VAASAN AMMATTIKORKEAKOULU
VASA YRKESHÖGSKOLA
UNIVERSITY OF APPLIED SCIENCES

IWES 2007

6TH INTERNATIONAL WORKSHOP ON AMBIENT INTELLIGENCE & EMBEDDED SYSTEMS

6 & 7 September 2007
Vaasa, Finland

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Node Positioning in a Limited Resource Wireless Network

IWES 2007 6th International Workshop on Ambient Intelligence & Embedded Systems 6-7 September, 2007, Vaasa, Finland

SEINÄJOKI UNIVERSITY OF APPLIED SCIENCES

SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGY

LABORATORY OF ELECTRONICS

Heikki Palomäki
heikki.palomaki@seamk.fi

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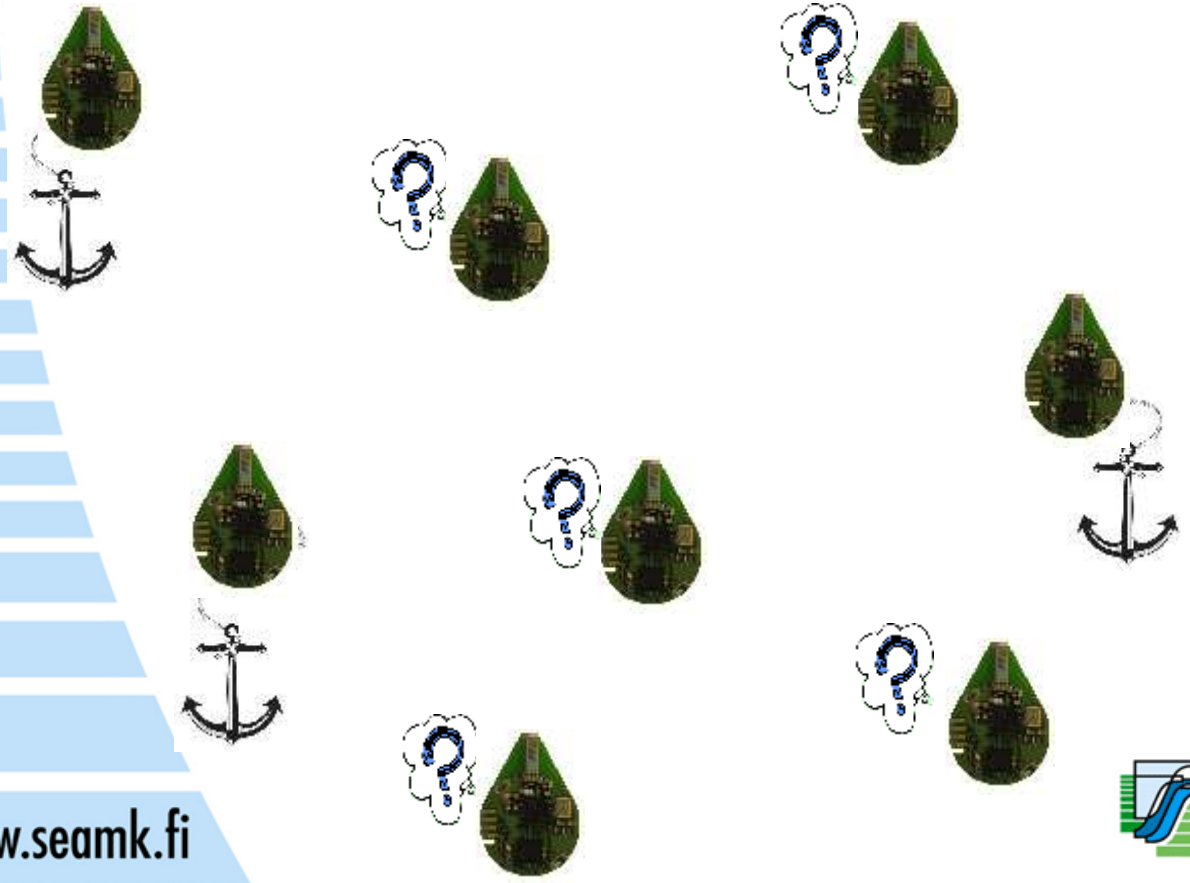
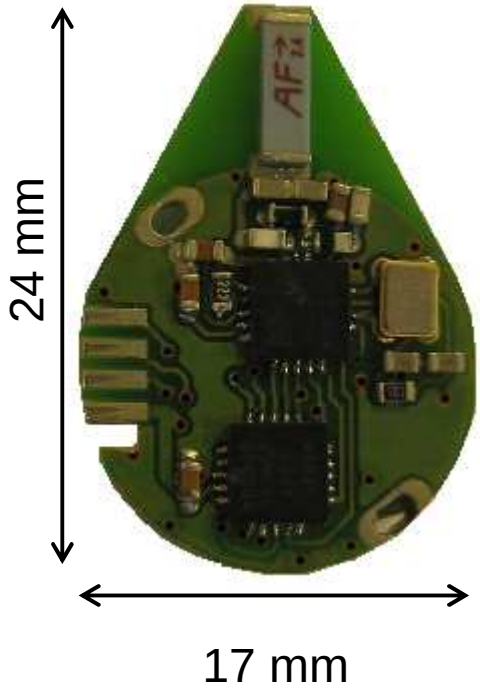
Node Positioning in a Limited Resource Wireless Network





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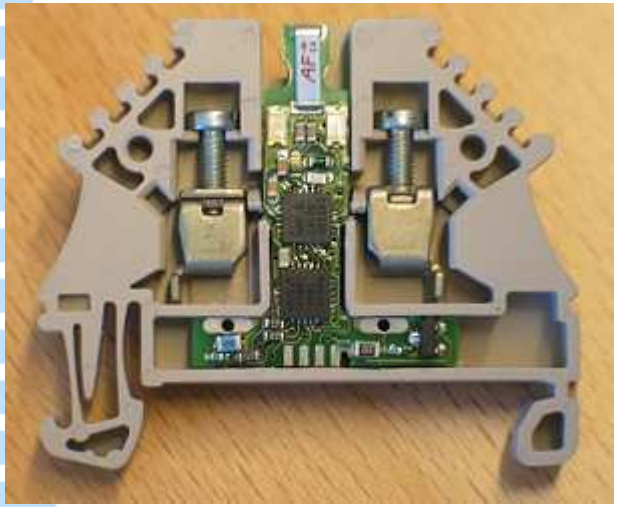
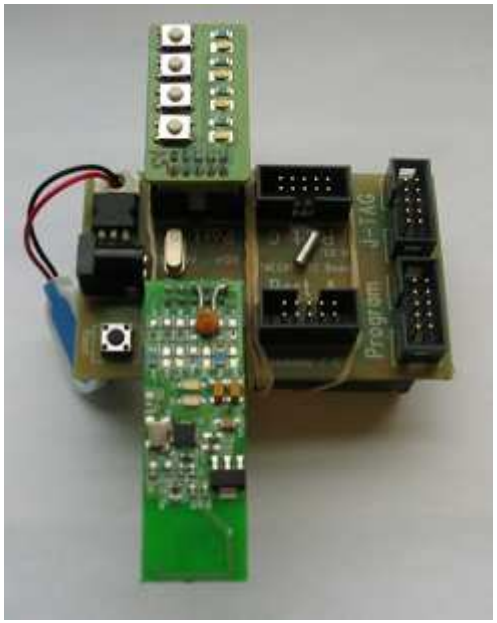
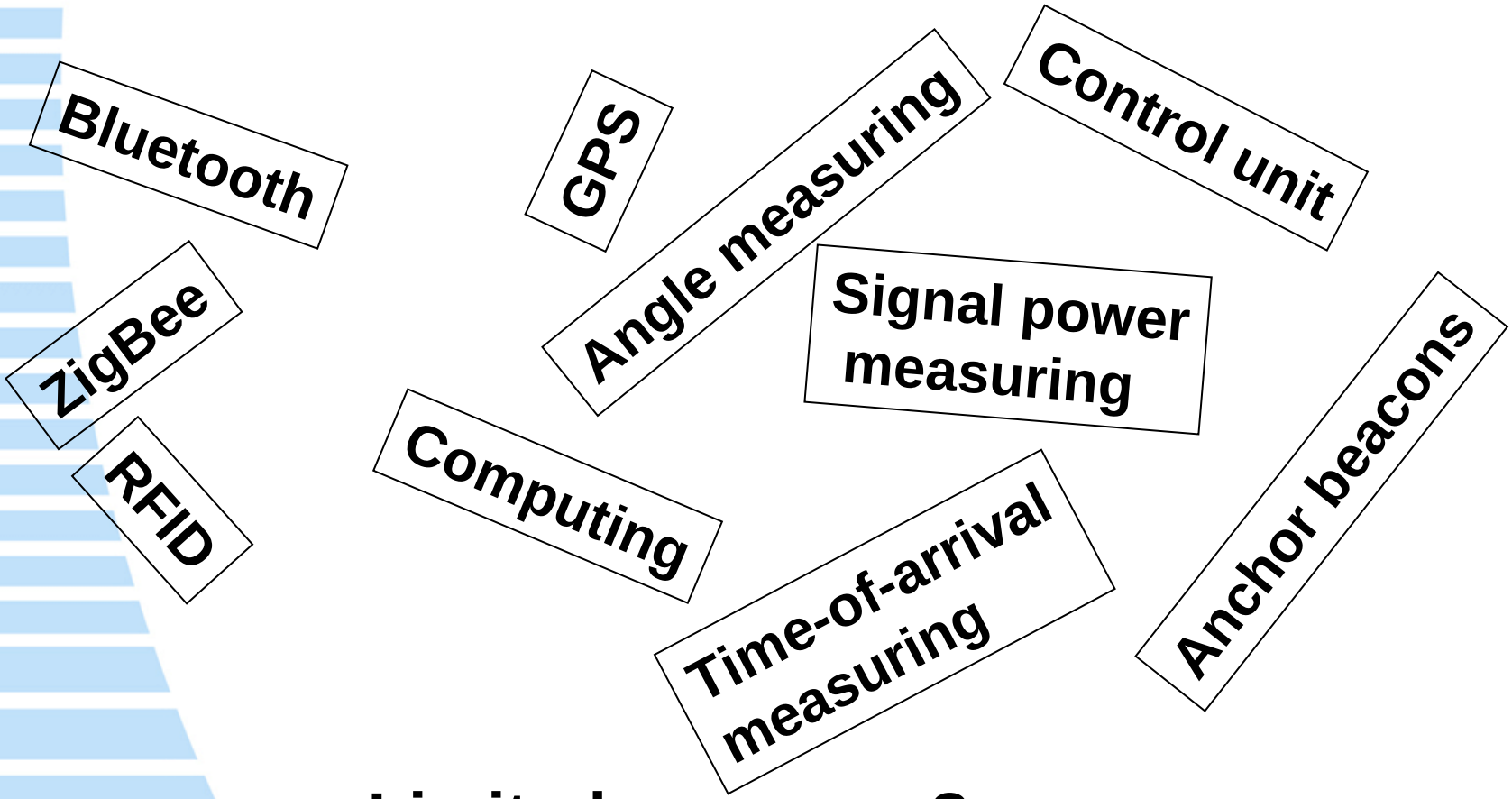
Applications



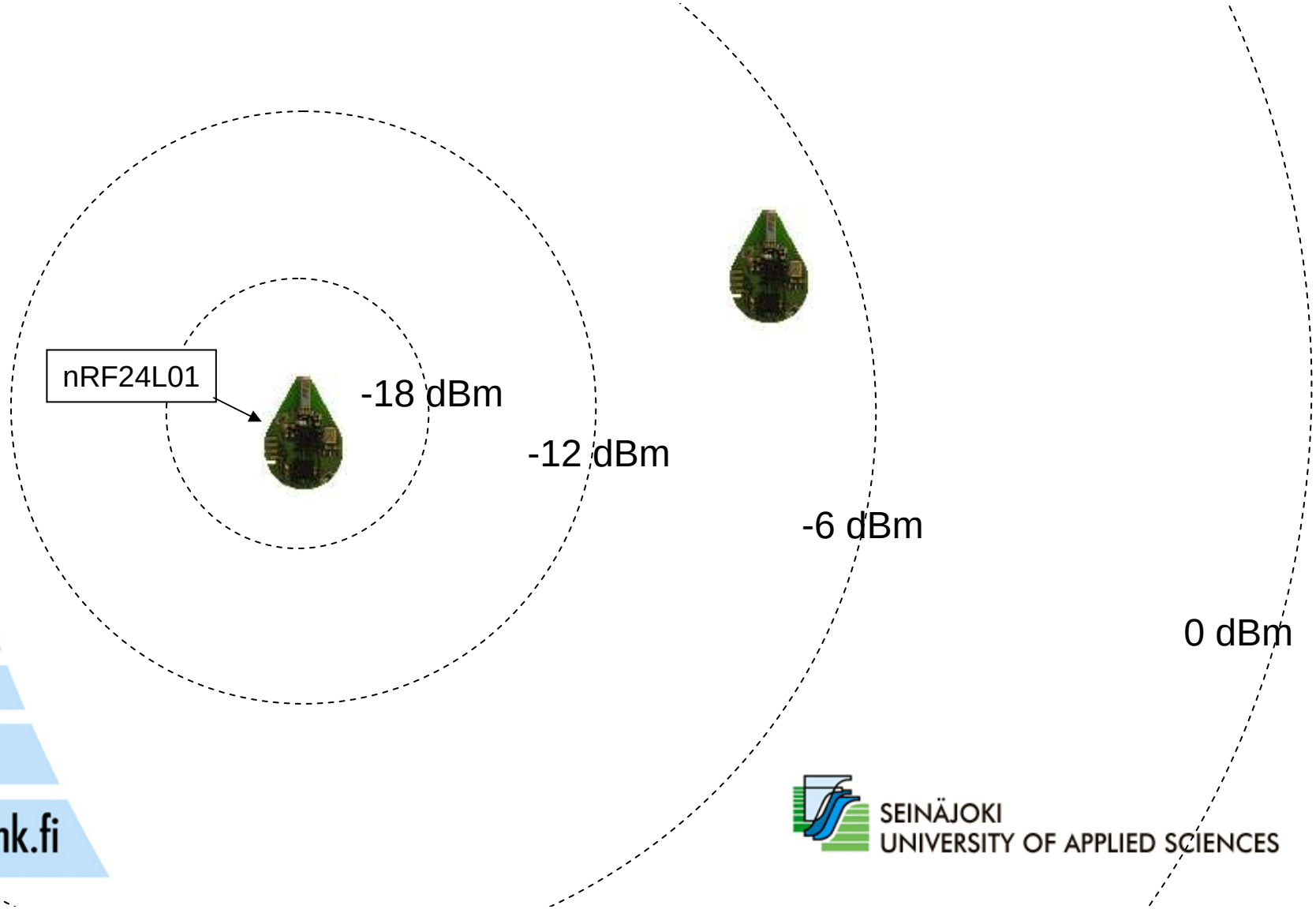


Existing possibilities

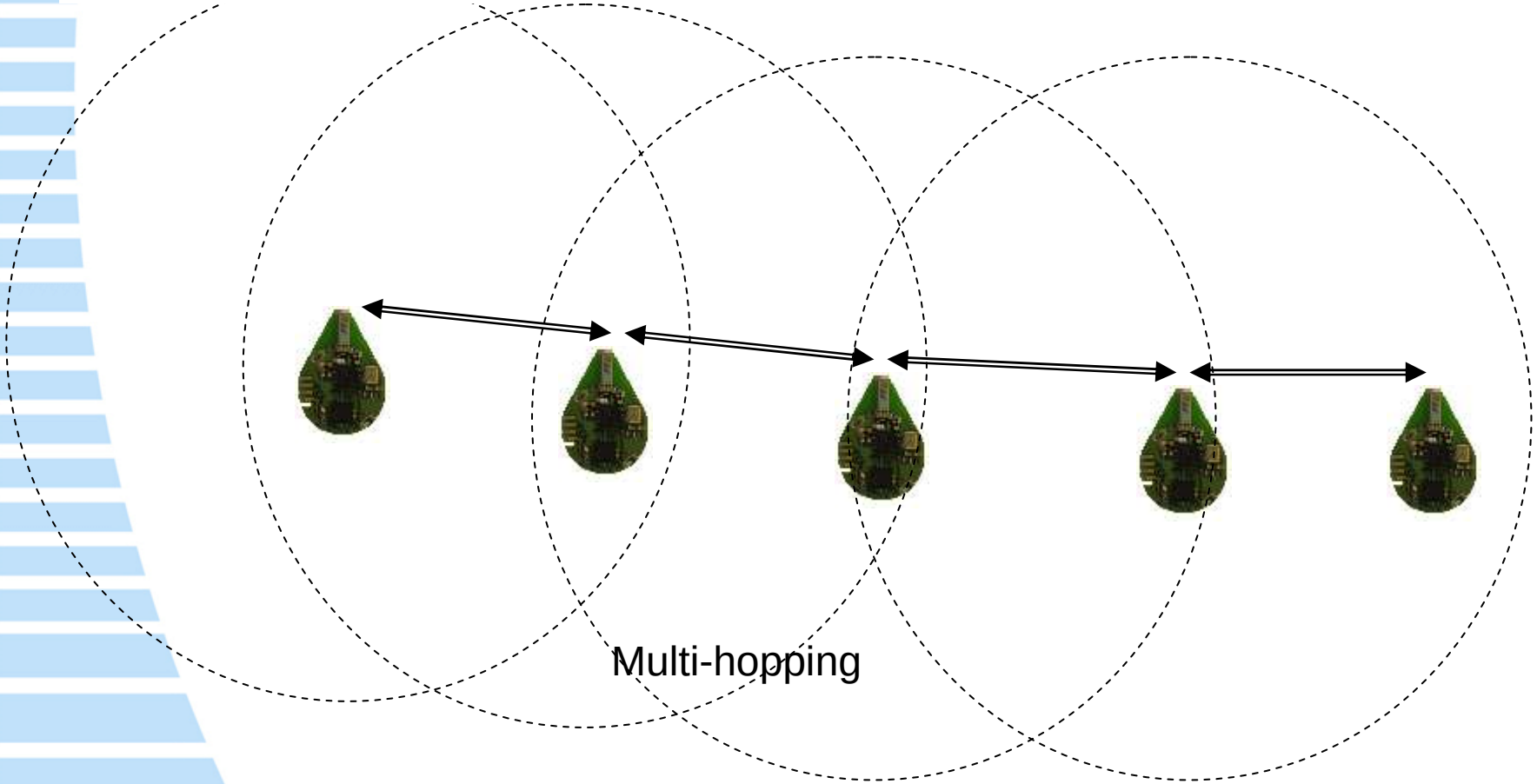


<u>Limited</u> resource ?

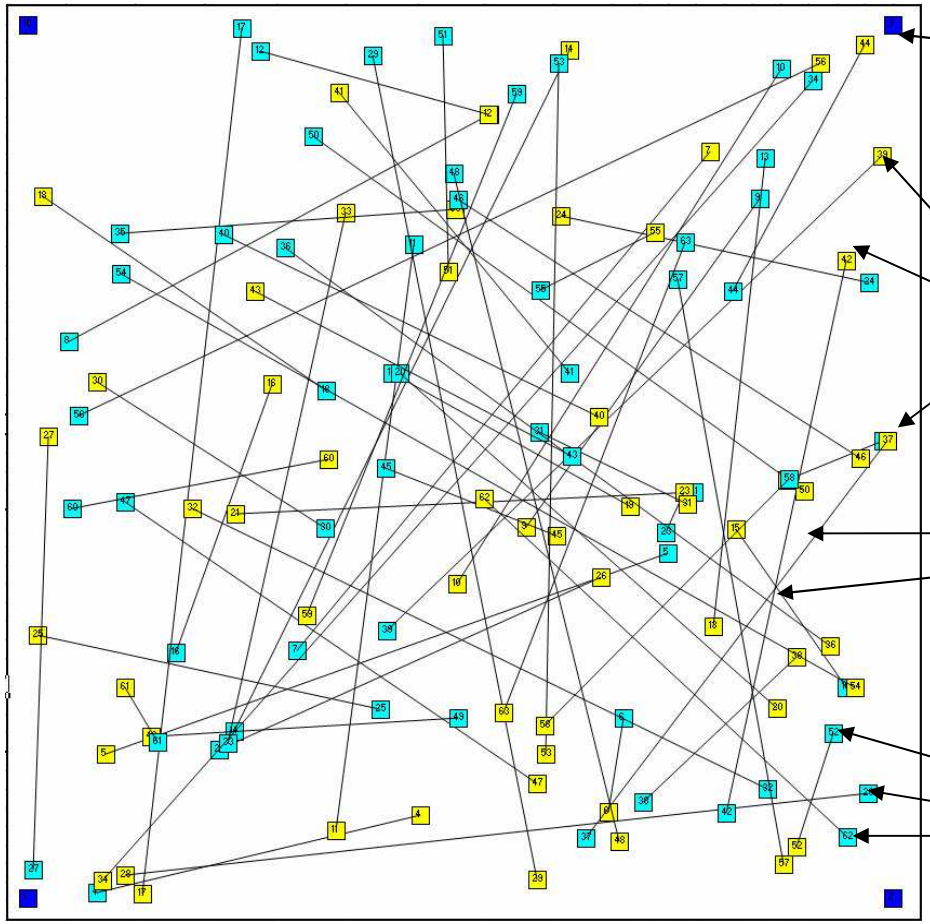
Distance measuring: RF-power



Distance measuring: Multi-hopping



The start state of the simulation



Four Anchors with fixed Positions

Estimated Positions

Position Errors

Real Positions

MSDE = 126

Mean value positioning

(X1,Y1)

(X2,Y2)

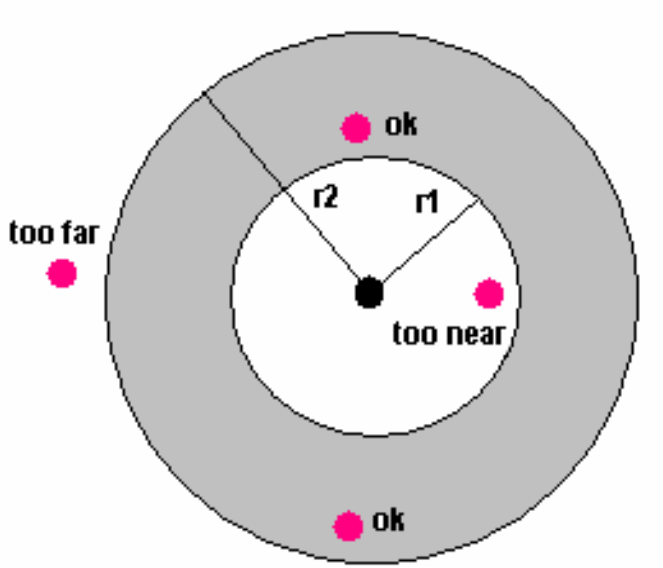
$$X = \frac{\sum_n X_n}{n}$$

$$Y = \frac{\sum_n Y_n}{n}$$

If distance is measured, the mean value is weighted by distance

(X3,Y3)

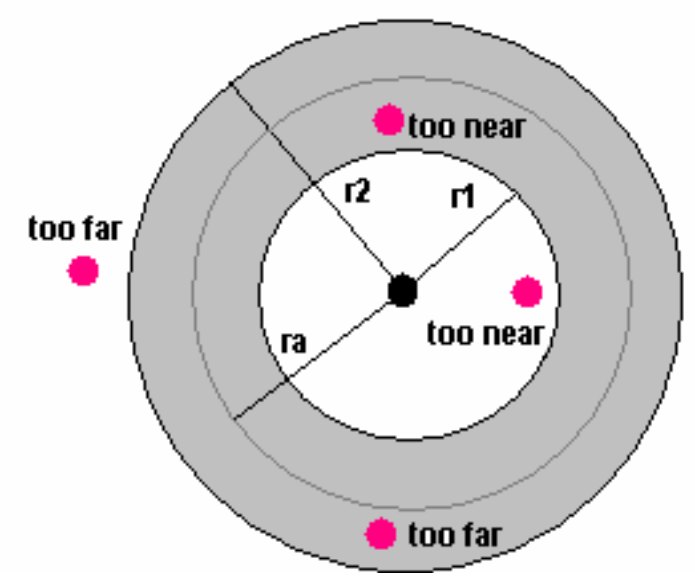
Iterative, Passive Position correction



- Measured, real distance
- Estimated distance

If the Neighbour is too far or too near, correct own estimated position

Iterative, Active Position correction

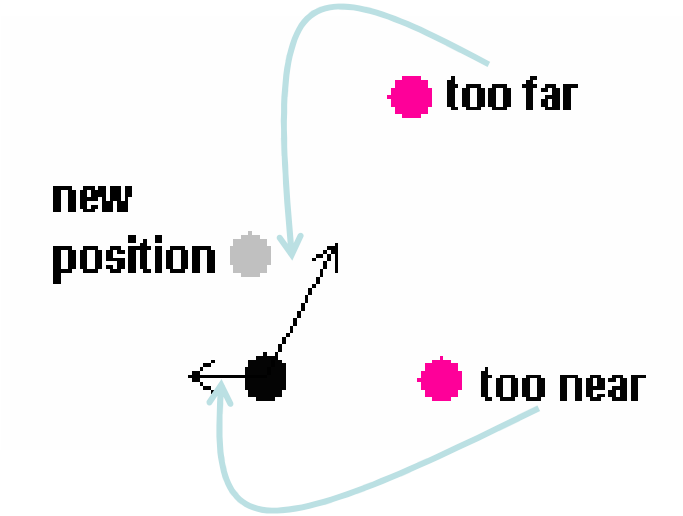


- Measured, real distance
- Estimated distance

If the Neighbour is too far or too near, correct own estimated position

$$r_a = \sqrt{\frac{r_2^2 - r_1^2}{2}}$$

Iterative correction



Do with all neighbours:
  read the estimated position and multi-hops of neighbour
  if neighbour is too far,
        move own estimated position nearer
  if neighbour is too near,
        move own estimated position farther

Positioning methods

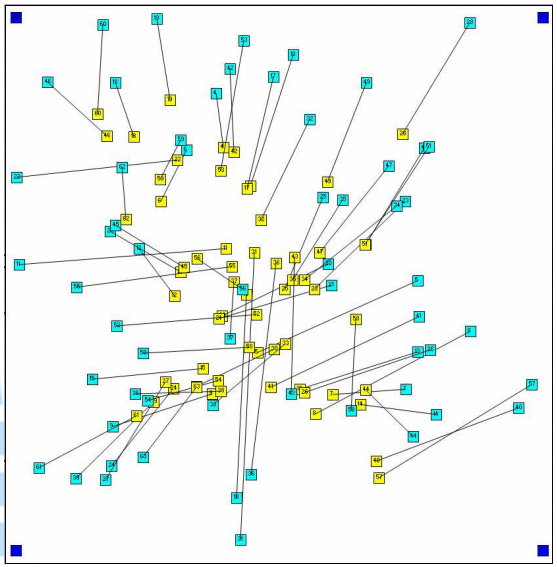
1. Mean value
2. Mean value in four sectors
3. Iterative passive positioning
4. Iterative active positioning

-Multihop distance measuring with 1-4 steps

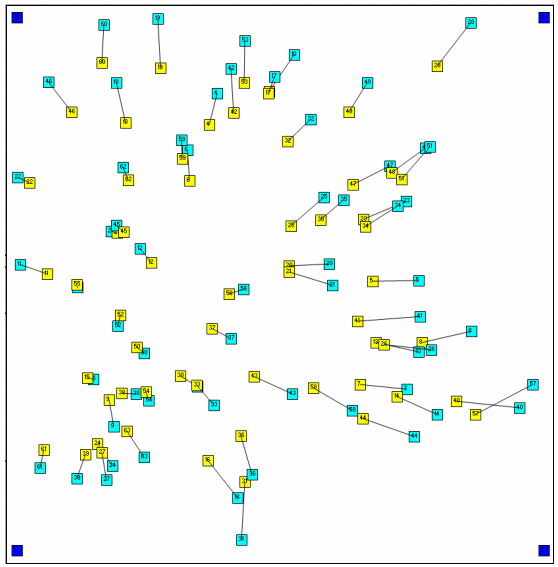
-Fixed or mobile nodes

-Neighbours within distances 5, 8, 11 or 14

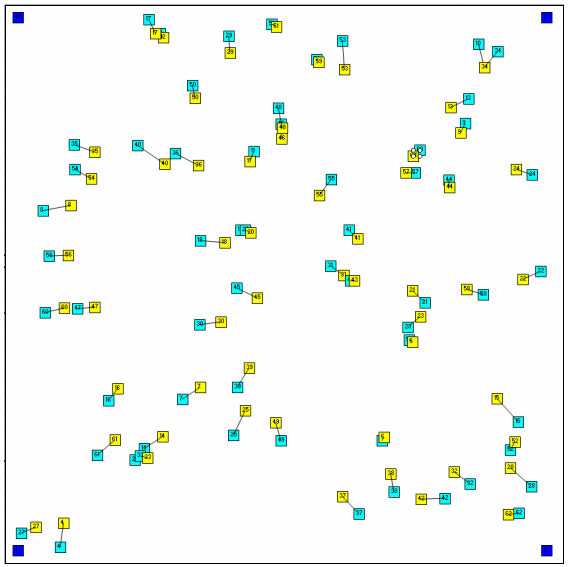
Positioning quality



MSDE = 22



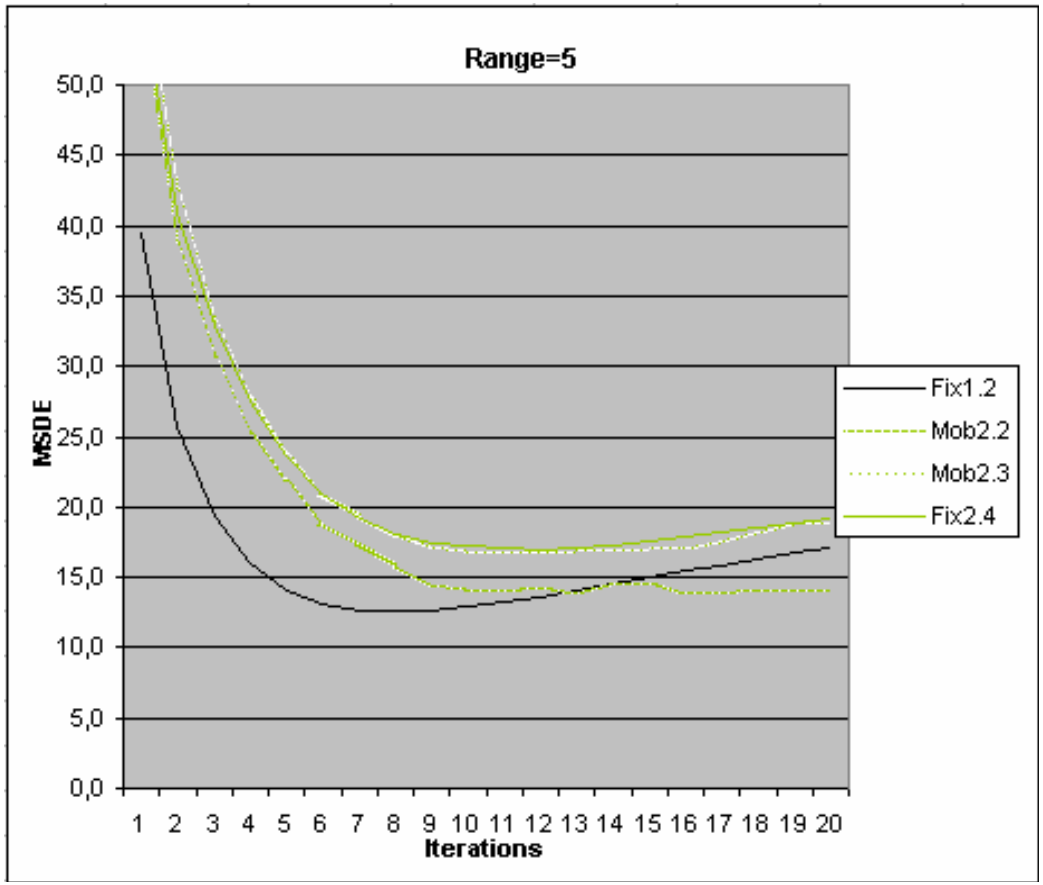
MSDE = 4.0



MSDE = 2,6

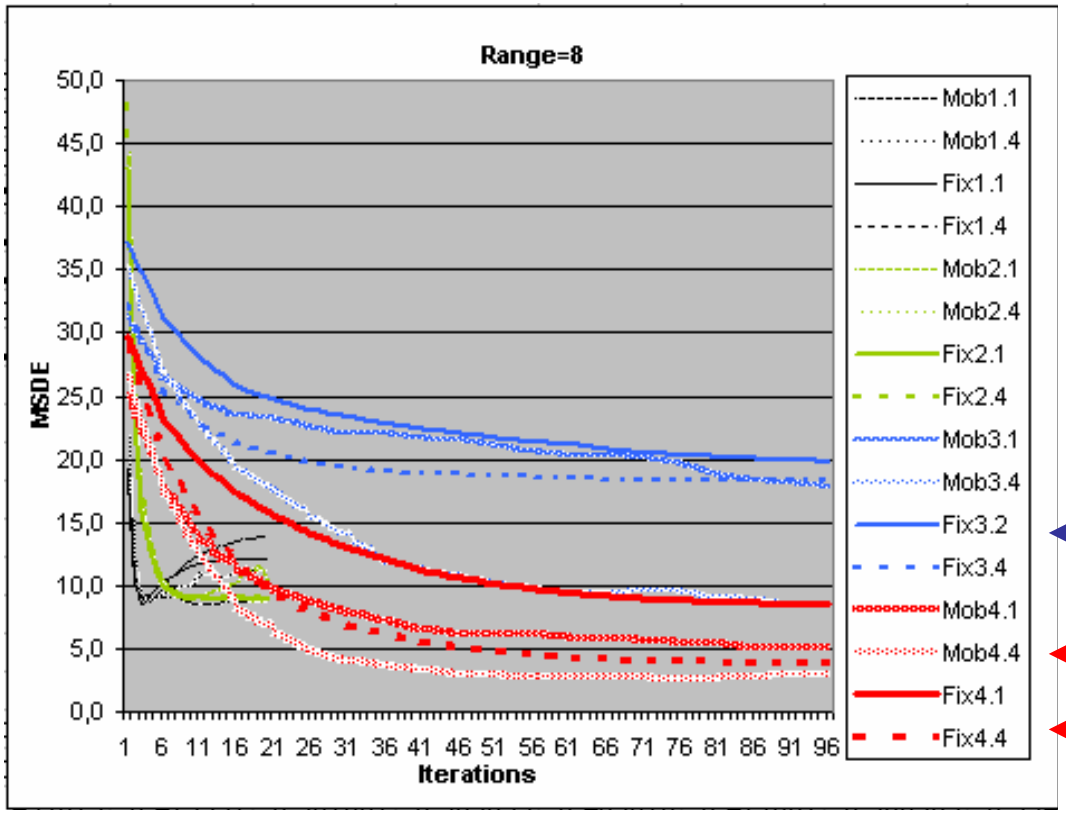
Positioning using range 5

(~ 6 neighbours)



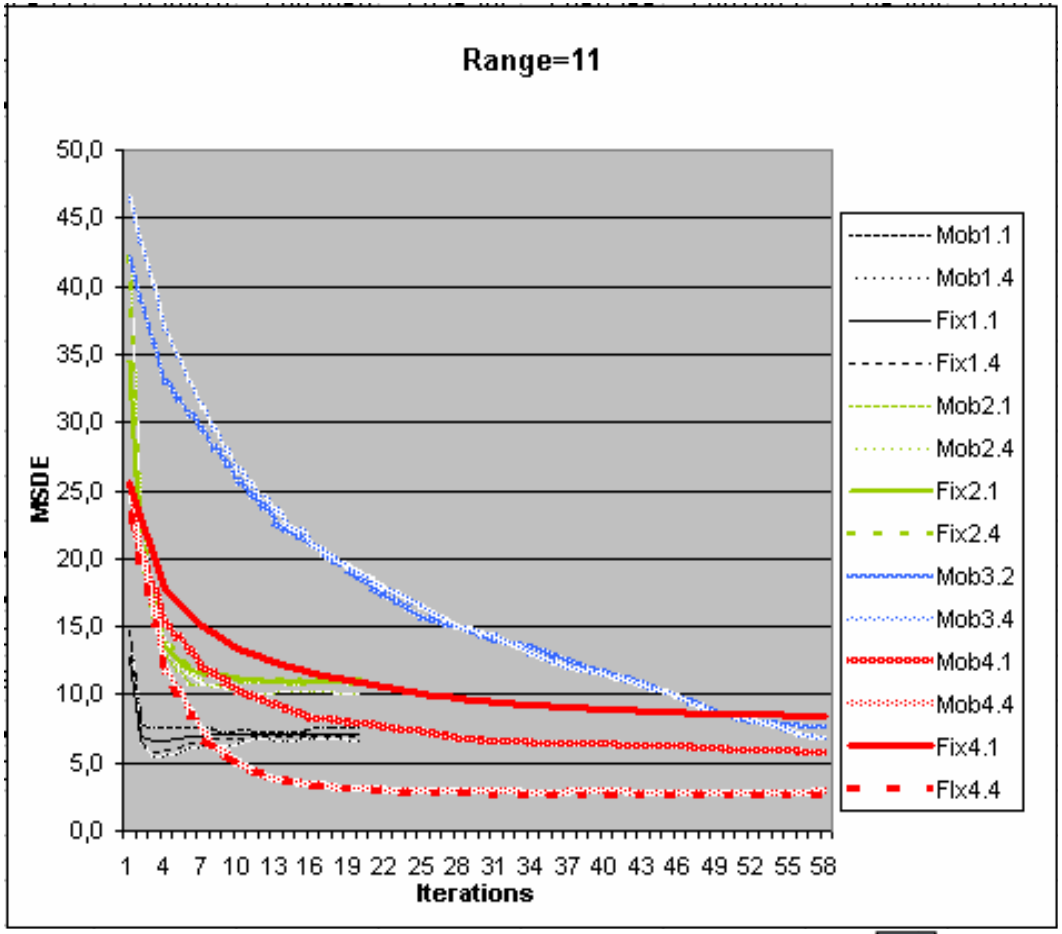
Positioning using range 8

(~14 neighbours)



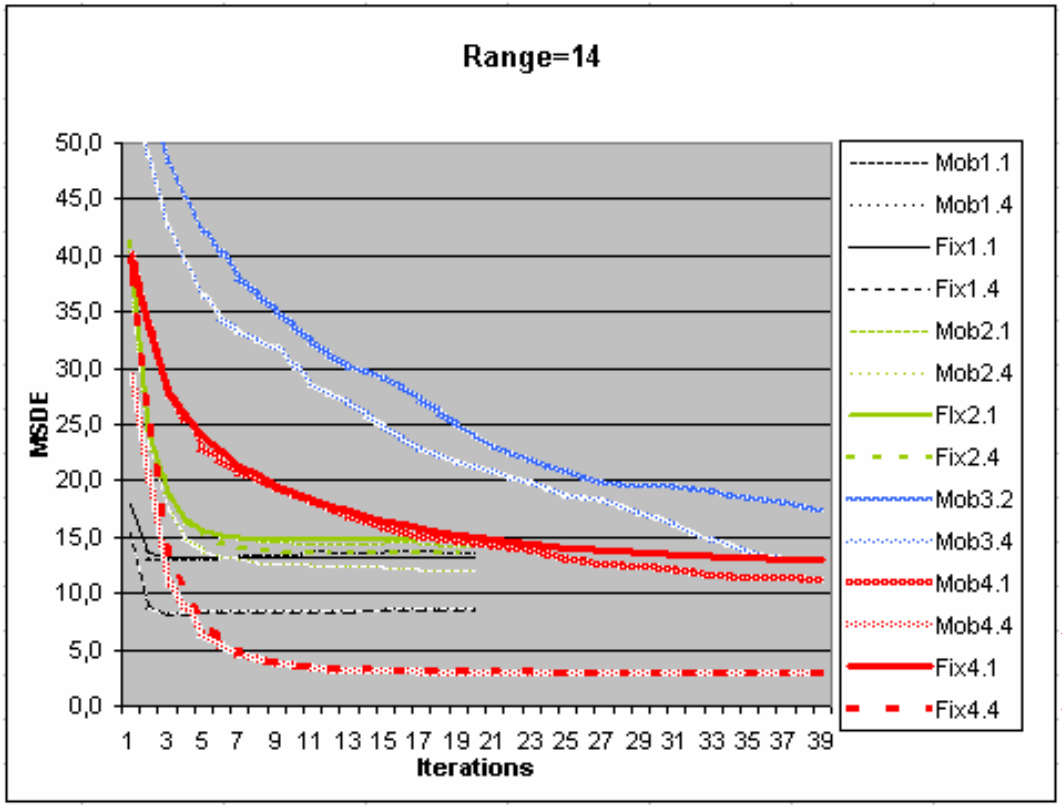
Positioning using range 11

(~22 neighbours)

