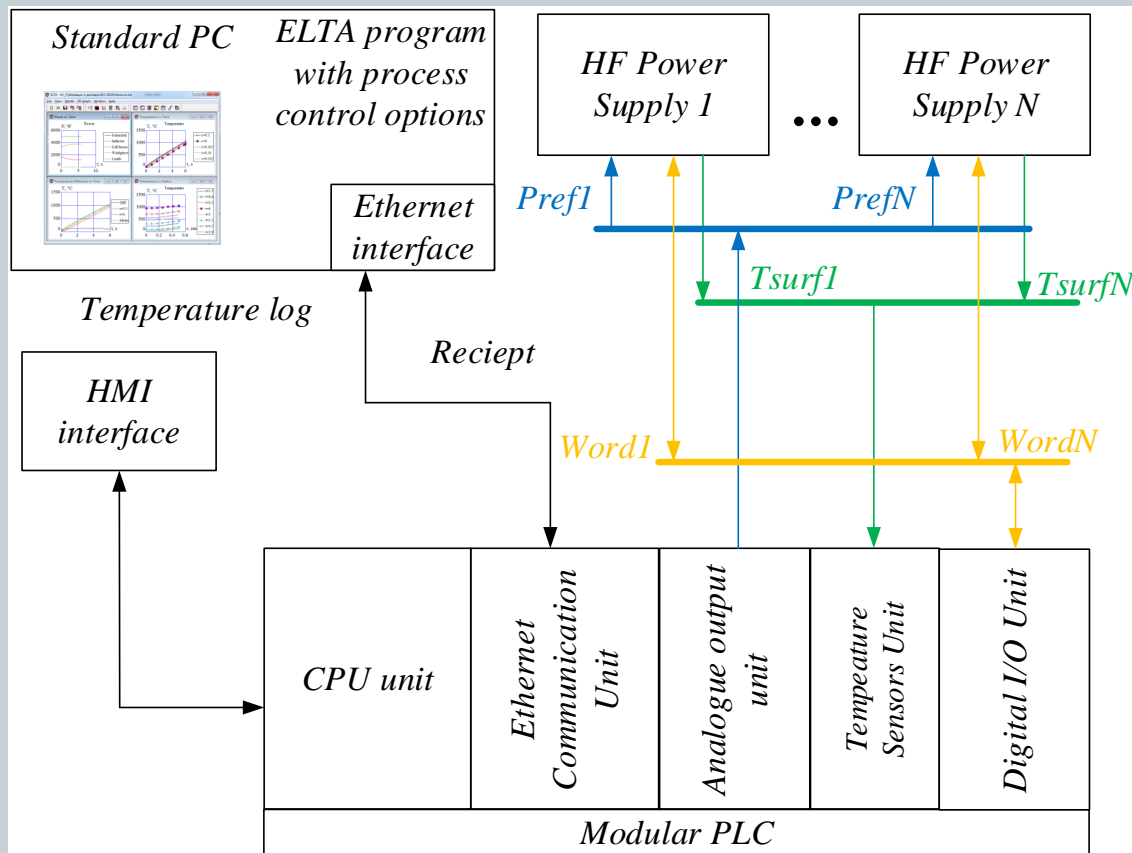


Goal: calculate output parameter of HF power supply (power, voltage, current) according to required final temperature

