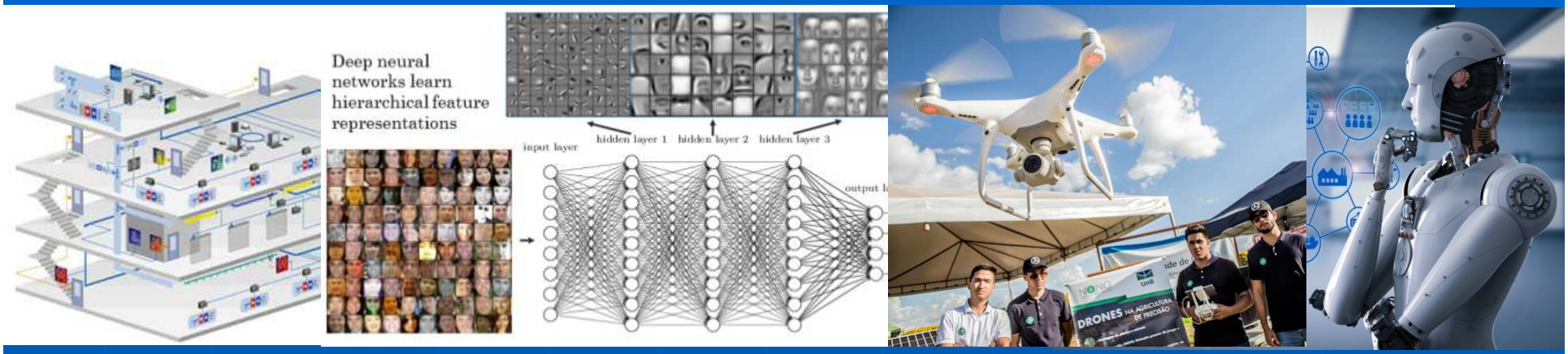


Área de Automação e Controle

- ENE/FT/UnB -

Prof. Adolfo Bauchspiess

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

Grupo de Pesquisa CNPq
LARA

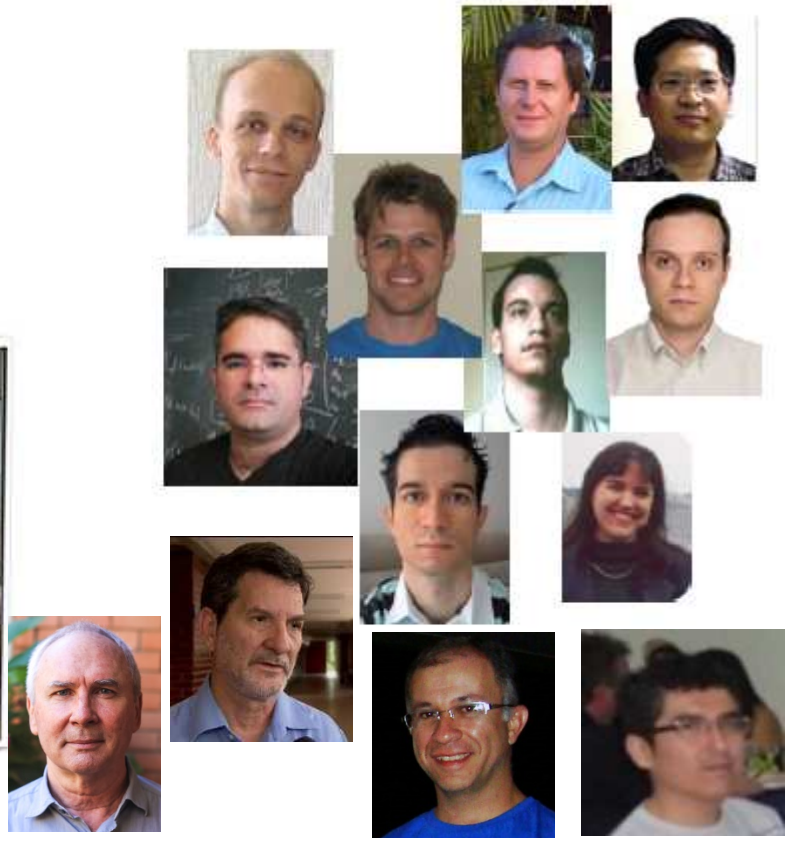
Grupo de Automação e Controle

- Membros

12 professores

- ±40 estudantes de pós-graduação
- ±60 estudantes de graduação

LARA, junho/2011



Laboratório de Automação e Robótica

- Laboratórios e grupos de pesquisa
  - Laboratório de Automação e Robótica (LARA)
- Áreas de pesquisa
  - Controle e estimação
  - Ambientes inteligentes
  - Engenharia aeroespacial
  - Robótica
- Infra-estrutura
  - Diversas plataformas experimentais
  - Estações de trabalho individualizadas

Ambiente de trabalho no LARA

Grupo de Pesquisa CNPq
LARA
Lab. de Automação e Robótica

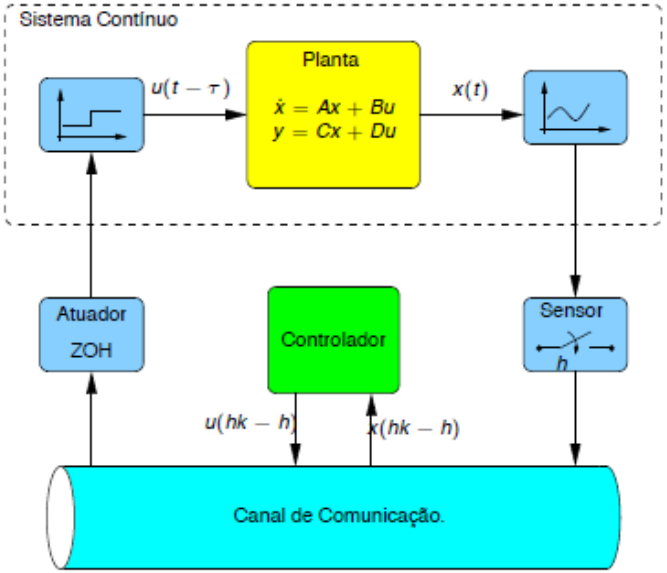
- LARA
  - Robótica
  - Ambientes Inteligentes
- Lab. Aero-Espacial
- Lab. Robótica Aérea
- Lab. Automação Processos
- Lab. Ensino CSD/CDig

Responsáveis

- Prof. Geovany A. Borges
- Prof. Adolfo Bauchspiess
- Prof. Renato A. Borges
- Prof. Henrique C. Ferreira
- Prof. Eduardo S. Tognetti

Controle, filtragem e identificação

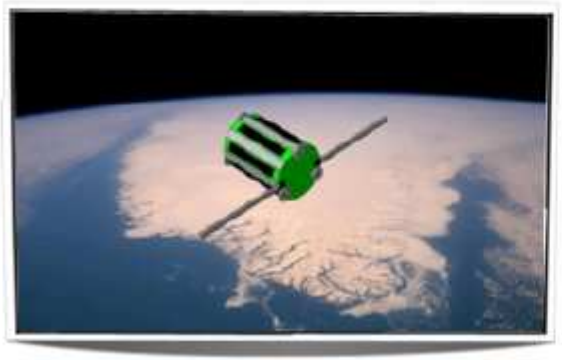
- Áreas de pesquisa
  - Controle robusto
  - Identificação de sistemas dinâmicos
  - Sistemas híbridos
  - Teoria de estabilidade de Lyapunov
  - Sistemas de controle em rede
- Professores envolvidos
  - Alex da Rosa
  - Eduardo Tognetti
  - Henrique Ferreira
  - João Ishihara
  - Renato Borges



Fonte: Eduardo Tognetti

Engenharia aeroespacial

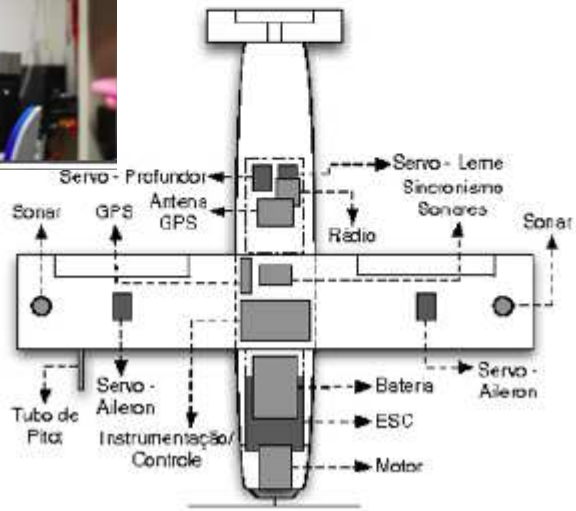
- Projetos de pesquisa
  - Controle de atitude de microsatélites
  - Sistemas de navegação baseado em satélites
  - Instrumentação e controle de foguetes de propulsão híbrida
- Professores envolvidos
  - Renato Borges
  - Geovany Borges
  - João Ishihara



Engenharia aeroespacial

Robótica aérea

- Projetos de pesquisa
  - Desenvolvimento de um sistema de Mini-VANT
- Plataformas experimentais
  - Veículo de asa fixa
  - Quadrirrotores
  - Helicóptero
- Professores envolvidos
  - Geovany Borges
  - João Ishihara



Locomoção de robôs

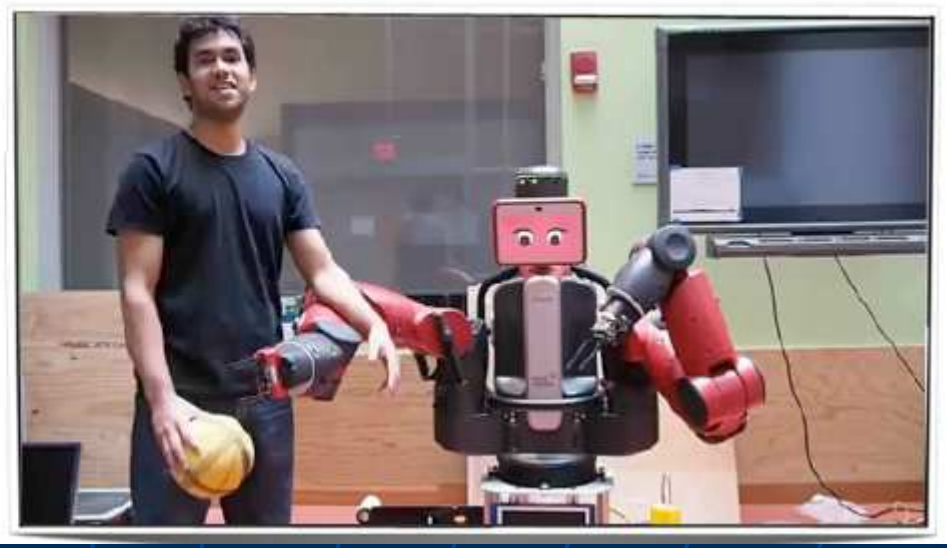
- Projetos de pesquisa em andamento
  - Marcha de robôs humanóides
  - Futebol de robôs
- Plataformas experimentais
  - Robô quadrúpede
  - Robô humanóide
- Professores envolvidos
  - Alexandre Romariz
  - Antônio Padilha
  - Geovany Borges

RoboCup 2014 João Pessoa, Brazil

UnBeatables

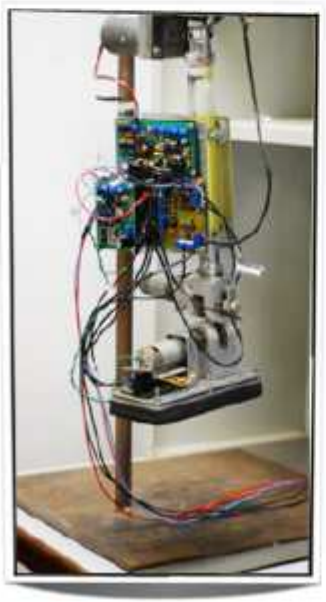
Robótica móvel e interação homem-robô

- Projetos de pesquisa em andamento
  - Manipuladores móveis para sistemas avançados de manufatura
- Áreas de pesquisa
  - Localização e mapeamento simultâneos
  - Controle servovisual
  - Controle de manipuladores
- Professores envolvidos
  - Antônio Padilha
  - Geovany Borges
  - João Ishihara



Robótica de reabilitação

- Projetos em andamento
  - Prótese robótica para amputados de membro inferior

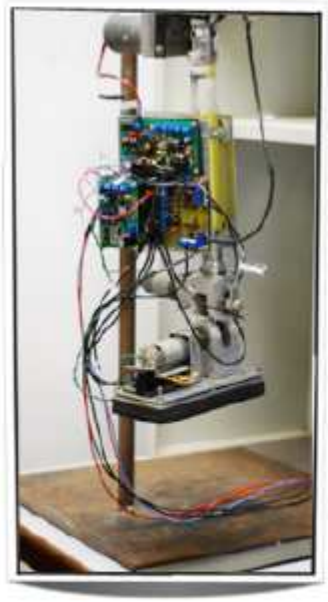


Nonfunctional prototype

- Professores envolvidos
  - Antônio Padilha e Geovany Borges

Robótica de reabilitação

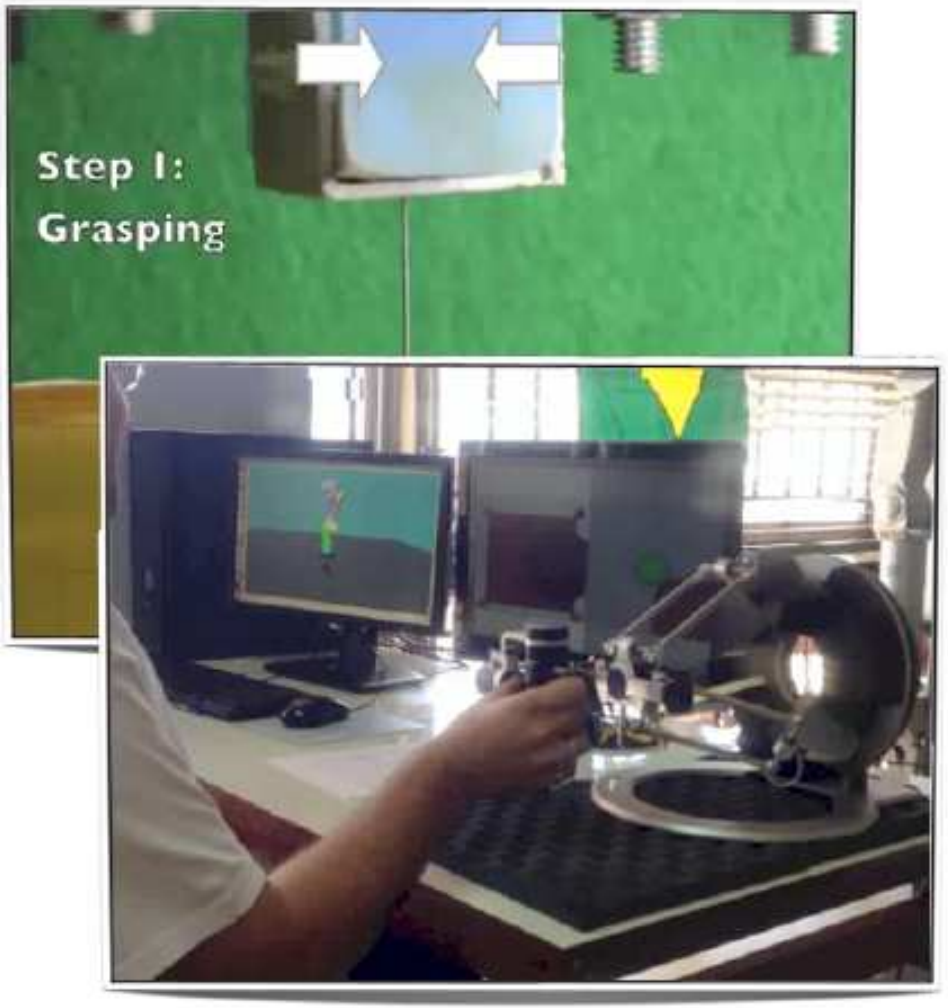
- Projetos em andamento
  - Prótese robótica para amputados de membro inferior
- Professores envolvidos
  - Antônio Padilha e Geovany Borges



Nonfunctional prototype

Robótica médica

- Projetos de pesquisa em andamento
  - Laparoscopia assistida por robô
  - Guiagem robótica de agulhas flexíveis
- Professores envolvidos
  - Antônio Padilha
  - Geovany Borges
  - Ícaro dos Santos



LARA - Múltiplas Áreas de Atuação

- Energia Solar (Egito)
- Controle não-linear, Caos (Vargas)
- Identificação de Sistemas (Alex)
- Qualidade da Energia (Lélio)
- Engenharia Biomédica (Flávia)
- Conversão de Energia (Gerson)

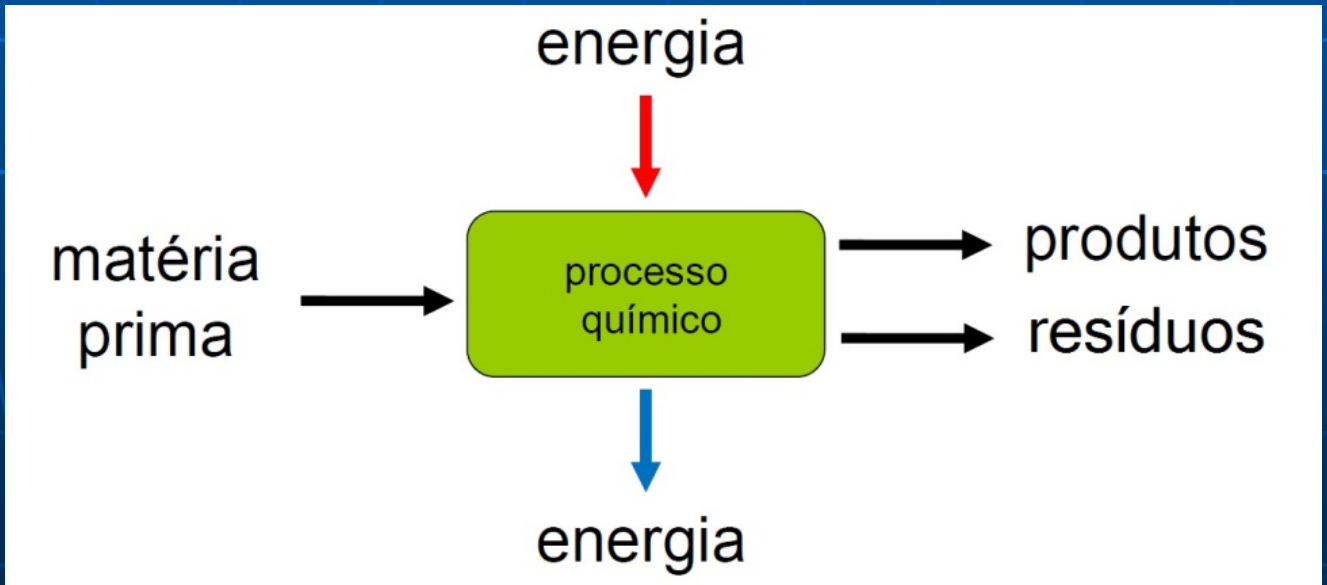
Controle de Processos Industriais

Prof. Eduardo Stockler Tognetti
estognetti@ene.unb.br

Processos Industriais

Processo

- Transformar matéria prima em produtos, através de operações fisicas e químicas
- Exemplos
  - refinaria de petróleo
  - usina de açúcar e álcool
  - amônia
  - ...

