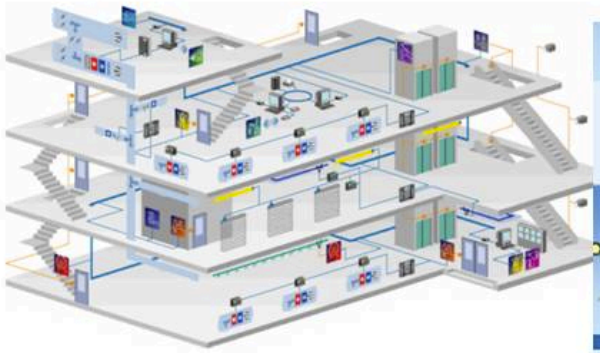
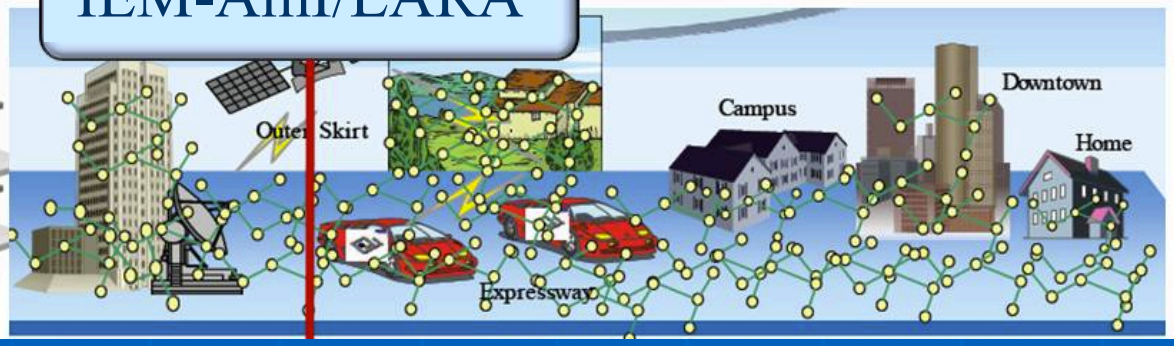




Introdução à Engenharia Mecatrônica

Ambientes Inteligentes no LARA

Prof. Adolfo Bauchspiess

LARA- Automation and Robotics Laboratory
Departamento de Engenharia Elétrica
Universidade de Brasília - Brazil

Ambient Ingelligence at LARA/UnB

1 – Ambient Intelligence:

"Provide services to the users of an ambient through an almost invisible wireless sensor and actuator network"

2 – Projects

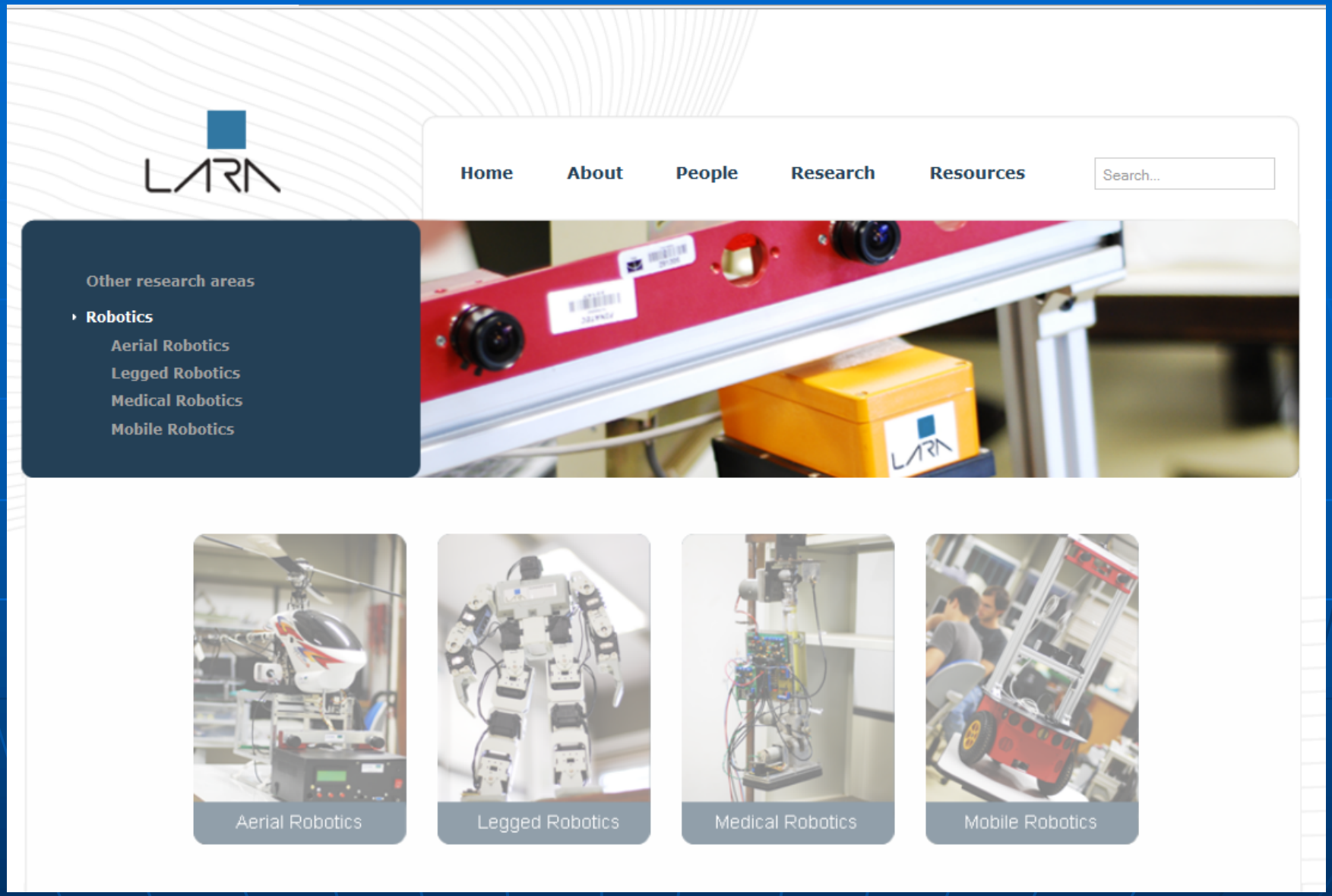
- Energy saving
- Comfort
- User Tracking

3 – Perspectives

Ipê Amarelo – Brazilian National Tree

LARA – www.lara.unb.br

LARA – www.lara.unb.br



- **Ambient Intelligence**
- Control, Estimation & Applications
- Field Robotics
- Human-Centered Robotics

4 – Some Projects at UnB

LabInov

The main objective of the LabInov project is to create an ambient intelligence laboratory for validation of innovations in the area. Besides that, it should help in the process of technology transfer between the university and companies. This project is a cooperation between the University of Brasília and Spin Engenharia de Automação Ltda

Highly Interacting Ambient Systems

In Ambient Systems, wireless networks are applied to promote information exchange among the different nodes of the ambient system network. This project goals are to answer existing theoretical questions and to reveal and bridge gaps between theory and praxis in interacting ambient systems. It is a cooperation between the University of Brasília and the University of Kaiserslautern

Ambient Intelligence

Control, Estimation & Applications

- **Field Robotics**

Human-Centered Robotics

4 – Some Projects at UnB

Helicopter-based aerial robot for aiding powerlines inspection

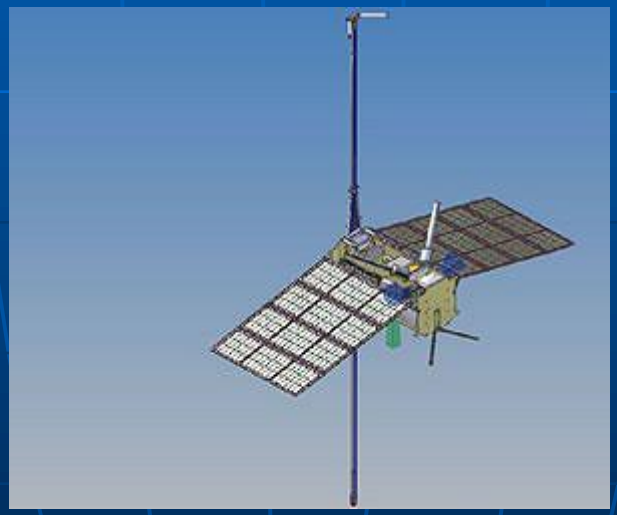
This project, funded by **Plena Transmissoras**, aims at the development of an aerial robot for aiding powerlines inspection.

4 – Some (newer) Projects at LARA/UnB

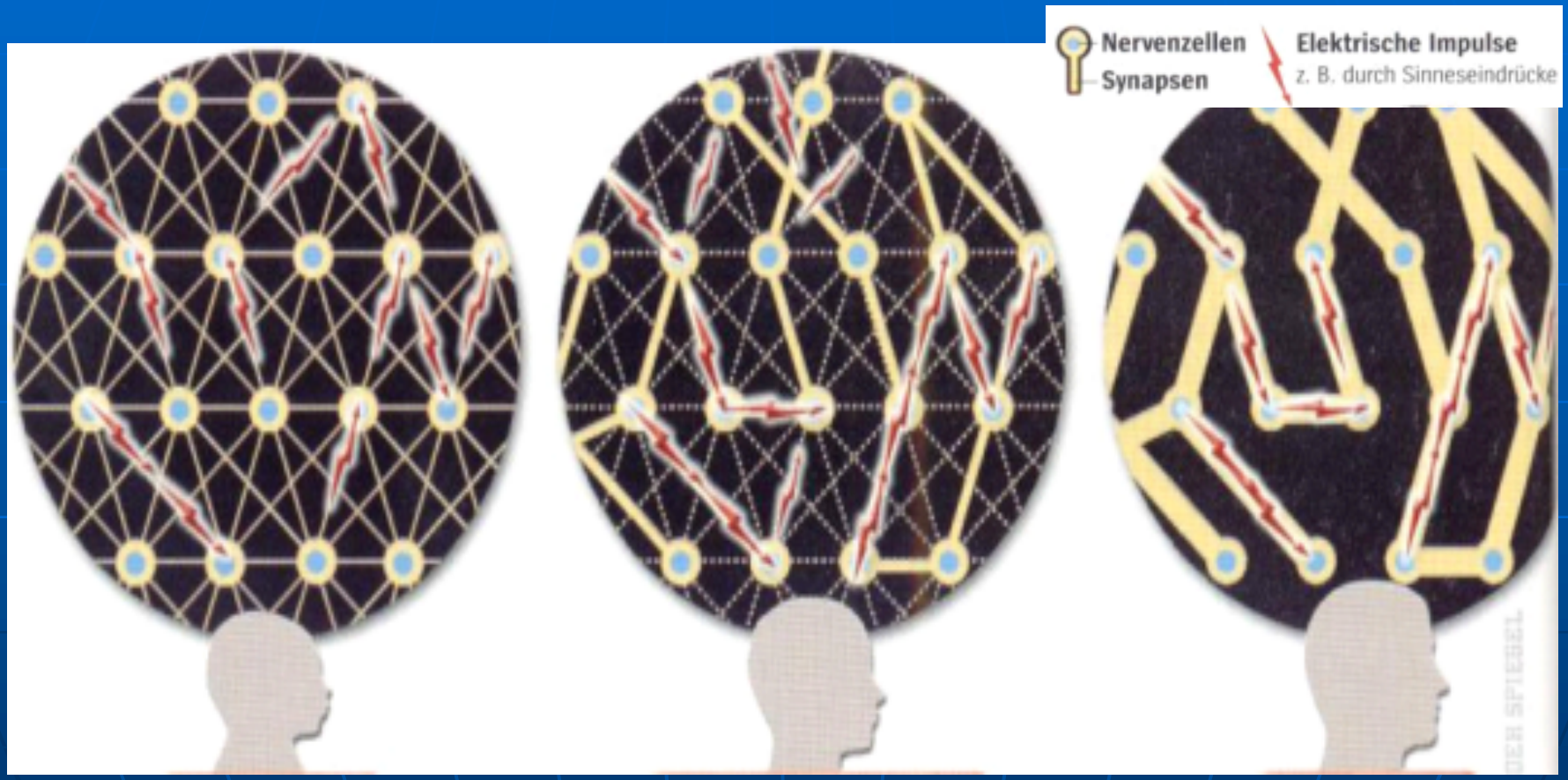
2911-... **Ukraine** Space Cooperation - Ancântara + Cyclone Rocket

2012-... Towards Robust Robotic Manufacturing UnB/UFMG/**MIT**

2012- ... **Japan** - Microsatelites

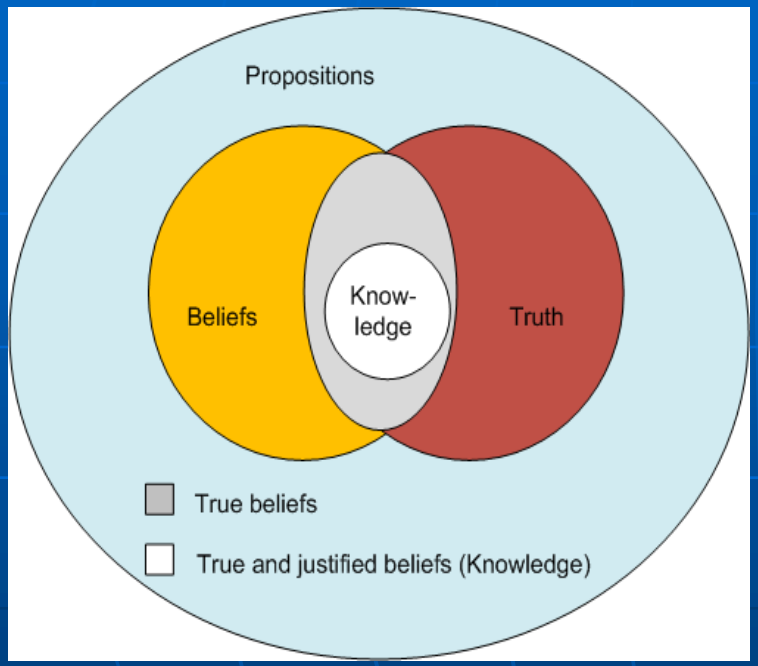


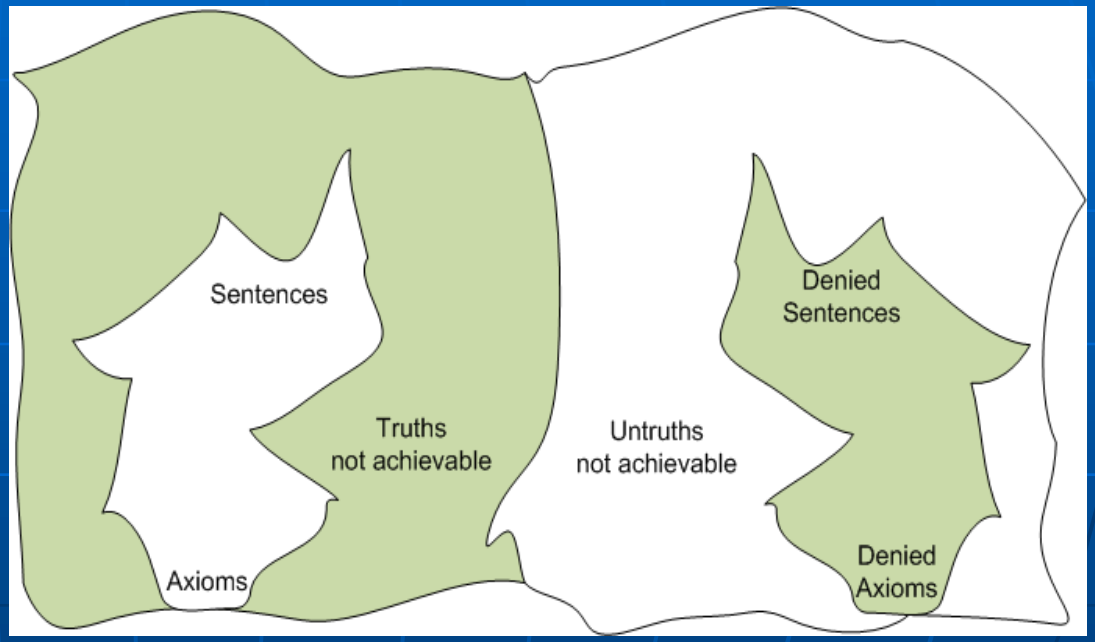
Neuron Synaptic Connections
Learning!



0-2 years 2 years to puberty Adult

Epistemology –
"Philosophy of Knowledge"





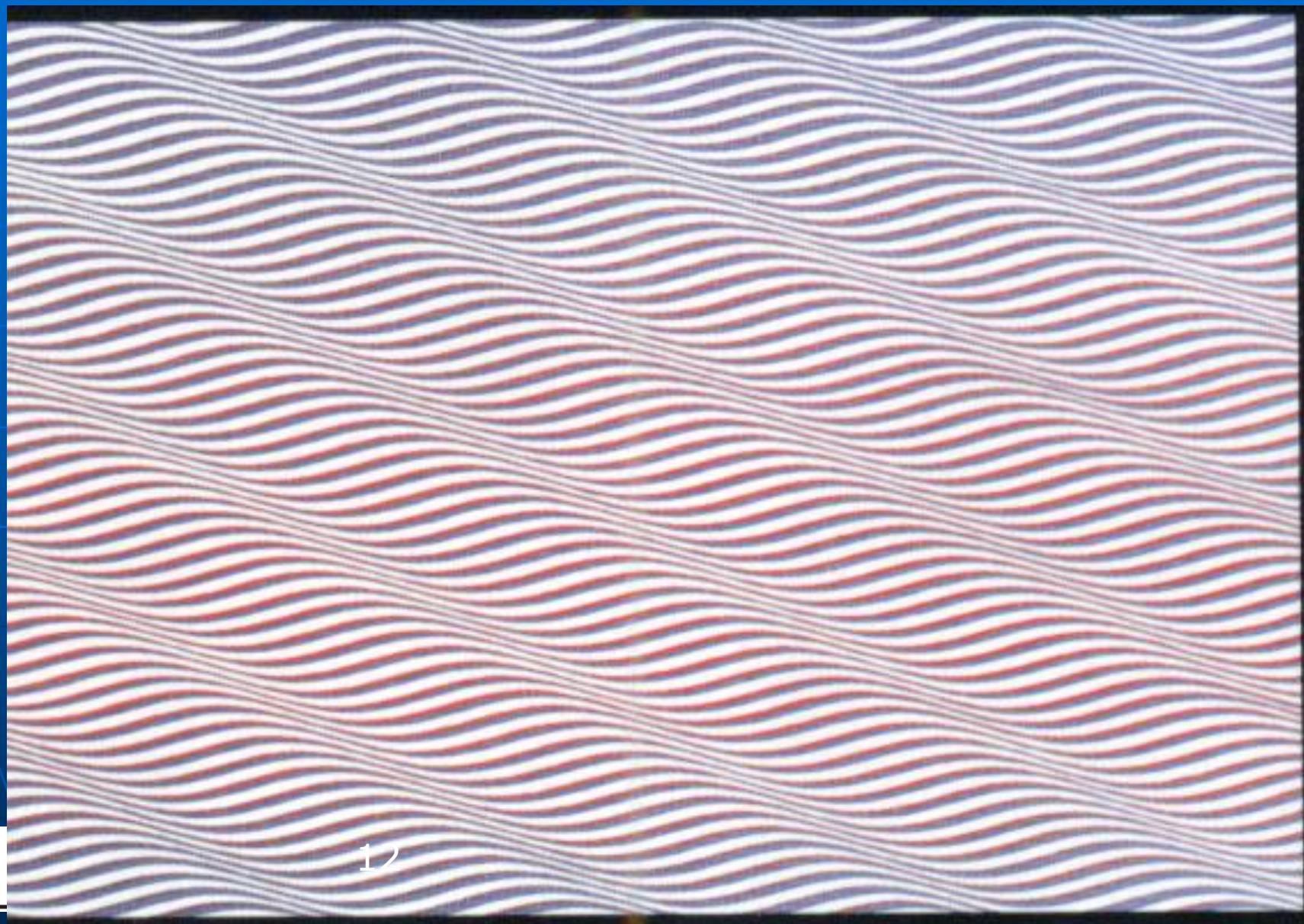
From Natural Intelligence to Artificial Intelligence

Ex. – Dislexia?

