Industrial Automation
(Automação de Processos Industriais)

Supervised Control of Discrete Event Systems - SCADA

http://users.isr.ist.utl.pt/~jag/courses/api19b/api1920.html

Prof. Paulo Jorge Oliveira, original slides
Prof. José Gaspar, rev. 2019/2020

Syllabus:

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Chap. 8 - DESs and Industrial Automation [2 weeks]

Chap. 9 – Supervised Control of DESs [1 week]
- *** SCADA**
- *** Methodologies for the Synthesis of Supervision Controllers**
- *** Failure detection**

Some jokes available in http://members.iinet.net.au/~ianw/cartoon.html

The End.

Some pointers on Supervised Control of DES

History: The SCADA Web, http://members.iinet.net.au/~ianw/

                  Monitoring and Control of Discrete Event Systems, Stéphane Lafortune,
                  http://www.ece.northwestern.edu/~ahaddad/ifac96/introductory_workshops.html

Tutorial: http://vita.bu.edu/cgc/MIDEDS/
                  http://www.daimi.au.dk/PetriNets/

Analysers &   http://www.nd.edu/~isis/techreports/isis-2002-003.pdf (Users Manual)
Simulators: http://www.nd.edu/~isis/techreports/spnbox/ (Software)

Bibliography: * SCADA books http://www.sss-mag.com/scada.html
                  * K. Stouffer, J. Falco, K. Kent, "**Guide to Supervisory Control and Data
                  Acquisition (SCADA) and Industrial Control Systems Security**",
                  NIST Special Publication 800-82, 2006
                  * Moody J. e Antsaklis P., **"Supervisory Control of Discrete Event
                  Systems using Petri Nets,"** Kluwer Academic Publishers, 1998.
                  * Cassandras, Christos G., **"Discrete Event Systems - Modeling and
                  Performance Analysis,"** Aksen Associates, 1993.
                  * Yamalidou K., Moody J., Lemmon M. and Antsaklis P.
                  Feedback Control of Petri Nets Based on Place Invariants
                  http://www.nd.edu/~lemmon/isis-94-002.pdf

Supervision of DES: SCADA
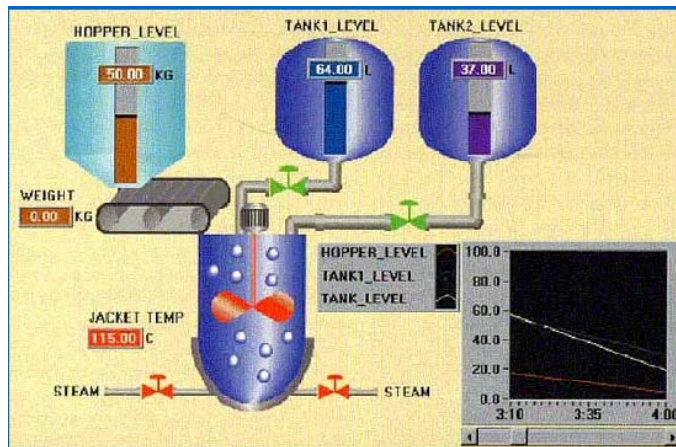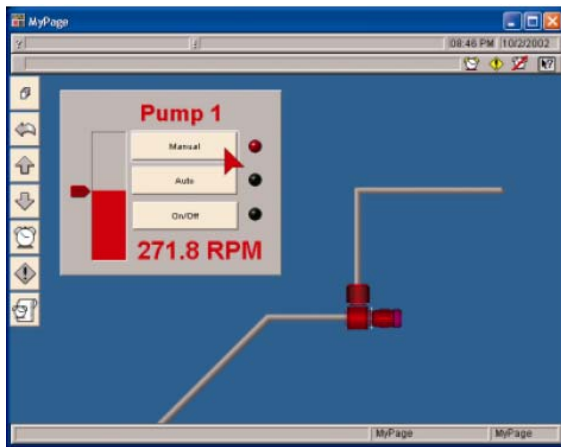
*S*upervisory

