Renesas Solutions for Home Connectivity

Geel Belgium
September 29th 2005

Raimund Stampa
ED System Engineering Platforms
Renesas Technology Europe
raimund.stampa@renesas.com

Contents

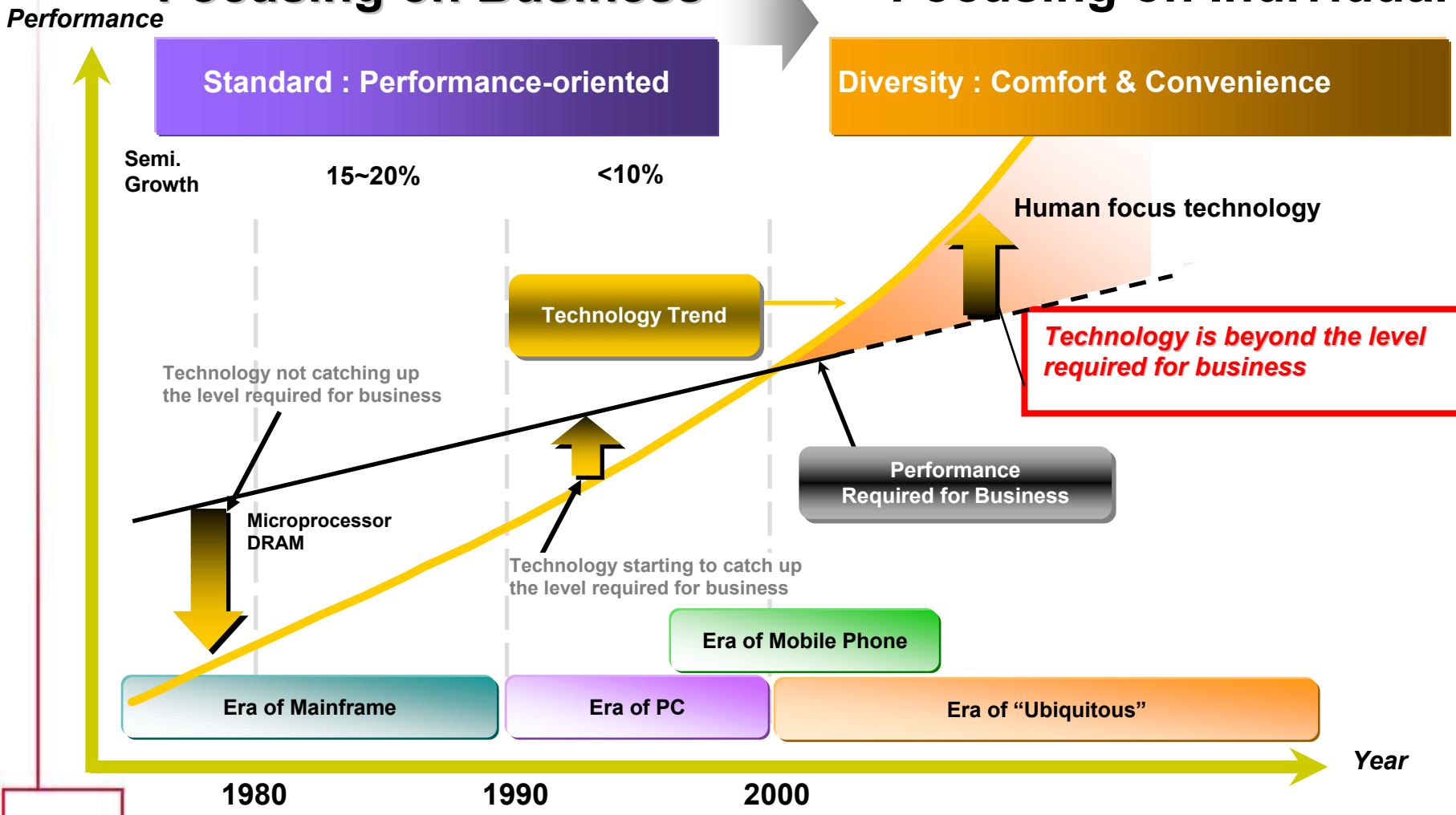
- Evolution of the semiconductor market
- Who is Renesas Technology?
- Home Control
- Power Line Communication
- ZigBee
- Conclusion

Visions and Reality

- "Computers in the future may weigh no more than 1.5 tons."
  Popular Mechanics 1949.
- “I think that there is a world market of maybe 5 computers”
  Thomas Watson, chairman of IBM 1943
- "640 KBytes ought to be enough for everybody”
  Bill Gates, Microsoft, 1981
- “There is no reason anyone would want a computer in their home".
  Ken Olson, president and founder of Digital Equipment, 1977
- „Blablabla“
  Raimund Stampa, Renesas Technology Europe, 2005