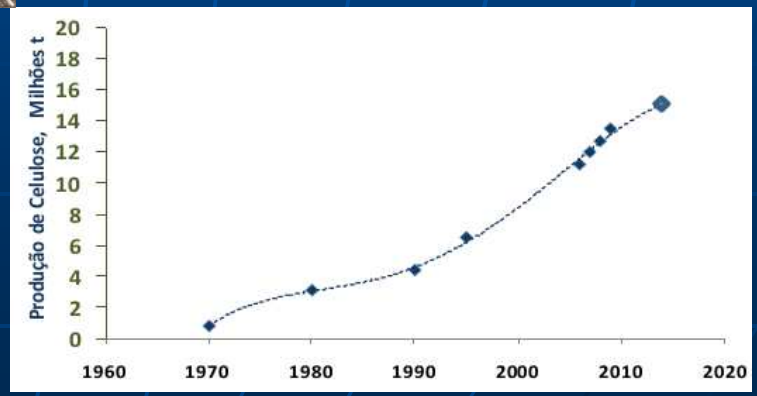


Indústria Petroquímica

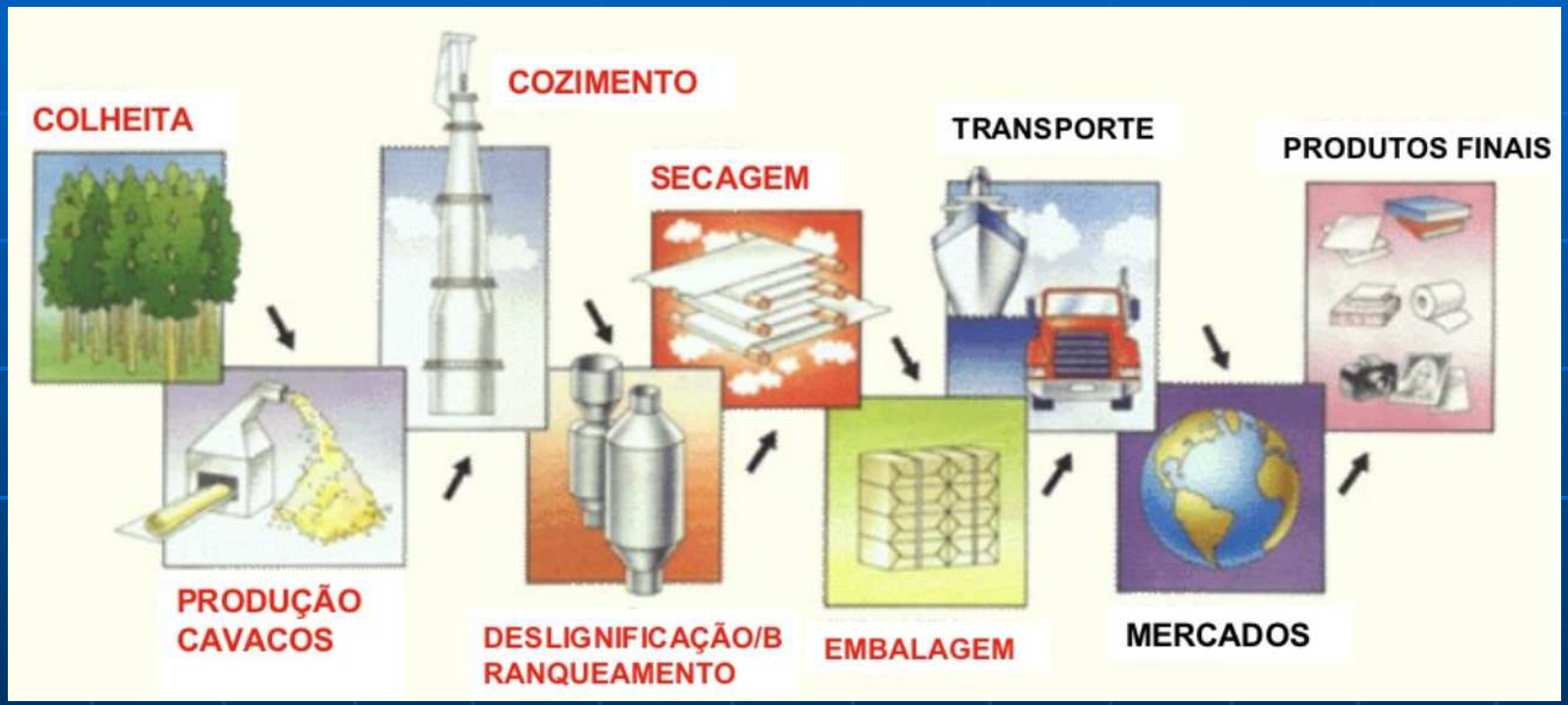
Refinaria

Extração

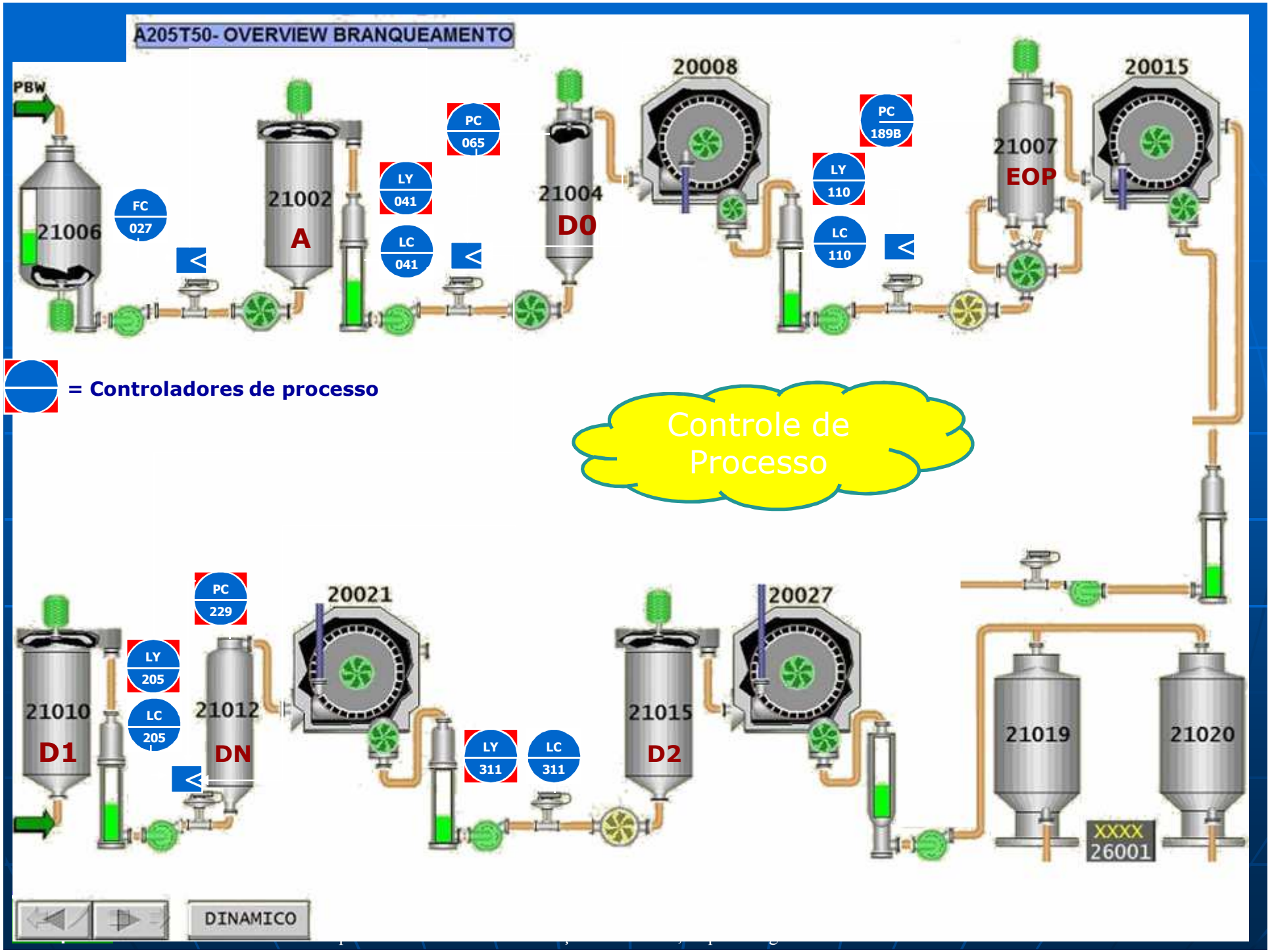
Indústria de Celulose e Papel



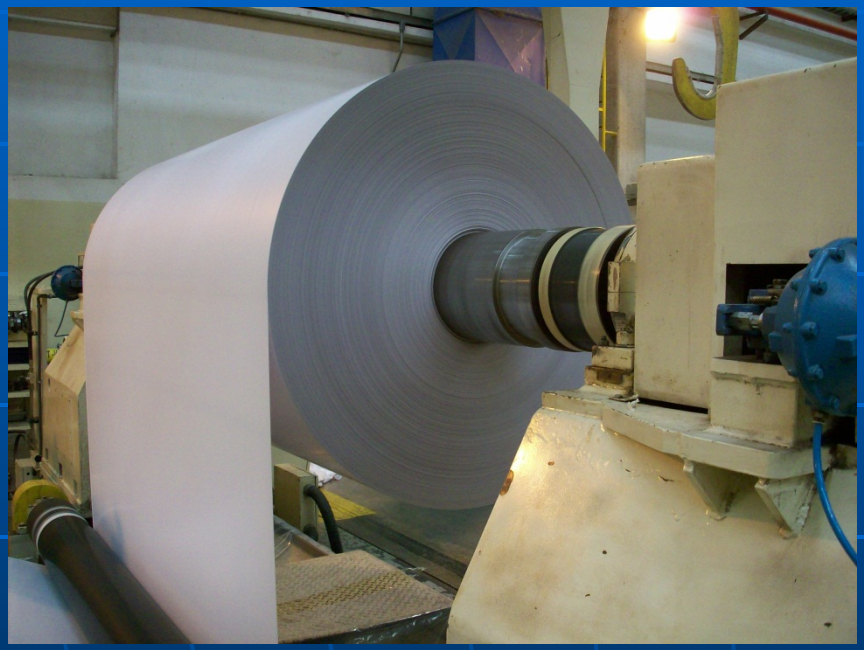
Visão Geral do Processo de Celulose



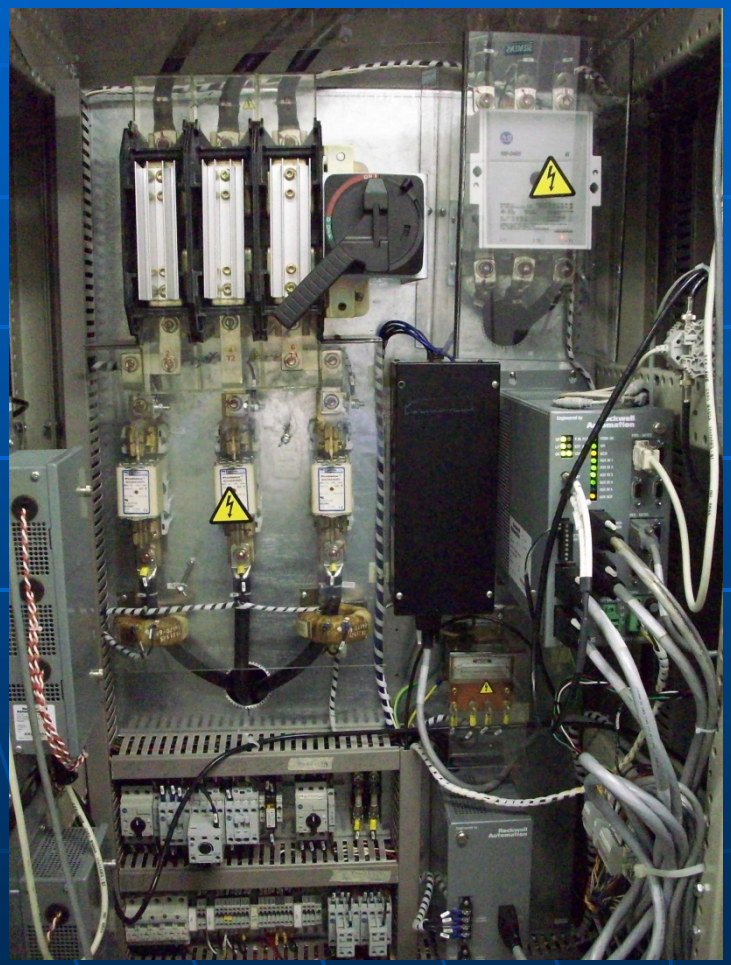
Processo Papel


A205T50- OVERVIEW BRANQUEAMENTO
PBW
21006
FC 027
21002 A
LY 041
LC 041
PC 065
21004 D0
20008
PC 189B
LY 110
LC 110
21007 EOP
20015
= Controladores de processo
Controle de Processo
21010 D1
LY 205
LC 205
PC 229
21012 DN
20021
LY 311
LC 311
21015 D2
20027
21019
21020
XXXX 26001
DINAMICO

Rebobinadeiras



Acionamentos Industriais

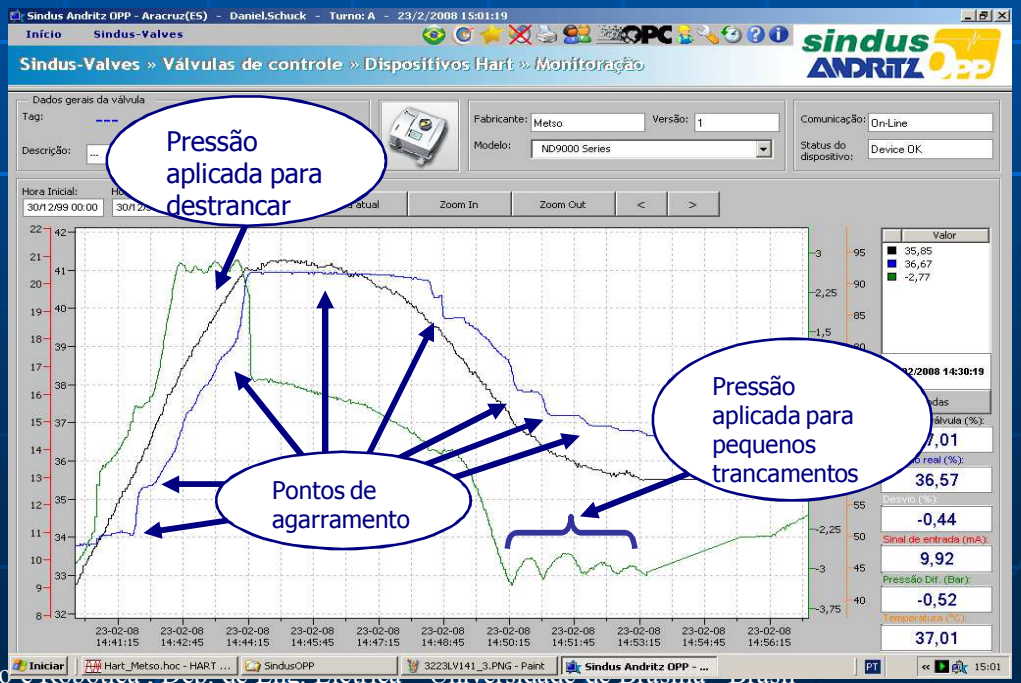


namento digital

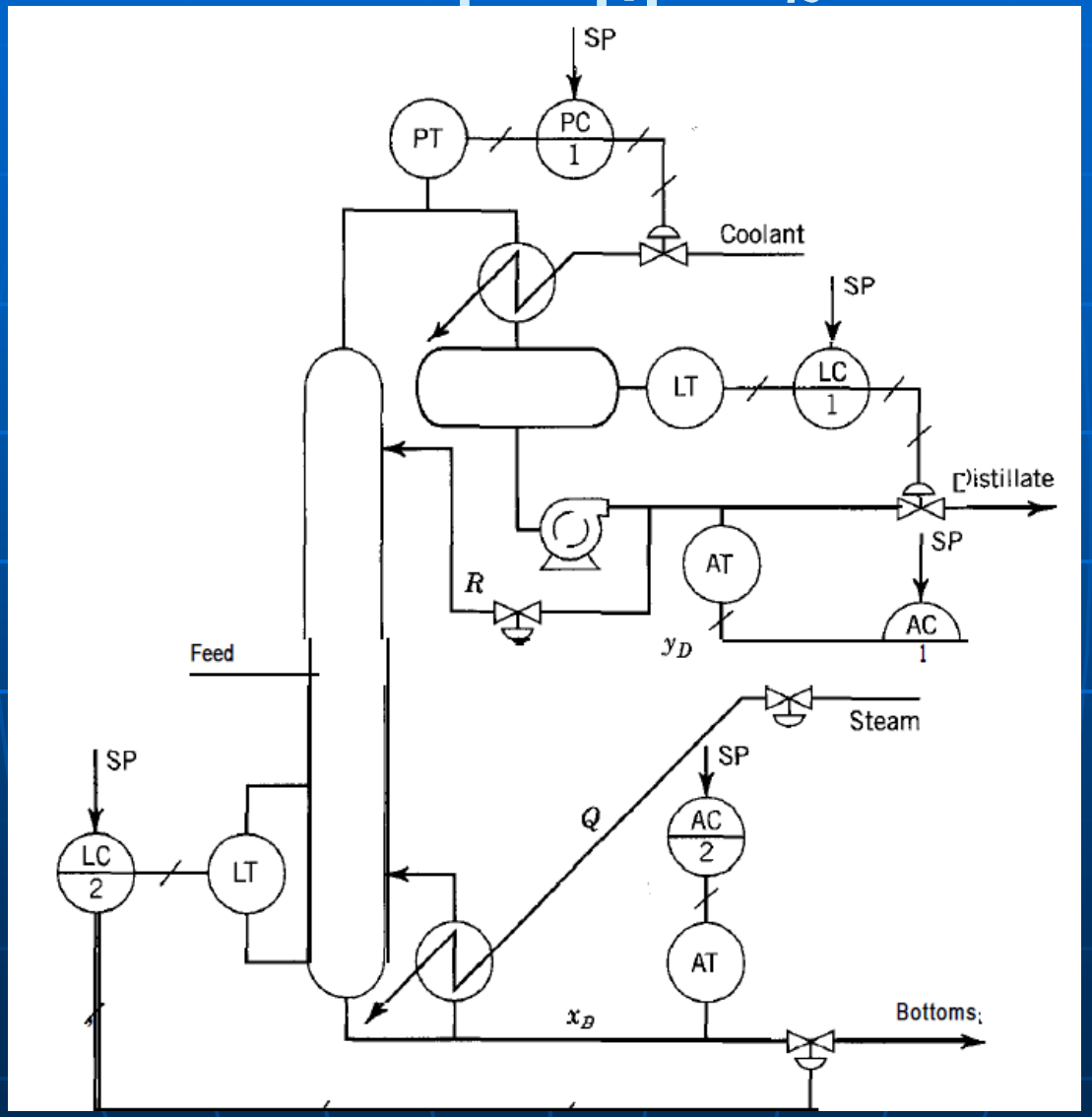
Acionamento analógico

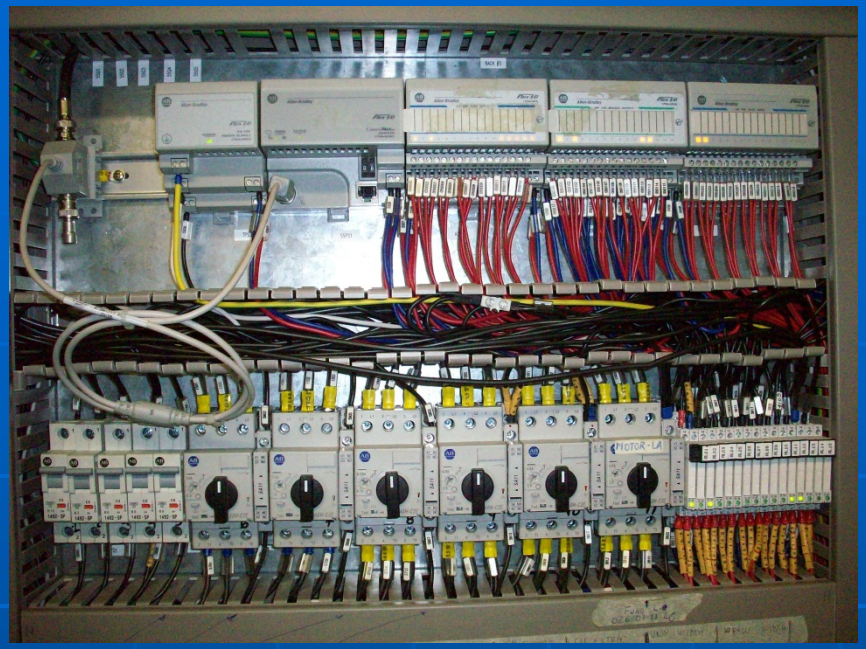
Instrumentos de Campo

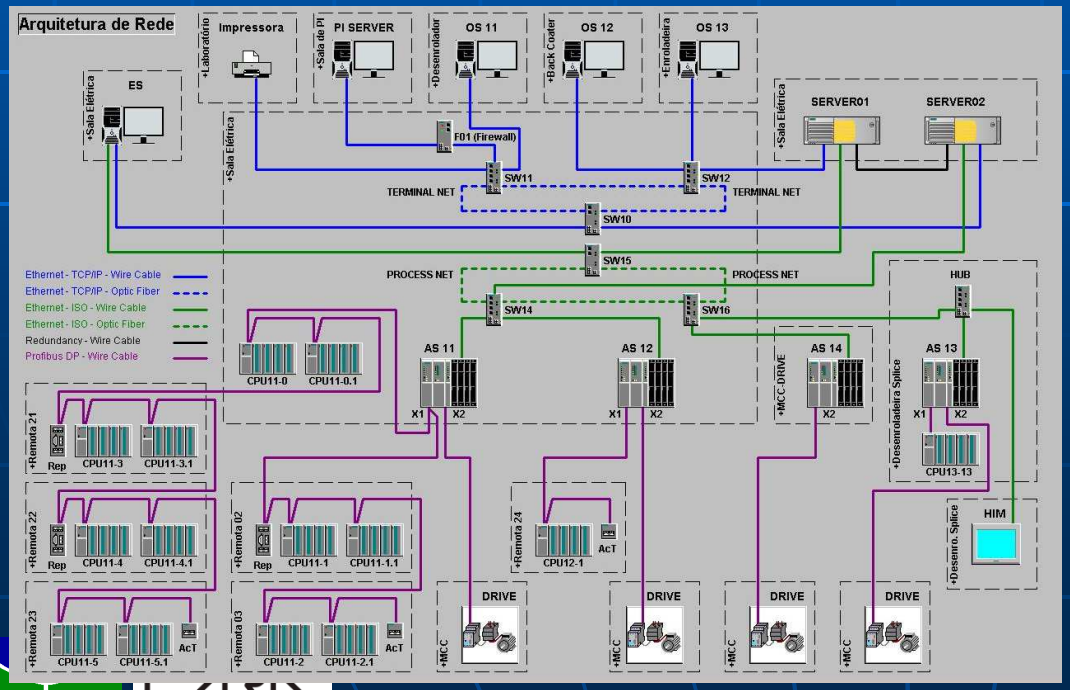
Afeta desempenho do controle



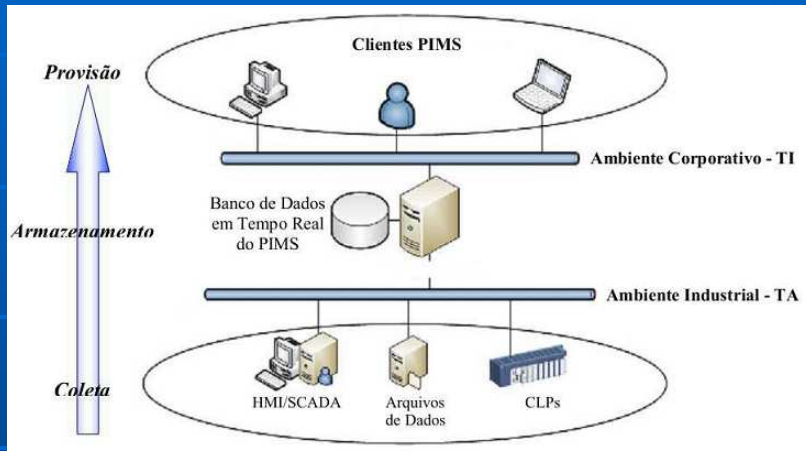
Controles de uma coluna de



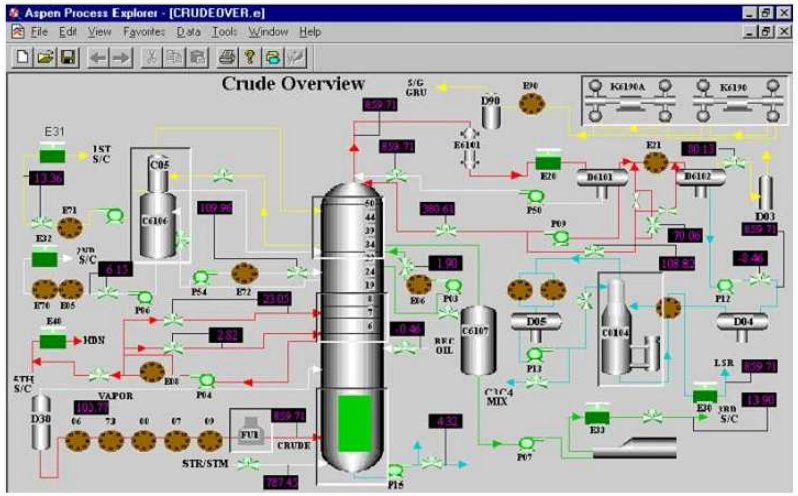


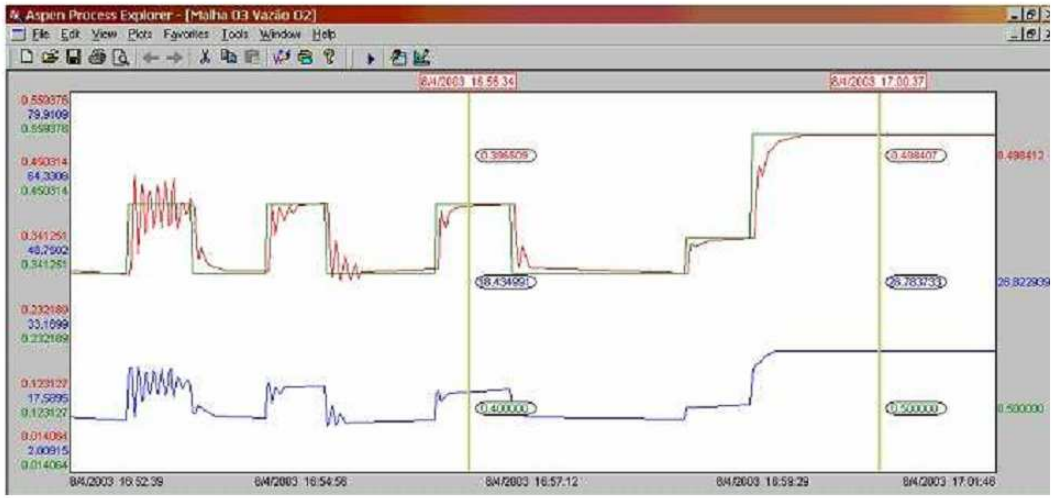

Arquitetura de Rede
Impressora
+Laboratório
PI SERVER
+Sala de PI
OS 11
+Desenrolador
OS 12
+Back Cooler
OS 13
+Enroladeira
ES
+Sala Elétrica
SERVER01
SERVER02
F01 (Firewall)
SW11
SW12
TERMINAL NET
SW10
SW15
PROCESS NET
SW14
SW16
HUB
Ethernet - TCP/IP - Wire Cable
Ethernet - TCP/IP - Optic Fiber
Ethernet - ISO - Wire Cable
Ethernet - ISO - Optic Fiber
Redundancy - Wire Cable
Profibus DP - Wire Cable
CPU11-0
CPU11-0.1
AS 11
AS 12
AS 14
AS 13
X1
X2
+MCC DRIVE
+Desenroladeira Splice
CPU13-13
+Remota 21
Rep
CPU11-3
CPU11-3.1
+Remota 22
CPU11-4
CPU11-4.1
+Remota 02
CPU11-1
CPU11-1.1
+Remota 24
CPU12-1
AcT
HIM
+Desenro. Splice
+Remota 23
CPU11-5
CPU11-5.1
+Remota 03
CPU11-2
CPU11-2.1
DRIVE
+MCC

PIMS - Sistemas de Gerenciamento de Informações de Processo em Tempo Real



Arquitetura típica de um PIMS





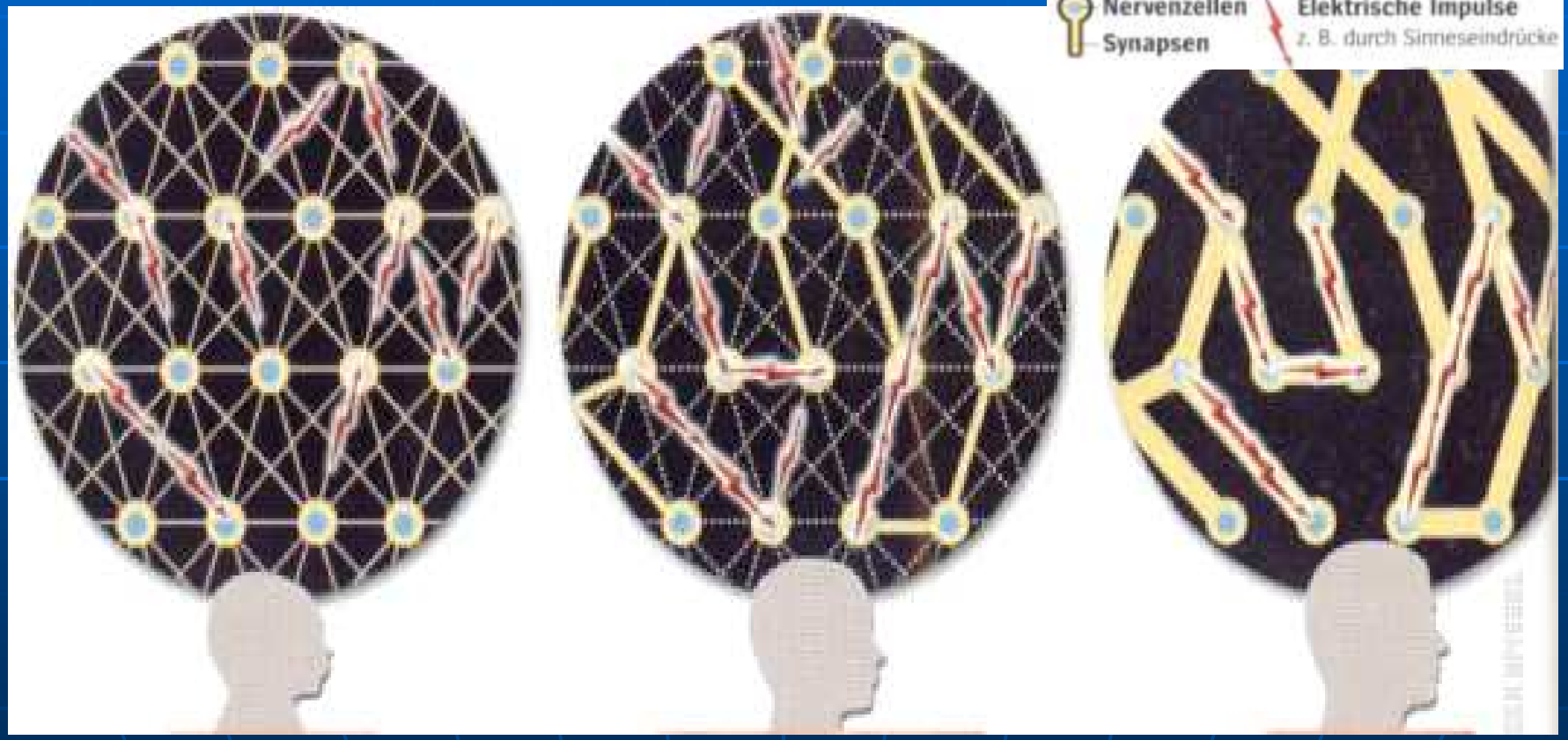
Sistemas Inteligentes

Prof. Adolfo Bauchspiess

Intelligent Systems

- Brain as the model !!

Neuron Synaptic Connections - Learning!



0-2 years 2 years to puberty Adult

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.

Simpathic?

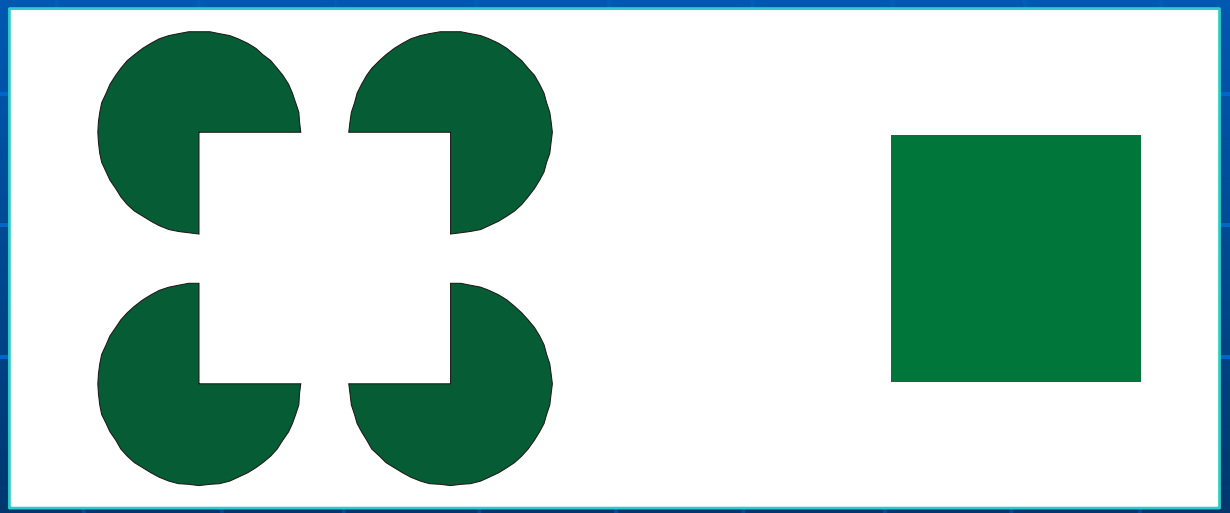

GRIMASSE STEHT KOPF
Auf den ersten Blick scheint das Foto von Margaret Thatcher nicht ungewöhnlich. Das ändert sich, wenn Sie das Bild auf den Kopf stellen. Der verblüffende Effekt tritt auf, weil Augen und Mund auf dem Foto um 180 Grad gedreht sind – und damit genau die Merkmale, auf die das Gesichtserkennungsprogramm des Hirns besonders sensibel anspricht.
EMILE LUIDER / RAPHO / AGENTUR FOCUS (L.); PERCEPTION (R.)

