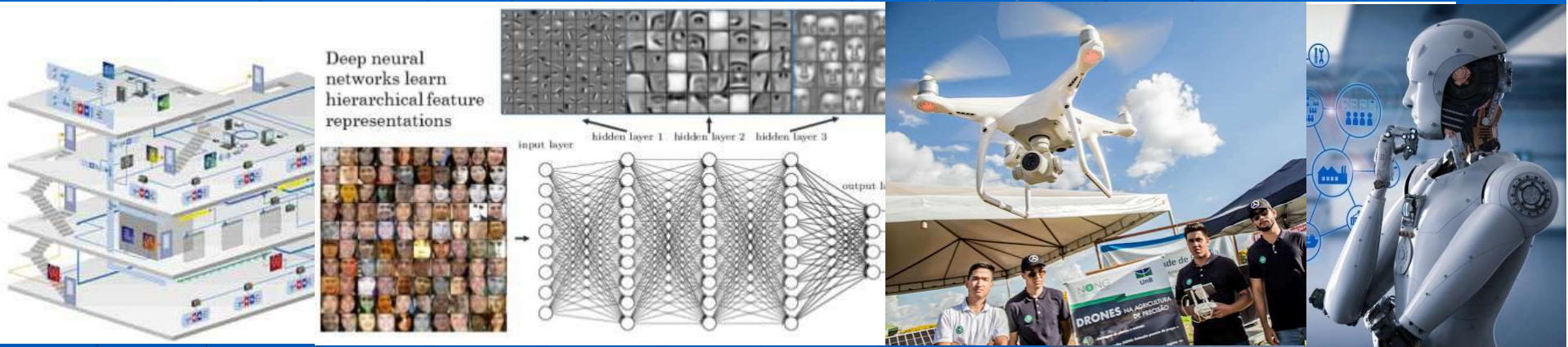




# Área de Automação e Controle

## - ENE/FT/UnB -

*Prof. Adolfo Bauchspiess*



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



# Grupo de Automação e Controle

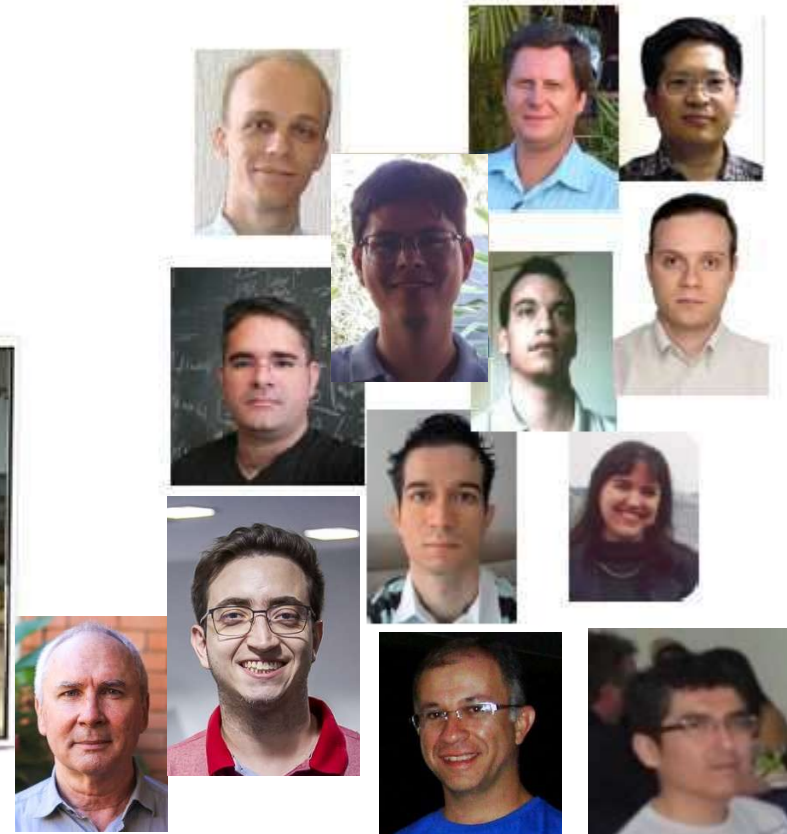
## ► Membros

12 professores

- $\pm 40$  estudantes de pós-graduação
- $\pm 60$  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 Automação, Controle e Robótica - CNPq

## Responsáveis

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

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



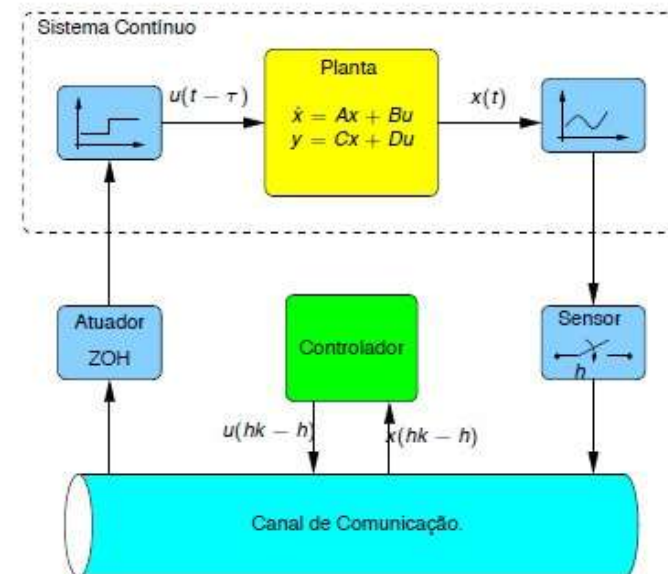
# Controle, filtragem e identificação

## ► 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



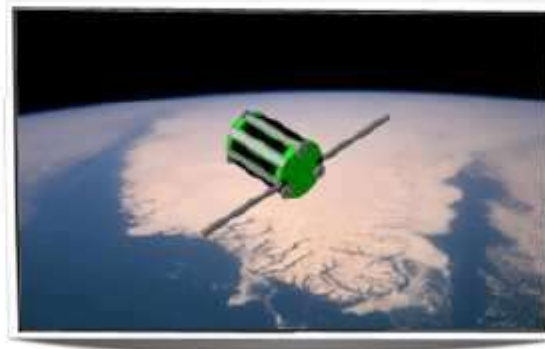
Fonte: Eduardo Tognetti

# Engenharia aeroespacial

---

## ► Projetos de pesquisa

- Controle de atitude de microsatelites
- 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

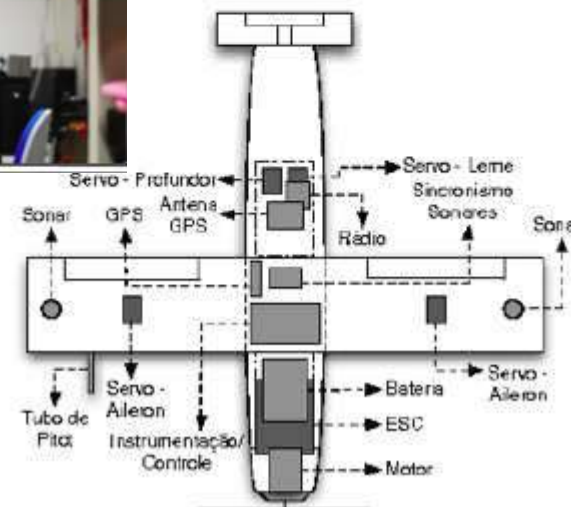
- Desenvolvimento de um sistema de Mini-VANT

## ► Plataformas experimentais

- Veículo de asa fixa
- Quadricópteros
- 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



# Robótica móvel e interação homem-robô

## ► Projetos de pesquisa em andamento

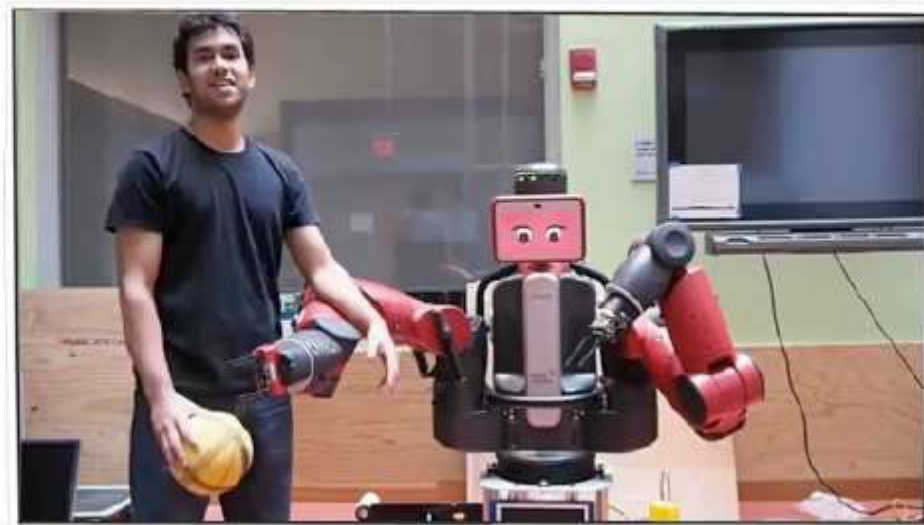
- Manipuladores móveis para sistemas avançados de manufatura

## ► Áreas de pesquisa

- Localização e mapeamento simultâneos
- Controle servovisual
- Controle de manipuladores

## ► Professores envolvidos

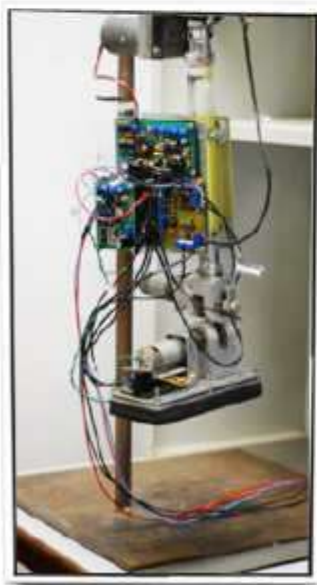
- Antônio Padilha
- Geovany Borges
- João Ishihara



# Robótica de reabilitação

## ► Projetos em andamento

- Prótese robótica para amputados de membro inferior



Nonfunctional prototype

## ► Professores envolvidos

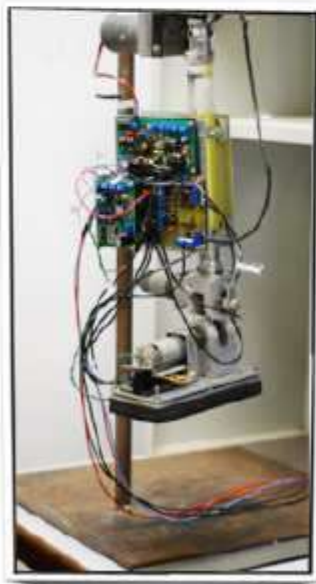
- Antônio Padilha e Geovany Borges



# Robótica de reabilitação

## ► Projetos em andamento

- Prótese robótica para amputados de membro inferior



Nonfunctional prototype

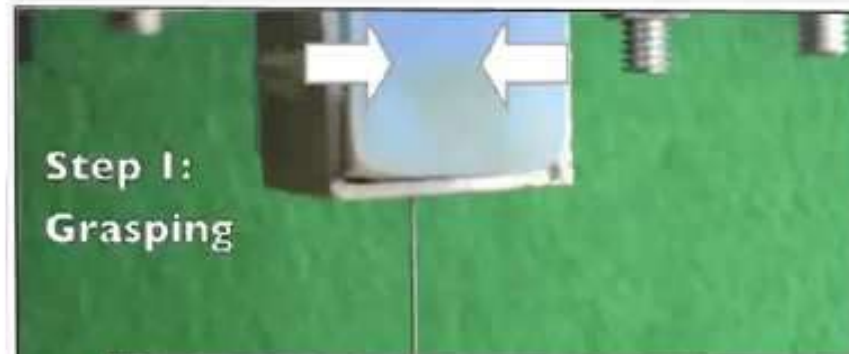
## ► Professores envolvidos

- Antônio Padilha e Geovany Borges



# 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

- Engenharia de Petróleo (Oniram)
- Controle não-linear, Caos (Vargas)
- Identificação de Sistemas (Alex)
- Qualidade da Energia (Lélio)
- Engenharia Biomédica (Flávia)
- Robótica – Quatérnions (Tadashi)