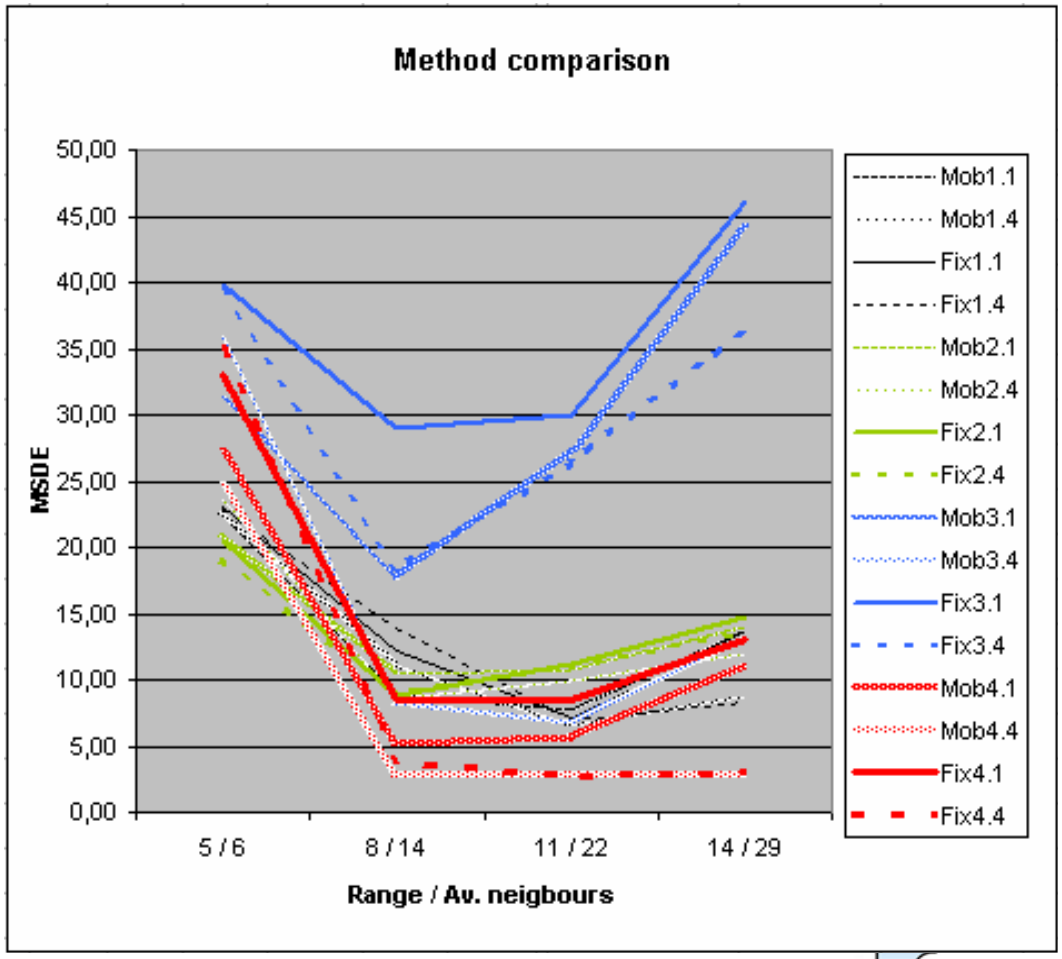


Positioning using range 14

(~29 neighbours)



Comparing methods



Children

Animals

Sensor Networks

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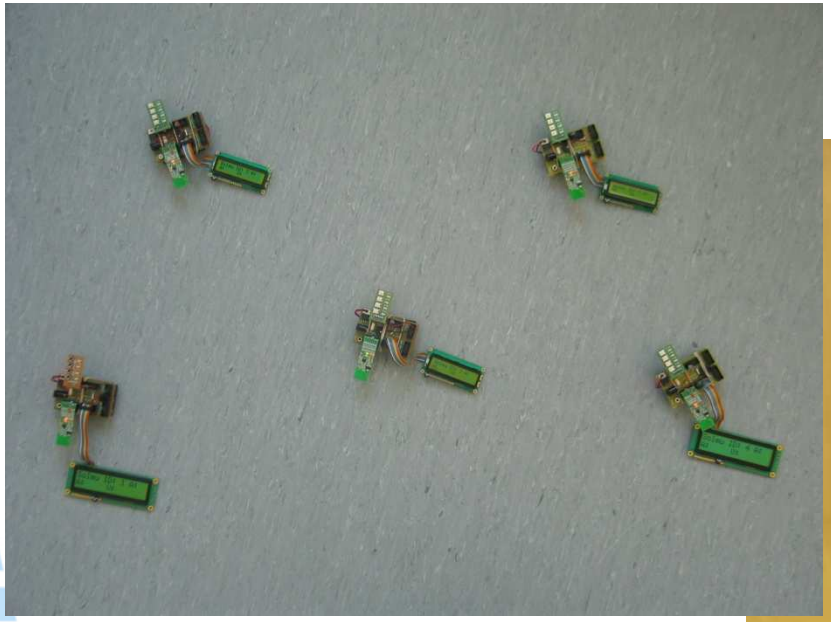
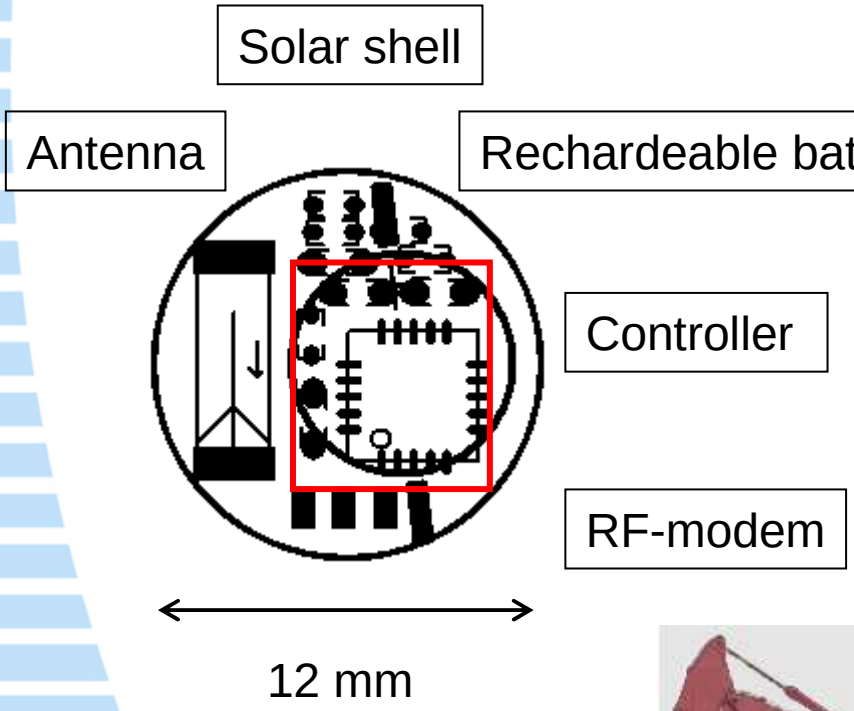
Testing



Future: distributed intelligence



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Thank you !

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LABORATORY OF ELECTRONICS

Heikki Palomäki
heikki.palomaki@seamk.fi

Artificial Landmark Recognition for Robot Navigation

Stylianidis A. Palamas G. Papadourakis G. Kavoussanos E.

Technological Educational Institute Of Crete
Department Of Applied Informatics and Multimedia

To operate successfully in indoor and outdoor environments, mobile robots must be able to localize themselves. The proposed approach detects and recognizes text in the surrounding environment from a vision sensor.

A support vector machine algorithm is responsible for classification of different raw text fonts and evaluation of text embedded in images and video sequences acquired from a typical camera mounted on a robot.

To aim text discrimination from the background, text can be framed with simple coloured geometrical shapes. Our system is able to calculate relative position and distance from detected landmarks.

To navigate successfully in a large-scale environment, mobile robot should know where it is within this environment

landmarks, are distinct features that a robot can recognize easily from sensory data

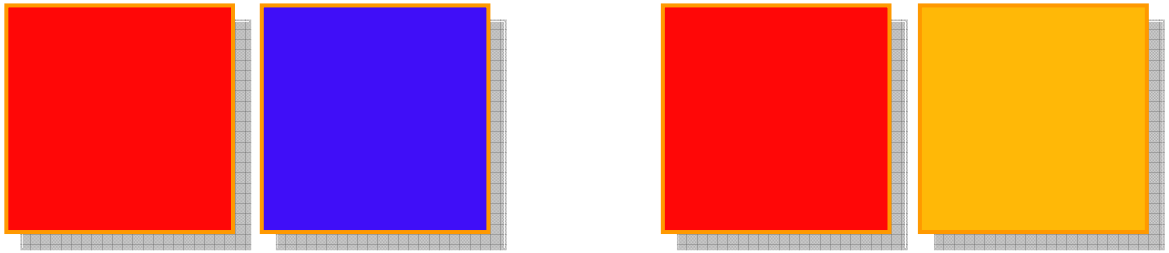
Artificial landmarks are objects purposefully placed in the environment, such as visual patterns or road signs

Why text?

More expressive, simple task programming for the end user

Color Spaces

Which pair is more similar?



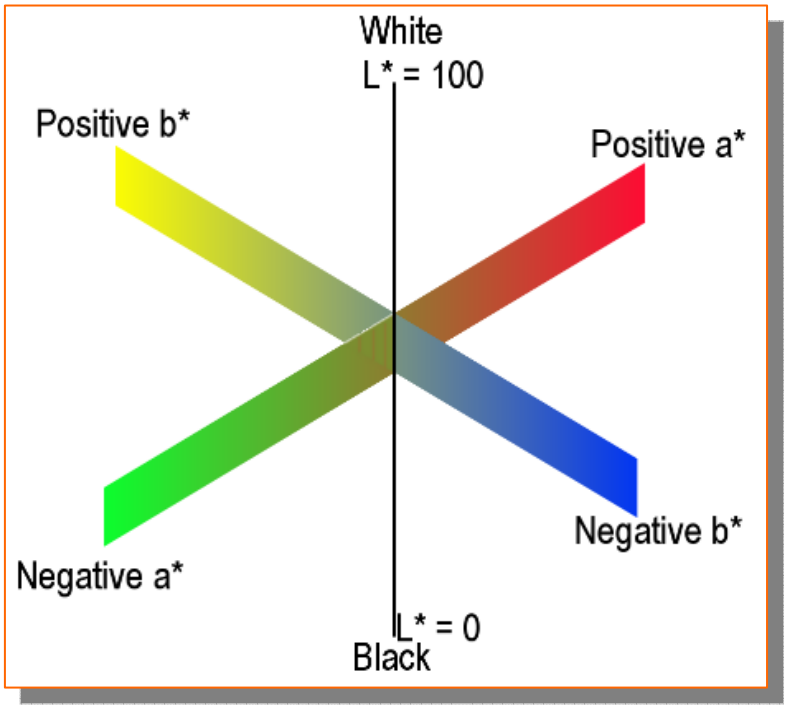
L*a*b* was designed to be uniform in that perceptual "closeness" corresponds to Euclidean distance in the space.

L*a*b* Color Space

L – lightness (white to black)

a – red to greeness

b – yellowness to blueness



Applying Kmeans in L*a*b Color Space

- Separate groups of sililar coloured pixels
- K-means treats each object as having a location in space
- objects are pixels with 'a*' and 'b*' values
- K-means requires to specify the number of clusters

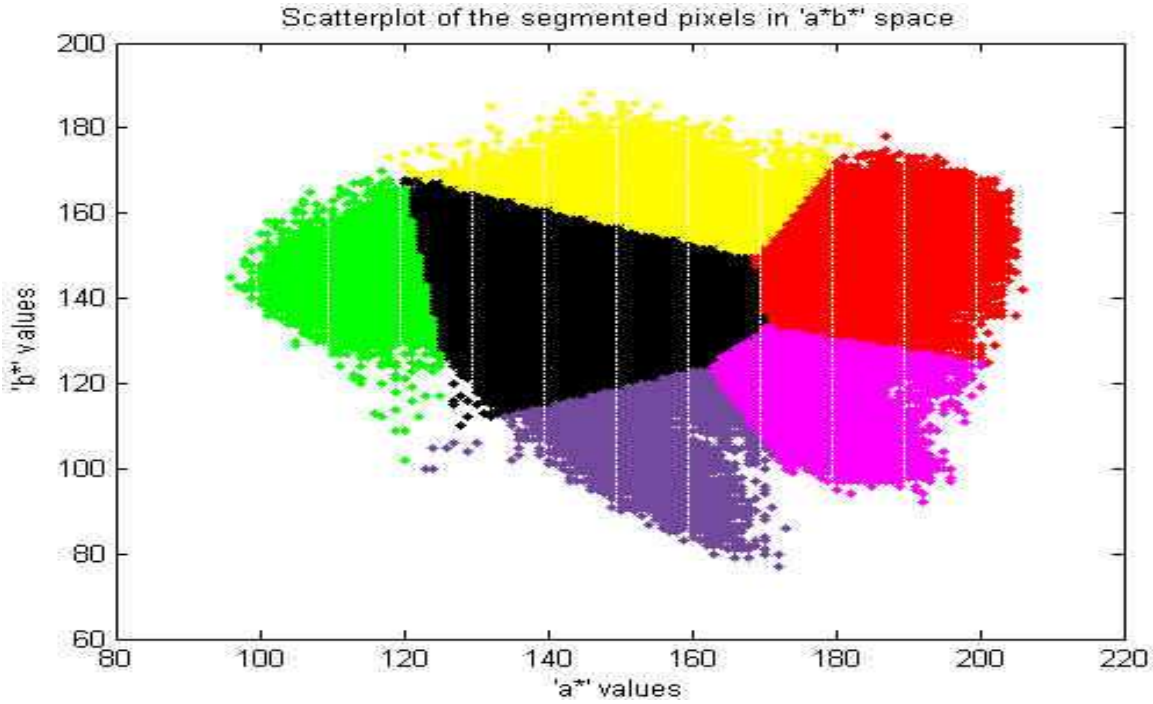
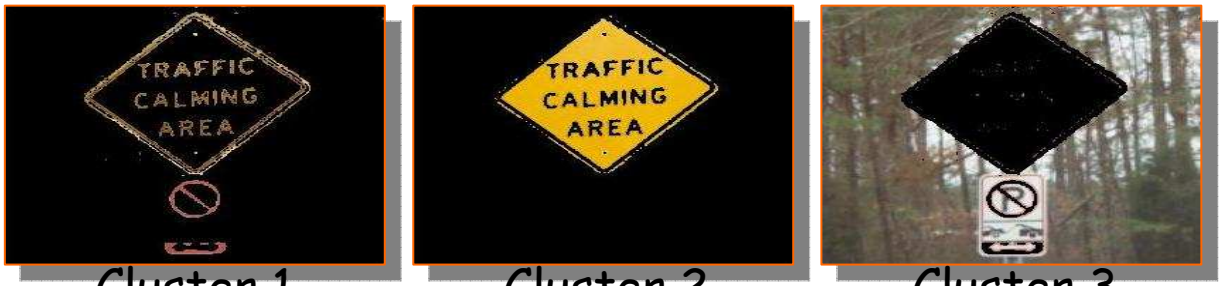


Image pixels clustered into six clusters using the Euclidean distance metric.

Automated Color Segmentation

Target Images

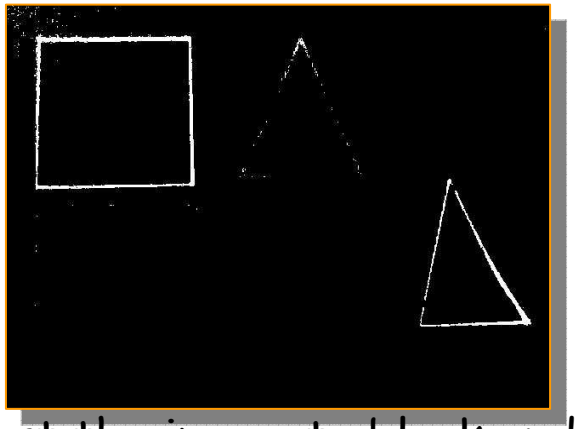
Cluster 1 Cluster 2 Cluster 3



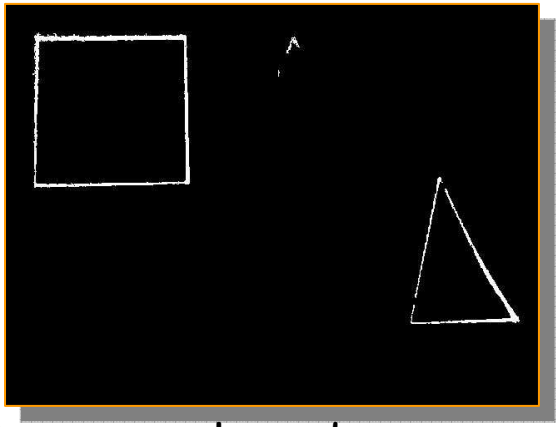
Cluster 1 Cluster 2 Cluster 3

Shape Detection

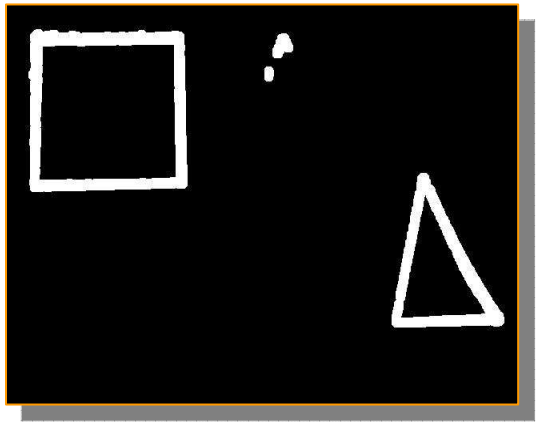
Morophological techniques application



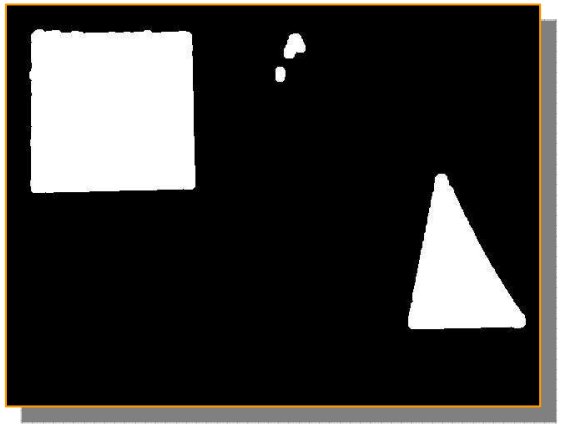
(1) Convert the image to black and white in order to prepare for boundary tracing



(2) Remove salt and pepper noise



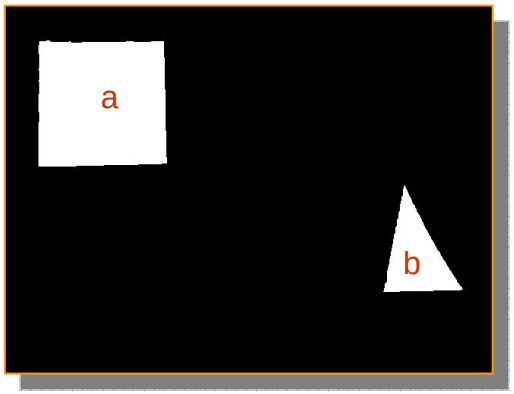
(3) Dilate image to fill closed shapes



(4) Fill all closed shapes

Find object of interest

- Remove all objects smaller than a predefined number of pixels
- Index all objects in image
- Through some metric, calculate the shape of every object
- Delete all unwanted shapes



Indexed objects

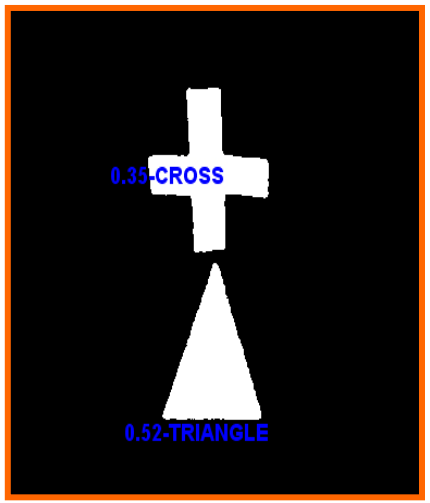
Filtered object

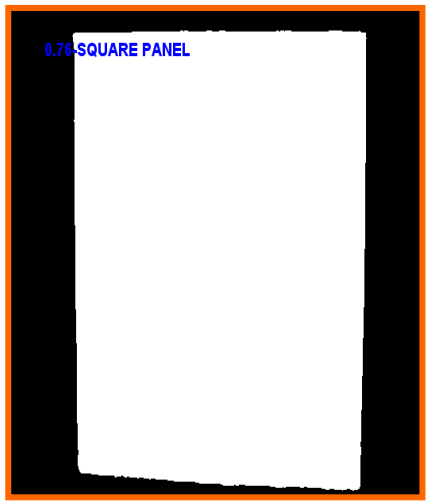
Determine the panel type

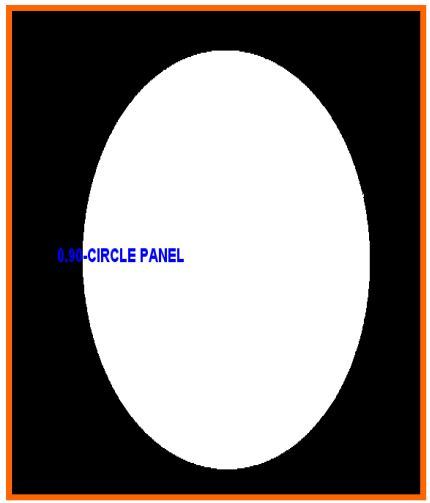
Estimate each object's area and perimeter. Use these results to form a simple metric indicating simple shapes

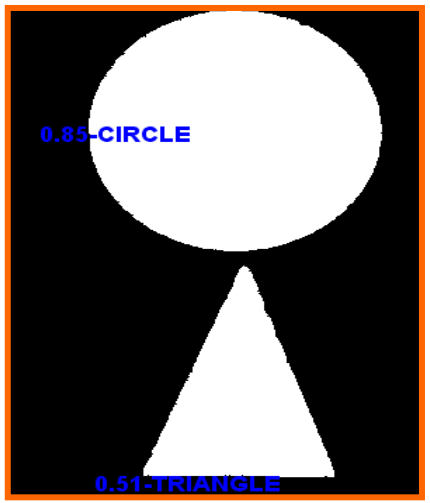
$$4\Pi * Area/Perimeter^2$$

Shape	Metric
Circle	0.85 → 1
Square	0.65 → 0.85
Triangle	0.45 → 0.65
Cross	0.30 → 0.45



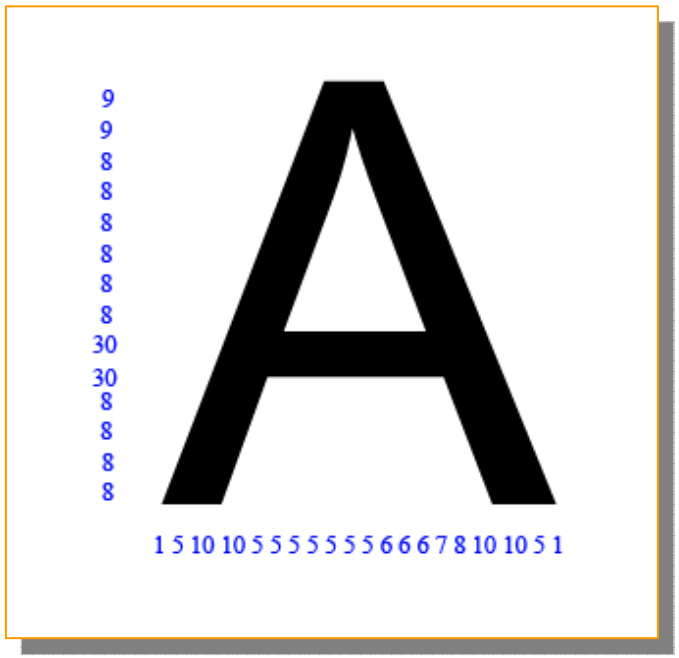






Building Character Signature

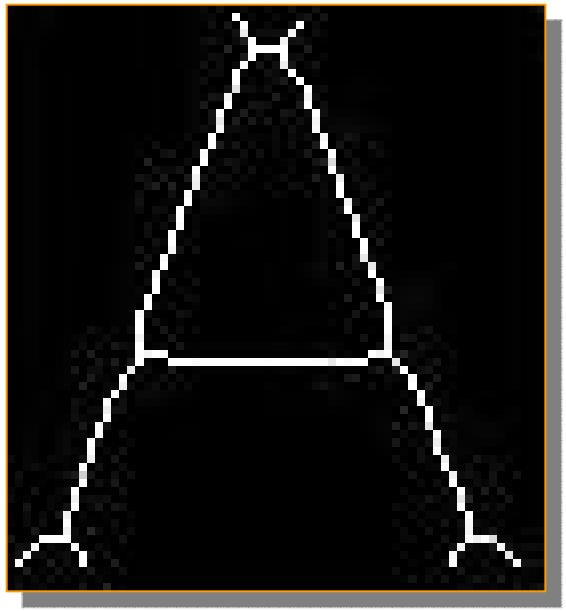
1. Transform L*a*b image to binary
2. Calculate sum of pixels line by line and column by column
3. Concatenation of both histograms



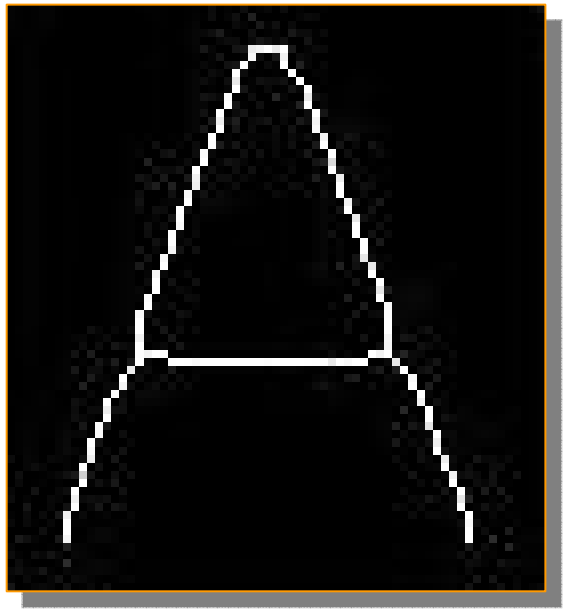
[1,5,10,10,5,5,5,5,5,5,5,6,6,6,7,8,10,10,5,1,9,9,8,8,8,8,8,8,30,30,8,8,8,8]

Skeletons & Spurs

- Reduce structural shape of a region to a graph
- Retain important information about the shape of original object
- Offset pruning means, identify and remove endpoints



Skeleton version of the letter with parasitic components.

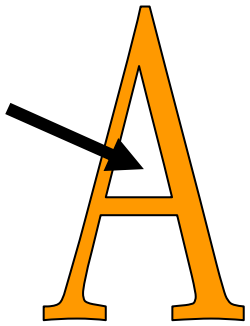


Skeleton after 6 applications of spur removal algorithm.

Complex Signatures (1/3)

- Upgrade quality of recognition
- These characteristics add to histogram signature:
  - Number of holes on the letter
  - Number of straight lines for every letter
  - The area of the letter shape

One closed curve



1 hole : A, D, O, P, Q, R
2 holes : B
0 holes : C, E, F, G, H, I, J, K, L, M, N, R, S, T, U, V, W, X, Y, Z

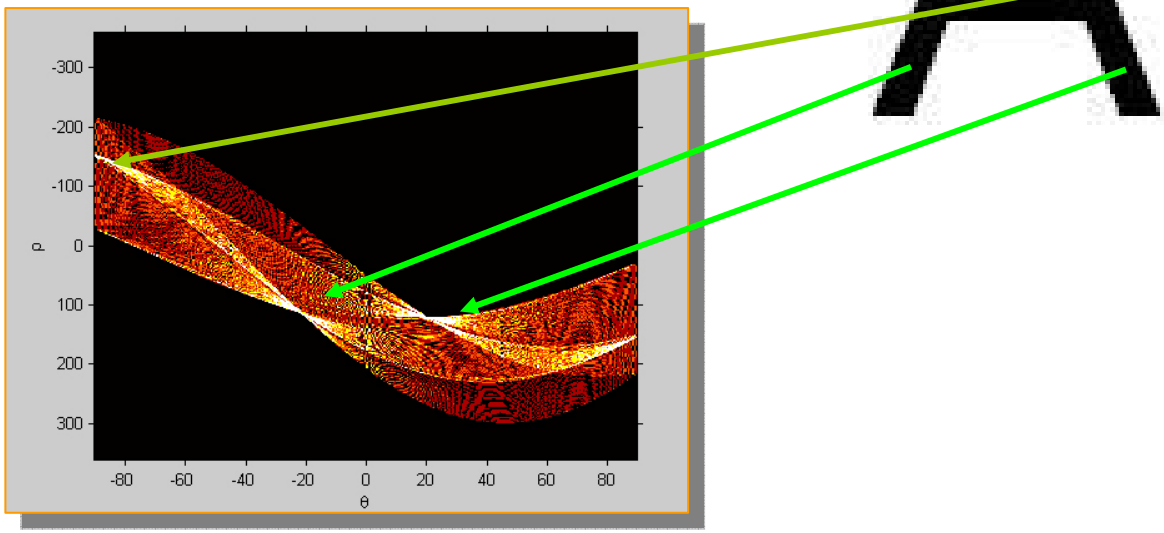
So, for example, if we have found 1 hole, we can check for next characteristics only on A,D,O,P,Q,R letters.

Complex Signatures (2/3)

Hough Transform: In the simplest form can locate straight lines if any

Every line is a vector of parametric coordinates

- ρ: the standard of the vector
- θ: the angle



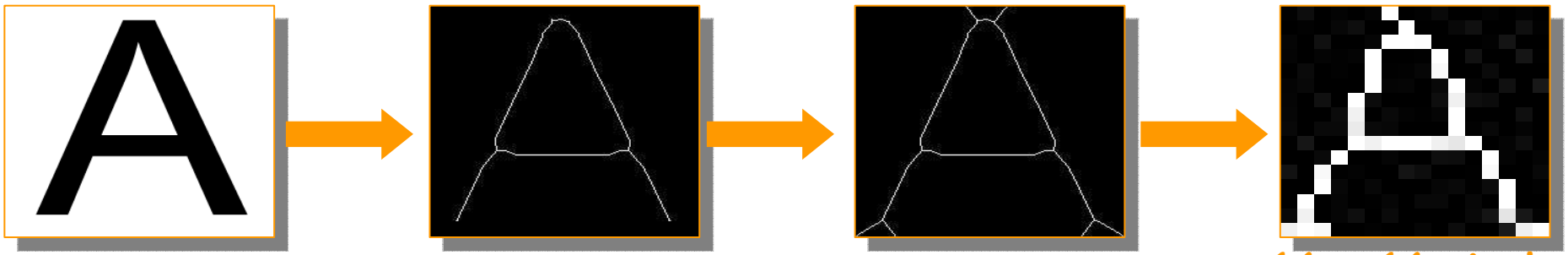
Hough transform for letter A (Skeletonized)
Left and right luminus points are part of the same line

Complex Signatures (3/3)

Area of letter shape

In order to have a coherent value the size must be the
Same for every letter. A good idea is to resize to
A fixed height and width

The letter must be in skeleton form
Smaller image means less parasitic information
increased performance and reduced time processing



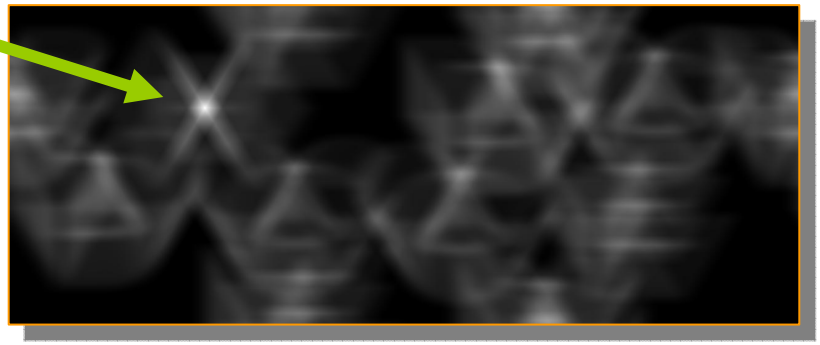
Matching by Correlation

Scan target object with a mask, here the mask is the letter with which we want to compare or find on the source image.
Typically the mask is much smaller than the source image

1. Source Image

2. Mask

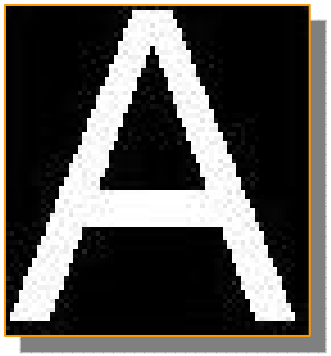
X:318 Y:257
Index: 1
RGB: 1,1,1



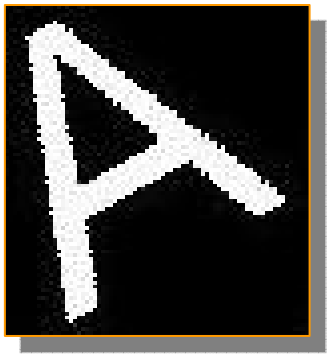
Letter A is found where luminosity is greater than anywhere else

SVM Training

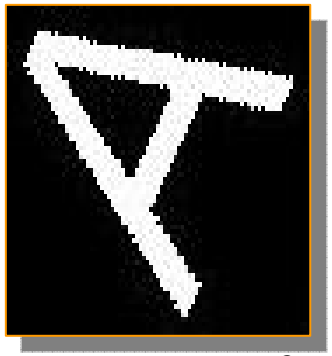
- Additional attributes from rotated images (30° and 60°)
  - All rotated characters have the same size
- Build signature from original & slightly rotated characters



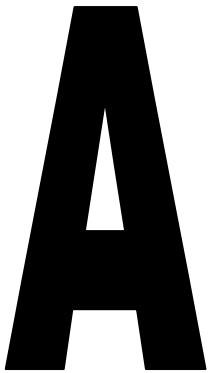
Original Image

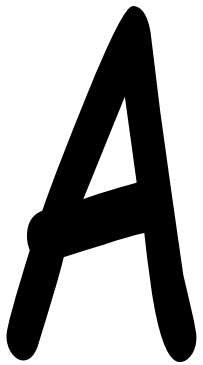


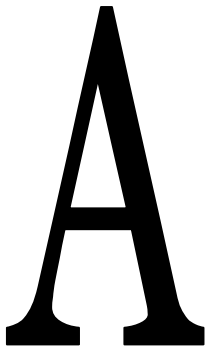
Rotated:30°



Rotated 60°



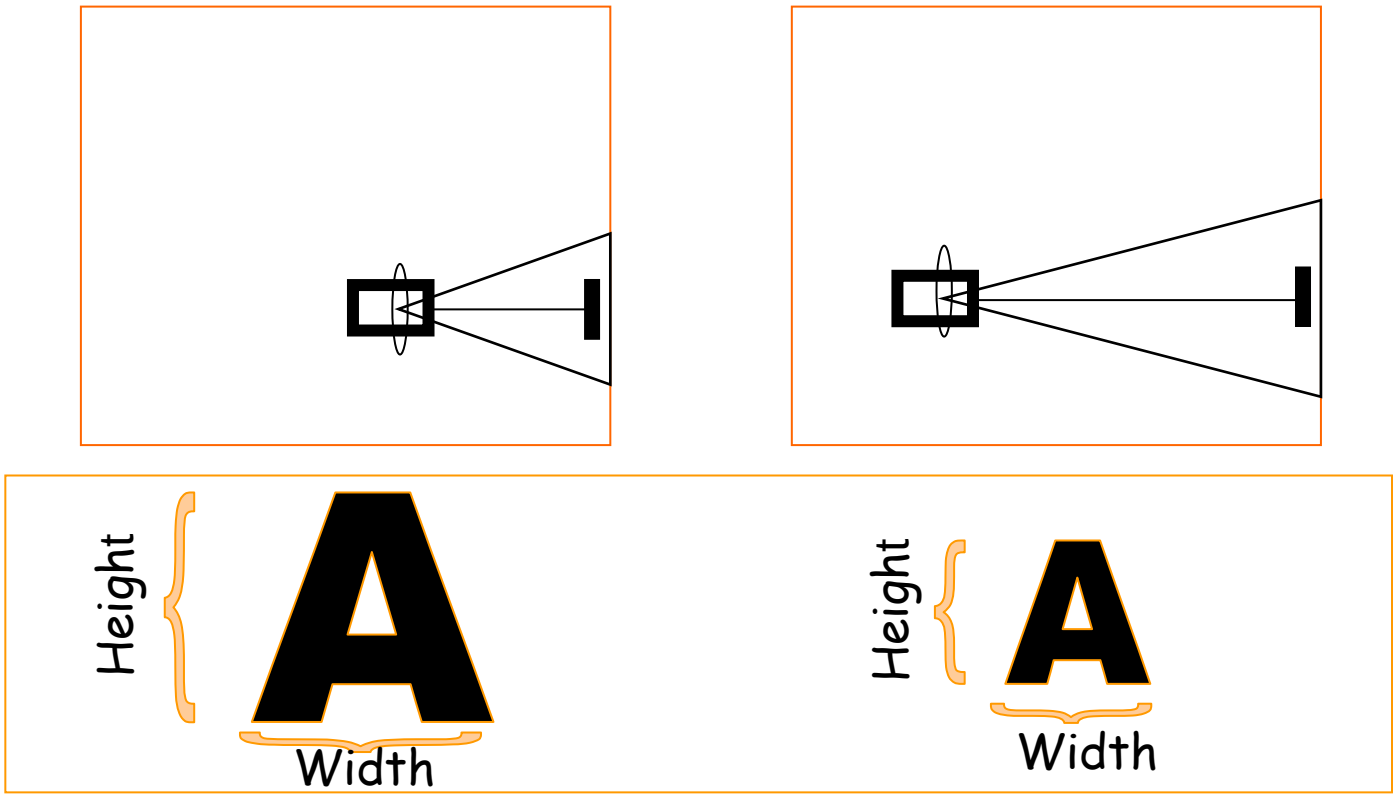




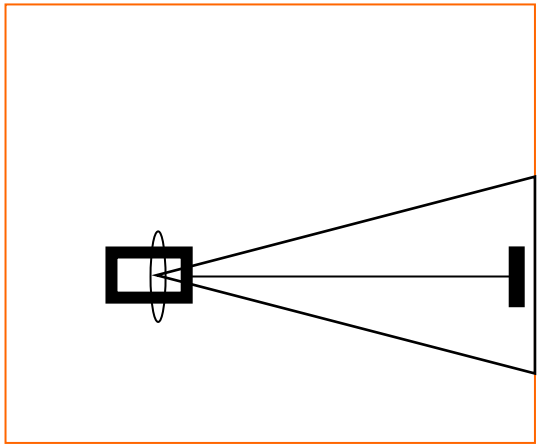
Train SVM with different fonts…

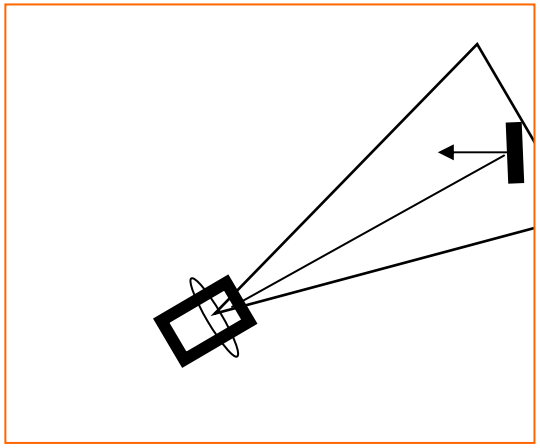
Distance & Angle from a Character

Text size and deformation can be used for accurate robot localization only after camera calibration