*C*ontrol

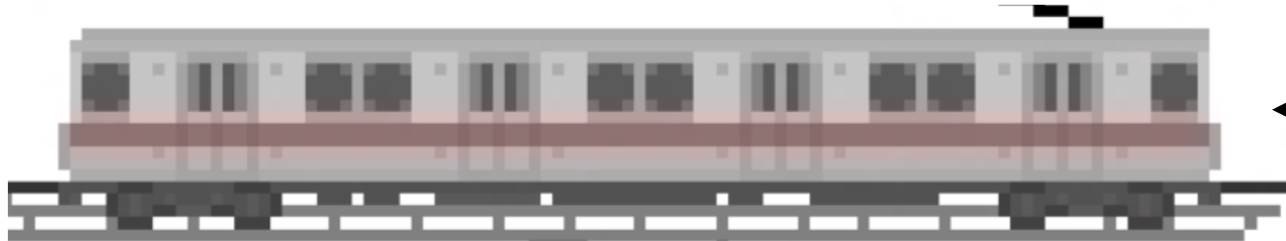### *A*nd

*D*ata

*A*cquisition

Supervision of DES

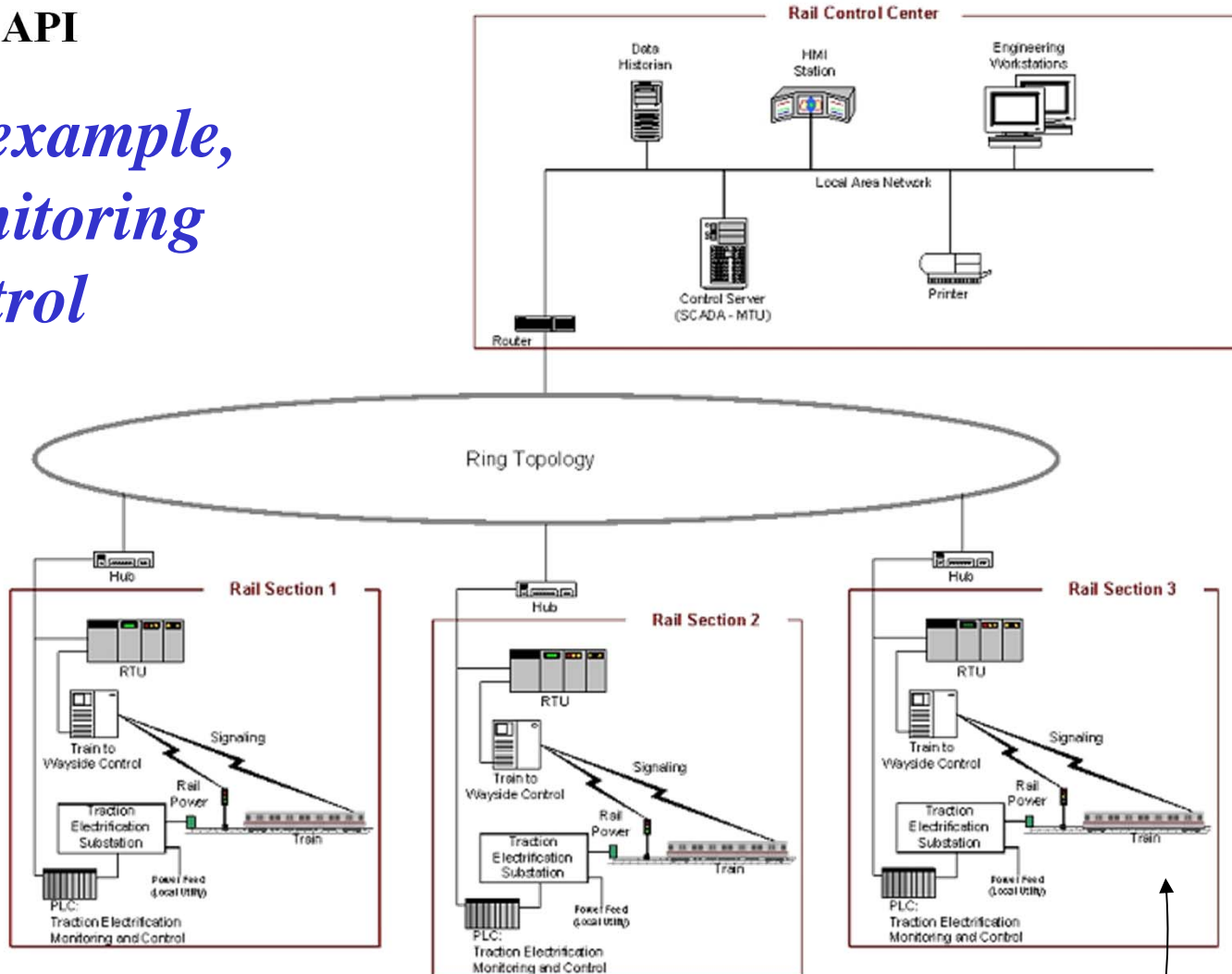## *SCADA interface*

Control / Data
GUI / HMI

SCADA example, Rail Monitoring and Control

Supervision of DES

SCADA vs ICS

Industrial Control Systems (ICS):
- Supervisory Control and Data Acquisition (SCADA) systems,
- Distributed Control Systems (DCS), or
- smaller configurations such as skid-mounted PLCs