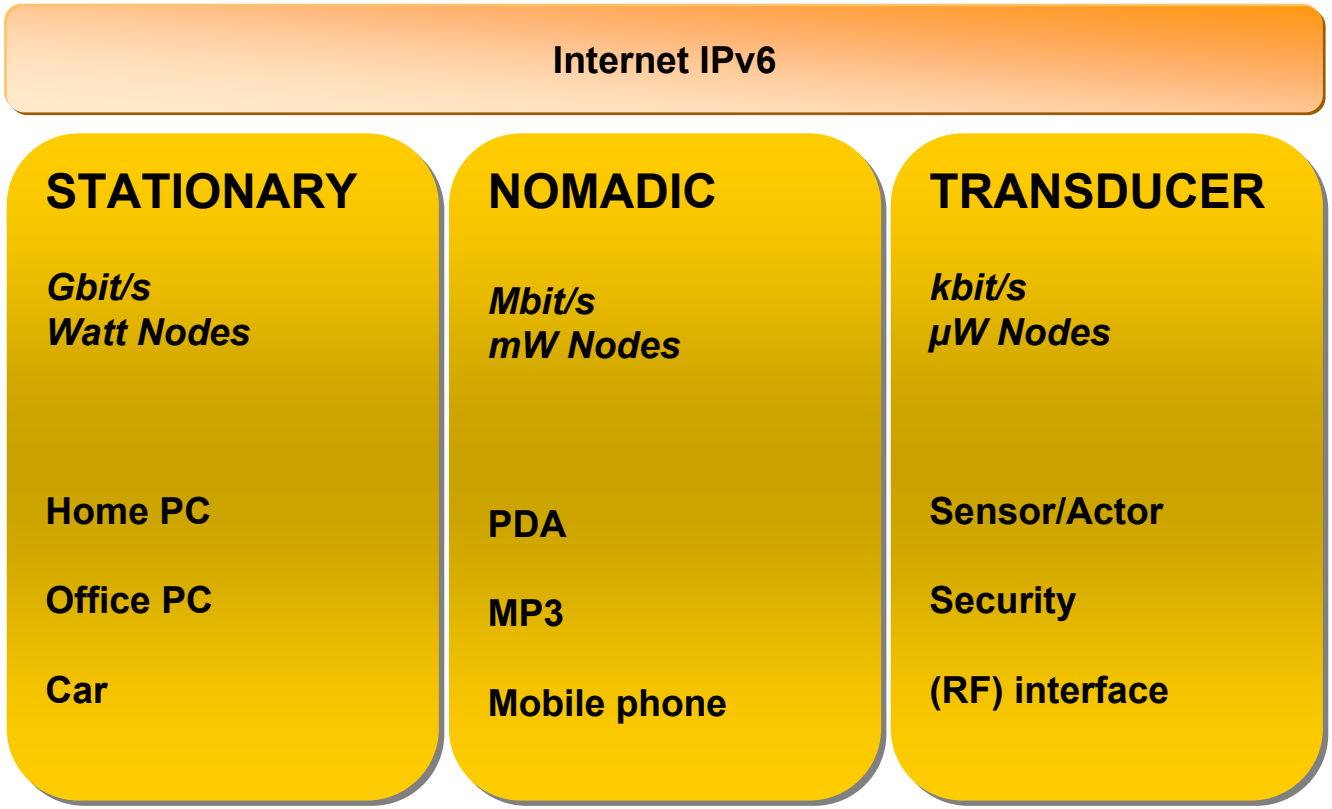
Shift of Focus from Business to Individual

- Focusing on Business
- Focusing on Individual



Devices classes for the Ubiquitous Era

- Embedded Everywhere
- Ambient Intelligence
- More than Moore



Introduction to Renesas Technology

- **Established April/2003**
  (Hitachi Semiconductor/Mitsubishi Semiconductor)
- **Head Office: Tokyo**
- **26500 Employees**
- **One of the worldwide top 5 semiconductor companies**
- **Worldwide top 1 microcontroller company**
- **Integrated Technology and Device Manufacturer (ITDM)**
  (Cutting edge process (65nm), own package technology, process/design integration, huge product line-up, abundant IPs, software and middleware, tools, partnerships)
- **Vision: Aiming to realize a ubiquitous network society**