I cnduo't bvleiee taht I culod aulaclty uesdtannrd waht I was rdnaieg. Unisg the icndeblire pweor of the hmuan mnid, aocdcrnig to rseecrah at Cmabrigde Uinervtisy, it dseno't mttaer in waht oderr the lterets in a wrod are, the olny irpoamtnt tihng is taht the frsit and lsat ltteer be in the rhgit pclae. The rset can be a taotl mses and you can sitll raed it whoutit a pboerlm. Tihs is bucseae the huamn mnid deos not raed ervey ltteer by istlef, but the wrod as a wlohe. Aaznmig, huh? Yaeh and I awlyas tghhuot slelinpg was ipmorantt! See if yuor fdreins can raed tihs too.

Giant x 3D Ilusion?

Waves?



Simpathic?

GRIMASSE STEHT KOPF

Auf den ersten Blick scheint das Foto von Margaret Thatcher nicht ungewöhnlich. Das ändert sich, wenn Sie das Bild auf den Kopf stellen. Der verblüffende Effekt tritt auf, weil Augen und Mund auf dem Foto um 180 Grad gedreht sind – und damit genau die Merkmale, auf die das Gesichtserkennungsprogramm des Hirns besonders sensibel anspricht.

EMILE LUIDER / RAPHO / AGENTUR FOCUS (L.); PERCEPTION (R.)

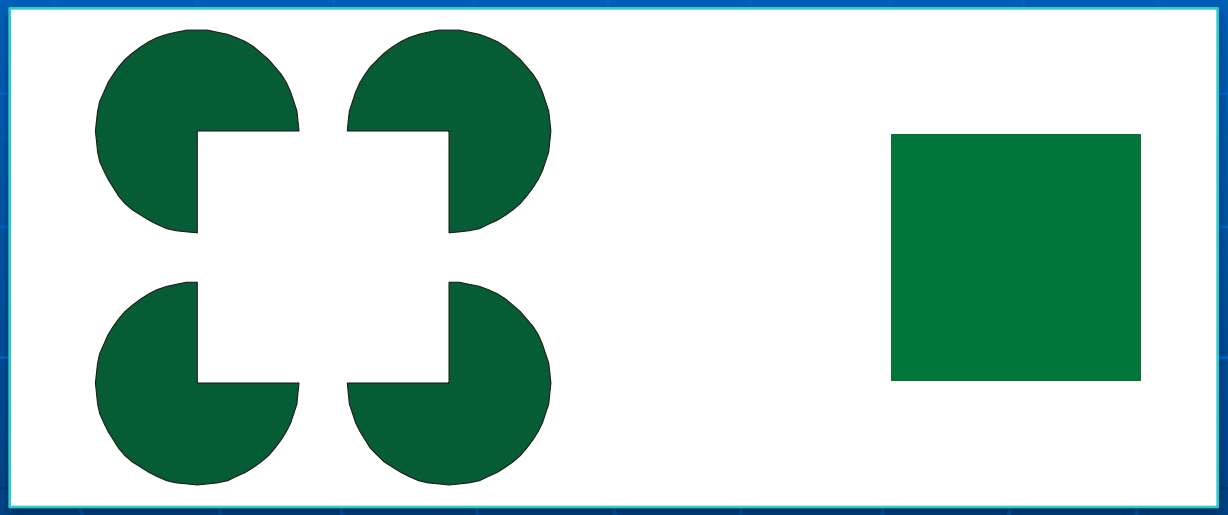
Antipathic?

GRIMASSE STEHT KOPF

Auf den ersten Blick scheint das Foto von Margaret Thatcher nicht ungewöhnlich. Das ändert sich, wenn Sie das Bild auf den Kopf stellen. Der verblüffende Effekt tritt auf, weil Augen und Mund auf dem Foto um 180 Grad gedreht sind – und damit genau die Merkmale, auf die das Gesichtserkennungsprogramm des Hirns besonders sensibel ansprycht.

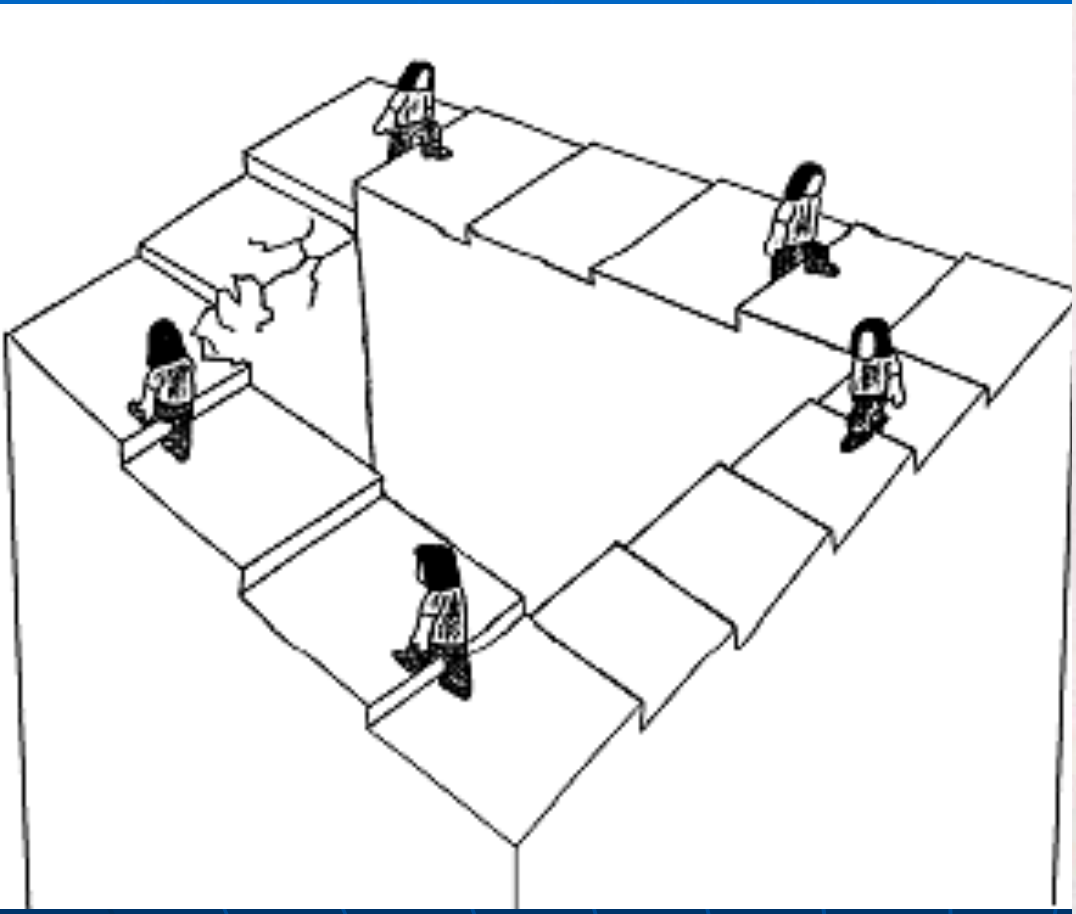
- Incomplete pattern -
Brain Interpolation!

-Perception



The Kanizsa square, 1976

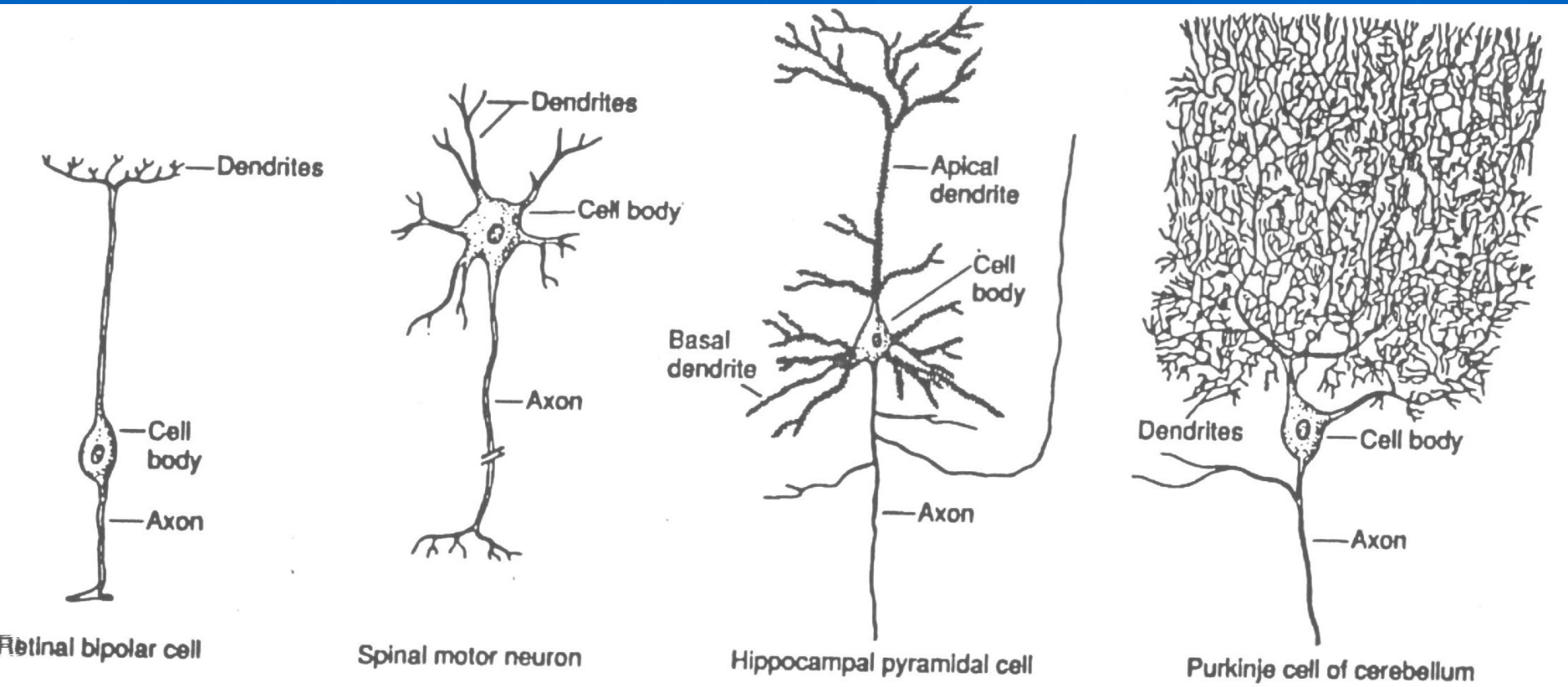
“Local Coherency –Global Paradox"



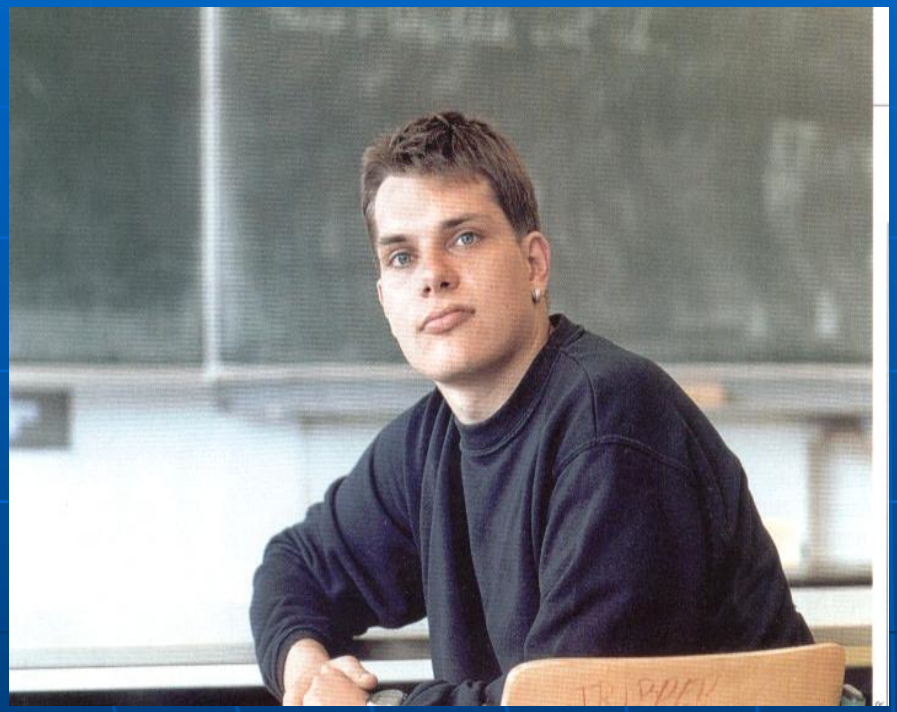
Sandro dell’Isola. Enigmas visuais. Rio de Janeiro, 2004, p. 45

Biological Fundaments

Some kinds of neurons



Epilepsy Patient – without left brain hemisphere since 12 years age



Leben ohne links

Seit zwölf Jahren lebt Philipp Dörr mit einem halben Großhirn. Trotzdem spielt er Schach, liest Goethe und taucht – ein verblüffendes Beispiel für die Wandlungsfähigkeit des Denkorgans.

Ambient Intelligence

http://perso.limsi.fr/jps/enseignement/examsma/2004/BHATTI/

Building Automation

- http://www.zb-connection.com/energy-conservation/building-automation-systems

Building Automation- Objetives

- Access Control
- Fire Detection

- Comfort (Productivity)
  - temperature, humidity,… (PMV)
  - illumination,
  - waiting time for elevators, …

- Health issues
  - air quality (renovation, filters…)
  - CO_2

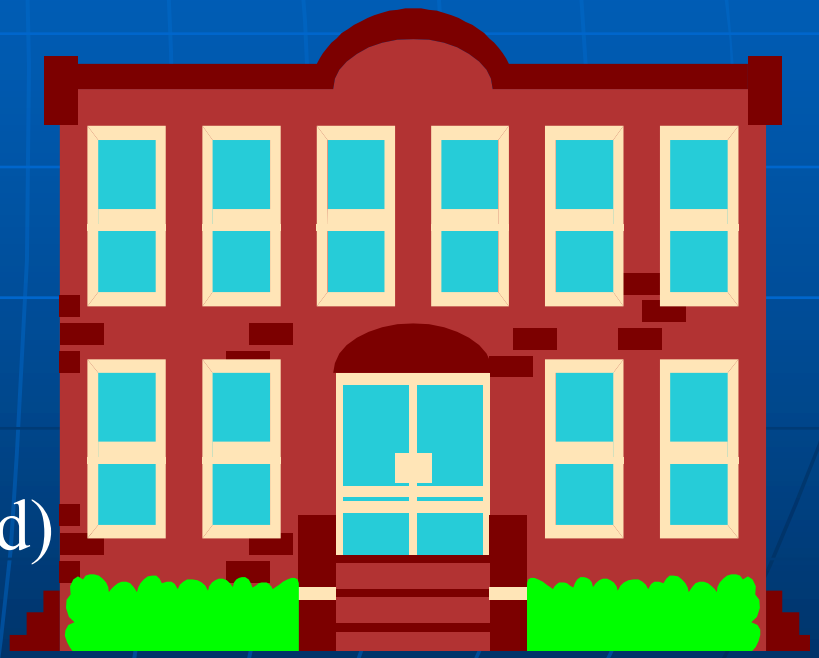
- Energy Saving

Building Automation- Technologies

- Supervision, Control, Data Acquisition (SCADA)
- Human-Machine Interface (HIM)
- Programmable Logical Controllers (PLC)

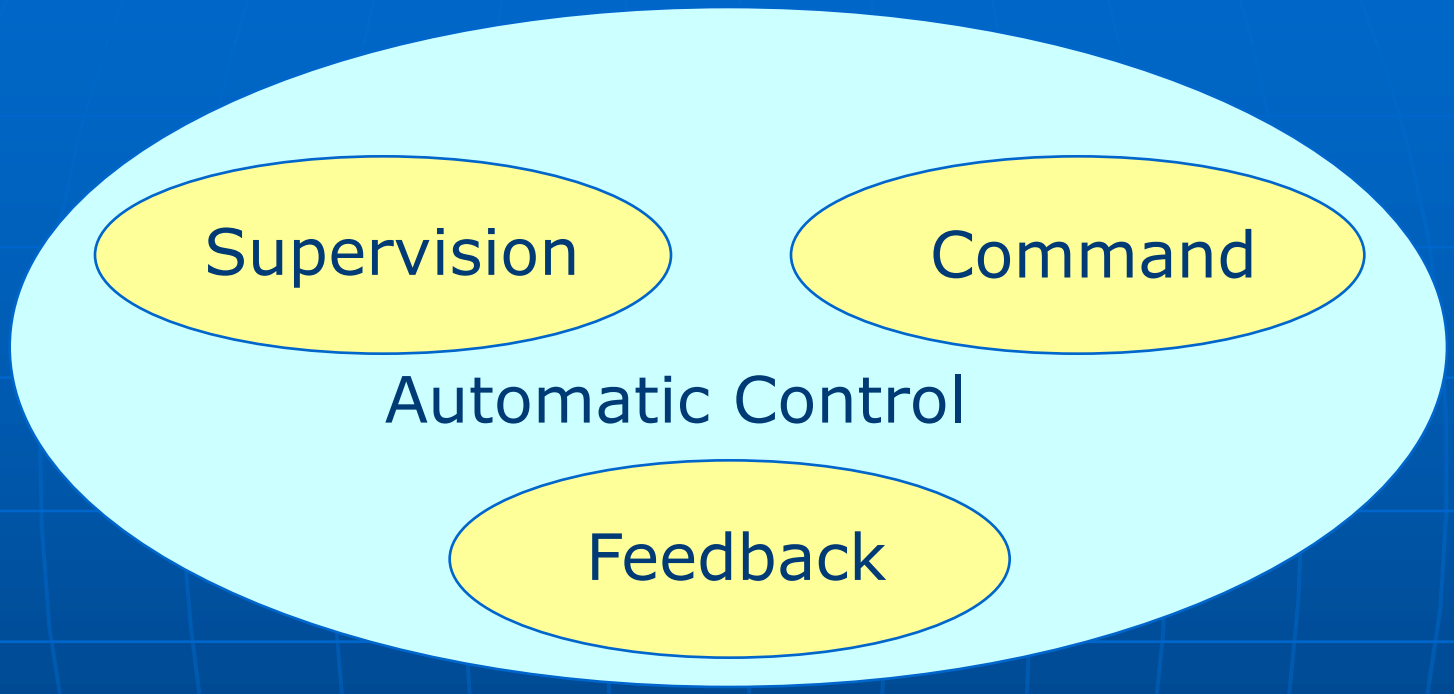
- Network
  - Cabled
  - PLC
  - Wireless