# Controle de Processos Industriais

**Prof. Eduardo Stockler Tognetti**

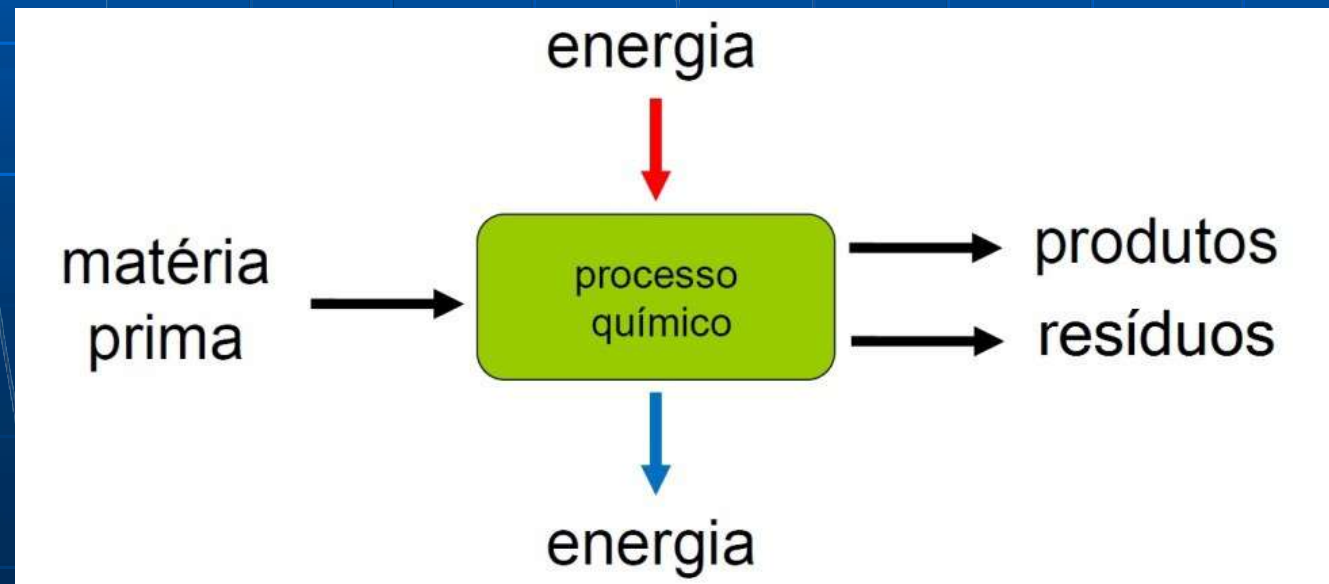


# Processos Industriais



# Processo

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



# Indústria Petroquímica

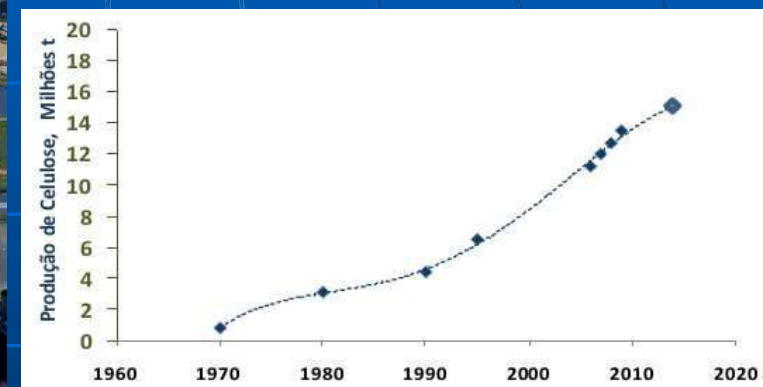
**Refinaria**



**Extração**



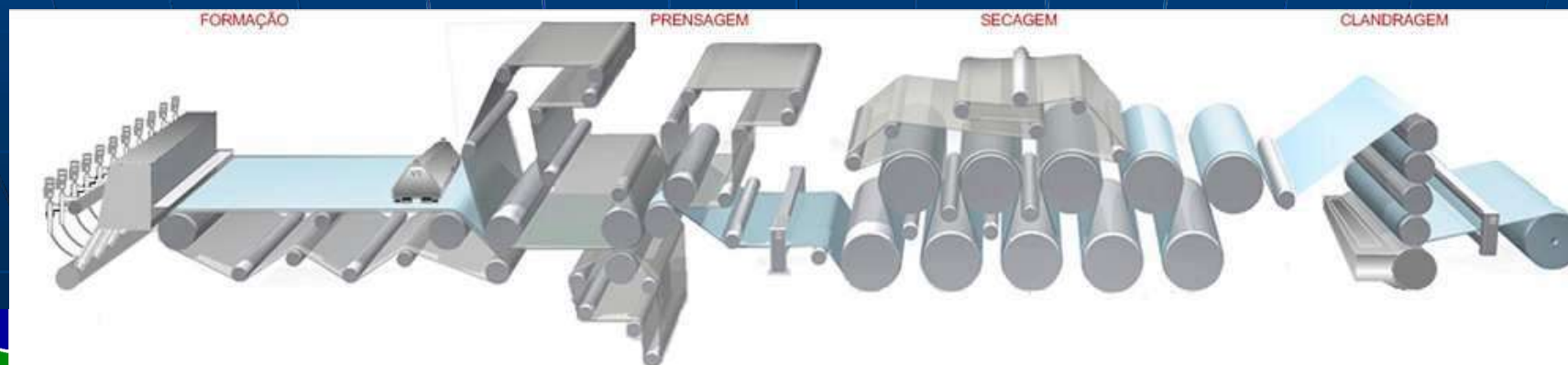
# Indústria de Celulose e Papel



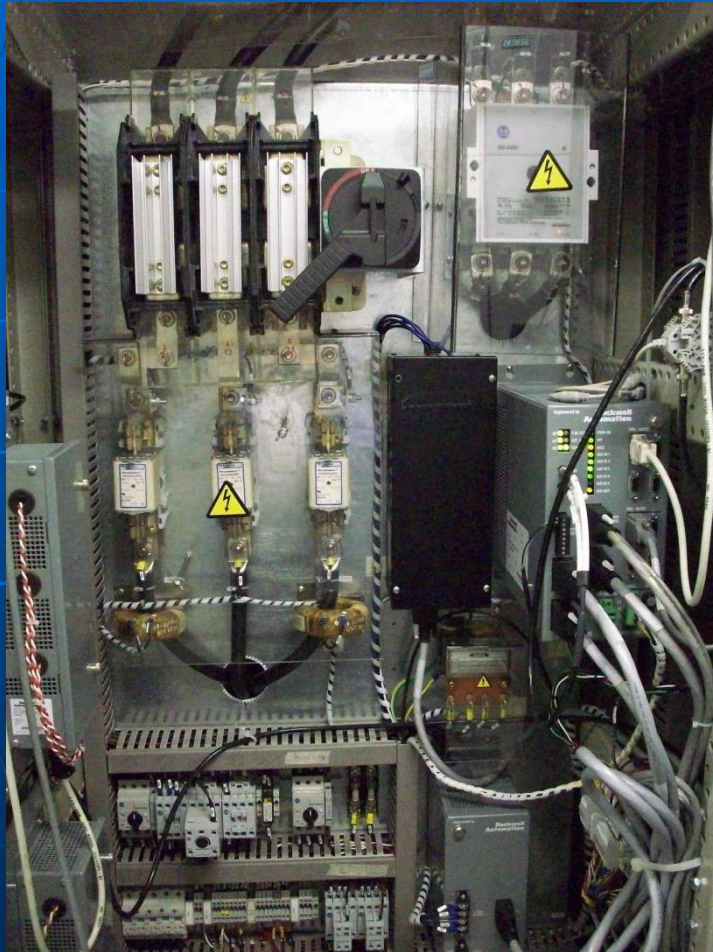
# Visão Geral do Processo de Celulose



# Processo Papel



# Acionamentos Industriais



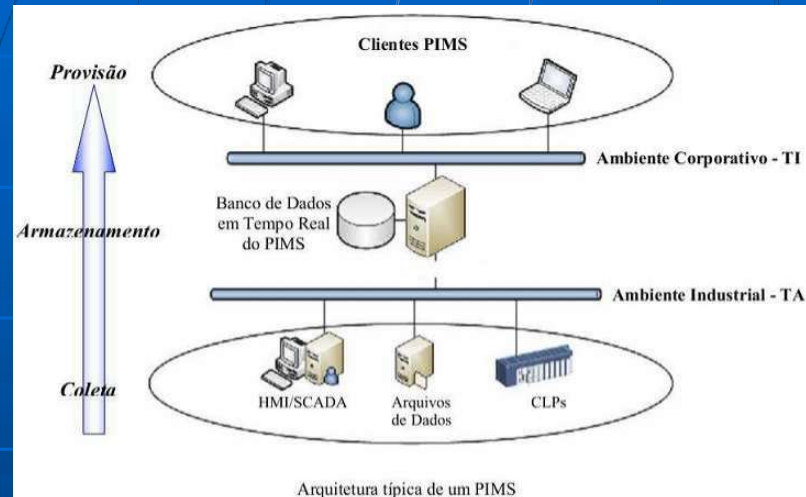
Acionamento digital



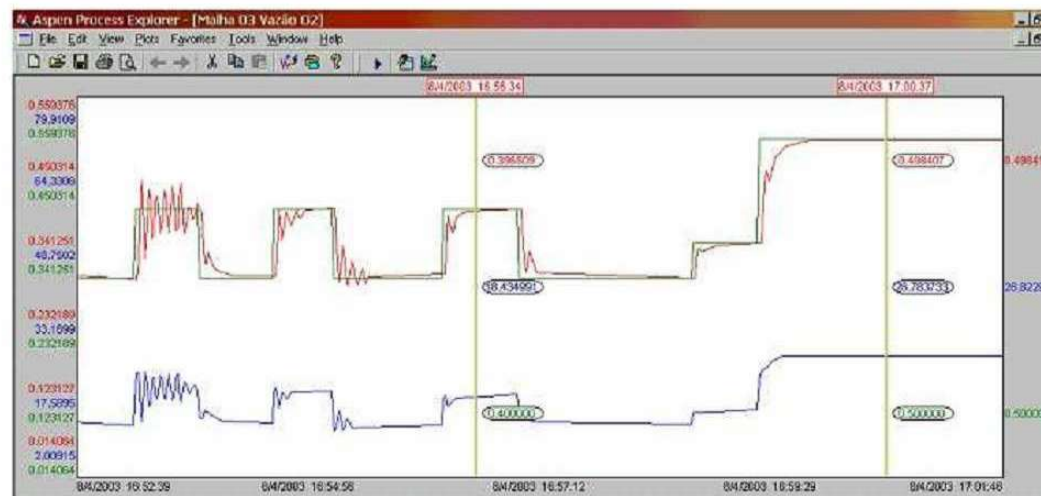
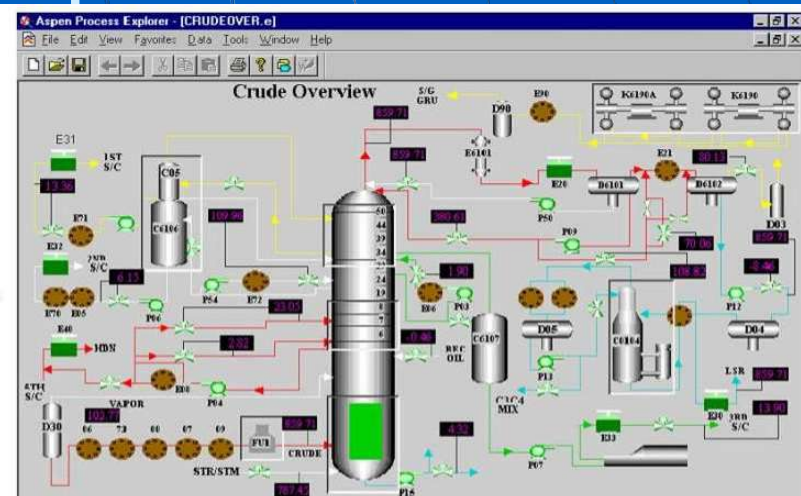
Acionamento analógico



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



Arquitetura típica de um PIMS



LAR

# Sistemas Inteligentes

**Prof. Adolfo Bauchspiess**



# O que está acontecendo? 29jan2025



HashStudioz Technologies  
DeepSeek AI Overview: Shaking Up C...



Start Smarter  
DeepSeek vs. ChatGPT: How AI T...



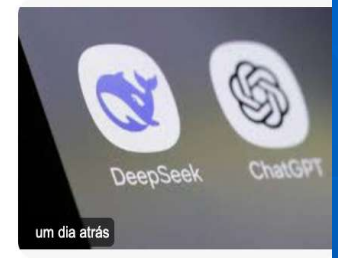
Forbes  
DeepSeek Hype Vs. Nvidia A...



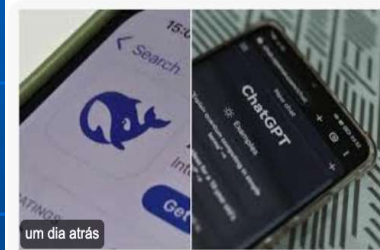
The Economic Times  
Deepseek chinese chatgpt: ...



MSN  
DeepSeek vs ChatGPT and NVIDIA: ...



Nikkei Asia  
DeepSeek crashes Nvidia stock with ...



Moneycontrol  
DeepSeek vs ChatGPT: How the Chinese AI c...



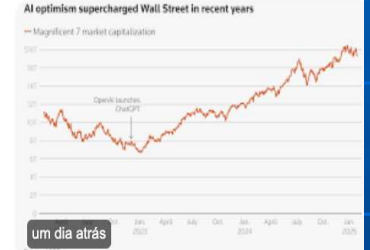
The Economic Times  
DeepSeek vs OpenAI: How China's A...



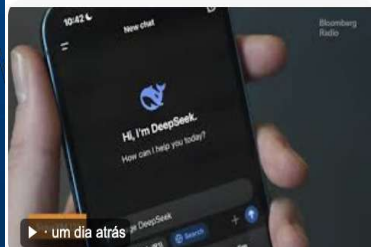
The Indian Express  
DeepSeek sparks AI stock selloff; Nvidia post...



Mint  
No Nvidia supercomputers needed: Deep...



Reuters  
DeepSeek sparks AI stock selloff; Nvidia ...



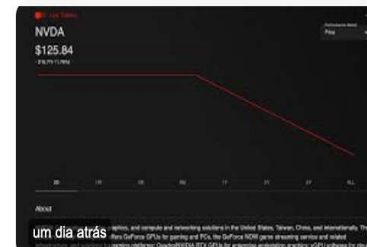
YouTube  
Nvidia Stock Beaten Down Due to DeepSe...



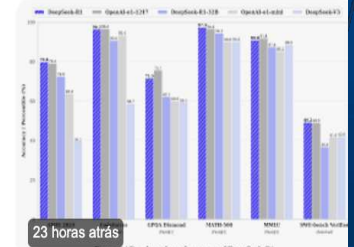
MSN  
DeepSeek vs ChatGPT and NVIDIA: Makin...



YouTube  
DeepSeek Obliterates Nvidia's Stock! Is \$N...



Medium  
Don't Be an Idiot and Sell NVIDIA Because...



Seeking Alpha  
Nvidia Stock: Buy The DeepSeek Fear ...



# Time Line - The 3<sup>rd</sup> AI Wave

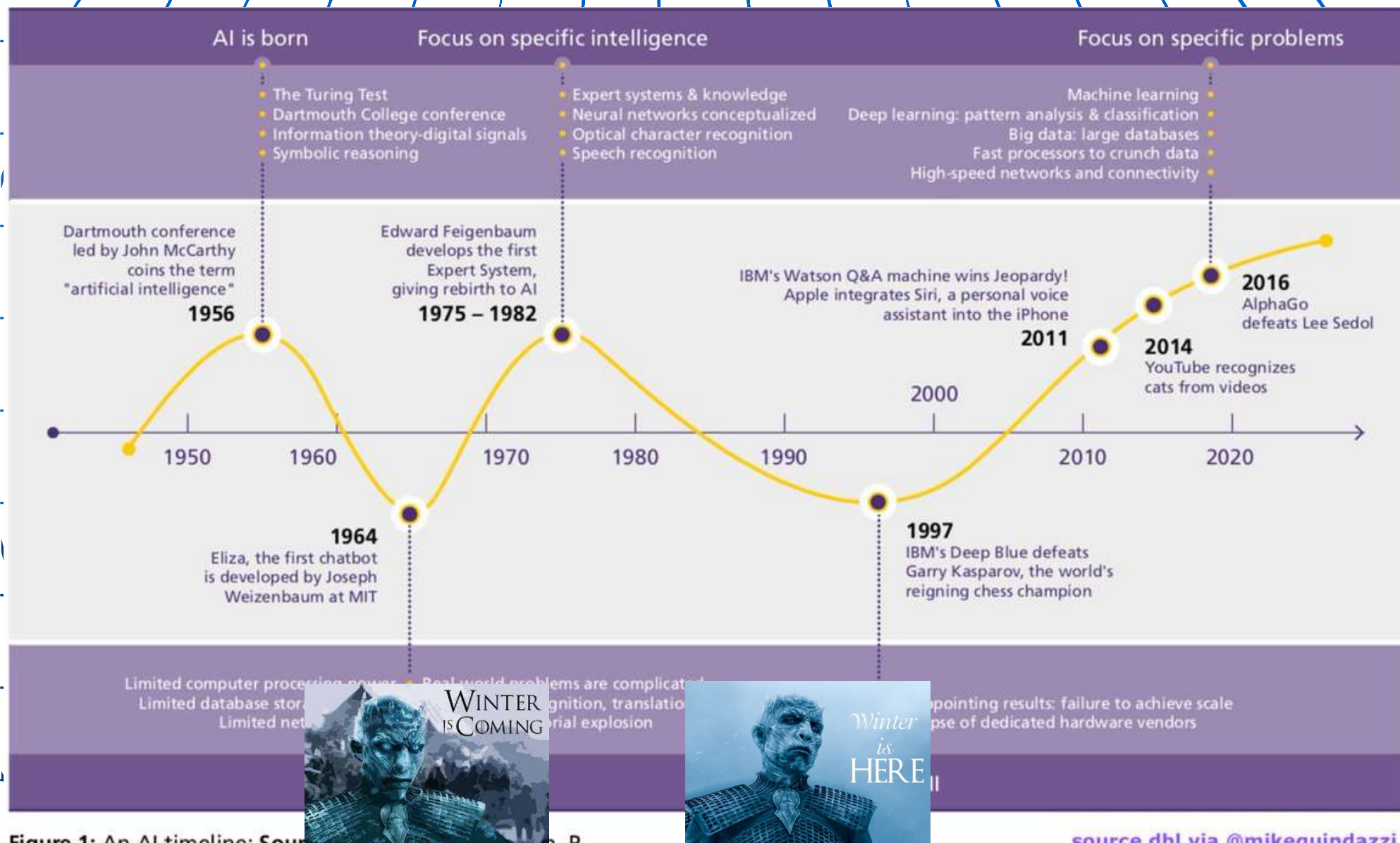


Figure 1: An AI timeline; Source: Laverda, D./Marsden, P.

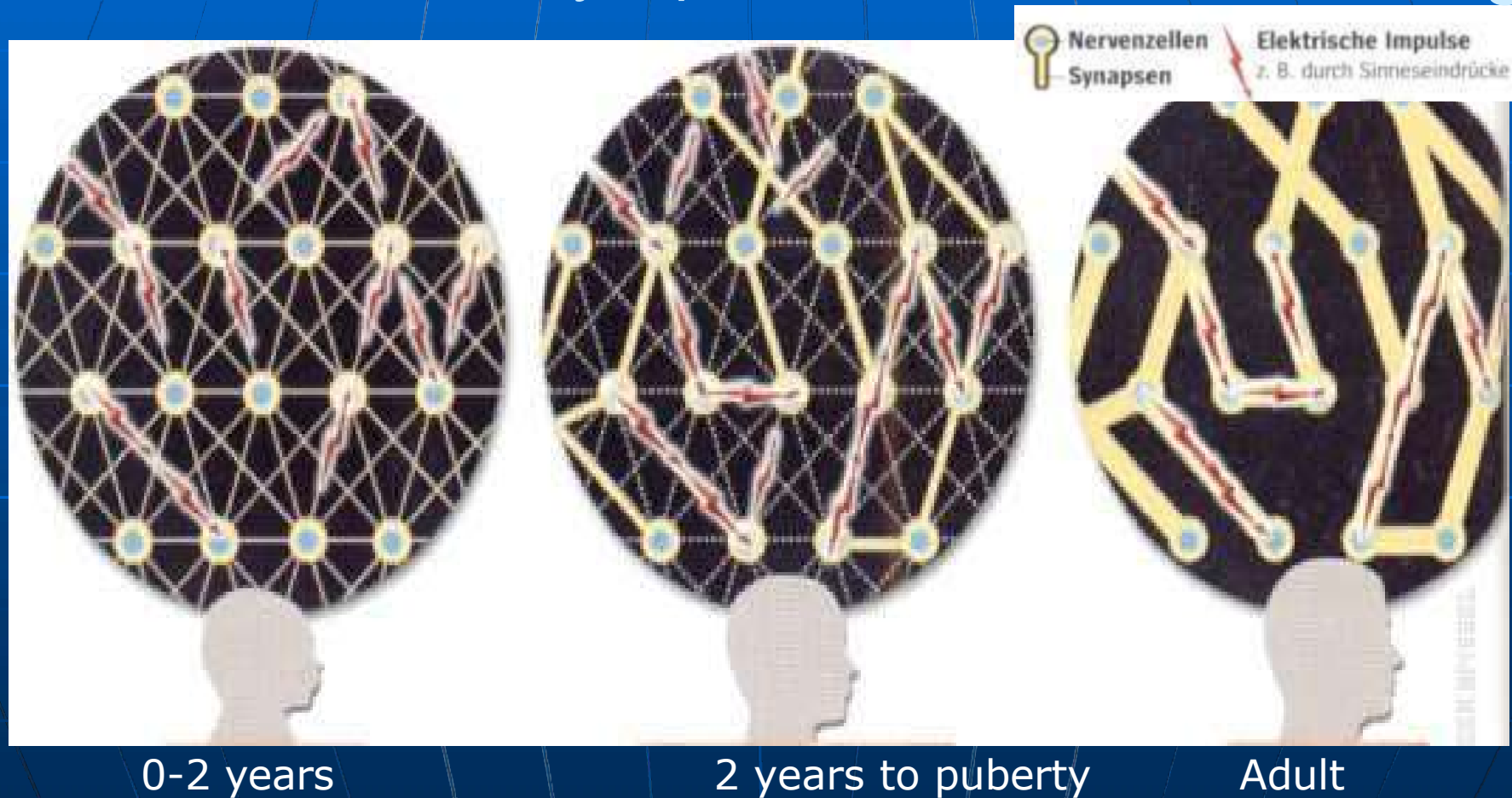
source dhl via @mikequindazzi

# The Deep Learning Superheros



# Intelligent Systems

- Brain as the model !! Neuron  
Synaptic Connections - Learning!



# From Natural Intelligence to Artificial Intelligence

## Ex. – Dislexia?

I cnduo't byleiee taht I culod aulacly uesdtannrd waht I was rdnaieg. Unisg the icndeblire pweor of the hmuan mnid, aocdcnig to rseecrah at Cmabrigde Uinervtisy, it dseno't mttar 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?