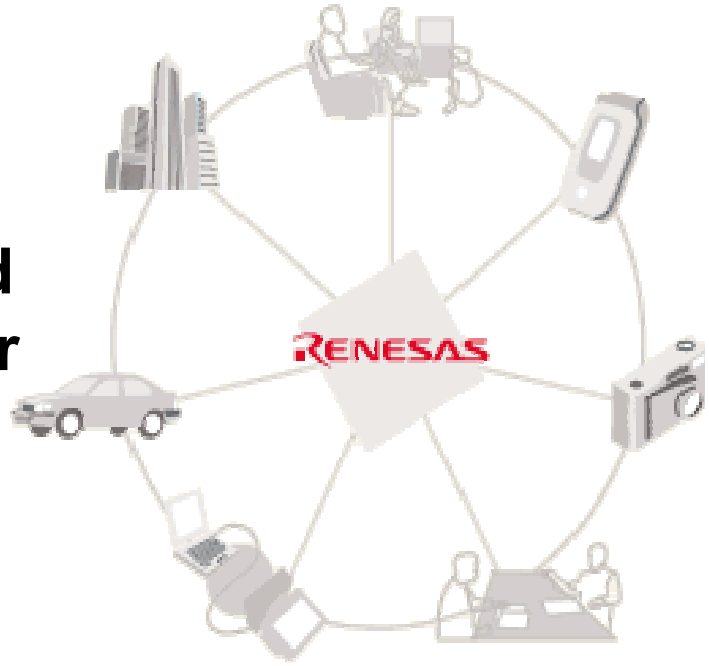
Why is Renesas at this Workshop?

- Renesas attended the Embedded IT workshops regularly
  - Vaasa Finland
  - Kiel Germany
  - Geel Belgium
- Attendance from Engineering side
- Targets:
  - technology exchange
  - co-operation with university/industry network
  - opportunities for students
  - brand awareness
  - showing our engineering activities in Europe
- We would like to join next time again

Corporate Slogan

‘Everywhere you imagine’

- Renesas Technology supports the world of ubiquitous networking and aims to make life easier for people everywhere



W/W Semiconductor Ranking in 2004

Top-tier W/W semiconductor company

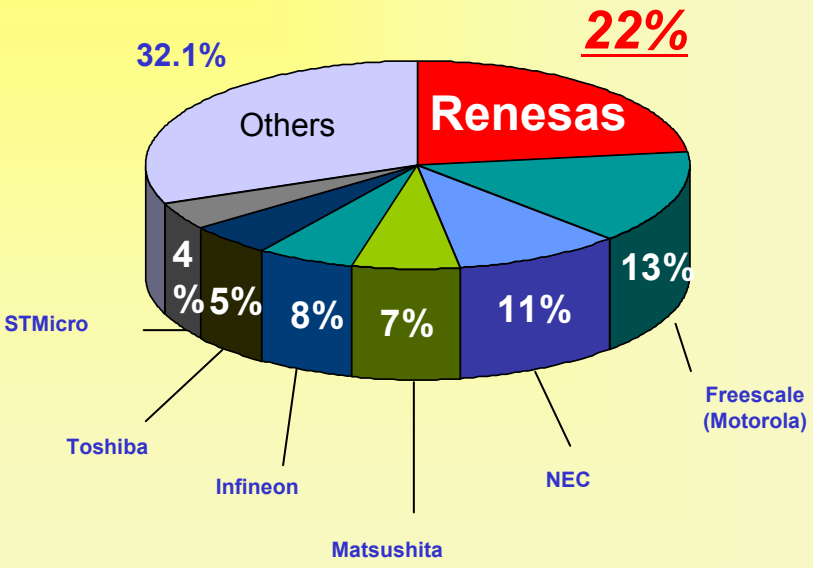
		Sales (US$m)
1	Intel	30730
2	Samsung Electronics	16276
3	Texas Instruments	9678
4	**Renesas Technology**	**9001**
5	Infineon Technologies	8945
6	STMicroelectronics	8761
7	Toshiba	8538
8	NEC	6438
9	Philips Semiconductors	5689
10	Freescale	5519