128px x 128p = 3 meters from camera 512px x 512p = 1.8 meters from camera





512px512p=1.8m angle: 0°

512px256p=1.8m, angle:30°

Conclusions

These preliminary results show that the method performs well for distinct coloured shapes and angles not exceeding 30°

Support Vector Machines appears to be a good approach but the performance depends on the learning database

The experiments have been performed in varying lighting conditions During experimental testing, illuminations occasionally caused misclassification of text

Everywhere you imagine. RENESAS

Renesas University Program

Renesas Technology Europe

Promotion Programs

Francesco Anwander

25/10/2007

Official launch of RTE University Program

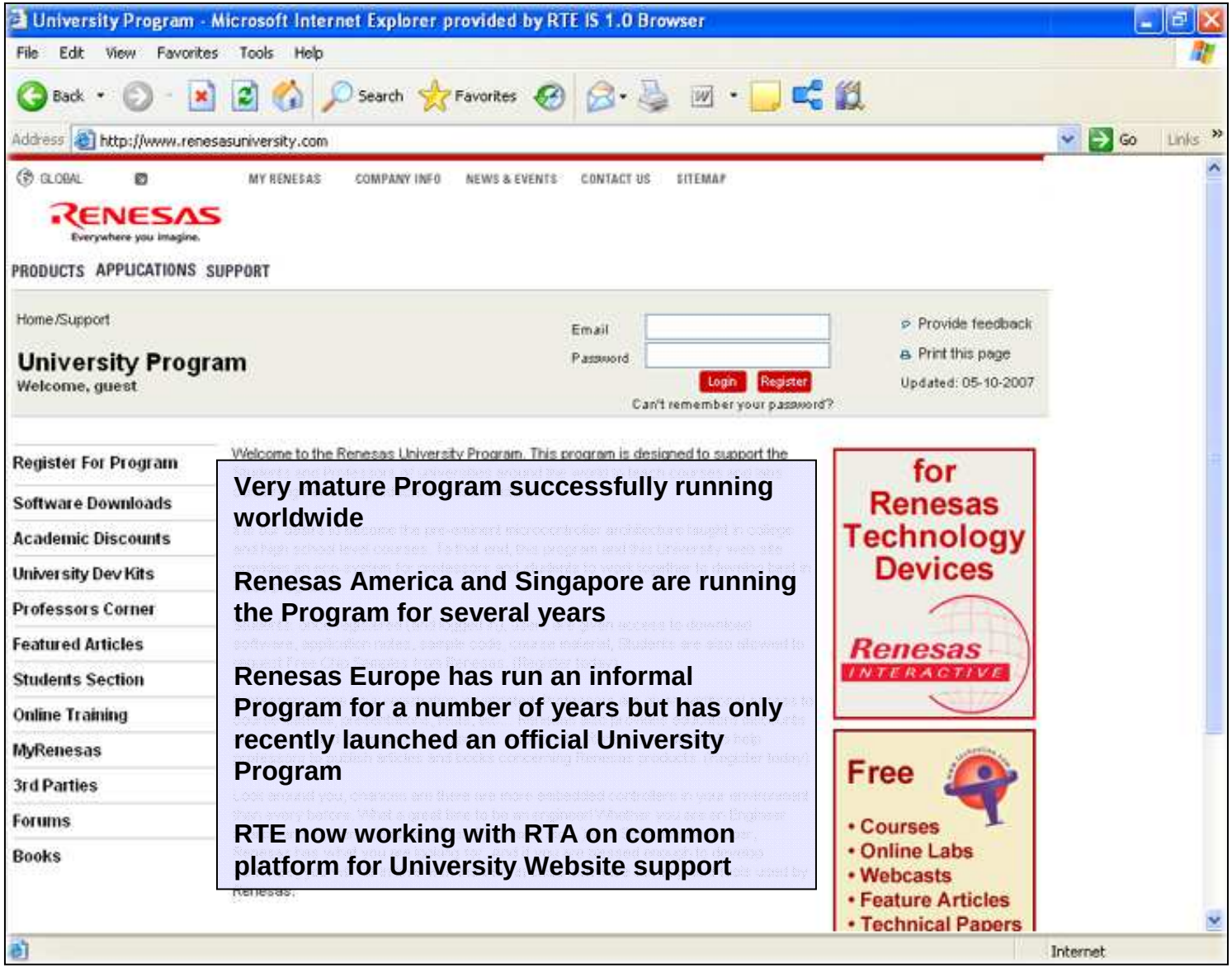
Embedded World February 2007

Professor Sturm of University Leipzig (awarded) as Professor of the Year 2006 is jointly co-operating with RTE

- 18 journalists joined Renesas press conference
- Many articles on RTE launching university were issued in the press

#1 MCU Reach further „rucksack" prepared by CID for Embedded World Fair

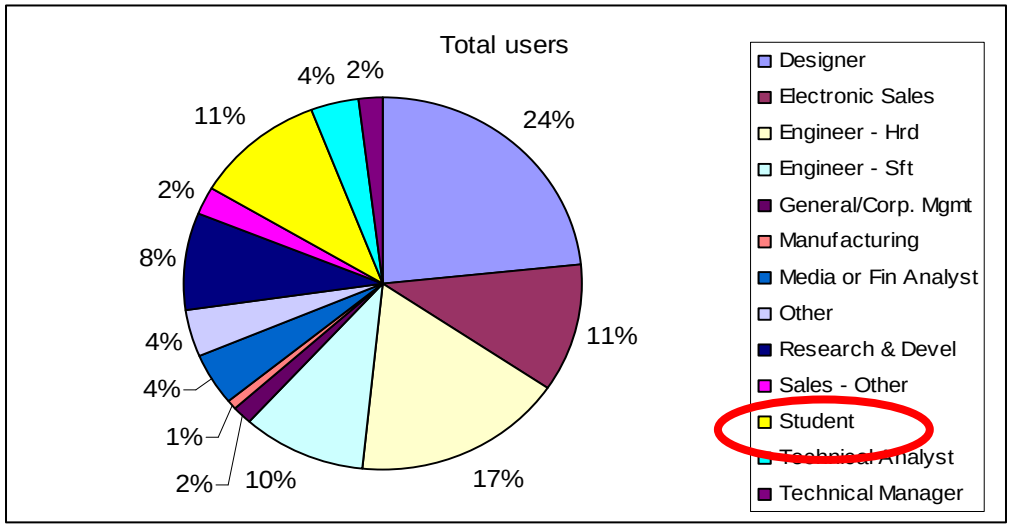
Renesas University Program – Worldwide on **www.renesasuniversity.com**



Renesas University Program – Worldwide on **www.renesasuniversity.com**

… featuring RENESAS INTERACTIVE

Total number of subscribers = ca 38000
Total number of students = ca 4000



Renesas Interactive provides a convenient Online environment for Customers, Distributors, Alliance Partners and **University Students** to get quality training on both Renesas devices and development tools.

Renesas University Program feat. Renesas Interactive - Virtual Lab

Goals of Renesas (RTE) University Program

- Support University teaching staff across Europe to setup labs & teach courses and with Renesas products.
- Provide the standard microcontroller architecture taught in Universities – worldwide!
- Focus on Universities with best in class engineering reputation teaching microcontroller architectures and programming.
- Enable students learning by providing nominated University staff free of charge development tools and benefits from world wide Renesas support infrastructure.
- Provide Universities with contacts to global employers, design houses and of course other European Universities working with Renesas products.

What do we offer to the Partner Universities

- Sophisticated Web acces with Renesas Interactive online labs and tools
- Discounted and free of charge Renesas Starter Kits (RSKs) which enable hands on course/project work based on MCUs/ high level programming language.
- Supply of literature: Renesas will provide hardware manuals, brochures and application notes for the chosen MCU.
- Technical support: Renesas will provide direct technical support to up to two nominated members of university staff on tools provided
- Technology trends
  Renesas newsletters inform students and professors on latest technology trends and technical updates on Renesas products.
- Joint PR

Focus starter kits for RTE Partner Universities

Device Family	RSK	Preferred Debug Tool	Availability
R8C	RSKR8C25	E8	Now
M16C/62P	R0K33062PS000BE	E8	Now
M32C/87	R0K330879S000BE	E8	Now
SH/Tiny	RSKSH7124	E10A-USB	Now
SH-2A	RSKSH7211	E10A-USB	Q107
SH-2A	RSKSH7201*	E10A-USB	Now

* *Ethernet plus USB optional communications board available on demand*

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Active Universities*

* Status July 2007

Logistics and support to RTE Universities

Legend:

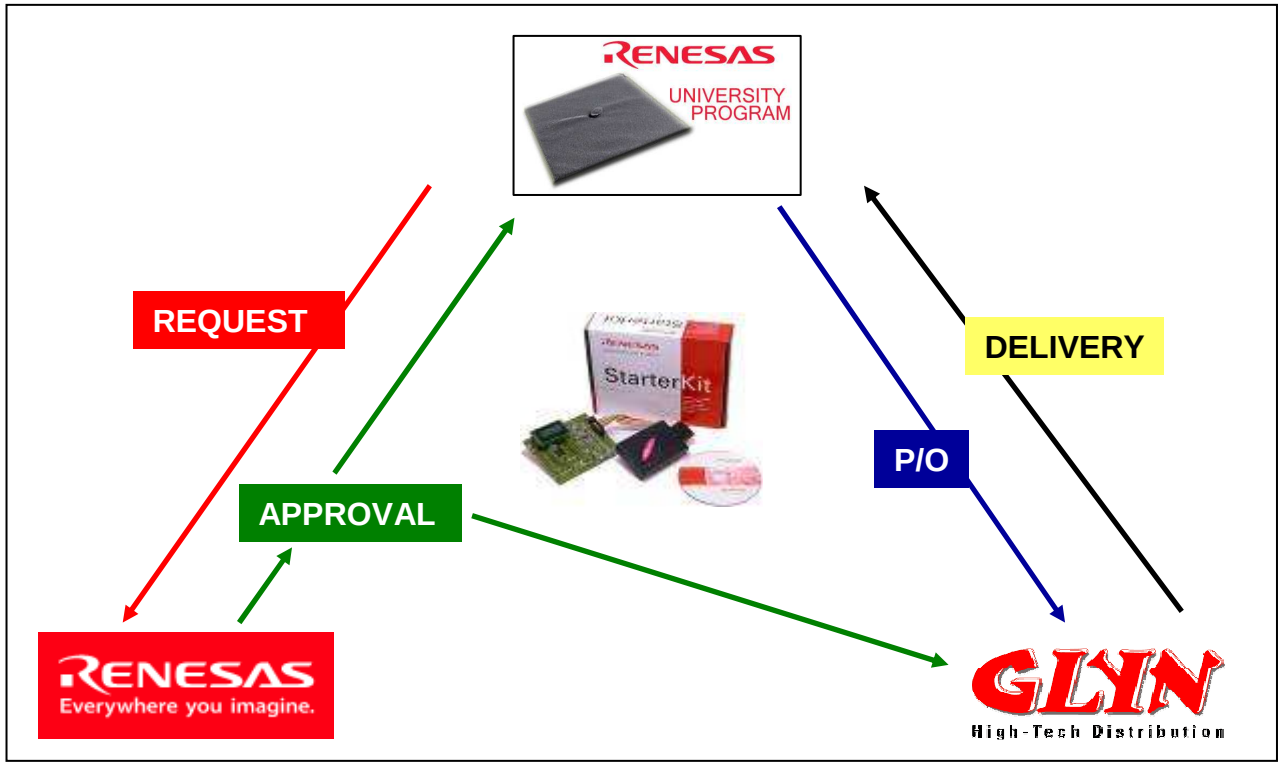
University or their key contact at Renesas

P/O

Optional Purchase Order

Logistic Service Provider

Logistics Business Model:



Contact Info
GLYN GmbH & Co. KG
Am Woertzgarten 8
D-65510 Idstein
Germany
Phone: +49-6126-590-222
Fax: +49-6126-590-111
sales@glyn.de

Actual University support and outcome

Universities working with RTE are requested to provide yearly reports to review the outcome reached with the provided devices and their status .
Universities are continuously informing us about the ongoing projects. Those are recorded and implemented into the daily business and PR.

Students @ Work with Renesas RSK Kits

Supported Products

Product	Qty
HS0005KCU11H	1
R0K33062PS000BE	43
R0K3306NKS000BE	4
R0K330879S000BE-BW	2
R0K42215RS000BE	2
R0K521256S000BE	9
R0K571242S000BE	5
R0K572011S000BE	2
R0K572115S000BE	1
R0K572115S000BE	1
ROK33062PS000BE	1
RZB-CC16C-ZDK	6
S32HEWNC30-N5-6	4

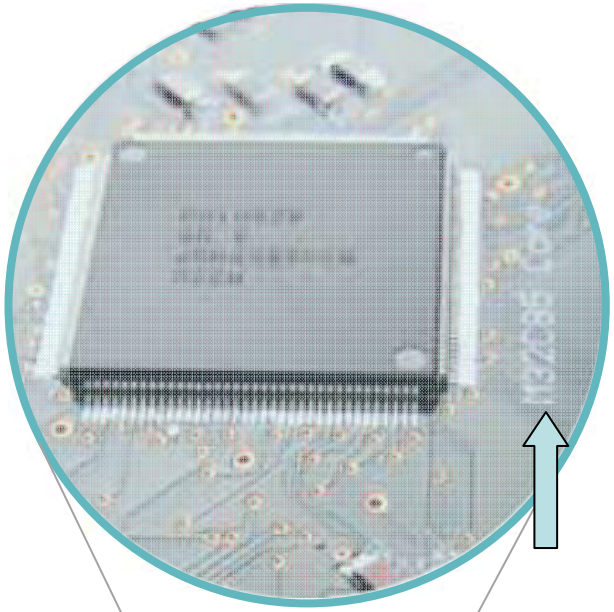
University

Glamorgan
Leipzig
Prague
Warszawa
Tampere
Kiel
Vaasa
Clermont
Lulea
Muenchen

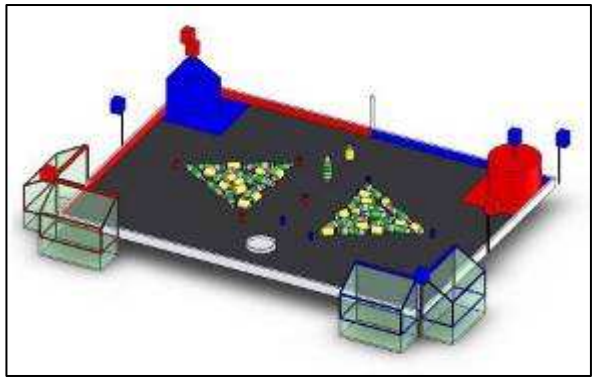
List of currently supported Universities and tools

Latest sucess story with CLUB-ELEK

(Insa Lyon)

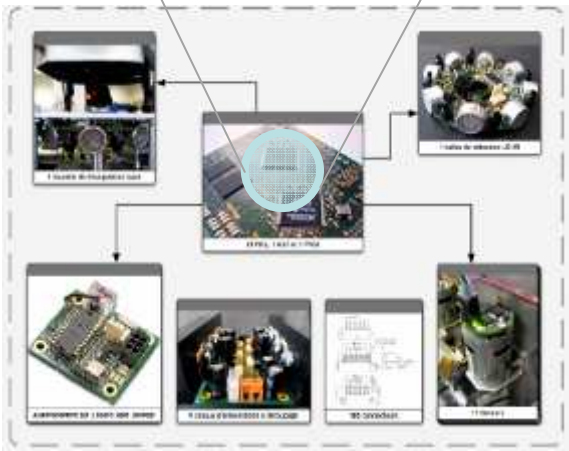


Eurobot Recycling Rally



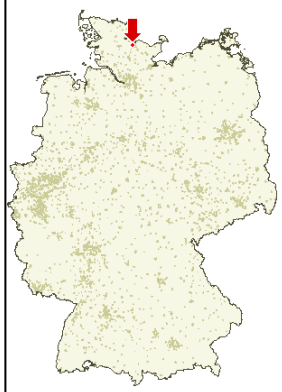
Waste, Sort & Win!
The robot which sorts the most waste into correct bins will be the winner.

INSA Lyon Robot run on the M32C/83 device took place at the Eurobot competition and won the 3rd place amongst the competition of 200 teams from 22 different countries.



Actual University outcome in detail

Kiel University of applied Sciences / Germany



Kiel University of Applied Sciences
Faculty of Computer Science and Electrical Engineering
Center for Adaptronics

Research and development with support of Renesas Europe:

Final Project Thesis, in co-operation with ECAM, Brussels, Belgium:
Sensor Networks with starterkit RSK R8C-15

Master-Thesis Information Technology:
Development of sensored network module considering the
ZigBee-Standards with RSK M16C-29, ZMD 44102

Master-Thesis Information Technology:
TCP/IP über 802.15.4 IEEE stack compared to the existing ZigBee stack.
RSK M16C-29, MicroChip ENC 28J60 Ethernet solution

Ongoing research activities employing the Renesas Technology:

Development of Wireless Sensor Network nodes for environmental monitoring with M16C-29

Development of Wireless Sensor Network applications for habitat and health monitoring with ZigBee

Feasibility study: recording handwritten information using accelerometers and ZigBee.

SniffBee - Realtime visualization of ZigBee sensor data: master student project related to "Ambient Intelligence".

Development of sample sensor nodes using ZigBee and I2C-bus RSK M16C-29 and ZigBee Starterkit

Development of a ZigBee-based energy-efficient data logger (with local, node-based intermediate data storage and processing) .

Co-operation with University of Aveiro, Portugal and the Federal University of Santa Catarina (UFSC), Florianópolis, Brasilien. Goal: development of new low power sensor network solutions based on ZigBee.

Actual University outcome in detail

INSA Lyon / France - **ranked among the top universities of Science and Technology in Europe**

- INSA sees a great benefits to teach their students on the Renesas 16-bit & 32-bit architectures as they want to prepare efficiently their students to work for international companies (big & middle sizes): Sagem, Renault, Schneider, Peugeot, Alcatel, Alstom,… they have about 1000 industrial contacts.
- What can we get out of this short term?
  Short term: make press release on the robot based on Renesas MCU, promote our image within the school, increase the Renesas awareness within the INSA network of schools in France.
  Mid-term/Long term:
  a) Get >100 students per year trained on Renesas MCUs: R8C & SH, "Renesas minded" people.
  b) Increasing demand on our MCU as the cores are more & more known.
- **Top result** – 3rd place on the european "EUROBOT" contest – see next slide for details

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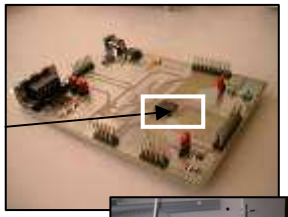
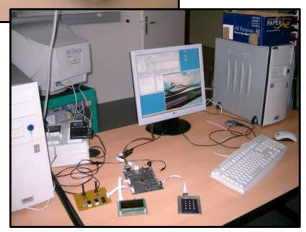
Polytech Clermont-Ferrand / France

Motor Control developments: DTC (Direct Torque Control) & FOC (Field Oriented Control) SW algorithms on SH Tiny



Practical Work (up to 200 hours per year)
… based on M32C + real-time kernel to drive a specific simulation car game on PC



A student from Polytech is currently working at Fagor in Lyon on M16C and has experience on SH Tiny for asynchronous motor. It's great opportunity for us to strengthen our relationships with Fagor in Lyon.
Furthermore, Polytech is supporting a French customer called ETME for their development on SH Tiny for asynchronous motor
Thanks to our cooperation with Polytech, several customers are now evaluating our MCUs.

… and outside Europe?

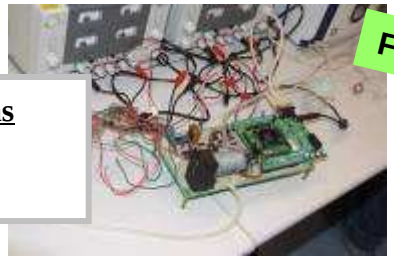
Here are some exciting examples….

Singapore

NANYANG TECHNOLOGICAL UNIVERSITY

One of the Lab – Computer Engineering

Various Interesting Projects



Detection of different **exhallations**
(H8S/2377 MCU)
(Final Year Student project)

Final Year Project

Testing of **hearing** capability
(H8S/2377 MCU)
(Final Year Student project)

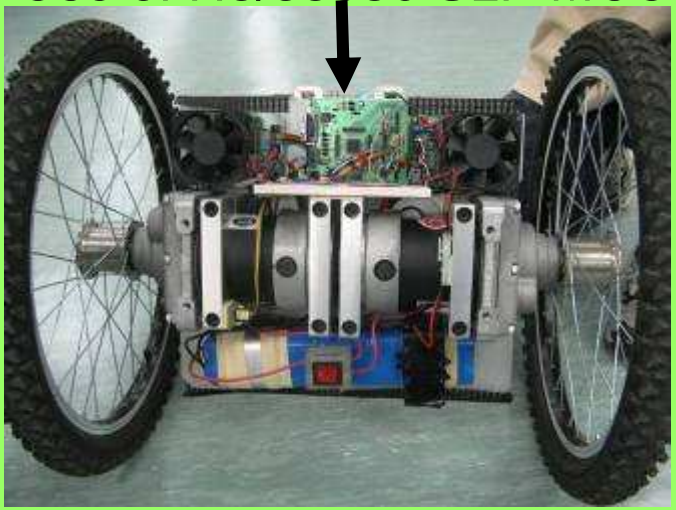
2nd Year Design Project

Final Year Student project
Sensor network using SLP

2nd Year Projects using SLP CPU Board – Java Programming in PC, controlling **Obstacle-avoidance moving robot**

Moving Robot picking up **color balls**
Using H8S/2377 MCU
(Final Year Student project)

Use of H8/38086 SLP MCU



Amazing Projects

Undergraduate Final Year Project - 1 person Output

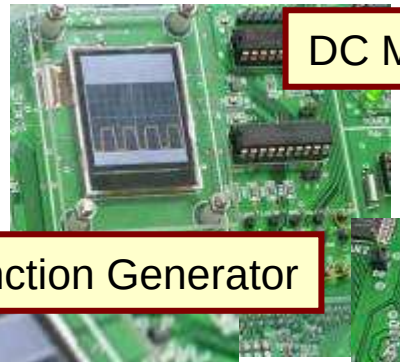
2nd Year Lab lesson
-Creation of general application on training board

Lift simulator

Text Editor

Printer control

DC Motor – PID controller



Function Generator

Tetris Game

3

Anna University
MCU Subject : R8C
Students : about 350 per year

Started in Year 2006

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

Renesas Lab

Local Partner :

FRONTLINE ELECTRONICS

Indonesia

Singapore India Indonesia Malaysia Australia Thailand Vietnam

6

Engage into having Renesas Tool and Lab in 4 main university

1. Malang (BCS Computer)
2. Surabaya (STTS, Mr. Budhy)
3. Jakarta (Trisakti University)
4. Semarang (Diponegoro University)

Main Activity: Conducting Courses

Started in Year 2005

Local Partner :

RENESAS PROMO INDONESIA
Tingga Teknologiku Maju Bangsaku

Renesas – With Confidence

Vaasa University of Applied Sciences / Finland

6th International Workshop on Ambient Intelligence and Embedded Systems

This is the sixth in the series workshop that has been held annually since 2001, and will bring together leading engineers, scientists and managers, around the world to benefit from the event and share their visions of the Embedded System future in the intteligent environment.

Renesas is proud to participate on the Workshop and to have the opportunity to share visions, see new perspectives and opportunities.
We see it as a chance to actively contribute and support the potentials in the area of the Embedded systems and Ambient intelligence.

Future visions

- **Student‘s contest,**
- **Press events,**
- **Support of competitions,**
- **University Forum,**
- **European University pages**
- **… and many more – in 2007 and 2008!**

Renesas Technology Europe

Everywhere you imagine.

Renesas Technology Europe

“Everywhere you imagine”

Intelligent chip solutions from the new semiconductor leader

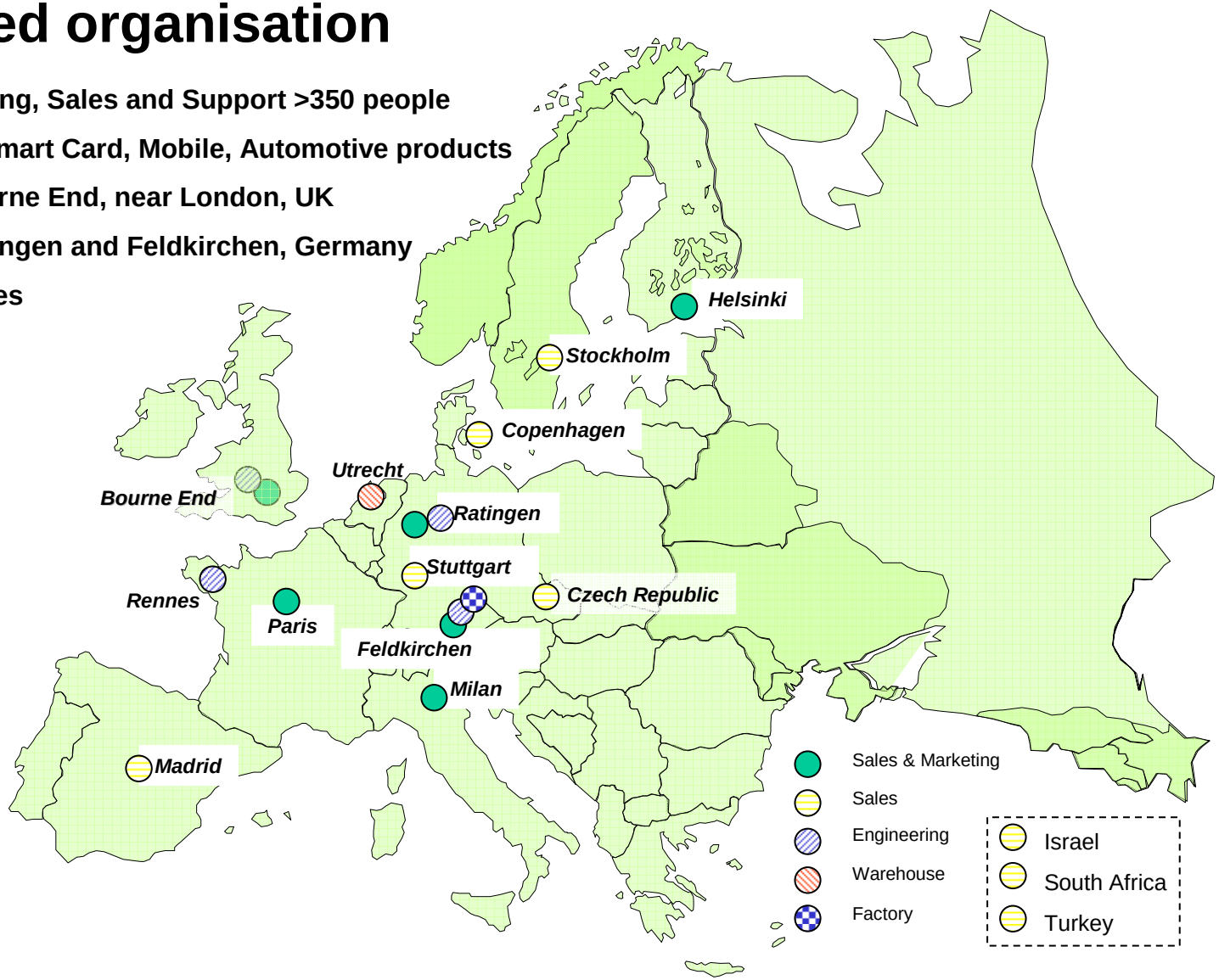
Renesas Technology Corp. - Profile

Name:	Renesas Technology Corp.
Established:	April 1, 2003
Paid-in capital:	¥ 50B (Hitachi: 55% Mitsubishi: 45%)
Sales:	¥906B in FY2005 (consolidated)
Capital Expenditure:	¥100B per year (average)
Employees:	26,000 (consolidated)
Management:	Chairman & CEO: Satoru Ito
	President & COO: Katsuhiro Tsukamoto
Head Office:	2-4-1 Marunouchi, Chiyoda-ku, Tokyo
Group Companies:	43 companies (18 in Japan)

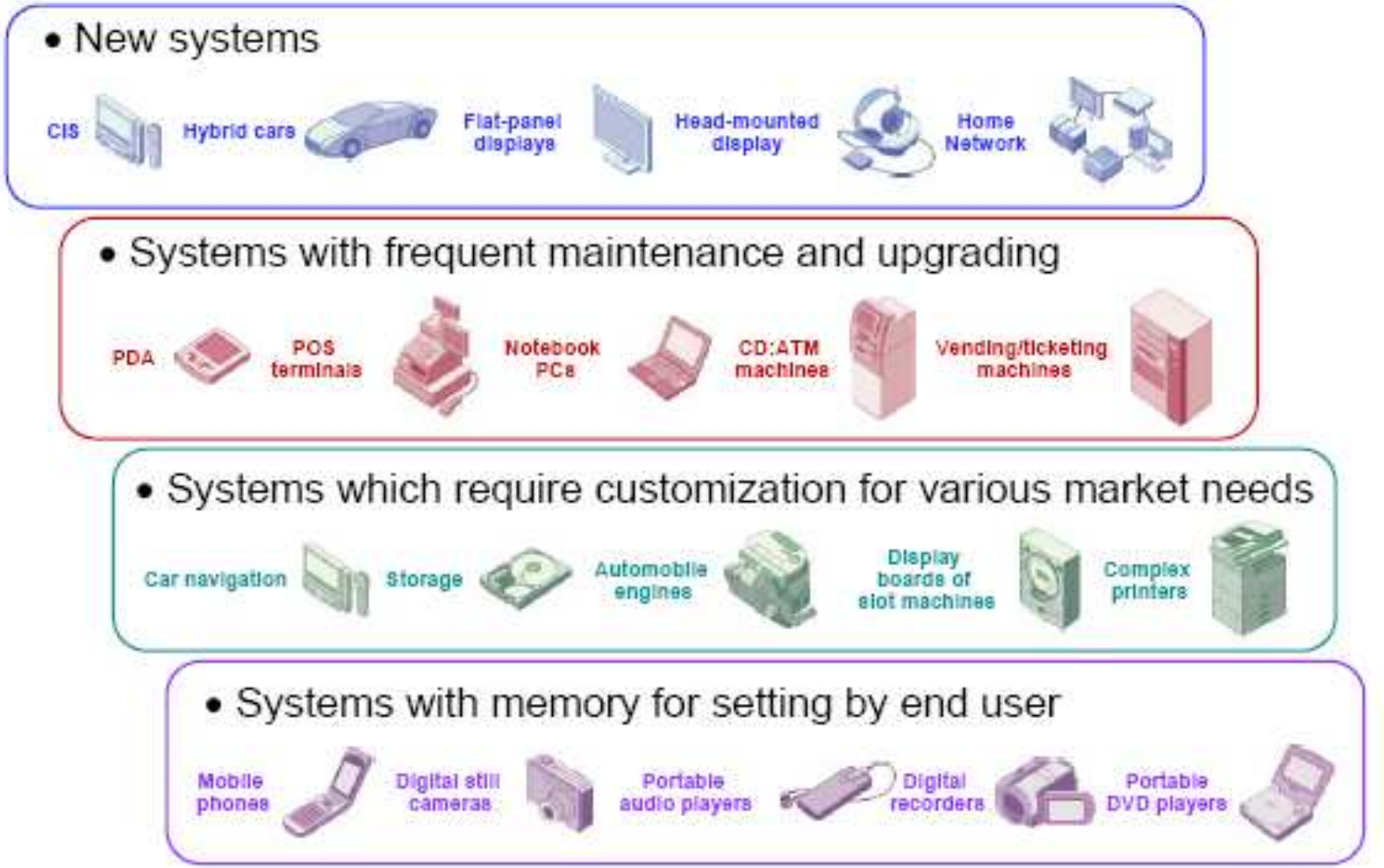
Renesas Technology in Europe

- a networked organisation

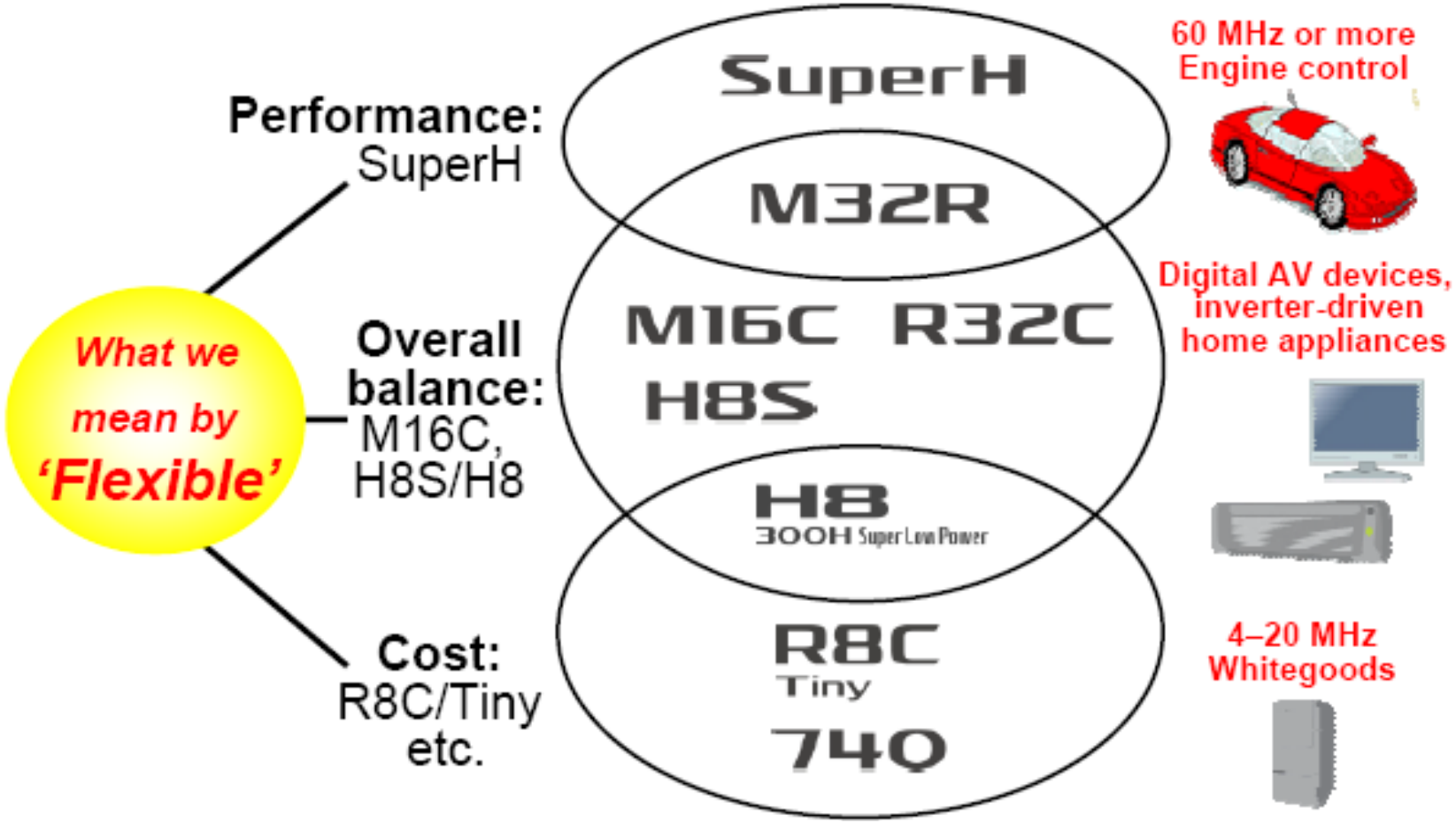
- Engineering, Marketing, Sales and Support >350 people
- Global support for Smart Card, Mobile, Automotive products
- European HQ in Bourne End, near London, UK
- Major centres in Ratingen and Feldkirchen, Germany
- Offices in 12 countries



Renesas MCU Products Applied to Various Fields



The most flexible lineup of flash-memory products: more than 300 product types in 30 groups



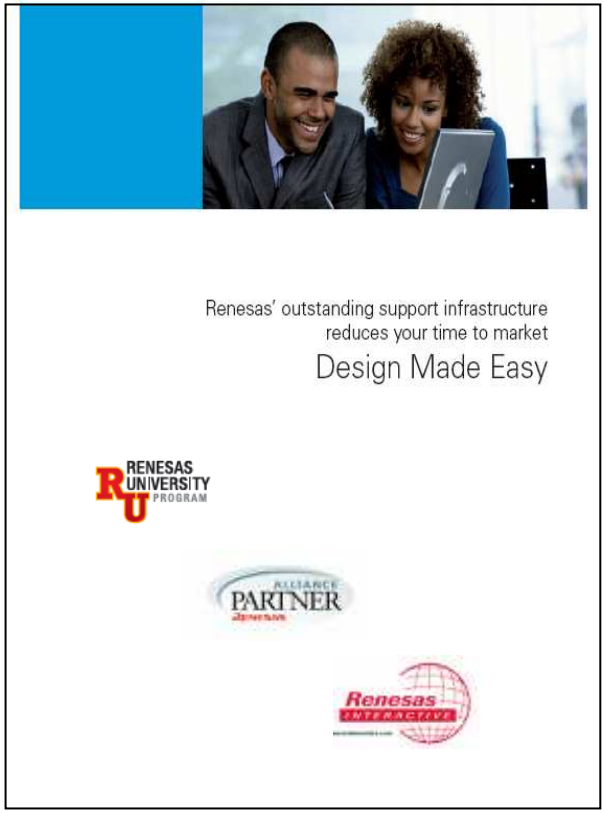
UNIVERSITY PROGRAMS

Greatest flexibility in development environments for flash-equipped products: Tools from more than 200 vendors are available

Renesas provides world class development tools.
We are continuously improving the functionality of our existing tools
and expanding our support with the introduction of new tools,to meet the evolving needs of our customers.
In addition to Renesas provided tools,many partner tools companies support Renesas microcomputers.

our SALES TOOLS

+



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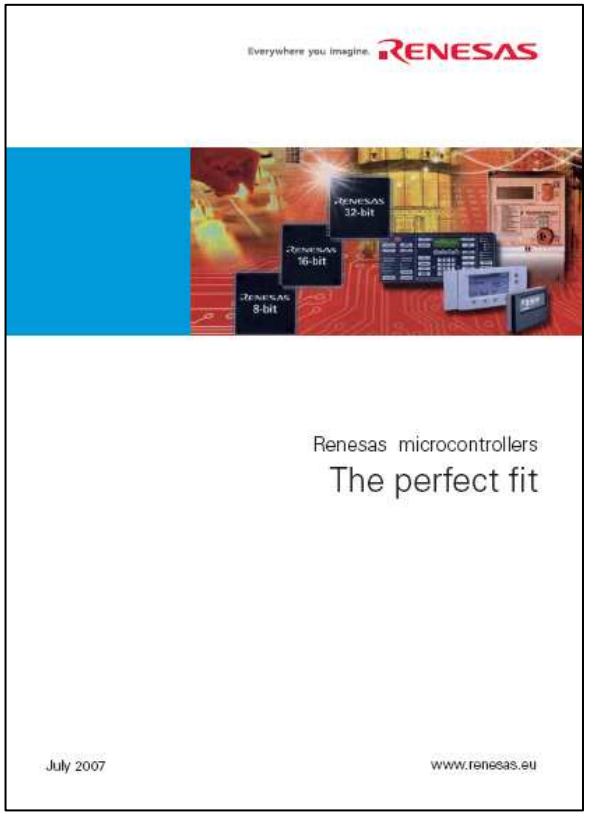


NEWSLETTER

Produced regularly for all product families, and for key application areas.