Antipathic?


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

- Incomplete pattern -
Brain Interpolation!

-Perception



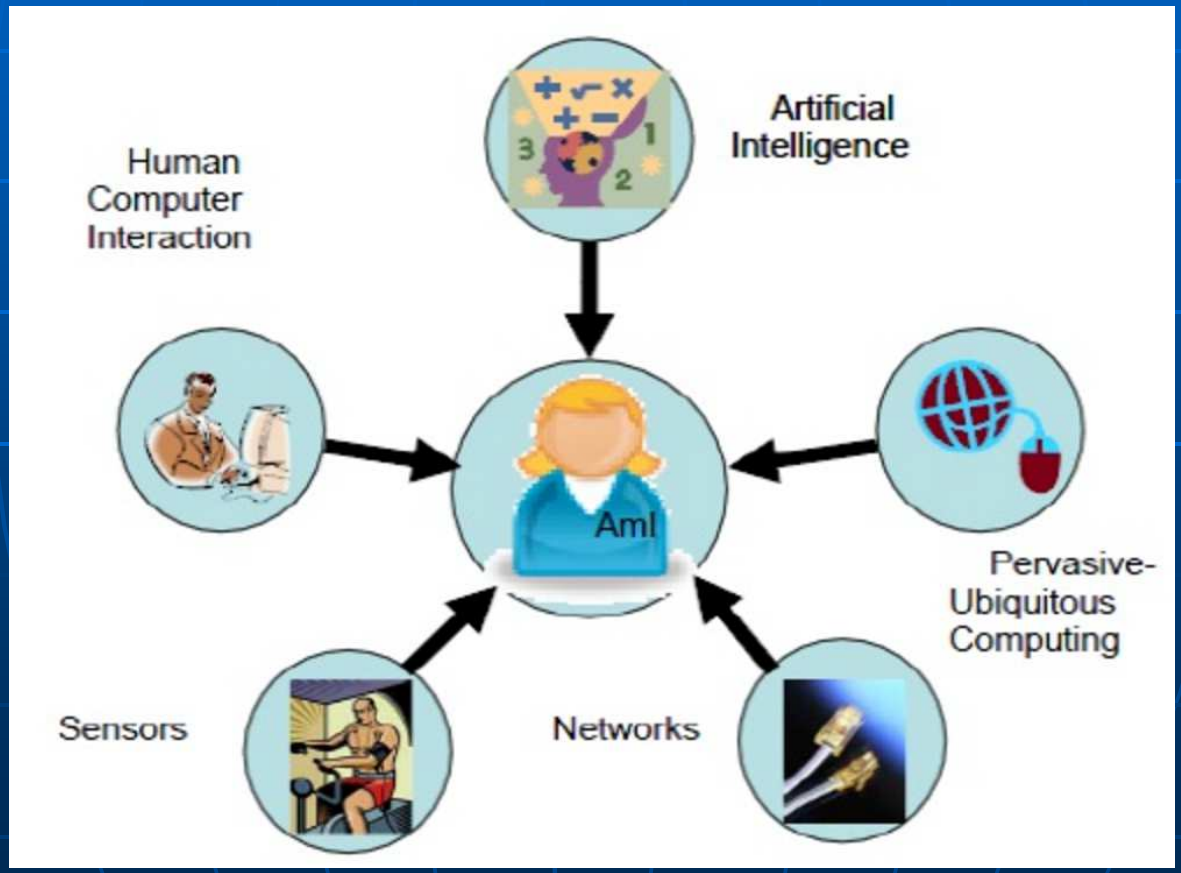
The Kanizsa square, 1976

Living connected

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

Ambient Ingelligence

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



Cities Evolution

City of neighbors ➛ City of Strangers

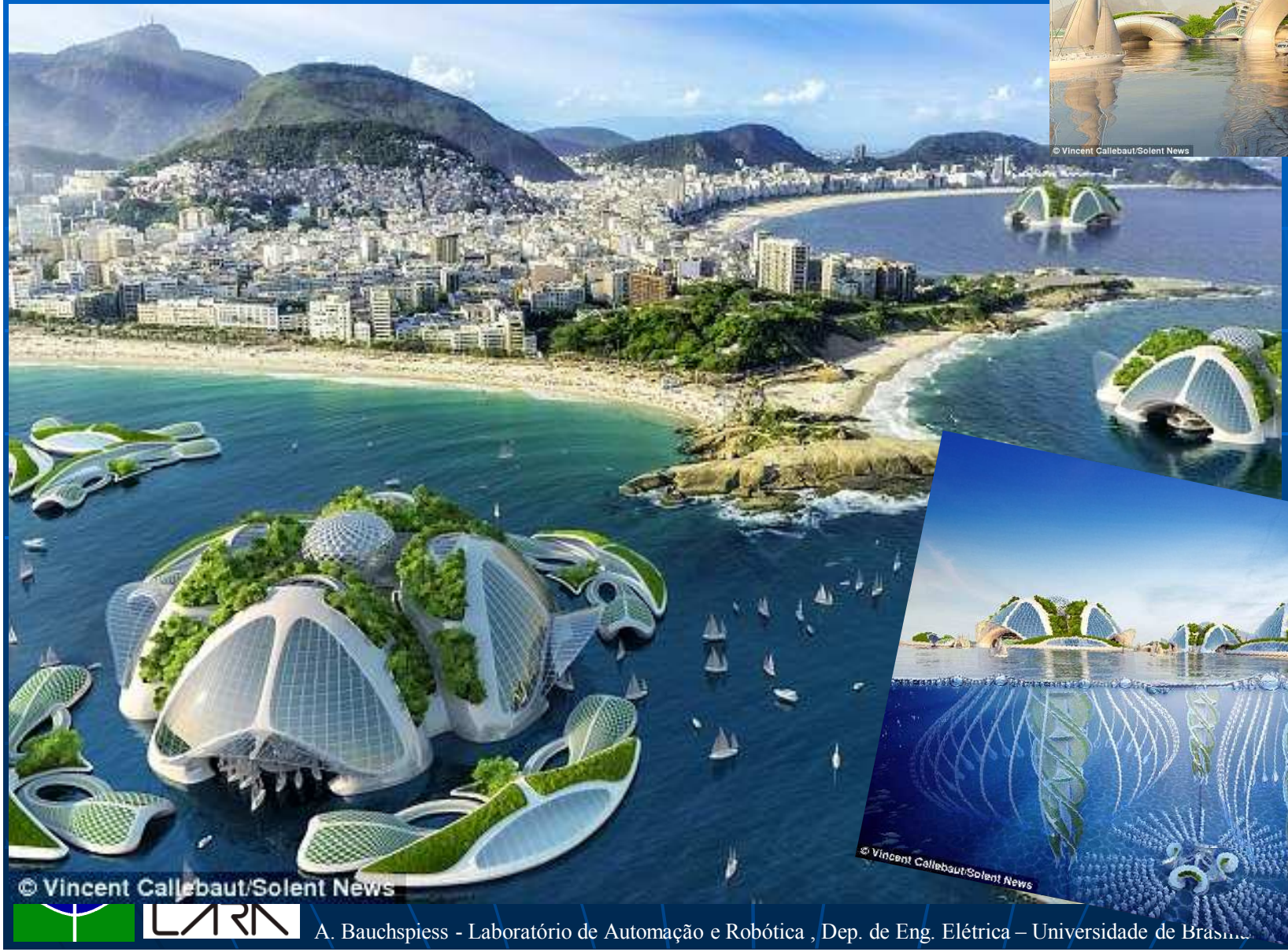
André de Oliveira Bueno, Julho 2019 – Trilha Smart Cities – The Developer's Conference

The world's cities occupy just 3% of the Earth's land,
but account for 60%-80% of energy consumption
and 75% of carbon emissions.

Prathombutr – Smart Cities Development in Thailand
https://www.nstda.or.th/nac/2019/images/seminar/26_Smartcity_passakorn.pdf

Future Smart City (?)

@Pinterest

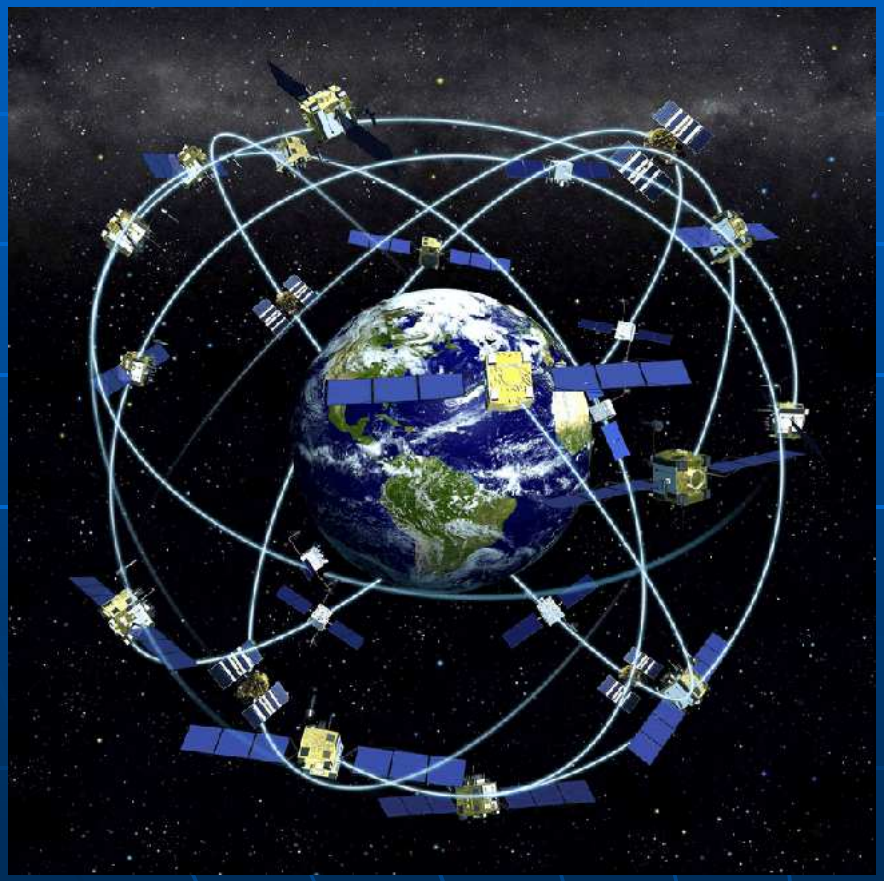


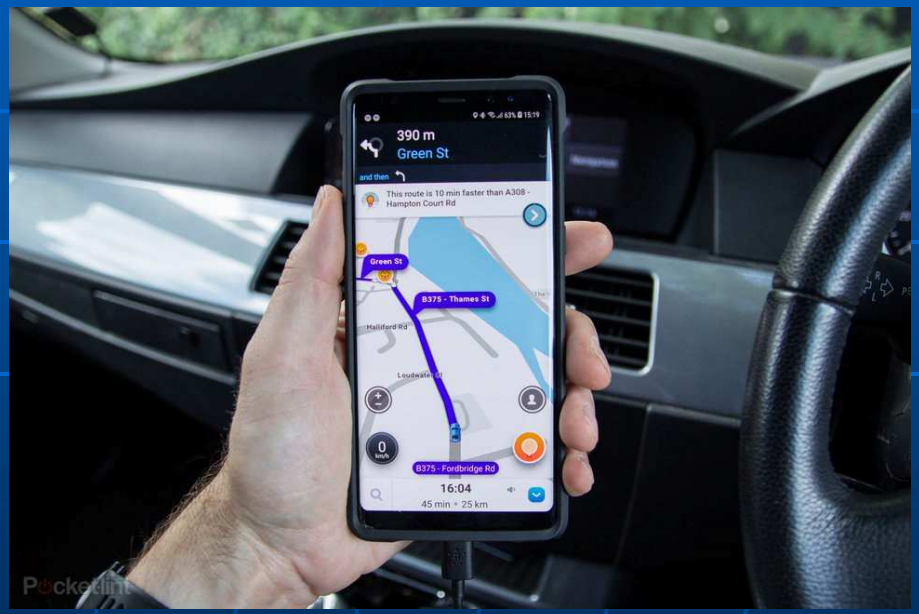
Future Smart City (?)

@Pinterest

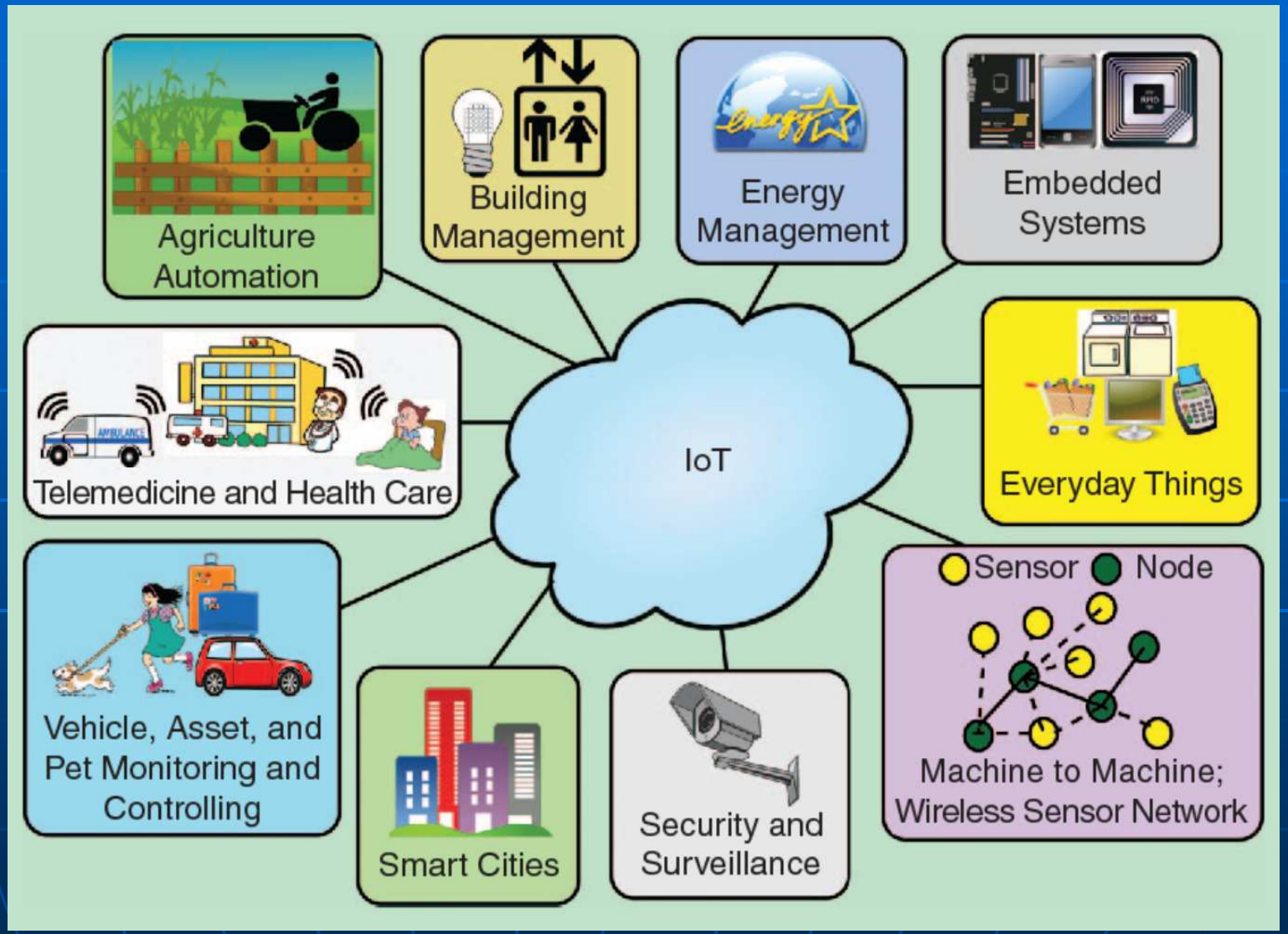
GPS + GIS

- Global Positioning System
- Geographical Information System



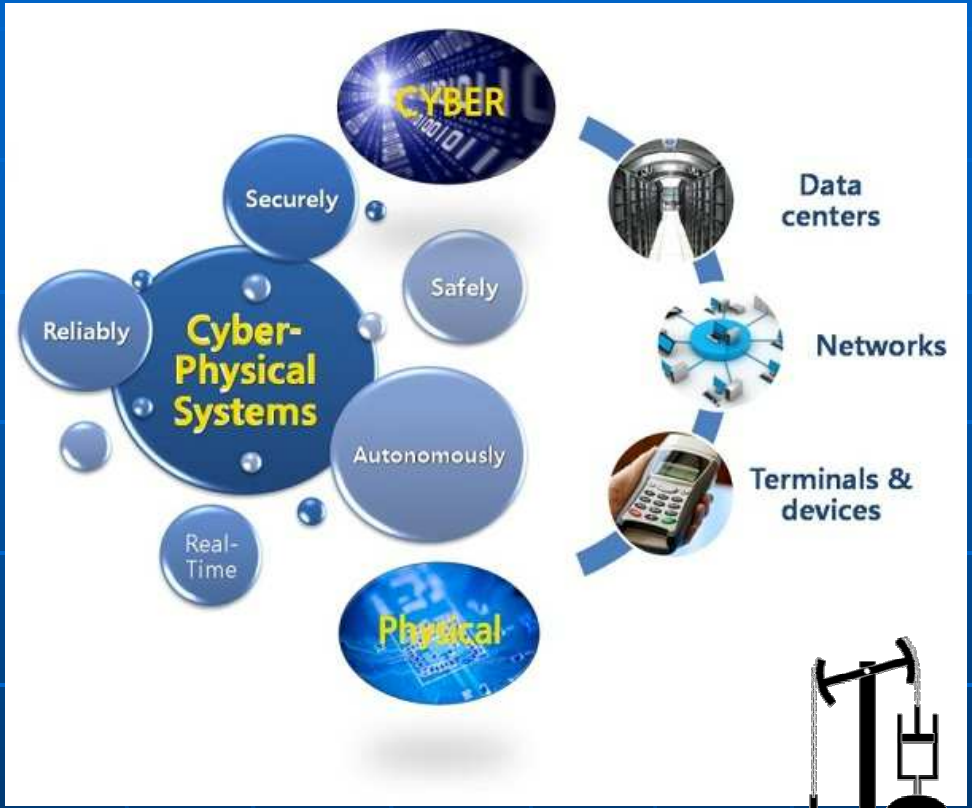


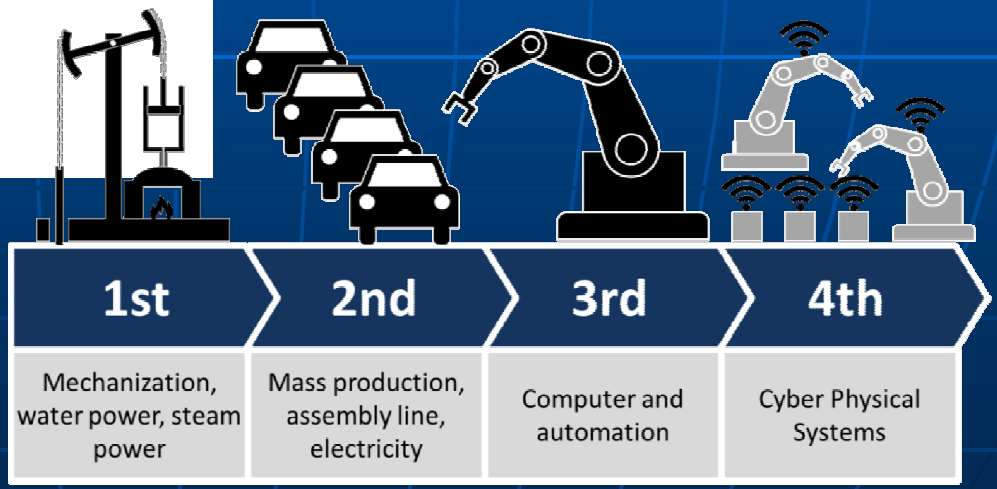
IoT ⋯› Internet of EveryThing



https://www.researchgate.net/publication/306046857_Everything_You_Wanted_to_Know_About_Smart_Cities/figures?lo=1

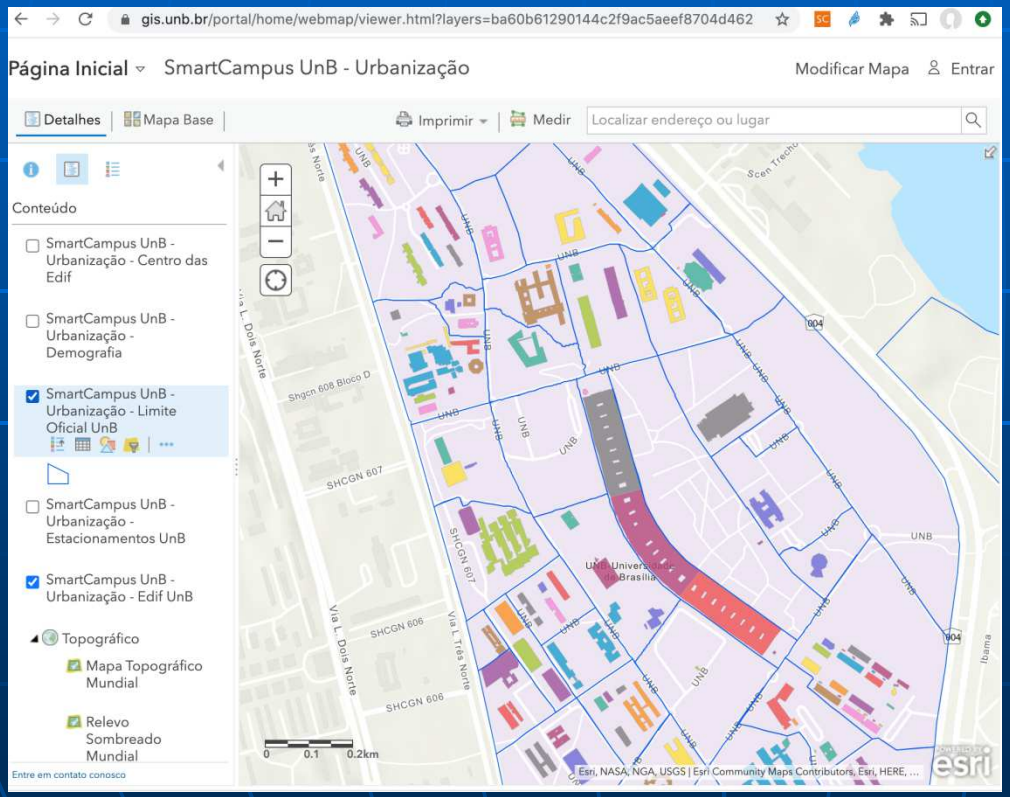
Cyber-Physical Sytems

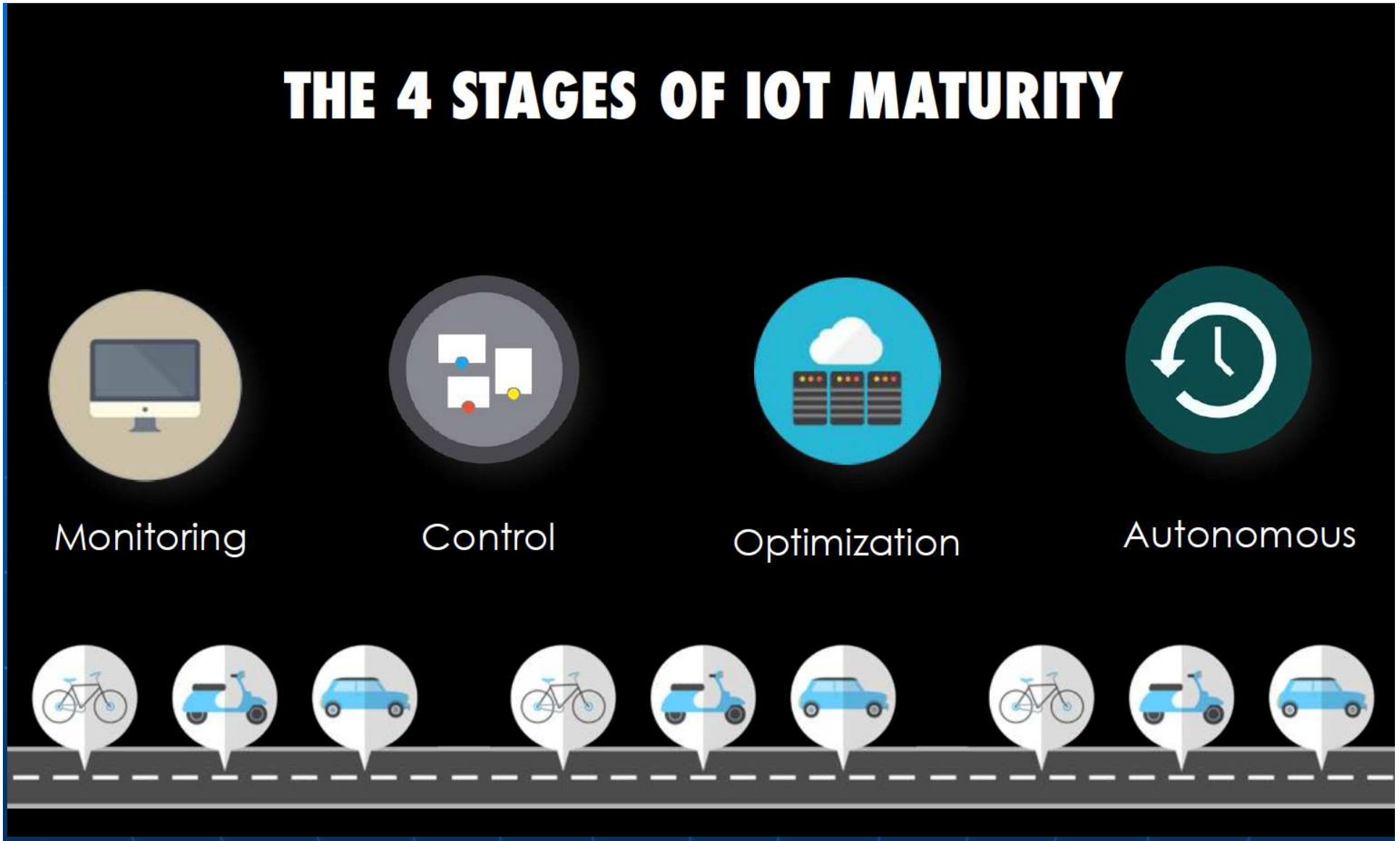




GPS + GIS + CPS
⇢ CyberGIS

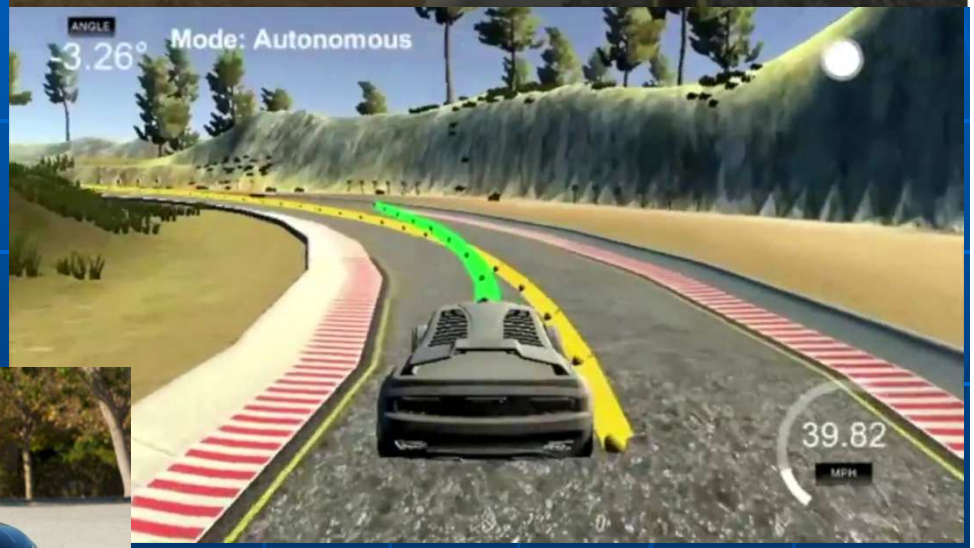
- CPS - Cyber-Physical Systems





https://www.slideshare.net/mazlan1/introduction-to-iot-smart-city/18-FUNCTIONAL_VIEW_OF_IOTTECHNOLOGIES