Source : Dataquest

Renesas W/W Market Share

Total MCU

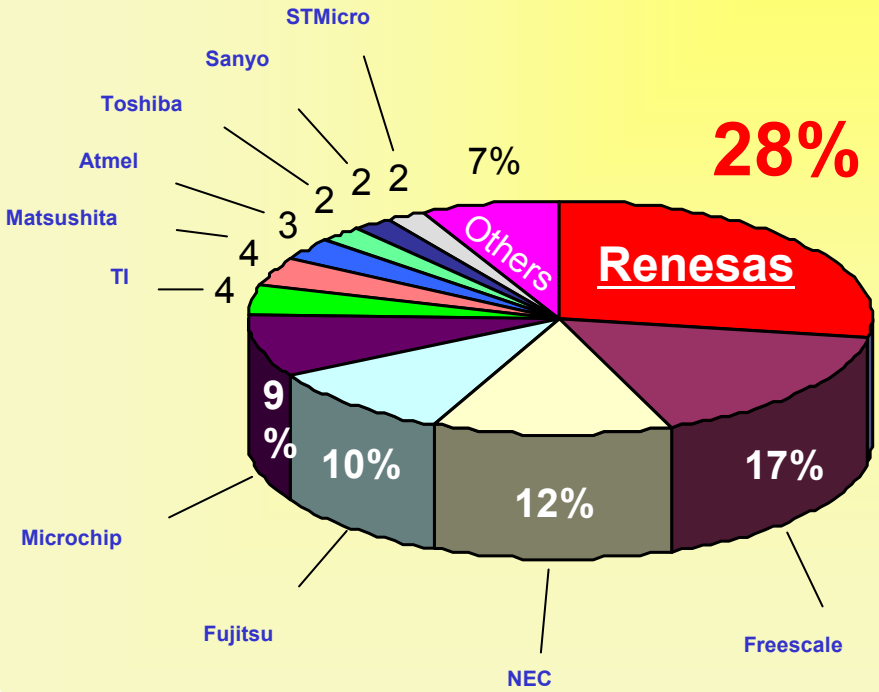
2004



Source : Gartner Dataquest
May,2005

FLASH MCU

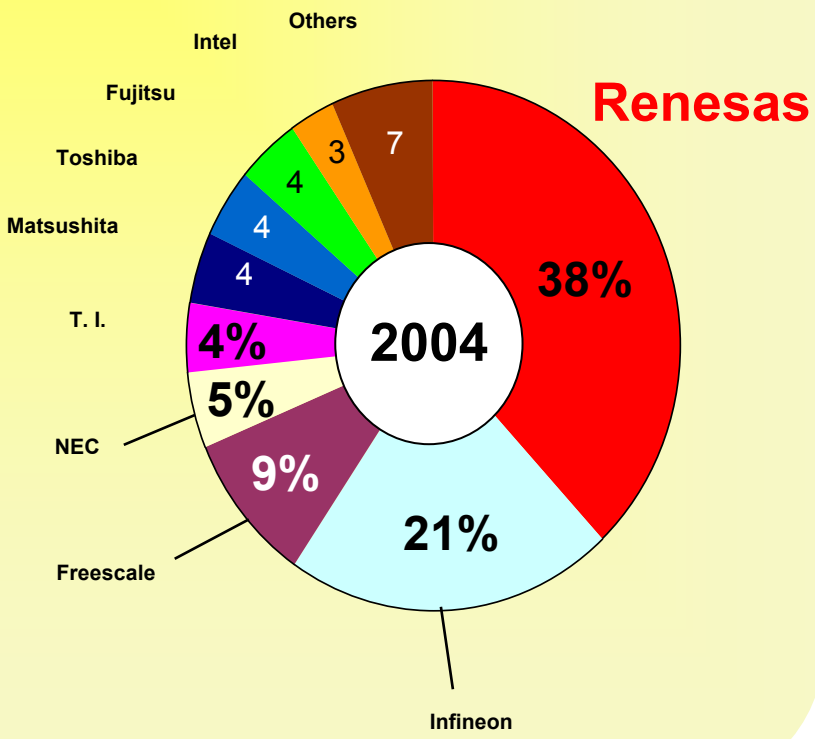
2005 Prospect



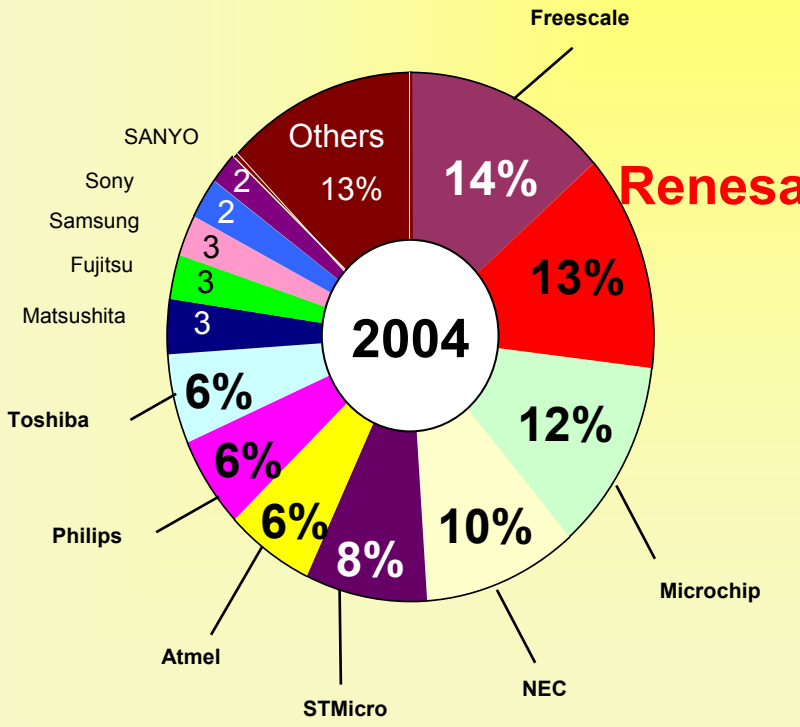
Source: Gartner Dataquest April,2005
Revenue base