- Devices
  - Modularity (Easy to expand)
  - Interoperability



Automation Systems

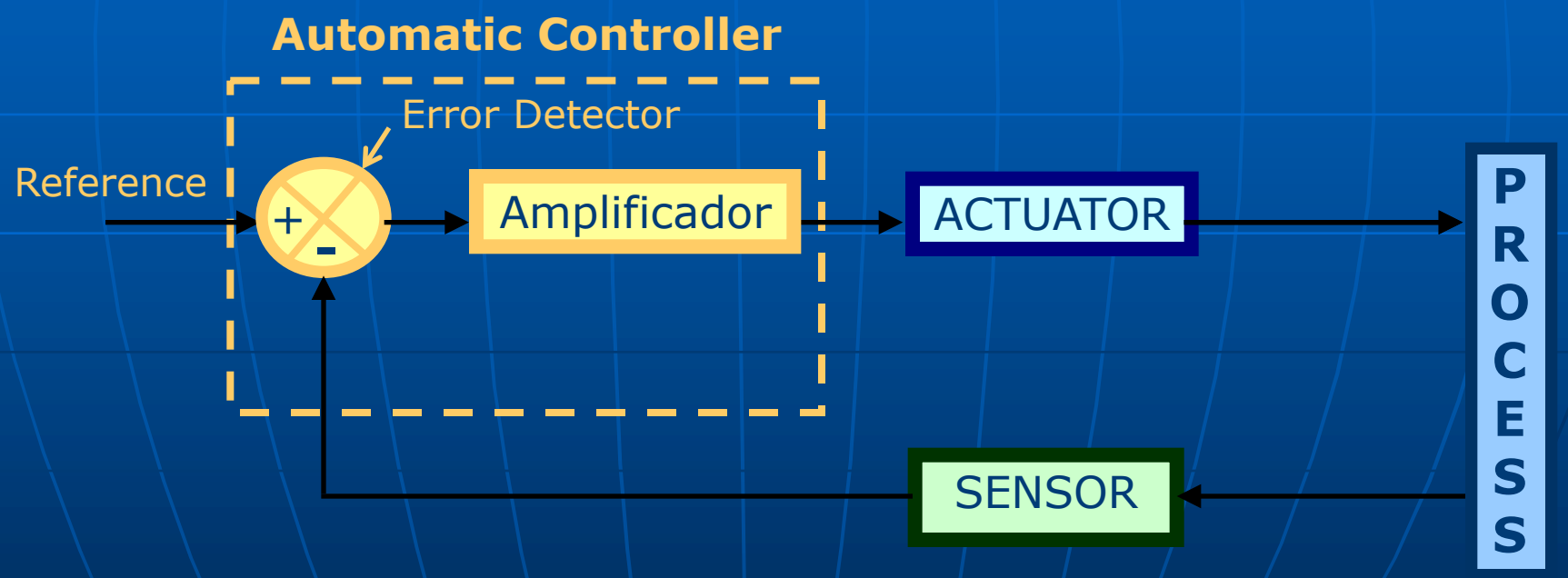
- Energy Management
- Ilumination
- Access Control
- Vertical Transport
- Fire Detection and Alarm
- Air Conditioning
- Hydraulic Management
- Closed Circuit TV


Supervision
Command
Automatic Control
Feedback

Automatic Control

Keep a process variable at the reference value

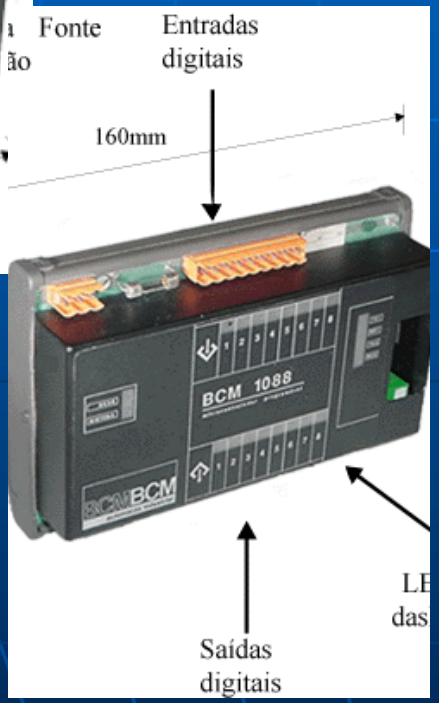
"Compare reference and measured value then act"

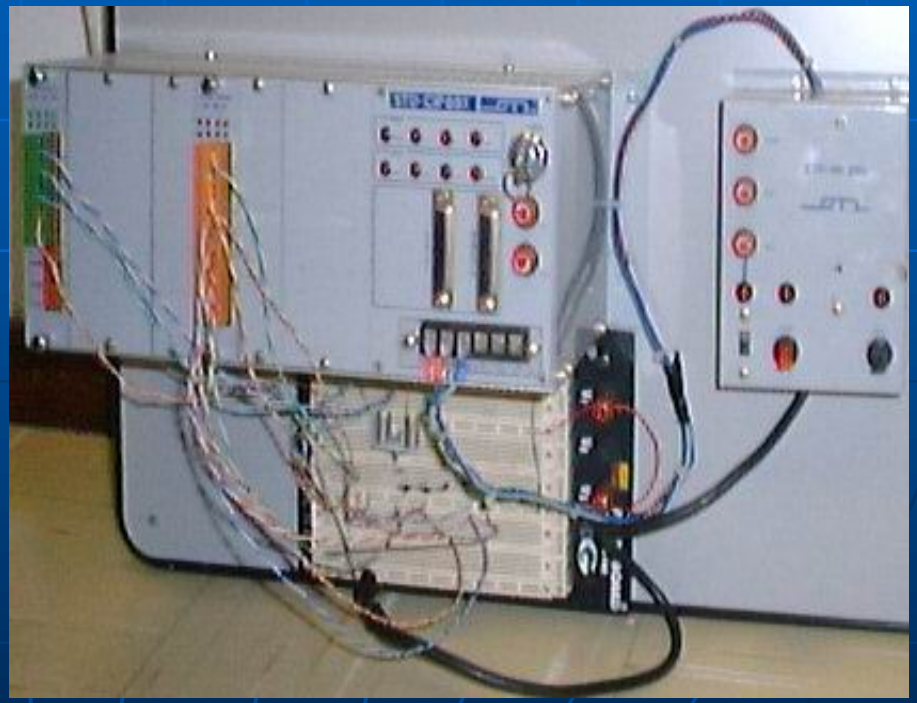


Some PLCs.br

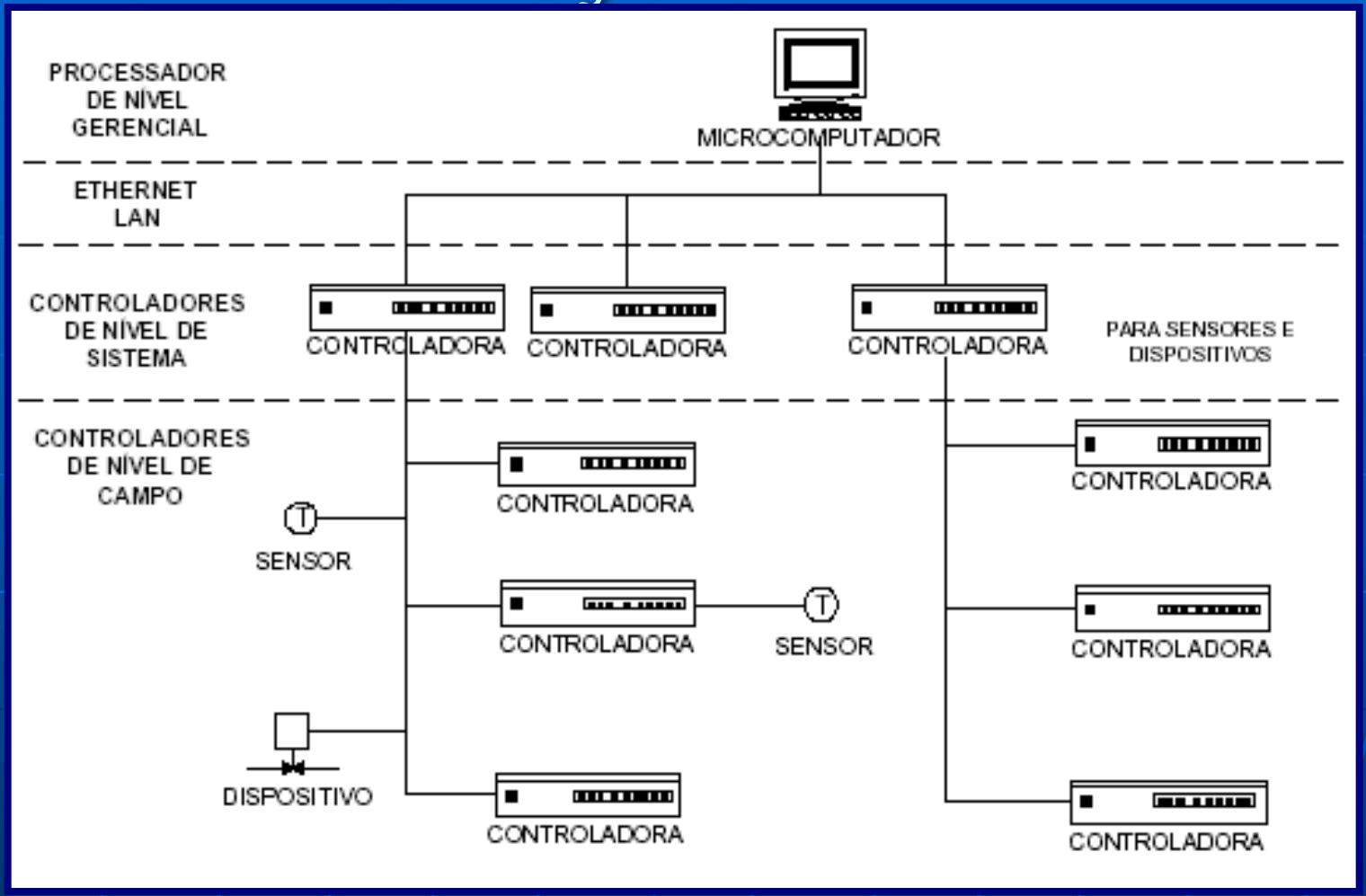

483,0mm


180mm


Fonte
Entradas digitais
160mm
BCM 1088
Saídas digitais



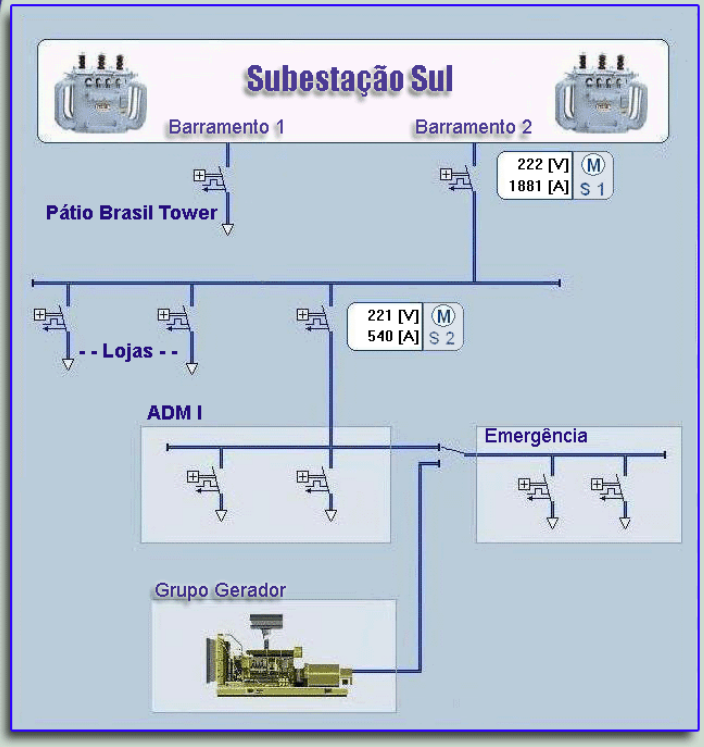
Automation System

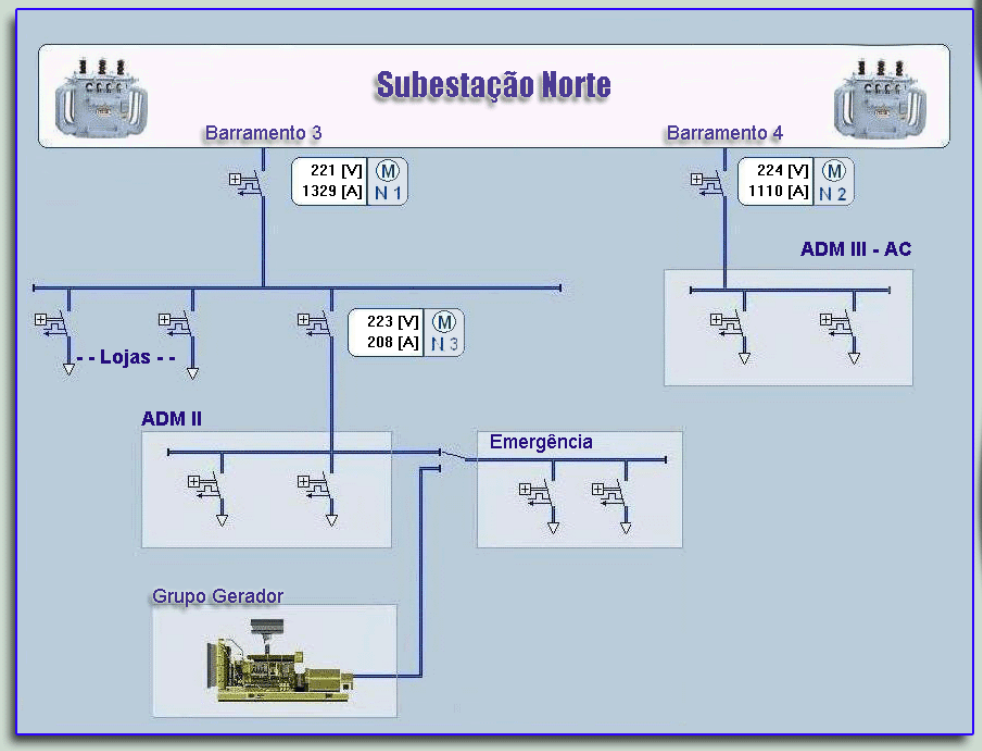


Energia Elétrica - Circuitos Alimentadores

PÁTIO BRASIL SHOPPING

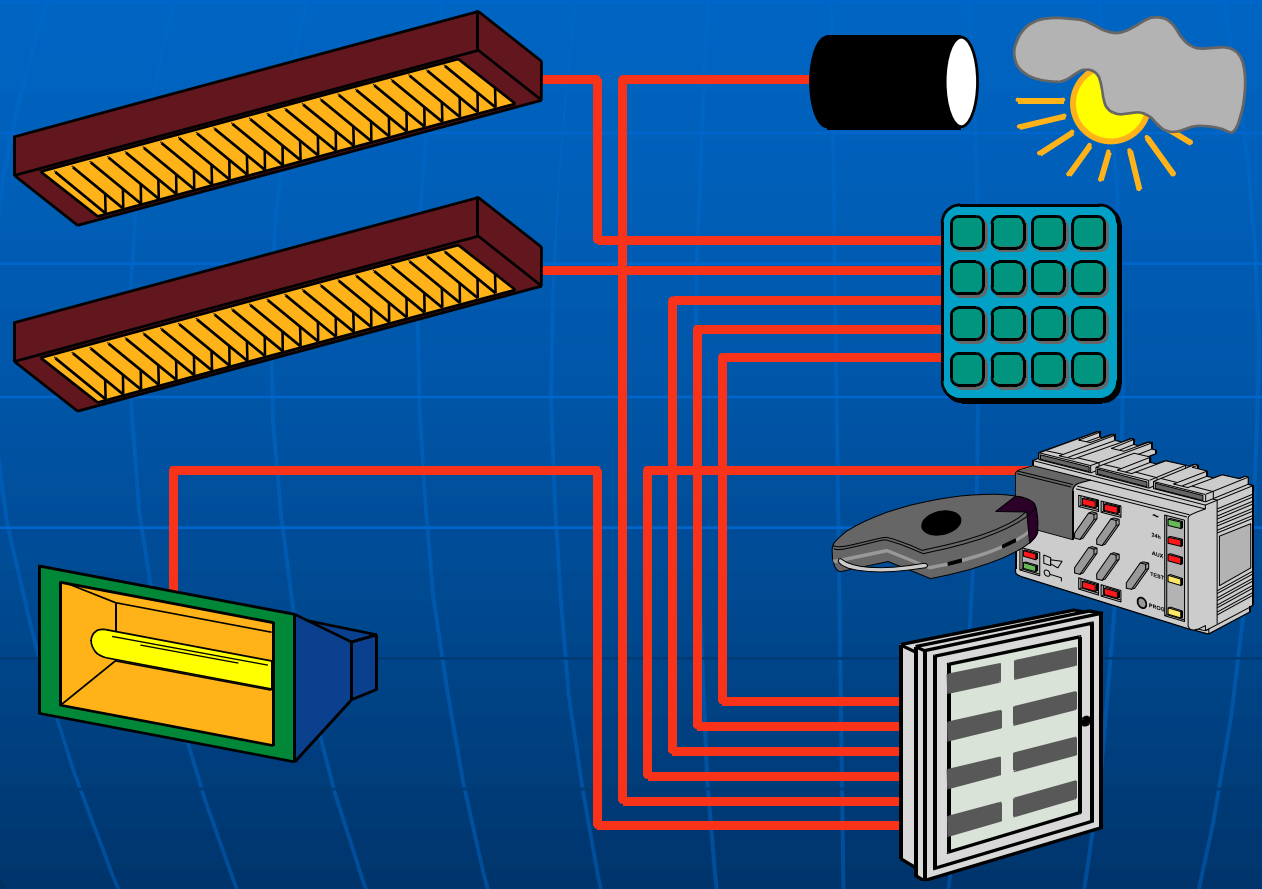
PRINCIPAL



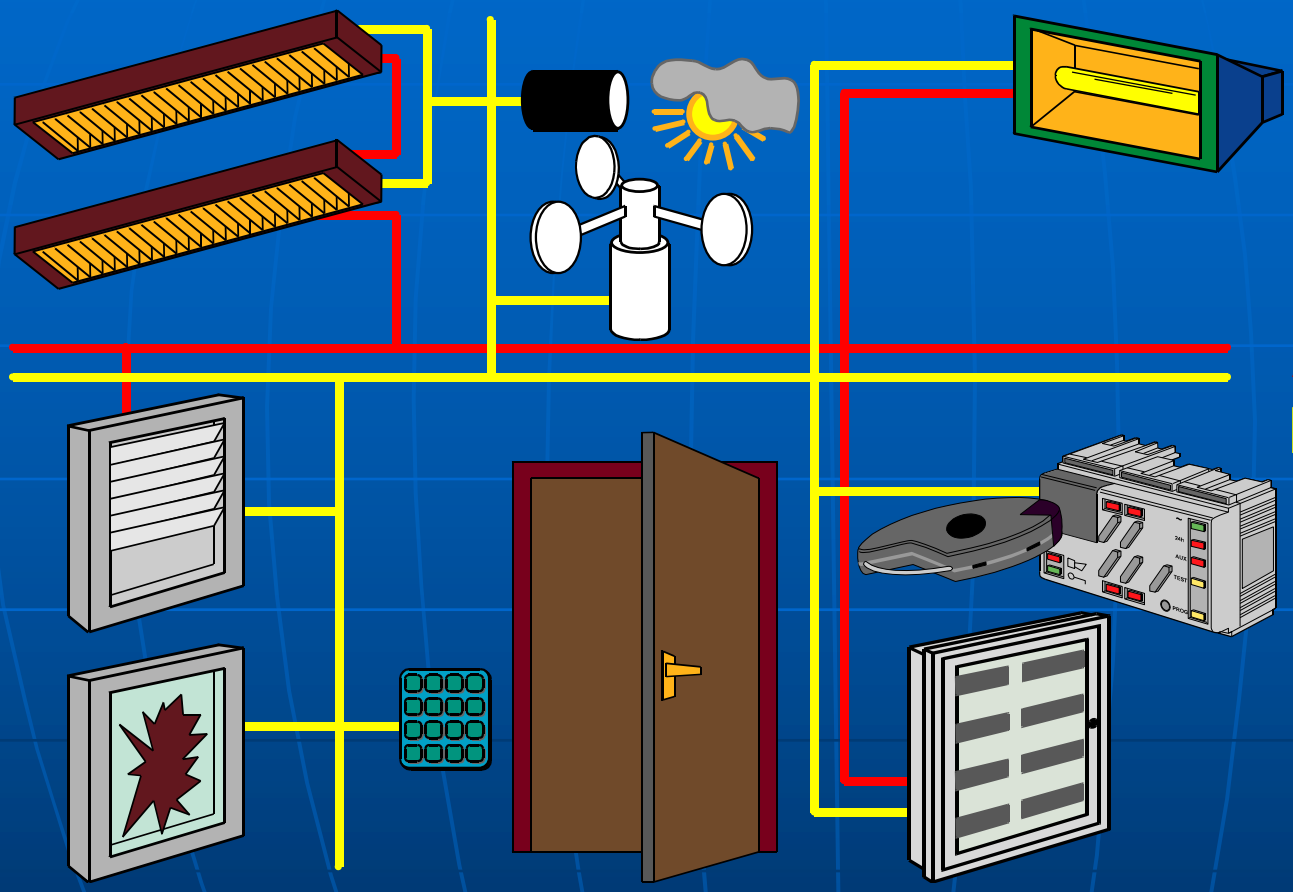


	Alimentador Sul - M S1				ADM I - Medidor M S2				Alimentador Norte - M N1				ADM II - Medidor M N3				ADM III (AC) - Medidor M N2			
	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]
FASE R	220	1930	0,89	378130	220	589	0,83	107742	220	1027	0,80	180481	221	211	0,95	44343	224	1090	0,97	236051
FASE S	222	1841	0,88	358394	222	519	0,80	92869	221	1436	0,91	288350	224	184	1,00	41140	224	1161	0,95	248133
FASE T	222	1872	0,88	364930	222	511	0,79	89937	222	1526	0,90	305239	223	227	0,97	48998	225	1080	0,95	229506
MÉDIA	222	1881	0,88	101455	221	540	0,81	290548	221	1329	0,88	774071	223	208	0,97	134481	224	1110	0,96	713690