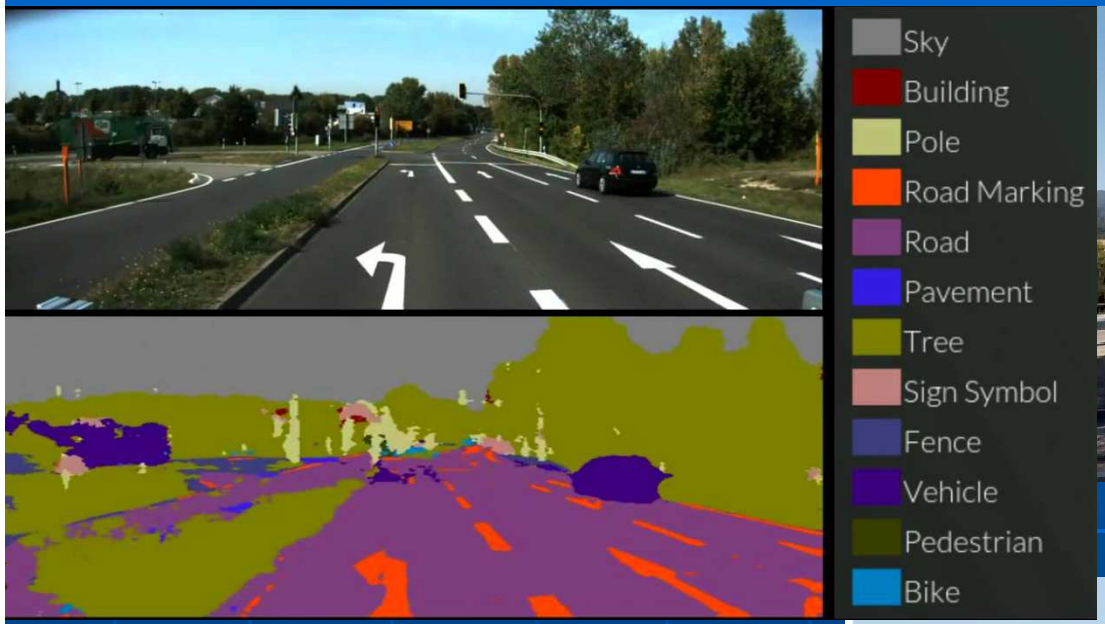
Model Predictive Control – Udacity Self-Driving Car



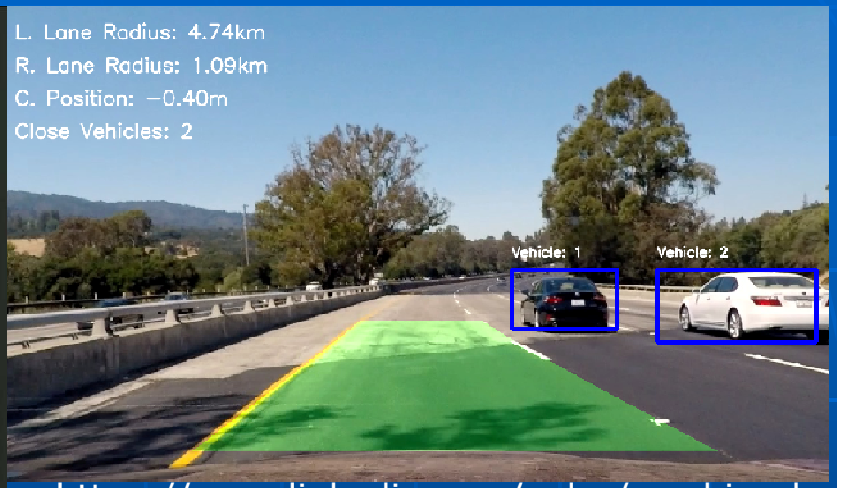
https://www.youtube.com/watch?v=r14Ll3Jycbw

A. Bauchspiess - Laboratório de Automação e Robótica , Dep. de Eng. Elétrica – Universidade de Brasília - Brasil

RL – Examples: Self Driving Cars



https://www.youtube.com/watch?v=kMMbW96nMW8

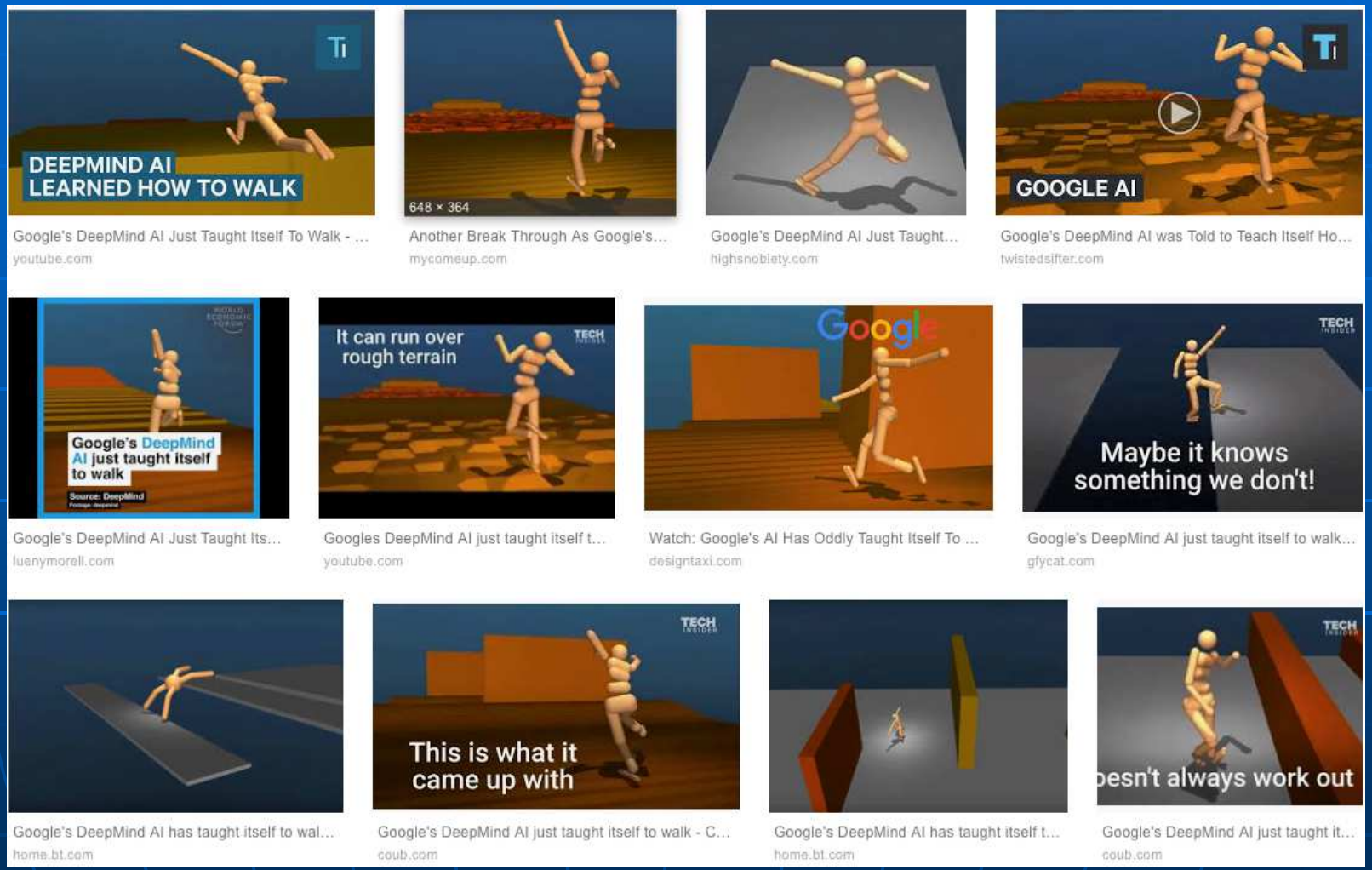


https://www.linkedin.com/pulse/machine-lea
fundamentals-self-driving-cars-david-silver/

Deep Learning:
Technology behind self-driving ca
6.194 visualizations
Pub. 25/dec/2016

http://www.alphr.com/cars/1001713/practice-makes-perfect-driverless-cars-will-learn-from

RL – Examples: Learn To Walk



Google's DeepMind AI
Just Taught Itself to Walk
5[illegible]5.455 vis. 12/jul/2017

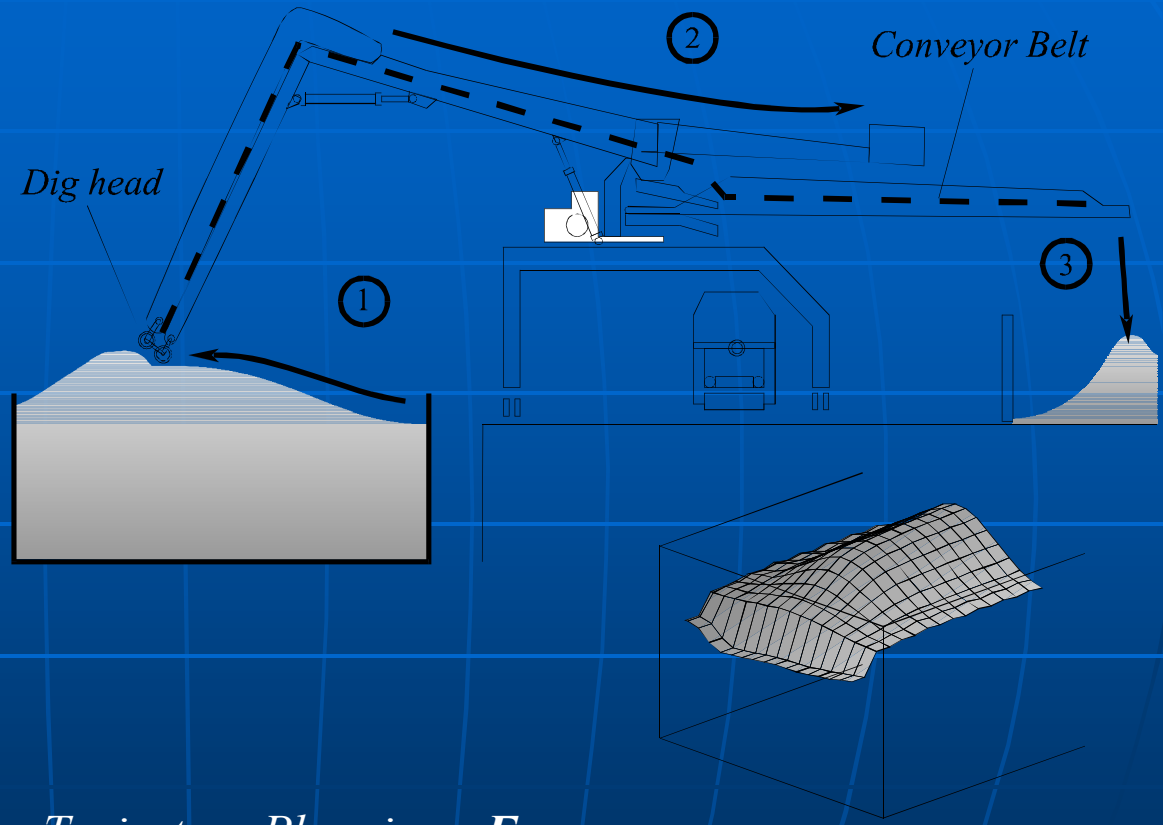
https://www.youtube.com/watch?v=gn4nRCC9TwQ

Alguns Projetos de Pesquisa

Prof. Adolfo Bauchspiess

Coal Unloading – Erlangen/Germany

River Crossing – Minden, Elbe, Germany



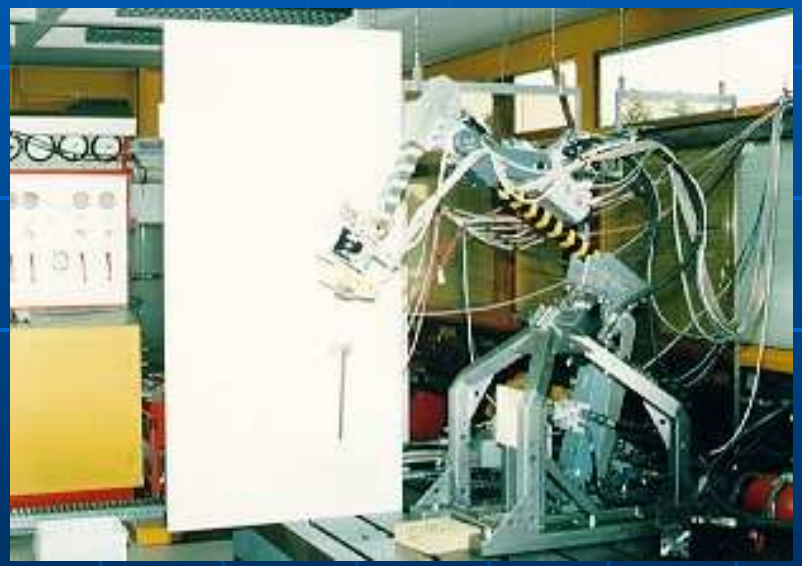
*Trajectory Planning - **Fuzzy***

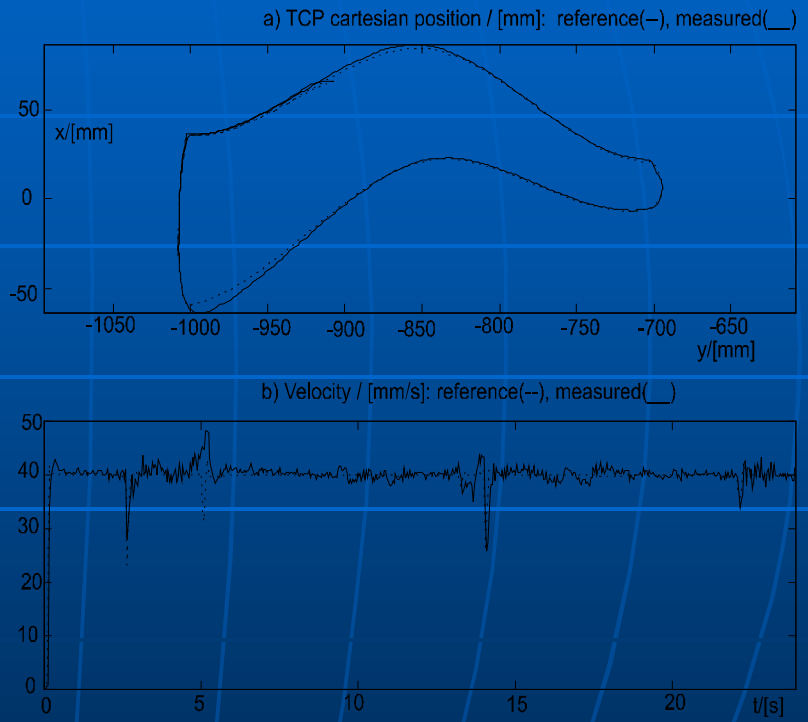
"Redundant Sensor Guided Unloading Crane"– MAN

Bauchspiess, 1995

Universität – Erlangen-Nürnberg

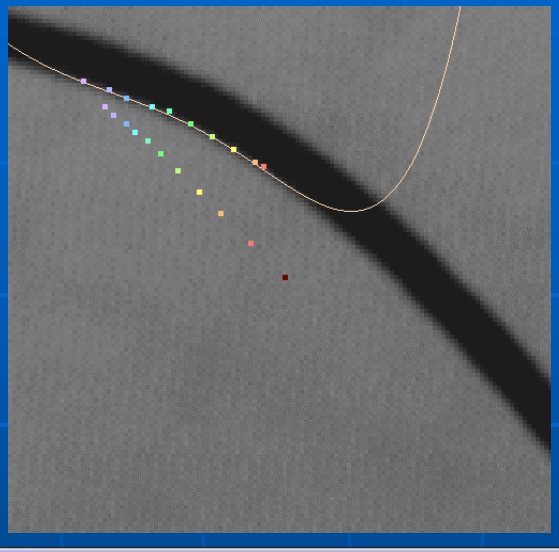
Sensor guided Hydraulic Robot

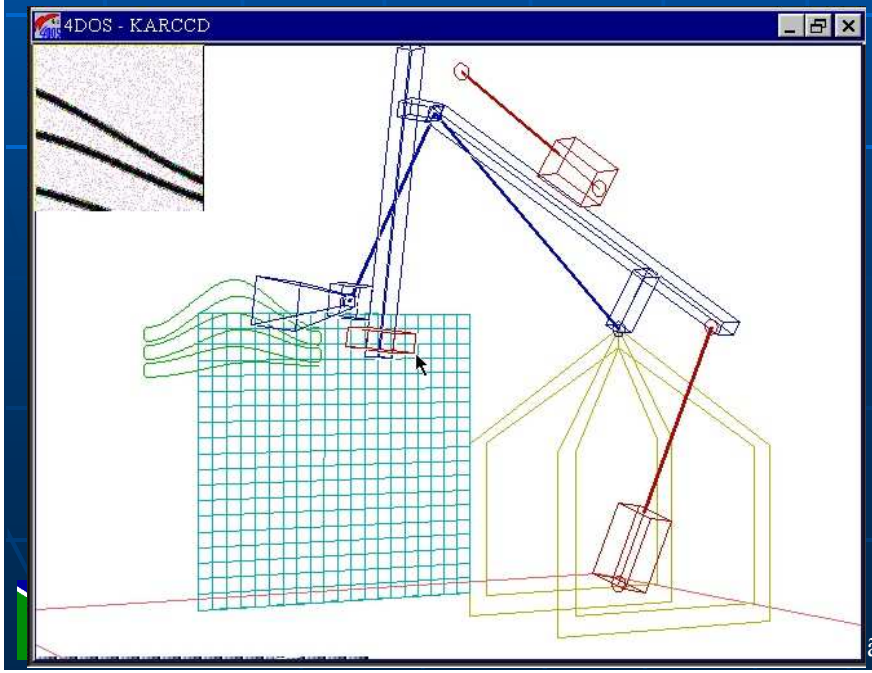


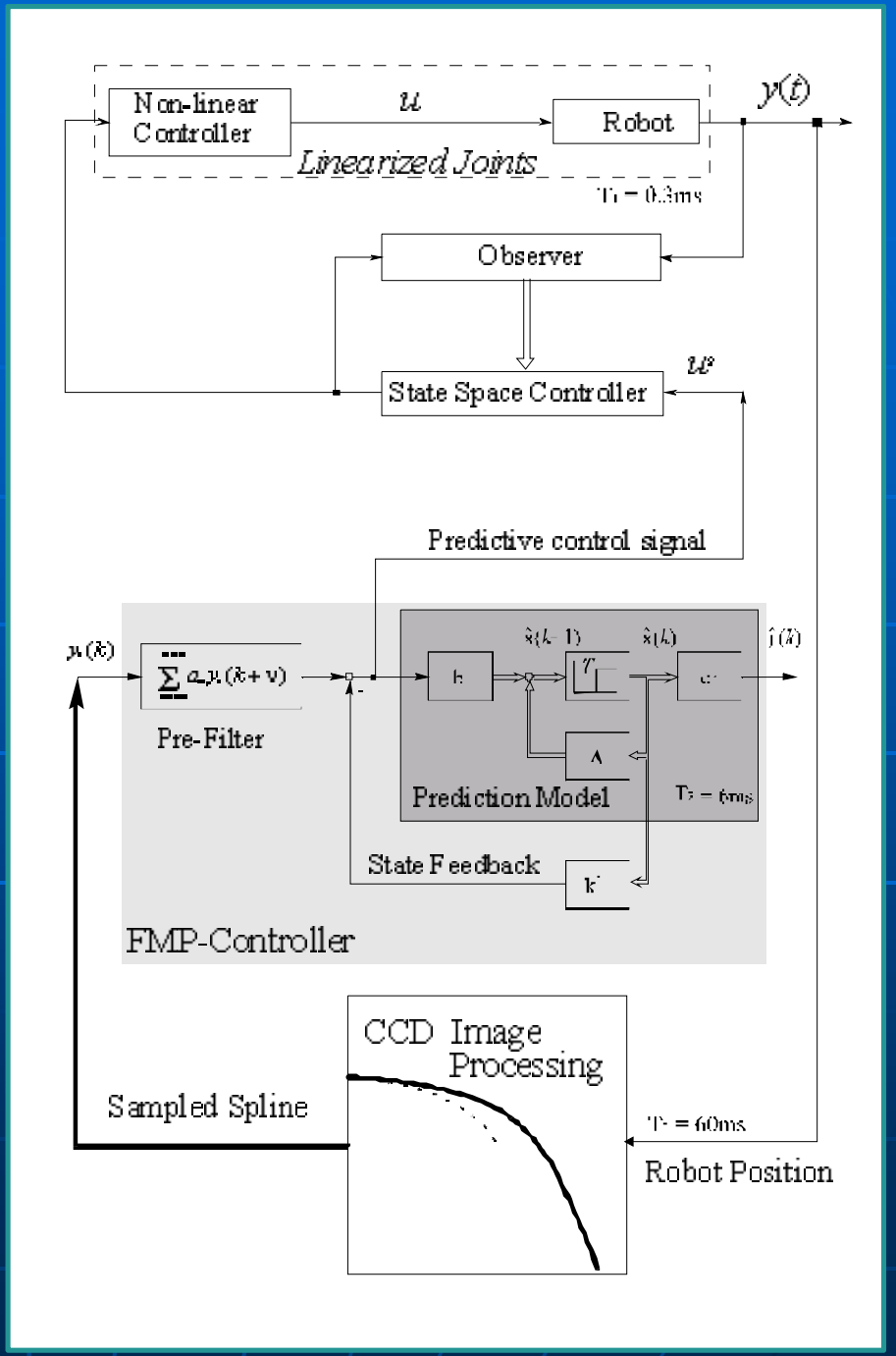


Bauchspiess, 1995

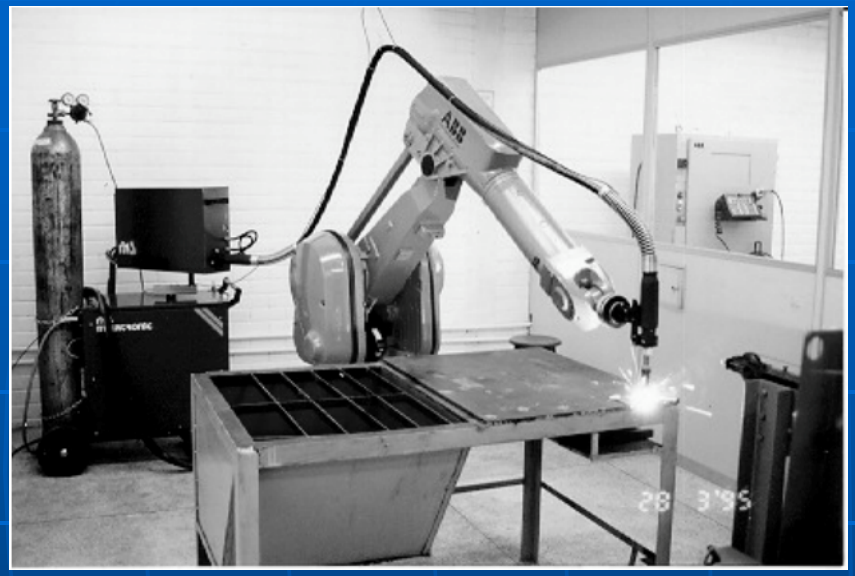
Predictive Path tracking

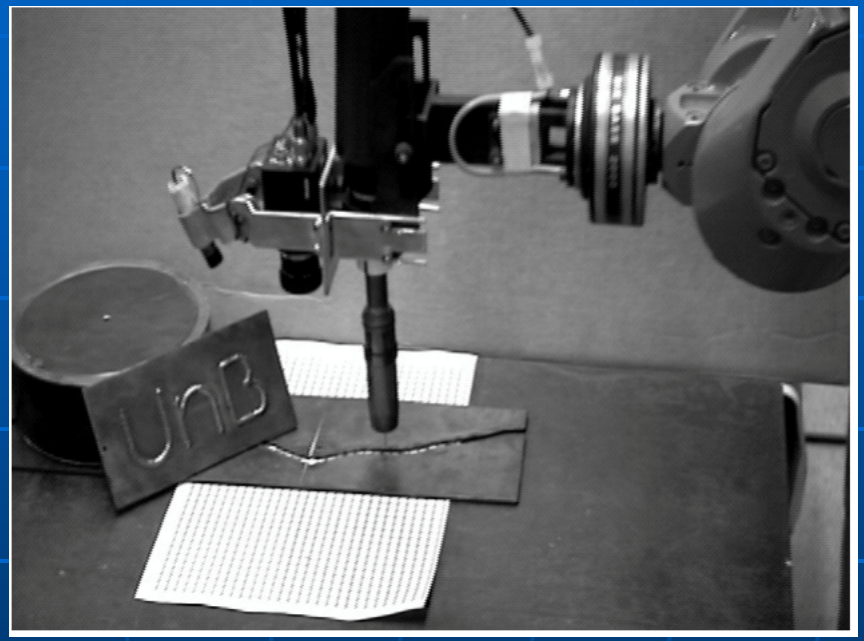


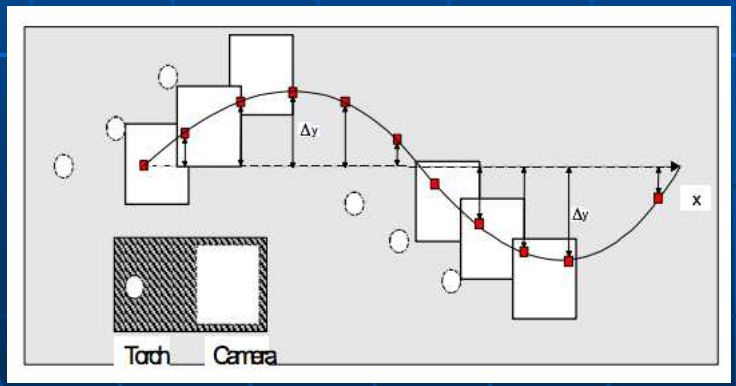


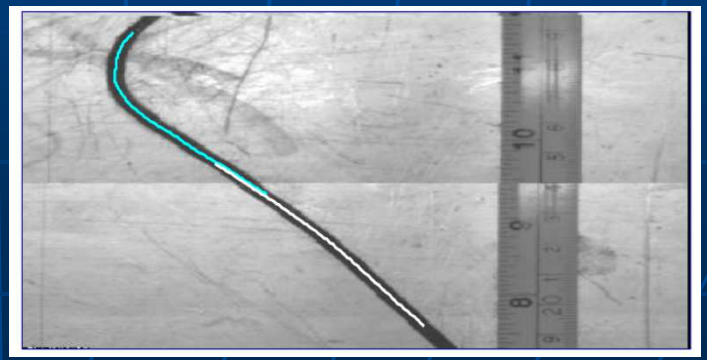


Welding Robot- GRACO-ENM/ENE-UnB









Plena/UnB – Fundos Setoriais

Inspection of Transmission Lines

A. Bauchspiess - Laboratório de Automação e Robótica , Dep. de Eng. Elétrica – Universidade de Brasília - Brasil

Inspection of Transmission Lines

- Autonomous computational system for the visual inspection of electricity transmission lines
- Detection of flaws in the gripper of the line spacers