Renesas W/W Market Share

16 Bit MCU

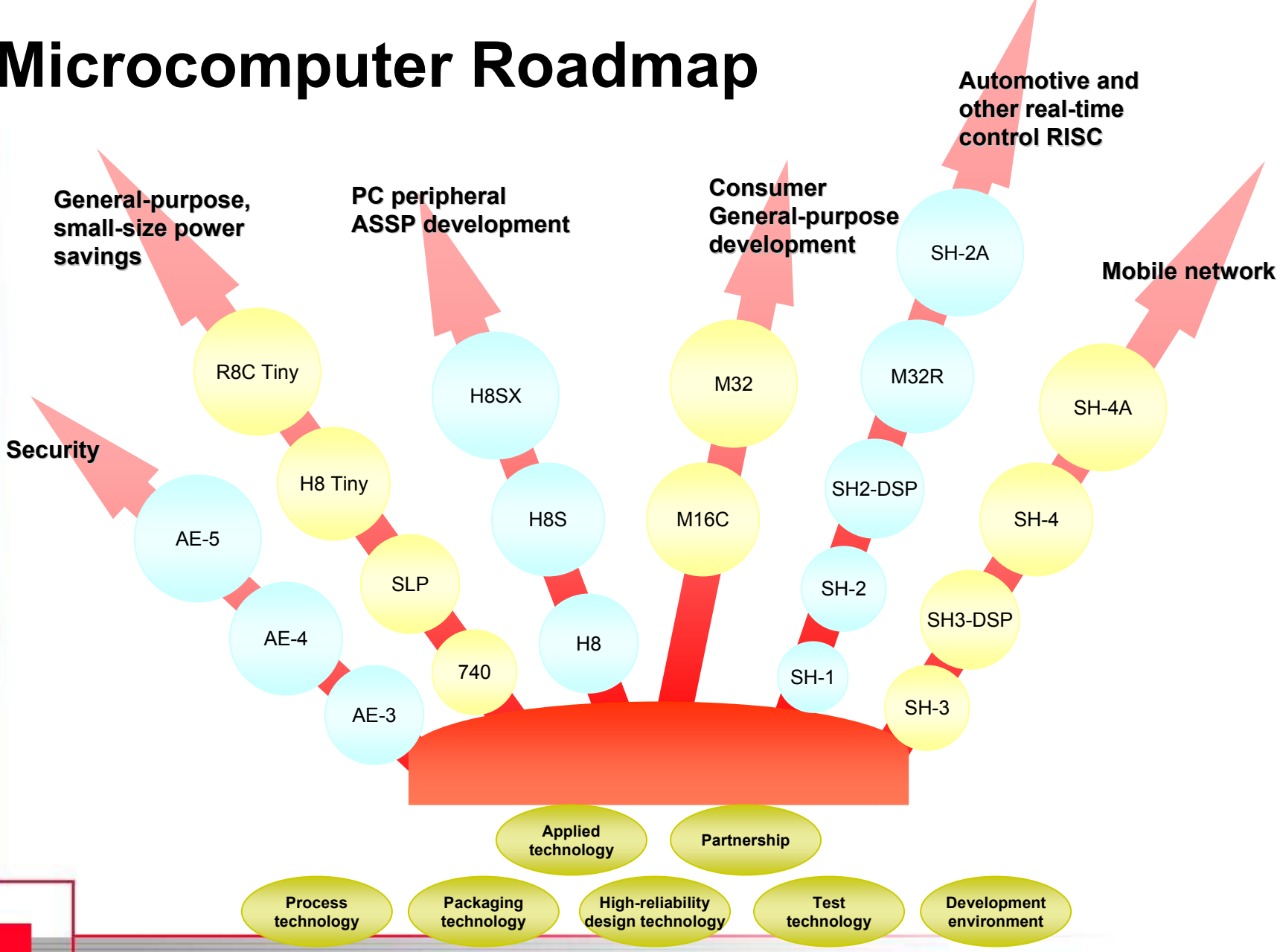


8 Bit MCU



Source : Gartner Dataquest Published in March '05

Microcomputer Roadmap



Renesas for Mobile

Middleware Products

Graphics

- MPEG4
- PNG/GIF
- JAVA
- 2D/ 3D
- Filtering
- Editing of image
- Rotation
- Biometrics
- Security
- Bluetooth
- Image sensors