Traditional Connection

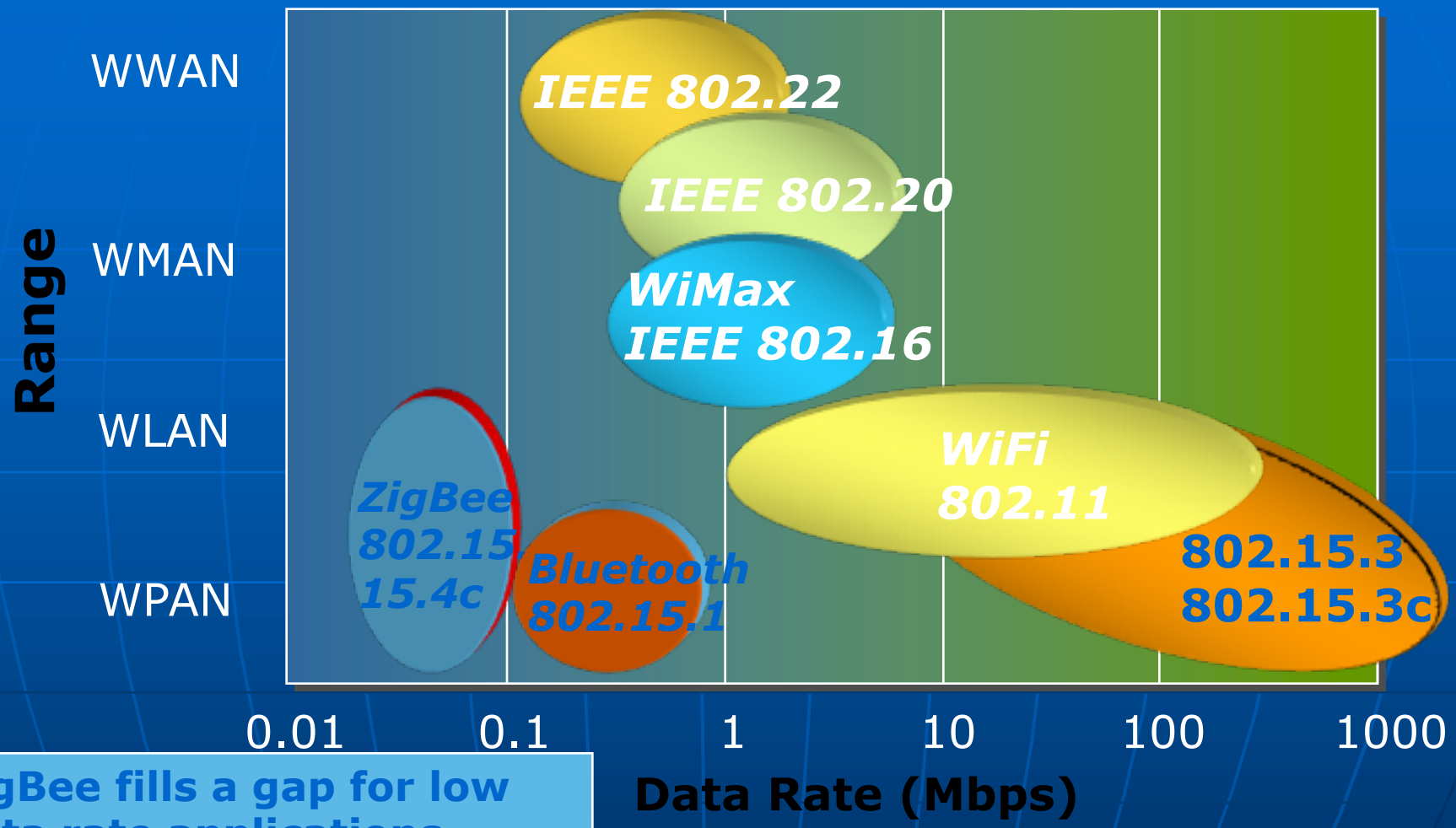


Bus Connection



...wireless

The IEEE 802 Wireless Space



ZigBee fills a gap for low data rate applications

ZigBee Applications

BUILDING AUTOMATION

security
HVAC
AMR
lighting control
access control

CONSUMER ELECTRONICS

TV
VCR
DVD/CD
remote

PERSONAL HEALTH CARE

patient monitoring
fitness monitoring

PC & PERIPHERALS

mouse
keyboard
joystick

TELECOM SERVICES

m-commerce
info services
object interaction
(Internet of Things)

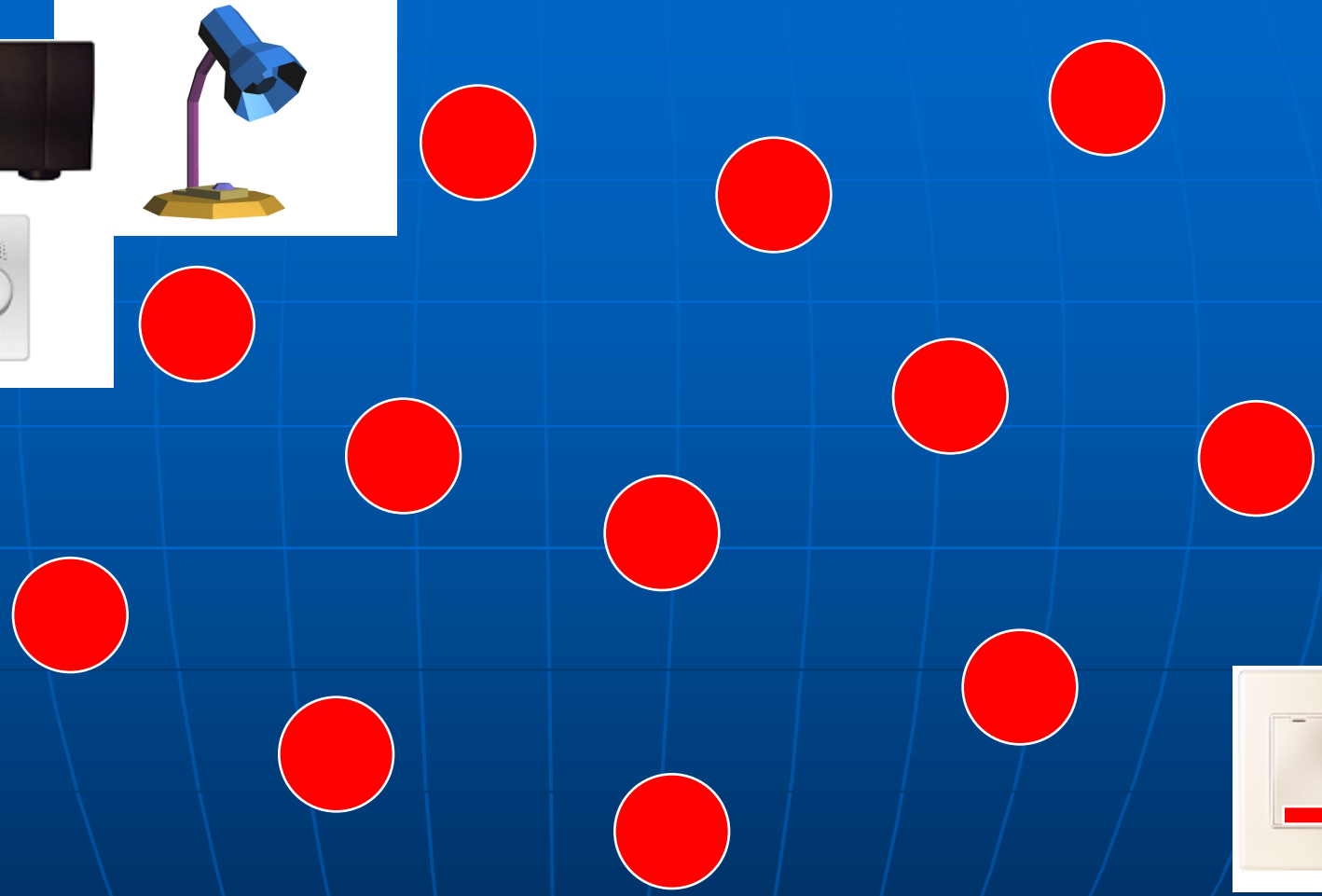
INDUSTRIAL CONTROL

asset mgt
process control
environmental
energy mgt

HOME CONTROL

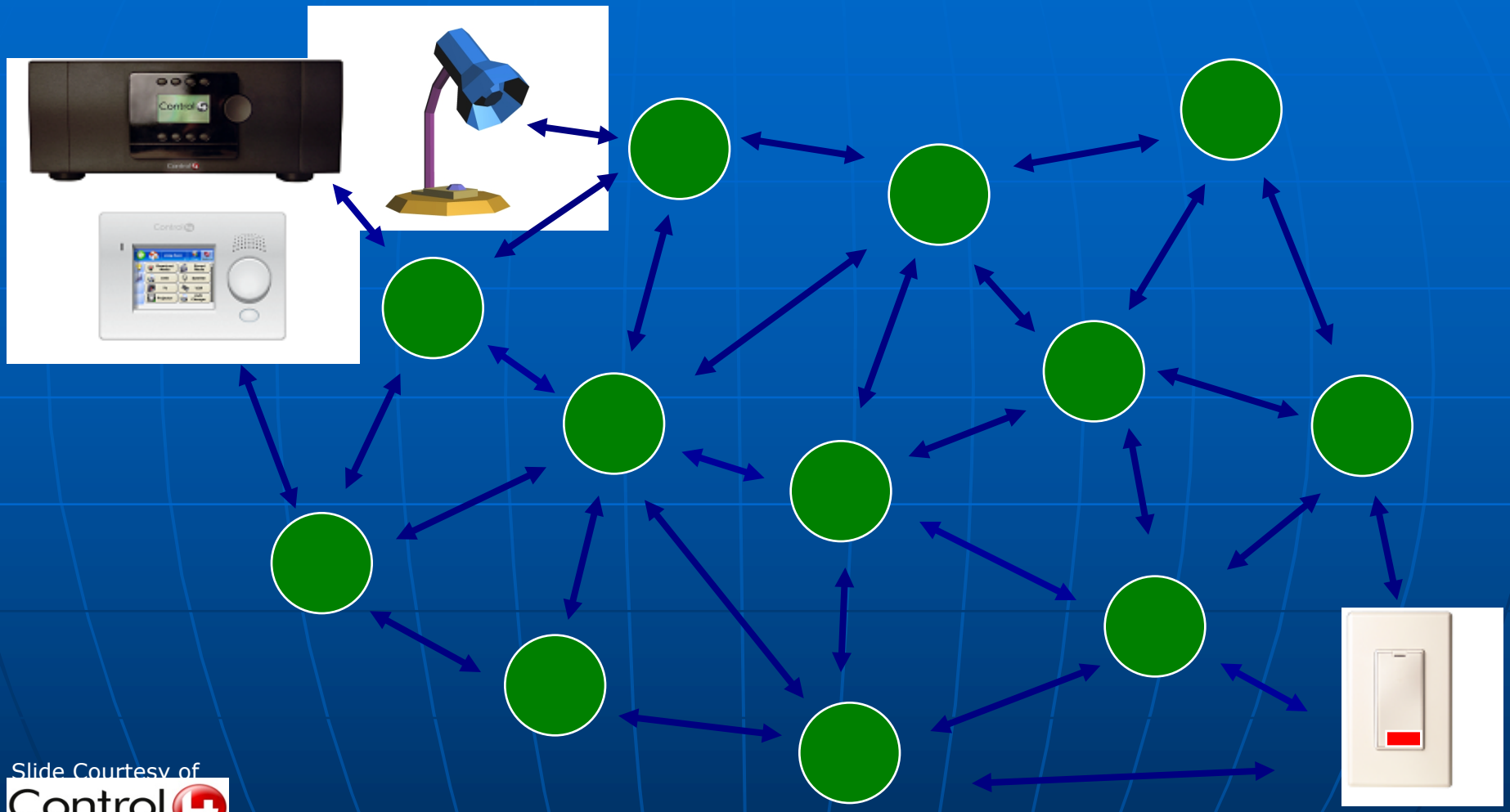
security
HVAC
lighting control
access control
irrigation

