eScop project physical layer development: INCAS conveyor line pilot case study

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Outline

• What is eScop project?
• INCAS conveyor line pilot
• eScop Physical Layer devices
• Development complexity
• Simulation model of INCAS pilot
• Control system of simulator
• Control system of pilot
• Next steps
eScop Project

Embedded systems Service-based Control for Open manufacturing and Process automation

• EU Artemis project

• 10 Consortium members:
  – Universities: Tampere University of Technology (FI) – Coordinator, Politecnico di Milano (IT), Warsaw university of Technology (PL), University of West Bohemia (CZ)
  – Companies: INCAS Group (IT), FluidHouse (FI), ESPEO Software (PL), ICONICS (CZ), THT Control (FI), SCM Group (IT)
eScop Kernel (Source: Description of Work)
INCAS Conveyor Line Pilot

- Buffers: BL1, BL2, BP1, BP2
- Decision making modules: D1, D2, D3
- Output modules: T1, T2
- Manual picking station: O1
- Ejection module: E1

Control system signals:
- **Inputs**: Photocels F<i>, bar code readers S1, S2
- **Outputs**: Clutch rolls (preceding photocells), Caterpillars
- **Note**: Gray color signals are not connected to control system
eScop Physical Layer devices

• Programmable embedded devices which control and monitor factory floor equipment
  – Cyber-physical systems, called RTUs (Remote Terminal/Telemetry Units) in eScop project

• Main features:
  – Provide services for upper layers (Representation and Orchestration layers) – RESTful web services
  – Local control of technology modules (equipment)
  – Easily re-configurable (via Ethernet)
  – Developed software is portable, i.e. not fixed neither to the particular hardware model nor to the only one operating system
eScop RTU Candidates

- Industrial PC (IPC)
- Single board computer
- + Remote I/Os

- Raspberry Pi with UniPi board
- Inico S-1000 (with ZigBee module)
Development Complexity

• Simultaneous development of all layers
• Quite demanding request for Physical layer software
  – e.g. support of several PLC programming languages in IEC 61131-3 standard
  – But open source solution is not available
• Our team decision:
  – Use REX control system (www.rexcontrols.com)
• Advantages:
  – Several team members participated in REX development
  – REX is compatible with Matlab/Simulink
Simulation of INCAS pilot

• Simulation tools for conveyor lines
  – Usually part of large software packages (mainly CADs) performed by big companies (Siemens, Dassault Systemes, etc.)
  – Modelica with its libraries
  – Such powerful tools are not necessary for eScop

• More important features:
  – Possibility to develop real-time simulator
  – Simulation from the control point of view
  – Possibility to make SIL and HIL (software/hardware-in-the-loop) simulations

• Solution: Development of the simulation task in REX
  – Using Model Based Design technique
Pilot simulation model
Simulation of buffer BL1
Control system of simulator
Control algorithm of buffer BL1
Control system of pilot

• Now, control system of the simulator should be split to individual RTUs...
• Add connections to the RTU’s inputs and outputs
Physical layer in INCAS Pilot

- 10 RTUs based on Raspberry Pi and UniPi interface board
- Put into operation during only 3 visits to Biella
Next Steps

• Physical layer of INCAS pilot has been successfully tested and presented to the project reviewers
• RESTfull web service interface to RTUs has been developed (O. Severa, R. Pišl)
• Structured Text language interpreter has been incorporated into eScop RTU (J. Faist, M. Štětina)
eScop RTU – current status
The End

Thank you for your attention.

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