Audio

- MP3/ AAC
- AMR/ WMA
- G.72

Multimedia Accelerator Platform

Application Development Platform

Display Function

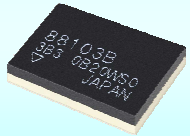
- LCD Controller

Data Storage(Memory)

- SIP, MCP
- Flash Card (MMC)

Radio Frequency

- HPA
- RFIC



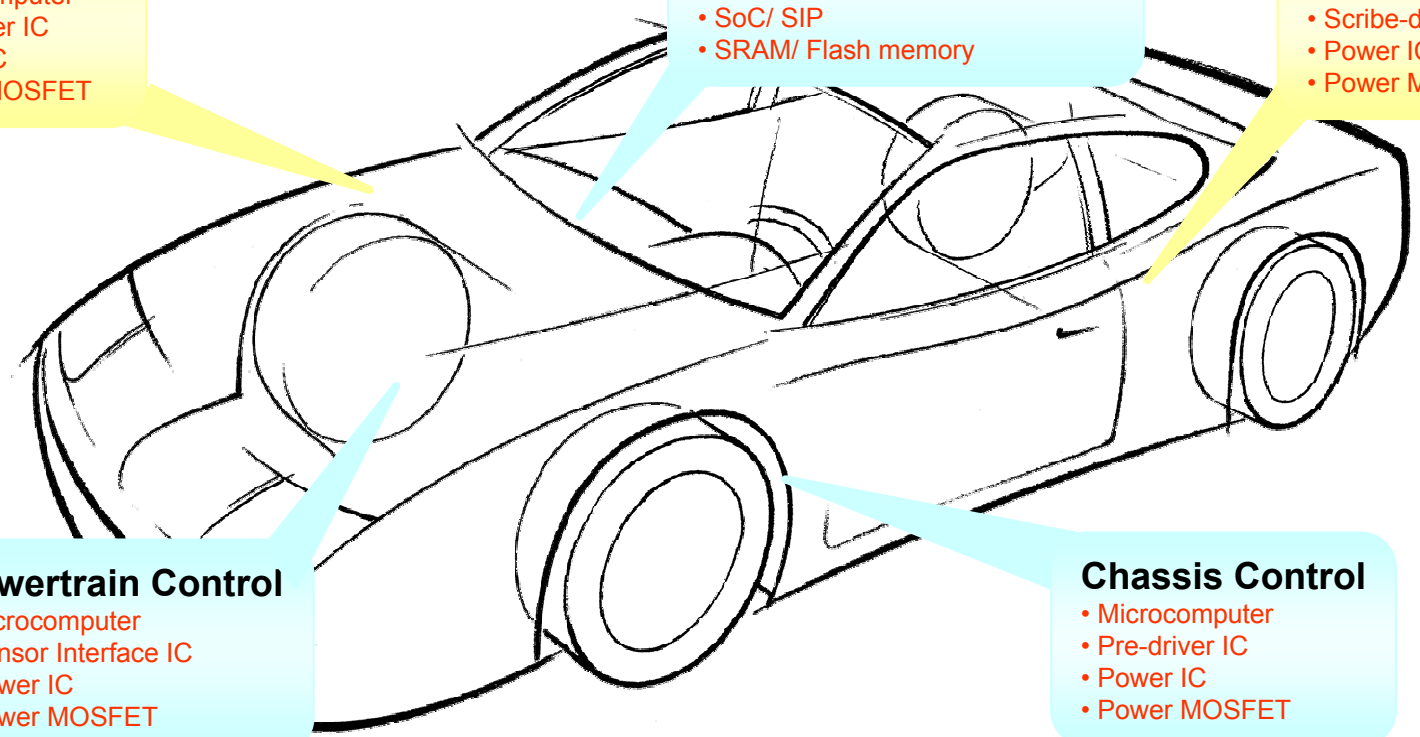
Application Processor

- SH-Mobile

Security

- Smart Card MCU

Renesas for Automotive



Body Control
- Microcomputer
- Pre-driver IC
- Power IC
- Power MOSFET

Car Audio & Navigation
- Microcomputer
- Middleware
- SoC/ SIP
- SRAM/ Flash memory

Safety Control
- Microcomputer
- Scribe-driver IC
- Power IC
- Power MOSFET

Powertrain Control
- Microcomputer
- Sensor Interface IC
- Power IC
- Power MOSFET

Chassis Control
- Microcomputer
- Pre-driver IC
- Power IC
- Power MOSFET

Renesas for Consumer and Industrial

White Goods
Washer, Dryer, Dishwasher, Oven,
Hob, Refrigerator, Freezer

Building Automation
Heating, Ventilation, Air Conditioning, Boiler Control

Small Appliances
Weight scales, Shaver, Vacuum cleaner,
Sewing Machines, Espresso Machines