ZigBee Mesh Networking



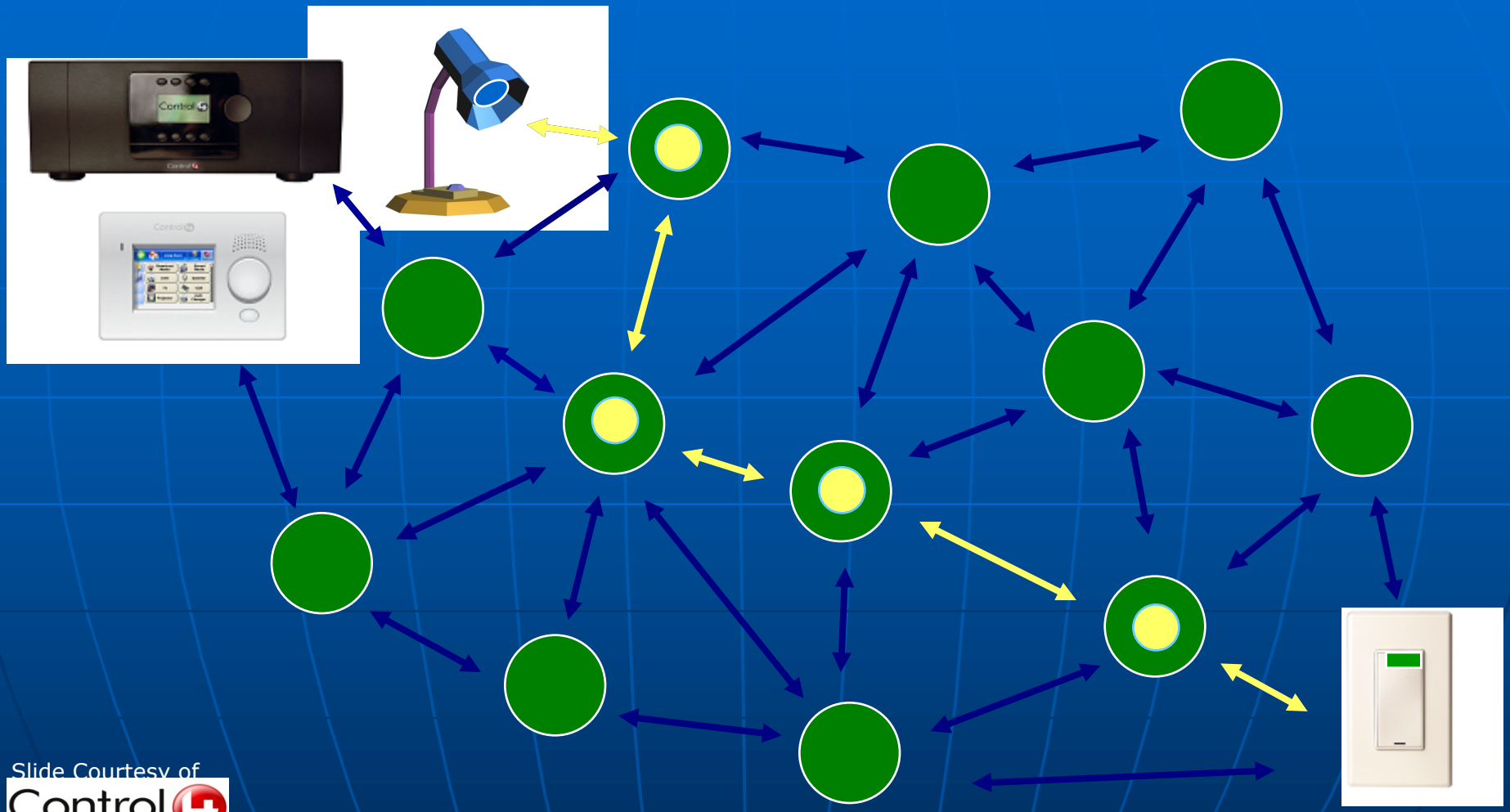
Slide Courtesy of

ZigBee Mesh Networking



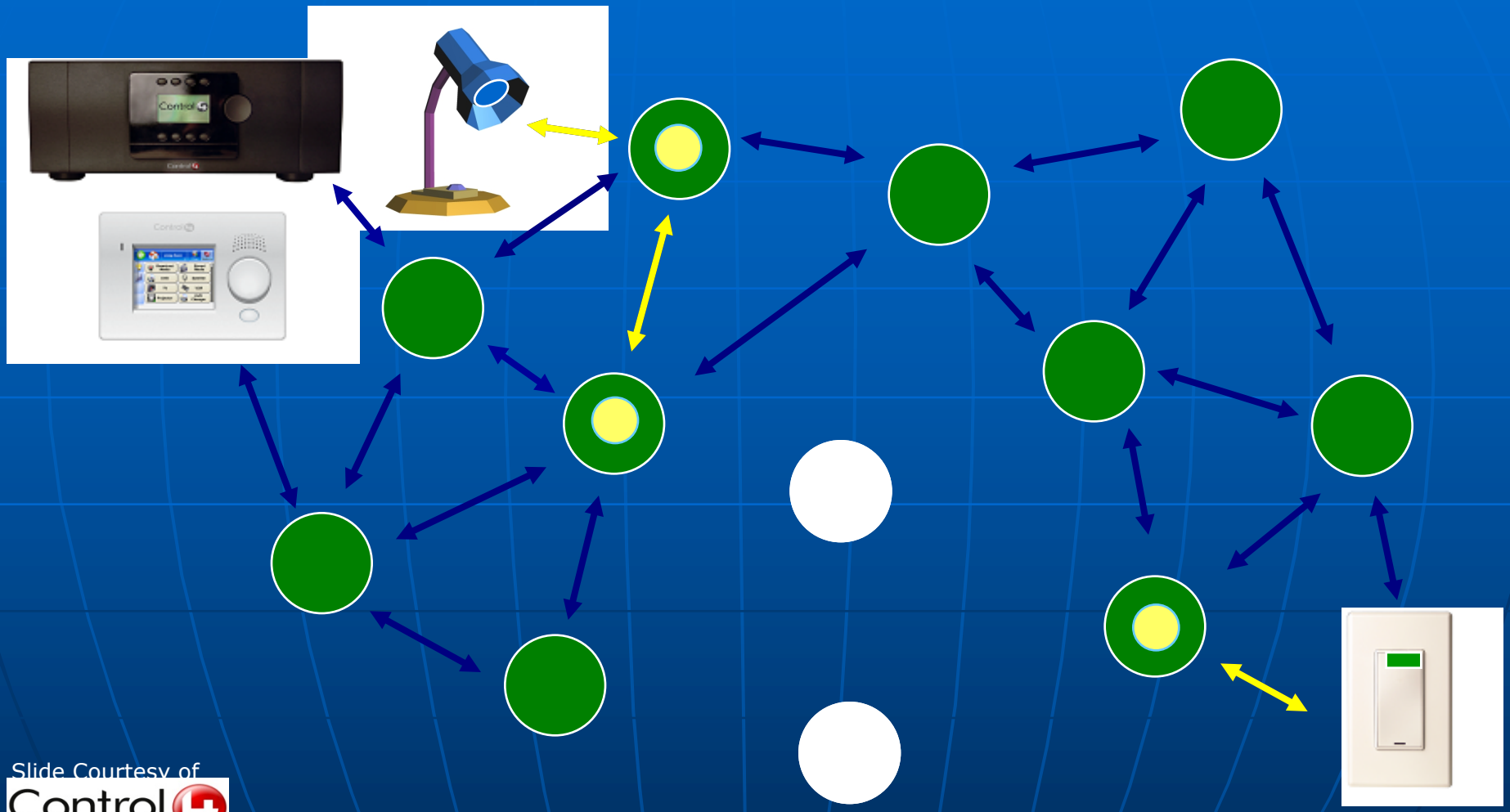
Slide Courtesy of

ZigBee Mesh Networking



Slide Courtesy of Control 4

ZigBee Mesh Networking

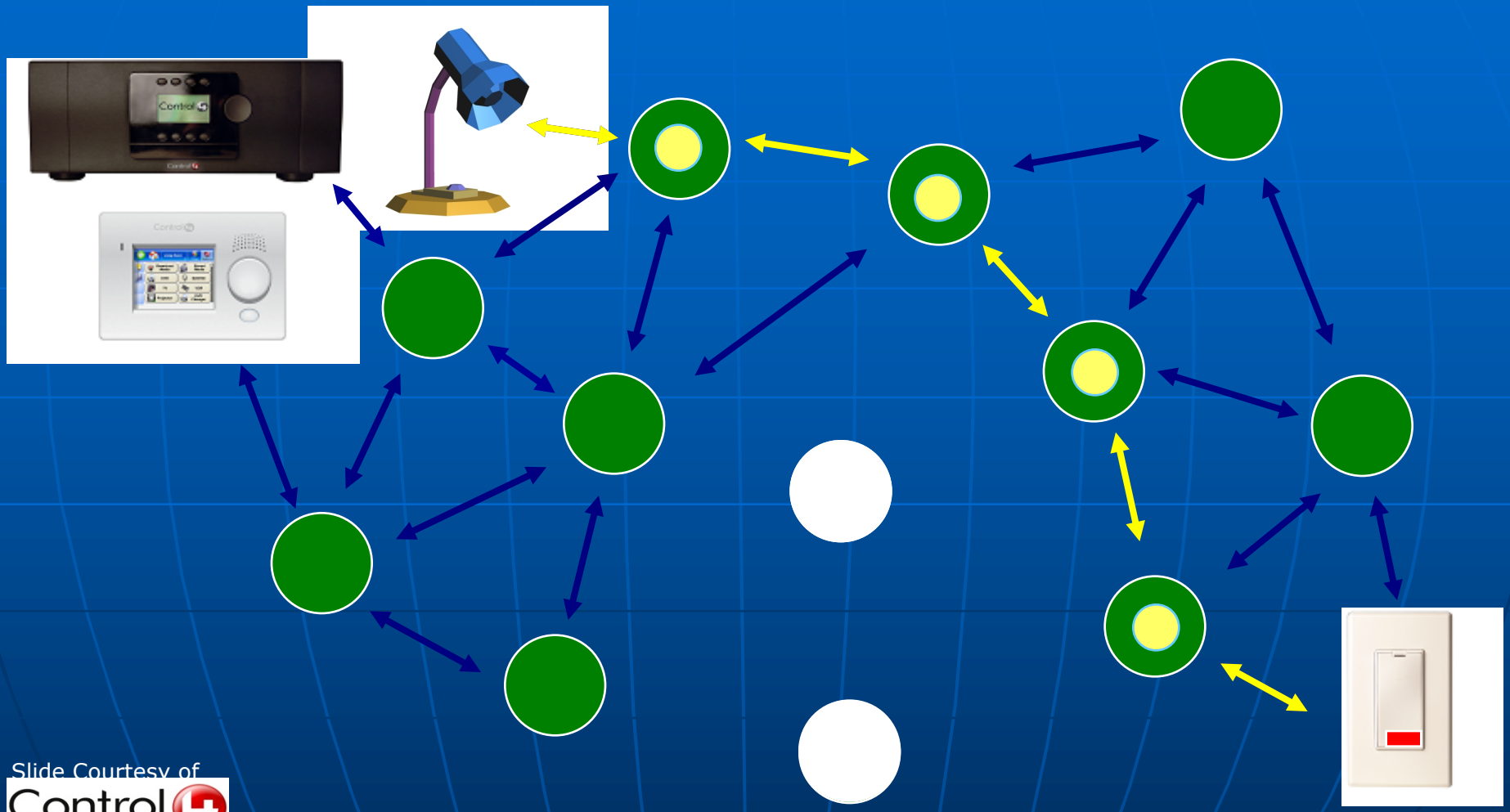


Slide Courtesy of

Control 4

LARA

ZigBee Mesh Networking

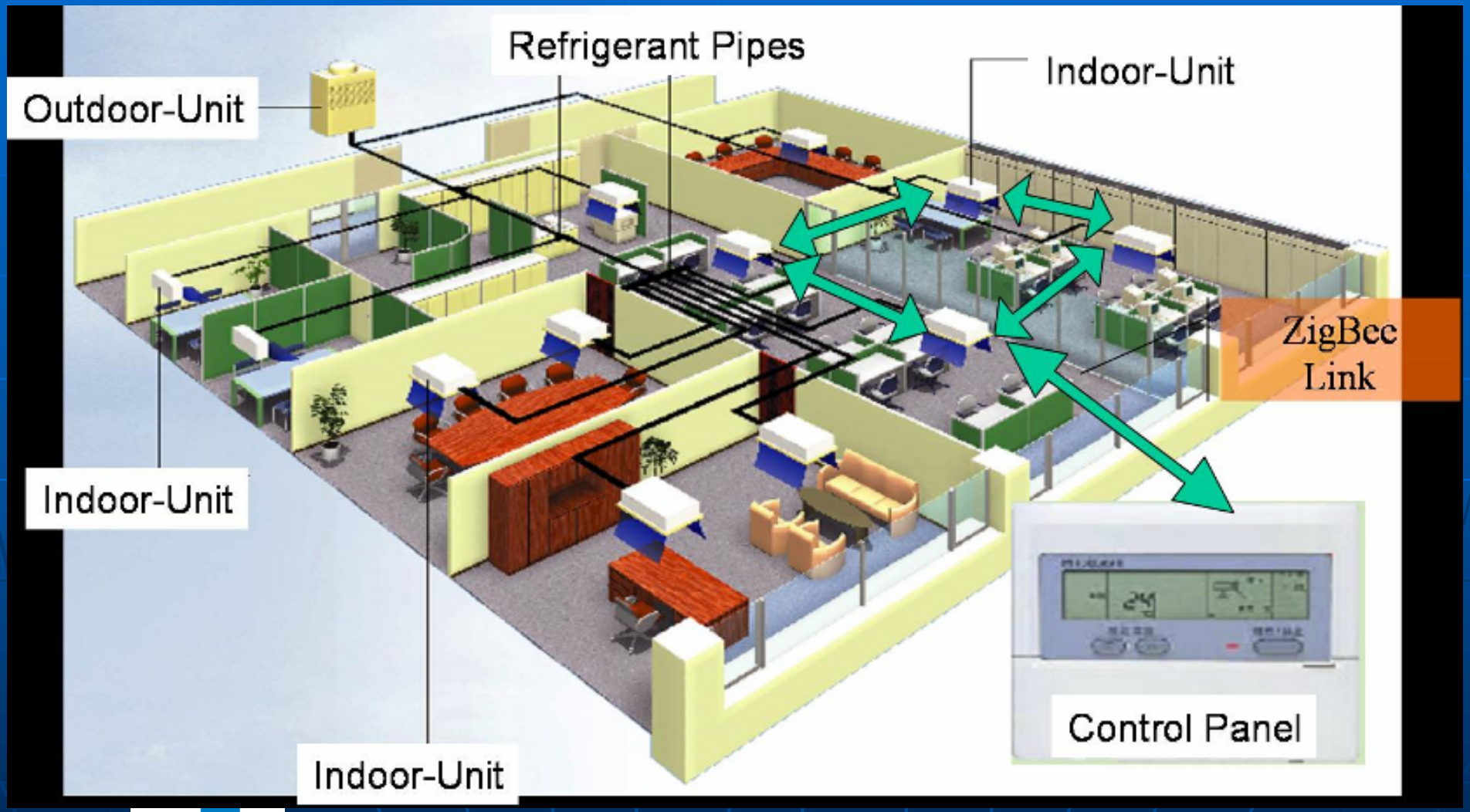


Slide Courtesy of

Control 4

LARA

Climatization Example



ActionView - Run Time - [AR CONDICIONADO]

Apresentar Ação Editar Exportar Imprimir Configuração Janela Acessórios Ajuda

SUPER

SPIN
ENGENHARIA DE AUTOMAÇÃO

HORA KMC
16 9

SALA CIRCULAÇÃO
25,79 °C

SALA DE REUNIÃO
26,55 °C

TEMPERATURA EXTERNA
26,55 °C

SETPOINT
24,50 °C

SALA DESENVOLVIMENTO
25,22 °C

SALA DIRETORIA
26,93 °C

LIG

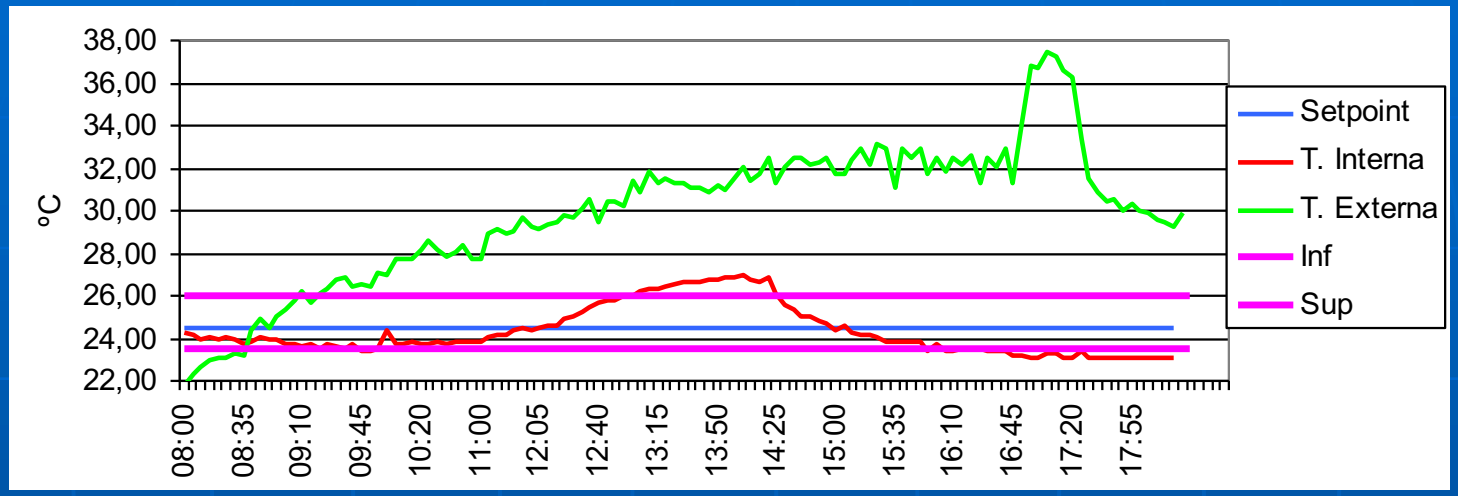
TEMPERATURA EXTERNA
26,55 °C

TEMPERATURA EXTERNA
32,46 °C

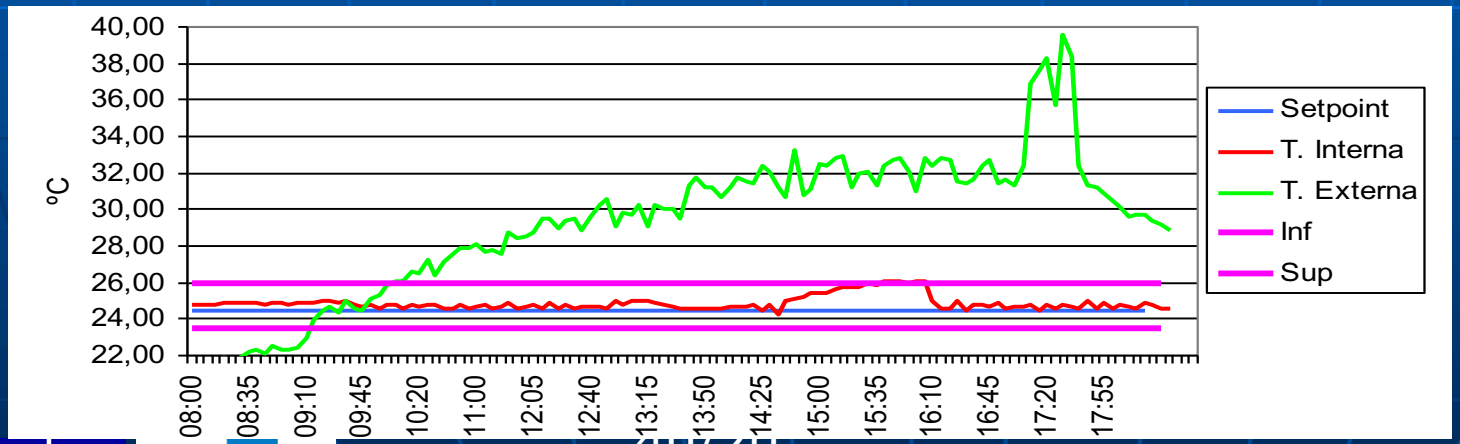
22/10/2006 13:47:55

Development Room

On-Off 16-09-2006

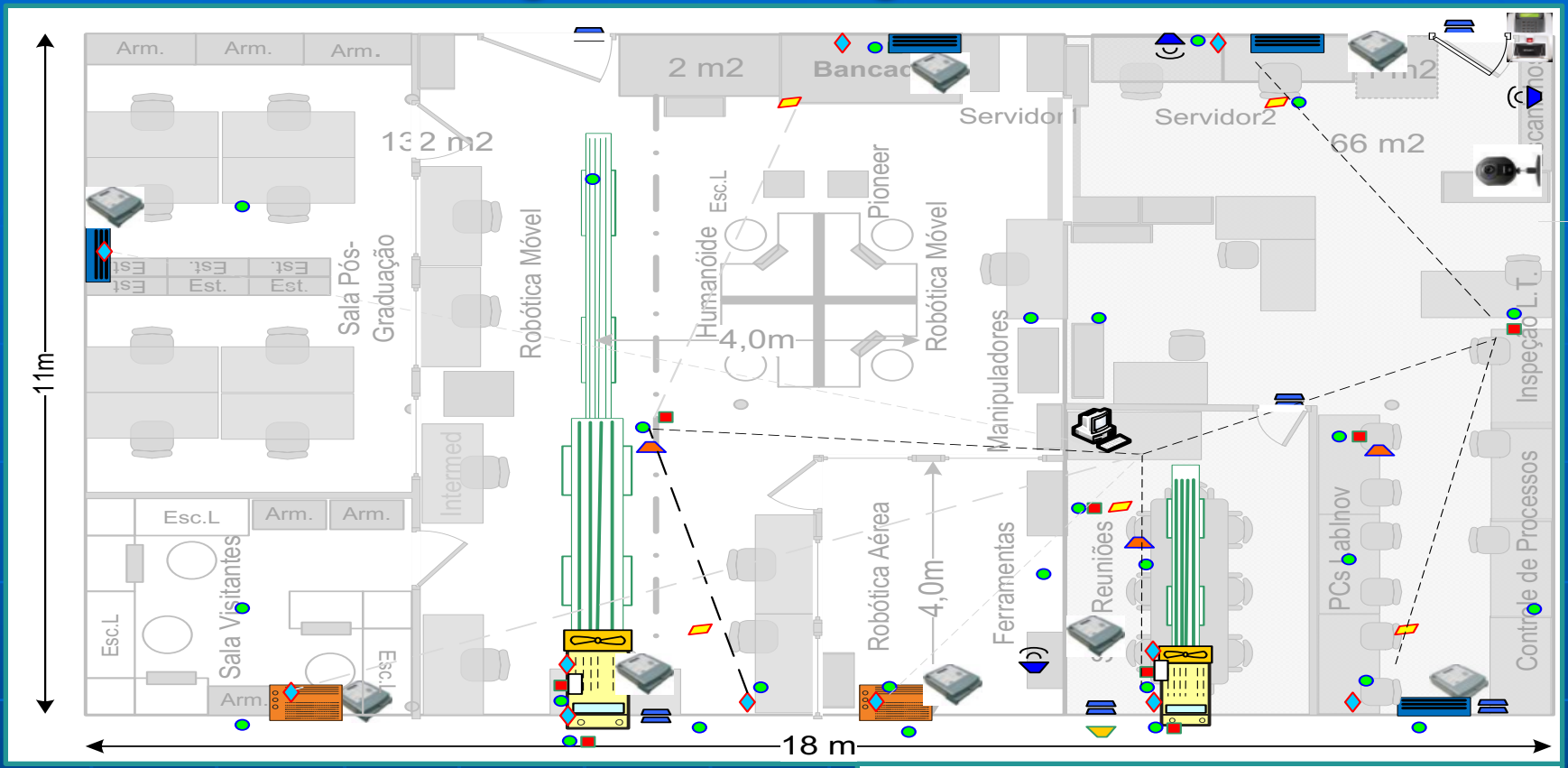


Fuzzy Control 14-09-2006



~30% saving!