Inspection of Transmission Lines

- Traditional inspection of transmission lines:
  - Aerial survey using a helicopter
  - Staff onshore

  Costly and expensive

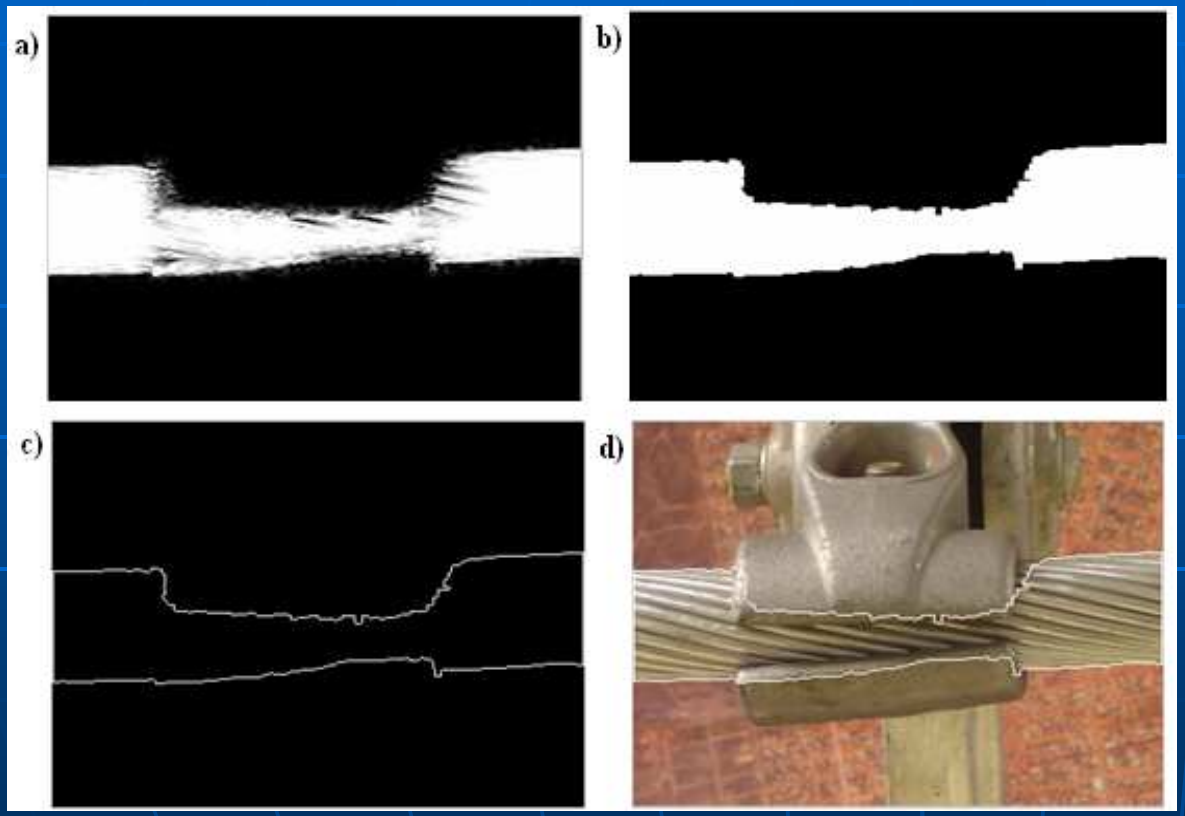
Inspection of Transmission Lines

UAV – LARA/UnB

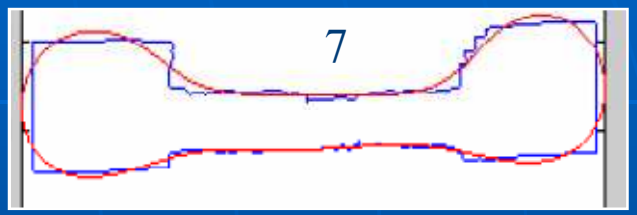
Inspection of Transmission Lines

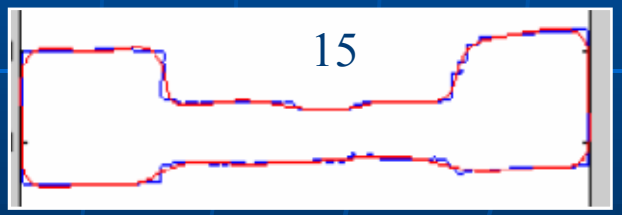
- Autonomous system - visual inspection of electricity transmission lines
- Detection of flaws in the gripper of the line spacers

Gripped cable contour:
FFT coefficients of directional chains



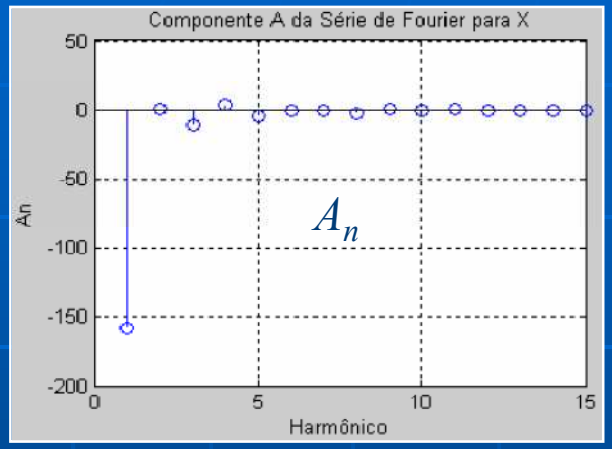
a) Gabor – b) Closing – c) Border – d)Image

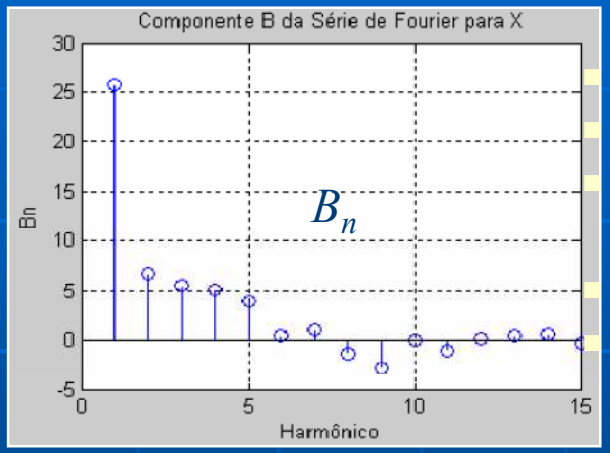


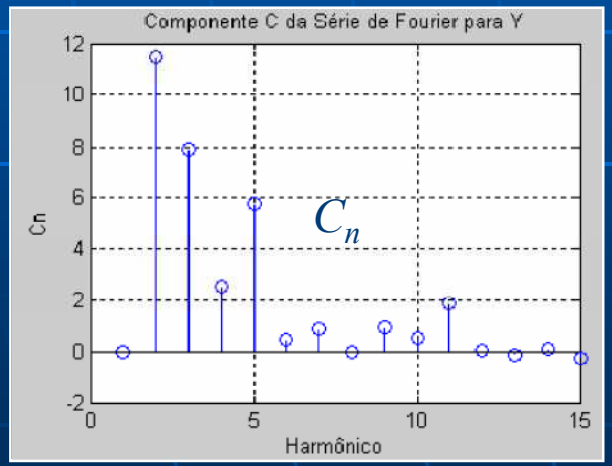


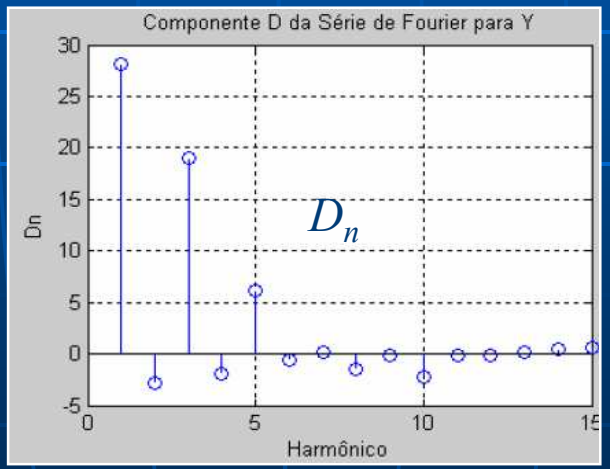
Reconstruction -
7 and 15 Harmonics

Gripped cable contour:
FFT coefficients of directional chains



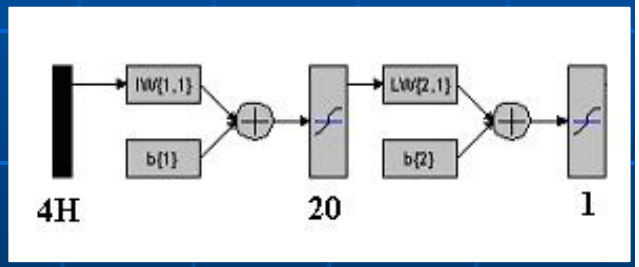






ANN –
"Need Maintenance"
classification

Training, Test, Validation
80, 25, 25 images



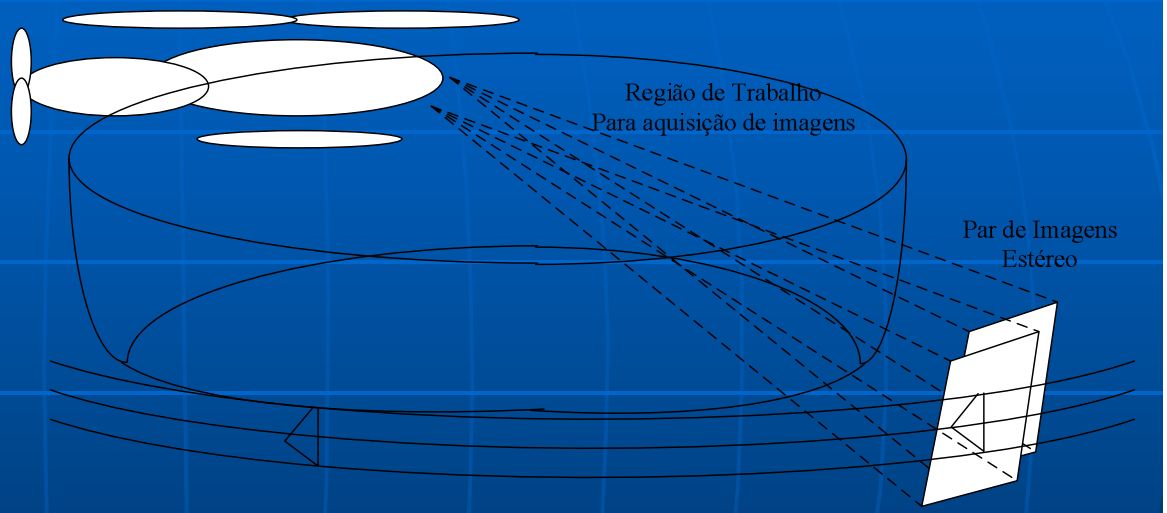
H=10 ➔
2 Misclassified images

H=12 ➔
1 Misclassified image

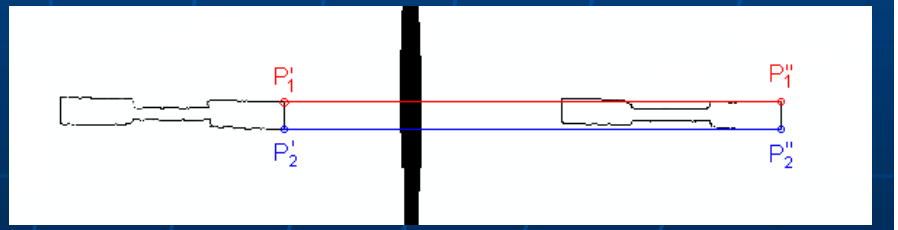
Flávio Oliveira & Alexandre Dias, 2007

Gripper inspection with 3D reconstr.

- It is not possible to train an ANN for every position/orientation in the visual field of the VANT.
- ANN trained for a fixed point of view.
- Build 3D contour model
- Reproject 3D contour to ANN point of view
- Classify with ANN



Different ROI's



Correspondence –ROI contour in stereo pair

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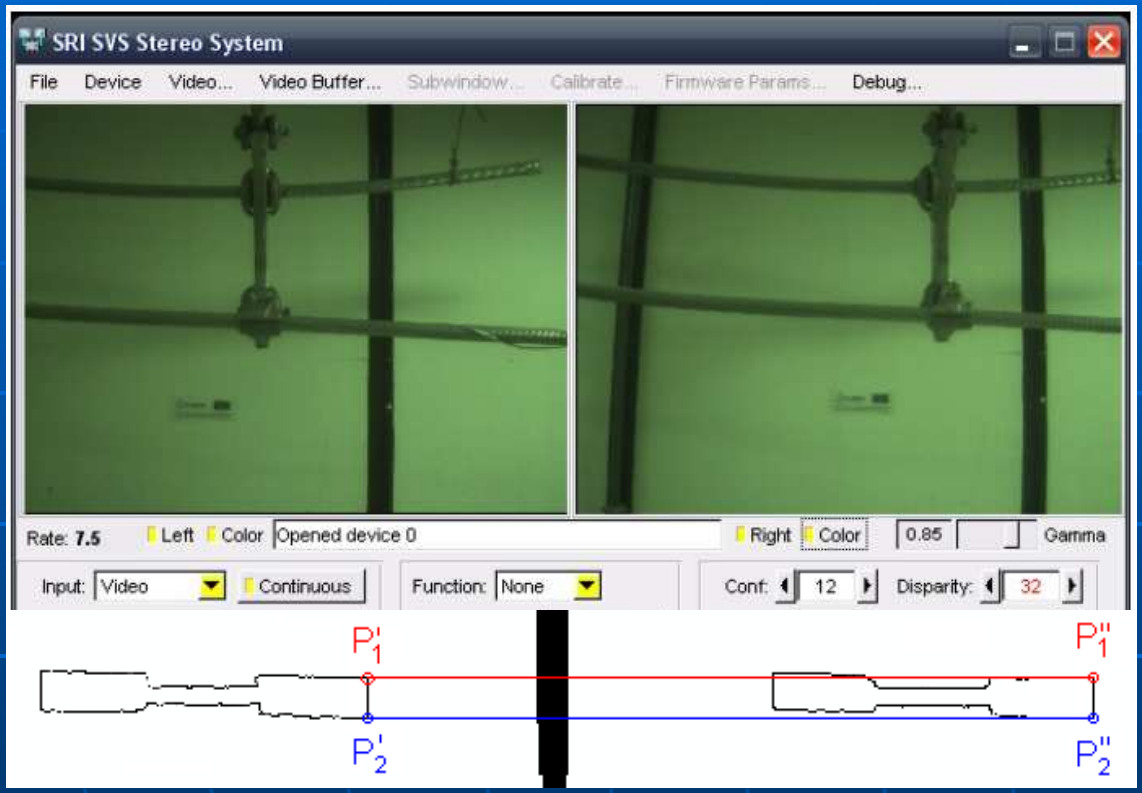
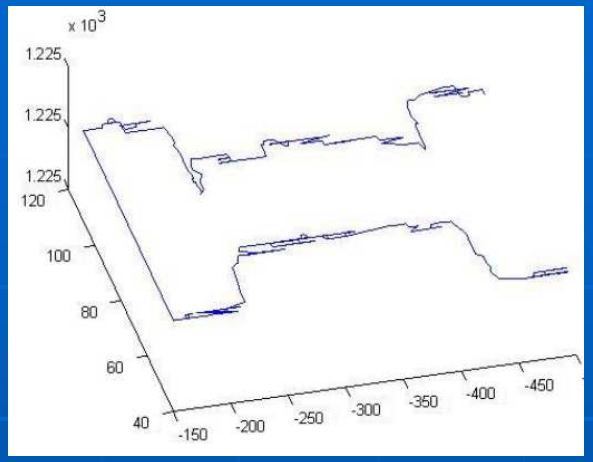
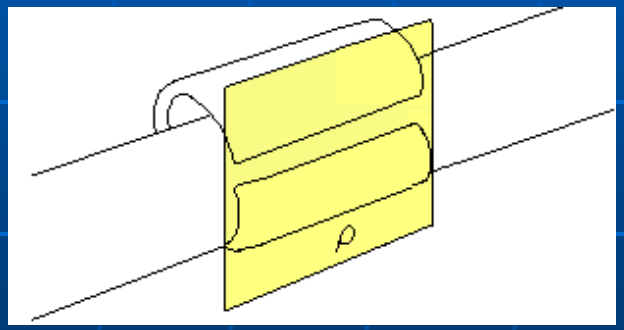
3D gripped cable



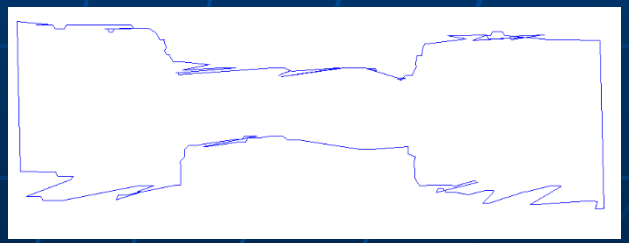
3D Reconstruction



ANN data bank Image plane



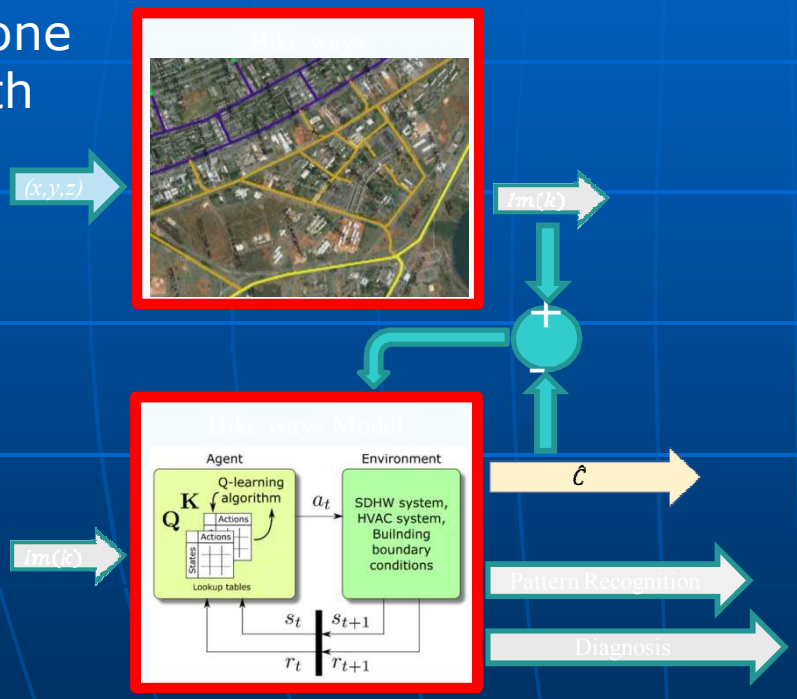
Reprojected contour for ANN



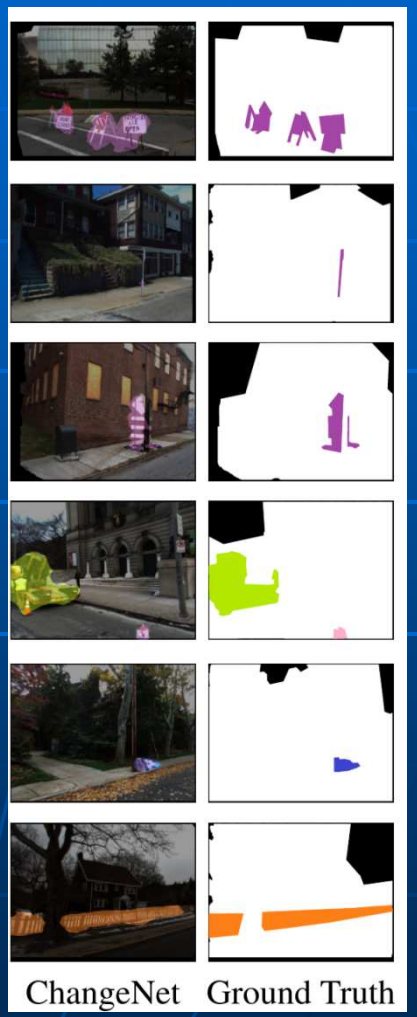
Results:
20 stereo pairs – 1 false pos., 1 false neg.
Elder Oroski, 2011

ChangeNet as Cycleway Digital Twin

Drone path



$[\hat{C}, \hat{P}, \hat{D},] = f(\text{Im(k), Im(k-1), Map, Inference Engine, Rule Basis})$



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DRL Drone Bikeway Inspection Digital Twins

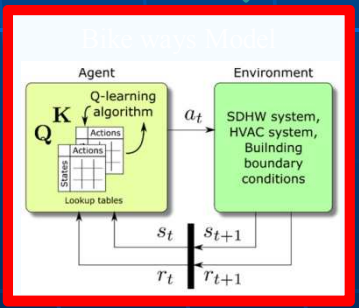
BSB Living Labs - ENE/ENC-UnB 2020

Stored Info
-Map
-Registered Bikes

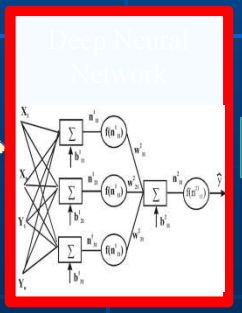
Trajectories
$(x,y,z,\emptyset,t)$

$Im(k)$

$Im(k)$

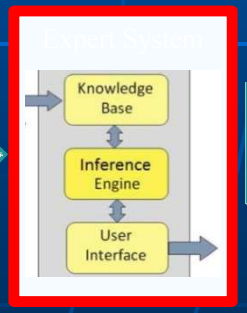


Change



Pattern Recognition

-Hole
-Near FT Block F
-Coord. (23N,300W)



Diagnosis
Recommended actions at (x,y)

-Urgent
-Send Mantainance

$[\hat{C},\hat{P},\hat{D}] = f(Im(k), Im(k-1),\ldots Map, Rule\ Base, Inference\ Engine)$

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Automação Predial

Prof. Adolfo Bauchspiess

Building Automation

Concepts:

- Sub-systems
- Segments
- Technologies
- Where can you work?
- Ambient Intelligence

Projects

- Energy Saving
- Thermal Comfort
- User tracking
- nZEB

Perspectives

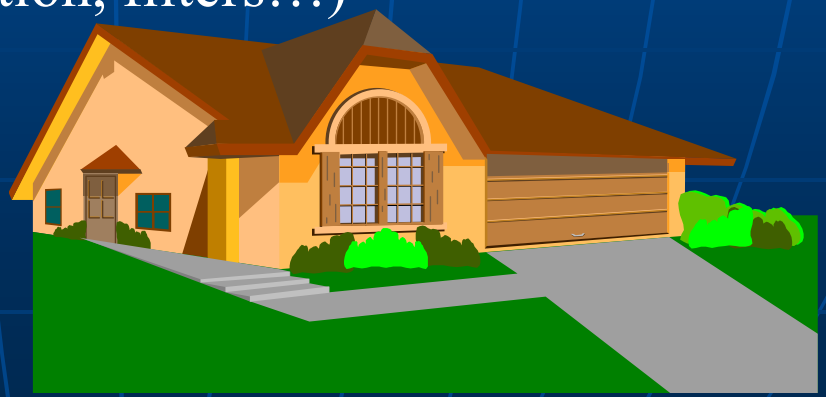
Intelligent Building Automation

#trend_topics

- *Building Automation*
- *Artificial Intelligence*
- *Ambient Intelligence*
- *Ubiquitous Systems*
- *Assisted Living*
- *Cyber Physical Systems*
- *nZEB*
- ***Smart** Environments / Buildings / Campus / Cities*

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

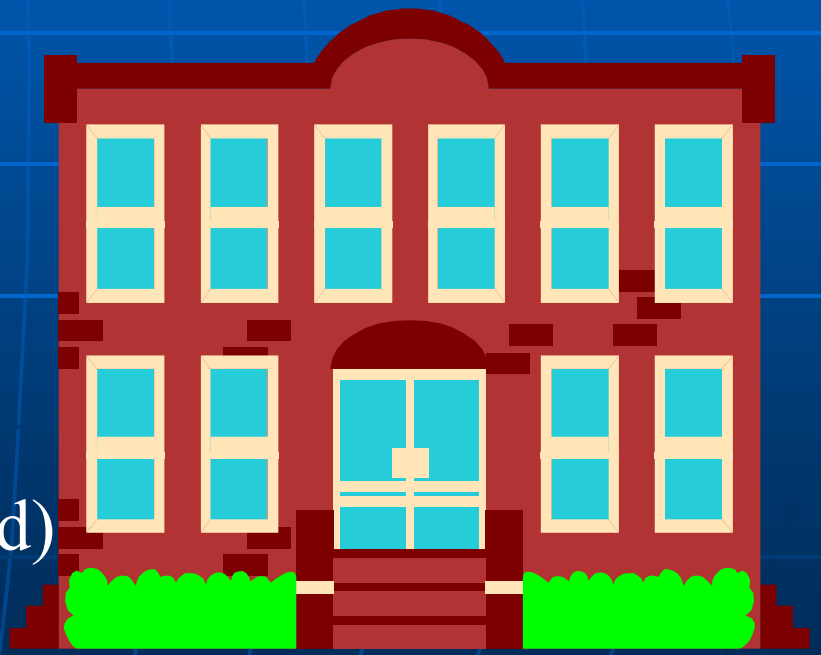


Building Automation- Technologies

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

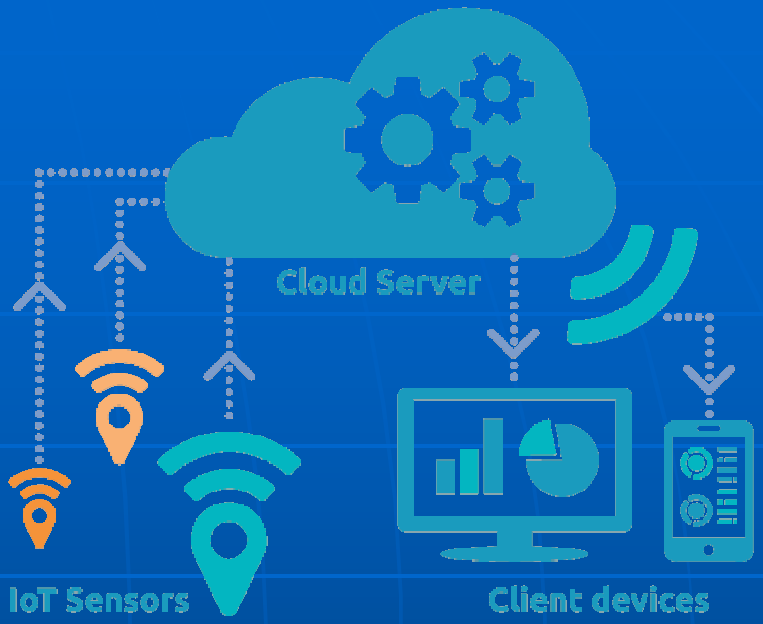
- Network
  - Cabled
  - PLC
  - Wireless

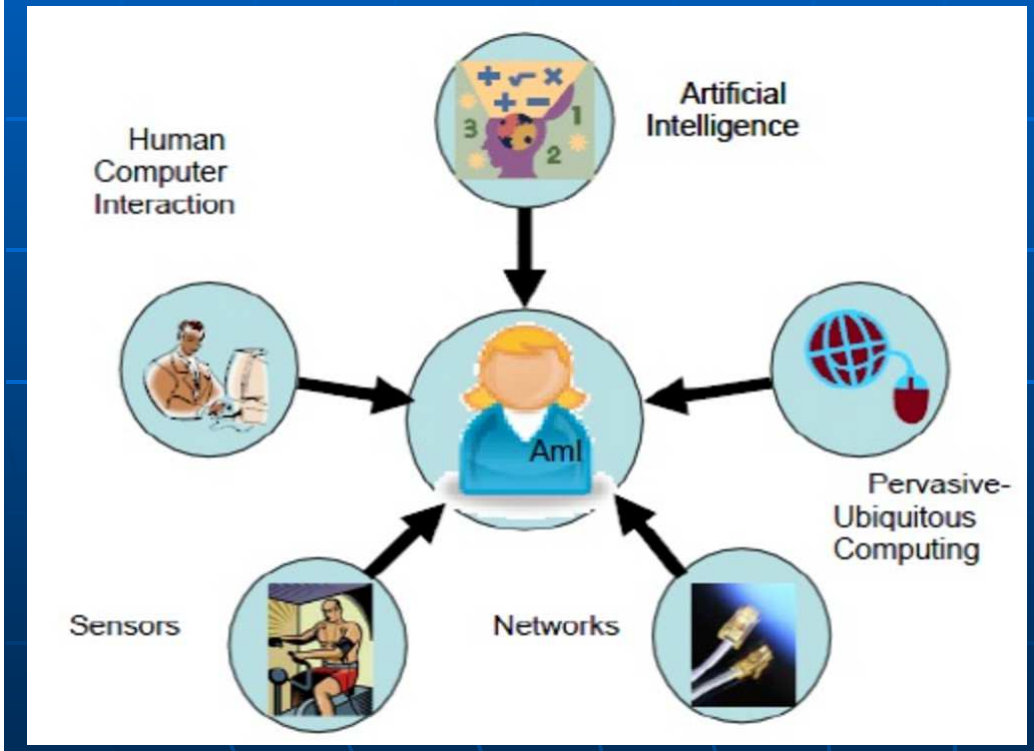
- Devices
  - Modularity (Easy to expand)
  - Interoperability



Ambient Intelligence

"Provides services to the users of an environment through a netwok, almost invisible, of sensors and actuators"





Which services?