# Methods/Approach

## Hardware structure (variant 1)

Structure of the control system for several HF power supplies built on PLC

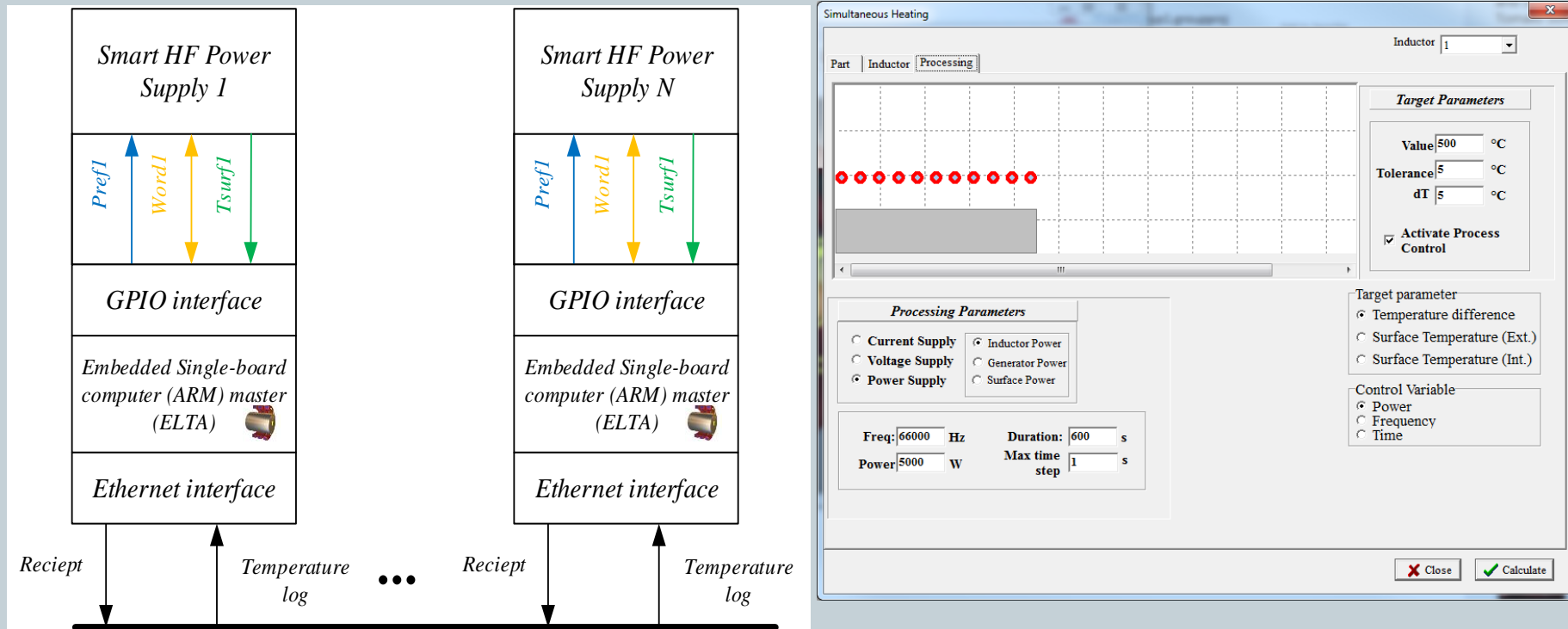




# Methods/Approach

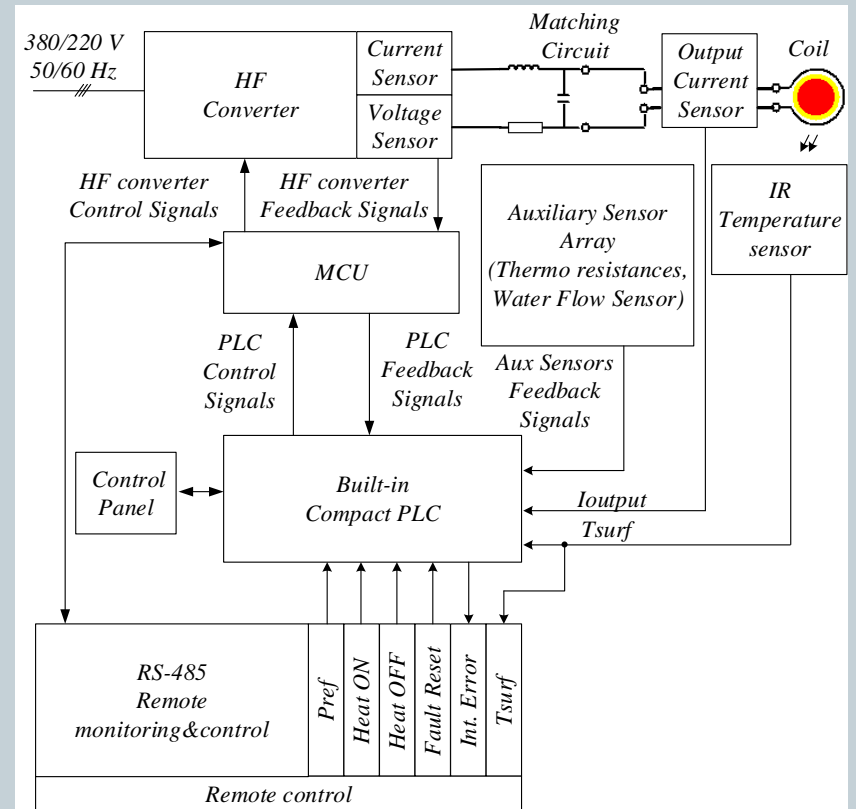
## Hardware structure (variant 2)

Structure of the control system for HF power supplies based on embedded computation



# The experiment

## Smart HF power supply of Freal ltd: Power part



# The experiment



## ELTA program with process control options

Simultaneous Heating

Inductor: 1

Part: Inductor Processing

**Target Parameters**

Value: 500 °C  
Tolerance: 5 °C  
dT: 5 °C

Activate Process Control

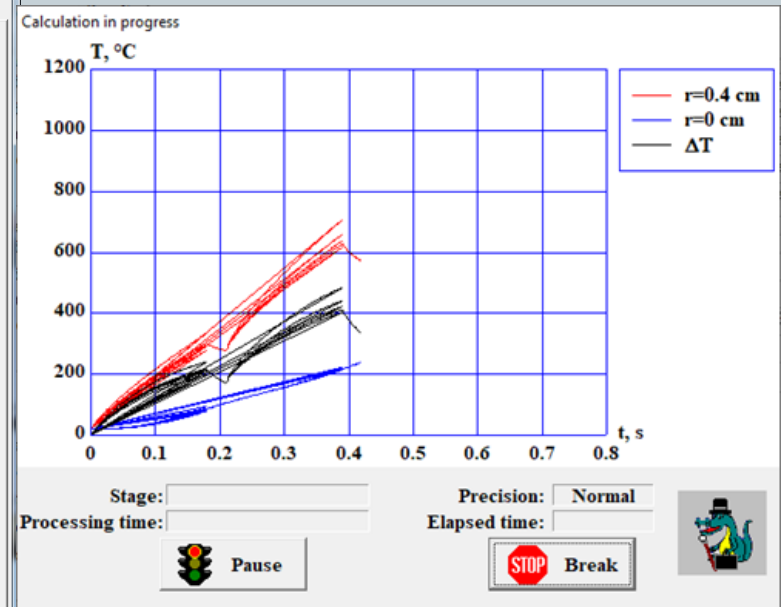
**Processing Parameters**

Current Supply     Inductor Power  
 Voltage Supply     Generator Power  
 Power Supply         Surface Power

Freq: 66000 Hz    Duration: 600 s  
Power: 5000 W     Max time step: 1 s

Target parameter:  
 Temperature difference  
 Surface Temperature (Ext.)  
 Surface Temperature (Int.)

Control Variable:  
 Power  
 Frequency  
 Time



# Conclusions



- The developed smart system enables technologists to control the quality of the final products more simply and efficiently than previously
- Further work should be aimed at finding specific types of industrial PCs that can allow the implementation of calculated algorithms for optimizing real-time processes.

THANK YOU



**Q&A**

**Alexandr Ivanov**  
**ANivanov@etu.ru**