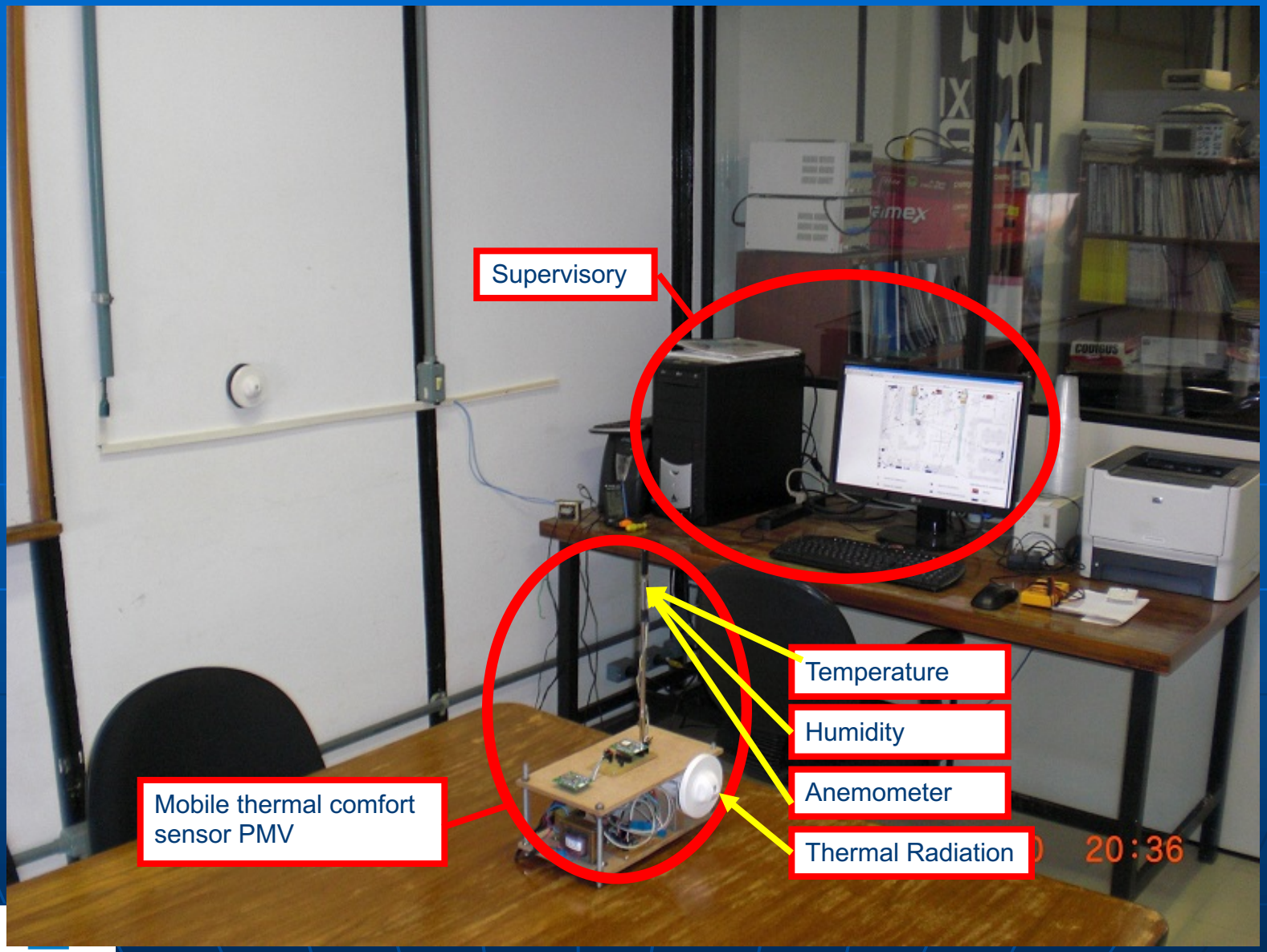
Intelligent Building Automation



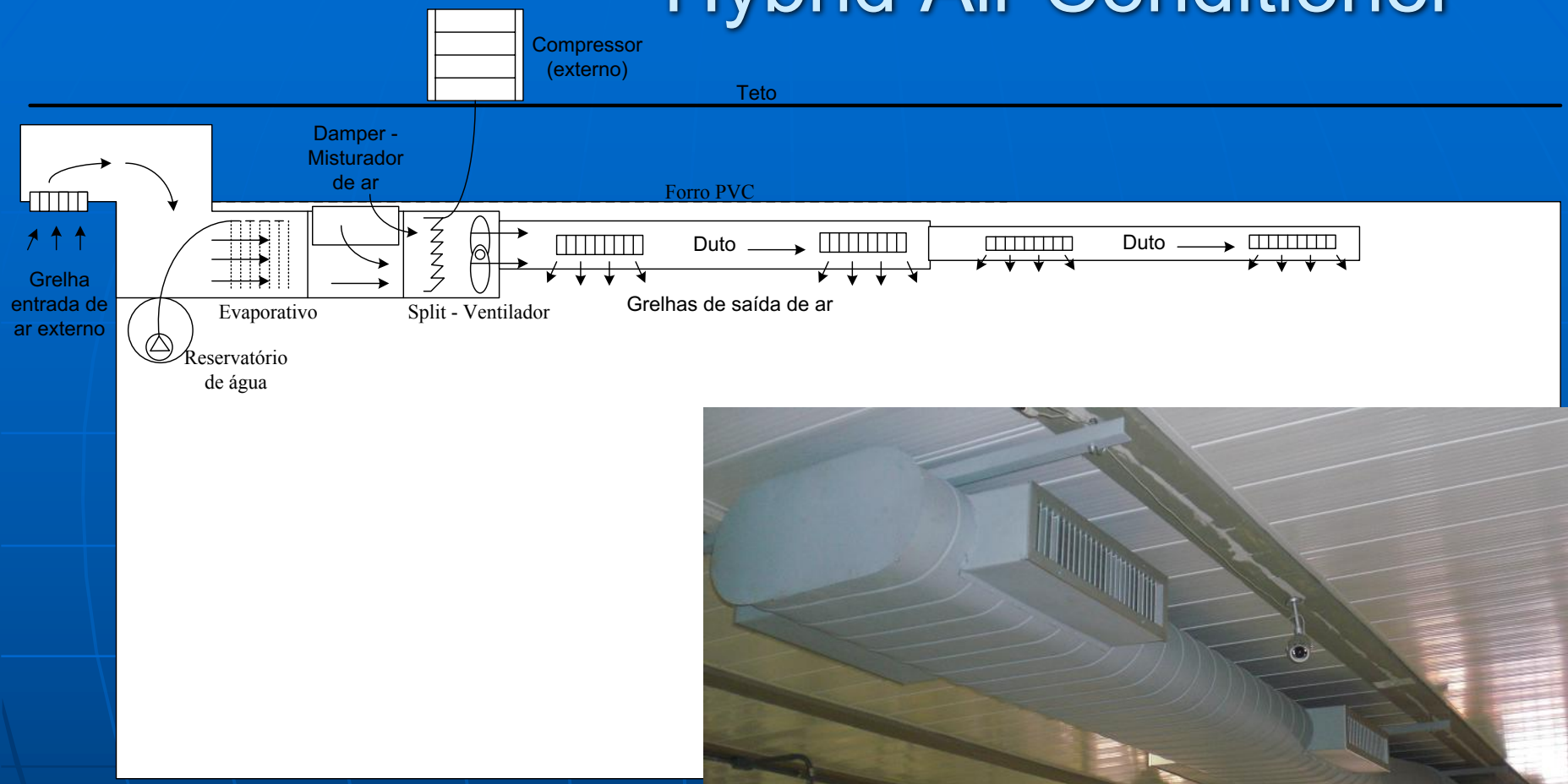
Laboratório de Automação e Robótica - ENE/UnB

- Sensor de Temperatura
- Sensor de Umidade
- Anemômetro
- Sensor Radiação Térmica Média
- Piranômetro
- Atuador Ar Cond.
- Detector de Presença
- Detector Porta/Janela aberta
- Medidor de Energia
- Camera de Vigilância
- Controle de Acesso
- BAS - Building Automation System

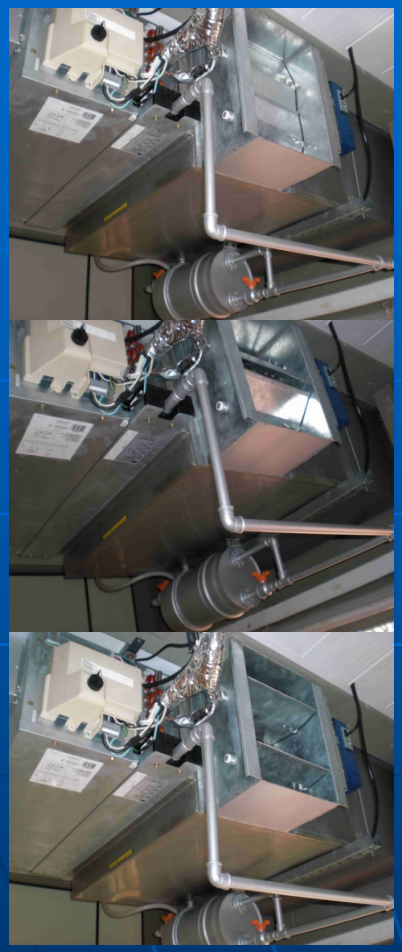
Mobile Thermal Comfort sensor module



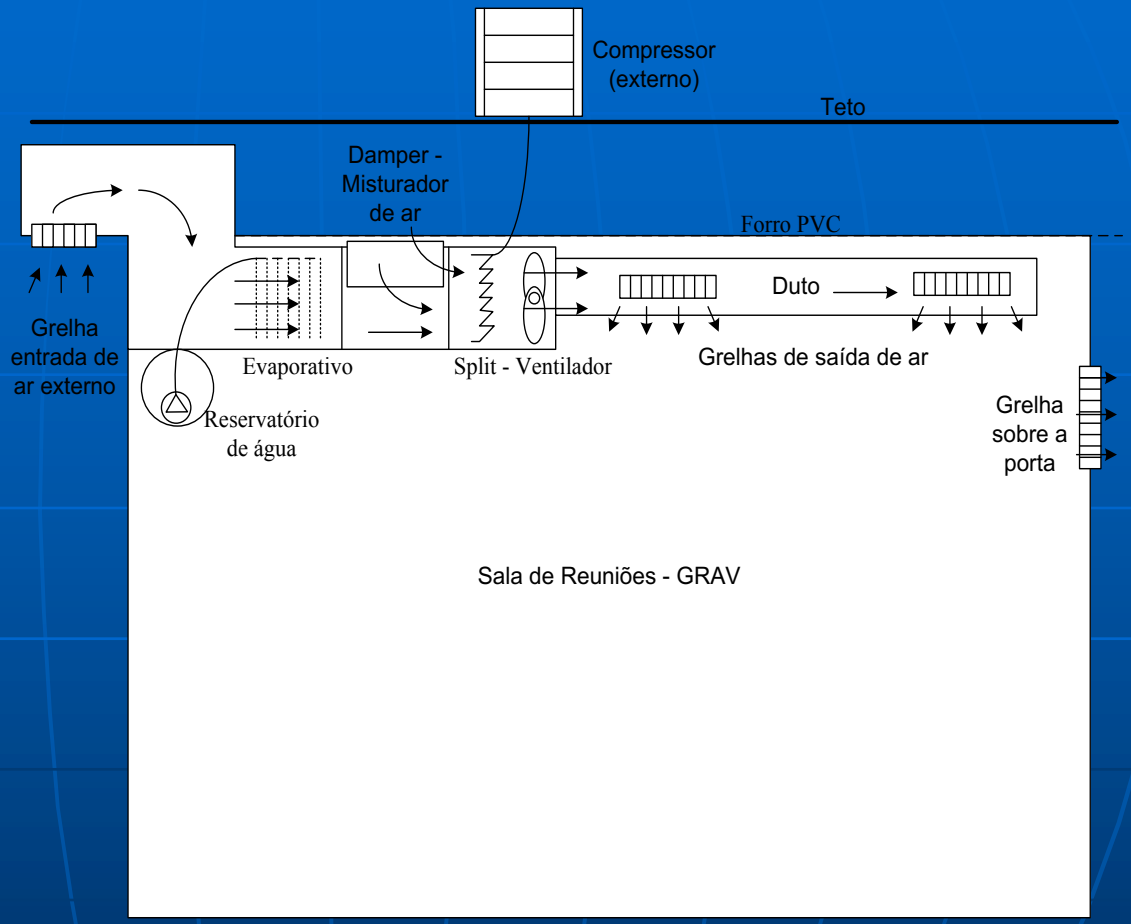
Hybrid Air Conditioner



Air Cond. Hybrid: Evaporativ-Conventional

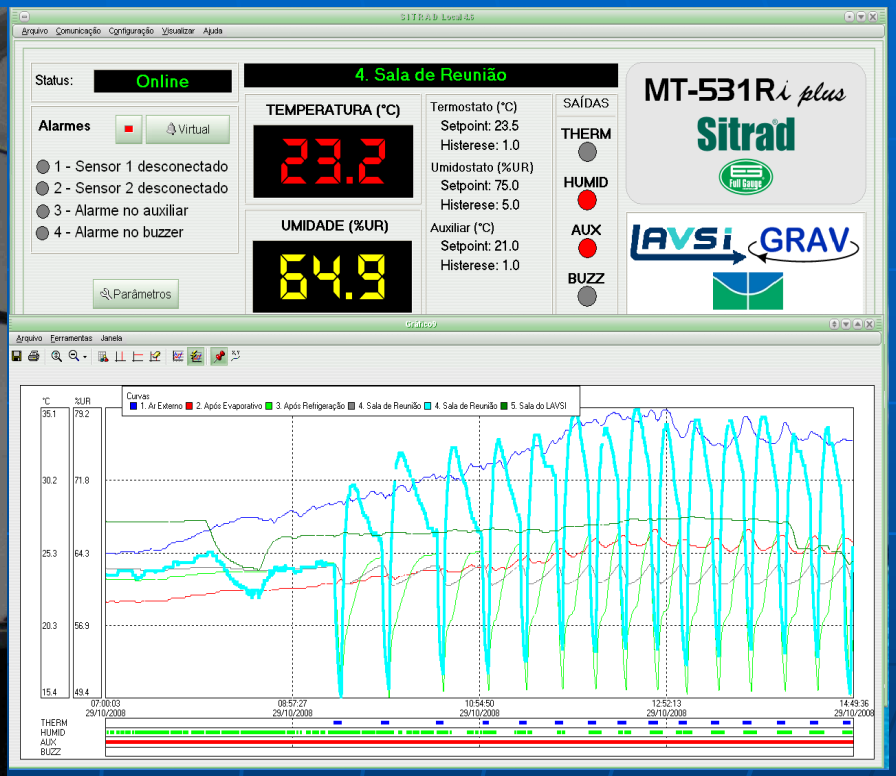


Damper

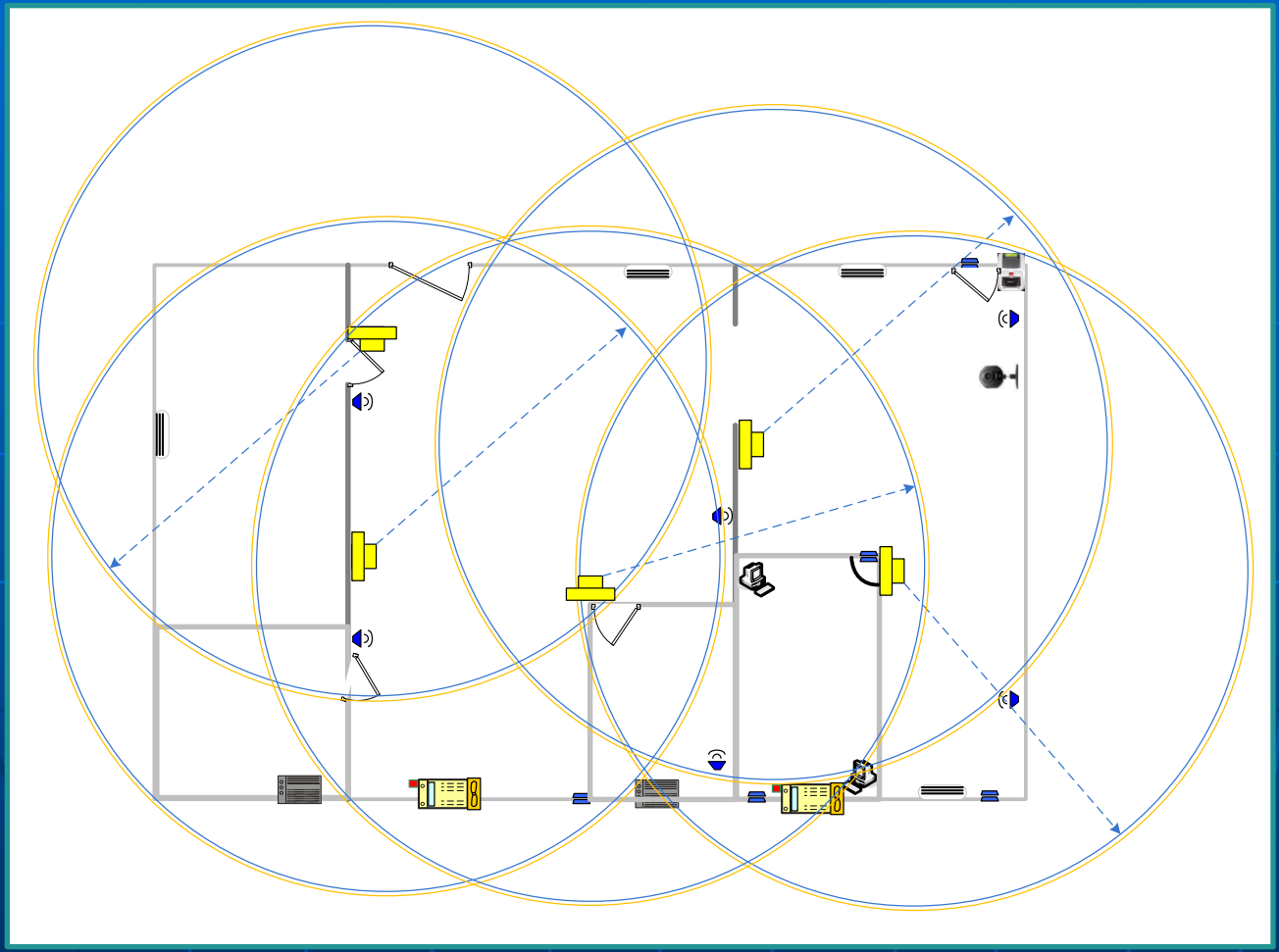


Schematics

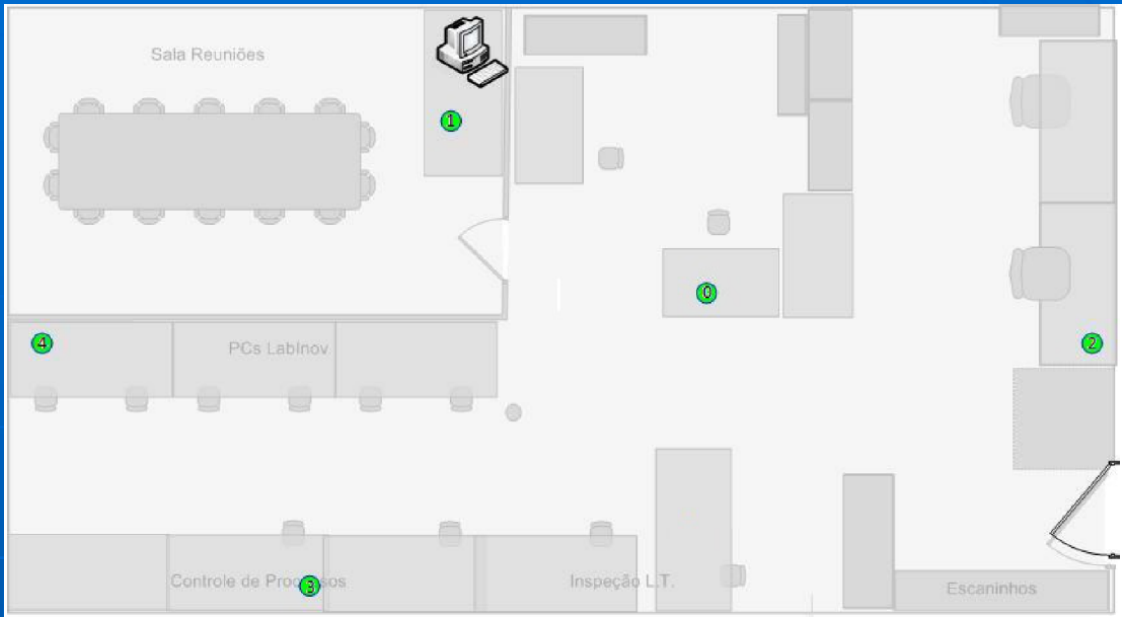
Hybrid Climatization: Evaporative-Conventional



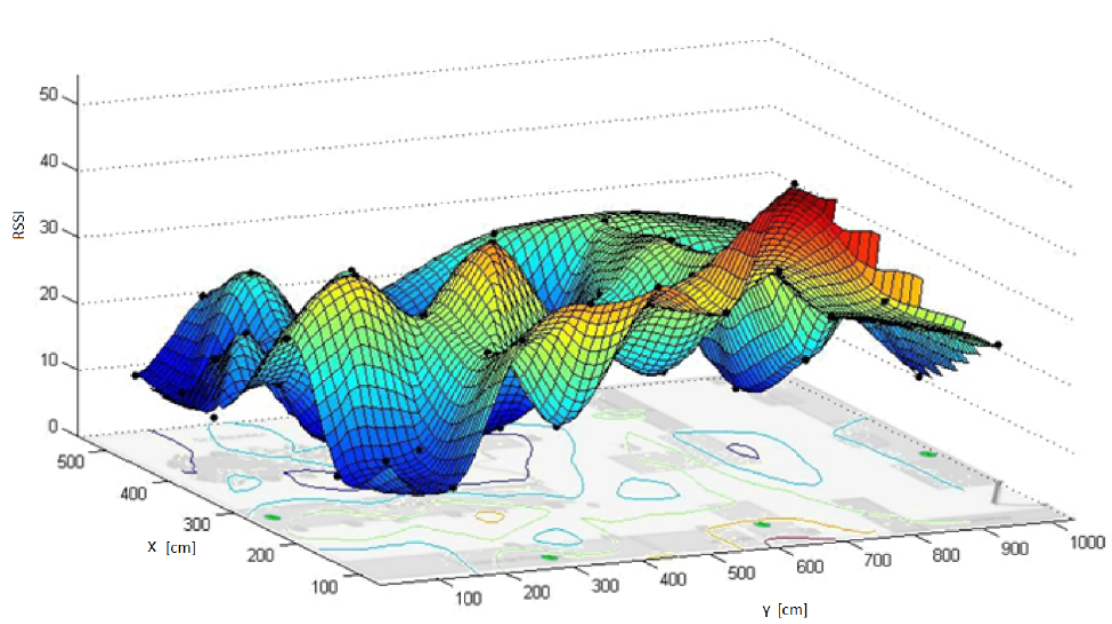
RFID occupancy identification for thermal load estimation