ICSs are typically used in industries such as electric, water, oil-and-gas, transportation, chemical, pharmaceutical, pulp-and-paper, food and beverage, and discrete-manufacturing (e.g. automotive, aerospace, and durable goods).
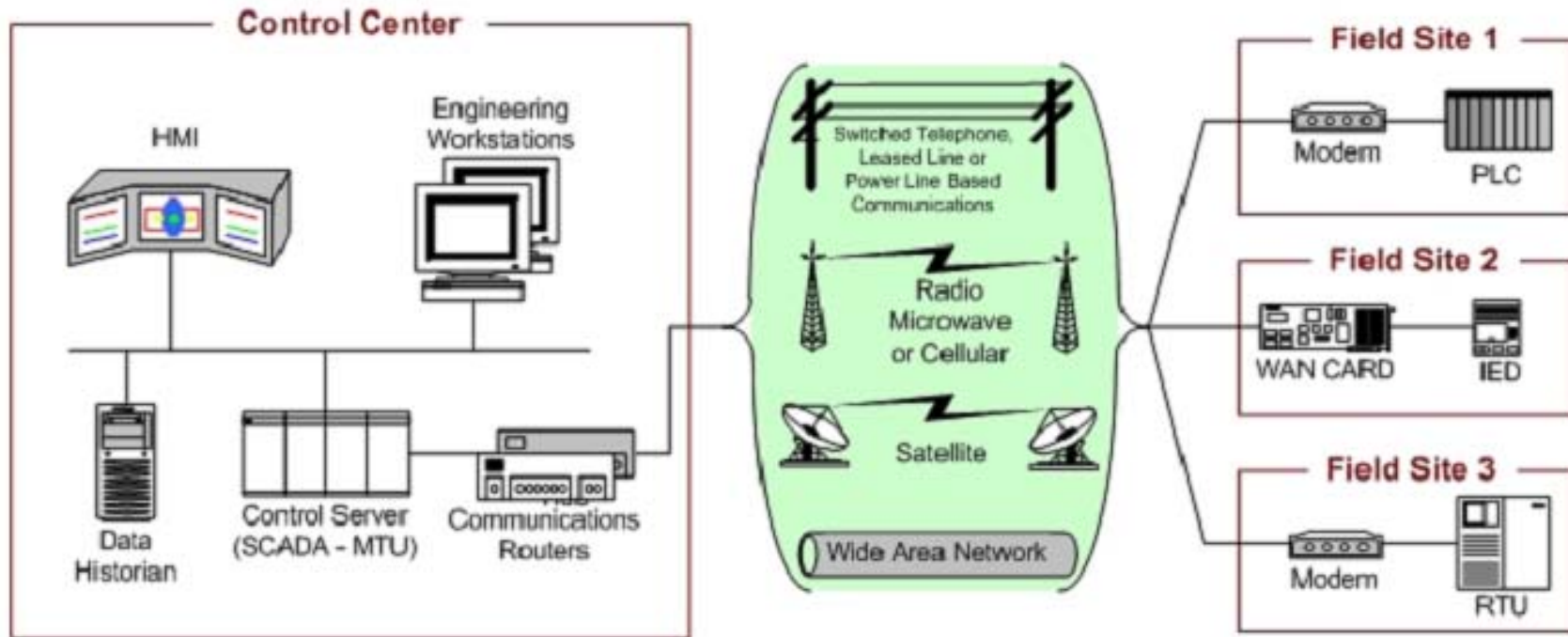
Supervision of DES

SCADA topics

- Remote monitoring of the state of automation systems

- Logging capacity (resorting to specialized Databases)

- Able to access to *historical* information (plots along time, with selectable periodicity)