Audio/Video
DVD, CD R/W, TV, VCR, Set-Top-Box, Portable Audio, Stereo Set, DAB, LNB, Remote control

Home Networking
XDSL/ISDN Terminal Adapter, ISDN Telephones, Modem, Wireless Connectivity, PLC

Utility Metering
Gas, Water, Electricity, Heat Power Meter
AMR (Automated Meter Reading)

Health Monitoring
Fitness/ Glucose Measurement

Pain relief/Muscle Stimulation

Security
Fire + Burglar Detection Systems
Sensors, CCTV

EPoS
Card Readers, Cash Registers, Bar Code Readers, Money Handling, Vending

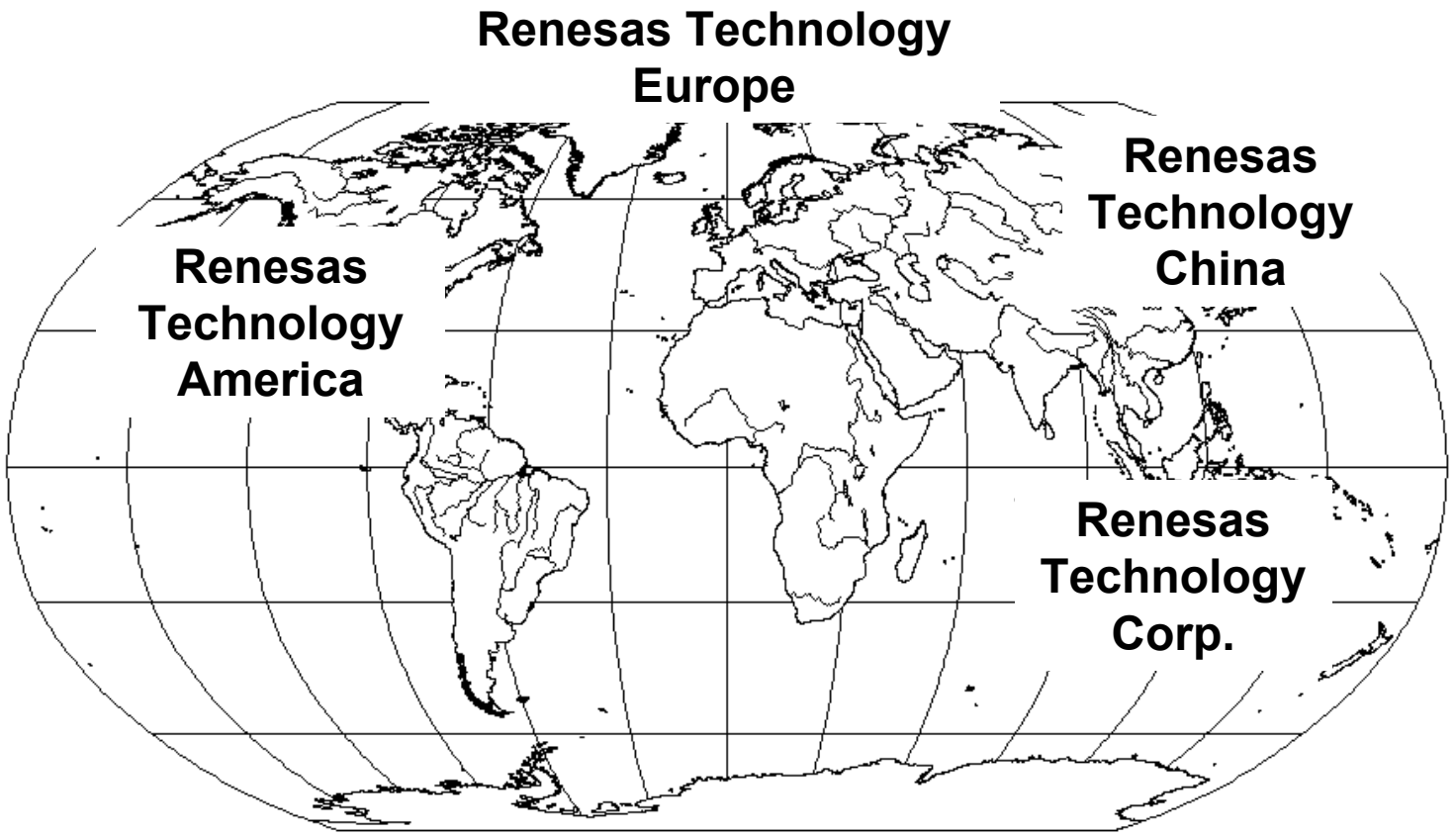
Industrial Automation
Industrial Drives + Pumps, Robotics, Door Openers