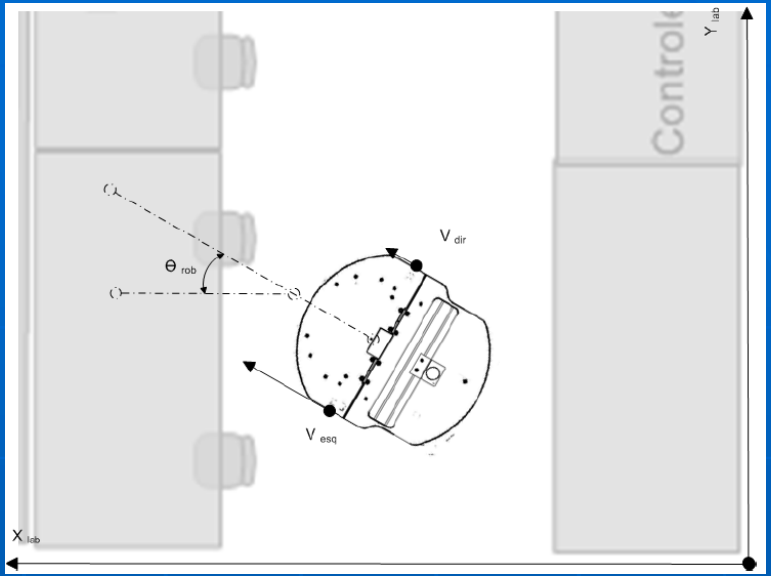
Indoor RFID Localization in the Context of Mobile Robotics with Application in Ambient Intelligence



Interpolated from measured RSSI



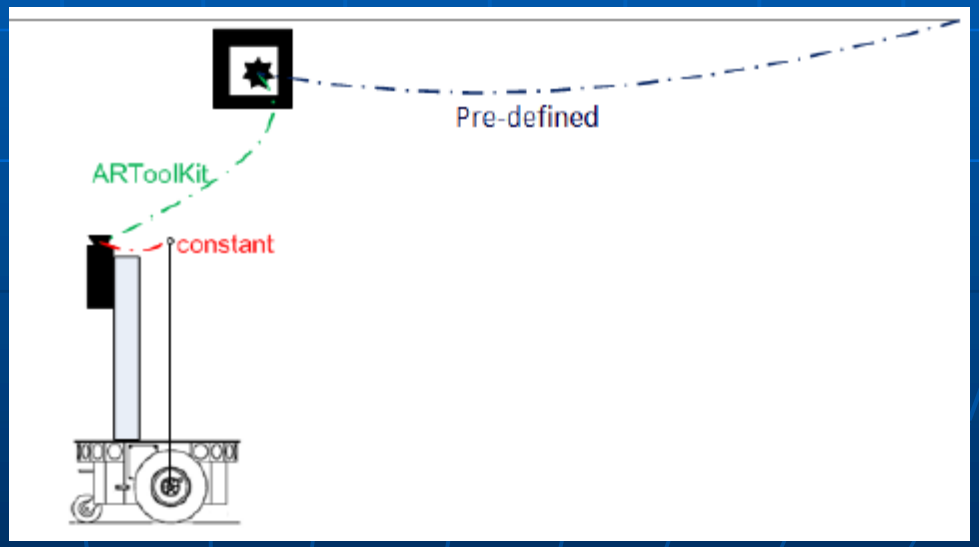
Indoor RFID Localization in the Context of Mobile Robotics with Application in Ambient Intelligence



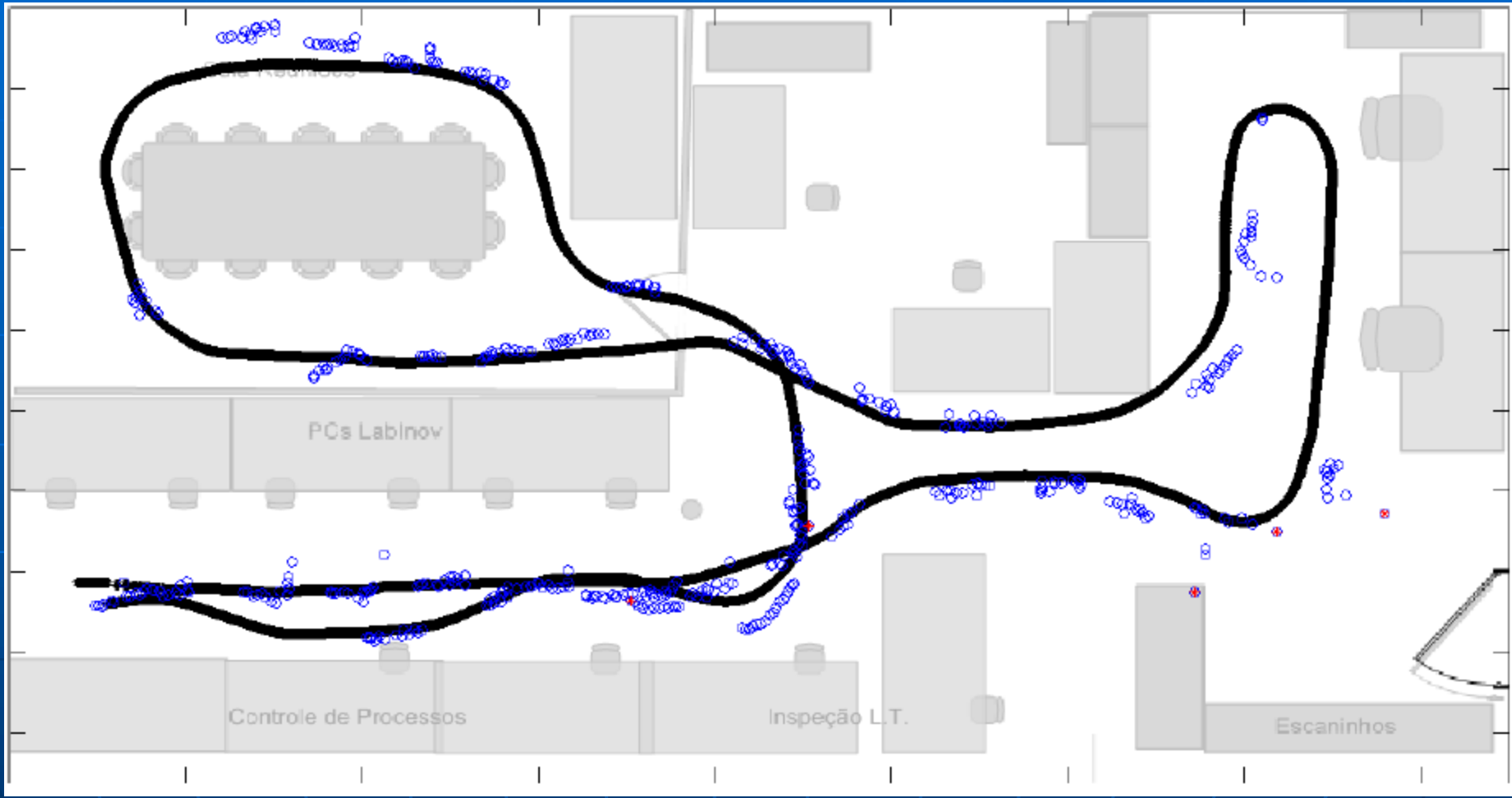
Localization results using encoders information in UKF without any update step

Indoor RFID Localization in the Context of Mobile Robotics with Application in Ambient Intelligence

Augmented Reality Localization System Results

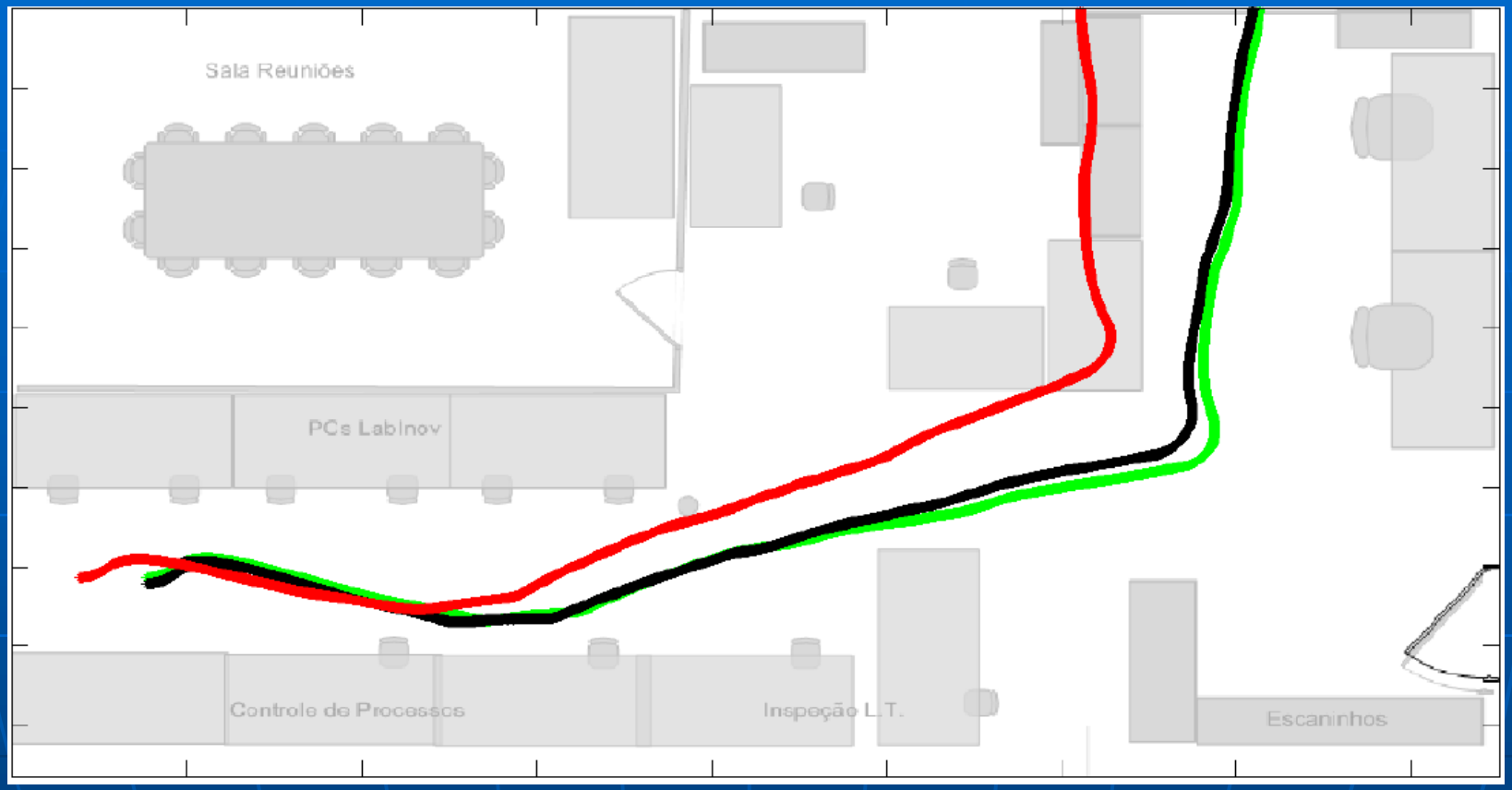


Indoor RFID Localization in the Context of Mobile Robotics with Application in Ambient Intelligence



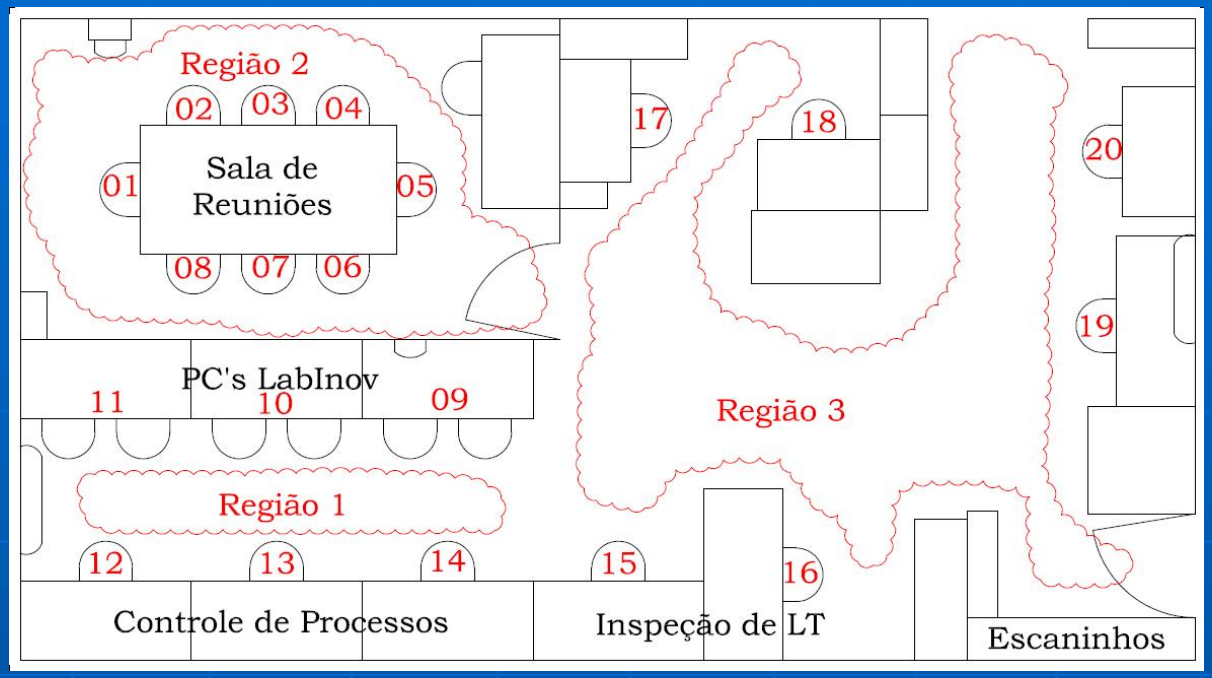
Augmented Reality Localization System Results

Comparison (Red – odo., Black – odo+vision, Green – all 3)



comparative results of the Augmented Reality-RFID RSSI system, Augmented reality system and pure odometry system

Thermal Load influence Areas



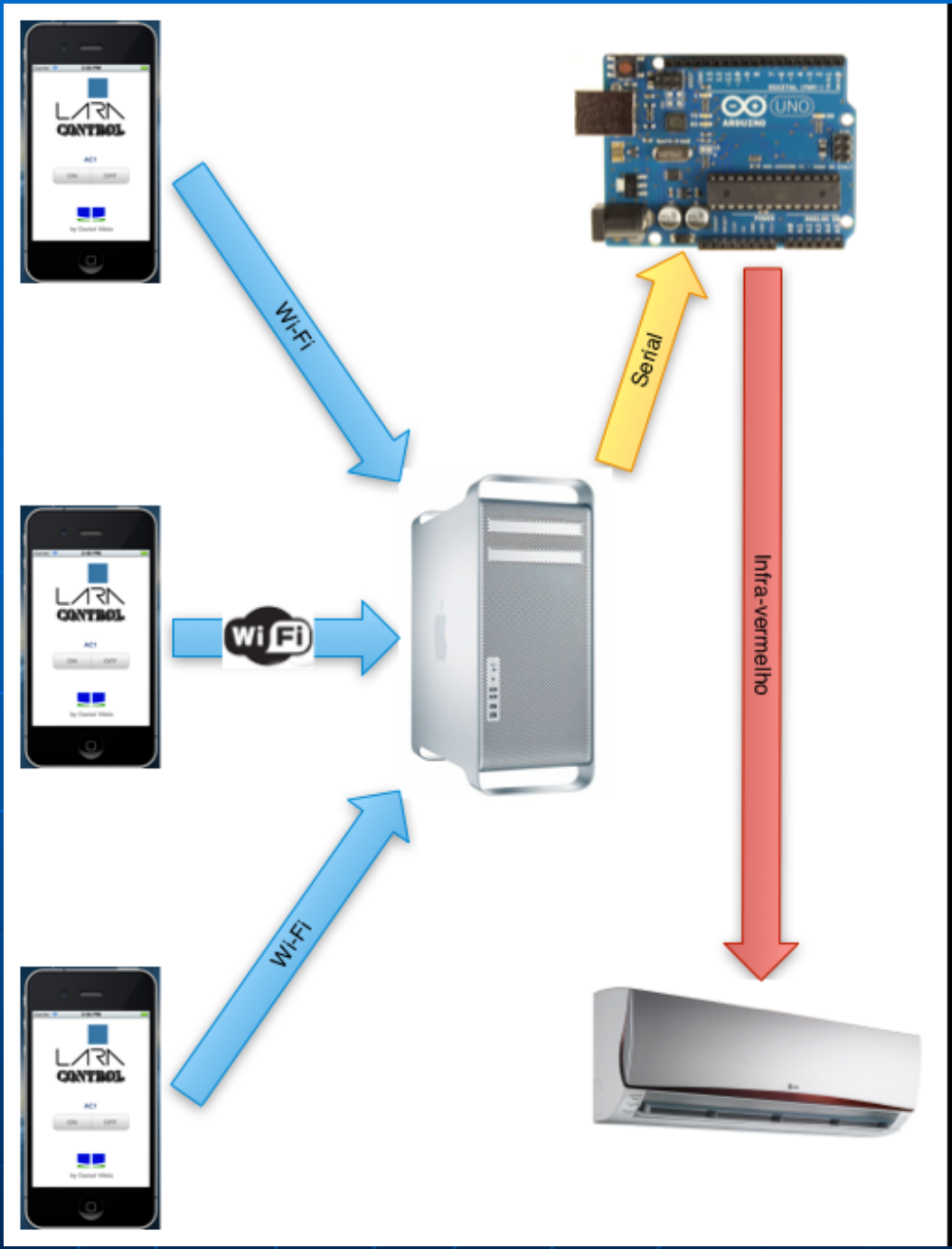
Identification of users in areas by RFID – RSSI classificators

(Cristovam Silva Jr., 2012)