DESIGN MADE EASY

All about the Alliance and University program, Renesas Interactive and Renesas outstanding support infrastructure.

THE PERFECT FIT

With this flyer-tool you can guide your customer to the right product family for the particular design. All Renesas MCU families with their key features

our SALES TOOLS

THE PERFECT FIT IN DETAIL

Application overview

The Perfect fit

The Perfect fit

The Perfect Fit for Every Application

Renesas Technology is one of the largest semiconductor companies in the world that designs and manufactures highly integrated semiconductor solutions for industrial, consumer, automotive and telcoms markets. Established in 2003 as a joint venture between Hitachi and Mitsubishi Electric Corp., headquartered in Tokyo Japan Renesas employs over 26,000 worldwide.

Application Examples	R8C TINY	M16C	M32C	H8 TINY	H8 SLP	H8S	H8SX	SH	Renesas Strengths
	8-bit	16-bit	16/32-bit	16-bit	16-bit	16-bit	16/32-bit	32-bit	
Automotive	–	■■■	■■■	–	–	–	–	–	Dedicated TS9xxx devices.
Building Automation	■■■	■■■	■■	■	■■	■■	■	■■	Scalable platforms with high integration. Huge choice.
EPOS/Vending	■	■■	■	■■	■	■■■	■■■	■■	High integration. ISO7618 support. Multiple communications peripherals.
General Purpose Applications	■■	■■■	■■	■	■	■■	■■■	■■■	Embedded comms peripherals including LIN, CAN, USB, Ethernet, PLC etc..
Health/Fitness	–	■■	–	–	■■■	■■	■	■■■	Super low power. Integrated LCD drive.
Instrumentation	■■	■■	■	■	■■■	■■	■	–	Embedded flash up to 1MB. Huge choice. Integrated LCD drive.
Metering	–	■■	■	–	■■■	■■	–	–	Super low power. PLC and Zigbee solutions for AMR.
Motor Control	■	■■■	■■	–	–	■■	■■	■■■	Dedicated motor control timers. High performance CPU cores.
Multimedia & AV	–	■■	■■	–	–	–	–	■■■	Highest MIPs/Watt.
Small Appliances	■■	–	–	■■	■■	–	–	–	Excellent price/performance ratio.
White Goods	■■■	■■	■	■■■	–	–	–	■■	Excellent price/performance ratio. Best in class EMC performance.

■■■ Target Market - Highly recommended
■■ Suitable Market - (Good fitting products)
■ Products available
– Products currently available

As the the No1 microcontroller supplier globally, Renesas is 100% committed to MCU/MPU providing the full range of controllers. From low power consumption technology such as R8C and H8 SLP, over a broad selection of 16-bit general purpose devices like M16C and H8S(X) up to real time SH RISC controllers and SH processors. Renesas offers a perfect solution for every application.

With this "Choice Made Easy" we would like to guide you to the right product family for new design projects. It gives you a comprehensive overview on all MCU controllers with their key characteristics and the corresponding tools. You will also find a recommendation of product families for certain applications, which is based on the current usage of controllers in certain segments. This is not binding of course. Feel free to select the controller of your choice for your new project - there are no limits!

Renesas outstanding support infrastructure with a fully commited partner network will support you to find new creative solutions and accelerate your time to market.

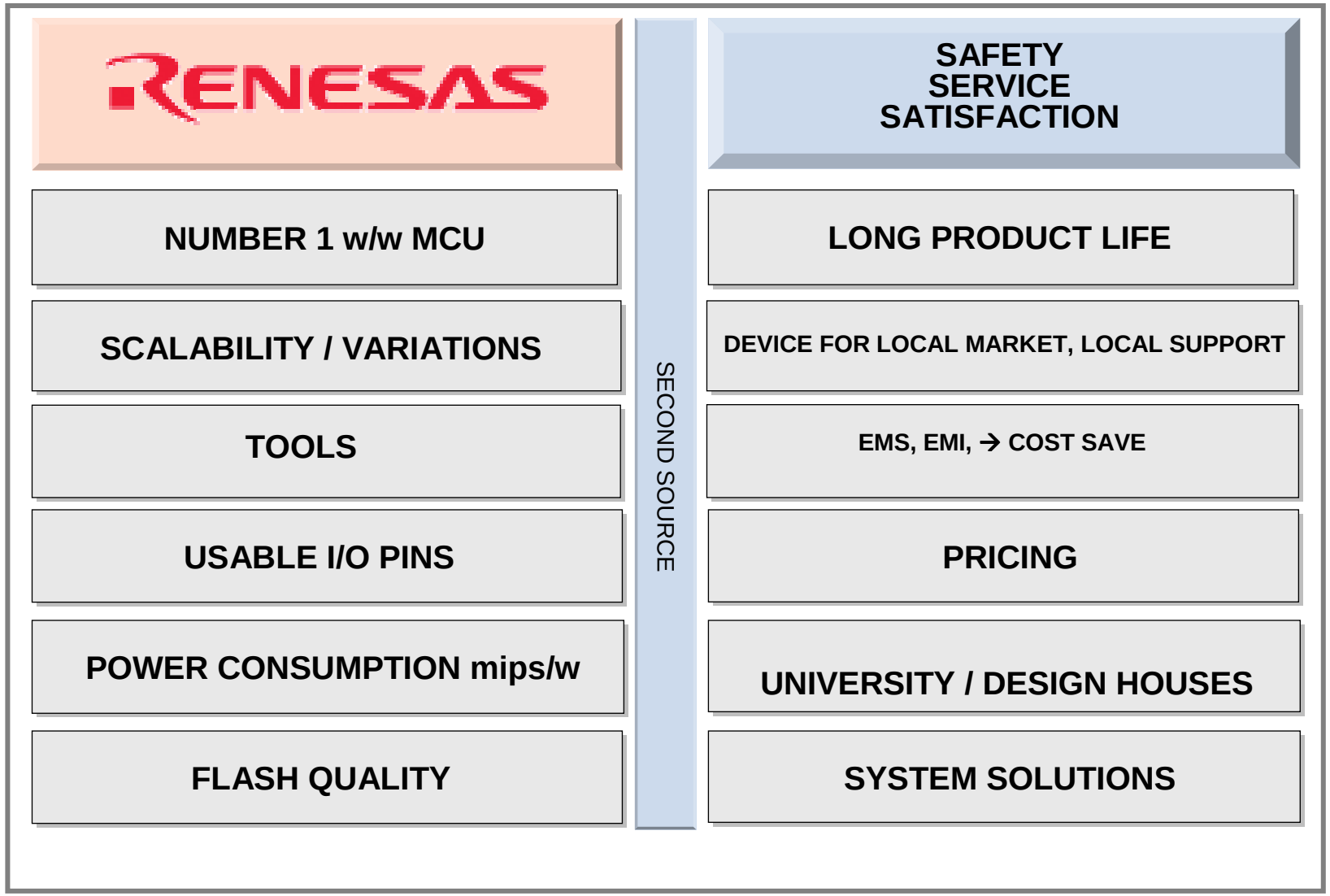
Renesas MCU Provides Customers with "Safety", "Service", and "Satisfaction"

Offer safety by
highly reliable design and
high quality manufacturing.

Offer satisfactory solutions
to share prosperity
with customers.

Offer complete solutions of
design to production stage.

INVINCIBLE CONTROLLER



My colleague

Andreas Schwaner
will continue to present our RSK

THANK YOU for your patient with me!

Renesas Technology Europe

Everywhere you imagine.

Renesas Starter Kits

Renesas Technology Europe

Raimund Stampa / Andreas Schwaner

25/10/2007

What is the „Renesas Starter Kit“ (RSK)?

- Hardware and software platform
for Renesas general purpose microcontroller devices
- Easy to use
- Low cost
- Worldwide standardardized
- Easy Upscaling/Downscaling
- Enhanceable by Application Boards
- Ideal for Universities and Students

RSK Facts (as of 7/2007)

- Program started in 2005
- More than 11.500 RSKs shipped, currently 1.000 per month
- More than 24 different device platforms available

M16C/26A	H8/38347,327	SH7211
R8C/2B,2D	M32C/84-88	SH7201
R8C/26-29	M16C/6NK	SH7124
R8C/24,25	M16C/62P,30P	H8SX/1664
R8C/20-23	M16C/28,29	H8SX/1582
R8C/1A,1B	SH7203/63	H8S/2215R
R8C/10-13	SH7086	H8/38099

- Supports devices from all general purpose device families:

Standard Example: RSKH8SX1544

Hardware:

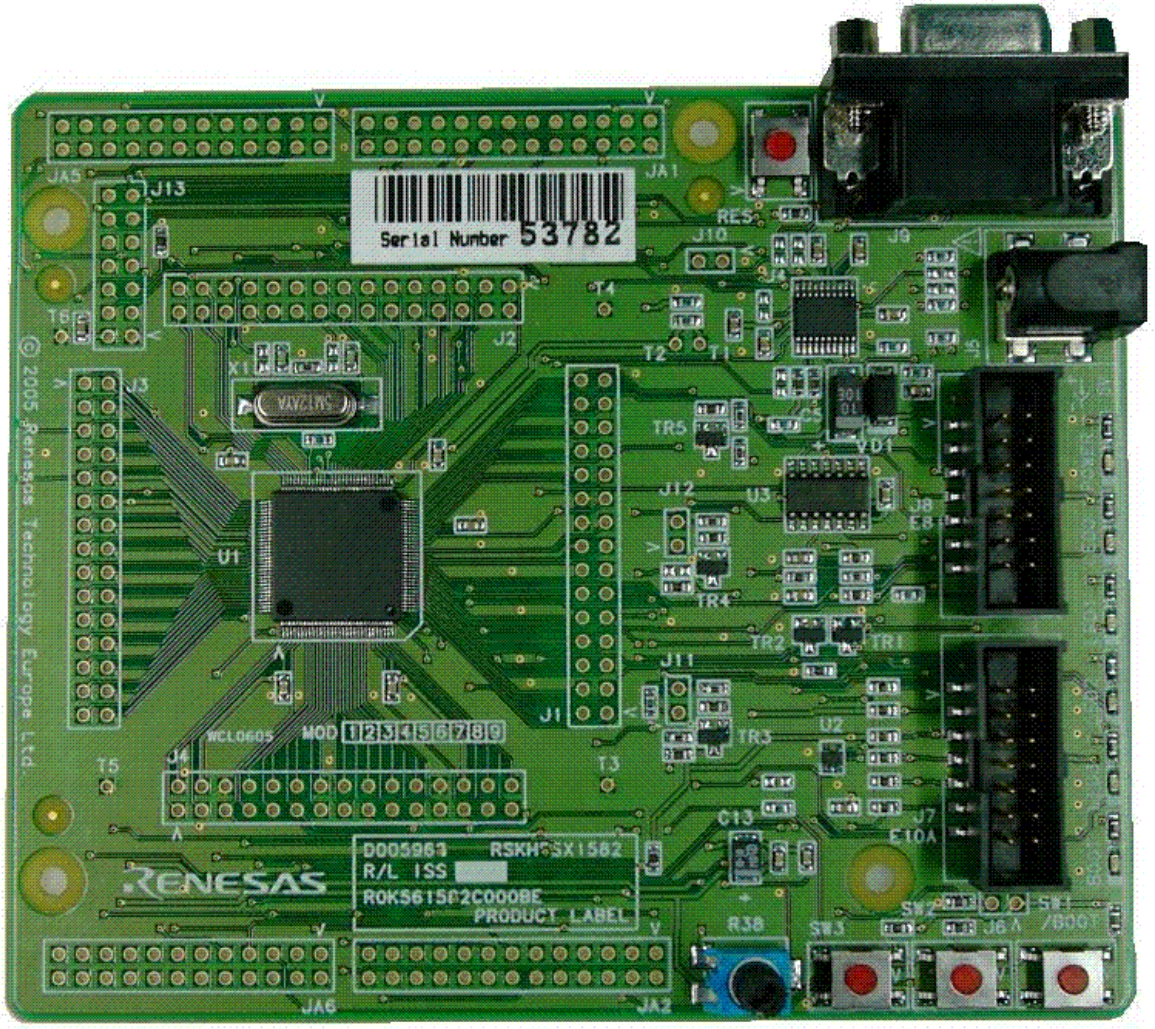
- Generic Header
- E8(A) / E10A-USB Debugger
- RS232 I/F
- LCD I/F
- LEDs, Switches

Software:

- Peripheral Driver Sample Code
  - ADC
  - DAC
  - DMA
  - Timer
  - SCI
  - RCAN
  - WDT
  - RTC
  - Low Power
  - IIC
  - Sound
  - LCD

Documentation

- User Manual
- Quick Start Guide
- Tutorial



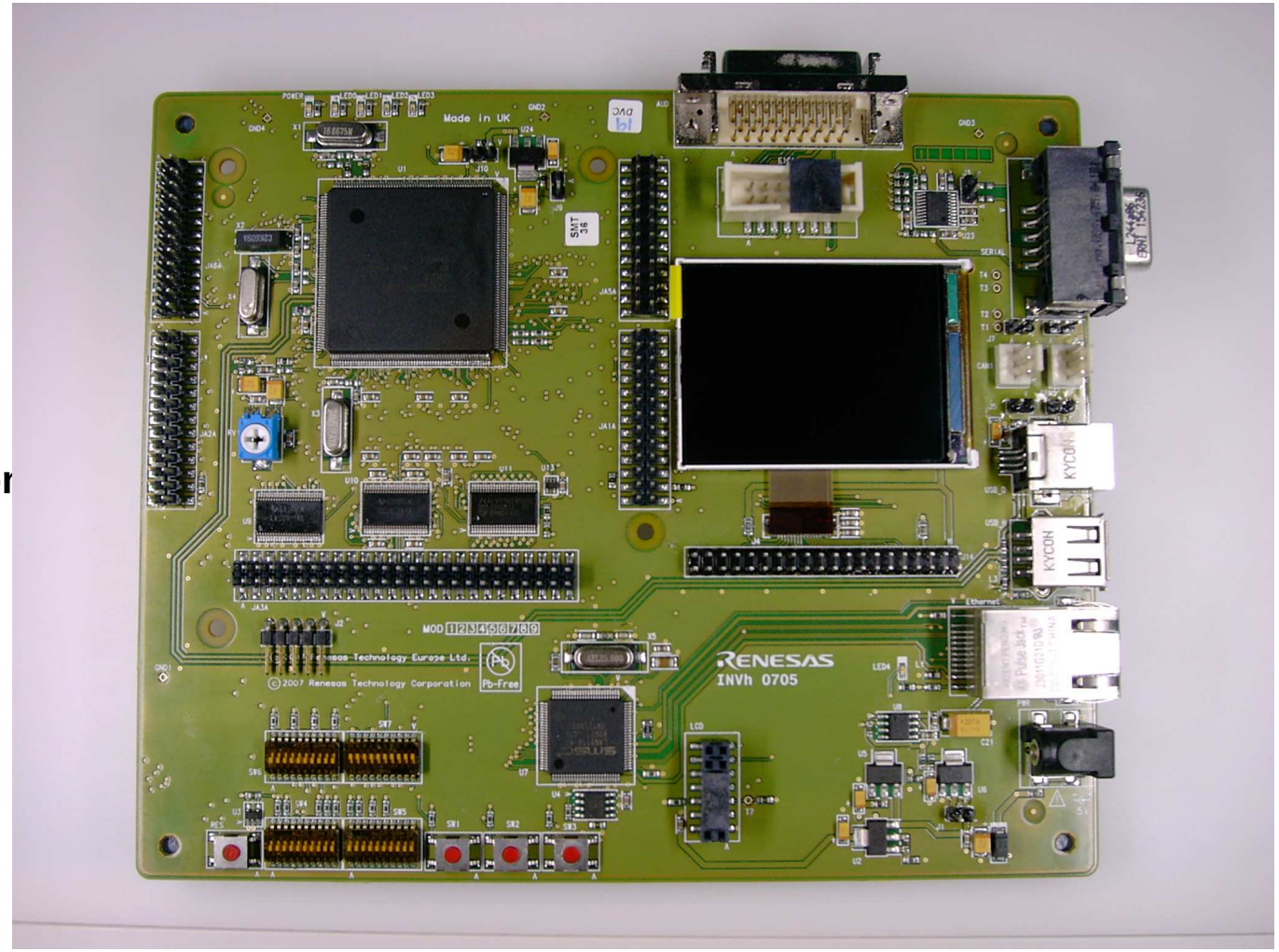
High End Example: RSK+SH7203

Hardware:

- Generic Headers
- TFT Display
- USB I/F and USB key
- Ethernet I/F
- 4MBit Flash (16bit)
- 16MBit SDRAM (16/32)
- E10A-USBSLII (JTAG)
- RS232 I/F
- LEDs / Switches

Software/Documentation

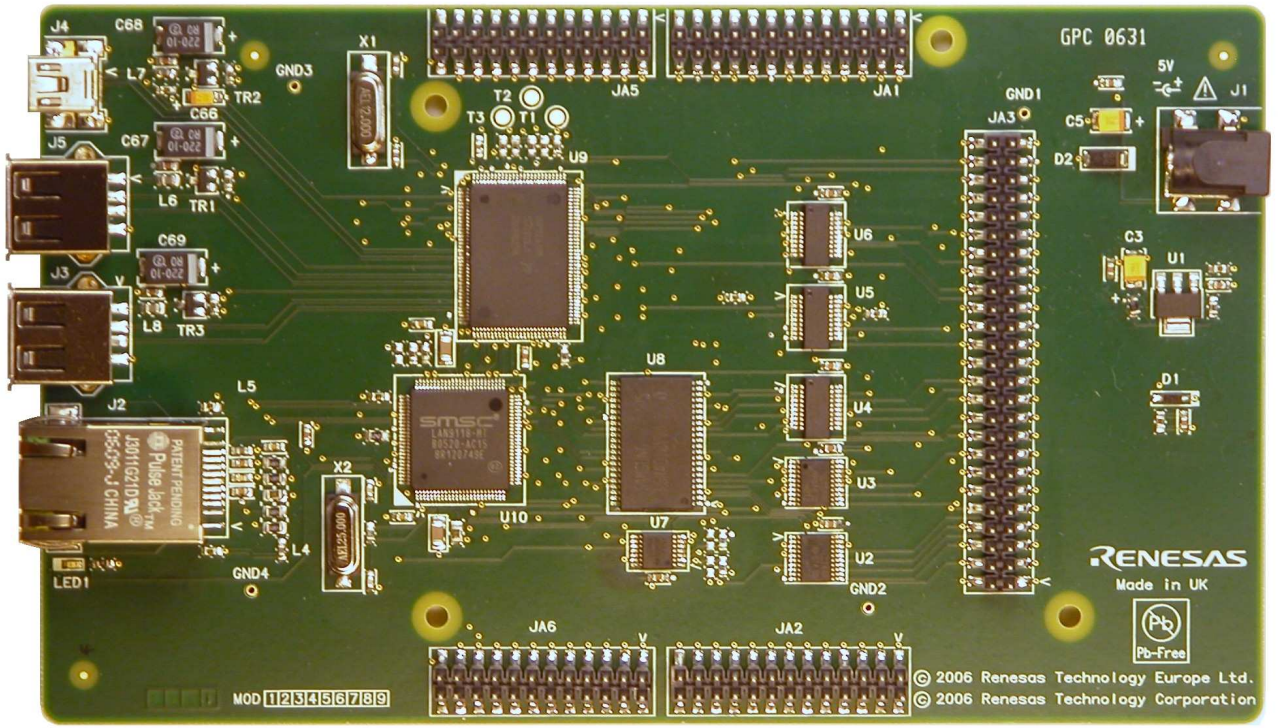
- Standard RSK CD
- plus µcLinux CD
  - Full device BSP
  - Ethernet driver
  - Embedded Web Server
  - USB host and function



Application Board Example: Ethernet/USB Comms Board

Hardware:
- Generic Headers
- Ethernet SMSC911
- USB OTG ISP1761
- SRAM 256Kx16bit
- LEDs

Software/Documentation:
- Quick Start Guide
- USB Application Note
- Ethernet Appl Note



Conclusion

- Get It!
- Use It!

+

+

Renesas Technology Europe

ZigBee-to-TCP/IP Gateway: New Opportunities for ZigBee-based Sensor Networks

Speaker: Alexandra Dmitrienko

Kiel University of Applied Sciences, Germany &
Saint-Petersburg State Polytechnical University, Russia

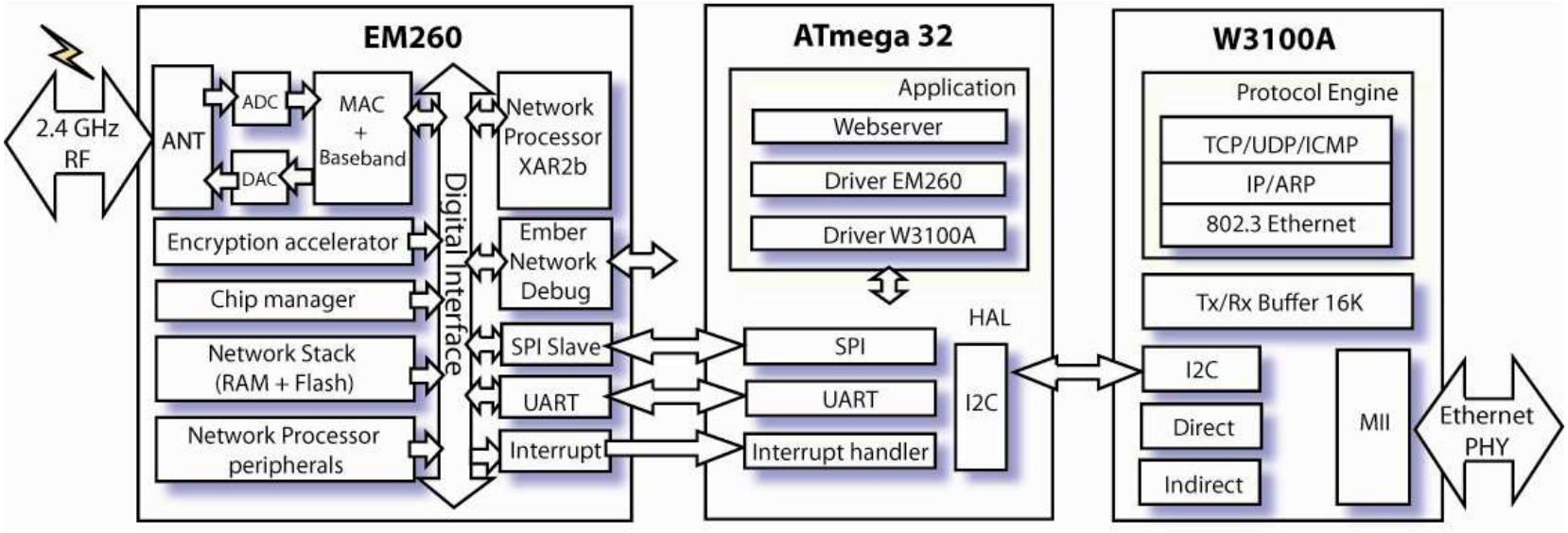
sdmitrienko@mail.ru, dav@efo.ru

Gateway TCP/IP <->ZigBee: utility

- getting remote access via Ethernet for control ZigBee network from any work station with internet connection
- possibility to upgrade firmware by remote uploading via Ethernet + over-the-air
- increase the size of the ZigBee network by integrating several small networks

Gateway TCP/IP<->ZigBee: structure

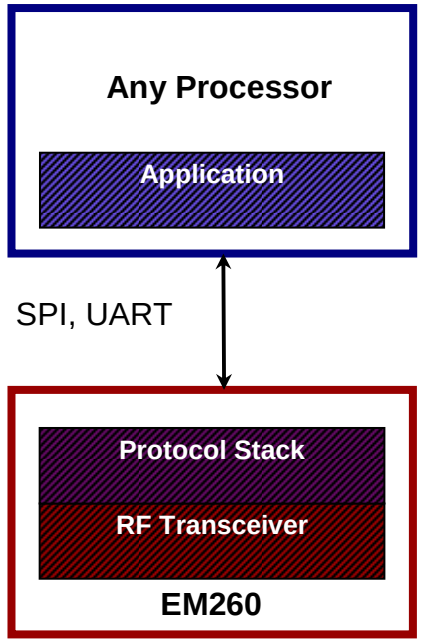
- ZigBee network processor
- Host controller for main application
- TCP/IP network processor



ZigBee network processor: EM260

EM260 Jump Start Kit

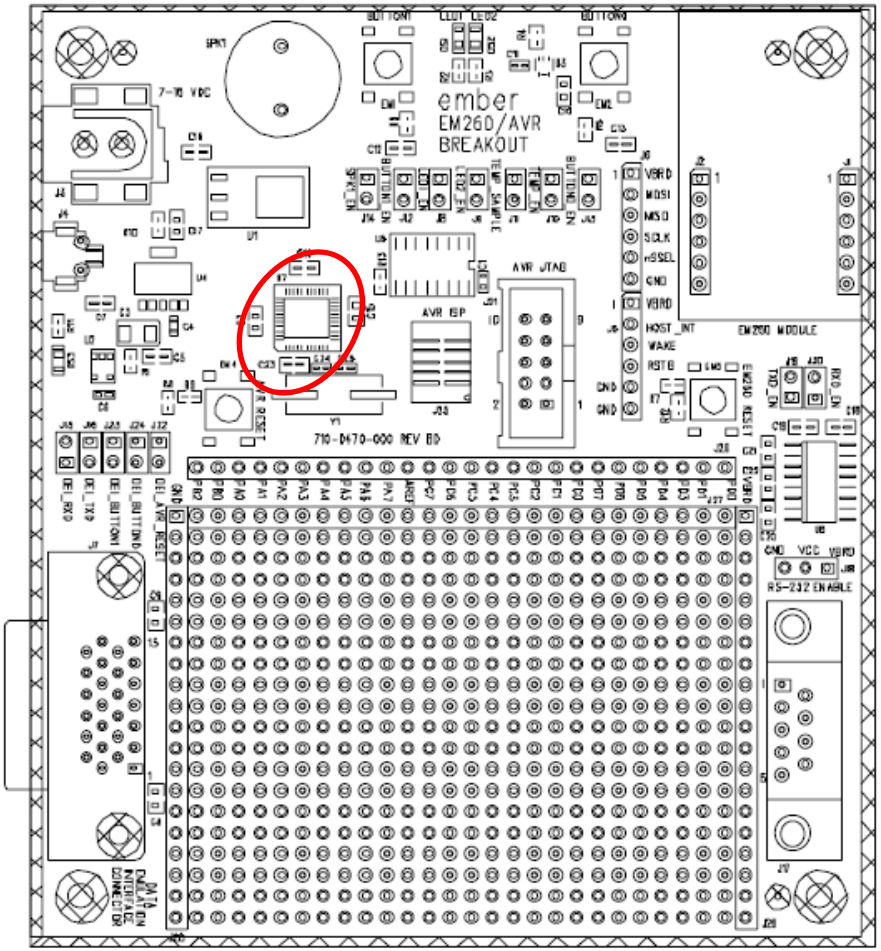
- **Breakout Boards, Radio Modules EM260 RCM**
  - Rapid prototyping and development
- **InSight Adapter (ISA)**
  - Enables on-chip and network-level debugging
- **Embedded Software**
  - EmberZNet libraries (binary)
    - Tree stack (ZigBee Stack)
    - Mesh stack (EmberZNet)
  - Supporting peripheral drivers (source)
  - Sample application source code
- **PC-Based Software**
  - InSight Desktop – development and deployment stage debugging



- Can be used with any MCU
- Adding ZigBee to any device is easier
- Self contained, and pre-programmed
- QFN 6mm X 6mm package

Host microcontroller: ATmega32

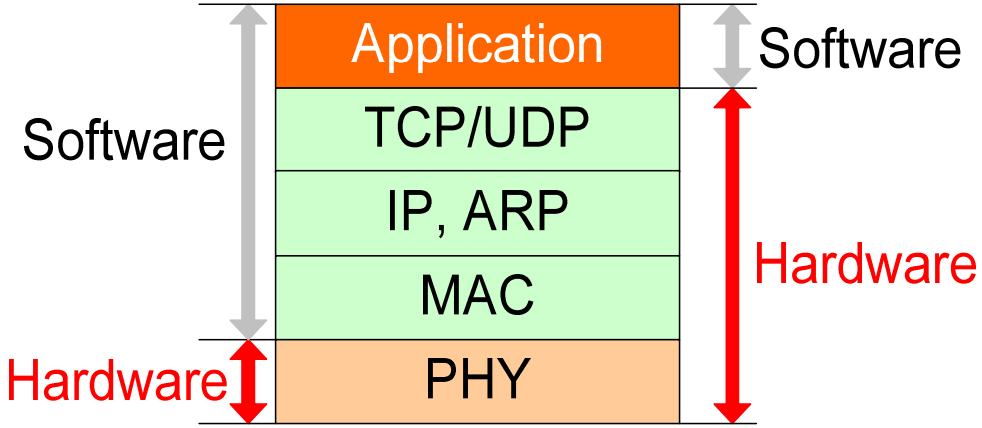
- 8-bit AVR microcontroller
- 16 MHz
- Low power
- High performance
- 32 K bytes Flash
- 1024 Bytes EEPROM
- 2 K byte Internal SRAM
- JTAG interface for debagging
- Hardware SPI



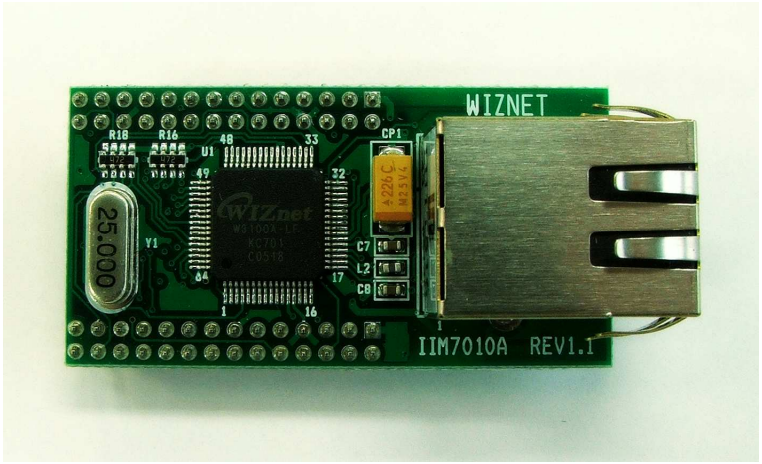
EM260 Breakout Board

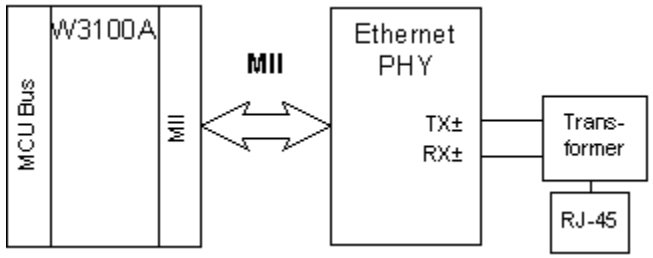
TCP/IP network processor: Chip W3100A

- Software TCP/IP solutions: Ubicom, Lantronix, NetSilicon, Rabbit, BECK…
- Hardware TCP/IP solution: WIZnet



Module NM7010A

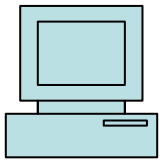




Implementation demands

- Configuration TCP/IP parameters
- Configuration ZigBee network options
- Transfer data through gateway

Realization:



Software for PC:
ConfigTool Utility

Firmware for MCU

Firmware for MCU

- Main application routine
- DHCP client
- UDP port for setting IP-options manually
- TCP server for configuration ZigBee network options and sending commands to ZigBee coordinator
- Transferring data between ZigBee and TCP/IP networks

WIZnet

- Driver for W3100A. I2C interface
- TCP server for transmitting data via TCP/IP network

ember

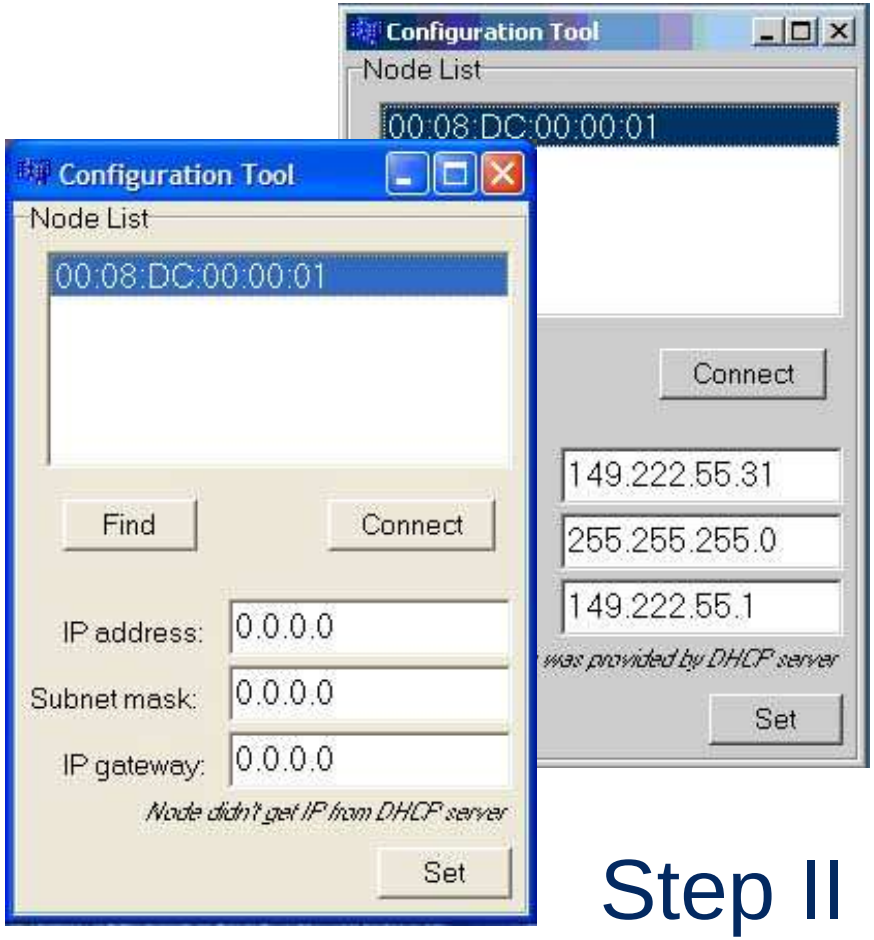
- Driver for EM260. SPI interface
- RS-232 interface
- HAL level (timers, buttons, leds, buzzer, WDT, etc…)

Software for PC: ConfigTool Utility

- Main user interface
- UDP port for configuration IP-options
- TCP-client for communication with gateway
- Configuration ZigBee network options
- Sending commands to ZigBee coordinator
- Getting of Coordinator's Binding Table

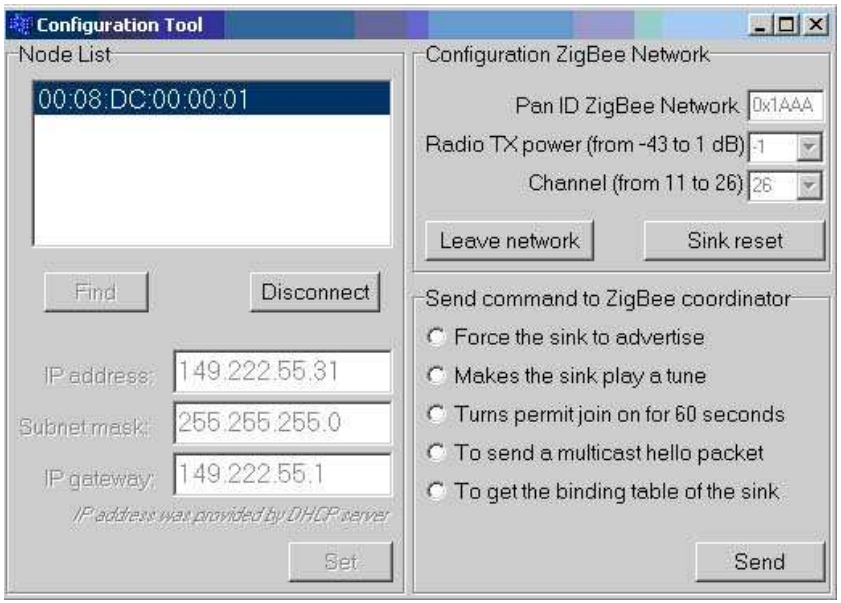
Utility ConfigTool: setting IP-options

Step I

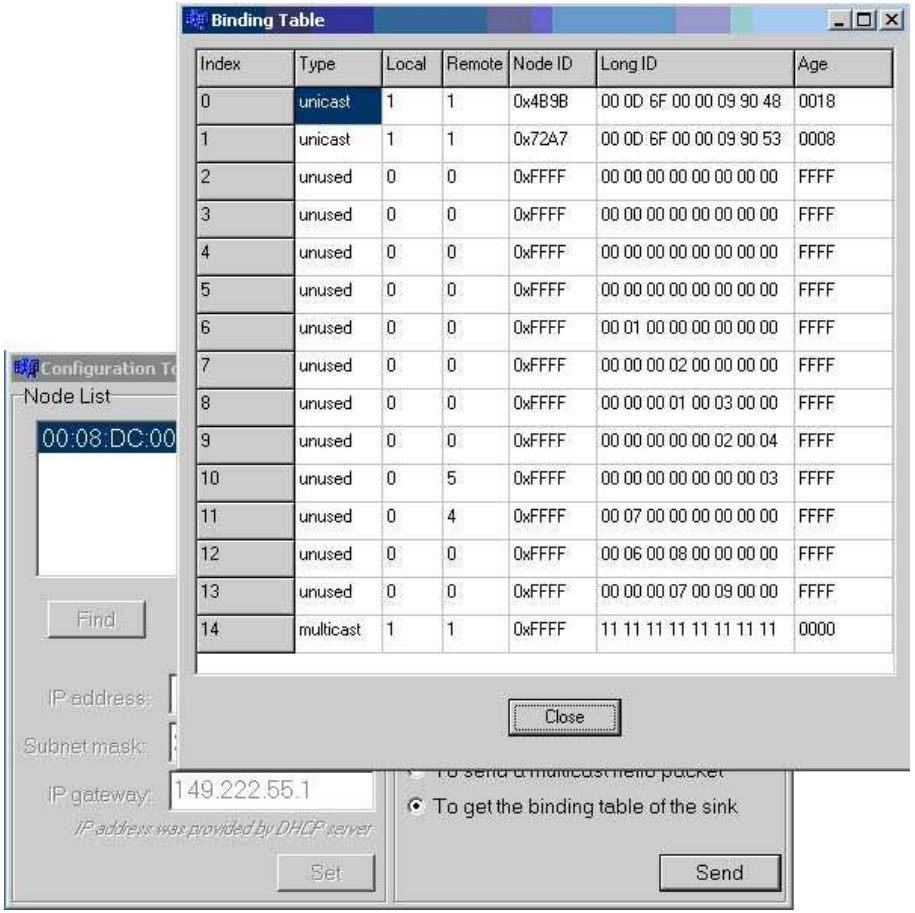


Step II

Utility ConfigTool: ZigBee configuration options

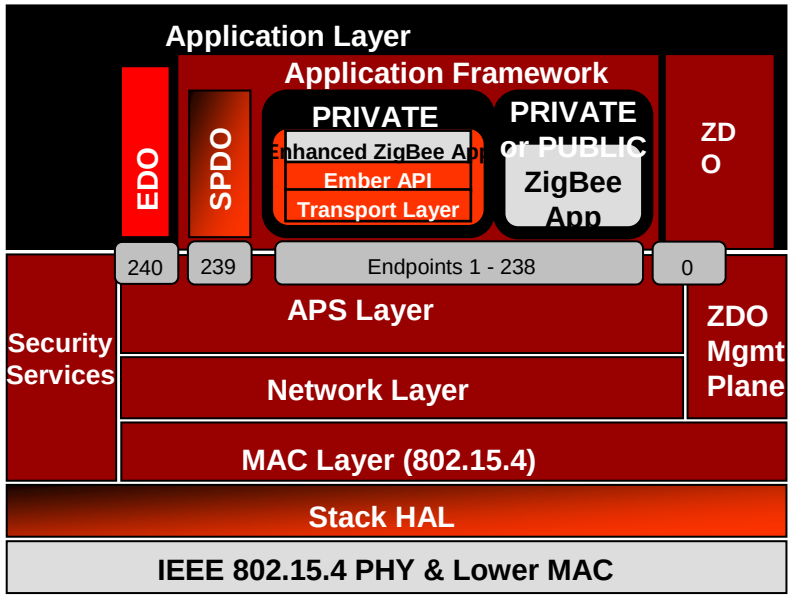


Step III



Transfer data

- Gateway is running in TCP-server mode
- For demonstration transfer data it is possible to use any standard TCP-client program (Telnet, Hyper Terminal)