# Antipathic?



31

- **Incomplete pattern -**  
**Brain Interpolation!**
- Perception



The Kanizsa square, 1976

# Living connected - IoT



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

# 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](https://www.nstda.or.th/nac/2019/images/seminar/26_Smartcity_passakorn.pdf)



# Future Smart City (?)



© Vincent Callebaut/Solent News

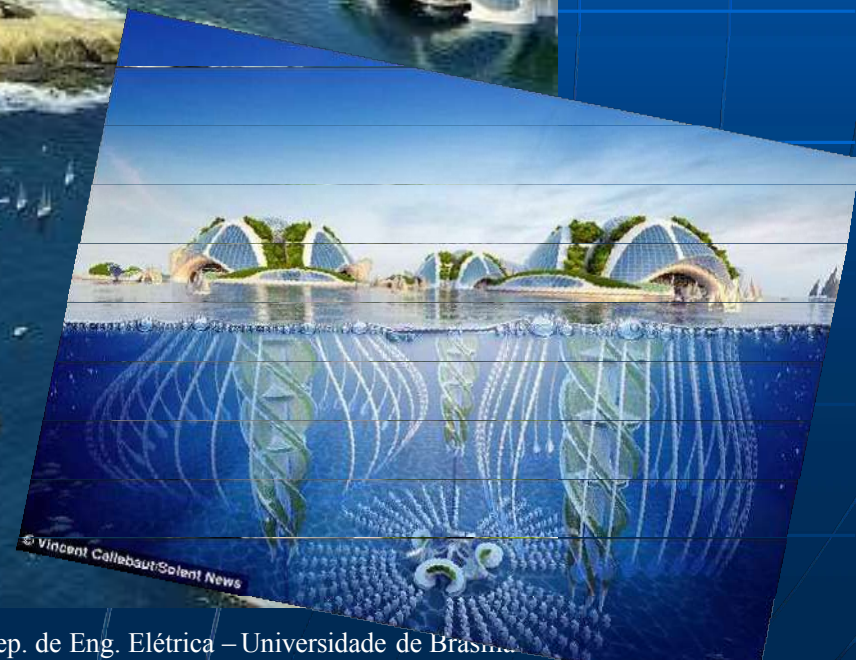


A. Bauchspiess - Laboratório de Automação e Robótica, Dep. de Eng. Elétrica – Universidade de Brasília



© Vincent Callebaut/Solent News

@Pinterest



© Vincent Callebaut/Solent News

# Future Smart City (?)



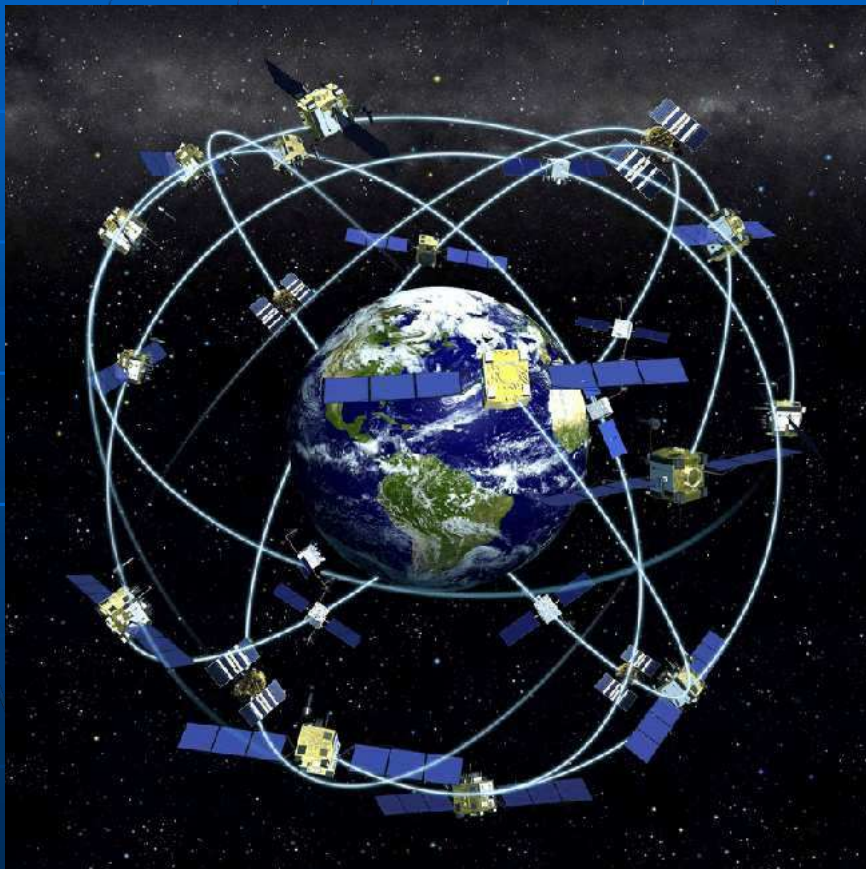
@Pinterest



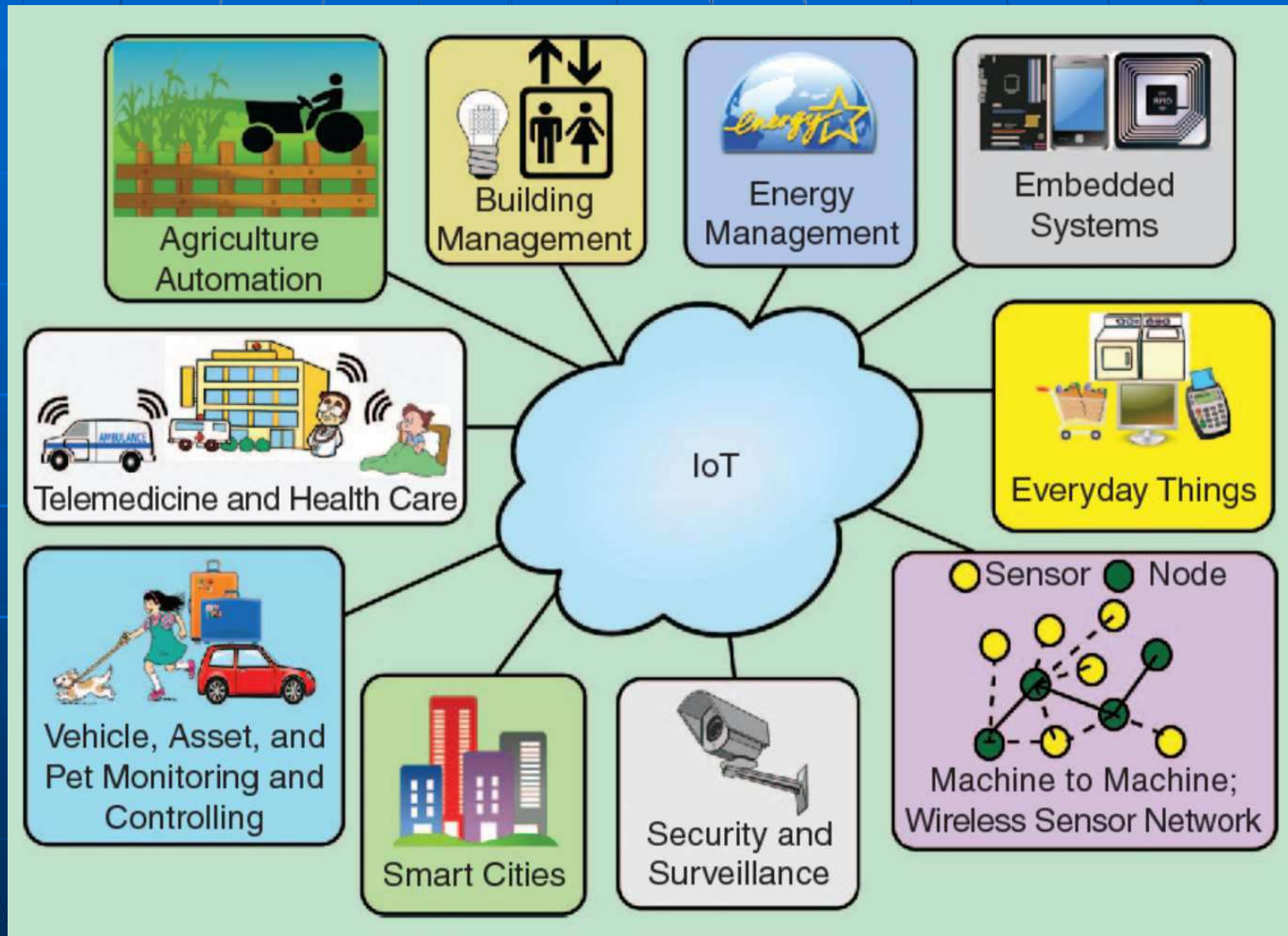
A. Bauchspiess - Laboratório de Automação e Robótica, Dep. de Eng. Elétrica – Universidade de Brasília - Brasil

# GPS + GIS

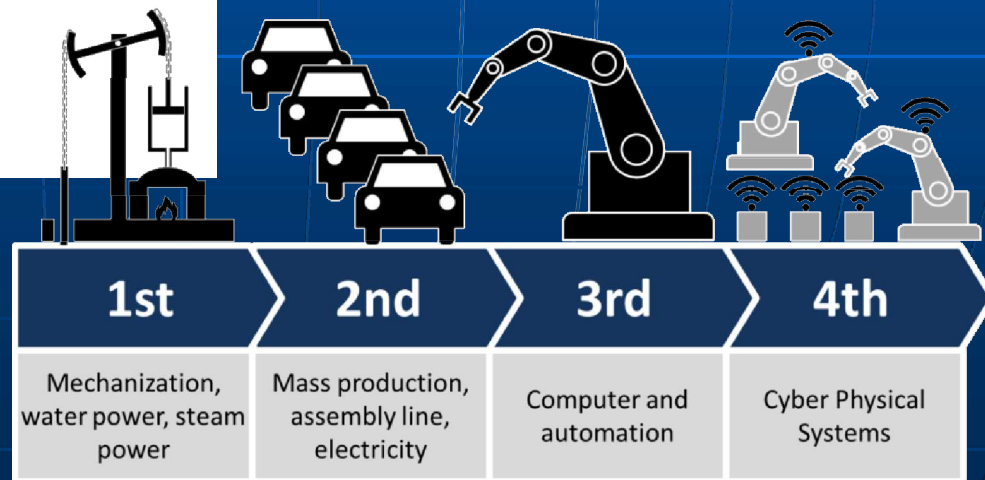
- Global Positioning System
- Geographical Information System



# IoT Internet of Everything

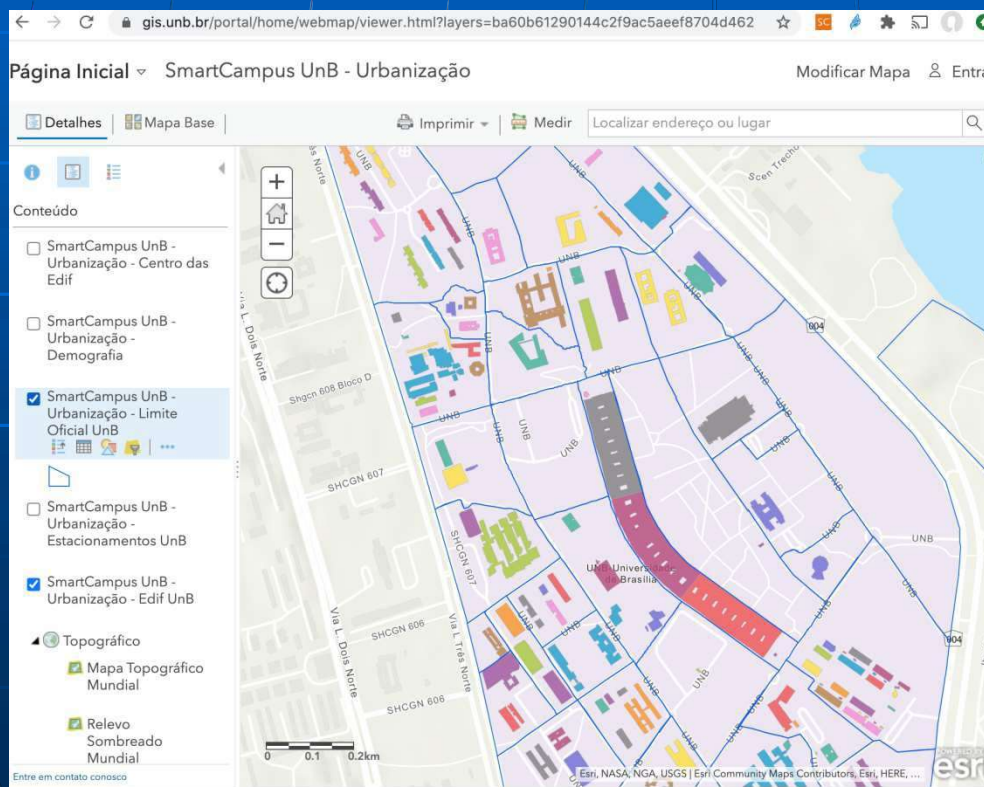


# Cyber-Physical Systems



# GPS + GIS + CPS .....> CyberGIS

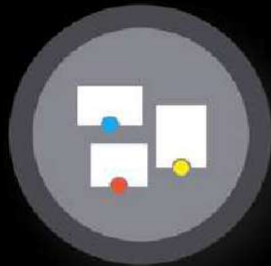
- CPS - Cyber-Physical Systems



# THE 4 STAGES OF IOT MATURITY



Monitoring



Control



Optimization



Autonomous



[https://www.slideshare.net/mazlan1/introduction-to-iiot-smart-city/18-FUNCTIONAL\\_VIEW\\_OF\\_IOTTECHNOLOGIES](https://www.slideshare.net/mazlan1/introduction-to-iiot-smart-city/18-FUNCTIONAL_VIEW_OF_IOTTECHNOLOGIES)

M

C

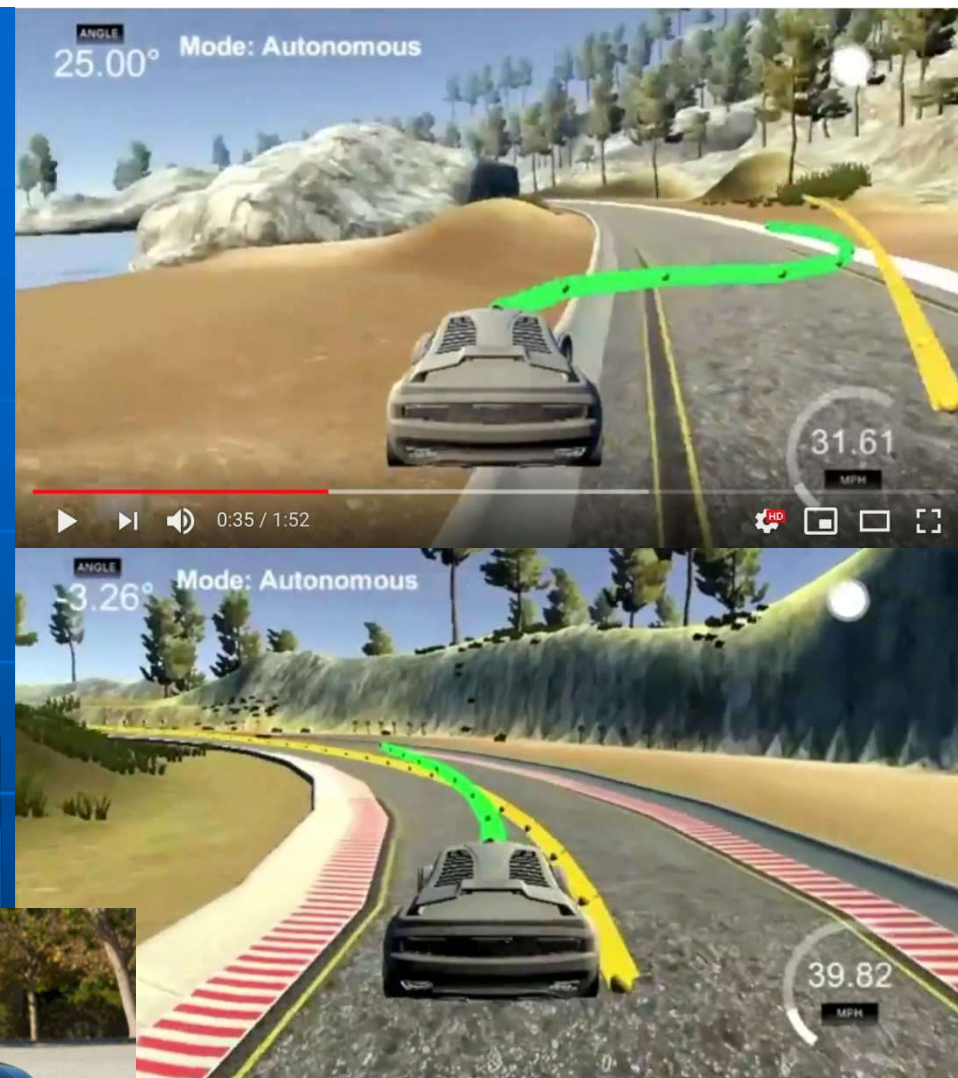
O

A



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

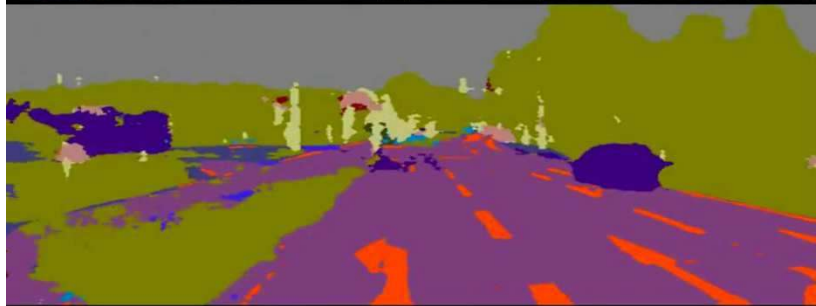
# Model Predictive Control – Udacity Self-Driving Car