Which informations can be obtained, from the Cloud? IOT?

What is "intelligent"?

(adaptation /learning /innovation)?

Building Automation Segments

- ✓ Schools
- ✓ Hospitals
- ✓ Hotels
- ✓ Pharma
- ✓ Commercial
- ✓ Airports
- ✓ Stadiums
- ✓ Domotics
- ✓ …

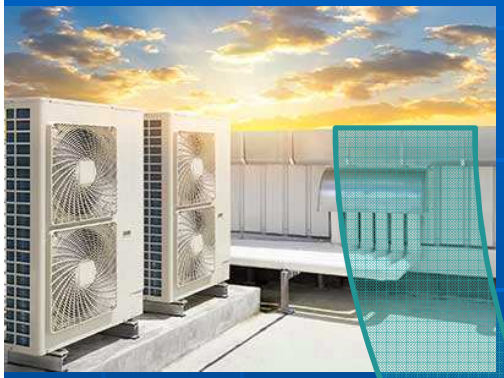








Subsystems



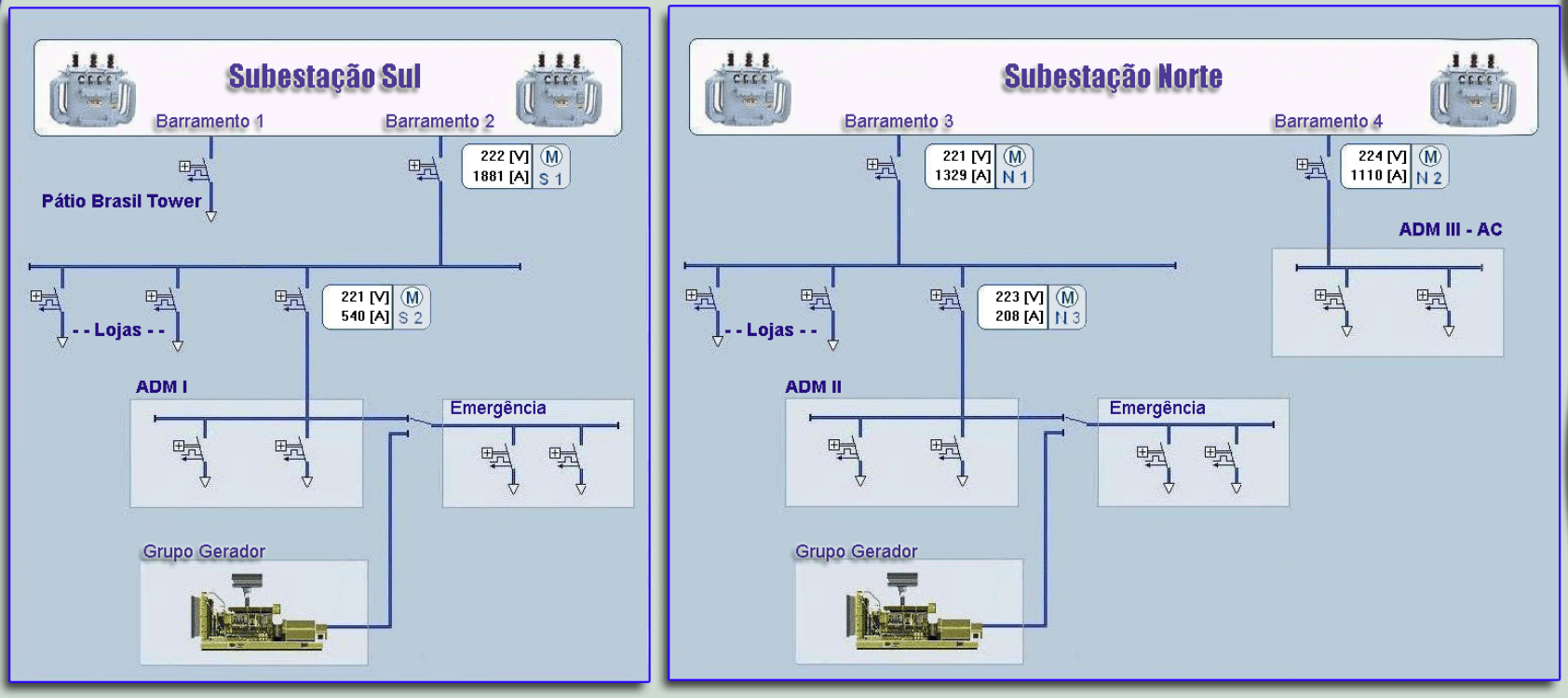
- ✓ HVAC
- ✓ Illumination
- ✓ Fire
- ✓ Energy
- ✓ Generator Group
- ✓ CFTV
- ✓ Access Control
- ✓ Elevators/Escalators
- ✓ …

Aplicação Elipse SCADA - Energia Elétrica

Energia Elétrica - Circuitos Alimentadores

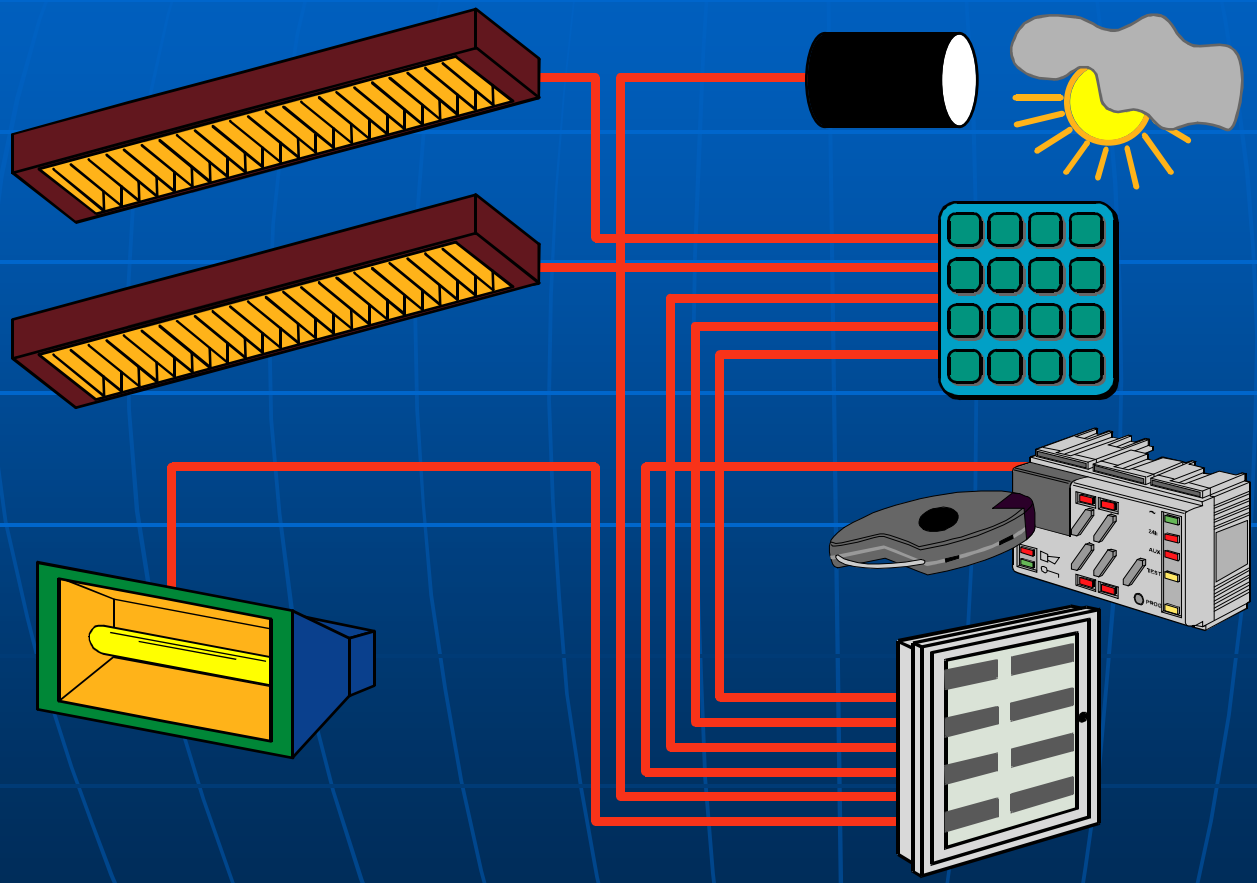
PÁTIO BRASIL SHOPPING

PRINCIPAL

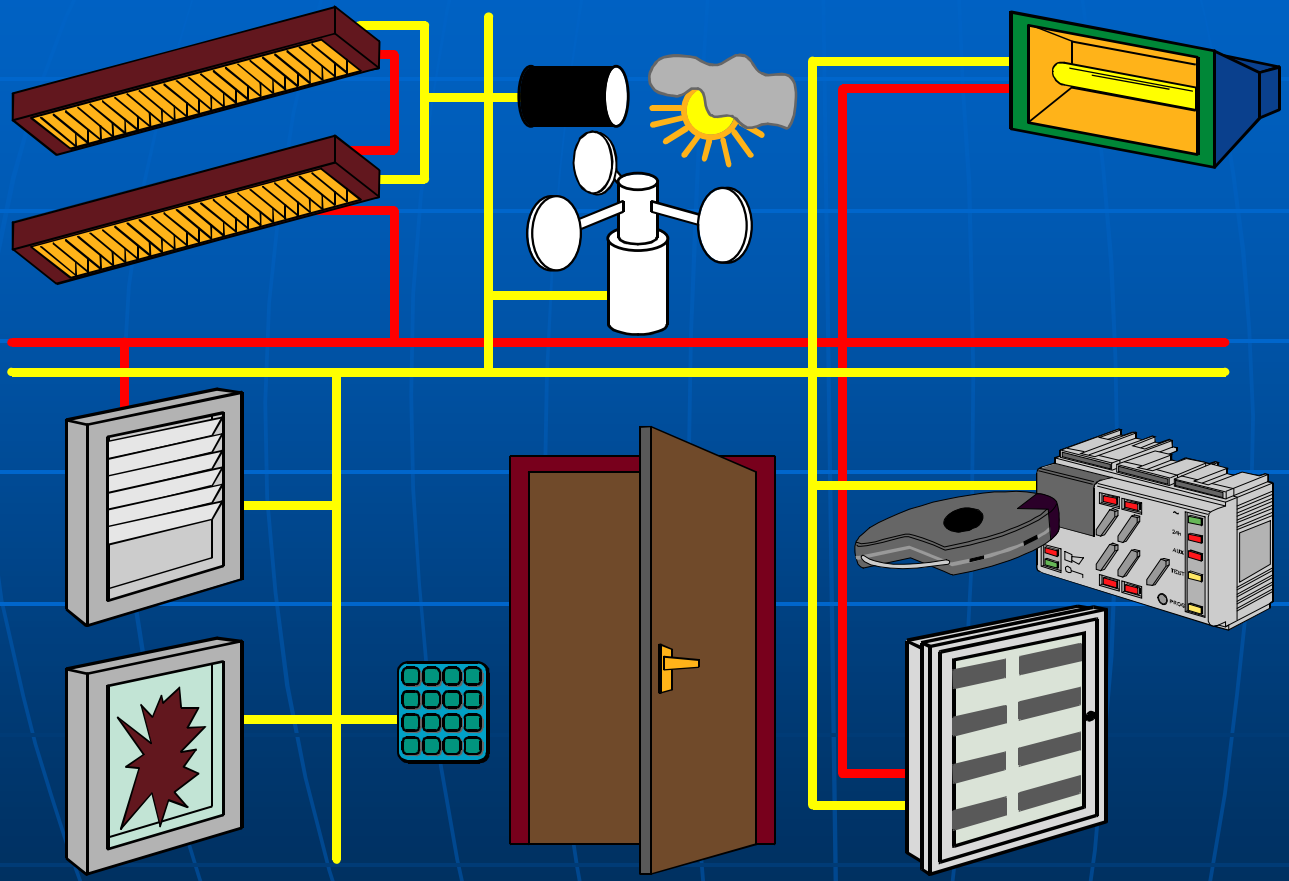


	Alimentador Sul - M S1				ADM I - Medidor M S2				Alimentador Norte - M N1				ADM II - Medidor M N3				ADM III (AC) - Medidor M N2			
	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]	[V]	[A]	FP	[kW]
FASE R	220	1930	0,89	378130	220	589	0,83	107742	220	1027	0,80	180481	221	211	0,95	44343	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