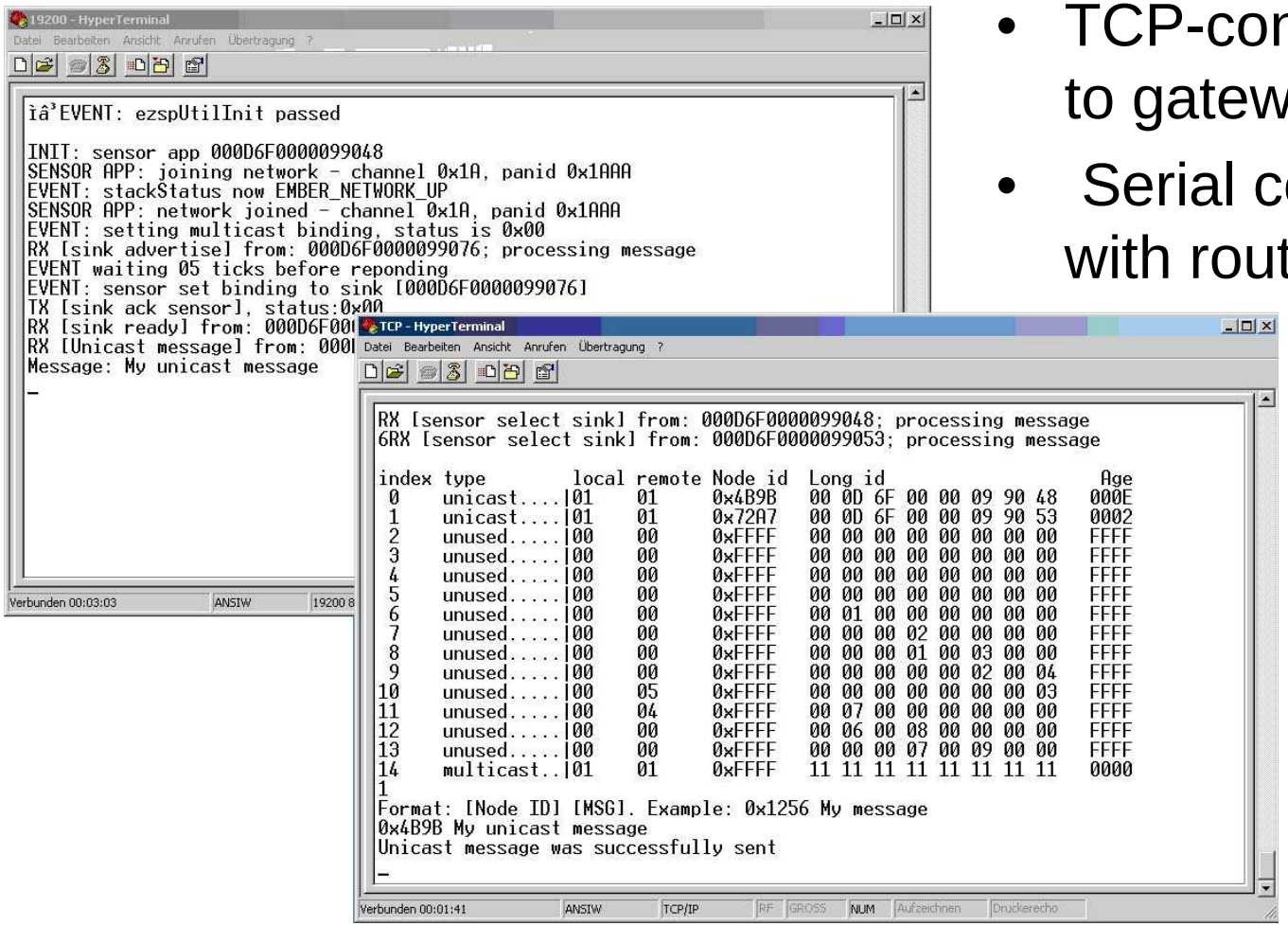
5 types of messages are available: Application Ember ZigBee

APS layer ZigBee

Transport layer EmberZNet

- unicast
- multicast
- broadcast
- datagram
- sequenced

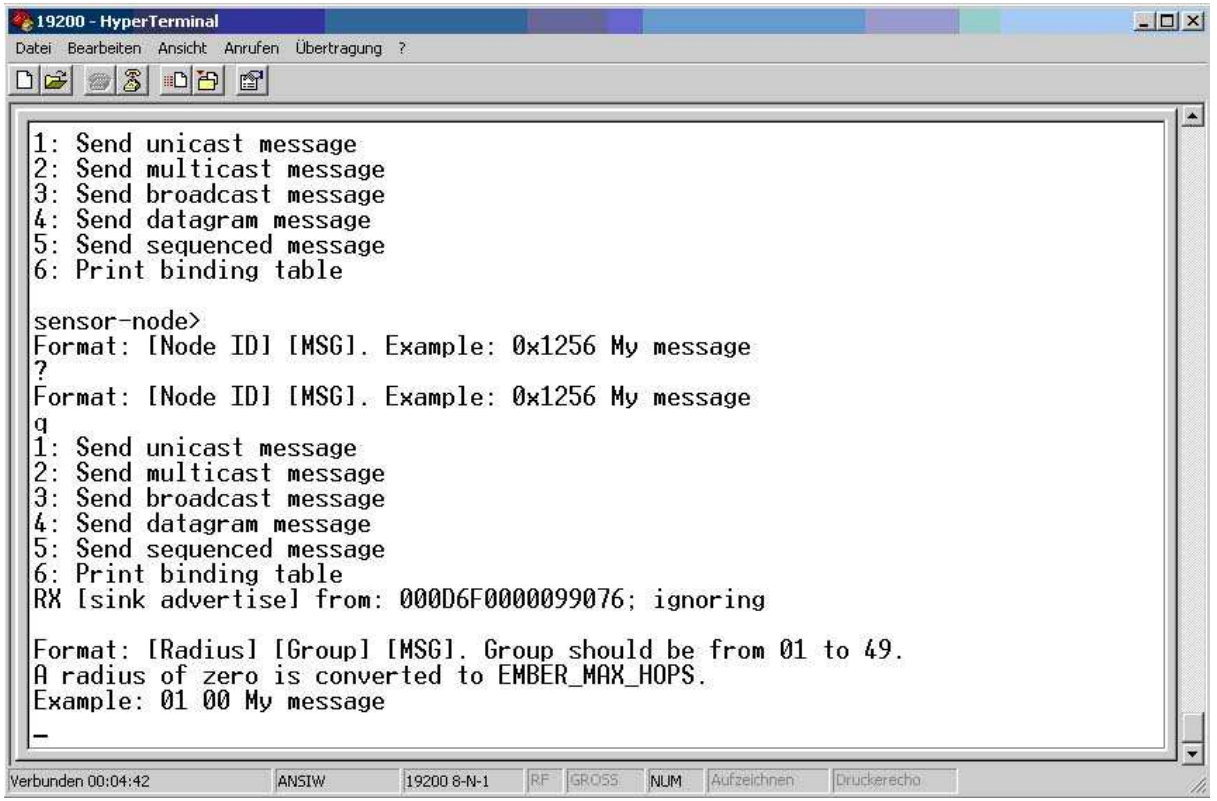
Transfer data



- TCP-connection to gateway
- Serial connection with router

Transfer data

- Help messages are available
- For getting help just button '?' should be pressed



Thank you for attention

SENSINODE

Zach Shelby, CTO

“I have a dream”

The *Internet*

+

The *physical* world

=

The Internet of things

A bit of Internet & wireless history

Arpanet,
Usenet,
BBSs

Internet

Web 2.0

Web Services

Sensor Networks

802.15.4 + 6LoWPAN -> Web Services

Ethernet

Proprietary
ISM Radios

Modems
Leased Lines
RS232

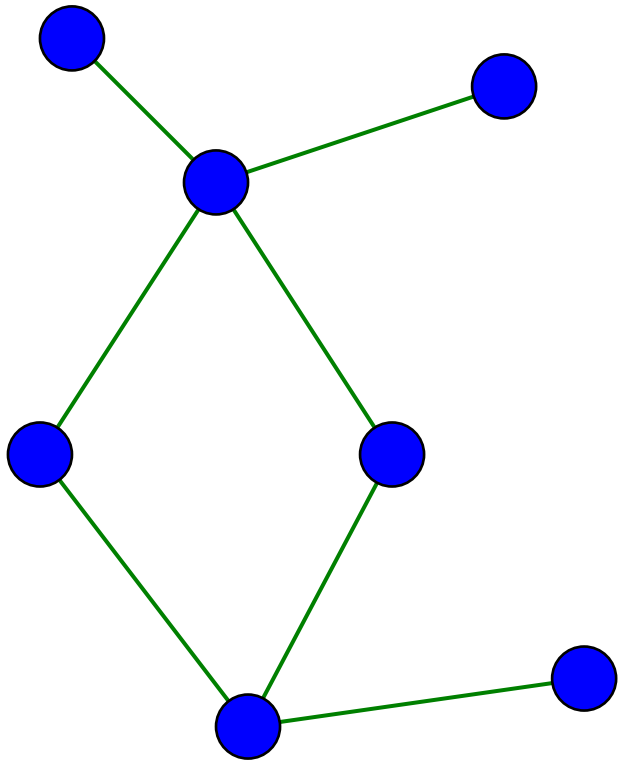
IEEE 802.15.4

6LoWPAN

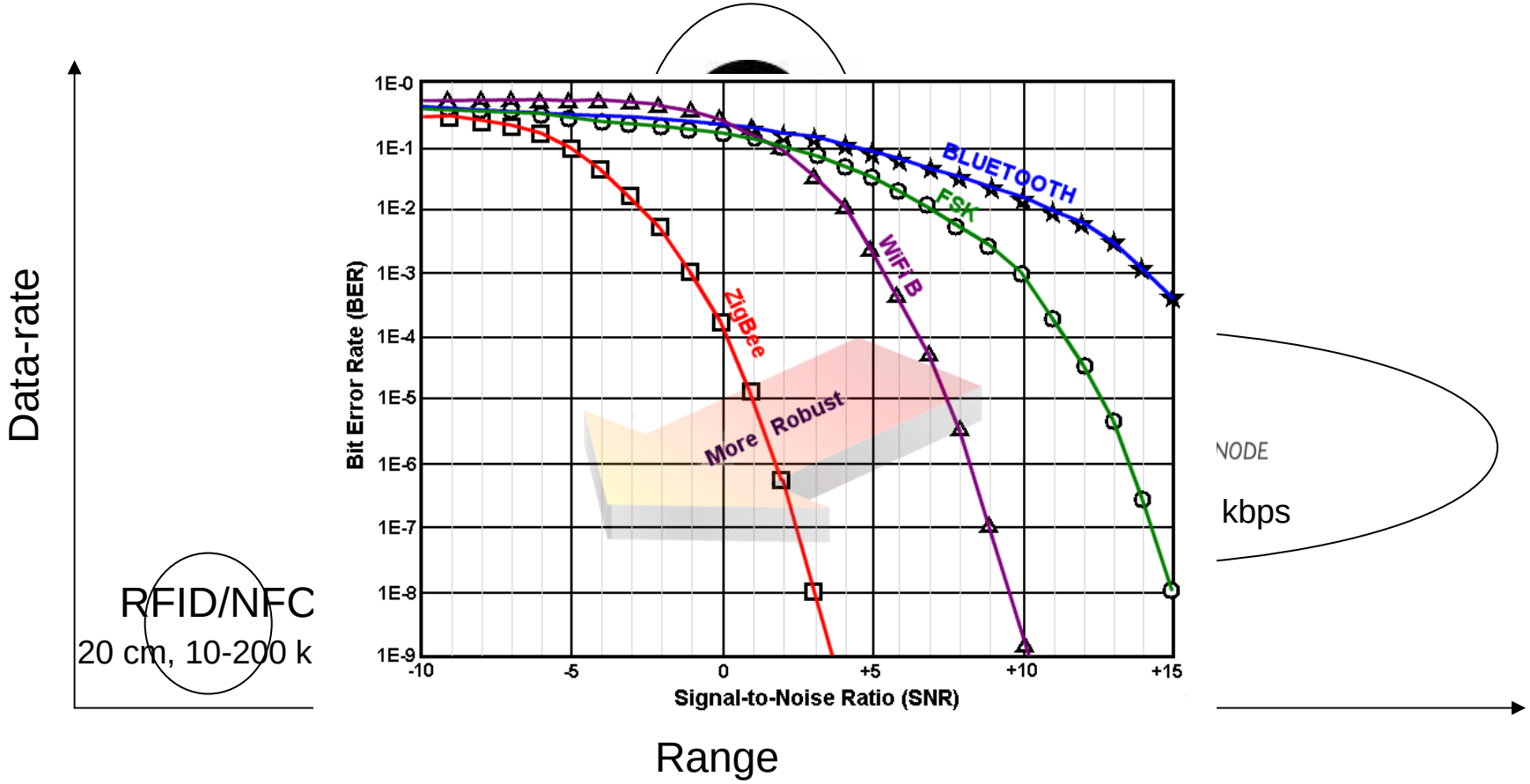
80s 90s 2000 2003 2006

IEEE 802.15.4 - The global standard

- Important standard for home networking, industrial control and building automation
- 802.15.4 Original
  - 250 kbps at 2.4 GHz (DSSS)
- 802.15.4a CSS and UWB
  - Up to 2 Mbps typical, accurate positioning
- Robust radio with flexible topology
  - Slotted CSMA algorithm
  - Beacon and beaconless modes
  - Reduced and full function nodes

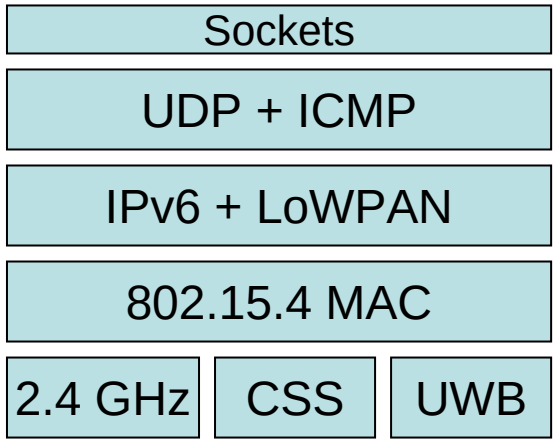


Technology Comparison



6LoWPAN - IP for low-power devices

- IETF Standard for IPv6 over IEEE 802.15.4
- 80% compression of headers
- Rich and flexible features
  - Autoconfiguration
  - IPv6 fragmentation
  - UDP + ICMP
  - Mesh forwarding ready
- Socket API!
- Super compact implementation
- Direct end-to-end Internet integration
- Extremely scalable



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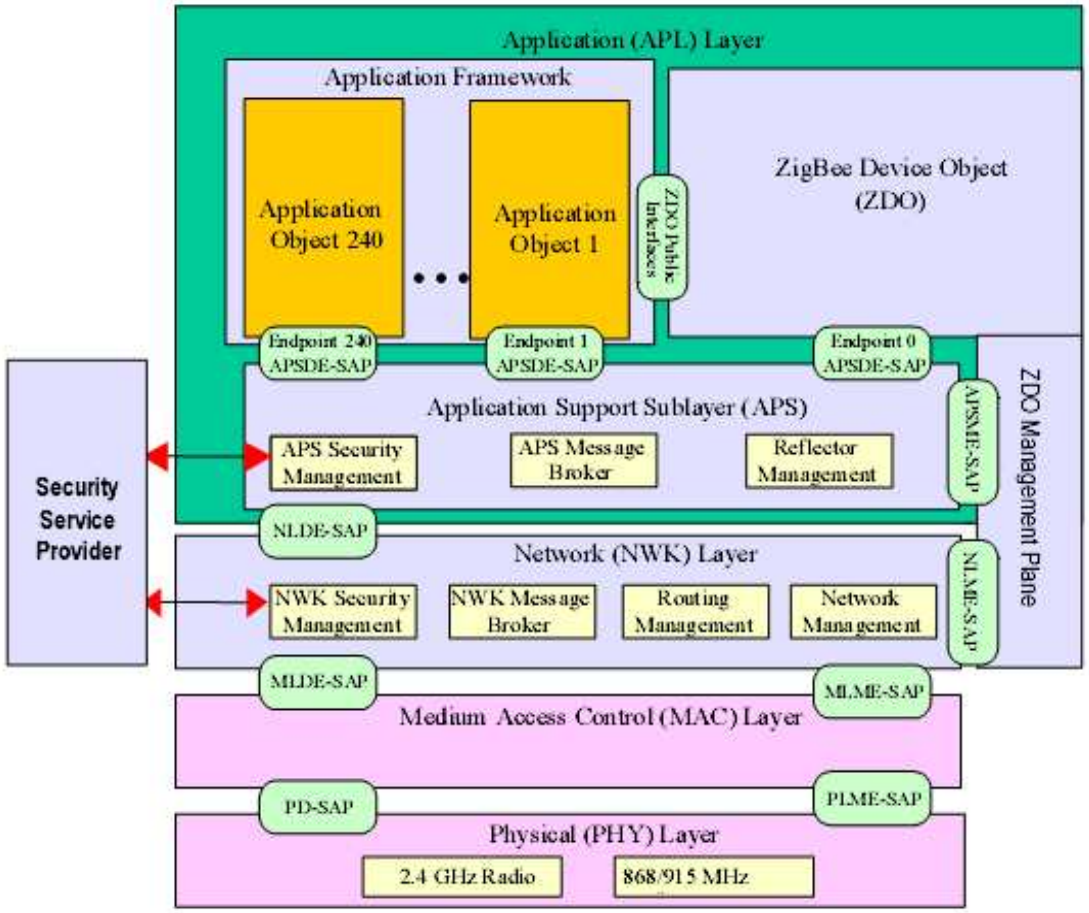

Application (APL) Layer
Application Framework
Application Object 240
Application Object 1
ZDO Public Interfaces
ZigBee Device Object (ZDO)
Endpoint 240 APSDE-SAP
Endpoint 1 APSDE-SAP
Endpoint 0 APSDE-SAP
Application Support Sublayer (APS)
APS Security Management
APS Message Broker
Reflector Management
APSME-SAP
ZDO Management Plane
Security Service Provider
NLDE-SAP
Network (NWK) Layer
NWK Security Management
NWK Message Broker
Routing Management
Network Management
NLME-SAP
MLDE-SAP
MLME-SAP
Medium Access Control (MAC) Layer
PD-SAP
PLME-SAP
Physical (PHY) Layer
2.4 GHz Radio
868/915 MHz
IEEE 802.15.4 defined
ZigBee™ Alliance defined
End manufacturer defined
Layer function
Layer interface

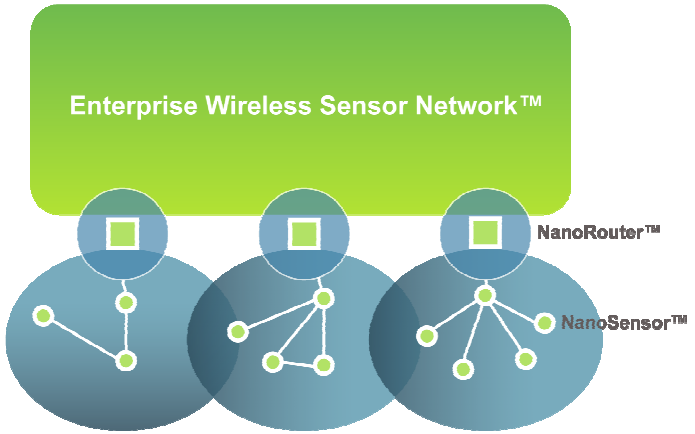
Applications

First: Enterprise, industrial, commercial
Later: Consumer

1. Cargo, warehouse, port logistics
2. Manufacting and automation
3. Security and buildings

About Sensinode

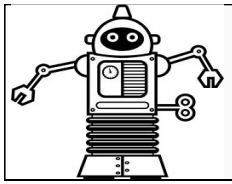
- Leading IP-based wireless sensor network company
- Products, Solutions and Services for Enterprise asset management & tracking
- OEM Products
  - For industrial and academic R&D
  - Sensor node platforms
  - NanoStack 6LoWPAN solution
- Enterprise Solutions
  - Logistics
  - Manufacturing
  - Security



Thank You!

Zach Shelby, CTO
zach@sensinode.com

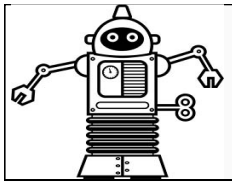
Sensinode Ltd.
Teknologiantie 6
FIN-90570 Oulu
+358(0)44-500-6778
www.sensinode.com



Unmanned Navigation and user Interface for Aerial Vehicles

Petrou f. Palogos A. Kavoussanos E. Palamas G. Papadourakis G.

Technological Educational Institute Of Crete
Department Of Applied Informatics and Multimedia



Autonomous air vehicle combines sensed heading and spatial coordinates and a user defined mission statement.

Modulated data produce navigation reference signals used to autonomously control the plane.

The system can switch, through remote control, between automatic or manual operating modes while in flight.

Additionally, a highly interactive user interface control serves for both trajectory editing and programming and flying data acquisition.

Experimental data shows that the plane is able to navigate between predefined coordinates and reach target positions.

UAV Design Requirements

- Use and development of UAV for military and civilian applications is rapidly increasing.

- Similar to the manned aircraft the challenge is to develop optimal configurations to produce a high performance aircraft that satisfy the mission requirements.

- UAV systems are ever increasingly becoming important topics for aerospace research and industrial institutions.

- Difficulties in these new concepts are
  - the compromising nature of the missions to be performed, like high or medium altitude surveillance
  - variable environments and many others.

How UAVs Operate

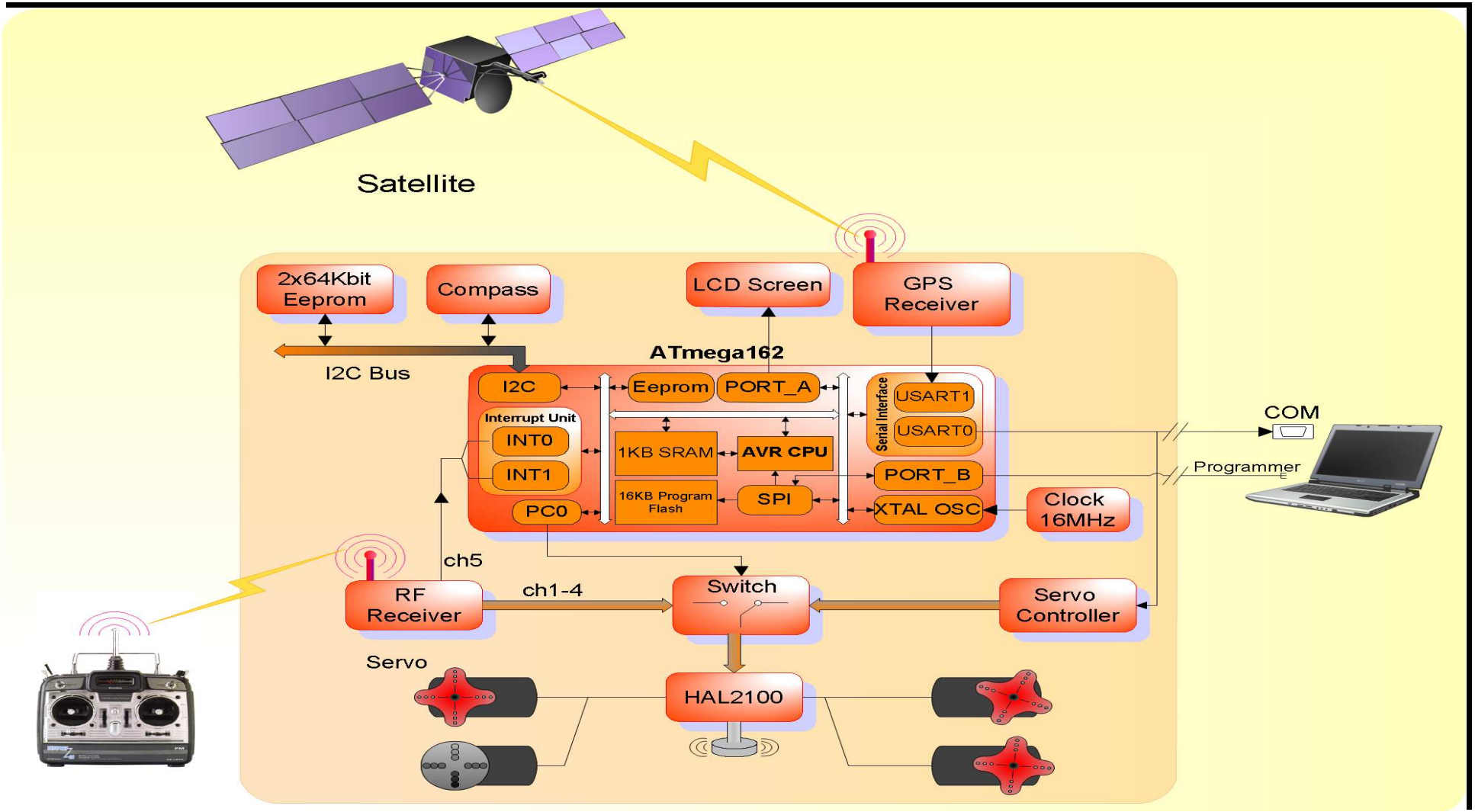
Unmanned Aerial Vehicle, also known as a drone,
an aircraft without a human operator on board

UAVs are flown and navigated by onboard computers
and operated by humans on the ground

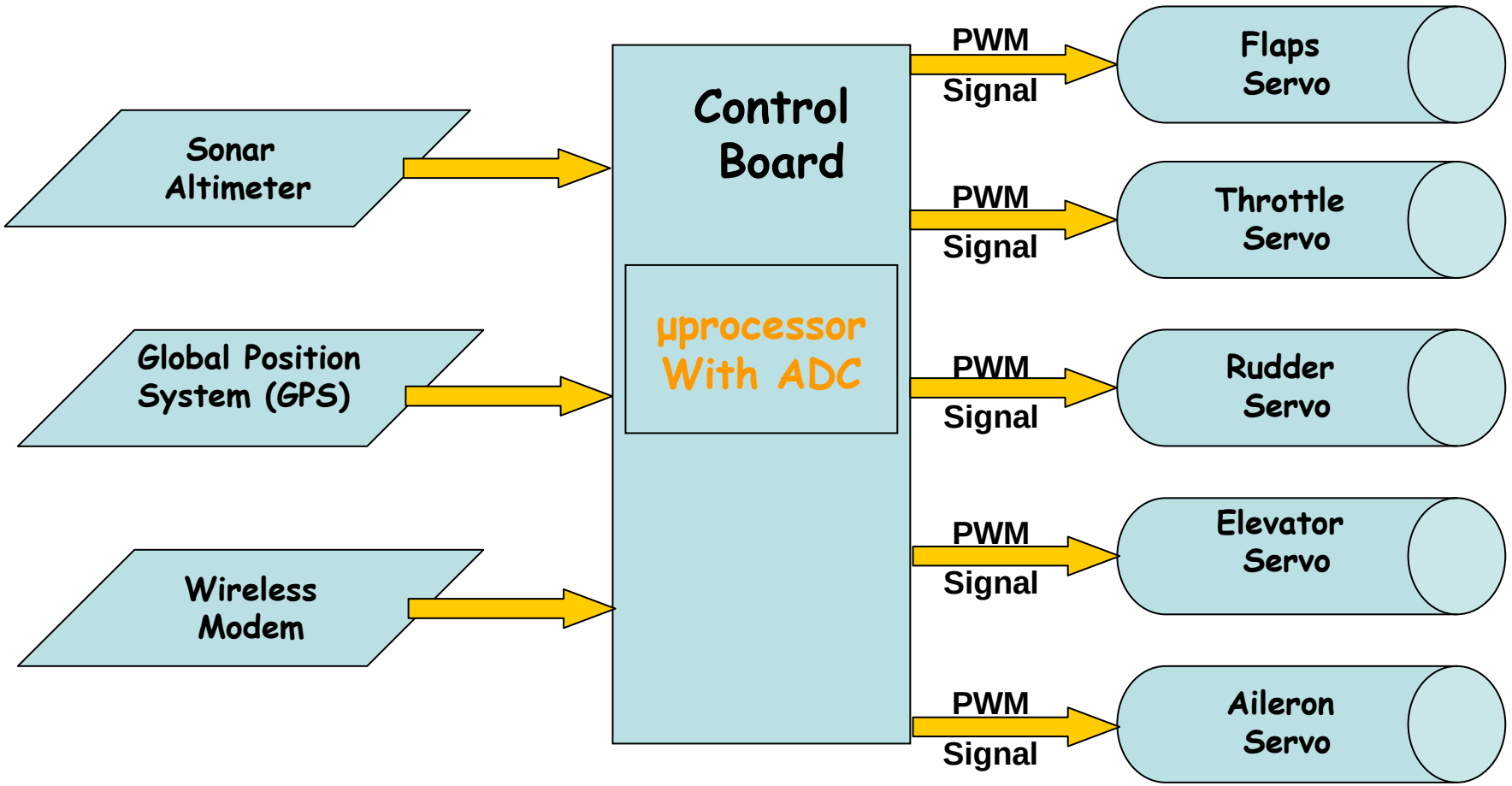
Software code containing the entire mission plan is downloaded
to the UAV's computers before or after it is launched

The operator on the ground does not "fly" the UAV
but can change the mission plan by sending new software
instructions to the computers via radio

General Schematic

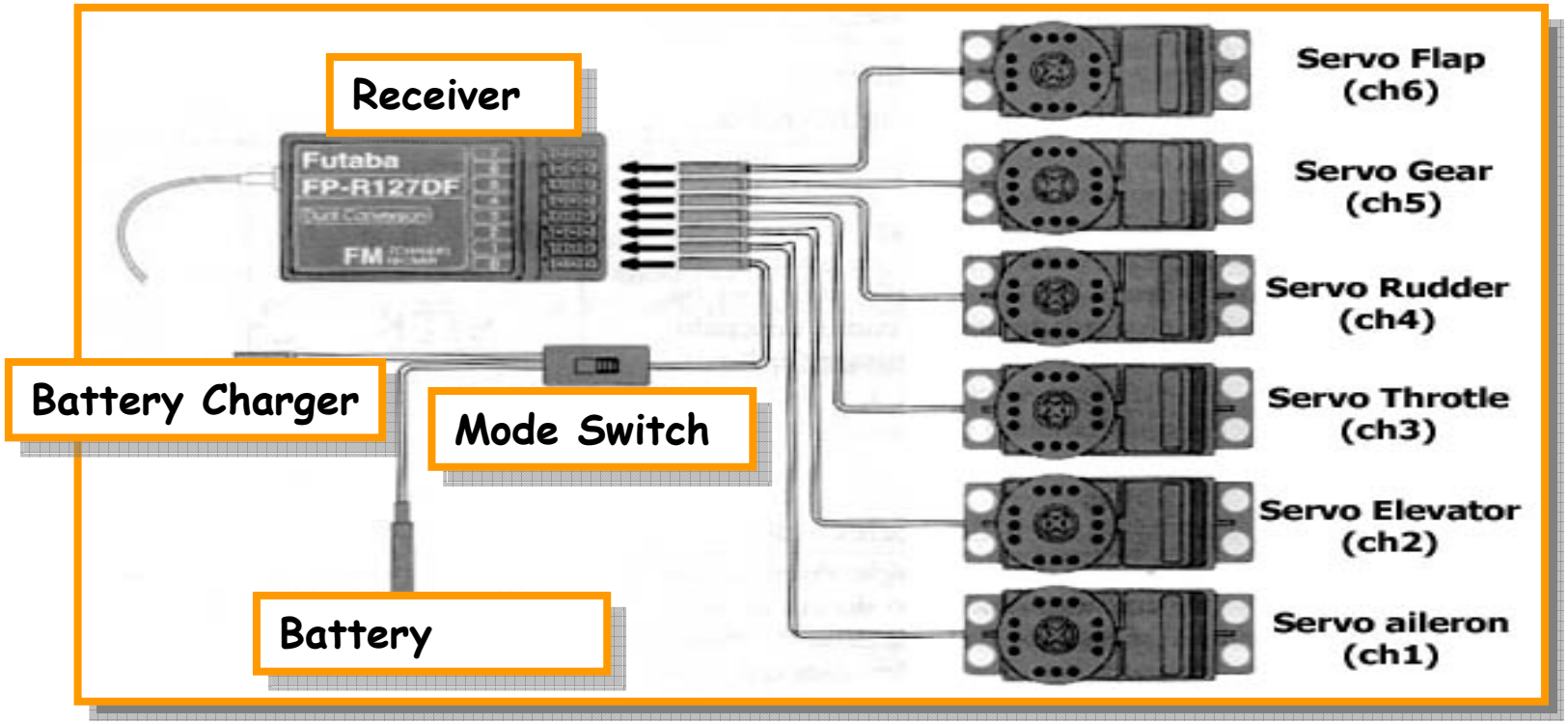


Control Board



Operational Modes

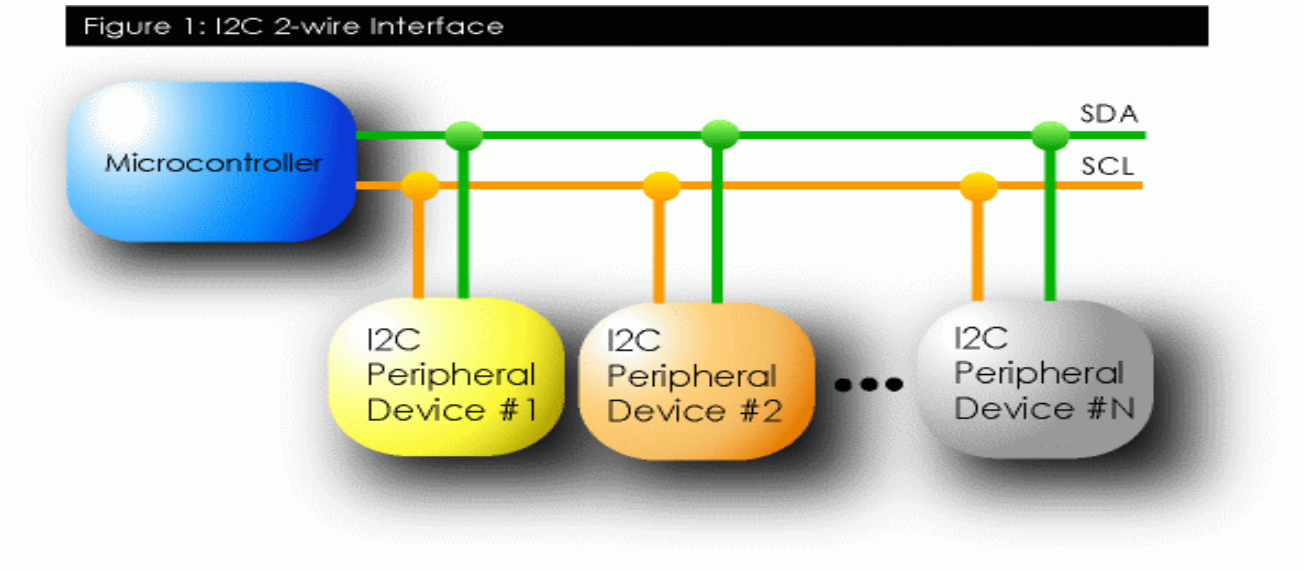
- Autonomous with the aid of autopilot
- Guided from the user (take off, landing, general emergency case)



I2C Protocol

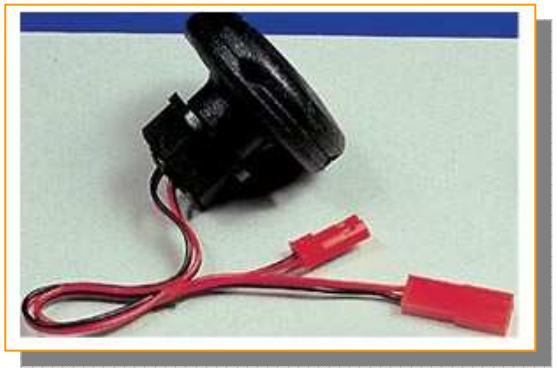
- I2C is a 2-wire, half-duplex, serial bus
- multi-master serial computer bus invented by Philips
- used to attach low-speed peripherals to embedded systems
  - Compass
  - Global Position System receiver
  - Altitude sensor
  - Gyroscope

Figure 1: I2C 2-wire Interface



Autopilot HAL 2100

- Horizontal Auto Levelling system
- Safely manoeuvres plane
- optical sensor monitors the attitude 100 times every second
- Integrated microprocessor instructs the servos to return the aircraft to straight and level flight



What is a Kalman filter (1/2)

The Kalman filter is an efficient recursive filter that estimates the state of a dynamic system from a series of incomplete and noisy measurements.

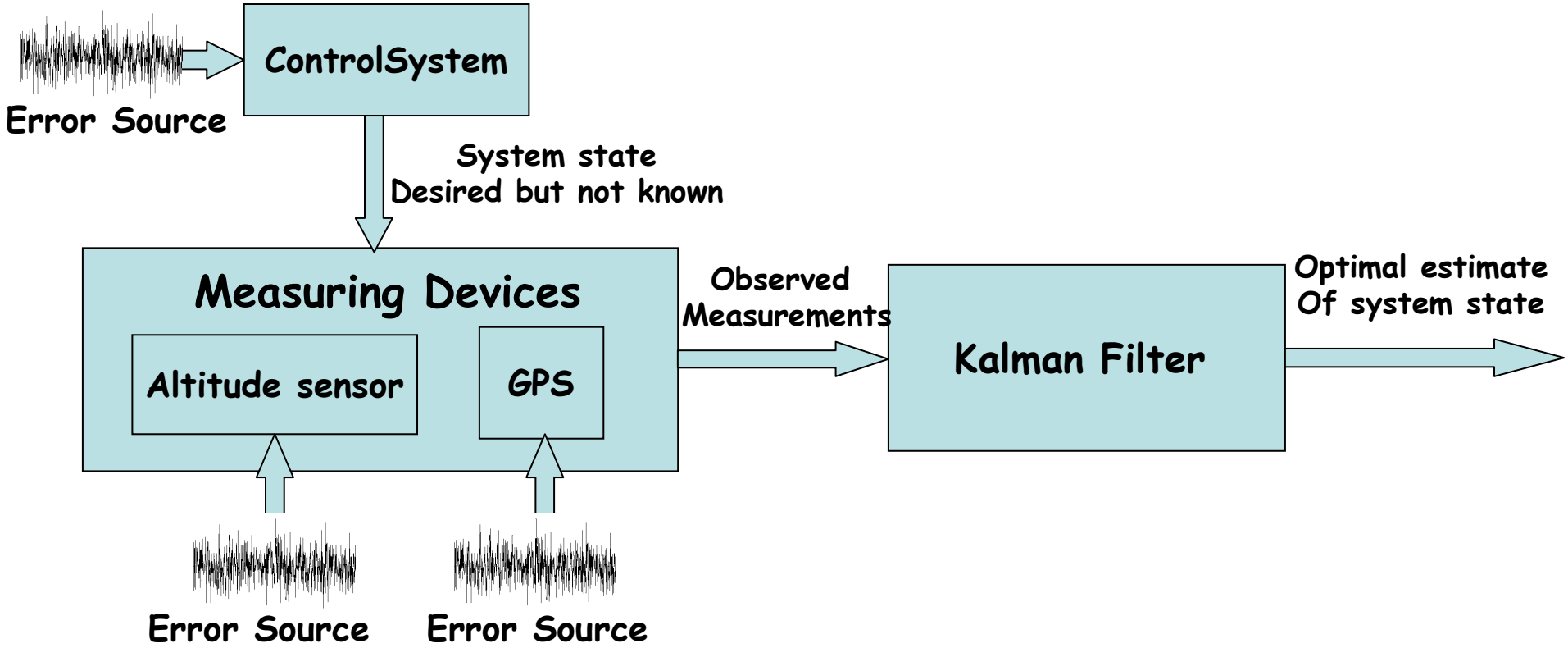
Information regarding location, speed, and acceleration of the plane is measured with a great deal of corruption by noise at any time instant.