<https://www.youtube.com/watch?v=r14LI3Jycbw>



# RL – Examples: Self Driving Cars



L. Lane Radius: 4.74km  
R. Lane Radius: 1.09km  
C. Position: -0.40m  
Close Vehicles: 2



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

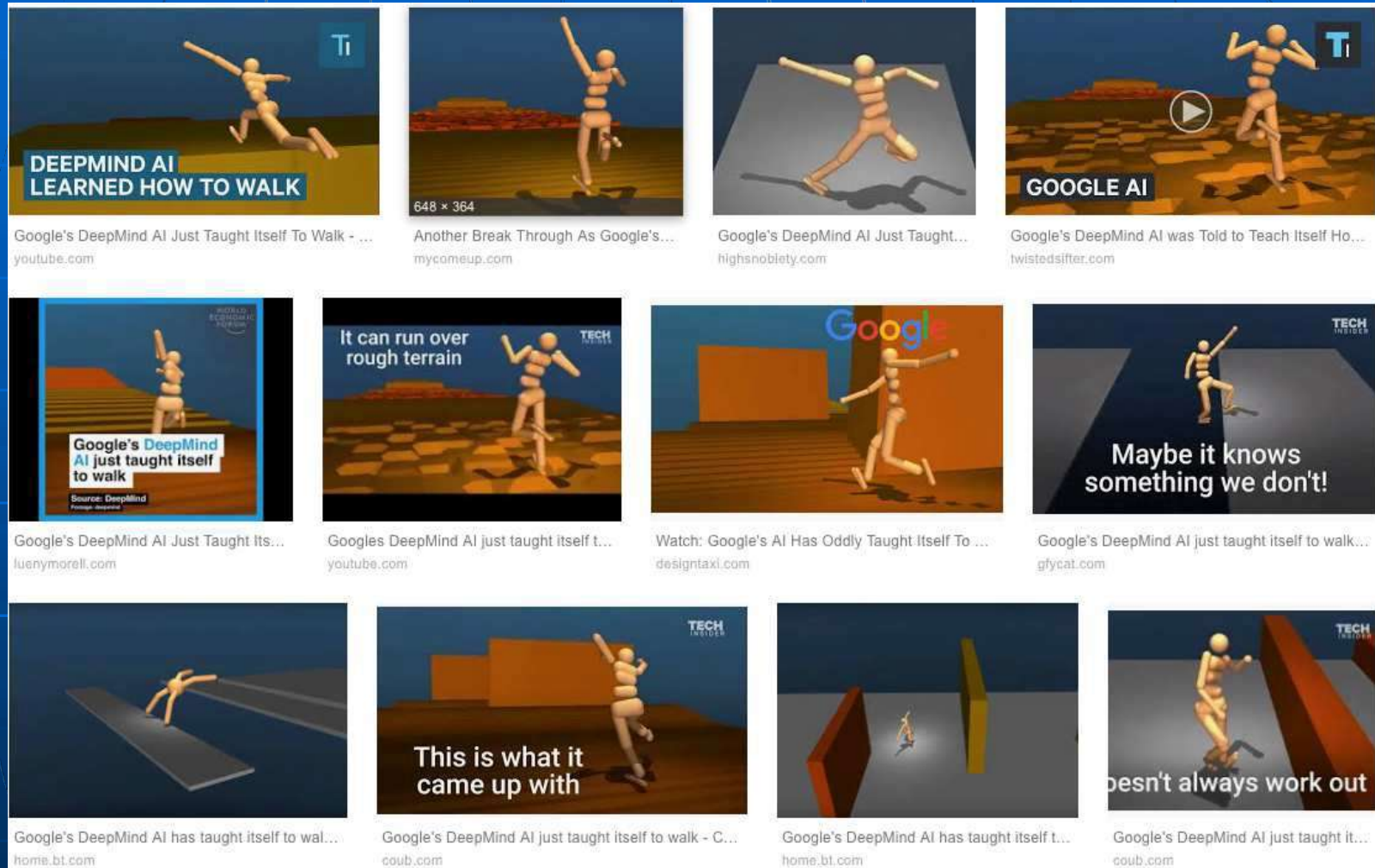
<https://www.youtube.com/watch?v=kMMbW96nMW8>

Deep Learning:  
Technology behind self-driving cars  
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

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

5 5.455 vis. 12/jul/2017

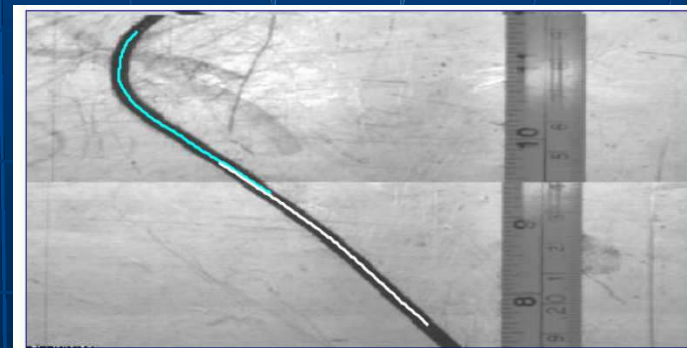
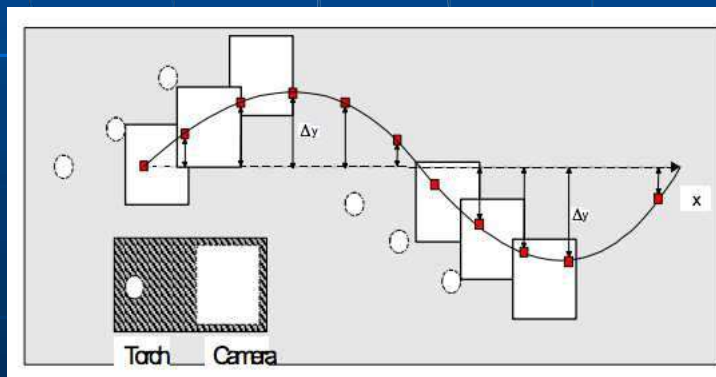
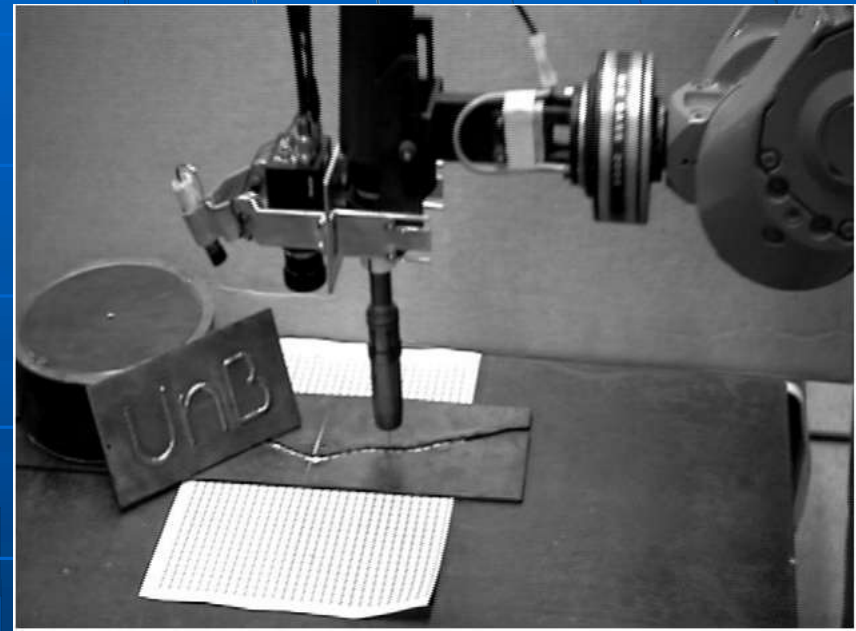


# Alguns Projetos de Pesquisa

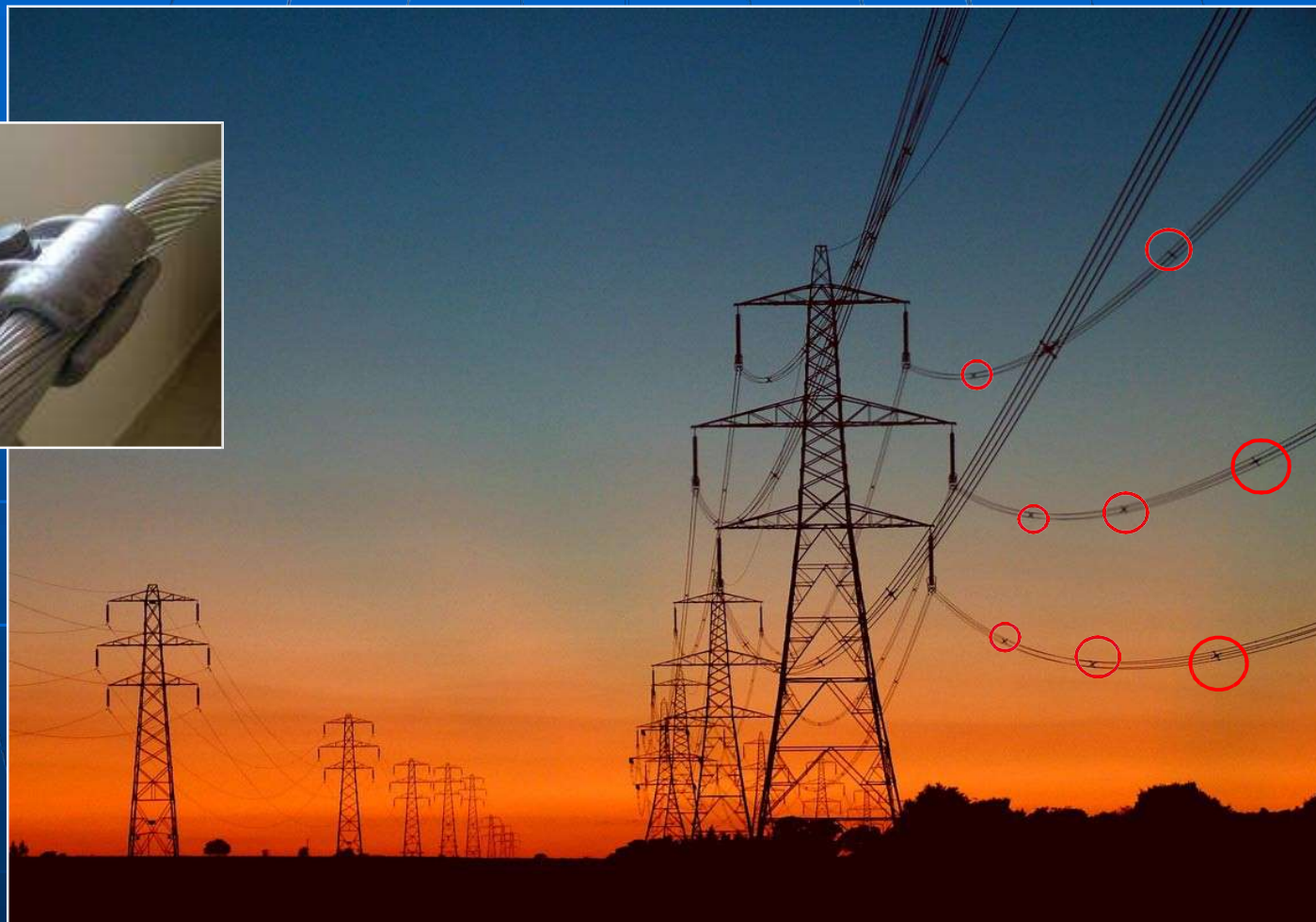
**Prof. Adolfo Bauchspiess**



# 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

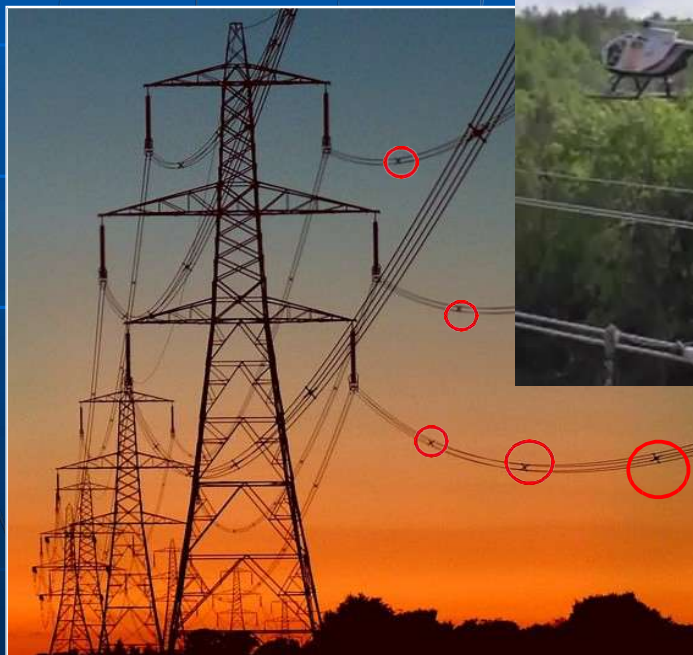


# UAV – LARA/UnB



# Inspection of Transmission Lines

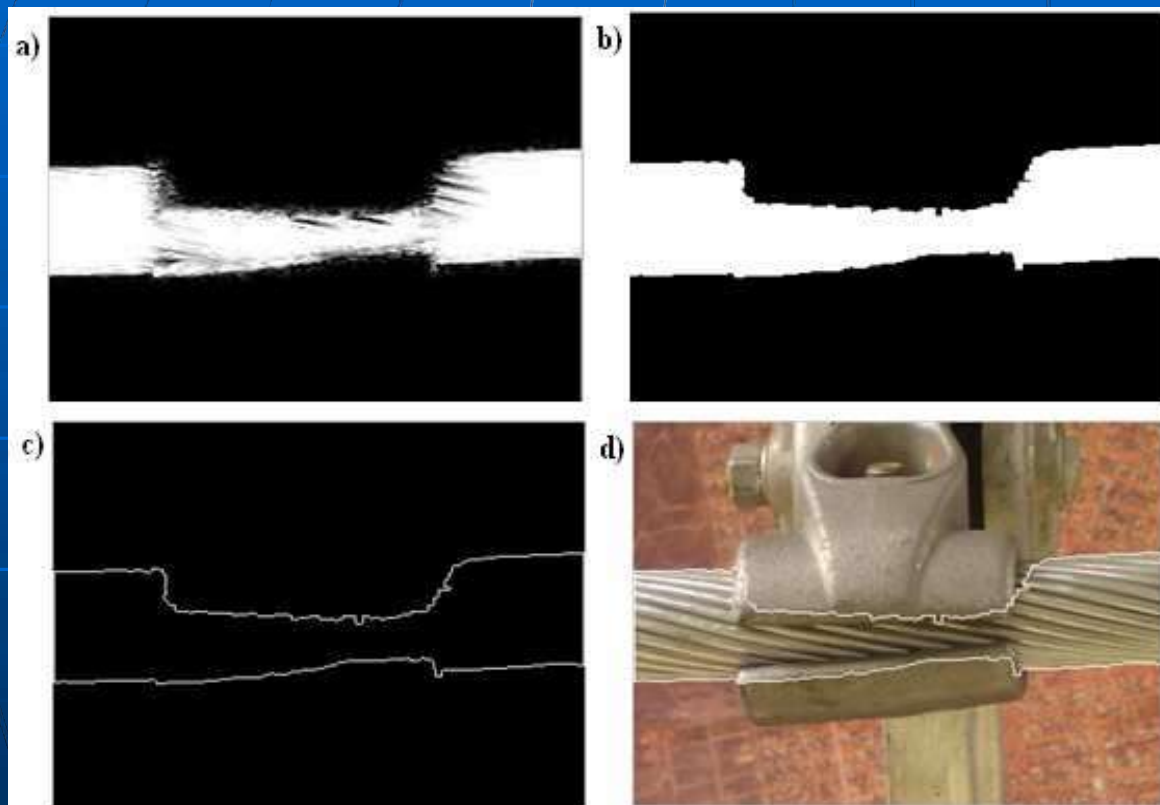
- Autonomous system - visual inspection of electricity transmission lines
- Detection of flaws in the gripper of the line spacers



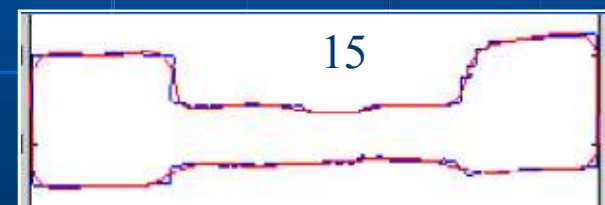
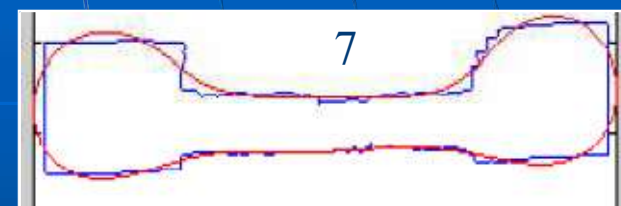
Need  
Maintenance!!