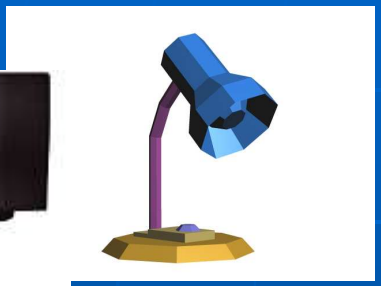


AC power line

Bus line

...wireless

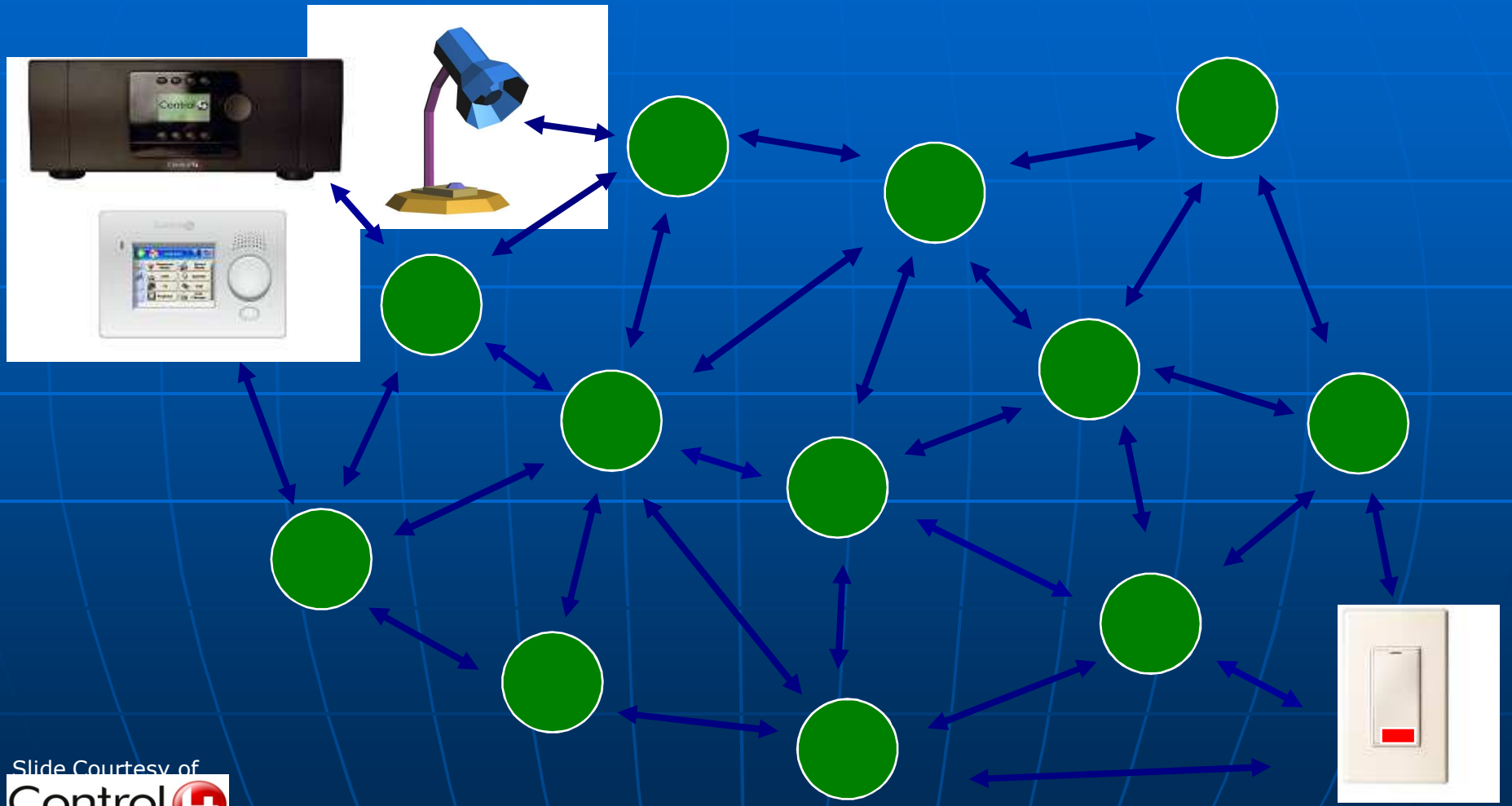
ZigBee Mesh Networking



Slide Courtesy of

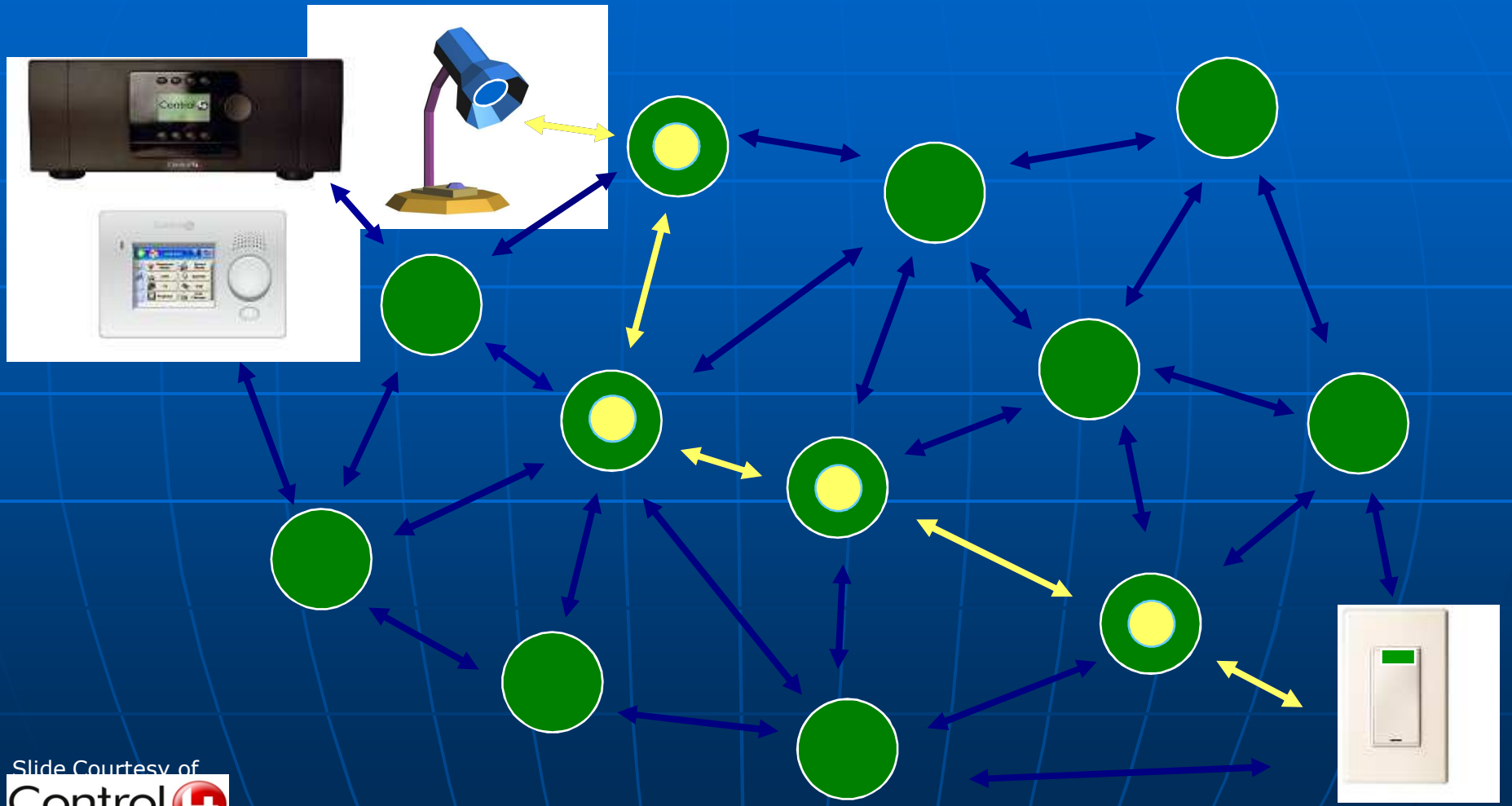
Control 4

ZigBee Mesh Networking



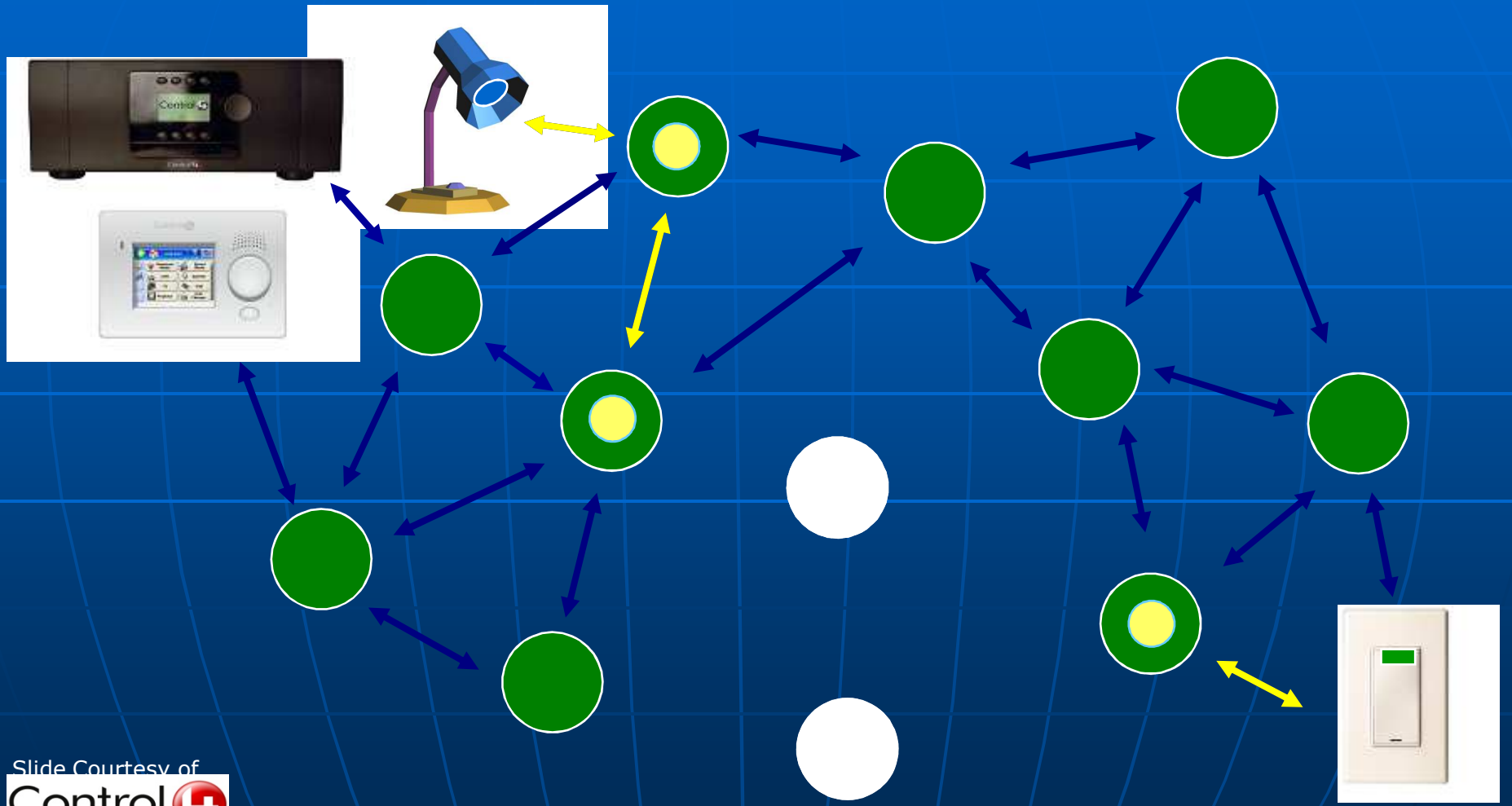
Slide Courtesy of Control 4

ZigBee Mesh Networking



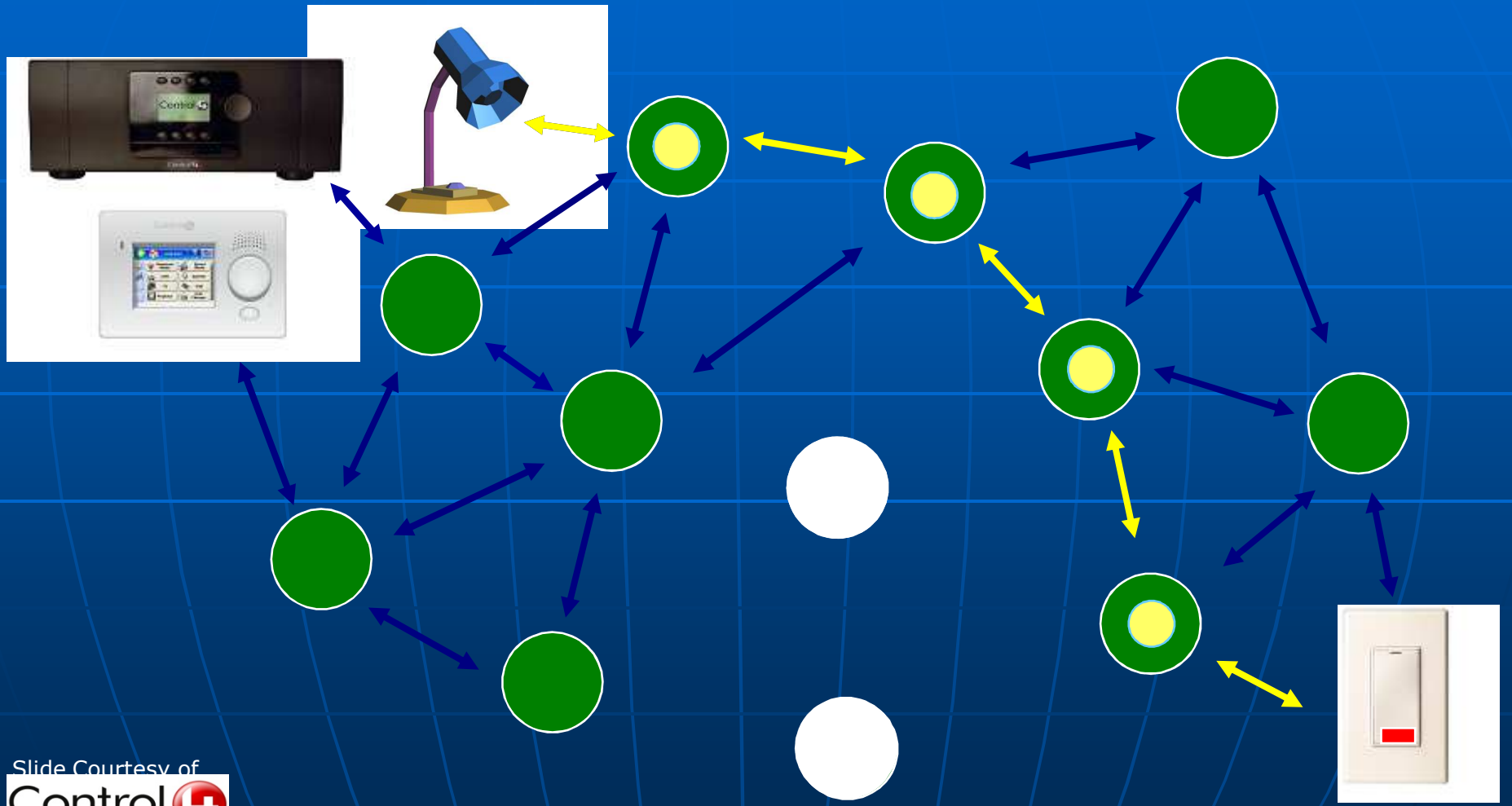
Slide Courtesy of Control 4

ZigBee Mesh Networking



Slide Courtesy of Control 4

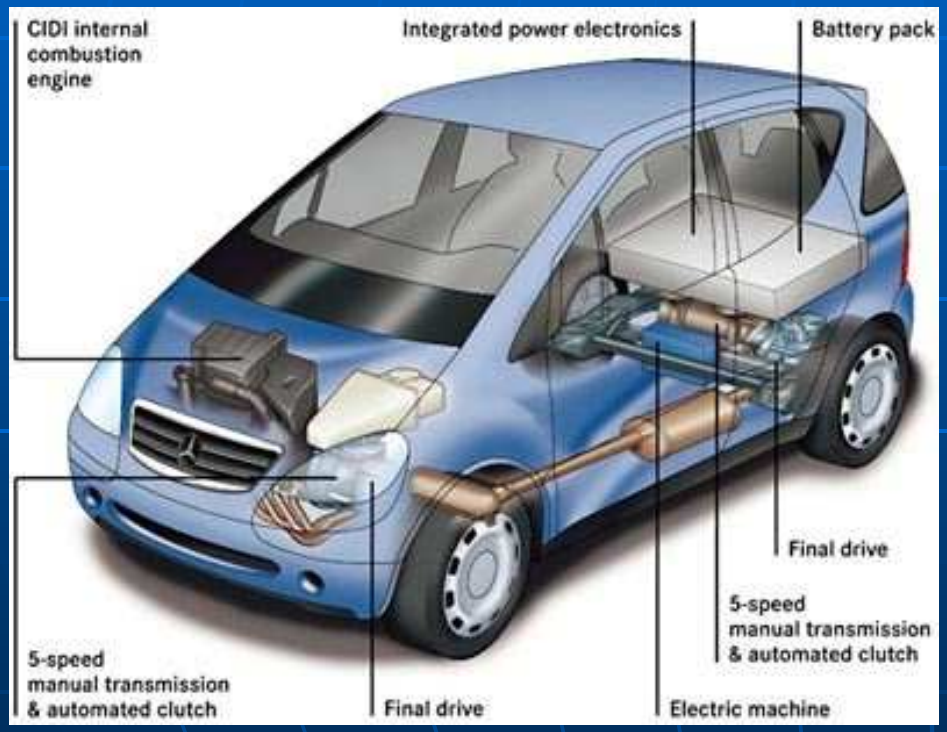
ZigBee Mesh Networking



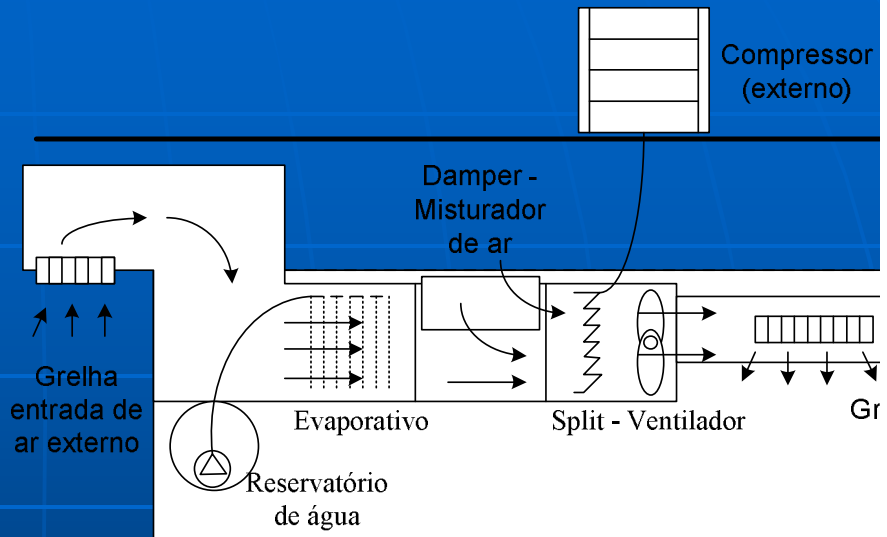
Slide Courtesy of Control 4

Energy Saving:

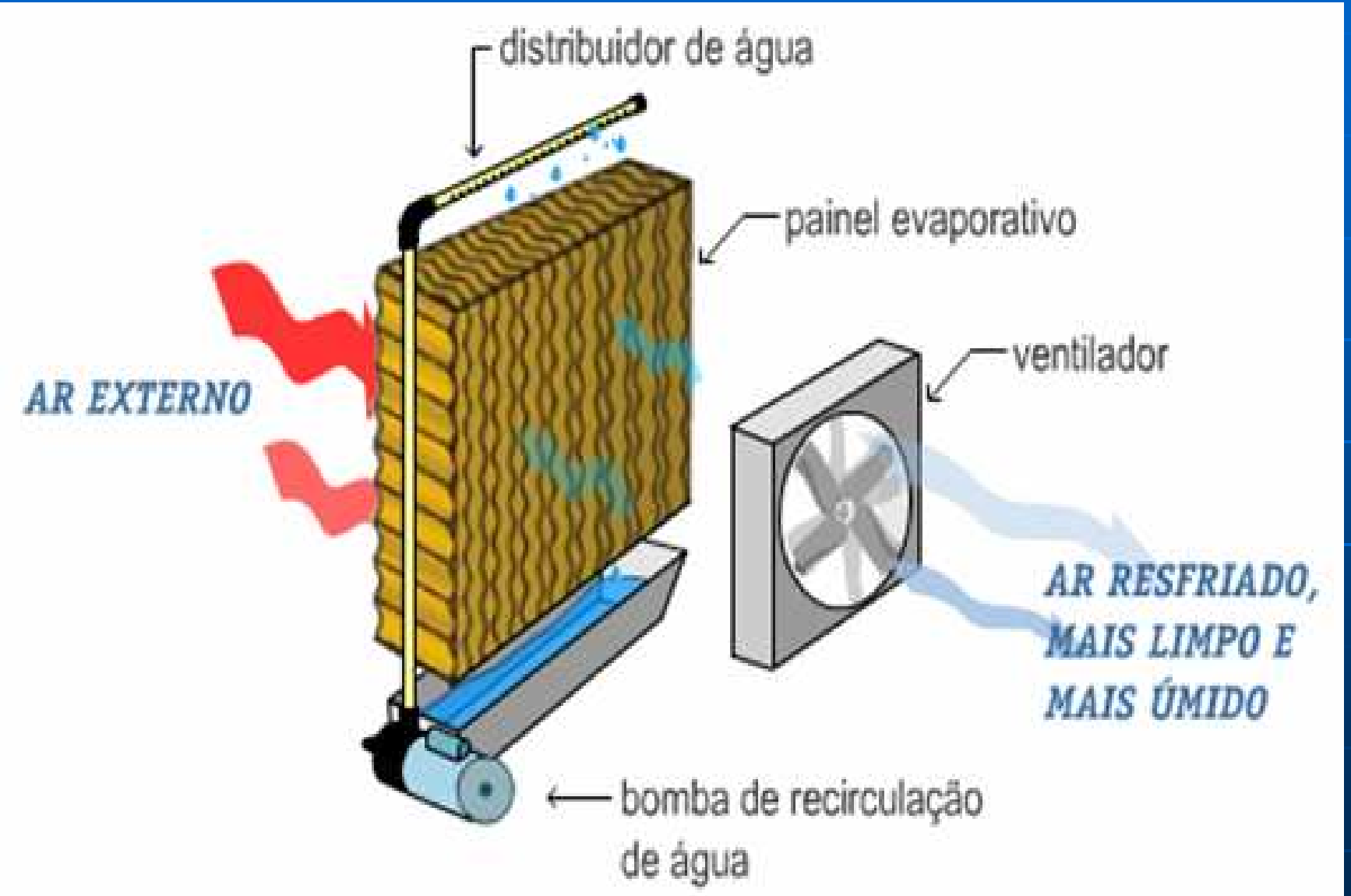
Hybrid Car



Hybrid Air Conditioner

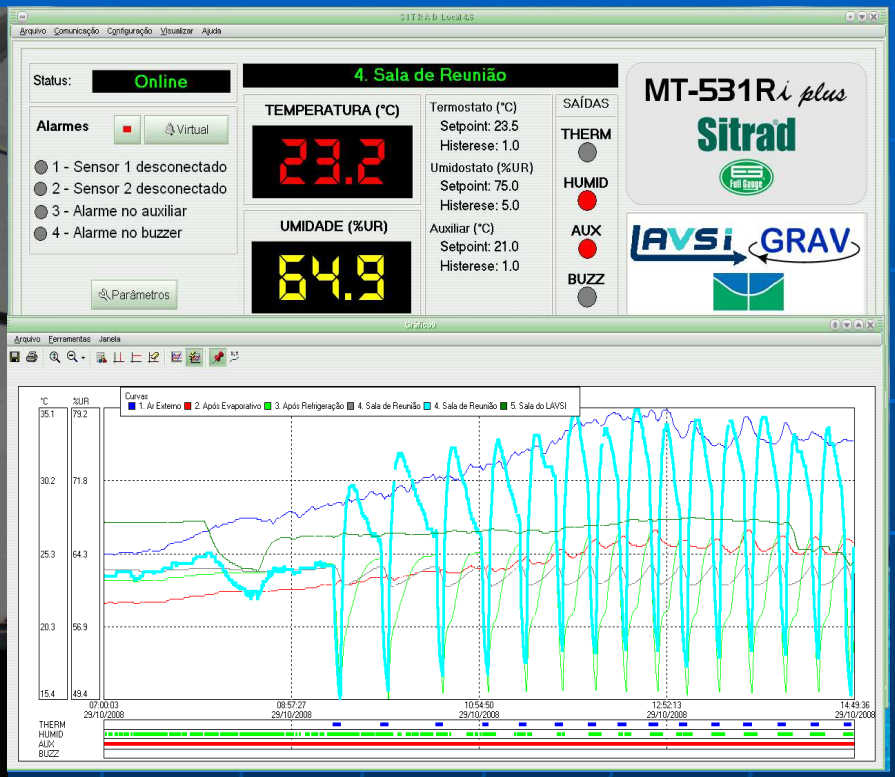


Fundamentos – Resfriamento evaporativo

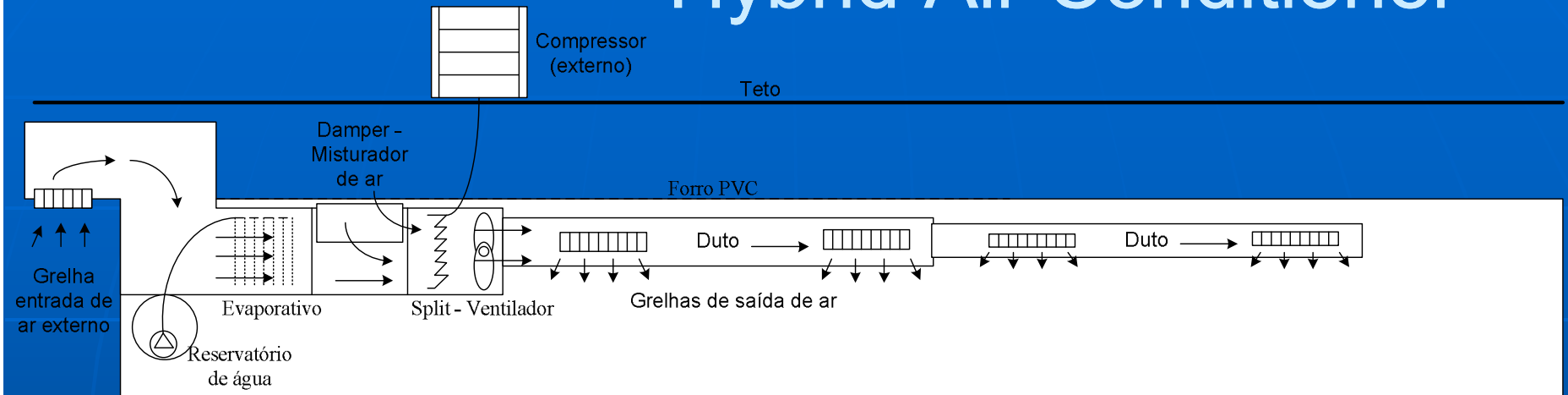


Hybrid Climatization: Evaporative-Conventional

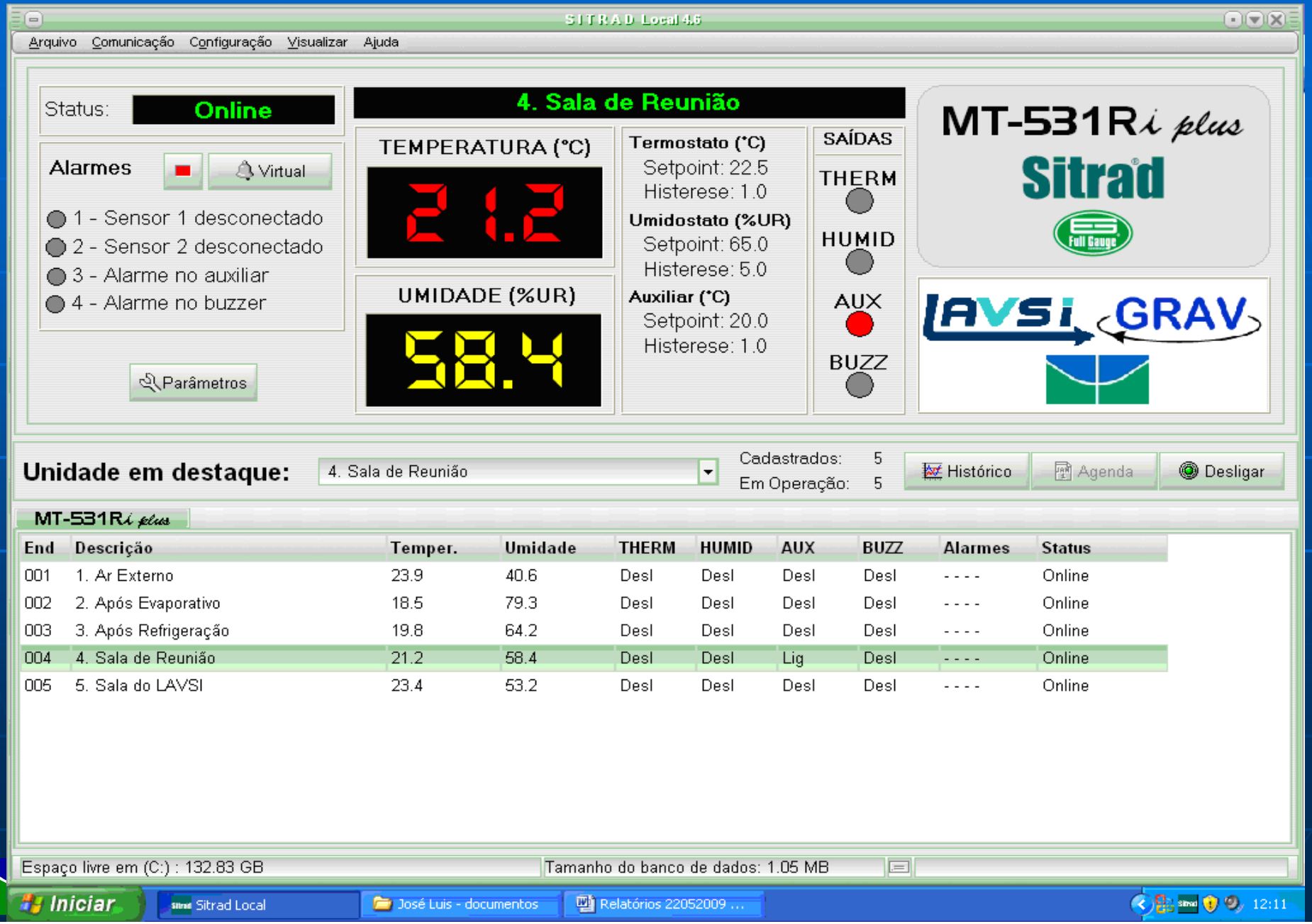
MSc José Luis Olmos Flores



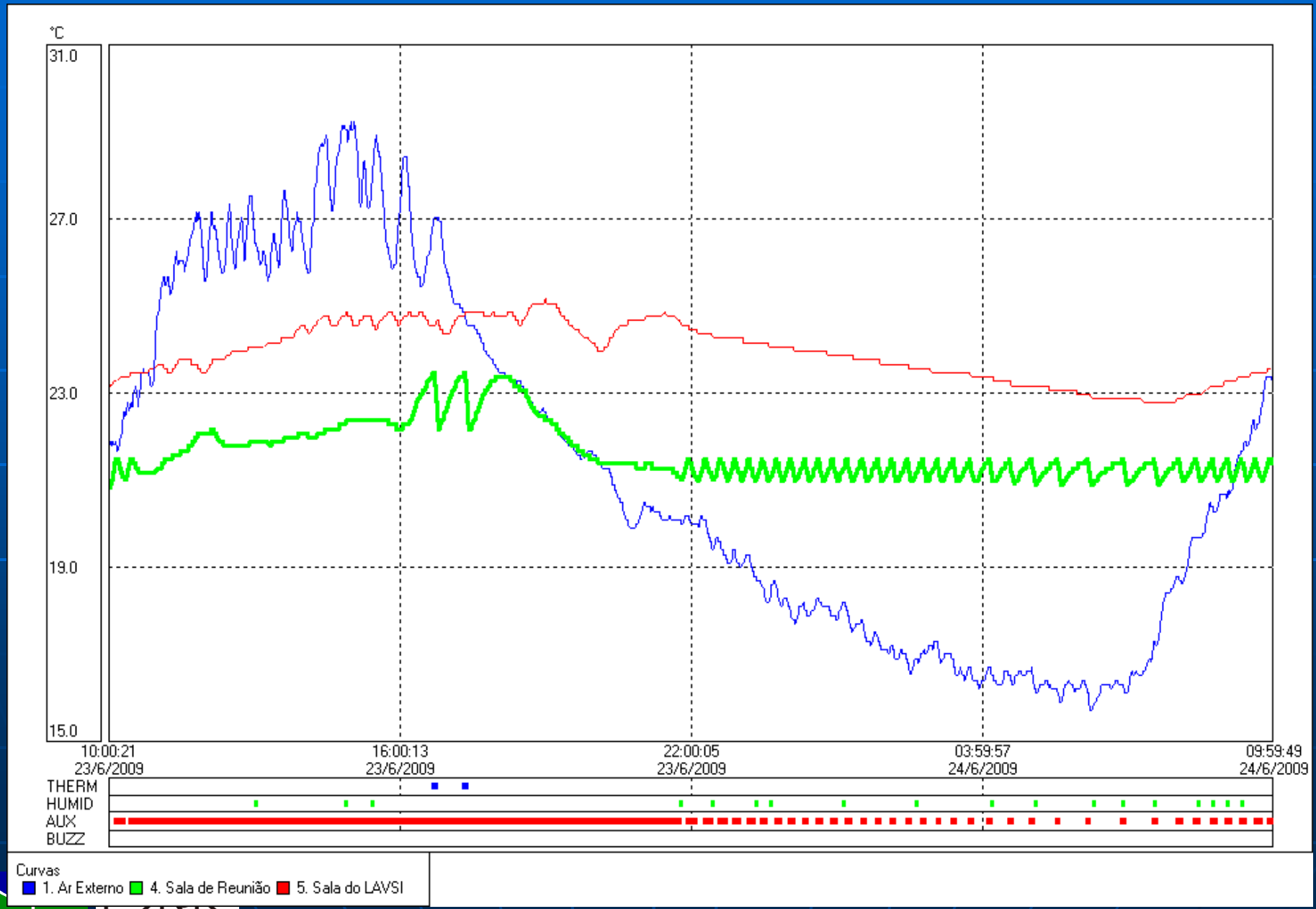
Hybrid Air Conditioner



Análise de dados – Tela do *Software Sitrad*



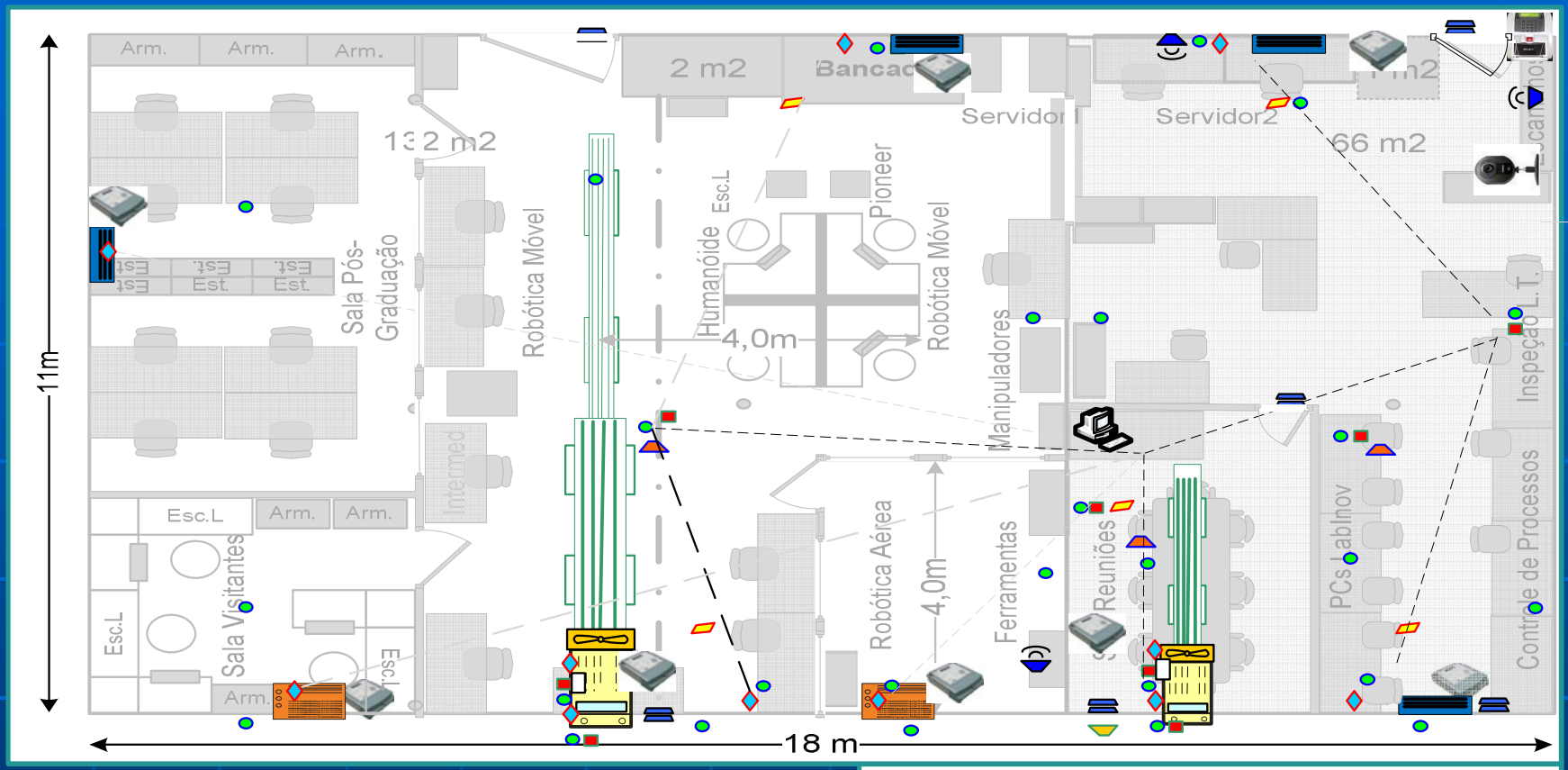
Resultados obtidos – Modo HIB - Temperatura



Análise de dados – Consumo de energia elétrica – 24 h.