Kalman filter exploits the dynamics of the target, which govern its time evolution, to remove the effects of the noise and get a good estimate of the location of the target at:

- *present time (filtering)*
- *at a future time (prediction)*
- *at a time in the past (interpolation or smoothing).*

What is a Kalman filter (2/2)

- Optimal recursive data processing algorithm
- Typical Kalman filter application:



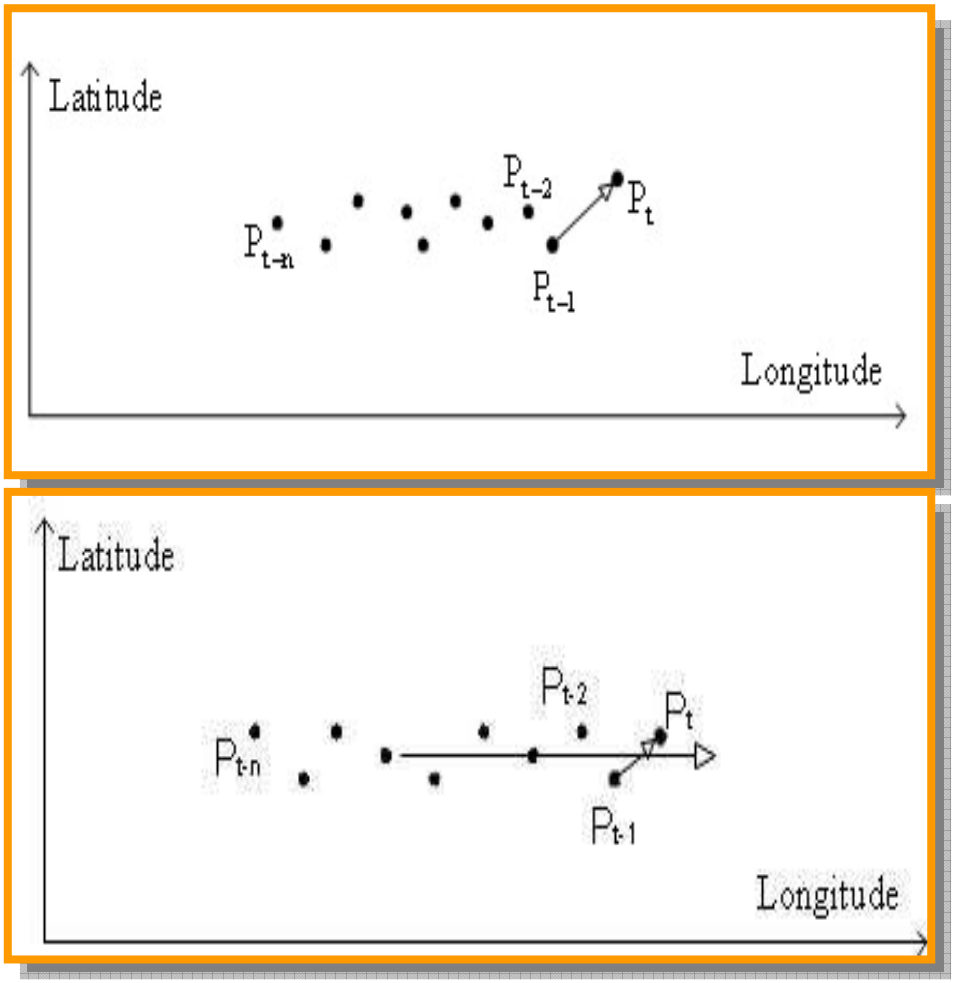
Least Squares Method

least squares is a method for linear regression that determines the values of unknown quantities in a statistical model by minimizing the sum of the residuals (the difference between the predicted and observed values) squared.

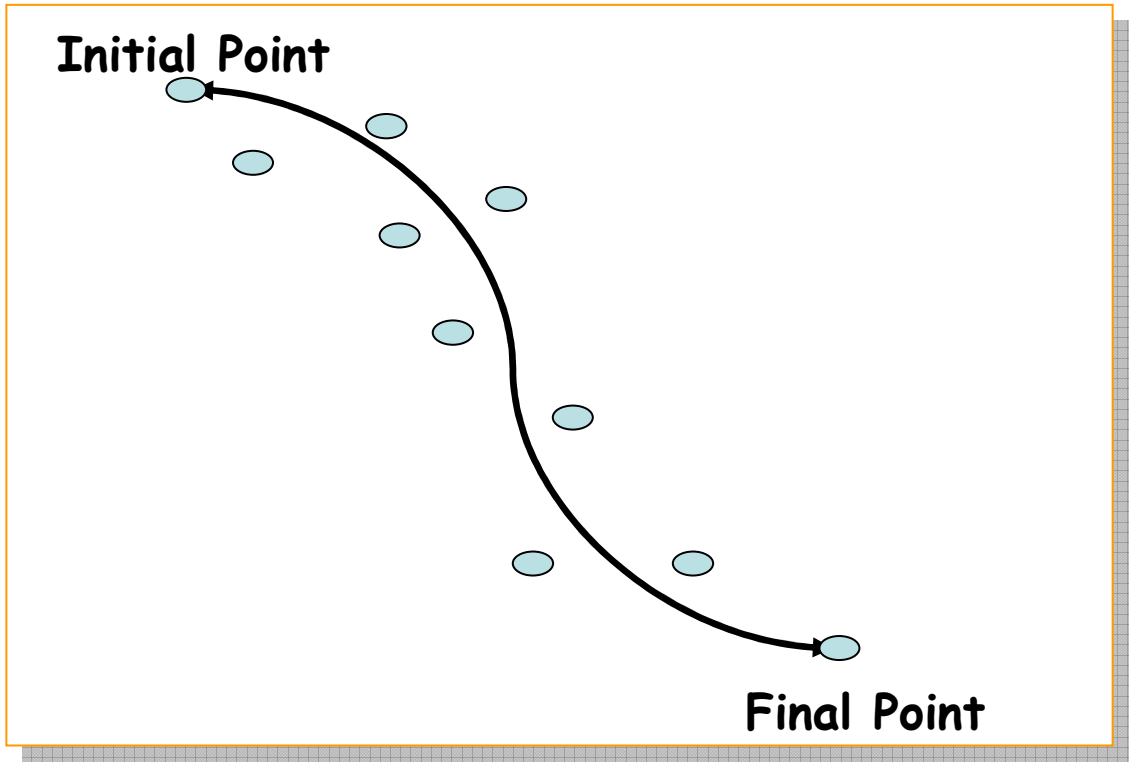
The least-squares approach to regression analysis has been shown to be optimal in the sense that it satisfies the Gauss-Markov theorem.

- The objective consists of adjusting a model function to best fit a data set.
- The chosen model function has adjustable parameters

Least squares trajectory planning

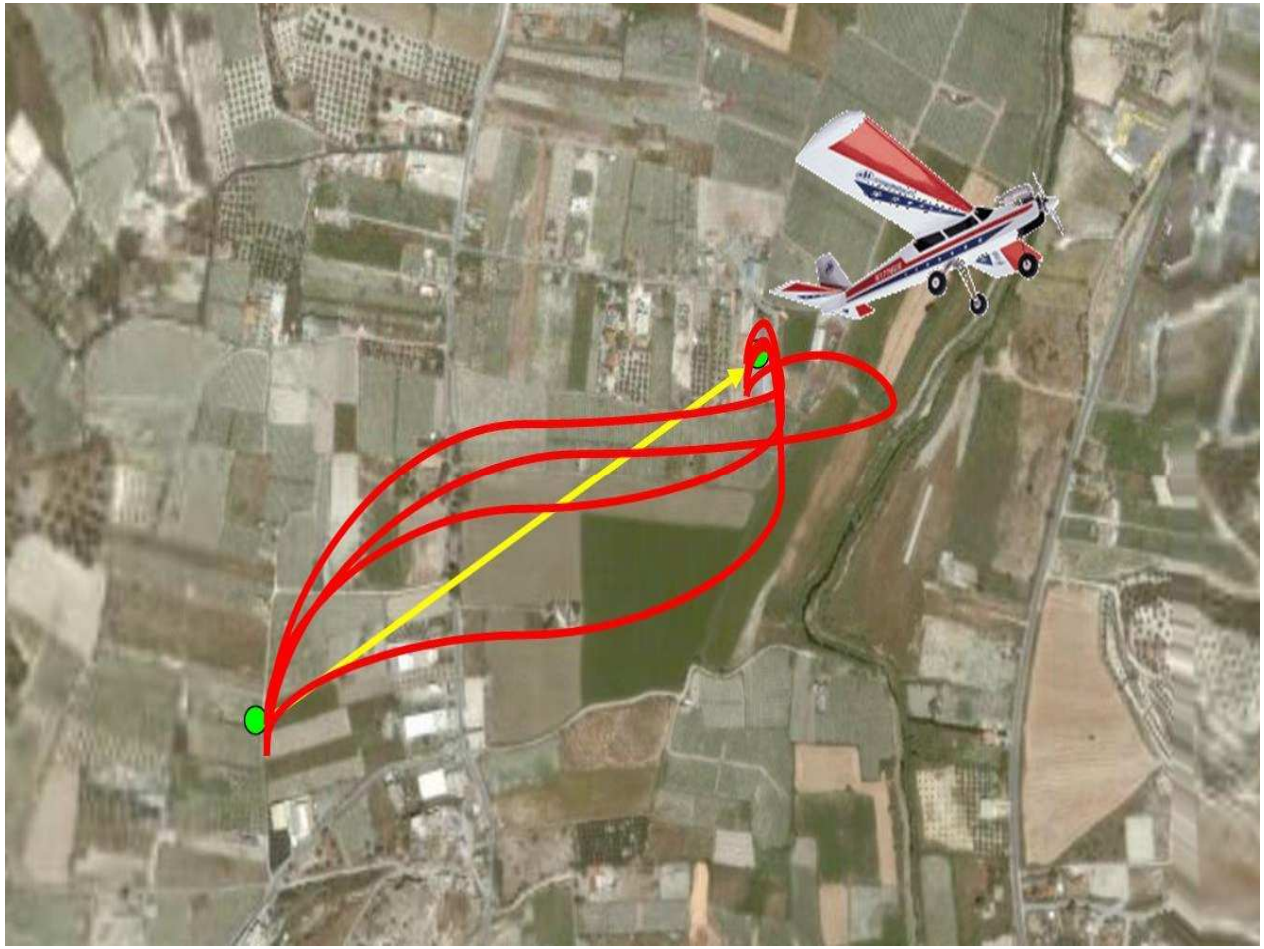


Optimal Route planning

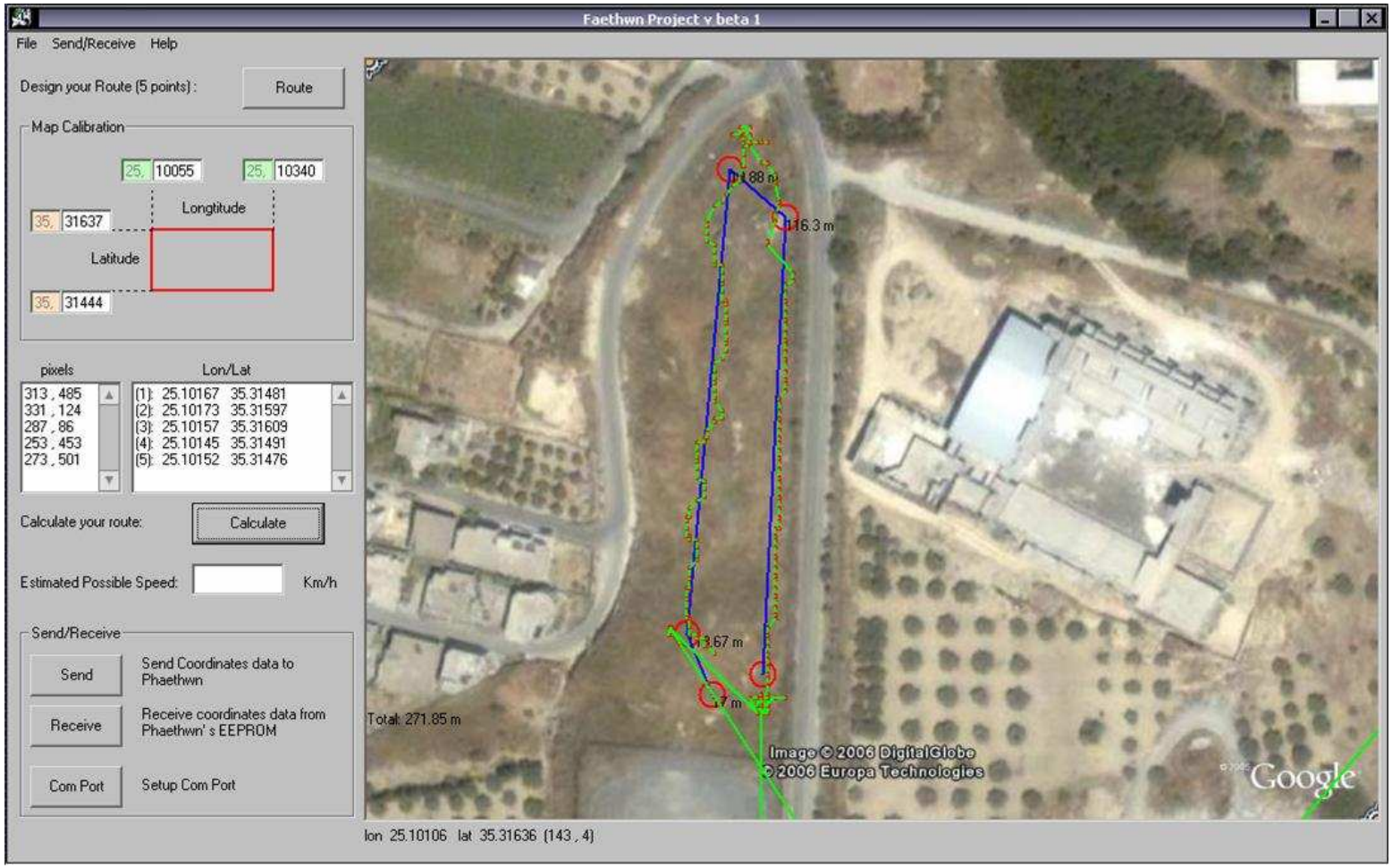


- Find minimum distance route
- Efficiently control speed and acceleration

Different Routes for Different Parameters



Monitoring and Control Software



Conclusions

- Model Plane is able to navigate through predefined positions
- Predictable behaviour for stable conditions like wind speed

But

- Parameters can only be adjusted through trial and error
- Different conditions like wind speed means different behaviour
- Microcontrollers are not very well suited for computations like Kalman filters and Least Squares

European Remote Radio Laboratory (ERRL) Project

http://errl.evtek.fi

Markku Karhu
EVTEK Univ Appl Sci
Espoo, Finland

Enhancing Engineering Education

- Increase attractiveness of engineering studies
- Make flexible arrangements
- Life-long-learning
- From theory to practice -> understanding
- CDIO: (http://www.cdio.org)
  Conceive – Design – Implement – Operate

ERRL Project Contributors

- Atılım University, TR, promoter
- Groupe ESIEE Paris, FR
- EVTEK University of Applied Sciences, FI
- Institute of Communication and Computer Systems, National Technical University of Athens, EL
- Institute of Vocational Education, Work and Technology at University of Flensburg, DE
- Balikesir University, TR
- The Norwegian University of Science and Technology, NO
- Transilvania University of Brasov, RO

EVTEK + Stadia -> Metropolia 1.8.2008

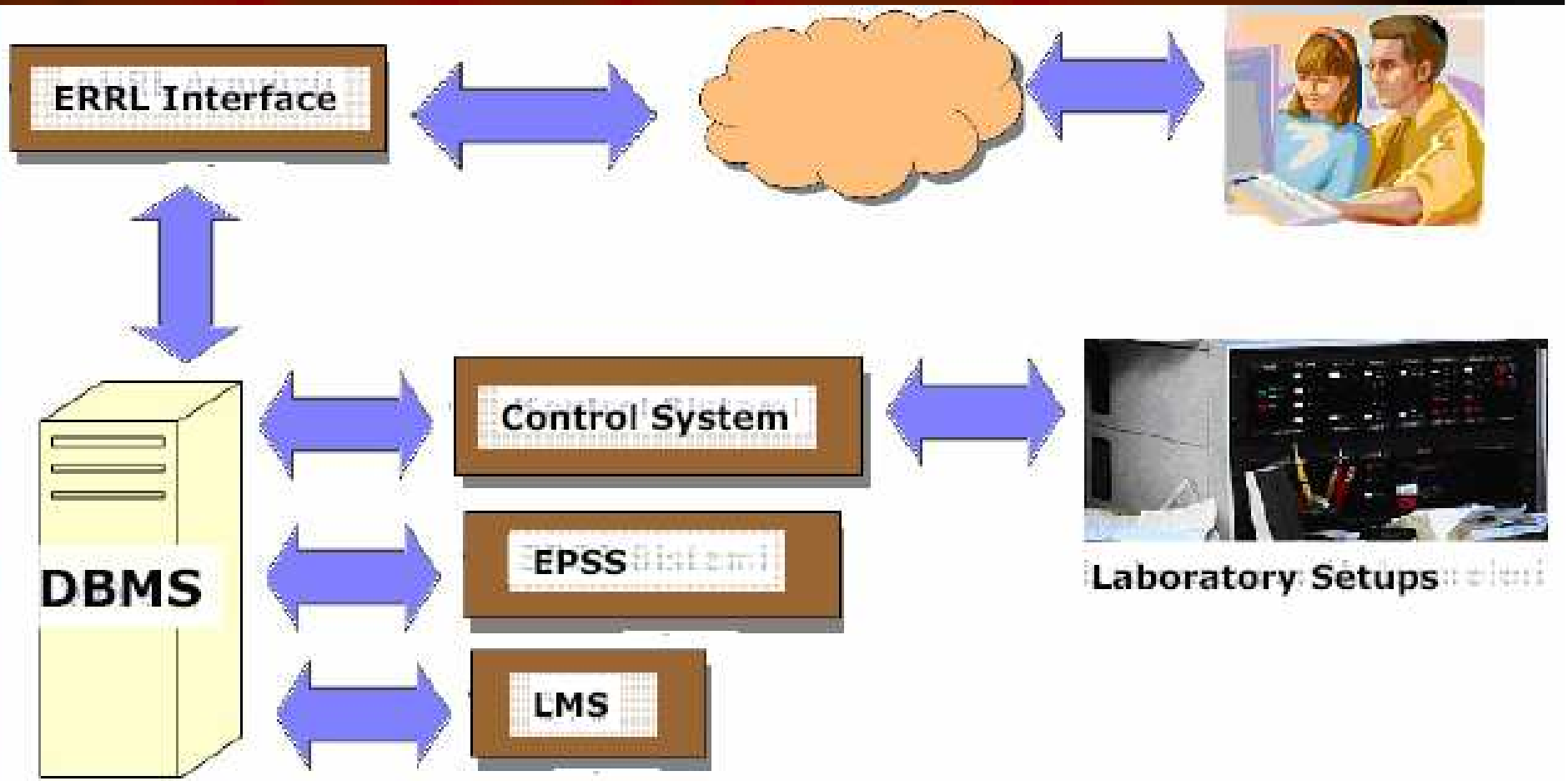
ERRL Project Scope

- Develop a distance access RF laboratory platform
- Provide access to
  - theoretical and particularly practical training
  - high-cost & high-tech equipment in radio communications field via Internet
- Duration: 2 years
- Budget: 500 000 €, 388 000 € from Leonardo da Vinci
- Start: October 2006
- URL: http://errl.evtek.fi

Project Content

- Six work packages
  - Management and Coordination
  - Specification and Needs Analysis
  - Course Material
  - Software Tools
  - Pilots and Test of Remote Experiments Modules
  - Valorisation

Platform Structure



EPSS – Electronic Performance Support System
LMS – Learning Management System

Features

- Introducing to the basic test and measurement devices
  - Use of EPSS
- Theorical background via course material
  - Use of LMS
  - Grouped in levels to support EQF (European Qualification Framework)
  - Assessment system
- Experimental Setups
  - Grouped in levels according to EQF
  - Conduct experiments remotely
  - Receive/display output data in several formats

Remote Experiment Modules

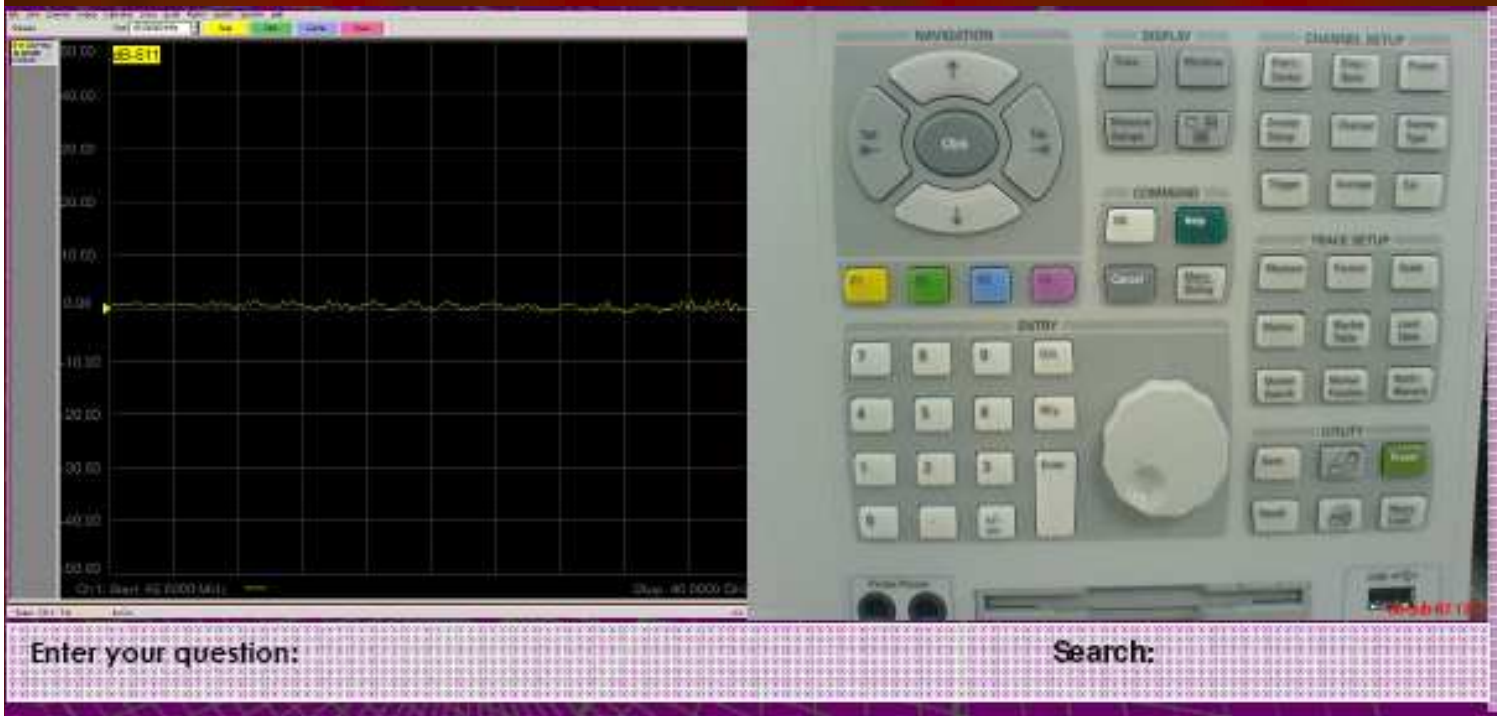
- 14 experimental setups are planned
- Setups will allow exploitation of high frequency equipments remotely
  1. Spectrum analyzer
  2. EMC analyzer
  3. Vector Network analyzer
- Experiments will be grouped in levels to support EQF (European Qualification Framework)

Basic Modules via EPSS

(Electronic Performance Support System)

- Different interfaces for each of the devices
- Each interface will contain the front panel of the device
- A simulation over the pre-defined data – no real experiments
- Support
  - Question and Answer
  - Keyword search

An Example – VNA (Vector Network Analyser)



- Show pictures

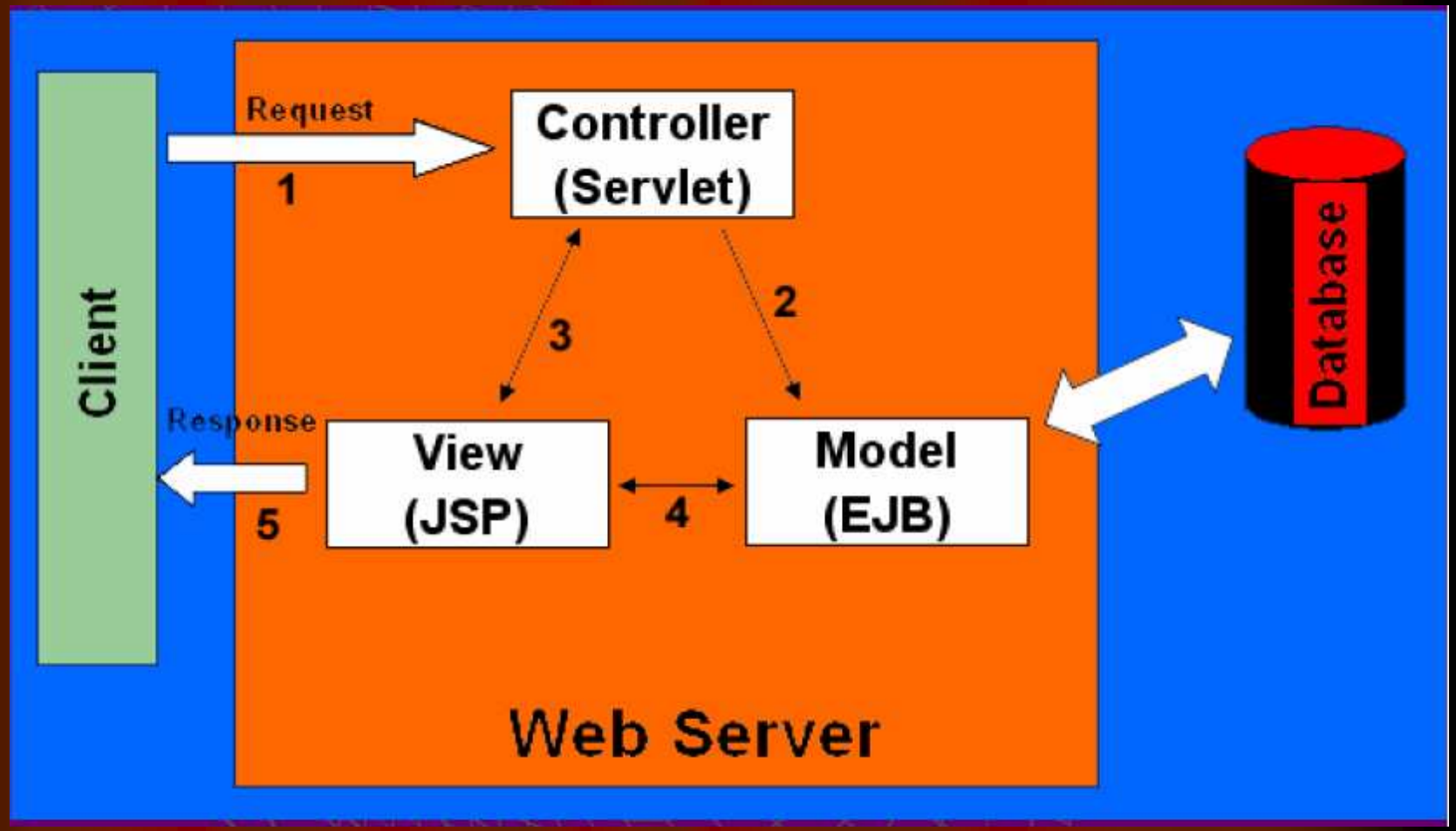
ERRL MOODLE

- http://errlmoodle.atilim.edu.tr/

Course Material

- Theoretical and reference course materials
- • Content for Learning Management System
- • A modular system to address different skill levels
- • Related to European Qualification Framework Assessment system
- In English and in some partner languages (Finnish included)

Web Server Architecture



Experiments 1/2

- Measurement of scattering parameters of short, open load, matched load (Device: VNA)
  - concepts of reflection and transmission (return loss, Standing Wave Ratio, reflection coefficient)
- Spectrum Analysis and Fourier Series (Device: Spectrum analyzer, signal generator)
  - frequency-domain representation of sine, triangle and square waves
- FSK, ASK and PSK modulation (Device: Spectrum analyzer, Modulation generator, oscilloscope)
  - Digital modulation techniques

Experiments 2/2

- Measurement of scattering parameters of wave guide, bandpass/lowpass filter, amplifier, phase shifter, directional coupler (Device: VNA)
  - transmission, phase shift, attenuation, directivity, filtering and amplification Equipment: Vector Network Analyzer
- Impulse Response and Multipath (Device: VNA)
  - relation between time and frequency domain response of a radio channel
- Frequency Modulation (Device: Spectrum analyzer, modulation generator, oscilloscope)

Expected Outcomes 1/2

- EPSS (Electronic Performance Support System) content on the use of test and measurement equipments.
- Radio-lab training modules with up-to-date course contents
- Test system which will evaluate the user's degree of success in completing ERRL courses

Expected Outcomes 2/2

- A project web site facilitating collaboration and discussion on radio systems education, among partners and in European level.
- Data for comparison of in-lab and remote training from didactical point of view
- An operational remote laboratory environment for full access

Lessons learned

- Enhancing engineering education through EU funded projects
- Forming of a productive consortium is many times difficult
  - randomly
  - commercial companies ?
- Procedures and working methods are different (administrational practices and procedures)
- Commitment and engagement ?
- Exchange of ideas, the transfer of technology and practices, and pedagogical approaches between partners
- Identify and deploy good learning management tools to facilitate learning and management of course materials developed
- If the courses and contents are not in the syllabus of degree programme, it makes difficult to persuade the students and teachers to seriously go through them
- Will education be next killer application of the Internet ?


Education and Culture
Leonardo da Vinci
THANK YOU !

Towards Design Tools for Wireless Networked Control Systems

R. Jäntti
S. Nethi, M. Pohjola, L. Eriksson
Helsinki University of Technology

Communications Laboratory
Helsinki University of Technology

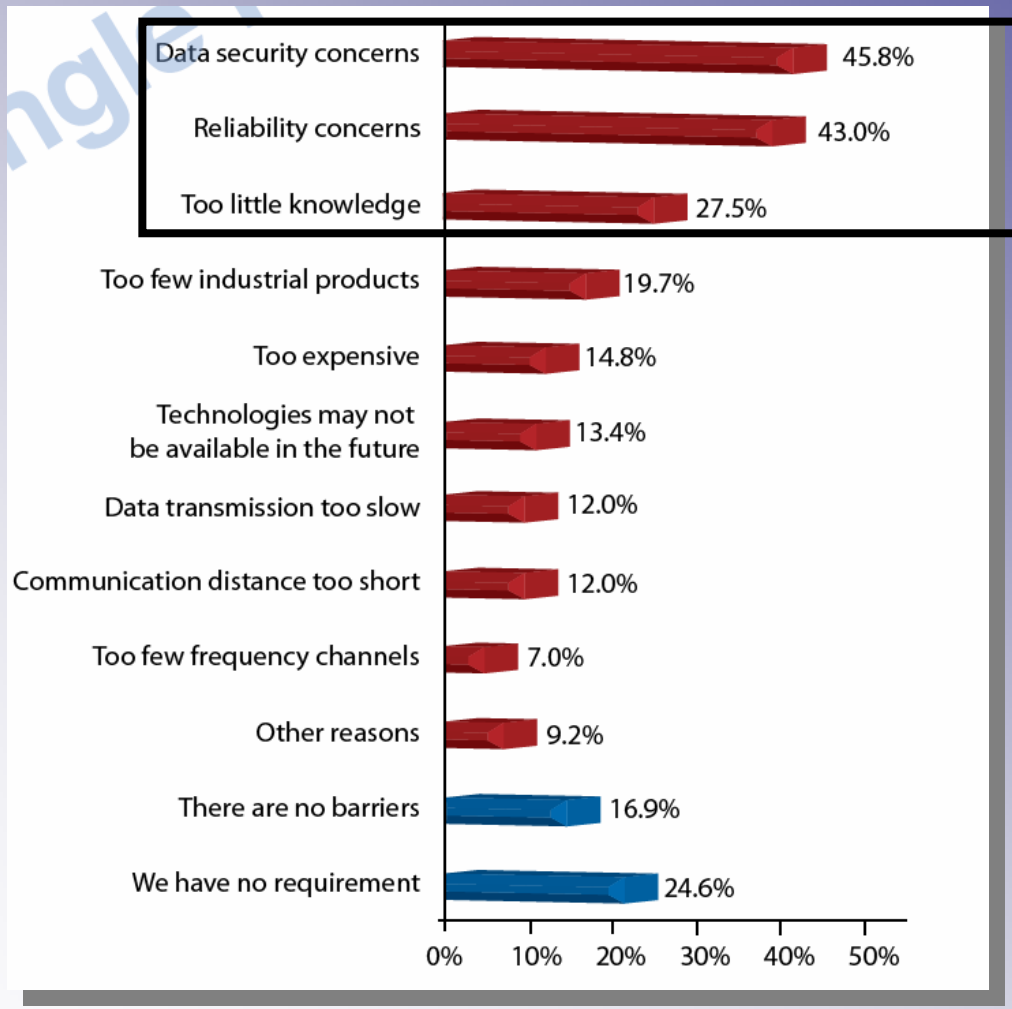
Outline

- **W**ireless **N**etworked **C**ontrol **S**ystems (WiNCS)
- Motivation
- Design tools
- PiccSIM-platform
- Case studies
- Demo

Wireless automation today: A journey towards reliable wireless automation

- **Wireless Networked Control Systems** are real-time computing and control systems over wireless networks.
- That is, **embedded systems** where the different devices (sensors, controllers and actuators) *communicate seamlessly* using *wireless technology*
- Connection of field devices through a field bus requires a lot of network planning, wiring and troubleshooting as a result, for many automation systems the cost is in "*all in the wires*"
- Wireless vision: autonomic communications and computing gets rid of the human-in-the-loop by making the systems self-configuring, self-healing, self-optimizing and self-protecting

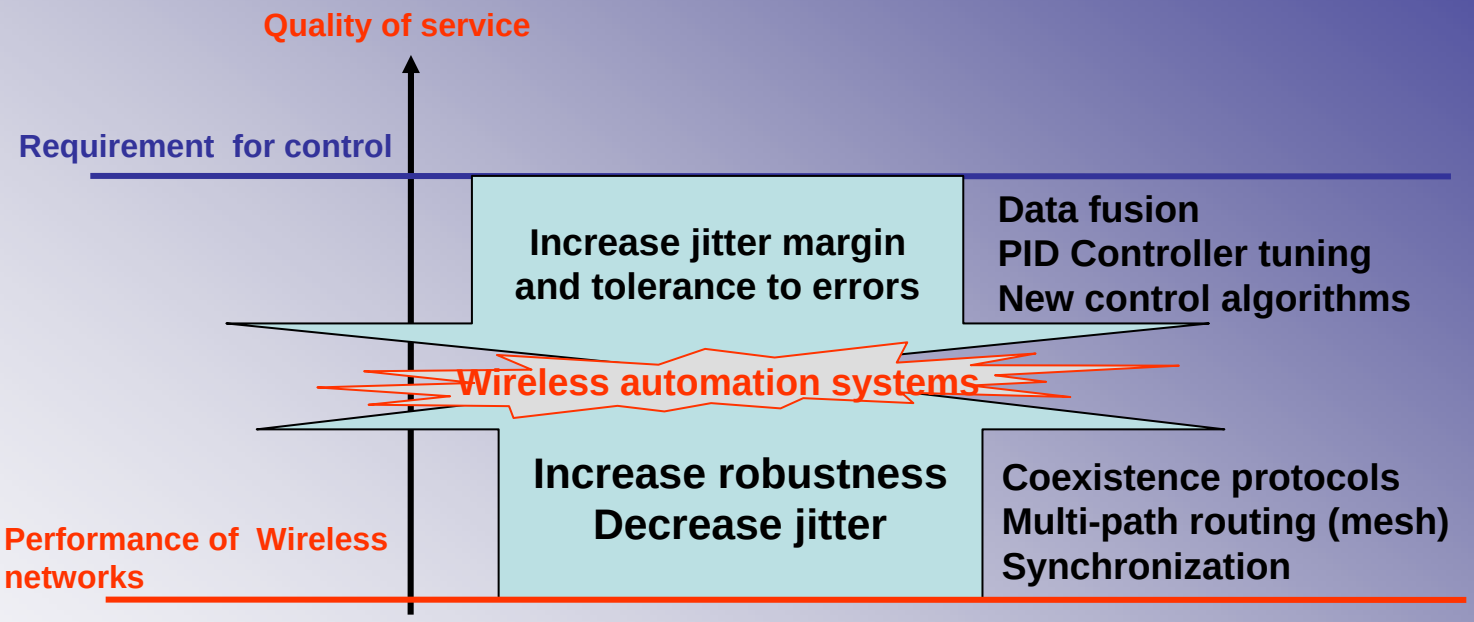
Challenges: the user perspective



Our focus

”Market pulse: Wireless in industrial systems: cautious enthusiasm”, Industrial Embedded Systems, Winter 2006.

Wireless automation today: A journey towards Reliable Wireless automation



Performance Evaluation: **A need for having a common testing platform for integrated Communication and Control Design**

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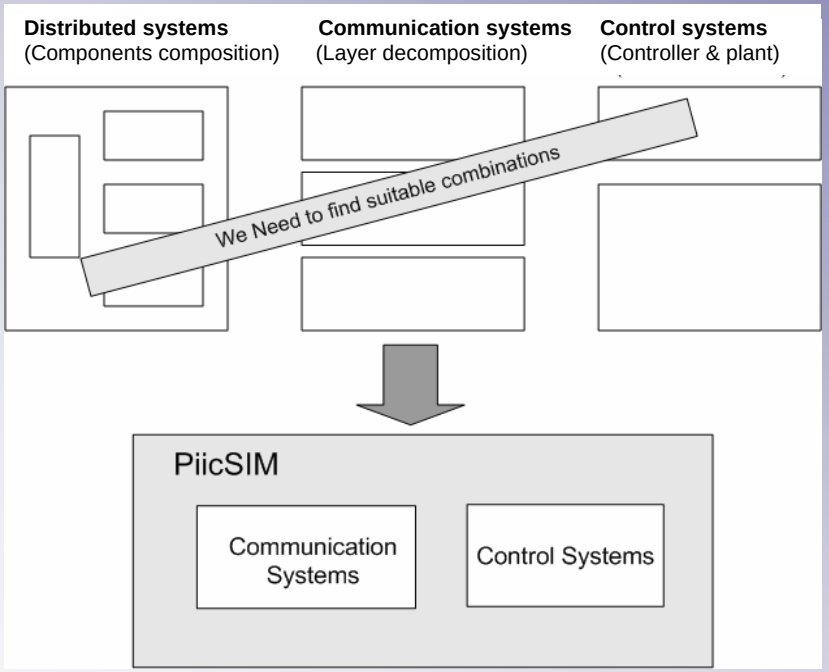
Tools for design?

- There is a lack of design tools that are able to deal with *integrated communication and control systems*
- TrueTime (Lund University): Network simulation with MATLAB/Simulink
  - Accuracy of network simulation?
  - Few network protocols available
  - Good for control performance analysis

Platform for **i**ntegrated **c**ommunication and **c**ontrol design **S**imulation, **I**mplementation and **M**odelling (**PiccSIM**)



Option 1: Develop a New Simulator (example: Java or MATLAB based simulators)

Option 2: Integrate existing available simulators

Control Design:

- MATLAB/Simulink/xPC Target (automatic code generation), MoCoNet-platform

Communications Systems Design:

- Ns2, OPNET, QUALNET, SENSE, etc.