# Gripped cable contour: FFT coefficients of directional chains



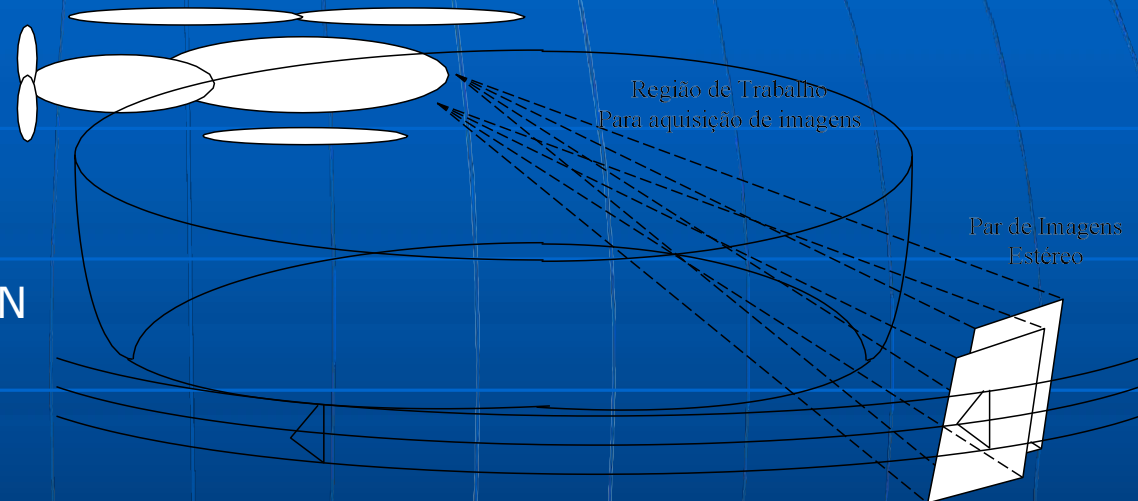
a) Gabor – b) Closing – c) Border – d) Image



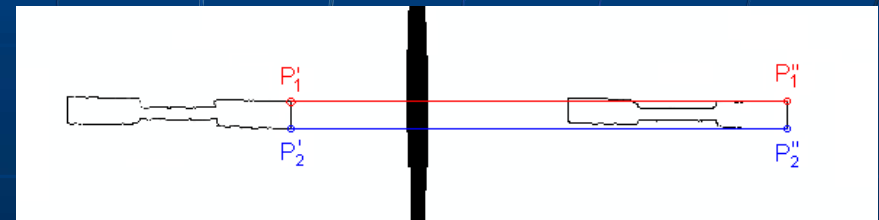
Reconstruction -  
7 and 15 Harmonics

# 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



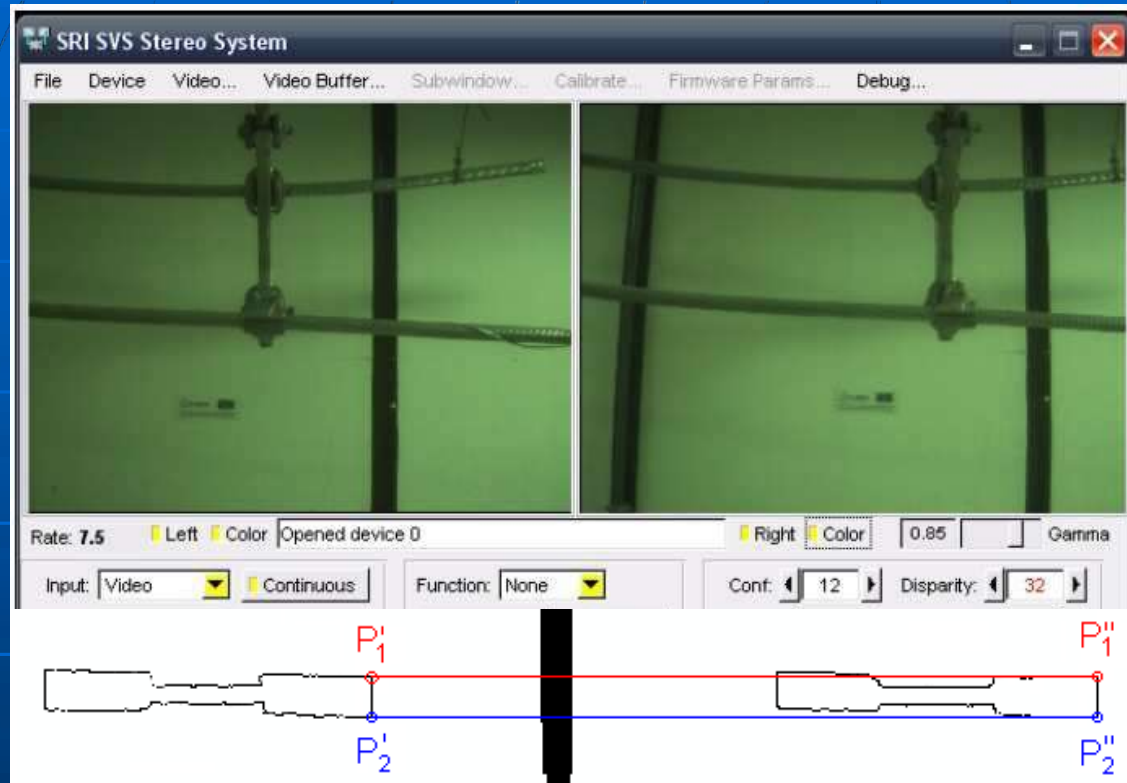
Different ROI's



Correspondence –ROI contour in stereo pair



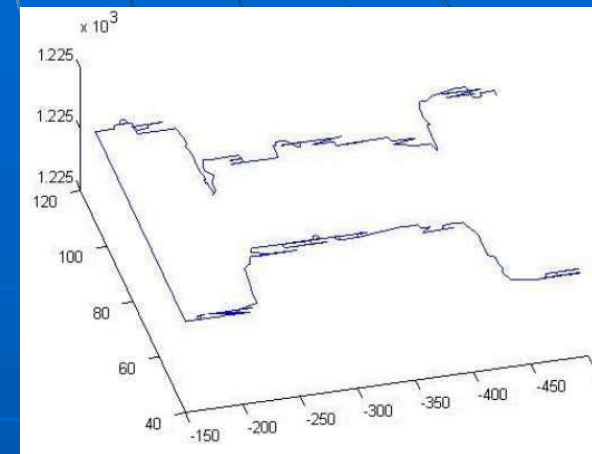
# 3D gripped cable



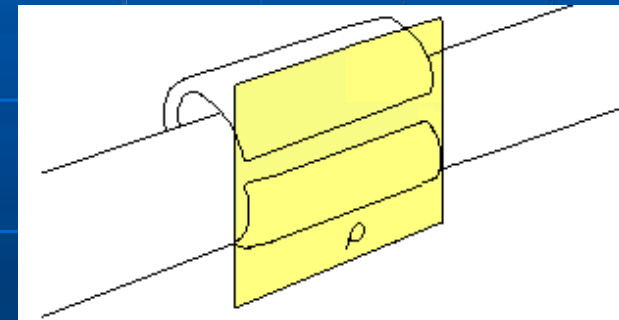
Results:

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

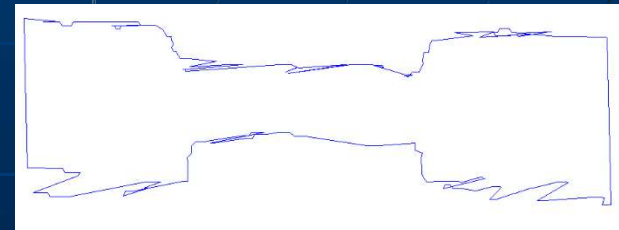
## 3D Reconstruction



## ANN data bank Image plane



## Reprojected contour for ANN



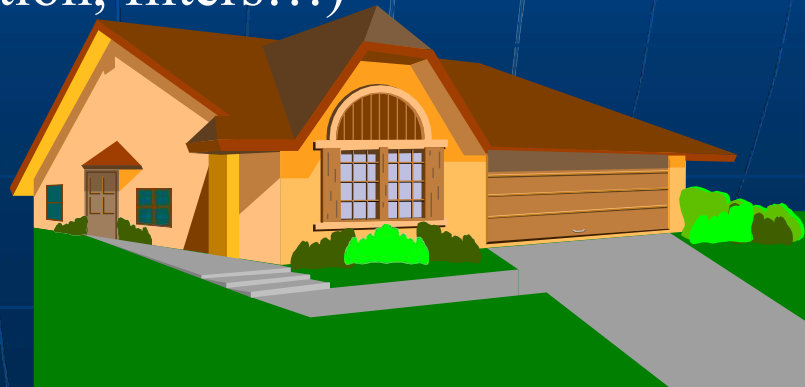
# Automação Predial

**Prof. Adolfo Bauchspiess**



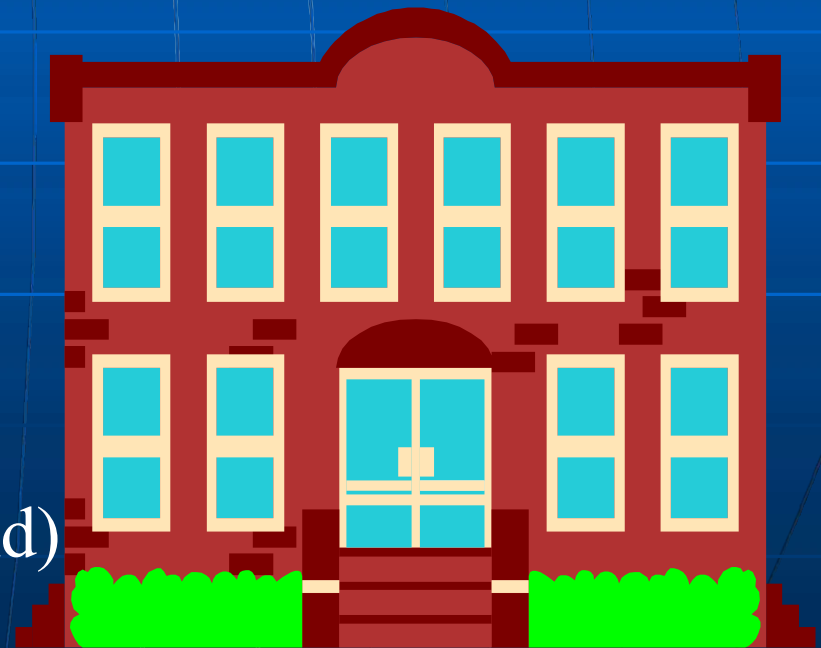
# Building Automation- Objectives

- Access Control
- Fire Detection
- Comfort (Productivity)
  - temperature, humidity,... (PMV)
  - illumination,
  - waiting time for elevators, ...
- Health issues
  - air quality (renovation, filters...)
  - CO<sub>2</sub>
- **Energy Saving**



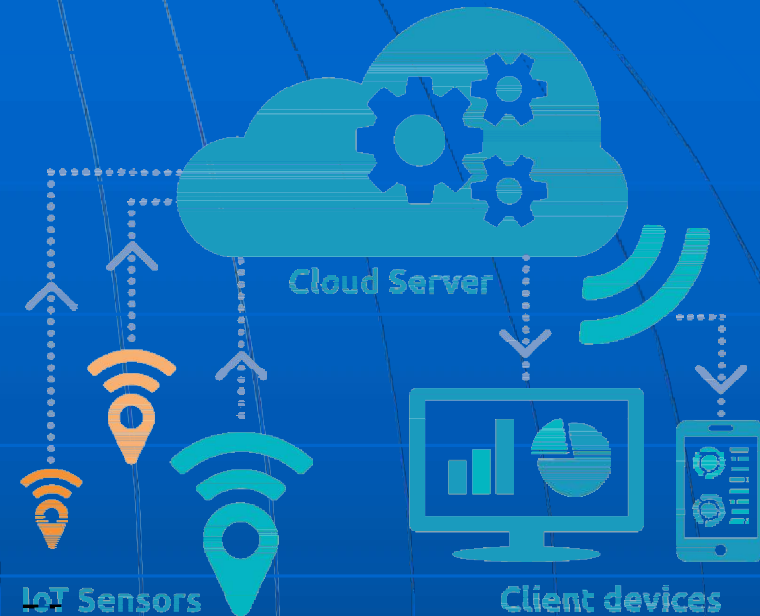
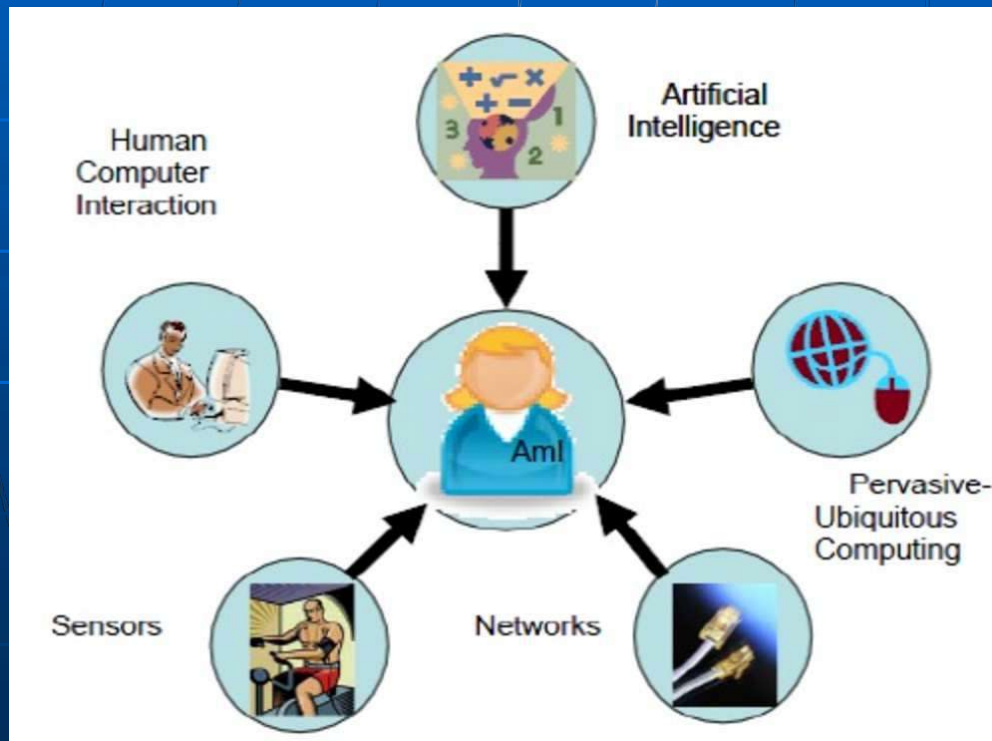
# Building Automation- Technologies

- 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 network, 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



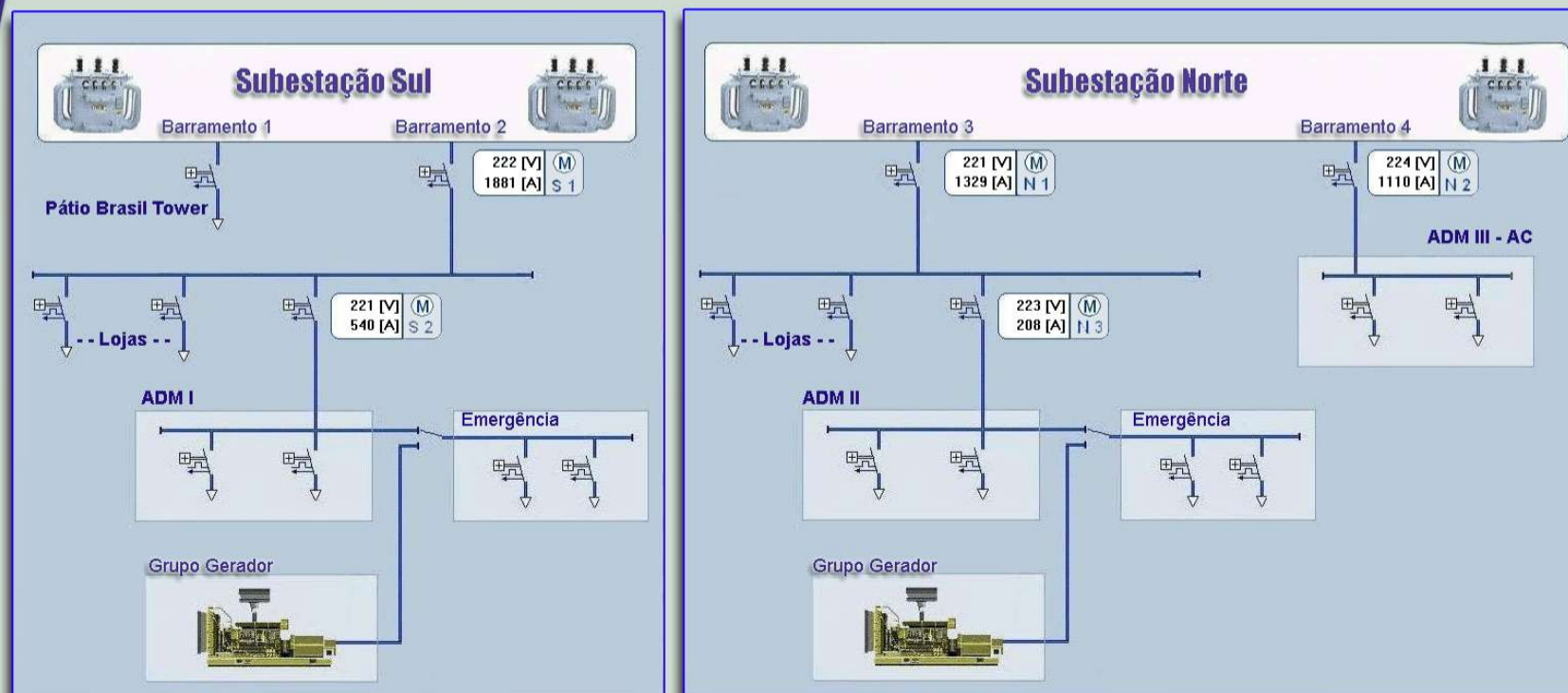
- ✓ HVAC
- ✓ Illumination
- ✓ Fire
- ✓ Energy
- ✓ Generator Group
- ✓ CFTV
- ✓ Access Control
- ✓ Elevators/Escalators
- ✓ ...