Modo de Operação	Tempo operação Ventilador	Tempo operação Bomba	Tempo operação Compressor	Consumo total de Energia	Observações
DESL	00h00m00s	00h00m00s	00h00m00s	0,17 kWh	Muito Baixo
VENT	22h15m45s	00h00m00s	00h00m00s	2,23 kWh	Normal
EVAP	13h52m54s	00h29m42s	00h00m00s	1,36 kWh	Normal
REF	22h58m08s	00h00m00s	01h49m57s	5,92 kWh	Alto
HIB	14h56m31s	00h28m40s	00h09m02s	1,95 kWh	Normal

Intelligent Building Automation

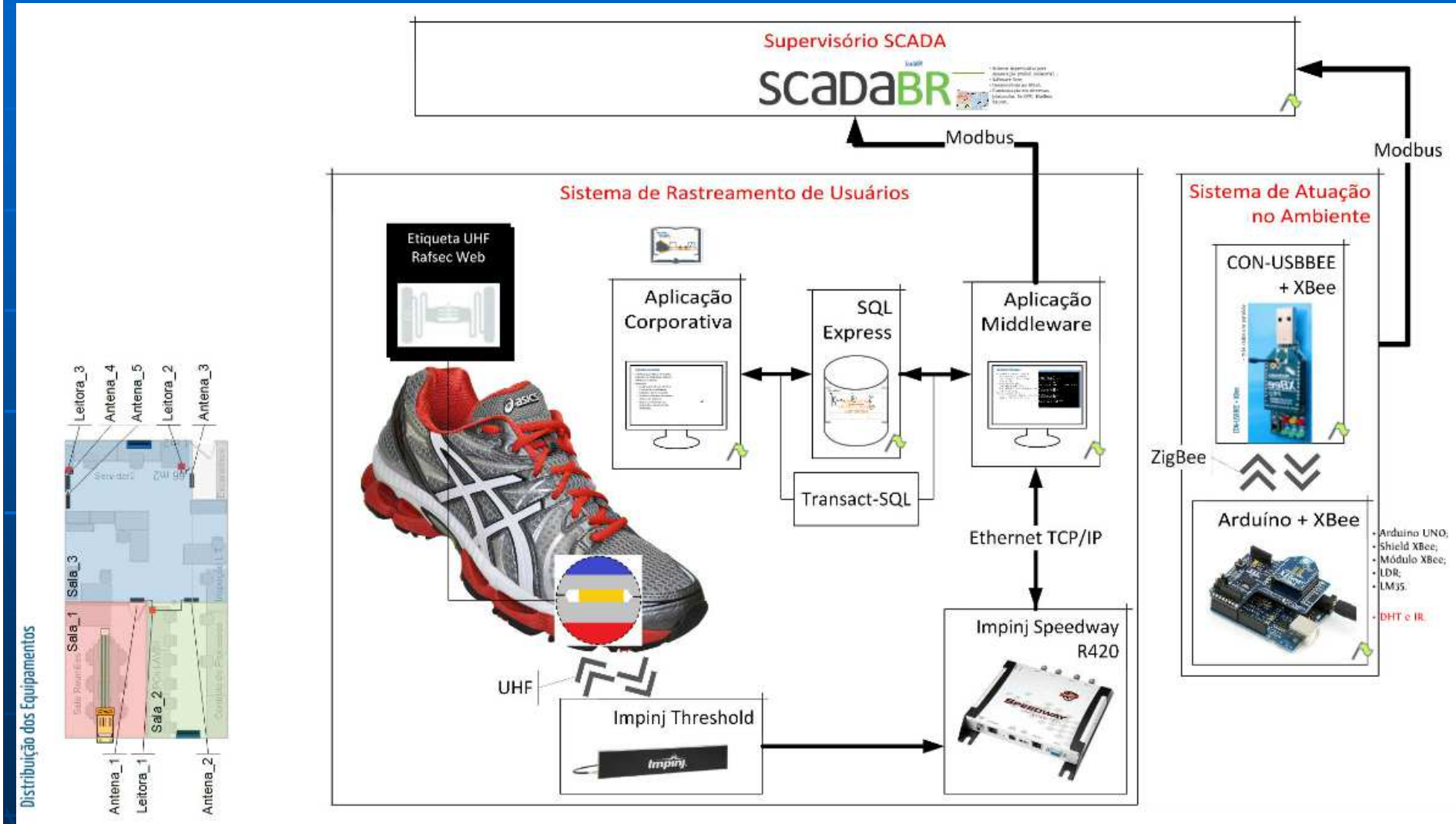


Laboratório de Automação e Robótica - ENE/UnB

- 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

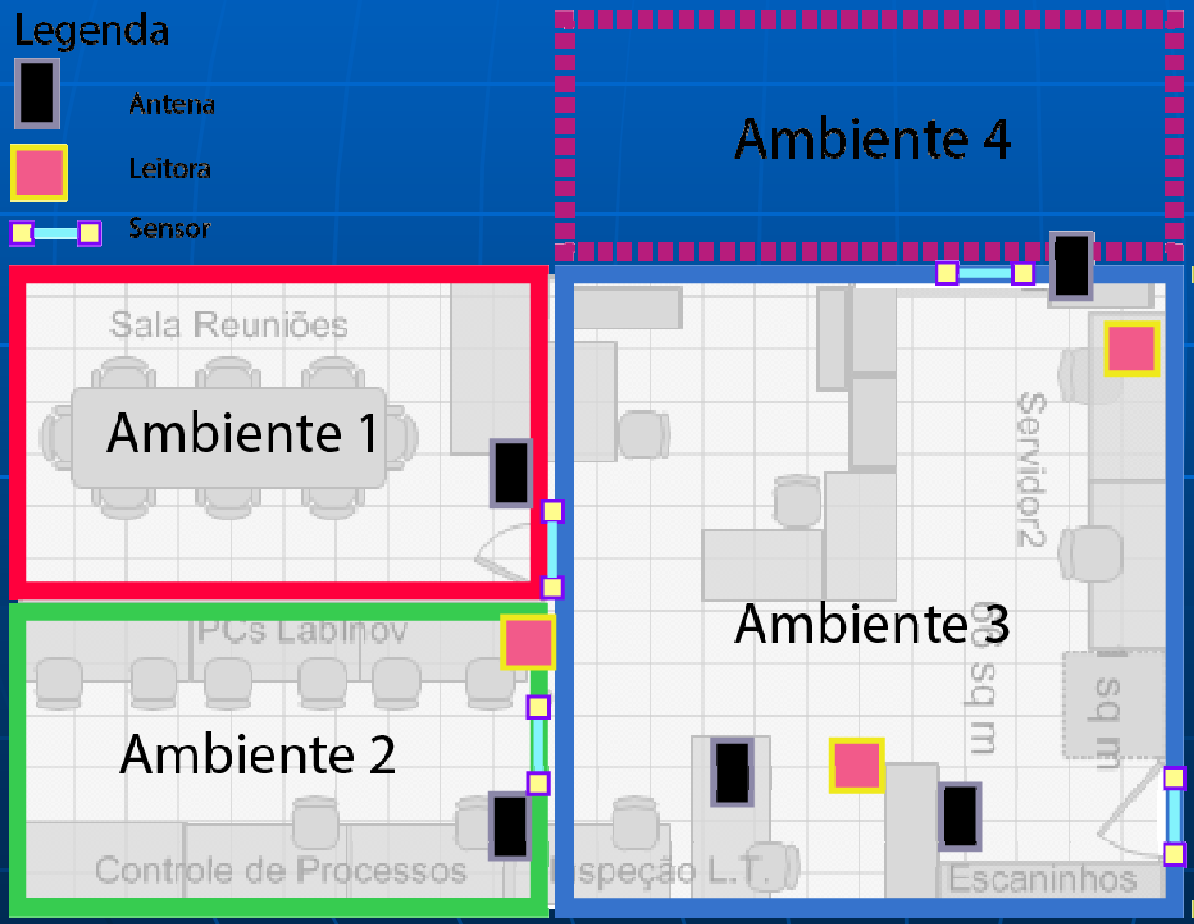
Passive RFID user tracking in building automation

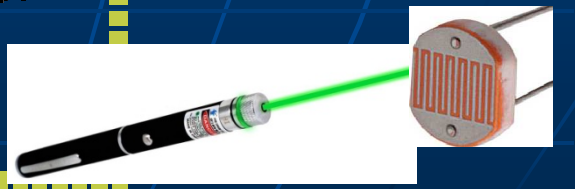
(Frederico Rocha e Filipe Oliveira, 2013)



Occupancy by Passive RFID + Laser Beam

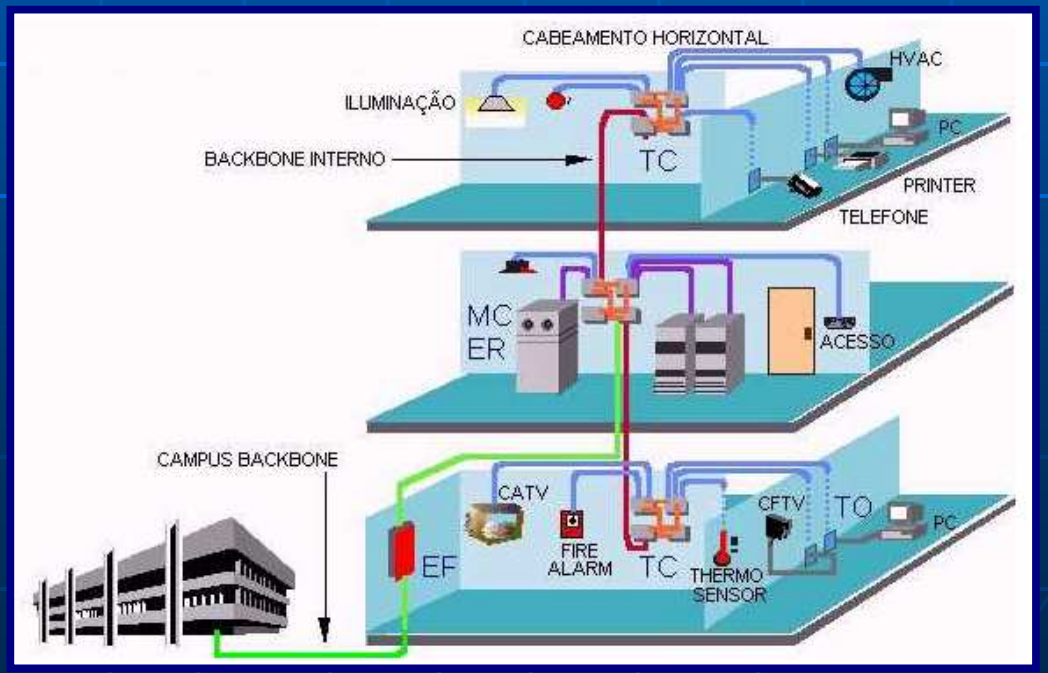
TG2015 Mecatrônica
Renata C.M. Chupel e Raissa A. Alves





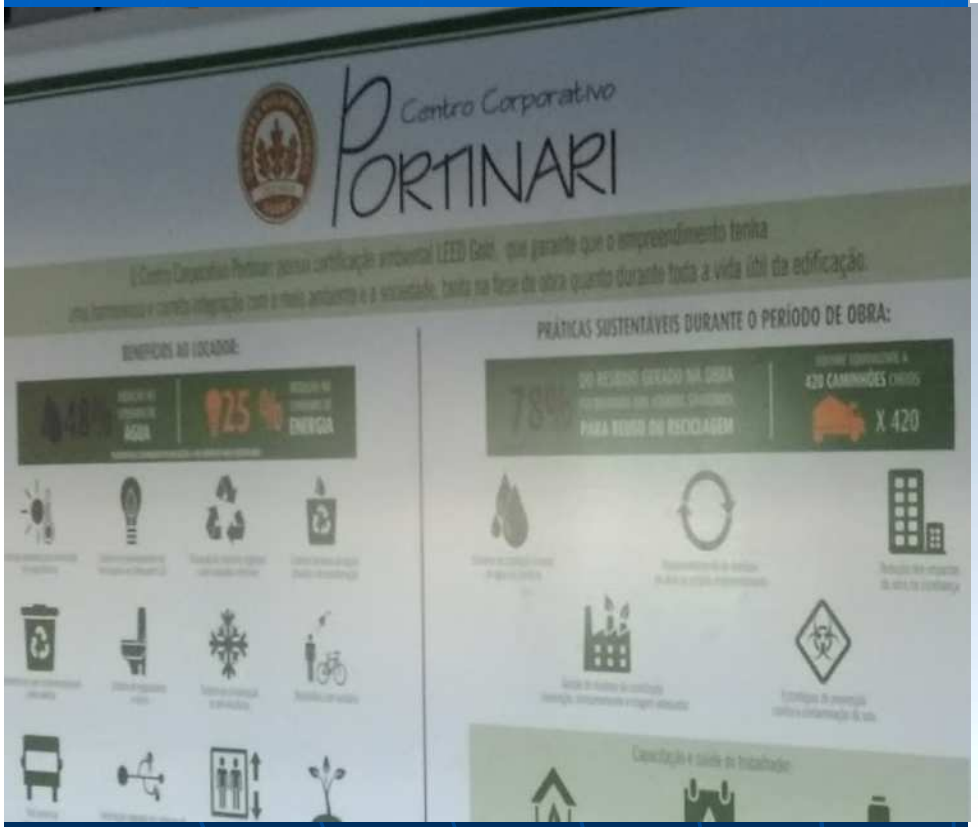
Perspectives

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



“Green Buildings”

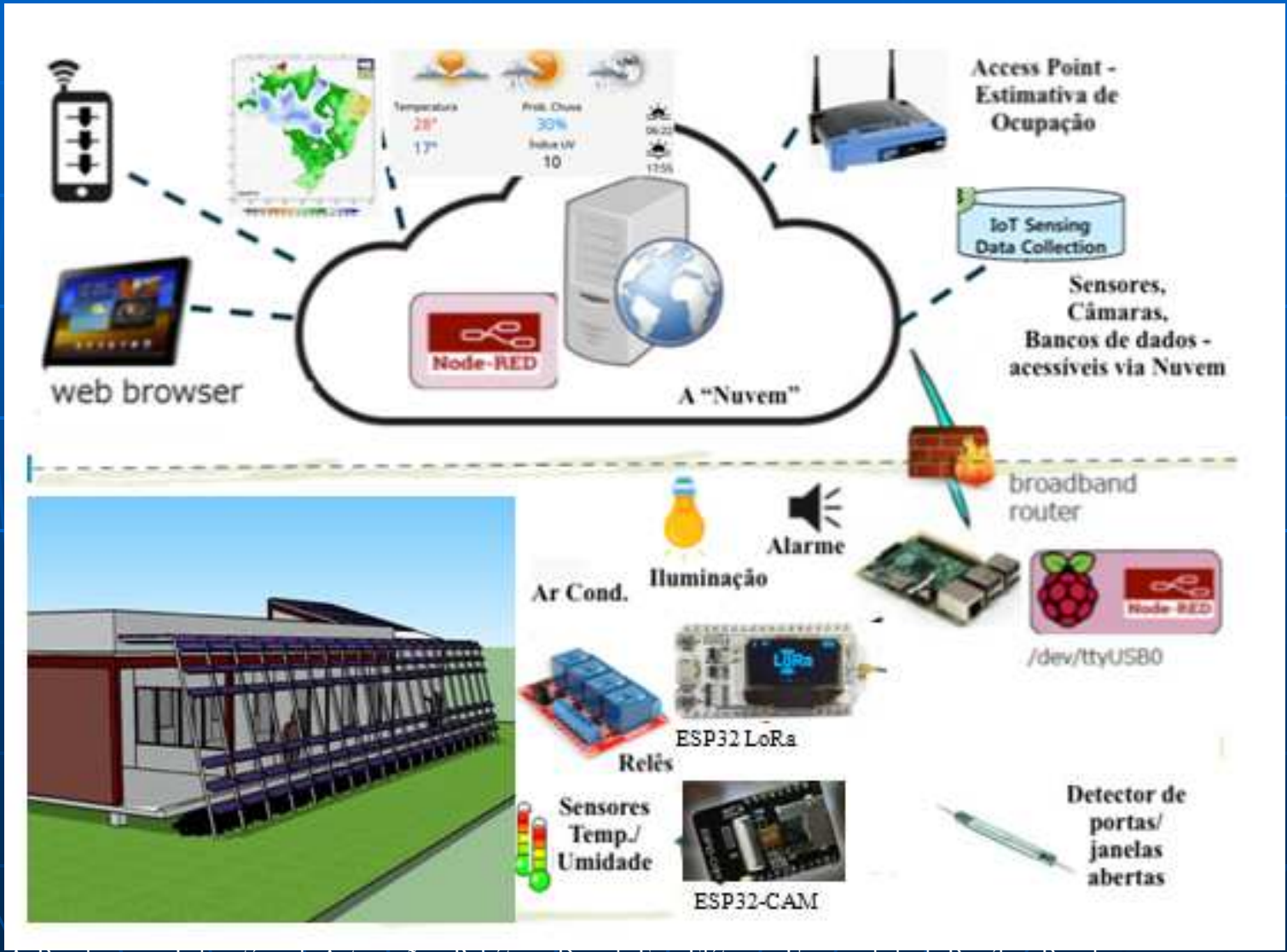
“Green Buildings”



2.2 million +

square feet is LEED certified every day with more than 90,000 projects using LEED.

Projeto ZEB/UnB/Eletrobrás
FAU/FT/GEP/FGA/FUP/CEPLAN



Simbologia (Adaptada da NBR 5444)

TT 101 / MT 101 — Temperatura e UR, Transmissão. DHT22: cabo 3 vias + blindagem: +5V, Gnd, data (serial, bidrecional)

Sensor Lux (DALI, montada na luminária)

Dimmer com Fonte alimentação +12 V (para elementos DALI: sensor, dimmer e Lâmpada) (+12V podem ser fornecidos, alternativamente, pelo sistema PV)

Luminária LED dimerizável: Controlada manualmente por potenciômetro ou via ESP32 associado.

AP 11 — Access Point

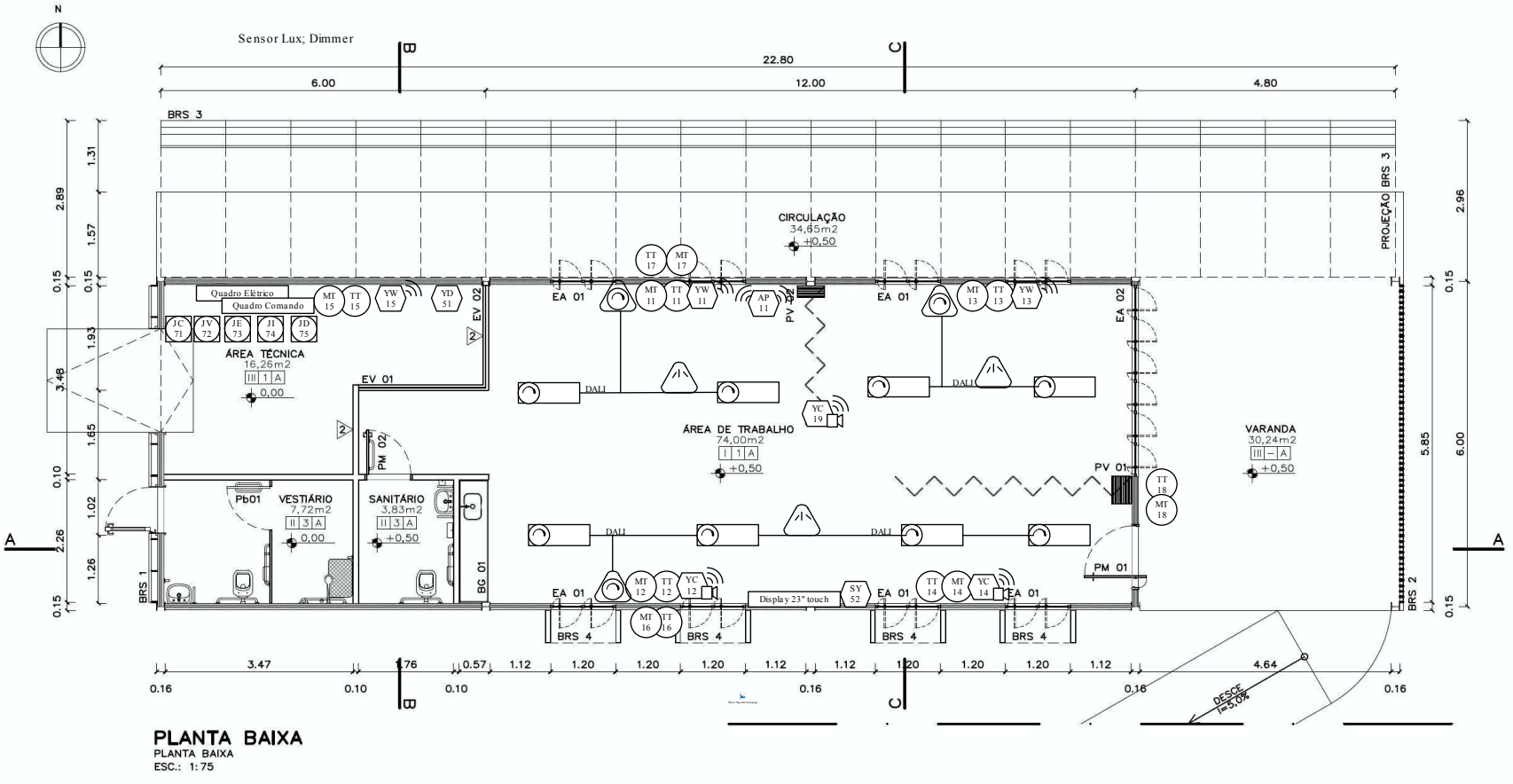
YD 501 — Computador de Desenvolvimento/Manutenção

YS 501 — Controle Supervisório (Openhab): Raspberry Pi 4 modelo B

YW 501 — Controlador Digital Distribuído: WiFi ESP32 LoRa Display OLED; Alimentação por bateria e 220V

YC 501 — Sensor de Presença/Ocupação: ESP32-CAM;Alimentação por bateria e 220V

JX 71 — Medidor de Potência Elétrica WiFi; JC HVAC–Compr.; JV HVAC–Vent.; JE HVAC–Evap.; JI - Iluminação; JD – Demais cargas (PCs co-working, geladeira etc)



Engenheiros, no Brasil e no Mundo

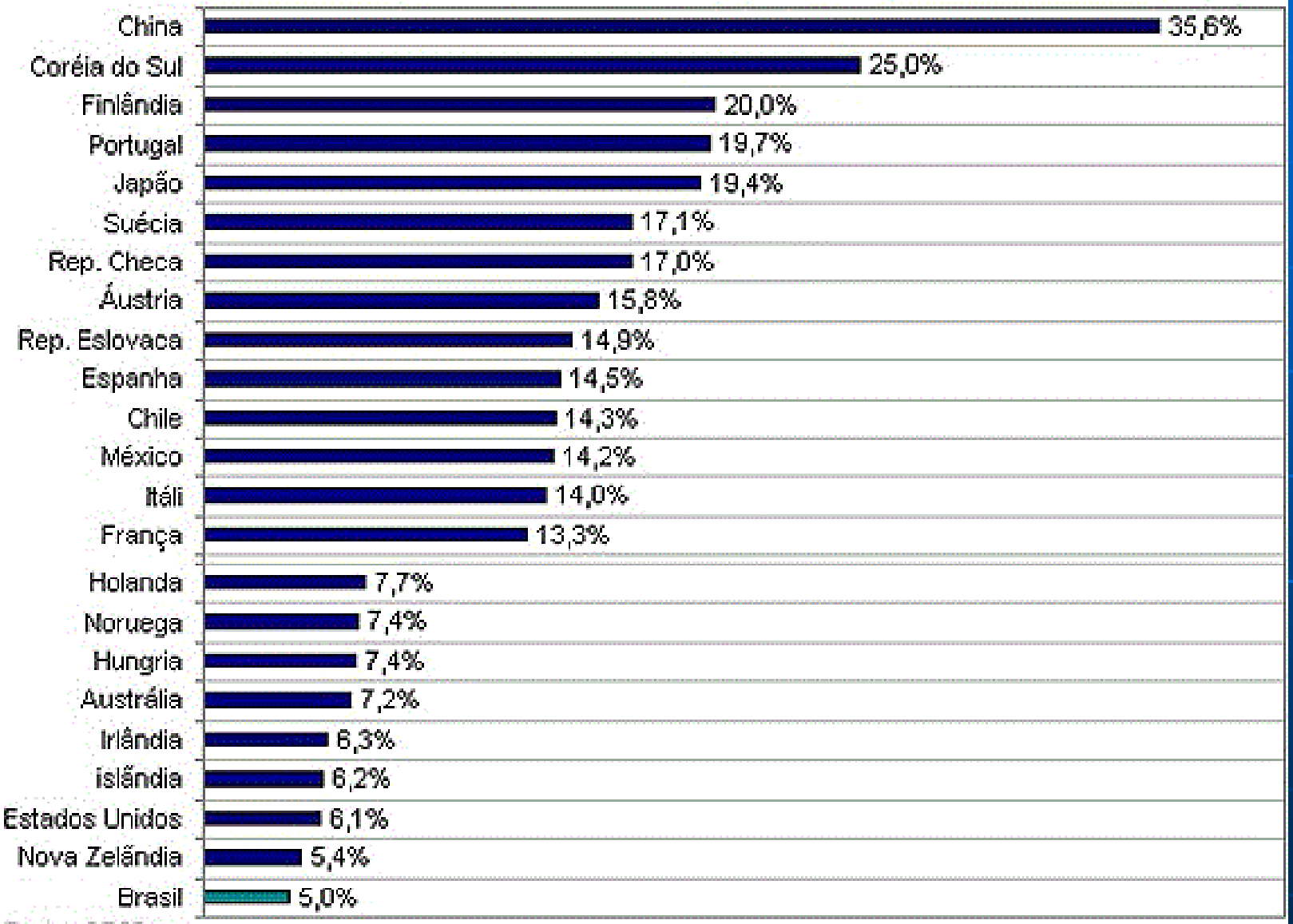
Prof. Adolfo Bauchspiess

Engenheiros/ 10.000 habitantes
comparações internacionais (2007)

Fonte:OCDE


MENOS ENGENHEIROS
Número de profissionais a cada 10 mil pessoas
5 MAIORES
Coreia do Sul 16,40
Finlândia 16,37
Portugal 13,86
China 13,41
Eslováquia 12,63
5 MENORES
Eslovênia 4,34
Chile 4,07
Grécia 3,89
Turquia 3,28
Brasil 1,95
Fonte: OCDE, 2010

Percentual de Egressos em Cursos de Nível Superior em Engenharia em Relação ao Total de Egressos Países Selecionados – 2007 – %



Fonte: OECD.

Obrigado!

Adolfo Bauchspiess

www.ene.unb.br/adolfo

adolfobs@ene.unb.br