PiccSIM = MoCoNet + Ns2

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PiccSIM- Key Features

Communications System Design (Ns2):

- System Level communication protocols testing from Control perspective
- Emulation testing platform for building automation design engineers for various wireless topologies/scenarios testing
- Wireless Network Simulations using Real processors
- Laboratory Resource Management
- Easy-to-use network configuration tool and accessible over Internet

Control Design (MoCoNet system):

- The impact of network parameters on the control system performance can be studied.
- New challenges for control design can be pointed out and the platform offers a possibility of verifying new stability proofs, and control and data fusion algorithms.
- Support for powerful control design and implementation tools provided by MATLAB
- Enabling automatic code generation from Simulink models for real-time execution real-time control of a true or simulated process over a user-specified network

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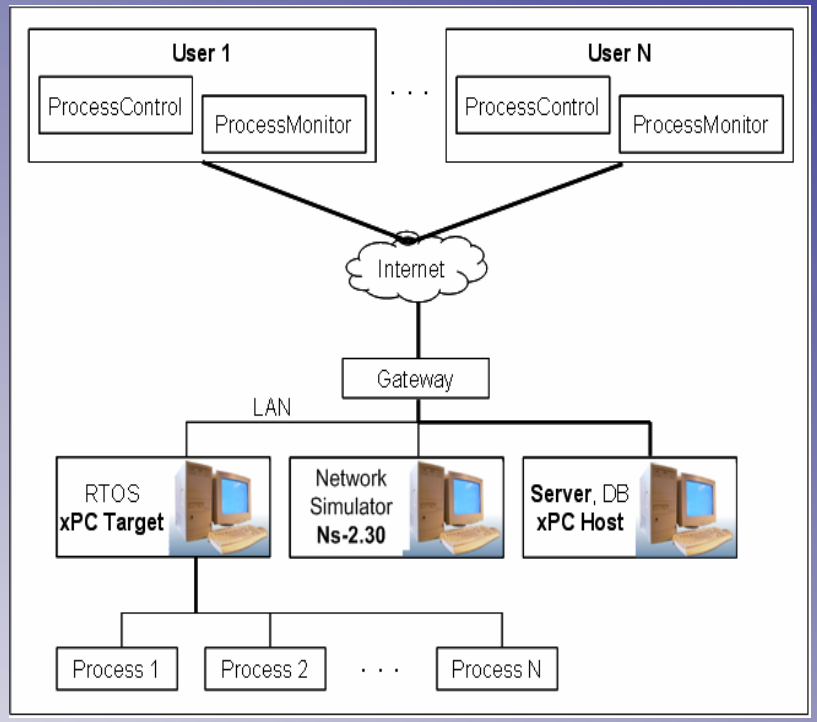
Platform for **i**ntegrated **c**ommunication and **c**ontrol design **S**imulation, **I**mplementation and **M**odelling (**PiccSIM**)

The system consists of **Three** computers:



- **Webserver, Database, xPC Host:** The server computer is responsible for maintaining connections between users and processes, running a reservation system for controlling Processes.
- **RTOS xPC Target:** the computer controls the real process or simulates a process in real-time. Equipped with an I/O controller board.
- **Network simulator (Ns2):** this computer runs simulated networks
- **Router:** All computers are connected through a network router

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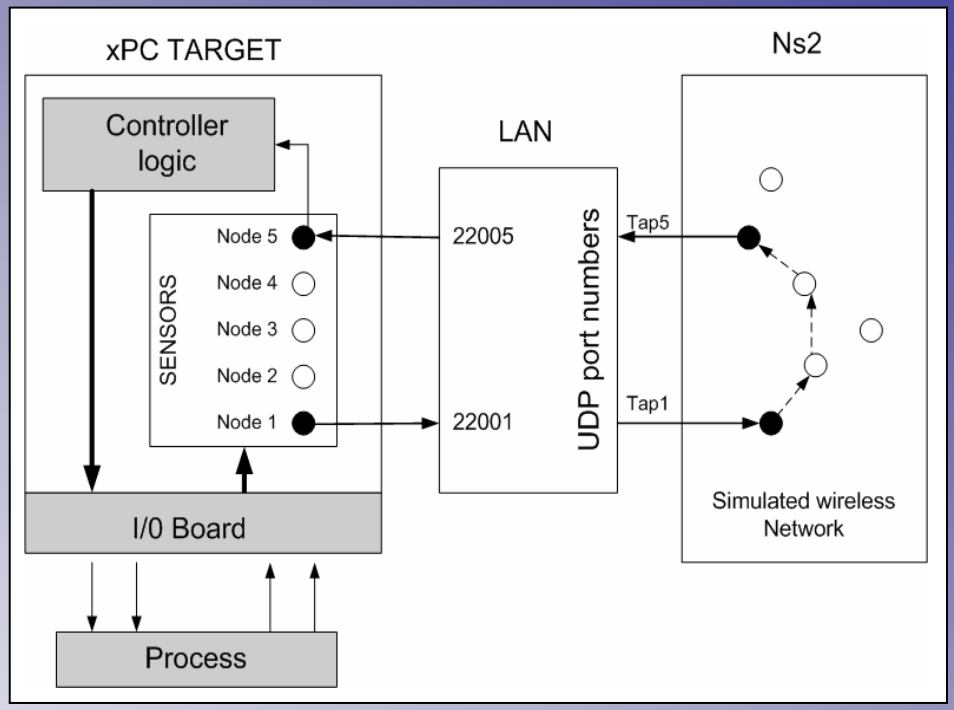
An example

- Two Models (xPC Target and Ns2)
- UDP packets are generated from the signal measured from the process.
- Packet are sent on to the network
- Ns2 computer using TAP agent captures packets and then node mapping is done using UDP port numbers



- On successful reception the packet is sent back to xPC TARGET

Simulation case studies

- Building Automation
- Target tracking and control

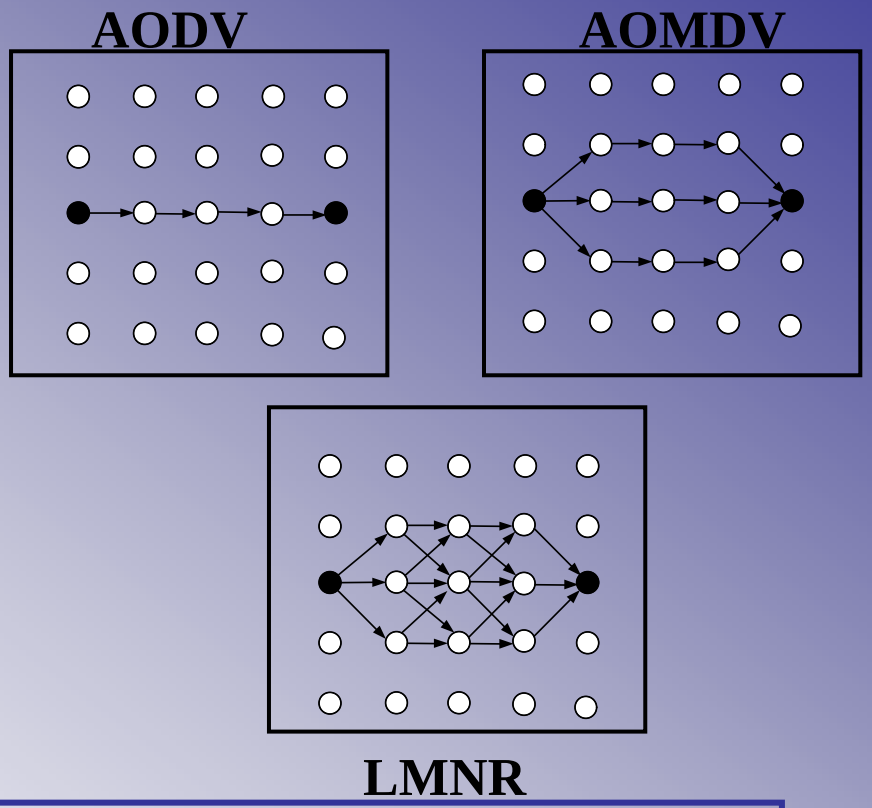
Performance comparison of AODV (Single path) and LMNR (Multipath Routing protocol) in different scenarios of industrial wireless systems

S. Nethi, M. Pohjola, L. Eriksson, R. Jäntti. Simulation case studies of wireless networked control systems, submitted to the *10th ACM/IEEE International Symposium on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MsWIM'2007),* Crete Islands, Greece, October 22-26, 2007

Multi-path routing

- **LMNR (Localized Multiple next hop routing)**
  - Set up multiple routes
  - Next hop is locally decided based on load, interference, and link availability

  => Increase robustness against link faults (decrease the need for rerouting in case of failures)

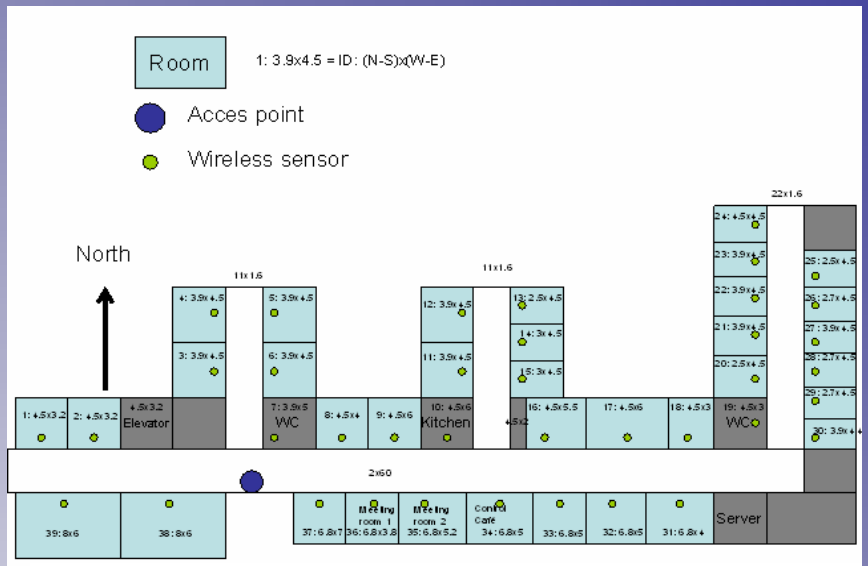


S. Nethi, C. Gao and R Jäntti, "Localized Multiple Next-hop Routing Protocol", to appear in *Proc. 7th international conference on ITS telecommunication (ITST 2007),* Paris, France, June 5-8, 2007

Building Automation

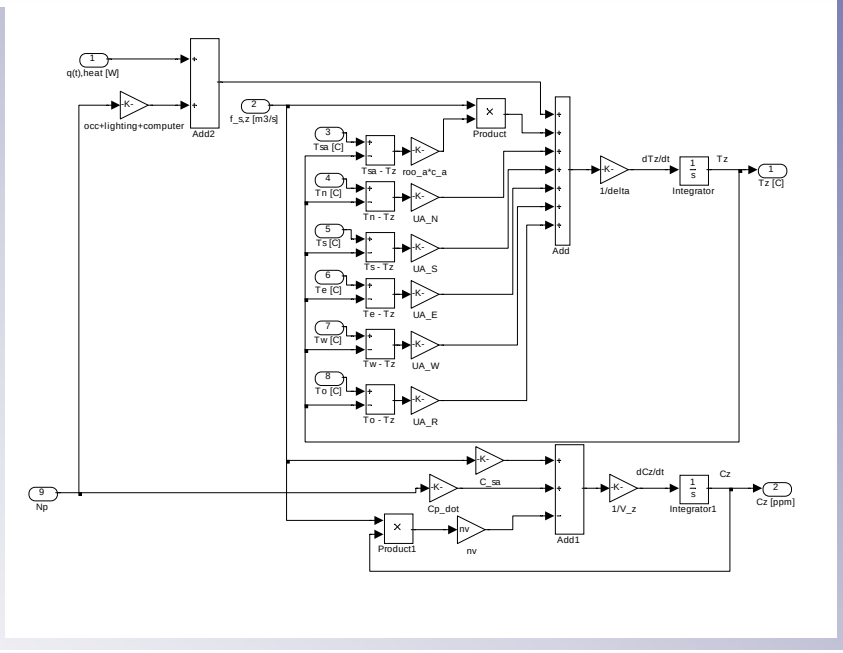
Physical Models:

- Heat balance in rooms (PID control)
- CO_2 concentration in rooms (relay control)
- Event driven signals, lighting (on/off)



Communication Model:

- Zigbee motes (15m range)
- Ricean propagation channel



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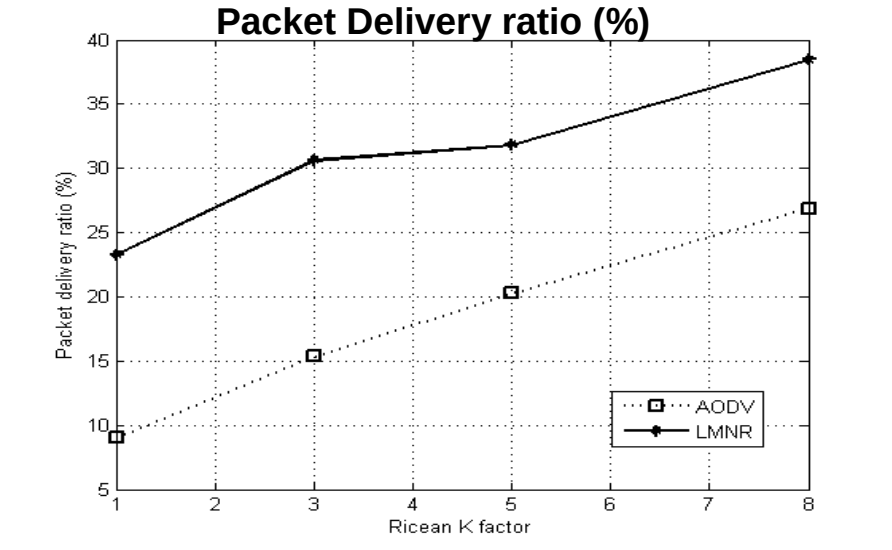
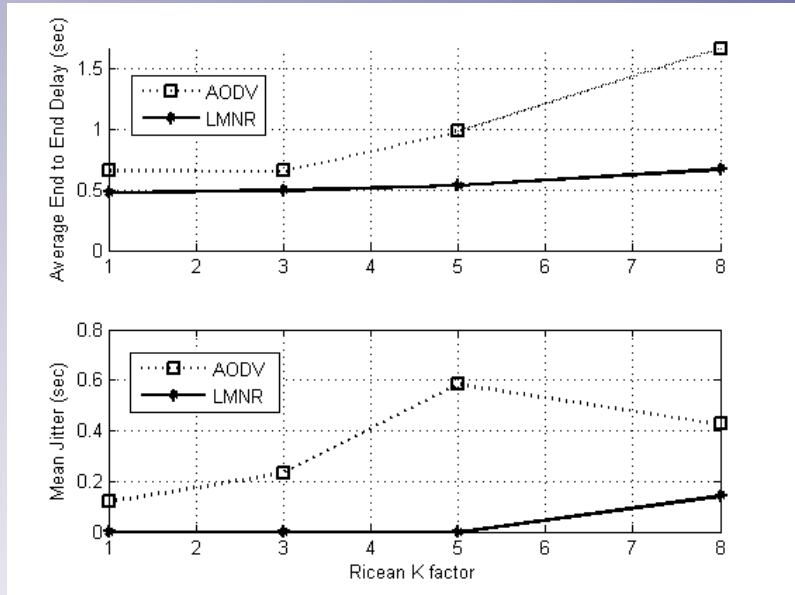
Results (LMNR vs. AODV)



Results clearly indicate that multipath routing has contributed to increased packet delivery ratio and decreased jitter (delay variance)

Avg. end-to-end delay and jitter (sec)



To improve system performance:

-Utilize group coordination and data aggregation to localize computation and decrease network traffic

- Redesign of network, i.e. adding more access points

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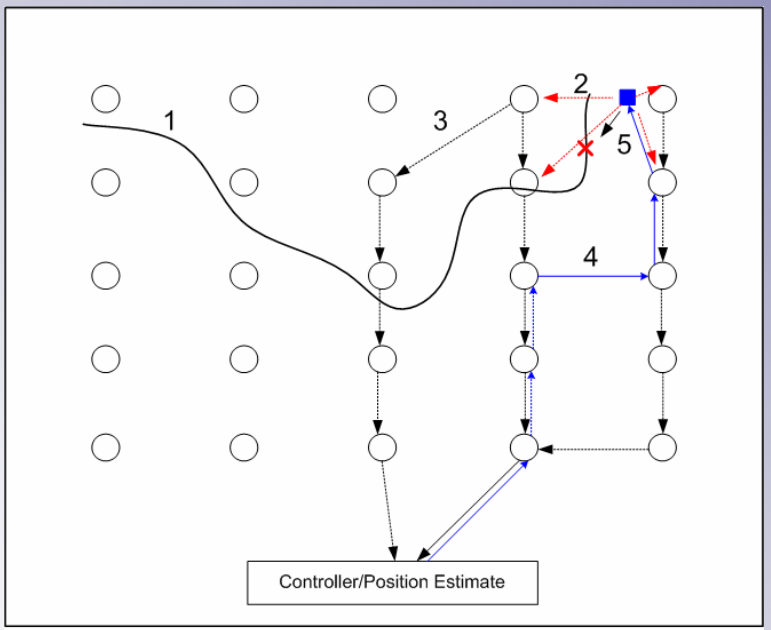
Target tracking and Control



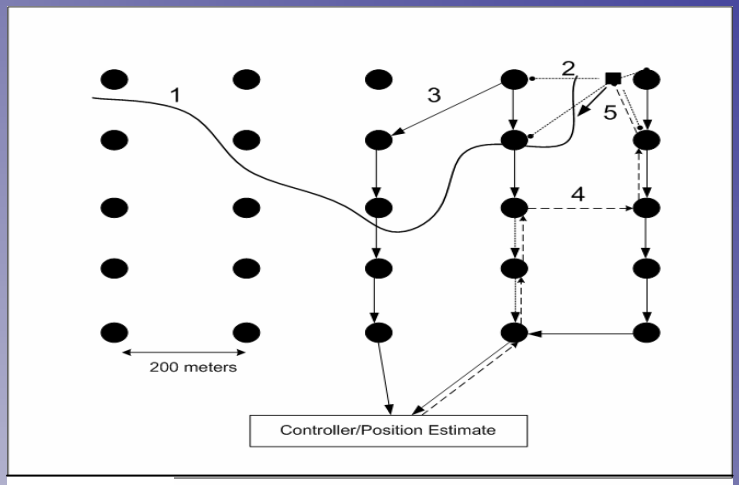
Sensors->Controller
Controller->Mobile Node

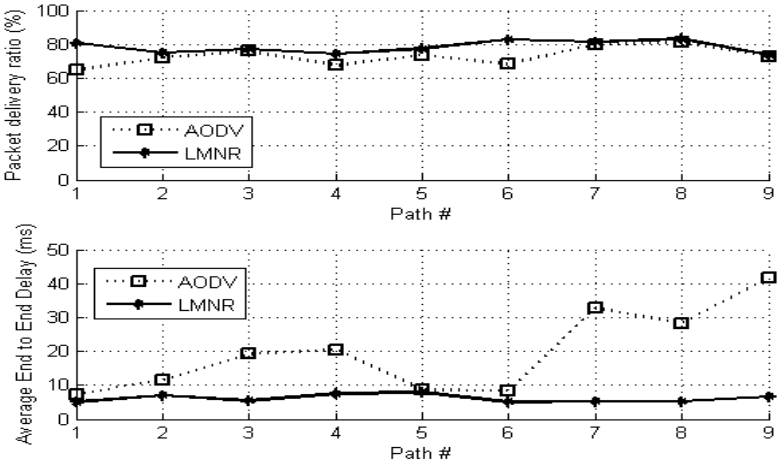
Model:

1. Sensor Motes equipped with Ultra sound receivers and a radio module forms a Grid network
2. A **mobile** Node (Trolley/Robot) emits Periodic Ultrasound pulse
3. Sensor Motes estimate the distance to the Mobile using
4. Distance information is forwarded to the Controller, where Position estimation is done
5. Controller estimates the position using 3-D Position Sensing scheme, where the Differences in the Time-of-Flights from a Wave Source to Various Receivers [Ajay].
6. Finally controller sends Control (Action) Message to the Mobile nodes.

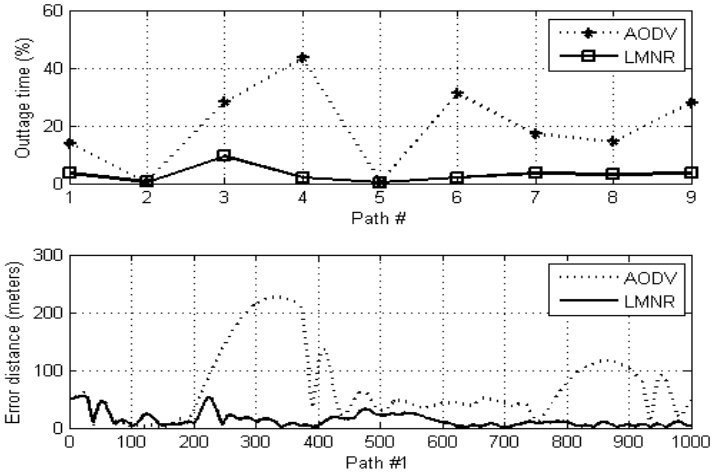
Target Tracking and Path Management

- **Two Communication pairs:**
  - Sensors-Controller
  - Controller-Mobile Node
- Propagation model:
  - Two ray ground model
- Results produced for 9 different reference paths



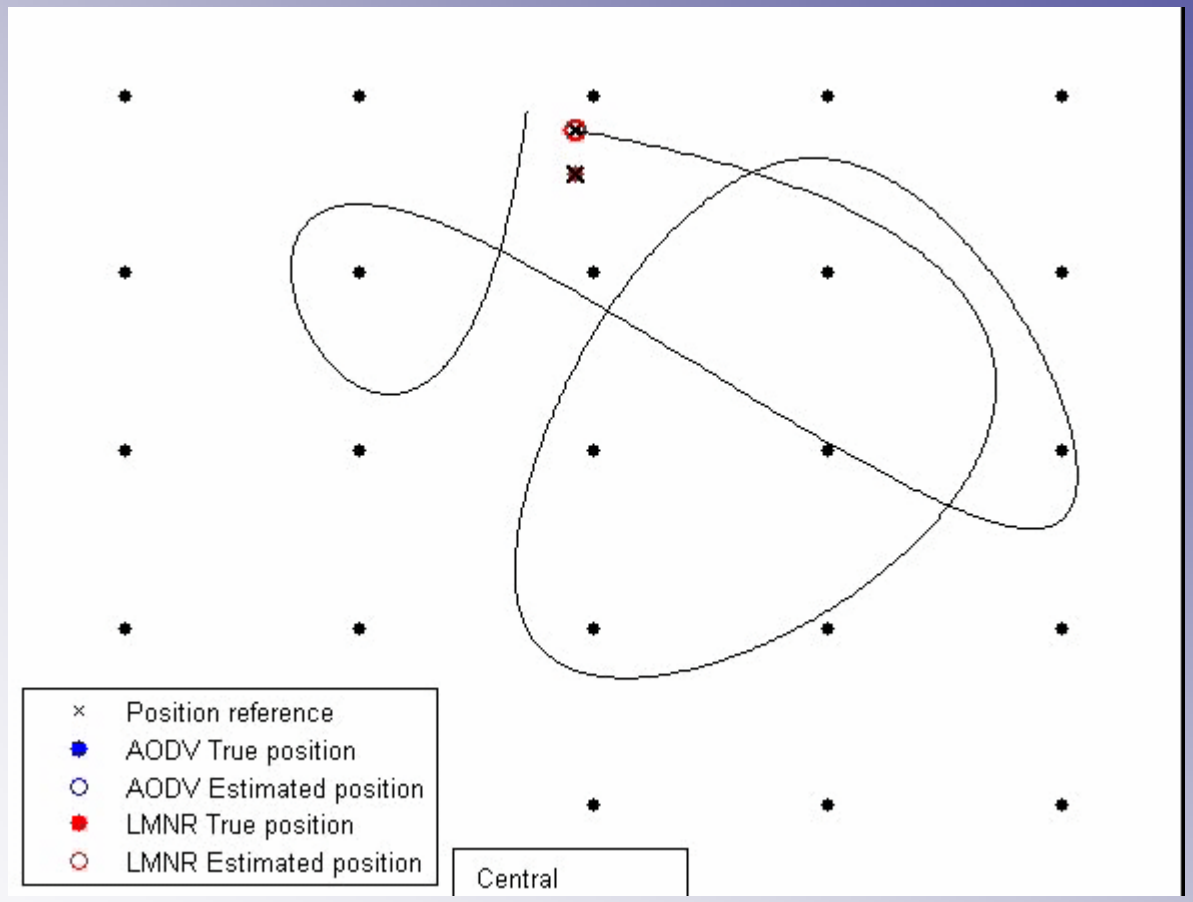


Packet delivery fraction and Avg. end-to-end delay



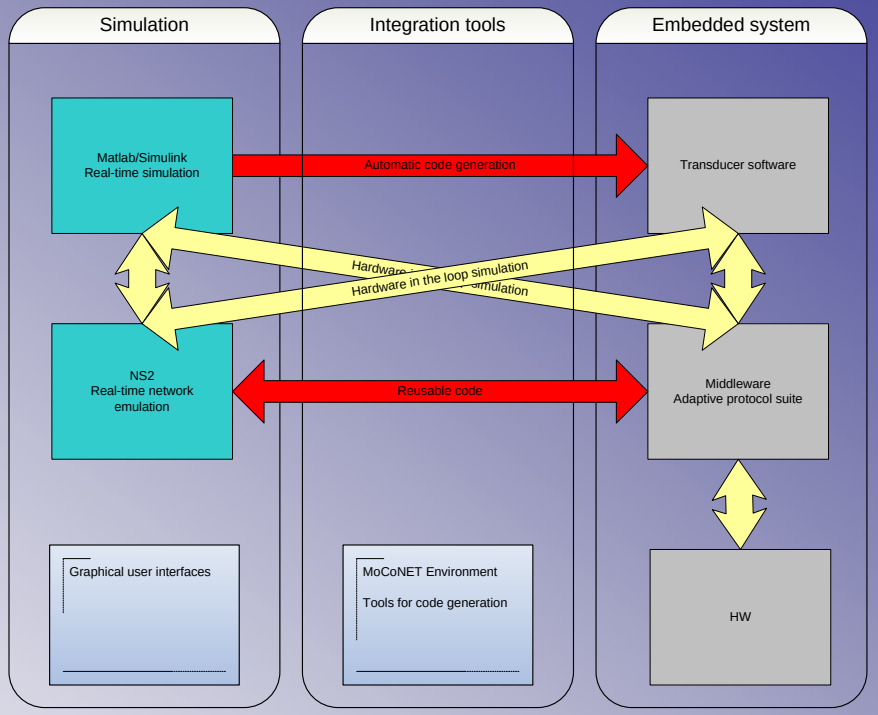
Outage time and Error estimate

Recorded simulation for Target tracking



Way forward

- Graphical user interfaces
  - setting the network parameters jointly for Ns2 and Matlab
- Automatic code generation
  - Control design
- Code reusability
  - The same networking protocols can be run both in real sensor network hardware and Ns2 emulator
- Hardware in the loop simulation
  - Laboratory scale processes
  - Real sensor network



Conclusions

- The traditional control theory assumes constant sample times and it is not well suited for asynchronic systems such as Wireless Networked Control Systems.
  - Need to develop new theory to deal with integrated wireless communications and control
  - Need to develop simulation platforms for testing and verifying the theories before implementing them on real industrial systems.
- Based on widely used simulation software tools such as MATLAB/Simulink (control design) and ns-2 (communications), we are currently developing a platform for evaluating and demonstrating interactions of wireless communications and embedded control systems.

Riku Jäntti
Professor, D.Sc.

Communications Laboratory
P.O. Box 3000, FI-02015 TKK, Finland
phone +358 9 451 2353
fax +358 9 451 2345
mobile +358 40 528 6996
riku.jantti@tkk.fi

HELSINKI UNIVERSITY OF TECHNOLOGY

Communications Laboratory
Helsinki University of Technology

Adaptation in Genetic Algorithms

Ghodrat Moghadampour
Vaasa University of Applied Sciences
Vaasa
Finland

Outline

- Evolutionary Algorithms
- Genetic Algorithms
- Parameters
- Adaptation
- Mutation Operator
- Adaptation for mutation operator
- Intelligent mutation operators

Motivation

- In the real world, there are numerous hard problems, which cannot be solved with conventional techniques within reasonable time, like optimization problems:

$$\frac{1}{4000}\sum_{i=1}^{n}(x_i-100)^2-\prod_{i=1}^{n}\cos\left(\frac{x_i-100}{\sqrt{i}}\right)+1$$

- Conventional techniques require rigid assumptions, like convexity, linearity, differentiability, explicitly defined objectives and so on.

Evolutionary Algorithms

- It is generally accepted that any evolutionary algorithm must have five basic components:
  1. a genetic representation of a number of solutions to the problem
  2. a way to create an initial population of solutions
  3. an evaluation function for rating solutions in terms of their "fitness"
  4. "genetic" operators that alter the genetic composition of offspring during reproduction
  5. values for the parameters, e.g. population size, probabilities of applying genetic operators

Purpose of Evolutionary Algorithms

- Classical optimization problems are more efficient in solving linear, quadratic, strongly convex, unimodal, separable and many other special problems.
- On the other hand, EAs do not give up so early when discontinuous, nondifferentiable, multimodal, noisy and otherwise unconventional response surfaces are involved.
- EAs show inefficiency on the classes of simple problems, but the effectiveness or robustness of them extends to a broader field of applications.

Genetic Algorithms

A simple GA works as follows:

1. Start with a randomly generated population of *n* individuals
2. Calculate the fitness *f(x)* of each individual in the population
3. Repeat the following steps until a new population is created:
   i. Select a pair of parent from the current population

Genetic Algorithms

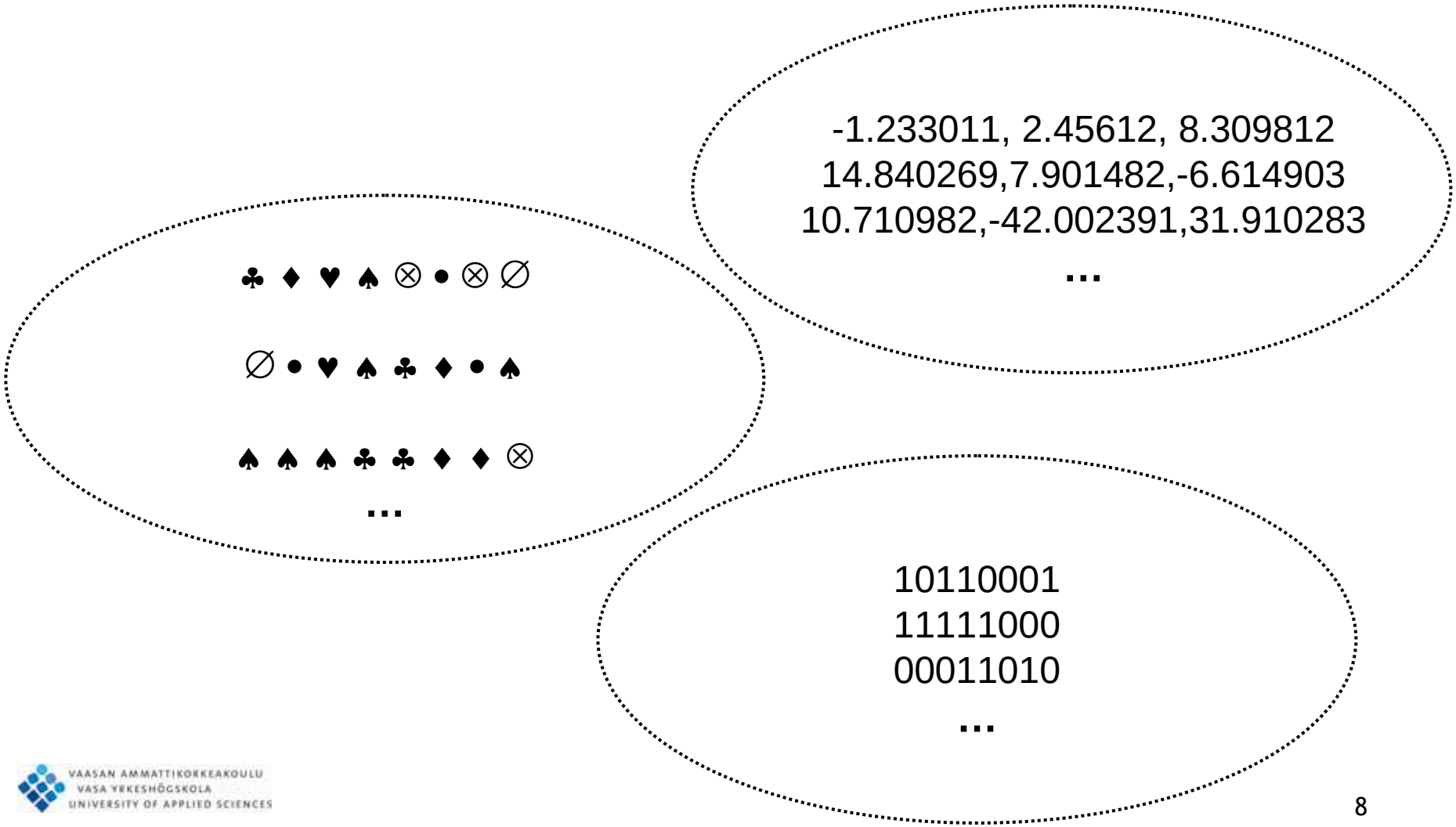
ii. Cross over the pair with crossover probability *Pc* at a randomly chosen point to form two offspring

iii. Mutate the two offspring at each locus with probability *Pm* and place the resulting individuals in the new population

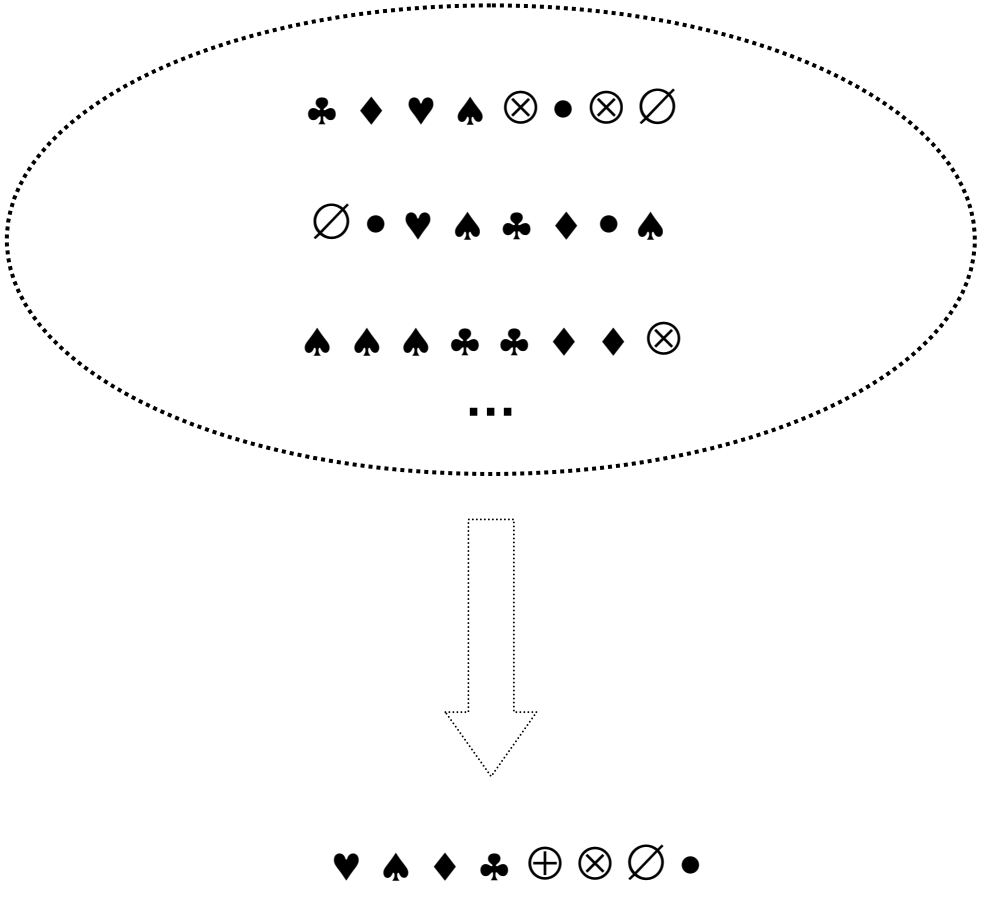
4. Replace the current population with the new population

5. While the termination condition is false go to step 2.

Representation



Evolutionary Process



Parameters in Evolutionary Algorithms

- Evolutionary algorithms are affected by more parameters than optimization methods typically.
- This is at the same time a source of their robustness as well as a source of frustration in designing them.
- Adaptation can be used not only for finding solutions to a given problem, but also for tuning genetic algorithms to the particular problem

Adaptation

- Adaptation can be applied to problems as well as to evolutionary processes.
  - In the first case, adaptation modifies some components of genetic algorithms to provide an appropriate form of the algorithm, which meets the nature of the given problem.
  - These components could be any of representation, crossover, mutation and selection.

Adaptation

- In the second case, adaptation suggests a way to tune the parameters of the changing configuration of genetic algorithms while solving the problem.
- Some of such parameters are:
  - population size and structure, like subpopulations
  - genome representation (floating point, binary, parse tree, matrix), precision and length
  - crossover type (arithmetic, -point, etc.), the number of crossover points and probability
  - mutation type (uniform, Gaussian, etc.), mutation variance and probability
  - selection type (tournament, proportional, etc.), tournament size.

Optimal Parameters

- The challenge is that optimal parameters of an EA are problem dependent and there is a large set of possible EA settings.
- The No-Free-Lunch theorem implies that no set of parameters for an EA is superior on all problems.
- Finding the right parameter values is a time-consuming task and it has been the subject of many researches.

Parameter Setting Methods

- The main criteria for classifying parameter setting methods are:

1) what is changed:
   - representation
   - evaluation function
   - variation operators (mutation and recombination)
   - selection
   - replacement
   - population

Parameter Setting Methods

2) How the change is made:

- deterministic (or fixed) parameter control (parameter tuning) in which the parameter-altering transformations takes no input variables related to the progress of search method
- adaptive (also called explicitly adaptive) parameter control in which there is some form of feedback from the search
- self-adaptive (implicitly adaptive) parameter control in which the parameters to be adapted are encoded into the chromosomes and undergo mutation and recombination

Mutation

- Mutation is a bit reversal event that occurs with small probabilities per bit.

Binary Mutation:

1 0 0 1 1 1 0 0 0 0 0 0 1 1 ⇨ 10.95

-50≤x≤50

0 0 0 1 1 1 0 0 0 0 0 0 1 1 0 ⇨ -39.05

Real Value Mutation:

6.290351 ⇨ 6.290102

Mutation Operators

- Efforts to tune the mutation probability have resulted to different values and hence leaving practitioners in ambiguity.
- As results of tuning "optimal" mutation rate, the best rate found to be Pm=0.001 (De Jong 1975), Pm=0.01(Grefenstette 1986), $0.005 \leq Pm \leq 0.01$ (Schaffer et al. 1989) and Pm=1/L (Mühlenbein 1992), where L is the length of the bit string (Michalewicz et al. 2004).