## Energia Elétrica - Circuitos Alimentadores

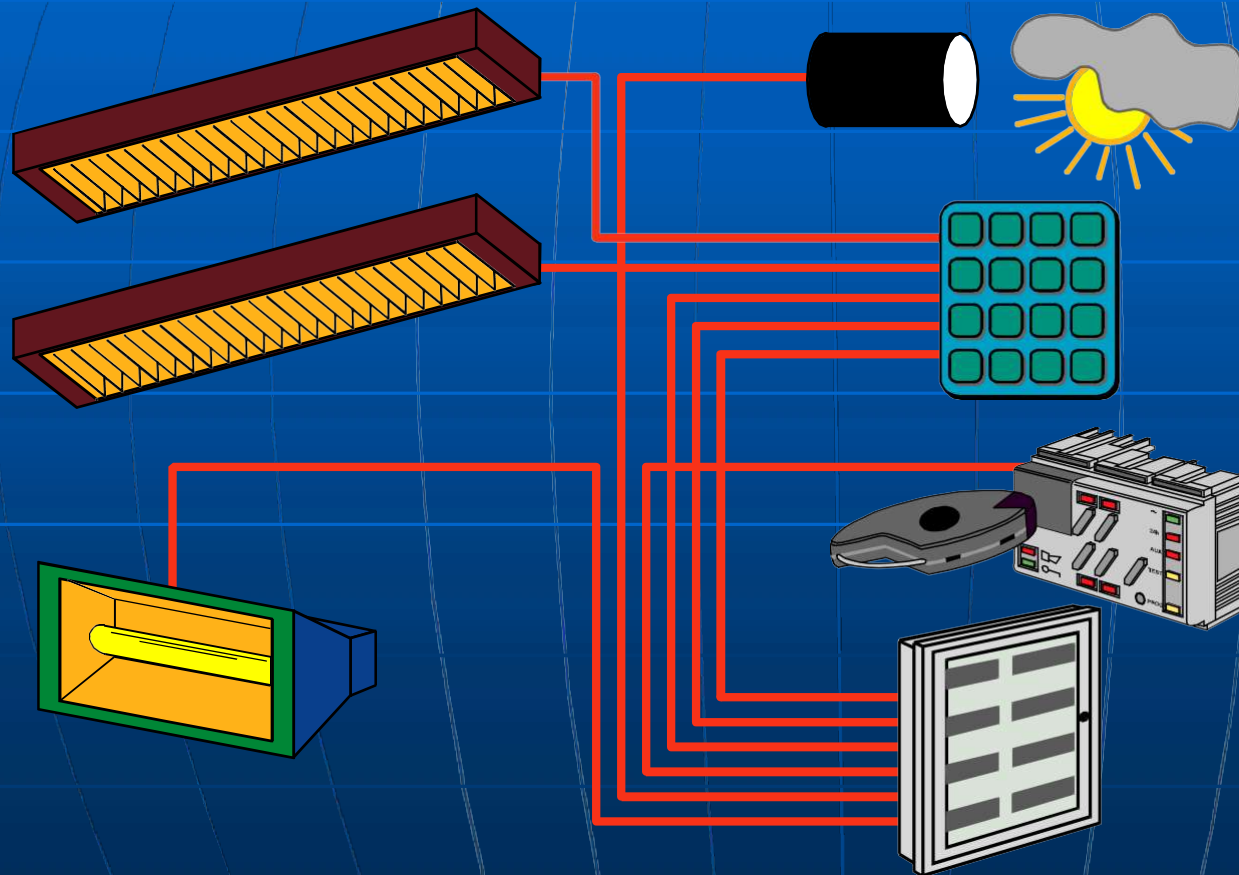


PRINCIPAL

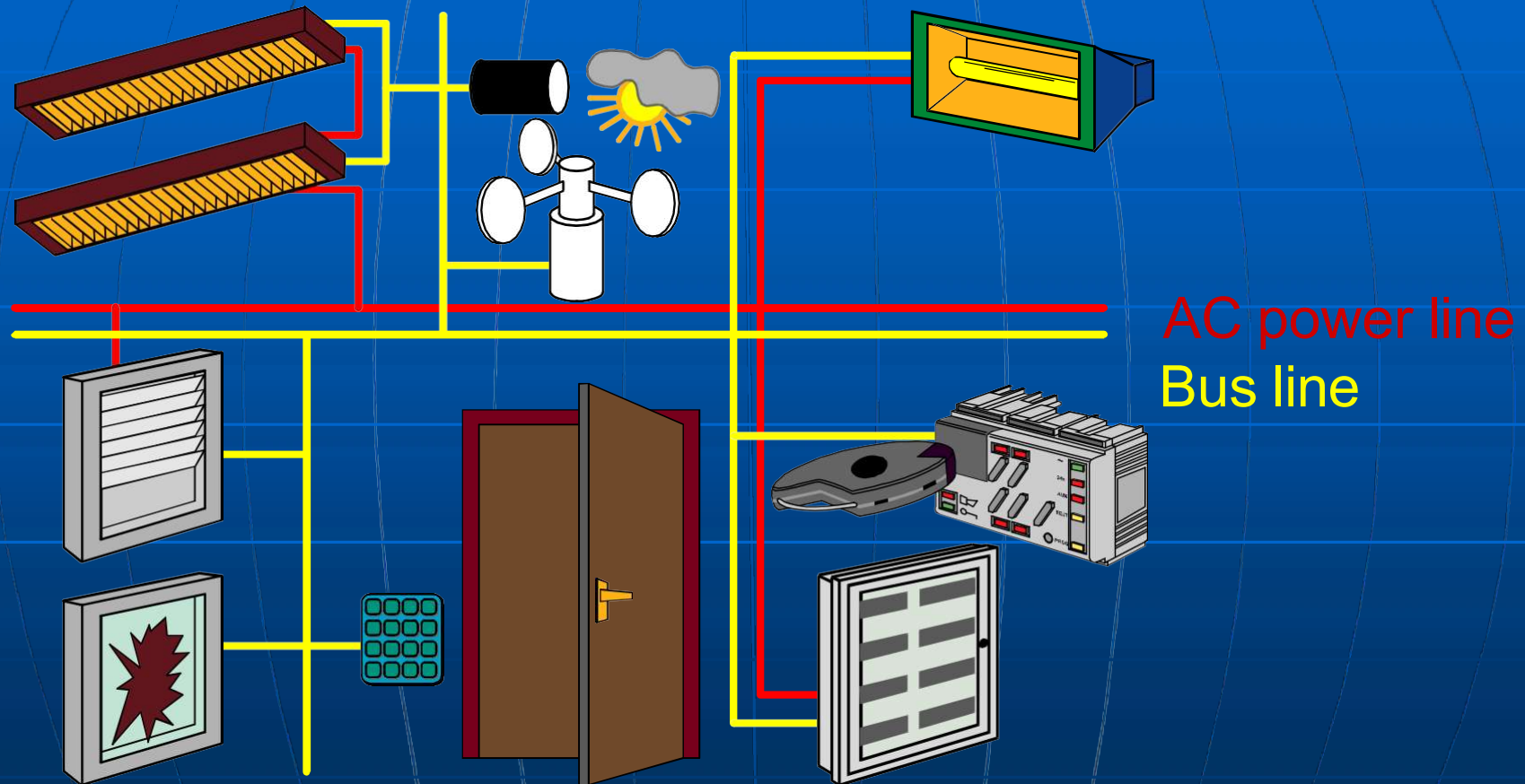


|        | Alimentador Sul - M S1 |      |      |        | ADM I - Medidor M S2 |     |      |        | Alimentador Norte - M N1 |      |      |        | ADM II - Medidor M N3 |     |      |        | ADM III (AC) - Medidor M N2 |      |      |        |
|--------|------------------------|------|------|--------|----------------------|-----|------|--------|--------------------------|------|------|--------|-----------------------|-----|------|--------|-----------------------------|------|------|--------|
|        | [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