- Advanced tools to design Human-Machine interfaces

- Failure Detection and Isolation capacity (*threshold* and/or logical functions) on supervised quantities
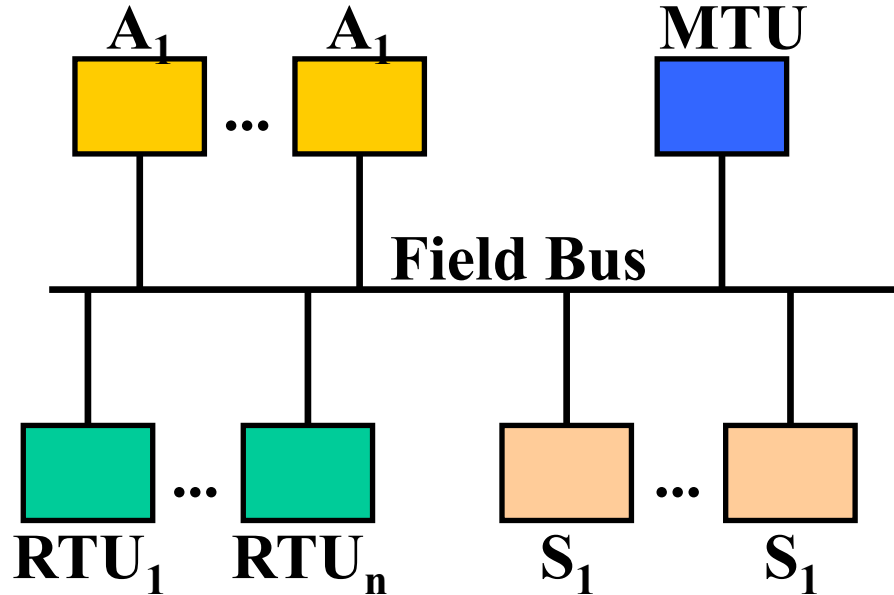
- Access control

Supervision of DES

SCADA system general layout

Supervision of DES

Hardware Support Architecture of SCADA

A_1　　　A_1　　　　　　**MTU**

…

Field Bus

RTU$_1$　**RTU$_n$**　　**S$_1$**　　**S$_1$**

Legend:

MTU - Main Terminal Unit

RTU - Remote Term. Unit

S – Sensor

A - Actuator

General term: *Fieldbus (IEC 61158).* ***Examples:*** *PROFIBUS (Fieldbus type, Siemens), MODBUS (Schneider), CAN bus (Bosch), …*

Supervision of DES

Examples of software packages including
SCADA solutions

- **Aimax**, de Desin Instruments S.A.
- **CUBE**, Orsi España S.A.
- **FIX**, de Intellution.
- **Lookout,** National Instruments.
- **Monitor Pro,** de Schneider Electric.
- **SCADA InTouch**, de LOGITEK.
- **SYSMAC SCS**, de Omron.
- **Scatt Graph 5000**, de ABB.
- **WinCC**, de Siemens.

Fieldbus	Bus power	Cabling redundancy	Max devices	Synchronisation	Sub millisecond cycle
AFDX	No	Yes	Almost unlimited	No	Yes
AS-Interface	Yes	No	62	No	No
CANopen	No	No	127	Yes	No
CompoNet	Yes	No	384	No	Yes
ControlNet	No	Yes	99	No	No
CC-Link	No	No	64	No	No
DeviceNet	Yes	No	64	No	No
EtherCAT	Yes	Yes	65,536	Yes	Yes
Ethernet Powerlink	No	Optional	240	Yes	Yes
EtherNet/IP	No	Optional	Almost unlimited	Yes	Yes
Interbus	No	No	511	No	No
LonWorks	No	No	32,000	No	No
Modbus	No	No	246	No	No
PROFIBUS DP	No	Optional	126	Yes	No
PROFIBUS PA	Yes	No	126	No	No
PROFINET IO	No	Optional	Almost unlimited	No	No
PROFINET IRT	No	Optional	Almost unlimited	Yes	Yes
SERCOS III	No	Yes	511	Yes	Yes
SERCOS interface	No	No	254	Yes	Yes
Foundation Fieldbus H1	Yes	No	240	Yes	No
Foundation Fieldbus HSE	No	Yes	Almost unlimited	Yes	No
RAPIEnet	No	Yes	256	Under Development	Conditional

← *recent (2003, 2010)*

← *used in our labs*

An invitation for project 3:

Do a presentation about OpenSCADA
http://oscada.org/

Some links:

General characteristics of OpenSCADA
http://oscada.org/main/characteristics/

OpenSCADA on a Raspberry-Pi
http://oscada.org/wiki/Using/Raspberry_Pi