Adaptation for Mutation Rate

- Controlling the mutation rate in bit-flip mutation (Fogarty 1989; Ursem 2003):

$$p_m(t) = \frac{1}{240} + \frac{0.11375}{2^t}$$

Adaptation for Mutation Rate

- A theoretically optimal schedule for deterministically changing *Pm* for the counting-ones function is presented in (Hesser & Männer 1991; Eiben et al. 1999; Michalewicz et al. 2004):

$$p_m(t) = \sqrt{\frac{\alpha}{\beta}} \times \frac{\exp(\frac{-\gamma t}{2})}{\lambda\sqrt{L}}$$

Adaptation for Mutation Rate

- An optimal schedule for decreasing the mutation rate as a function of the distance to the optimum is defined in (Bäck 1992 a; Eiben et al. 1999; Michalewicz et al. 2004) in the following way:

$$p_m(f(x)) \approx \frac{1}{2(f(x)+1)-L}$$

Adaptation for Mutation Rate

- Controlling the variance in Gaussian mutation is very critical in successful application of real-encoded EAs.
- The standard approach for doing this is to set the variance of the mutation according to a monotonic decreasing function depending on the generation number.

Adaptation for Mutation Rate

- Gaussian mutation of a real-encoded variable is usually performed according to:

$$x_i' = x_i + N(0, \sigma_i(t))$$

- The mutation variance is traditionally set using either a linear or an exponentially decreasing function such as:

$$\sigma_i(t) = 1/\sqrt{1+t}$$

Adaptation for Mutation Rate

- The mutation rate *Pm* of GAs can also be self-adapted by adding the rate of mutating , coded in bits, to every individual.
- Then the new is used to mutate the individual's object variables.
- This is based on the idea that better *Pm* rates will produce better offspring and then hitchhike on their improved children to new generations, while bad rates will die out

Adaptation for Mutation Rate

- Mutating a floating-point object variable in a self-adaptive way may happen in the following way:

$$x_i' = x_i + \sigma_i N(0,1)$$

- where the mean step sizes can be modified for instance lognormally:

$$\sigma_i' = \sigma_i \exp(\tau' N(0,1) + \tau N_i(0,1))$$

Intelligent Mutation Operators

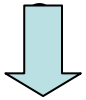
- **Problem with the classical implementation of binary mutation**: it is difficult to control effect or to restrict changes caused by multiple point mutation or the crossover operator within certain limits
- **Solution**: implement the genetic operators intelligently so that the resulting modifications on the binary string will cause changes in the real values within the desired limits

Mutation

Binary Mutation:

1 0 0 1 1 1 0 0 0 0 0 0 1 1 ⇨ 10.95

$-50 \leq x \leq 50$



0 0 0 1 1 1 0 0 0 0 0 0 1 1 0 ⇨ -39.05

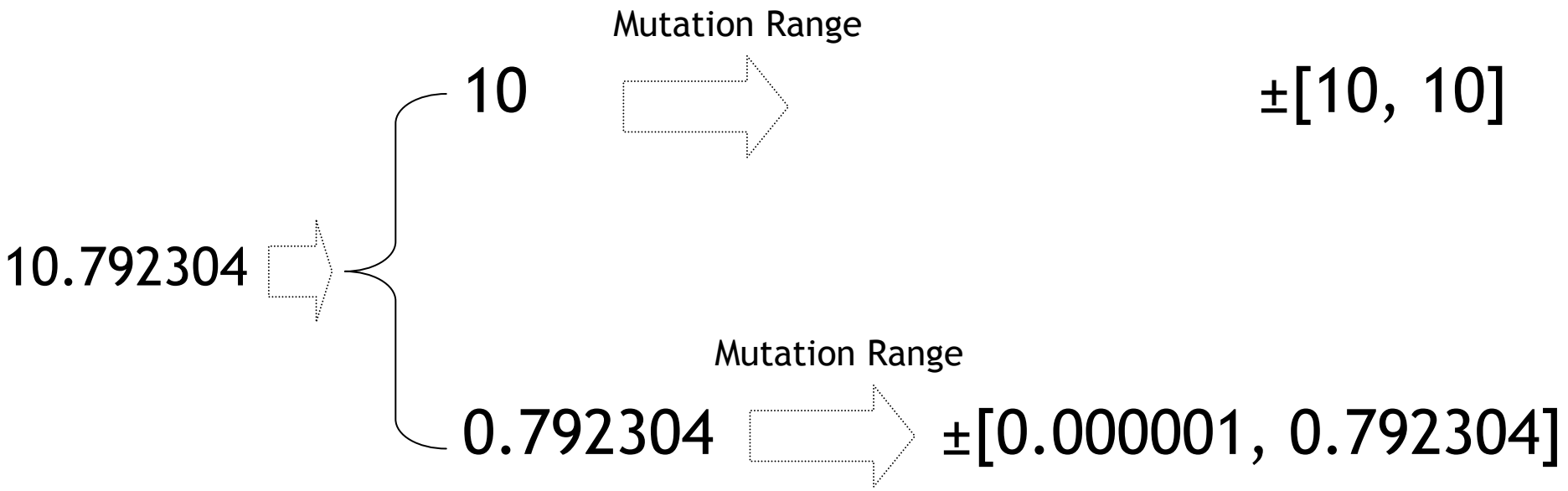
Real Value Mutation:

6.290351 ⇨ 6.290102

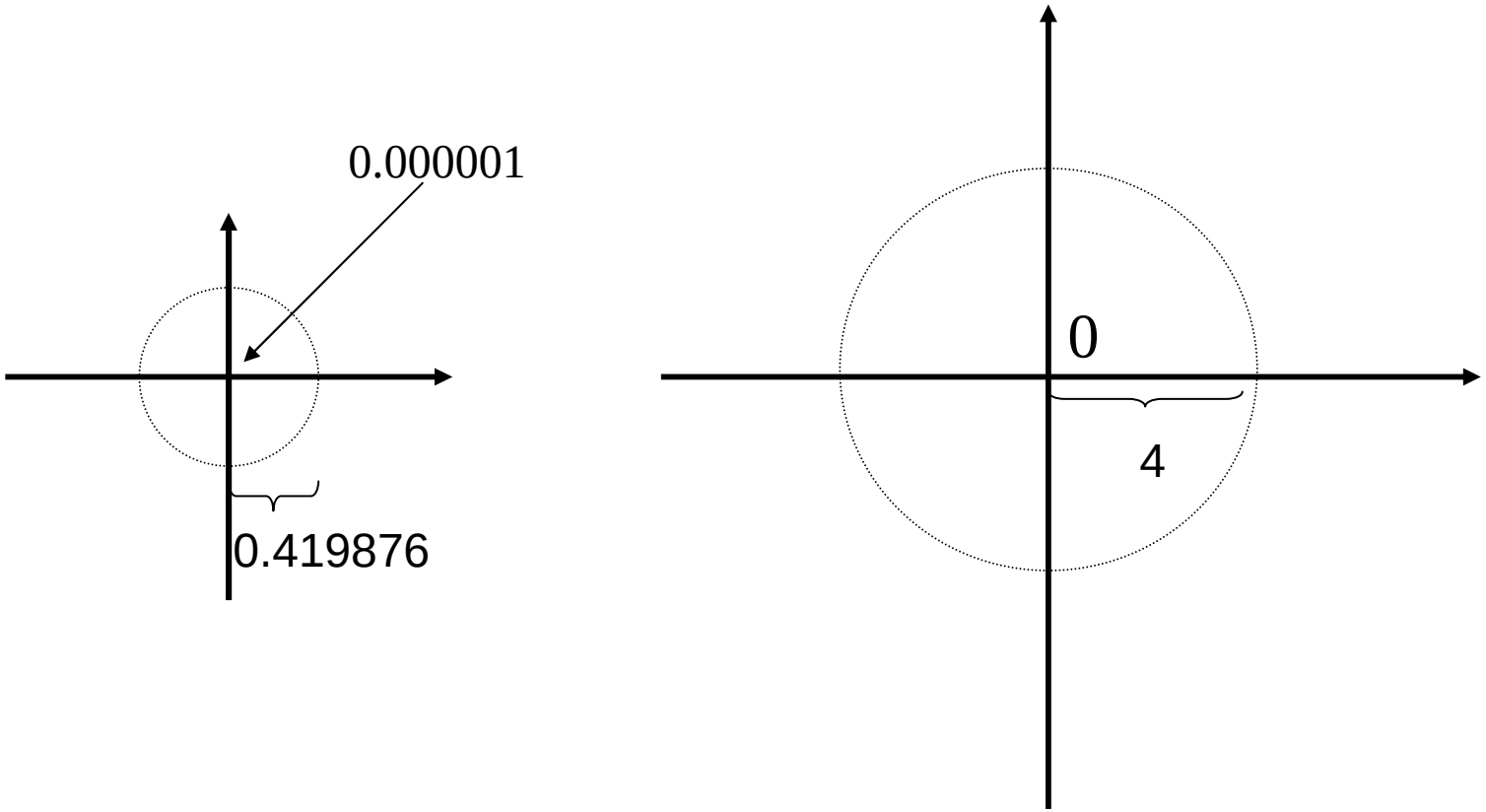
Intelligent Mutation Operators

- Changes of different magnitudes are required at different stages of the evolutionary process:
- Modifying variables with integer values. The bounds for the absolute values of such changes are at least 1 and at most the integer part of the real value representation of the variable.
- Modifying variables with values from the range 0<x<1. The lower bound for the absolute value of such changes is determined by the required precision of the real value presentation of the variable, like 10-6. The upper bound for the absolute value of such changes is determined by decimal part of the variable.

Intelligent Mutation Operators



Intelligent Mutation Operators



Experimentation & Conclusions

- These operators were tested on 44 test problems in 2200 runs.
- Experimentation showed that the most efficient operators are the integer mutation and the decimal mutation operators, which were able to improve the population fitness values the most.

Thank you!

☺

VAASAN AMMATTIKORKEAKOULU
VASA YRKESHÖGSKOLA
UNIVERSITY OF APPLIED SCIENCES

Simulation of Radio Resource Management for Handover in WCDMA Network

Author: Cao Zhichao
Supervisor: Mr. Gao Chao

Vaasa University of Applied Sciences
Department of Information Technology

Outlines

- Introduction
- Node movement and handover concept
- Traffic types and generation
- Simulation parameters
- Simulation Results
- Conclusion

Introduction

WCDMA (Wideband Code Division Multiple Access) is a high speed 3G cellular network standard.

This project will simulate a downlink transmission WCDMA network in a 7-cell cluster especially for handover in WCDMA using Matlab, and compare the results under different situations.

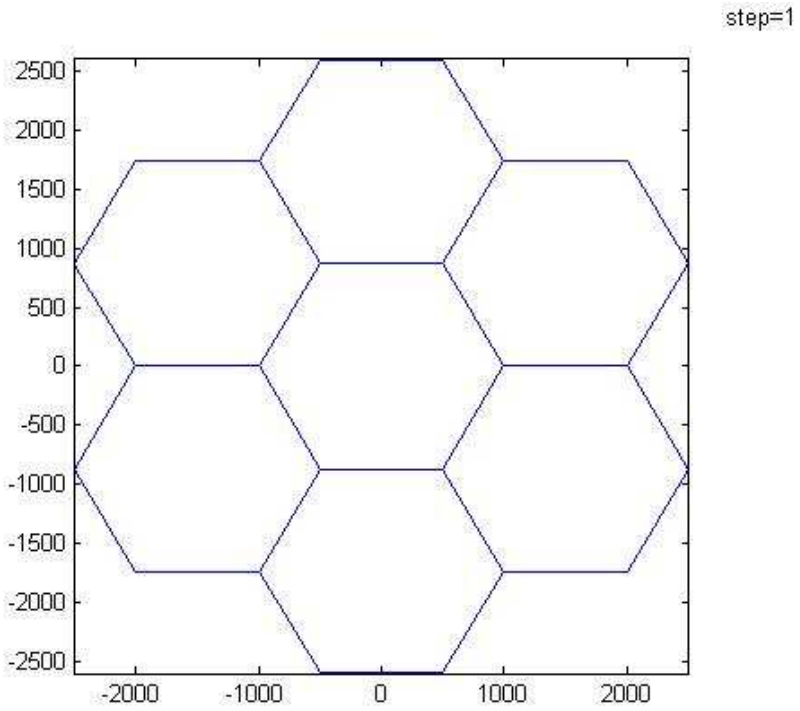
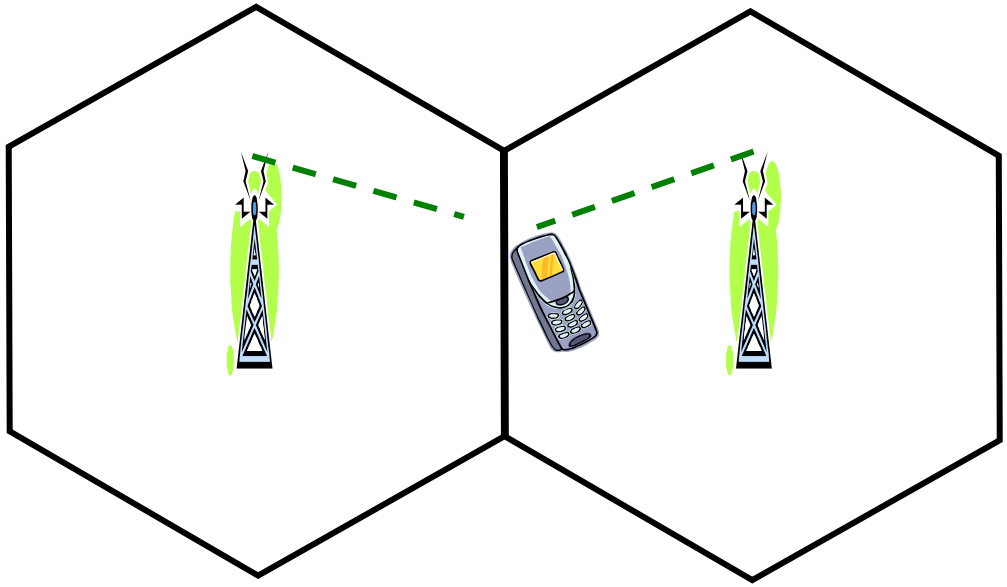


Figure1 Overview of simulation area

Handover (Handoff)

- The process of transferring an ongoing call or data from one channel to another.
- Hard handover: usually is called ‘break-before-make’.
- Soft handover: used in CDMA network. Simultaneously connected to two or more cells ‘make-before-break’.



Example of hard handover

Traffic Classes

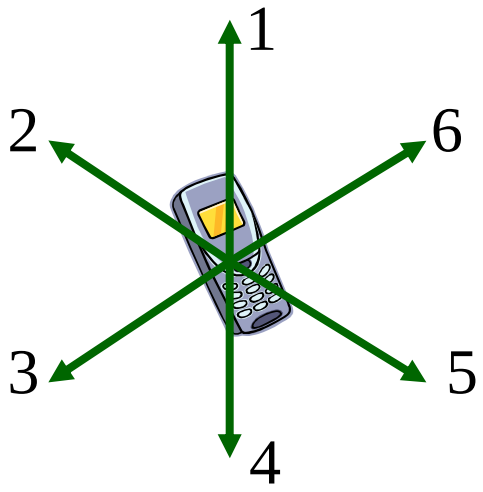
Traffic Classes	Representative Application
Conversational	VOIP (8-32kbps)
Streaming	Video Streaming (128kbps)
Interactive	Web browsing (varying)
Background	E-mail (varying)

Table1 Traffic Classes and Representative Application

In the simulation, VOIP and video streaming are treated as CBR traffic but with different transmission rates. Interactive and Background traffic are treated as burst traffic.

Node Movement

- Directional random walk:
  - A mobile node is initiated randomly with one of the 6 directions to move.
  - Every second a node makes a move based on the speed randomly set at beginning of simulation.
  - A fluctuation is given at each move so that the node may move to other directions with small chance.



Nodes Movement

A torus area is established in the simulation to cope with edge effect.
Example: a mobile node moves out of cell 1 with direction 1 will move into cell 5.

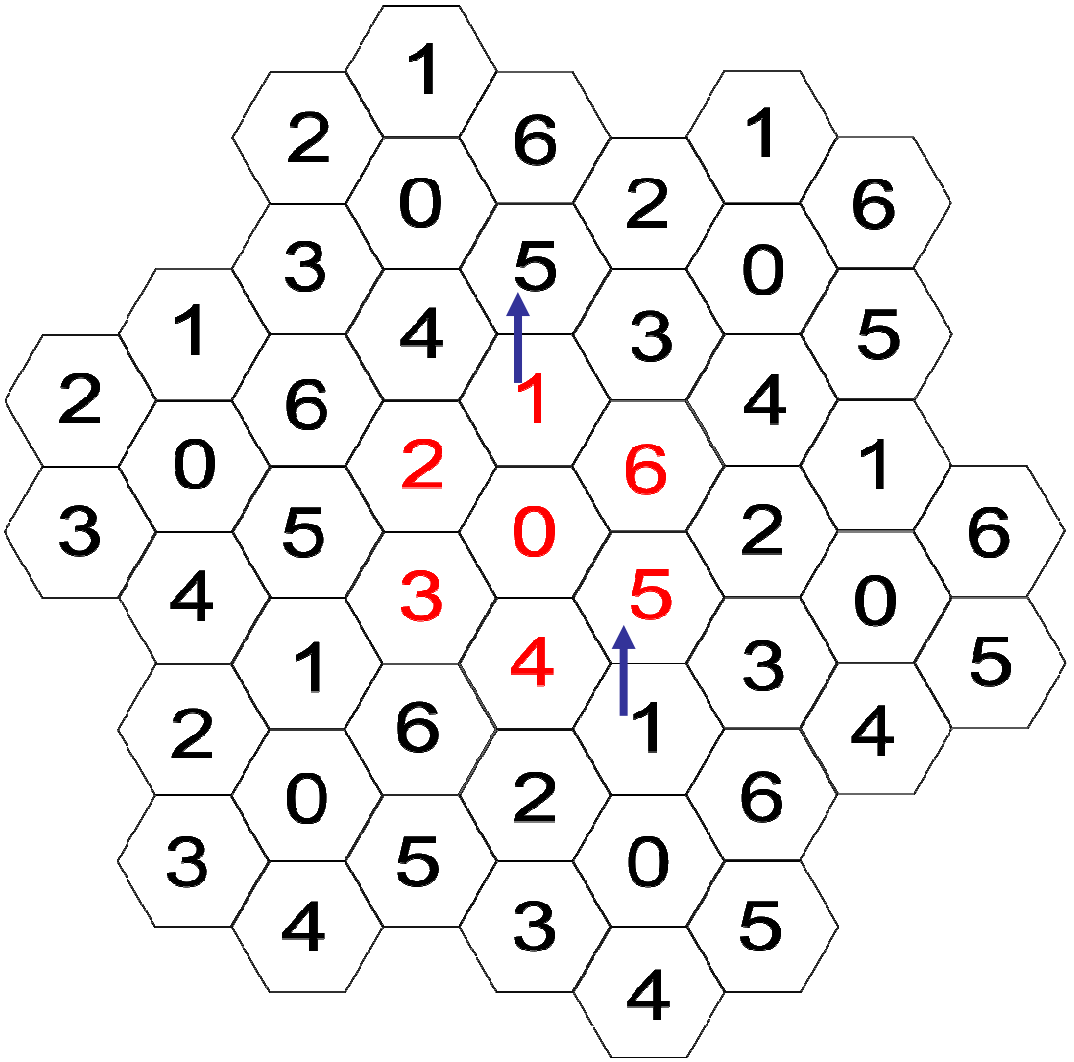


Figure2 Nodes Movement

Traffic Types & Spreading Codes Assignment

- Priority for different kinds of traffic:

  Ongoing CBR traffic > Handover CBR traffic > new CBR traffic > Burst traffic
- For burst traffic: Proportional assignment

- OVSF: Orthogonal Variable Spreading Factor. Spreading factors available from 4 to 512.

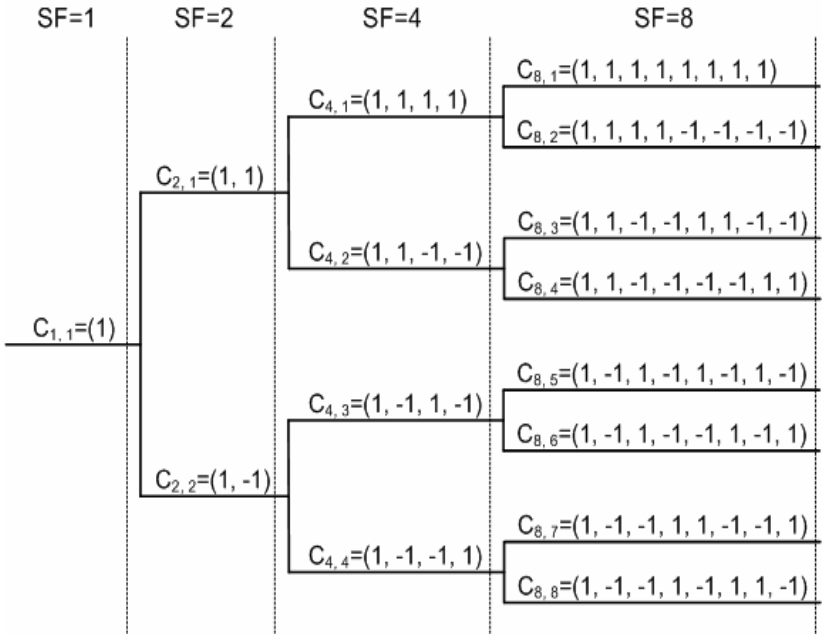


Figure3 OVSF code tree

Spreading Code Pool

- To simplify the design, a spreading code pool with all the available SF=512 codes are managed by the base stations.
- With half-rate coding, the basic rate for a SF=512 code becomes

$$r_b = 3.84Mcps / 512 \times \frac{1}{2} = 3.75kbps$$

- So that a 8kbps voice channel with be assigned 2 SF=512 codes. There are totally 512 such codes in one cell. The code assignment is managed by the base station.

Traffic Generation

- CBR Traffic

  Probability: a mean probability is given by user, the system generates an **uniformly distributed random** number, if the random number is greater than the mean probability, traffic happen.

  Duration: an average duration is given by user, a **normally distributed random number** with this specific mean is generated by system. The **default standard deviation** of this distribution is ‘mean/4’

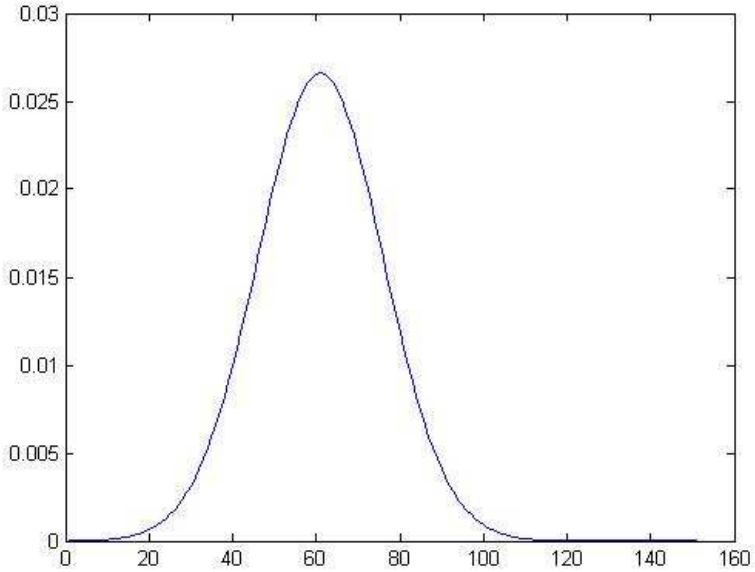


Figure4 Probability Density Function (pdf) of normal distribution with mean=60, standard deviation=15

Traffic Generation

- Burst Traffic

  Burst traffic follows the **Poisson Distribution**. An average burst packet coming rate and the size of one packet is given by user. A **uniformly distributed** random number is generated by system.

  According to the inverse of Poisson cumulative distribution function (cdf) with specific mean, we can get the number of packets for each random number.

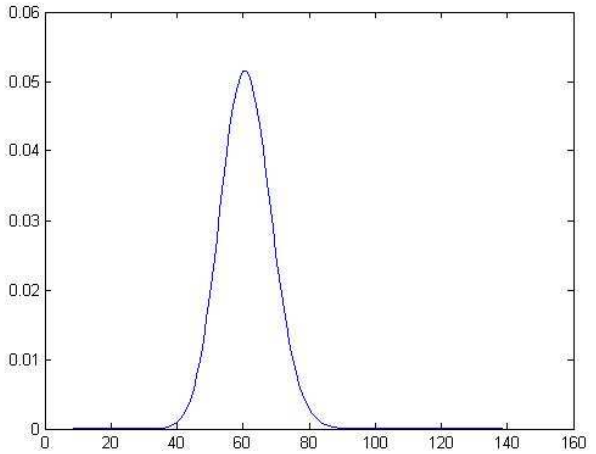


Figure5 pdf of Poisson Distribution with mean=60

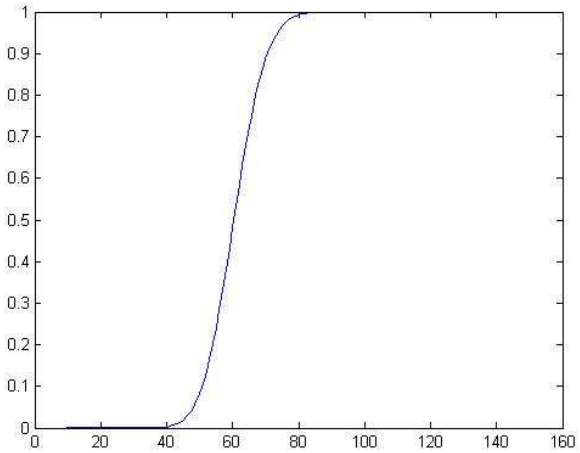


Figure6 cdf of Poisson Distribution with mean=60

Important Parameters

- Here are some important parameters used in simulation:

  Simulation time

  number of users

  CBR coming rate: how many CBR traffics for one user in a given T time

  Voice traffic average duration

  Video traffic average duration

  Average burst traffic rate: average burst packet coming rate for one user

  Burst packet size: the size of each burst packet unit

  Minimum moving velocity

  Maximum moving velocity

Simulation Result (Burst traffic delay)

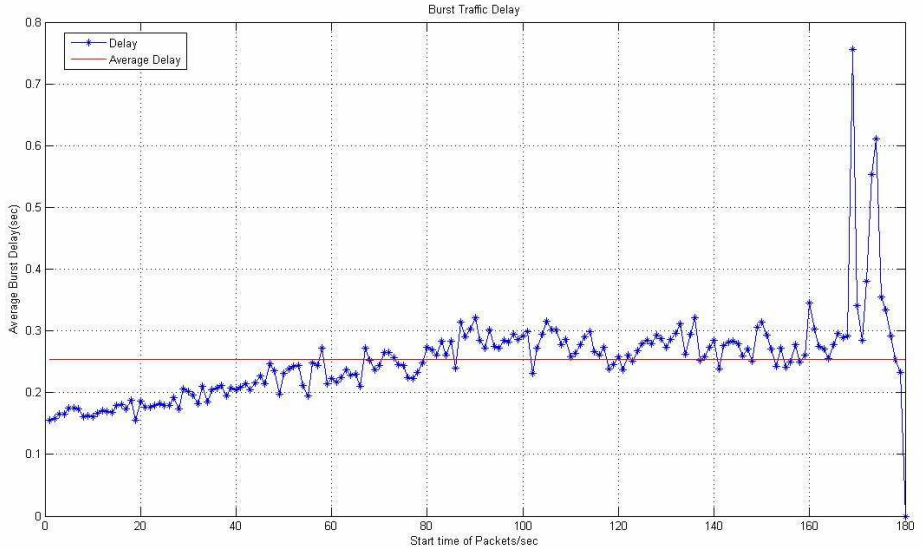
Parameters:

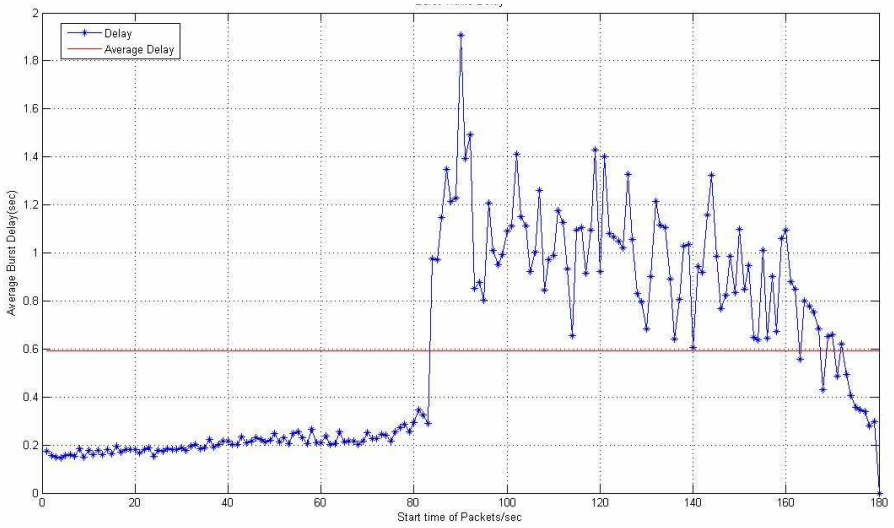
Same:

Sim time=180s
N=100
CBR=8/hour
voice=70s
video=60s
b_rate=0.3/s
b_size=10kb

Diff:

Speed=20-40km/h
Speed=60-120km/h





Simulation Result (CBR Satisfying Ratio)

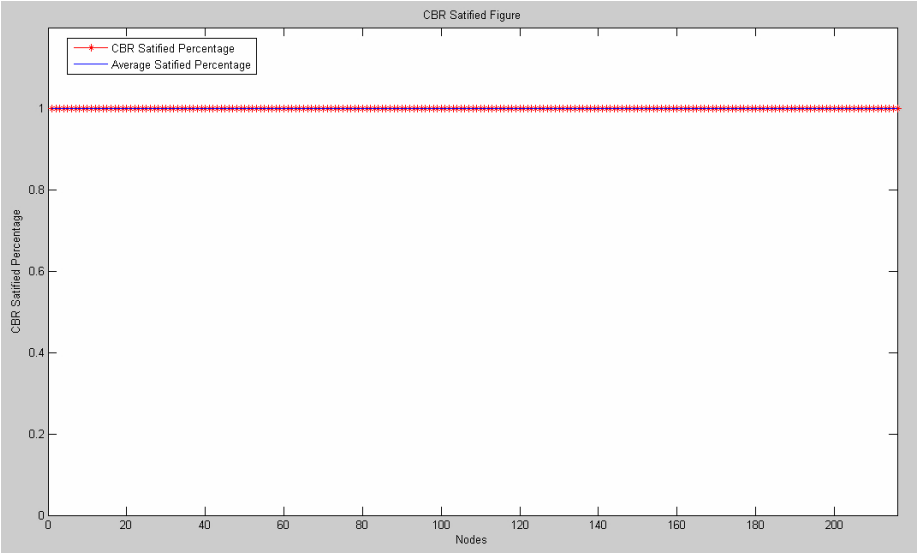
Parameters:

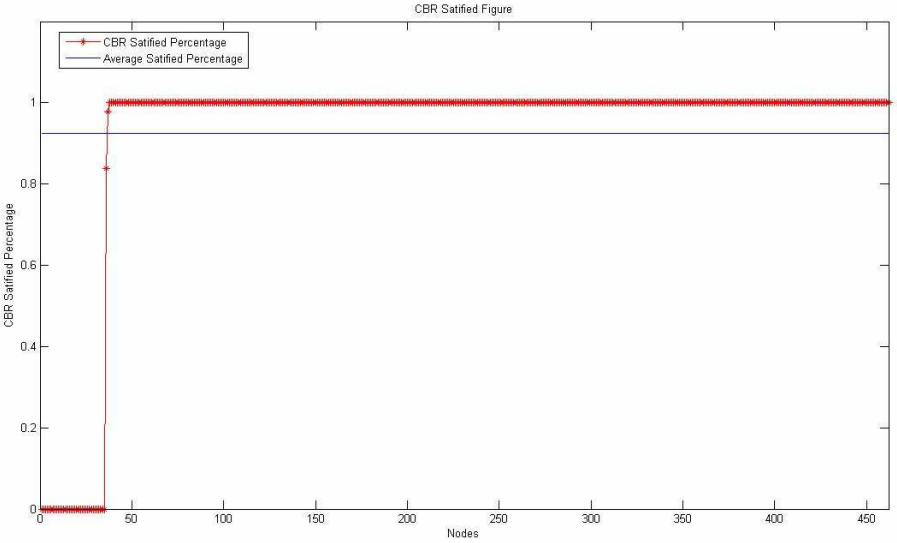
Same:

Sim time=180s
N=100
voice=70s
video=60s
b_rate=0.3/s
b_size=10kb
Speed=20-40km/h

Diff:

CBR=8/hour
CBR=16/hour





Simulation Result (Handover Ratio)

Parameters:

Same:

Sim time=180s

N=100

b_rate=0.3/s

b_size=10kb

Speed=20-40km/h

Diff:

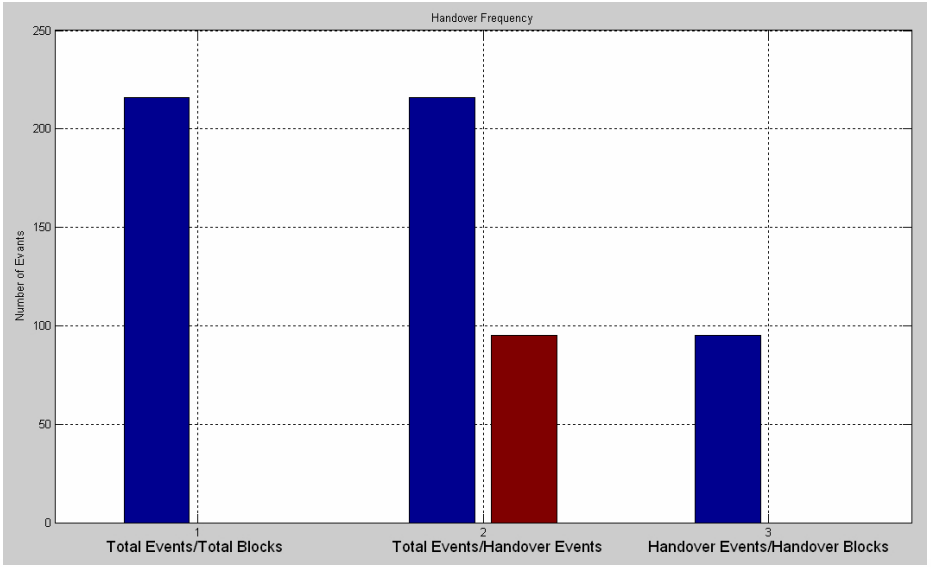
voice =70s

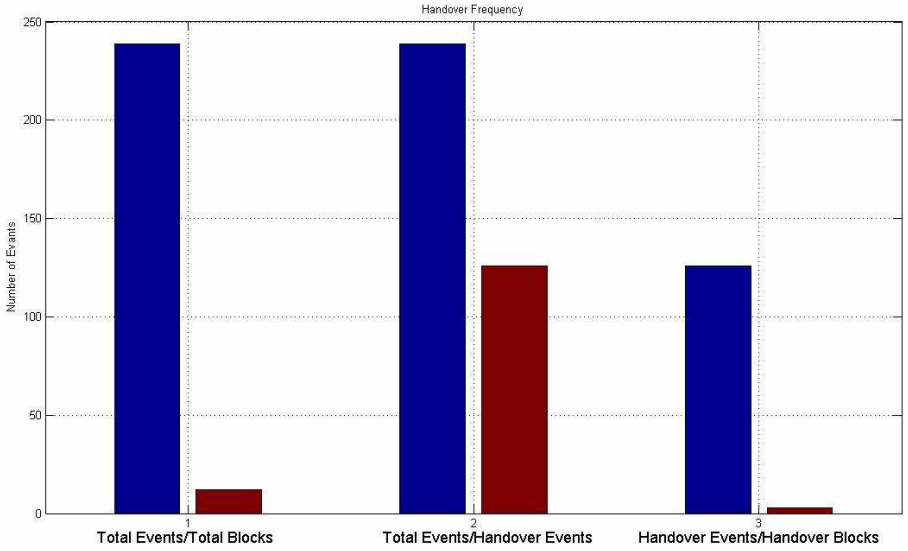
video =60s

Vs.

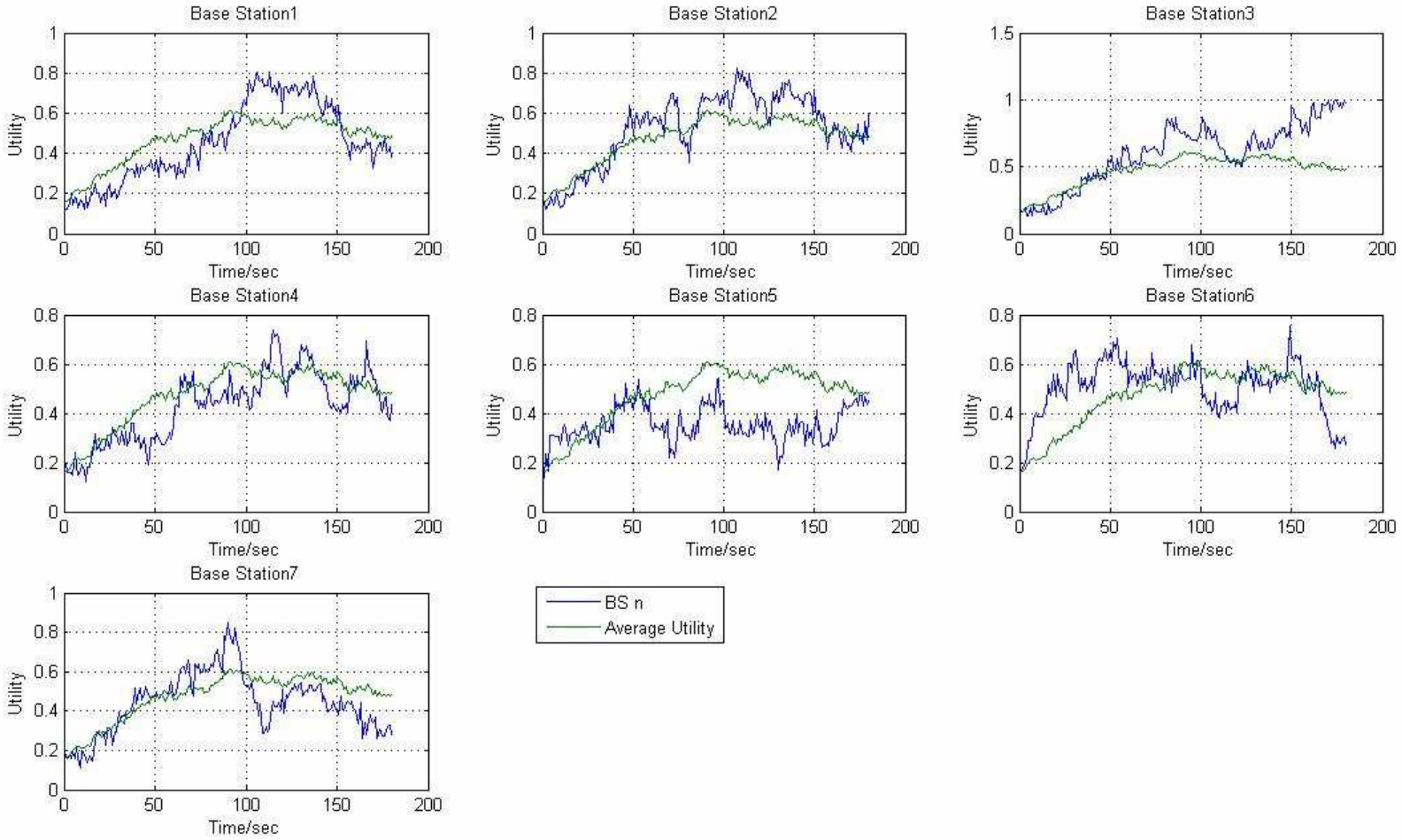
voice =105 s

video =90s





Simulation Result (Base station Utilization)



Conclusion

- About 2000 lines of source codes written in MATLAB.
- Topics cover WCDMA basics, traffic generation & properties, probabilities & statistics, programming & debugging, etc. The project yields a nice starting for future cellular research.
- MATLAB is a suitable tool for simulator design (manipulating data, math functions, and plotting).
- Reasonable results are obtained from simulations.

Thank you very much for you attention!

Questions?