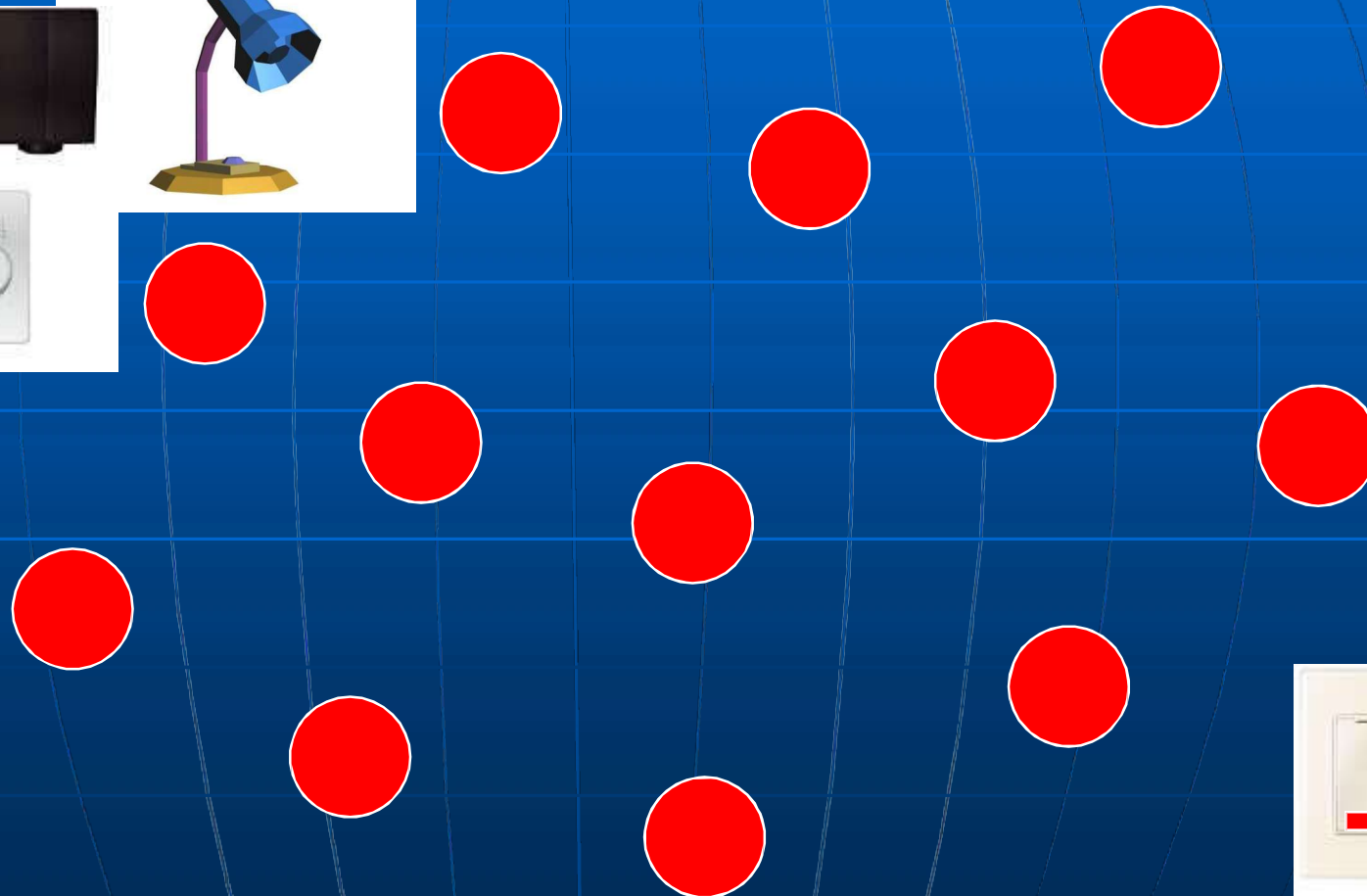
# Bus Connection



...wireless



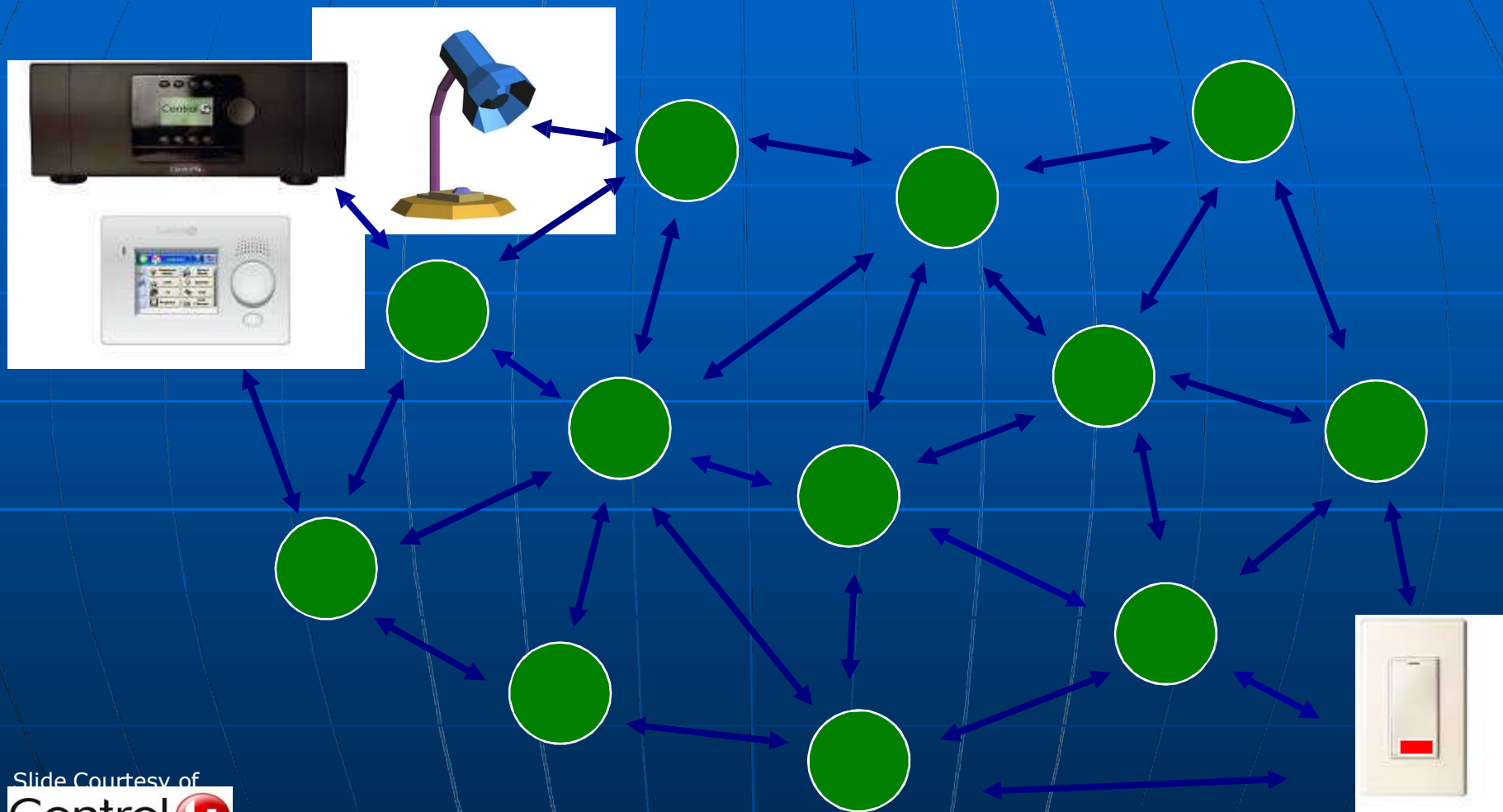
# ZigBee Mesh Networking



Slide Courtesy of  
**Control4**



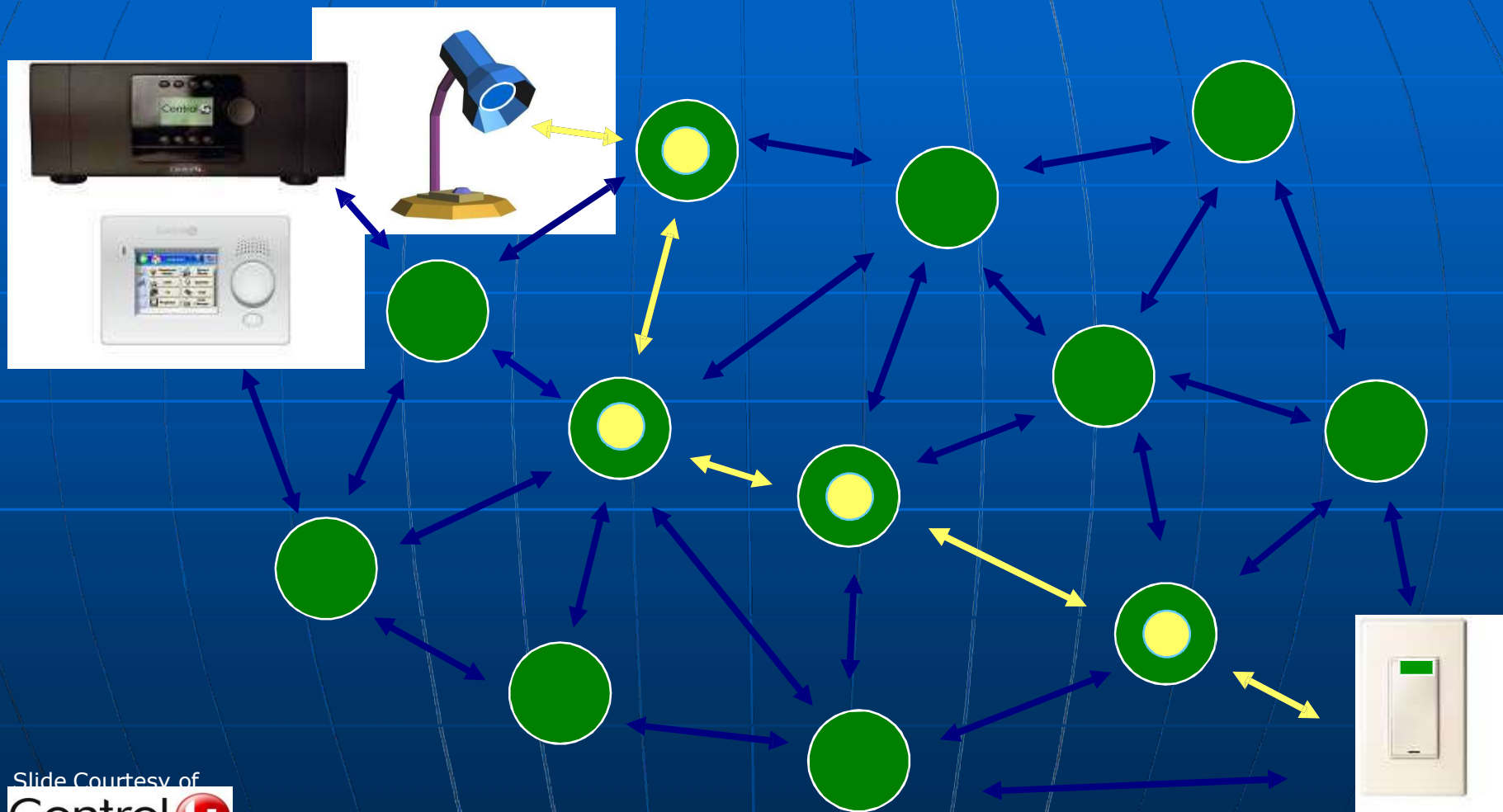
# ZigBee Mesh Networking



Slide Courtesy of  
**Control 4**



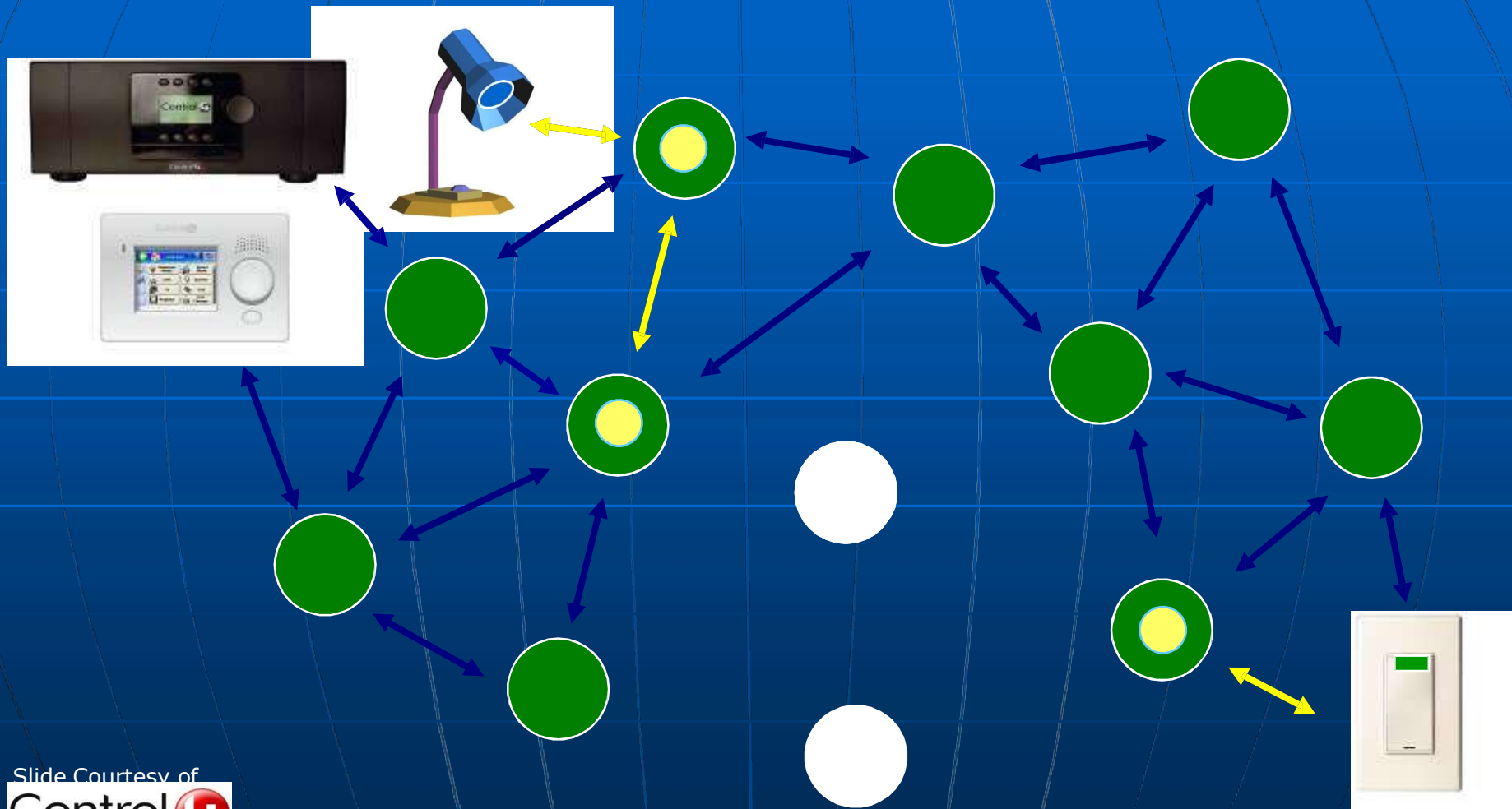
# ZigBee Mesh Networking



Slide Courtesy of  
**Control 4**



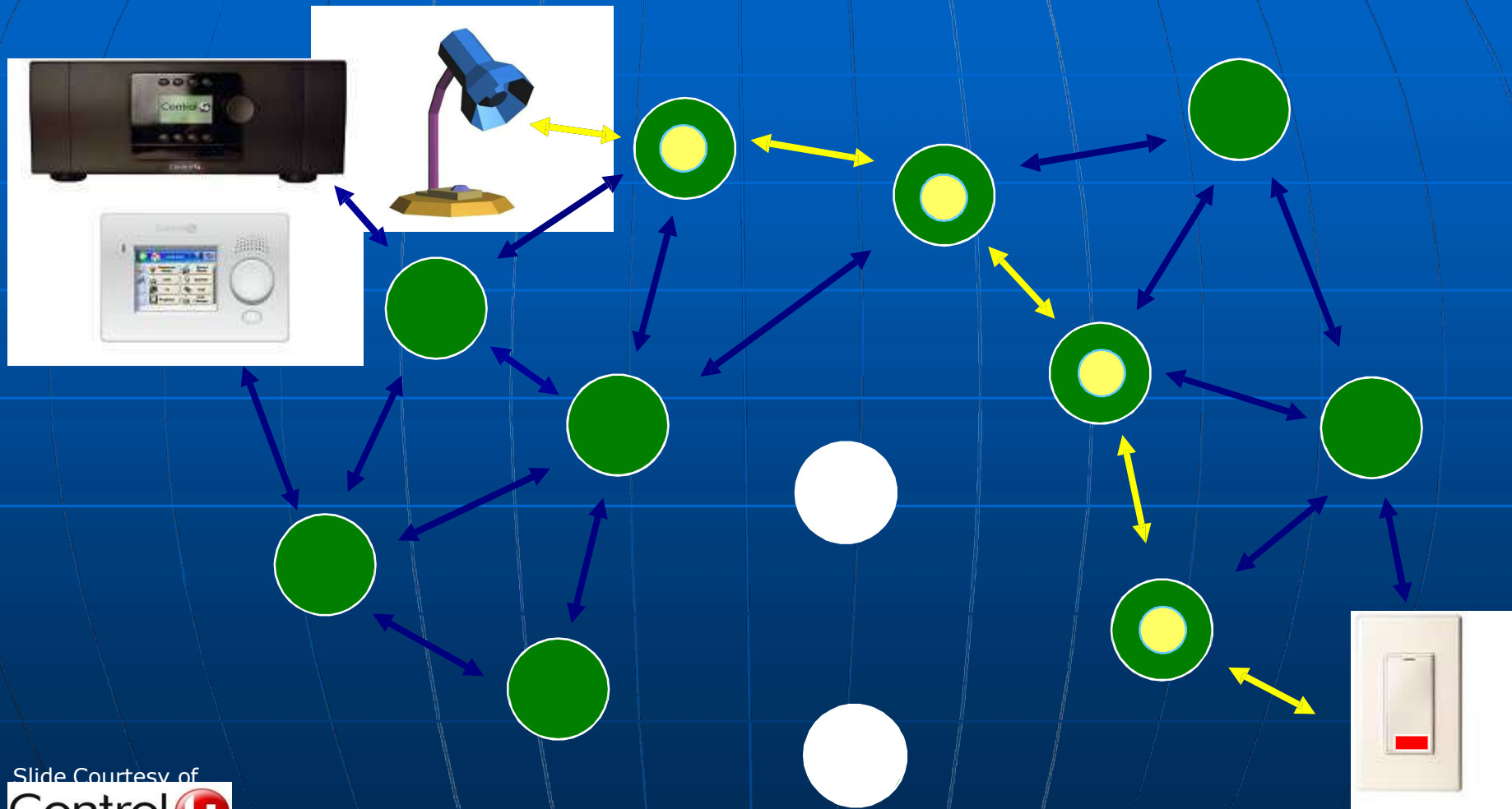
# ZigBee Mesh Networking



Slide Courtesy of  
**Control 4**



# ZigBee Mesh Networking

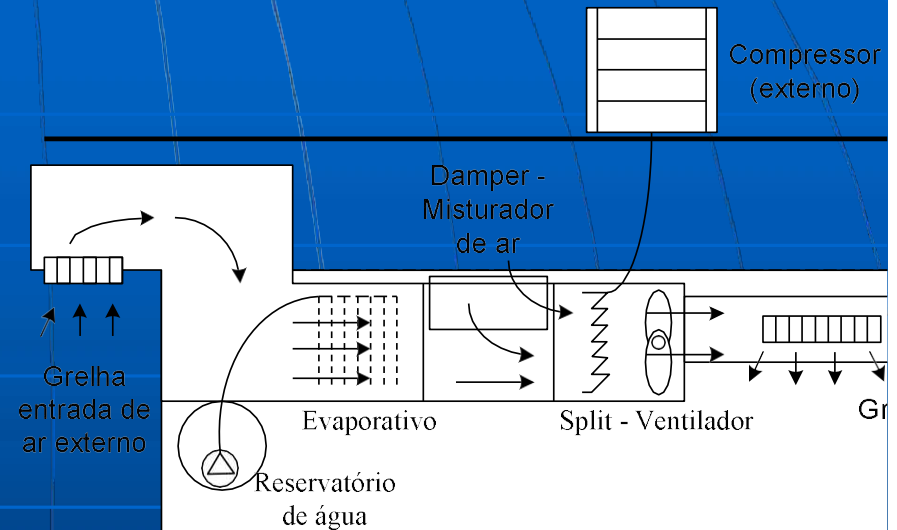
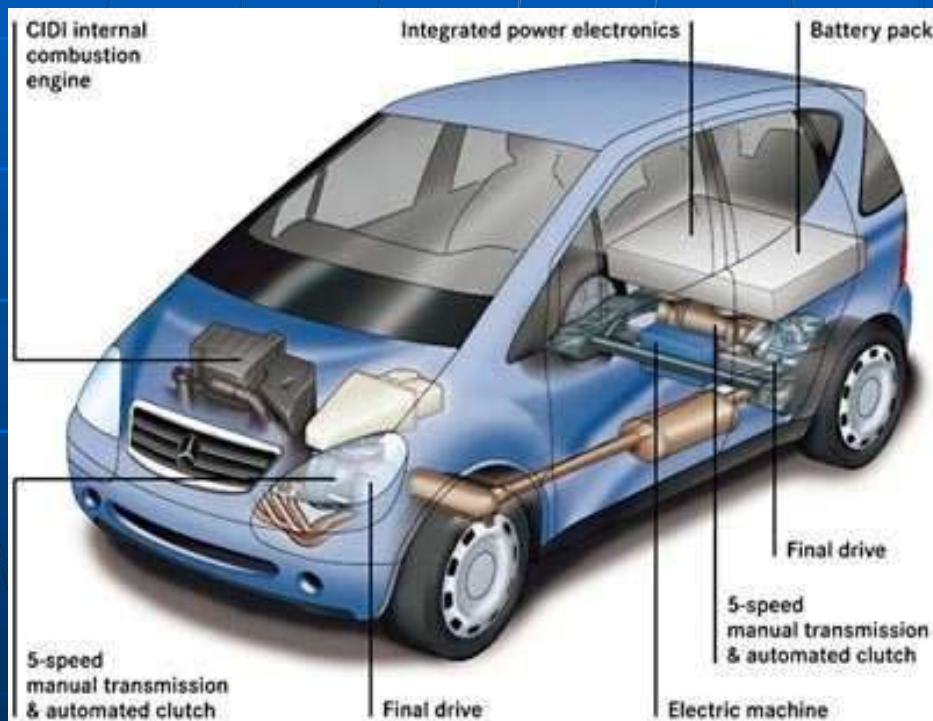