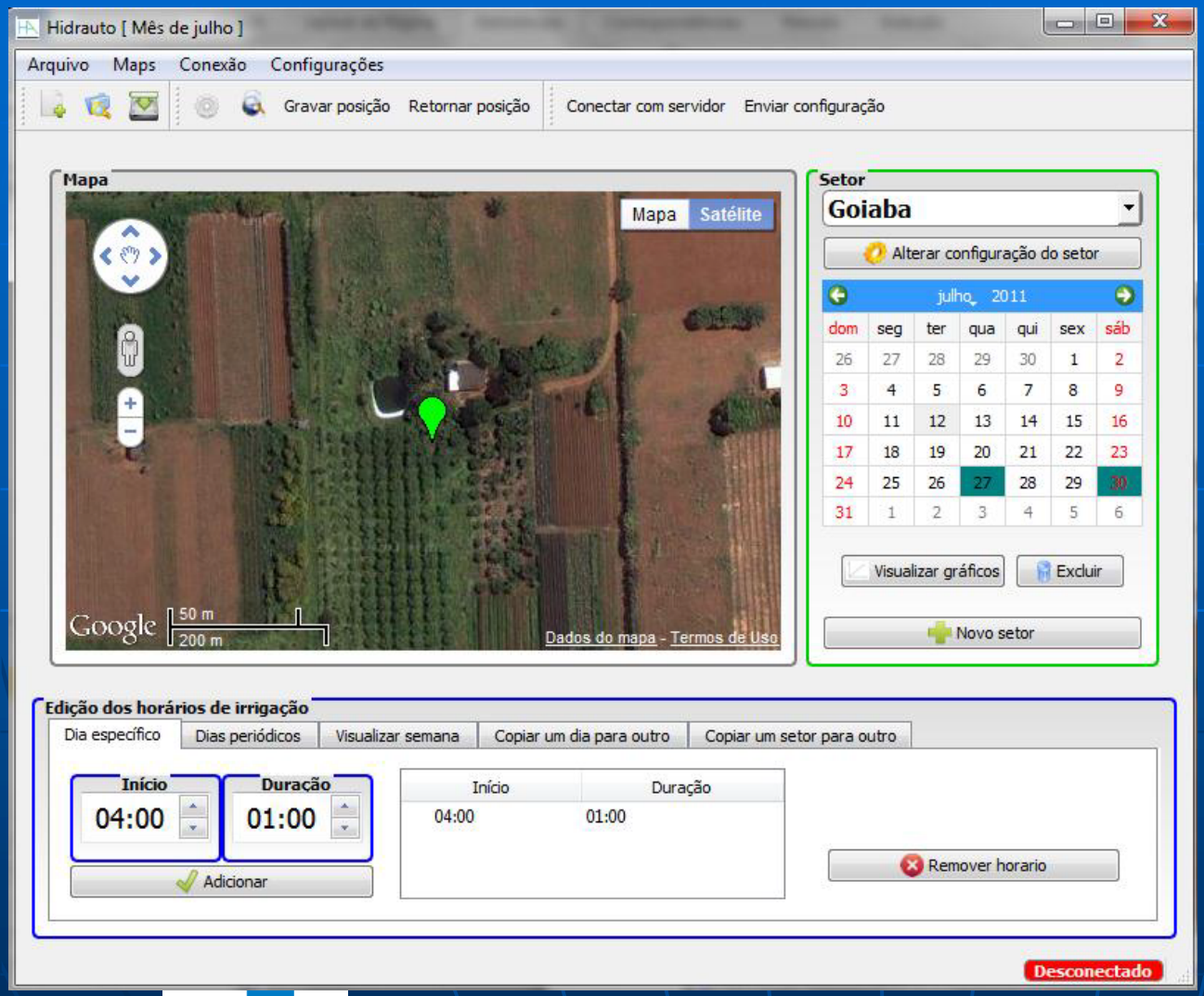
Automação Predial

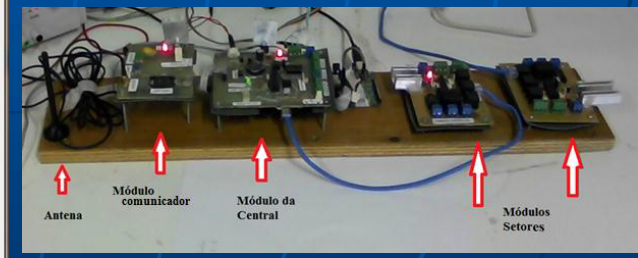
iPhone
WiFi
Arduino
ZigBee
Infra-Vermelho
Ar Condicionado

(Daniel Vilela, 2012)



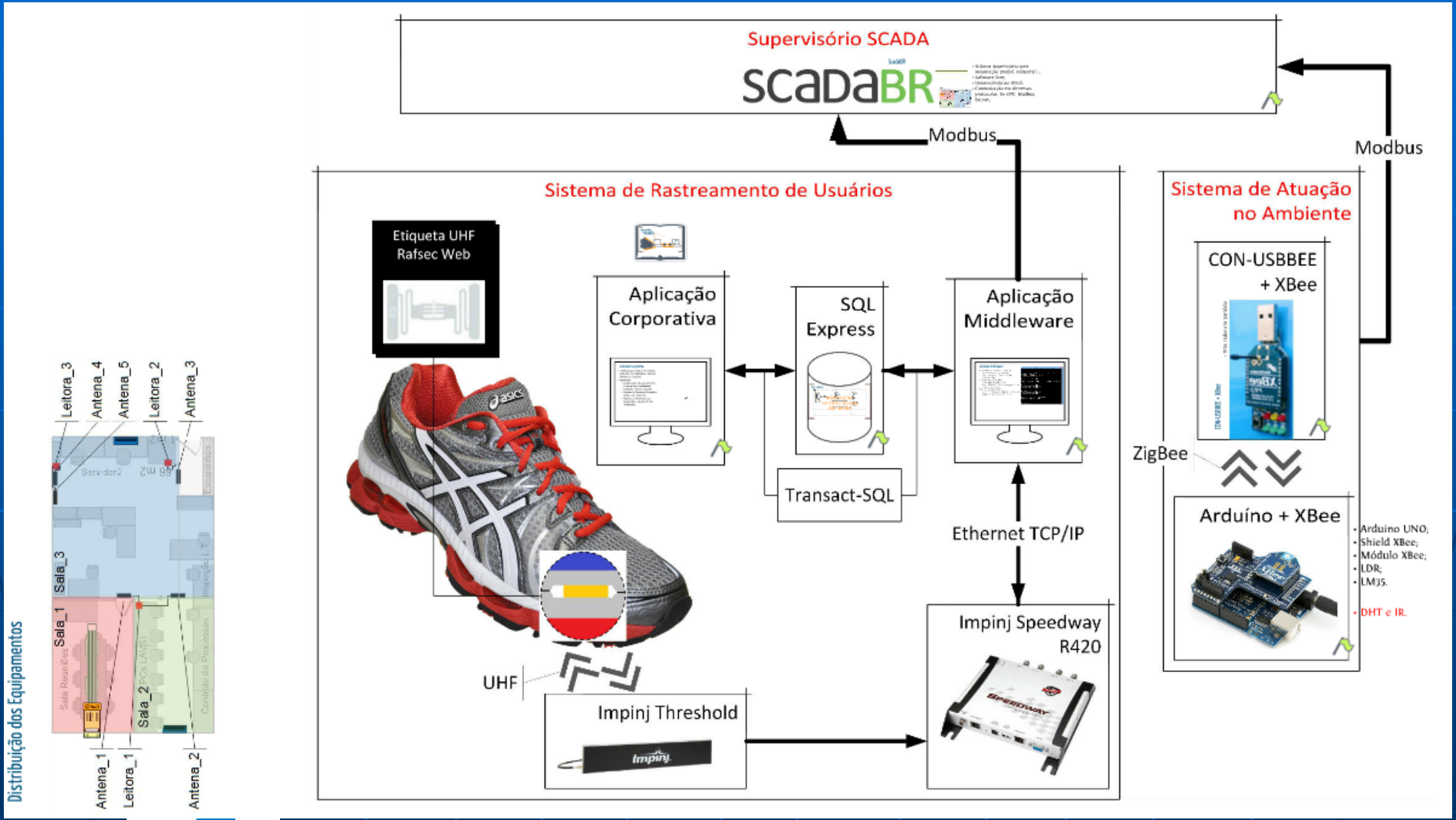
Automação e Monitoramento Remoto de Sistemas de Irrigação Visando Agricultura Familiar



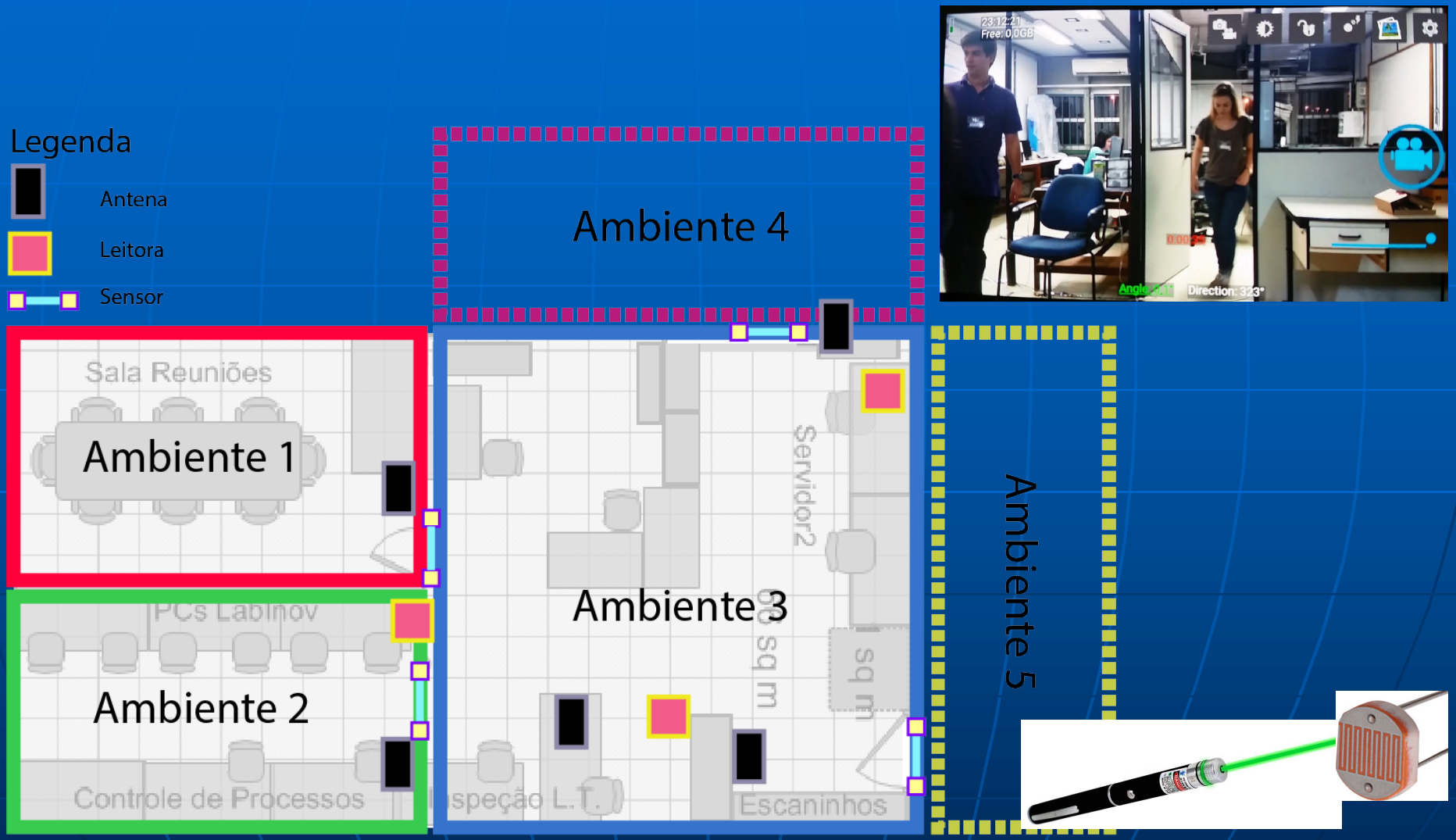


(Vinícius Guimarães, 2011)

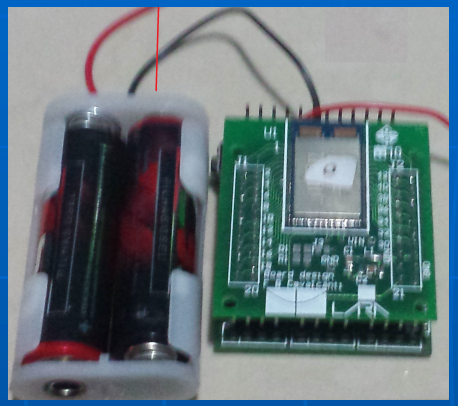
RFID passiva no rastreamento de usuários para a automação predial (Frederico Rocha e Filipe Oliveira, 2013)



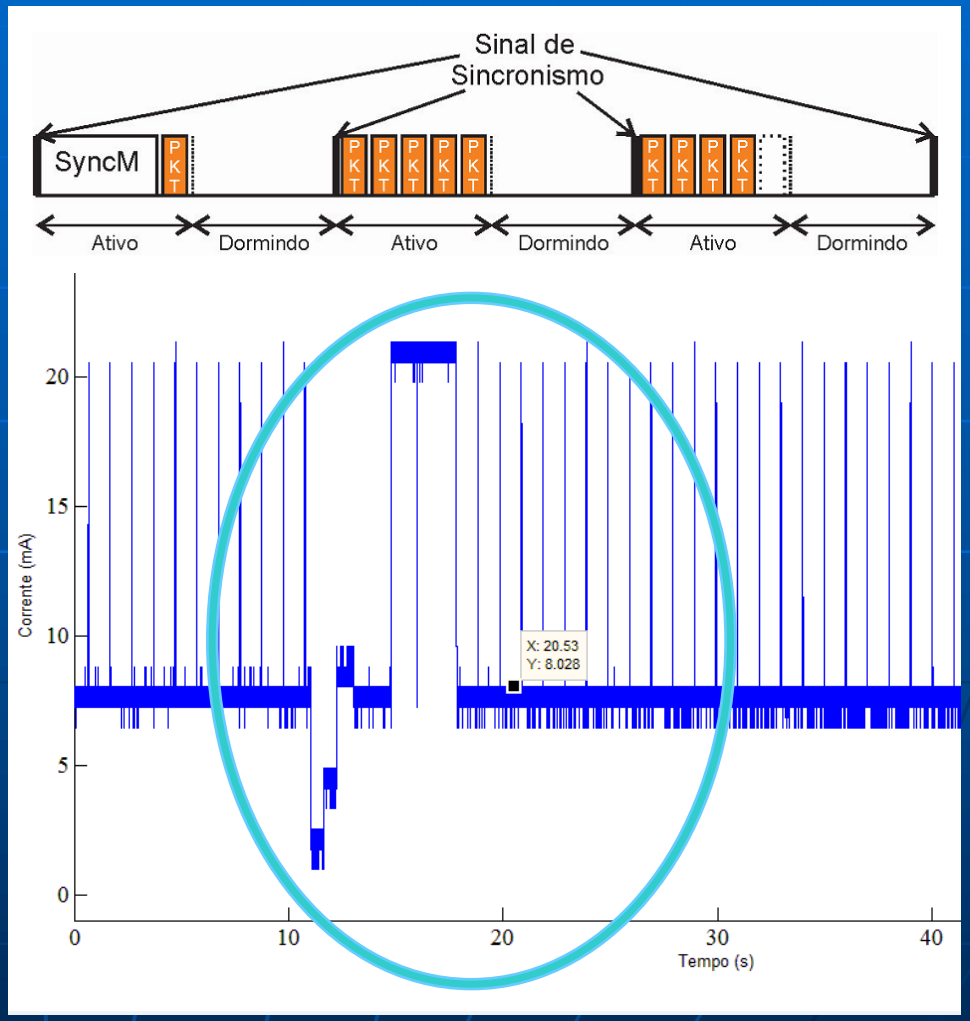
Occupancy by Passive RFID + Laser Beam



DyTEE MAC/UnB – Dynamic Timed Energy Efficient



Sensor Node

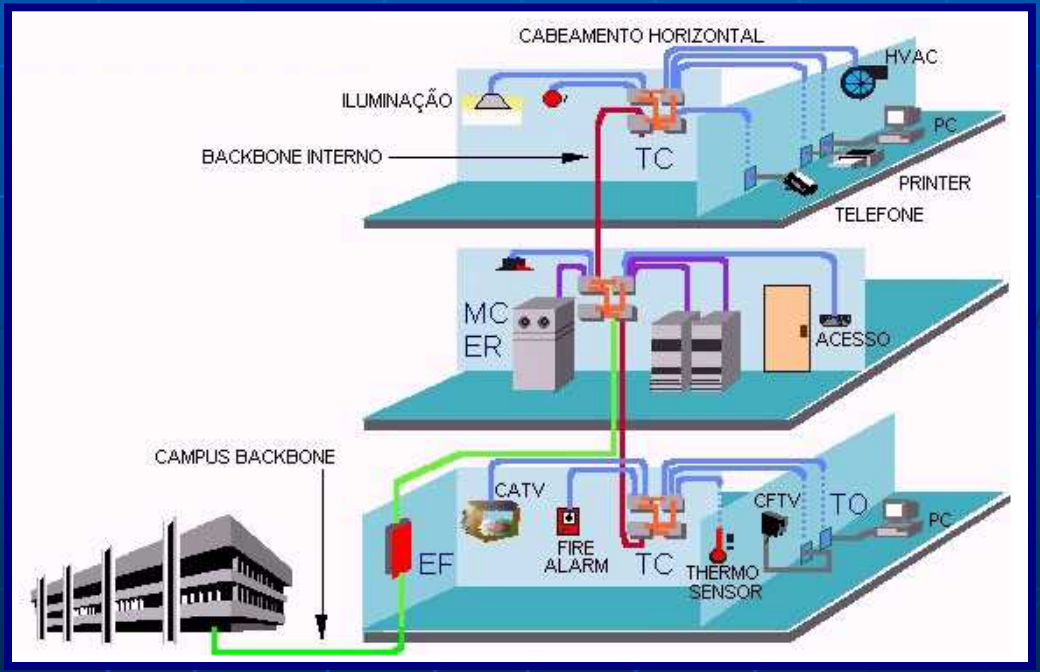


DyTEE

IEEE 802.15.4

Perspectives

- Energy Efficiency Labeling of Buildings
- nearly Zero Energy Building
- Assisted Living
- Virtual Campus
- Ambient Intelligence



Prof. Adolfo Bauchpiess

Short C.V.

– SENAI/1982 – Eletricista de Dispositivos de Comandos Elétricos

– UnB/1986 - Eng. Elétrica

  – Estágios: Telebrasília (1984), Prólogo (1985), Novadata (1986)

- Engenheiro: Novadata Sistemas e Computadores Ltda (1986-1990)

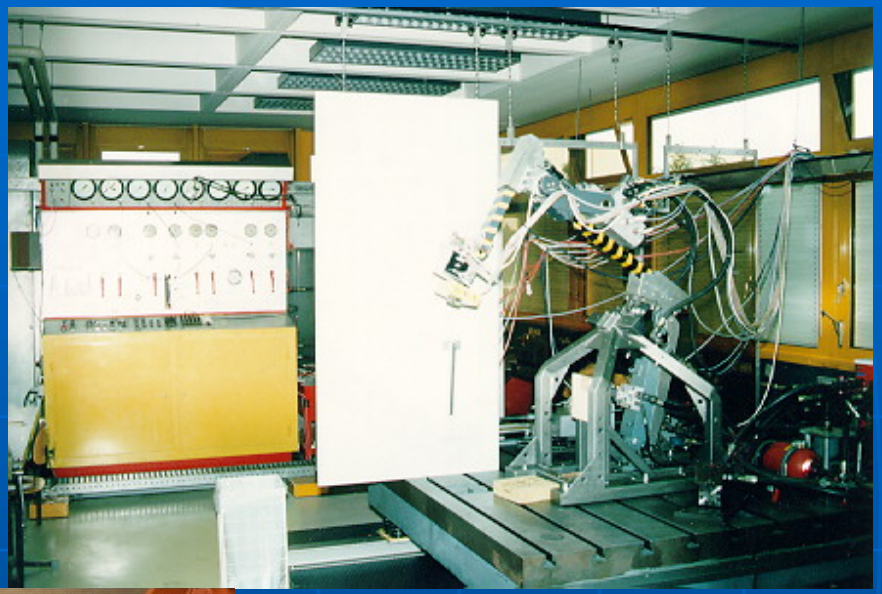
– UnB/1990 - Mestre Eng. Elétrica

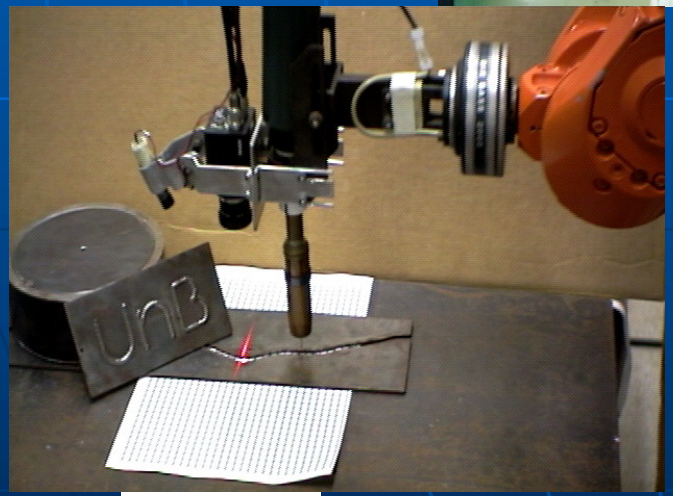
– Erlangen/1995 – Dr.-Ing.

– ENE/UnB 1995 ... atual - Prof. área de Controle

  - Pós-Doc (Aachen/1997, Kaiserslautern/2005-6, Santa Barbara/2014)
  - Projetos: FAP-DF, CNPq, CAPES, FINEP
  - Erasmus Mundus – Kaiserslautern

Projetos…





Thank You!

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