Slide Courtesy of  
Control 

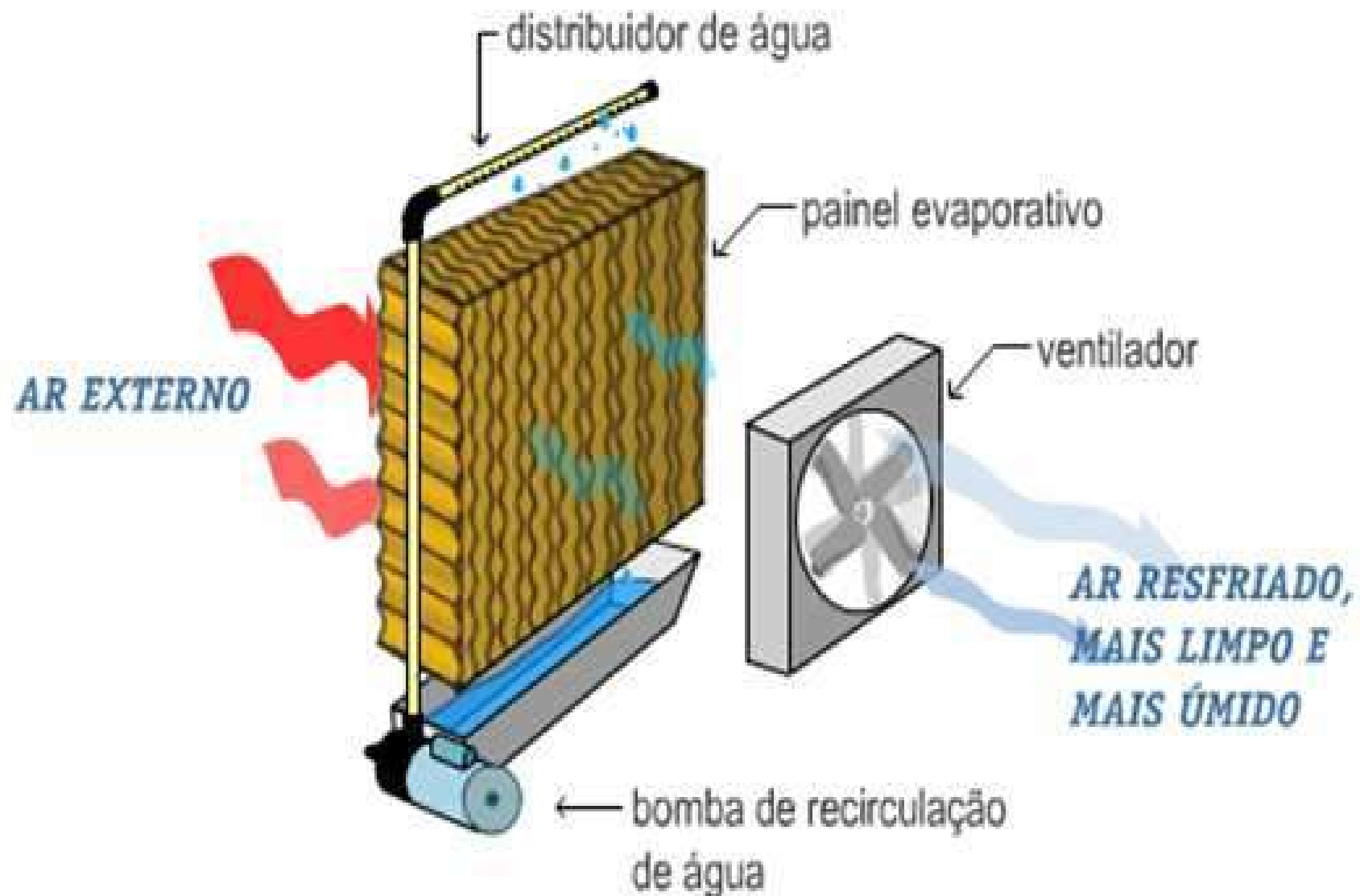


# Energy Saving: Hybrid Car

## Hybrid Air Conditioner

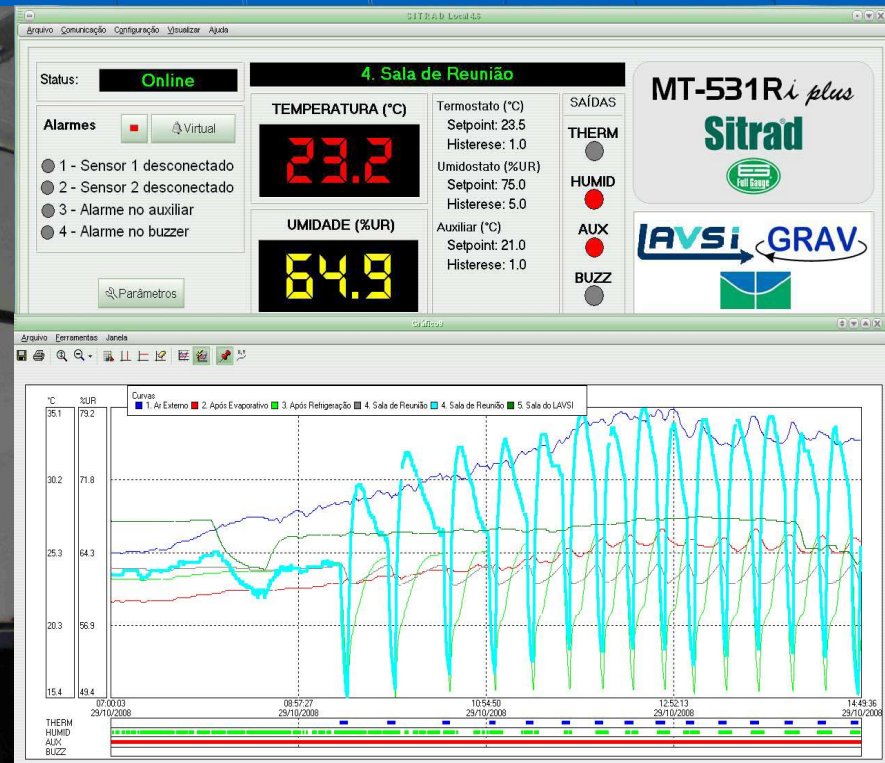


# Fundamentos – Resfriamento evaporativo

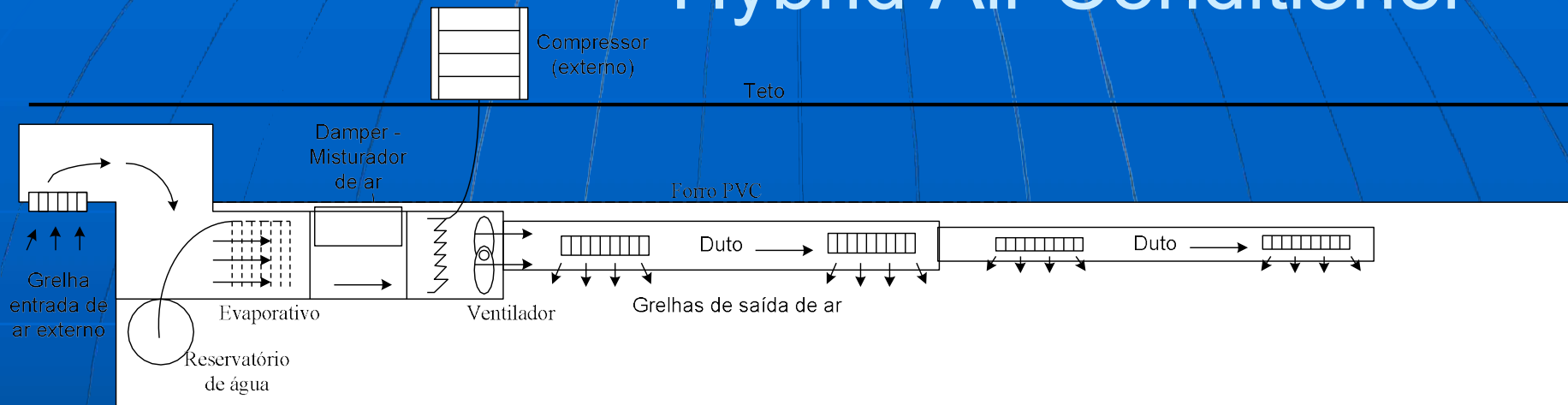


# Hybrid Climatization: Evaporative-Conventional

MSc José Luis Olmos Flores



# Hybrid Air Conditioner



# Análise de dados – Tela do Software Sitrad



# Resultados obtidos – Modo HIB - Temperatura

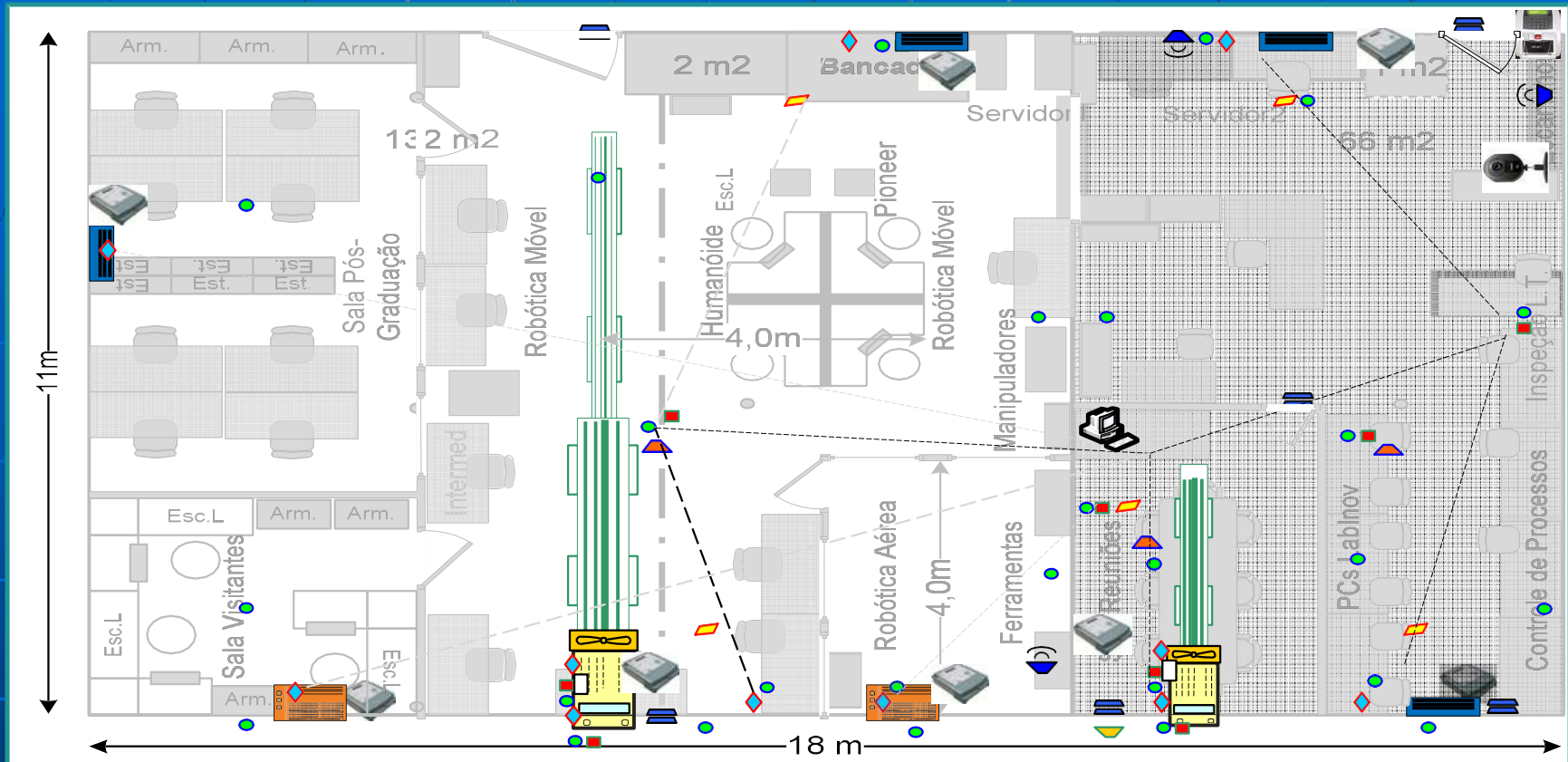


Curvas  
■ 1. Ar Externo ■ 4. Sala de Reunião ■ 5. Sala do LAVSI

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

| <b>Modo de Operação</b> | <b>Tempo operação Ventilador</b> | <b>Tempo operação Bomba</b> | <b>Tempo operação Compressor</b> | <b>Consumo total de Energia</b> | <b>Observações</b> |
|-------------------------|----------------------------------|-----------------------------|----------------------------------|---------------------------------|--------------------|
| 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         |  | Detector de Presença                |
|  | Sensor de Umidade             |  | Detector Porta/Janela aberta        |
|  | Anemômetro                    |  | Medidor de Energia                  |
|  | Sensor Radiação Térmica Média |  | Camera de Vigilância                |
|  | Piranômetro                   |  | Controle de Acesso                  |
|  | Atuador Ar Cond.              |  | BAS -<br>Building Automation System |



# “Green Buildings”



# “Green Buildings”

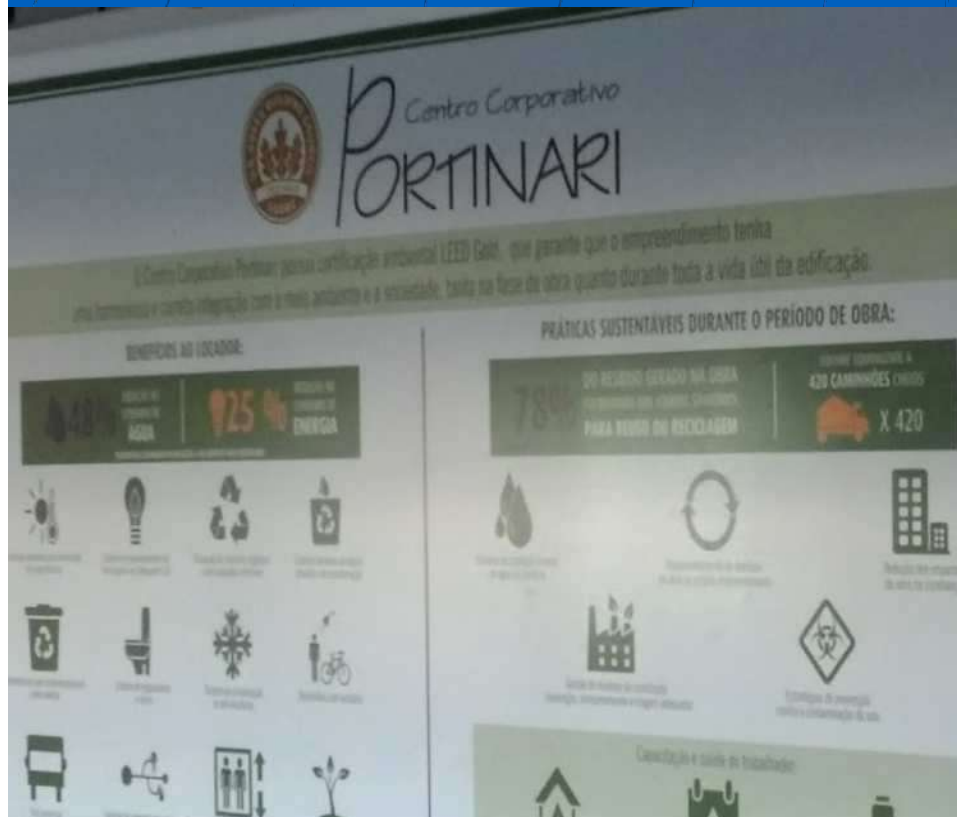


Basic Certification  
40 – 49 points

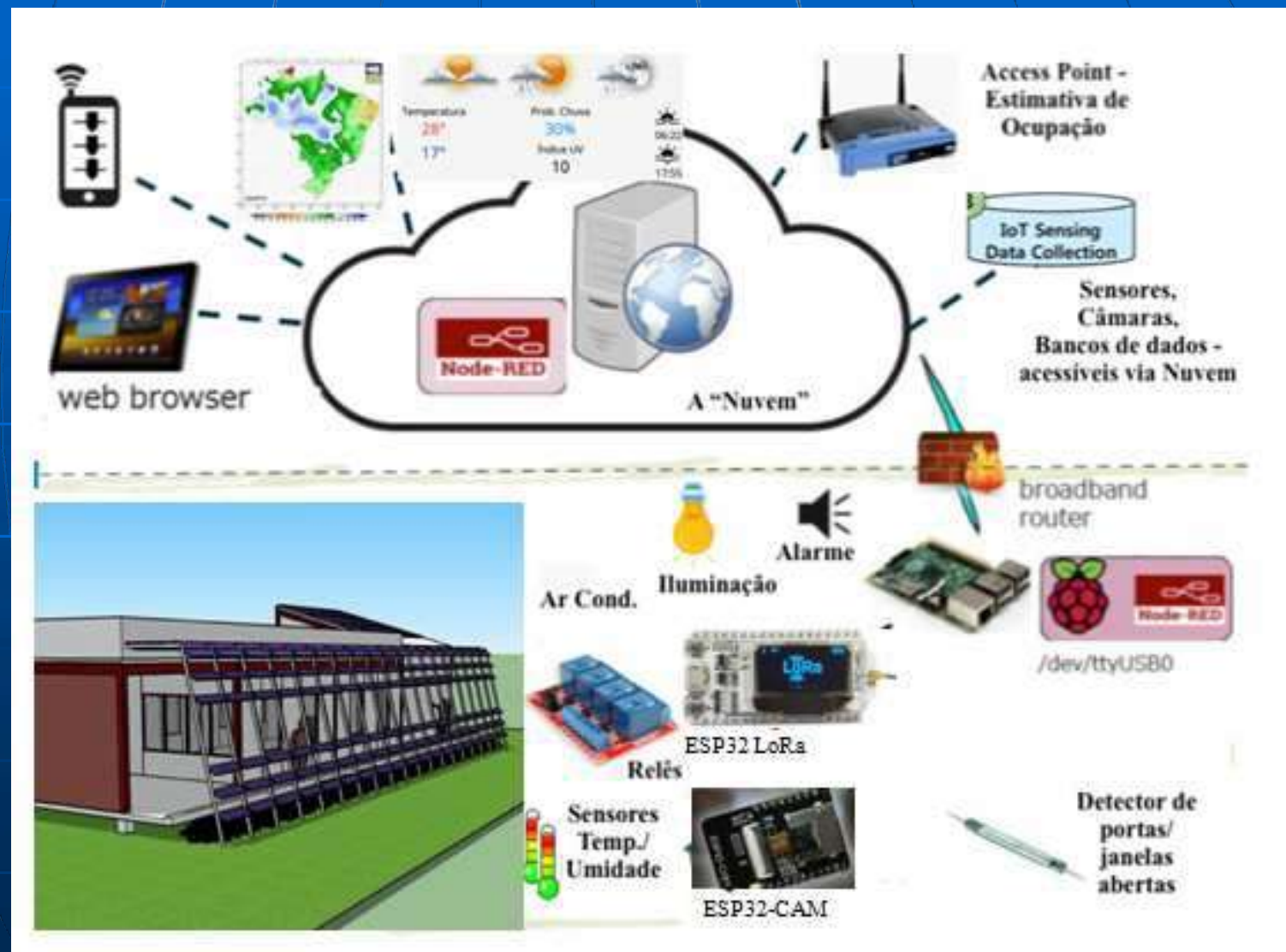
Silver Certification  
50 – 59 points

Gold Certification  
60 – 79 points

Platinum Certification  
80 – 110 points



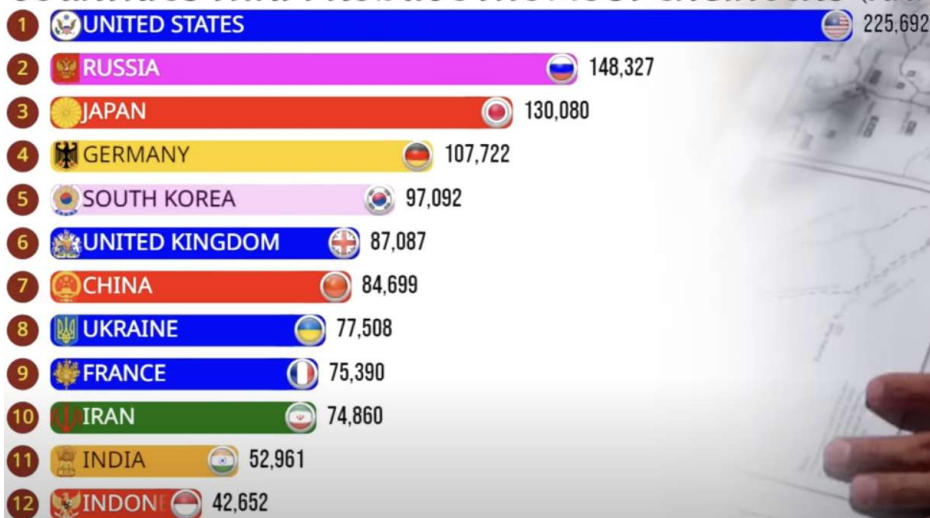
# Projeto ZEB/UnB/Eletróbrás FAU/FT/GEP/FGA/FUP/CEPLAN



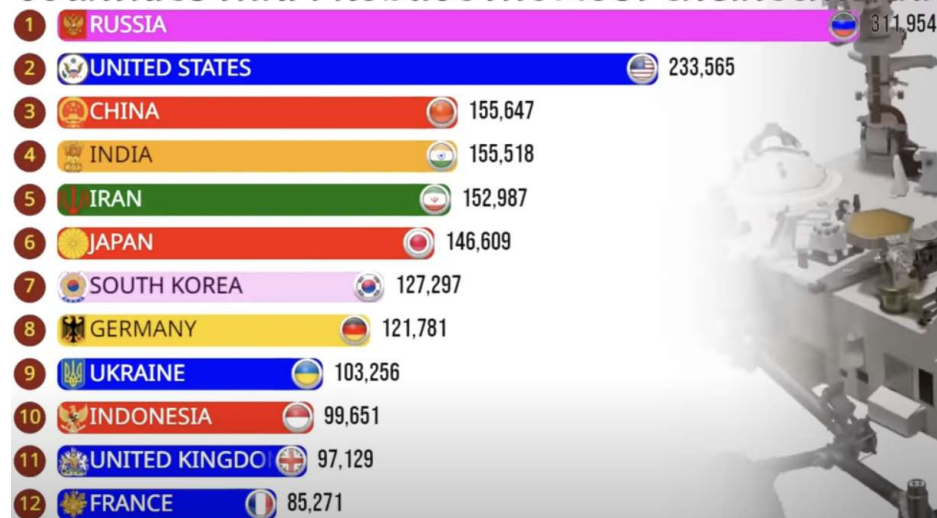
# Engenheiros, no Brasil e no Mundo



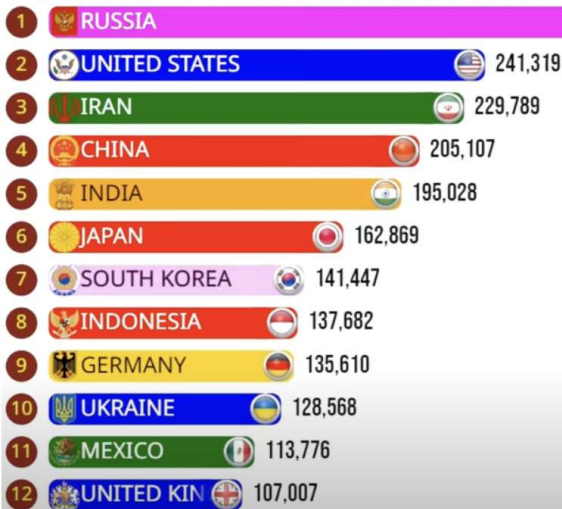
## COUNTRIES THAT PRODUCE THE MOST ENGINEERS (ANNUAL) 1992



## COUNTRIES THAT PRODUCE THE MOST ENGINEERS (ANNUAL) 2002



## COUNTRIES THAT PRODUCE THE MOST ENGINEERS (ANNUAL) 2012



## COUNTRIES THAT PRODUCE THE MOST ENGINEERS (ANNUAL) 2022



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AS 20 MAIORES COMUNIDADES DE IMIGRANTES NA TAILÂNDIA



# Obrigado!

Adolfo Bauchspiess

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[adolfo@ene.unb.br](mailto:adolfo@ene.unb.br)