R&D Design Centres

	Location
Renesas Technology Corp. Kita-Itami	Japan
Renesas Technology Corp. Musashi	Japan
Renesas System LSI Design Corp.	Japan
Renesas Device Design Corp.	Japan
Renesas Solutions Corp.	Japan
Renesas Technology America, Inc. Design Engineering Centres	Durham, NC, San Jose, CA, USA
Renesas Technology Europe, Engineering Division	Bourne End, UK; Ratingen & Feldkirchen, Germany
Renesas System Solutions Asia Pte. Ltd.	Hong Kong, Shanghai, & Shenzen, China; Singapore; Taipei, Taiwan
Renesas Semiconductor Design Co., Ltd. (Beijing)	China
Renesas System Solutions Co., Ltd. (Beijing)	China
Renesas Design France S.A.S	France
Renesas Design Vietnam Co., Ltd.	Vietnam

Renesas Technology Europe

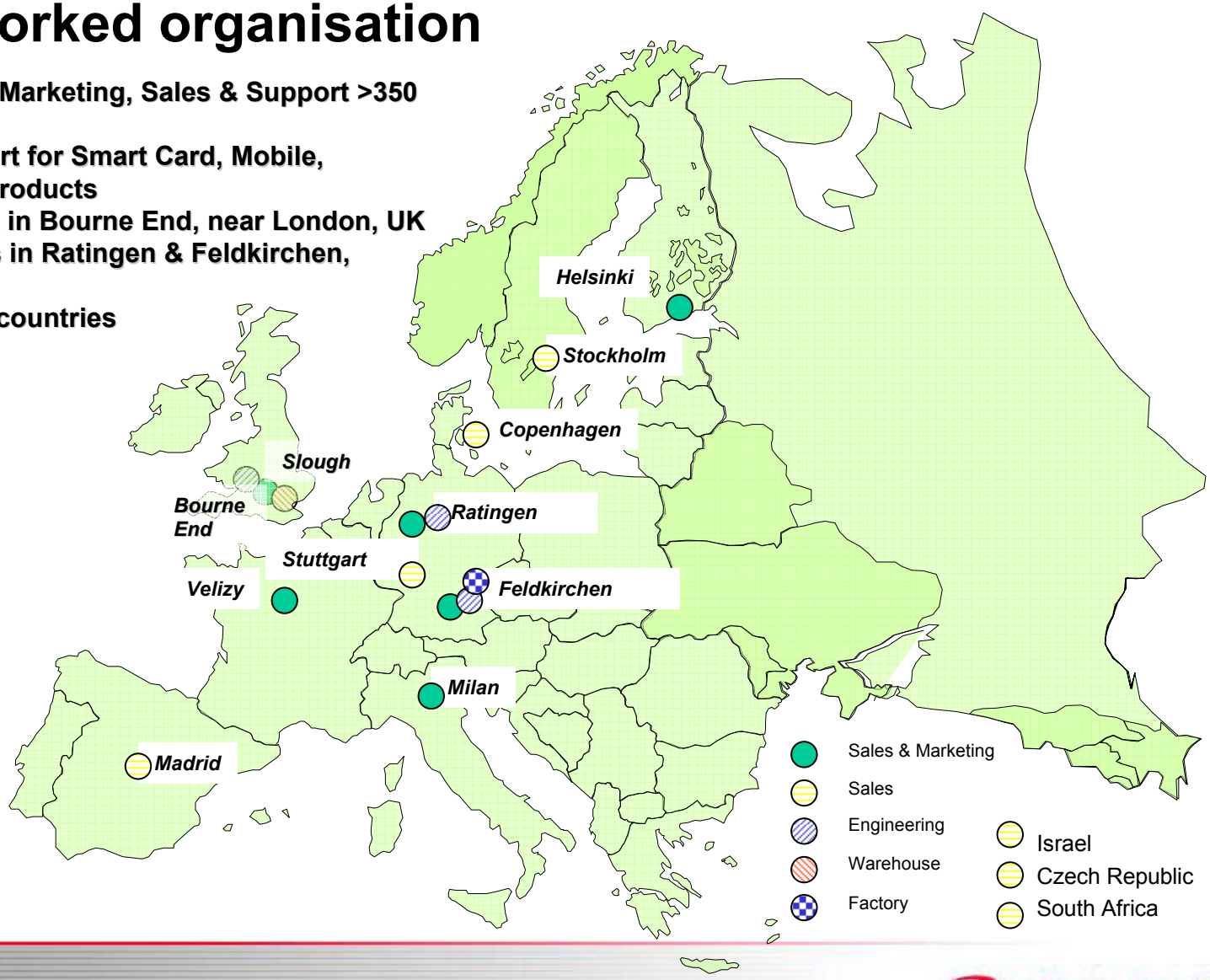
- part of Renesas' global network



Renesas Technology Europe

- a networked organisation

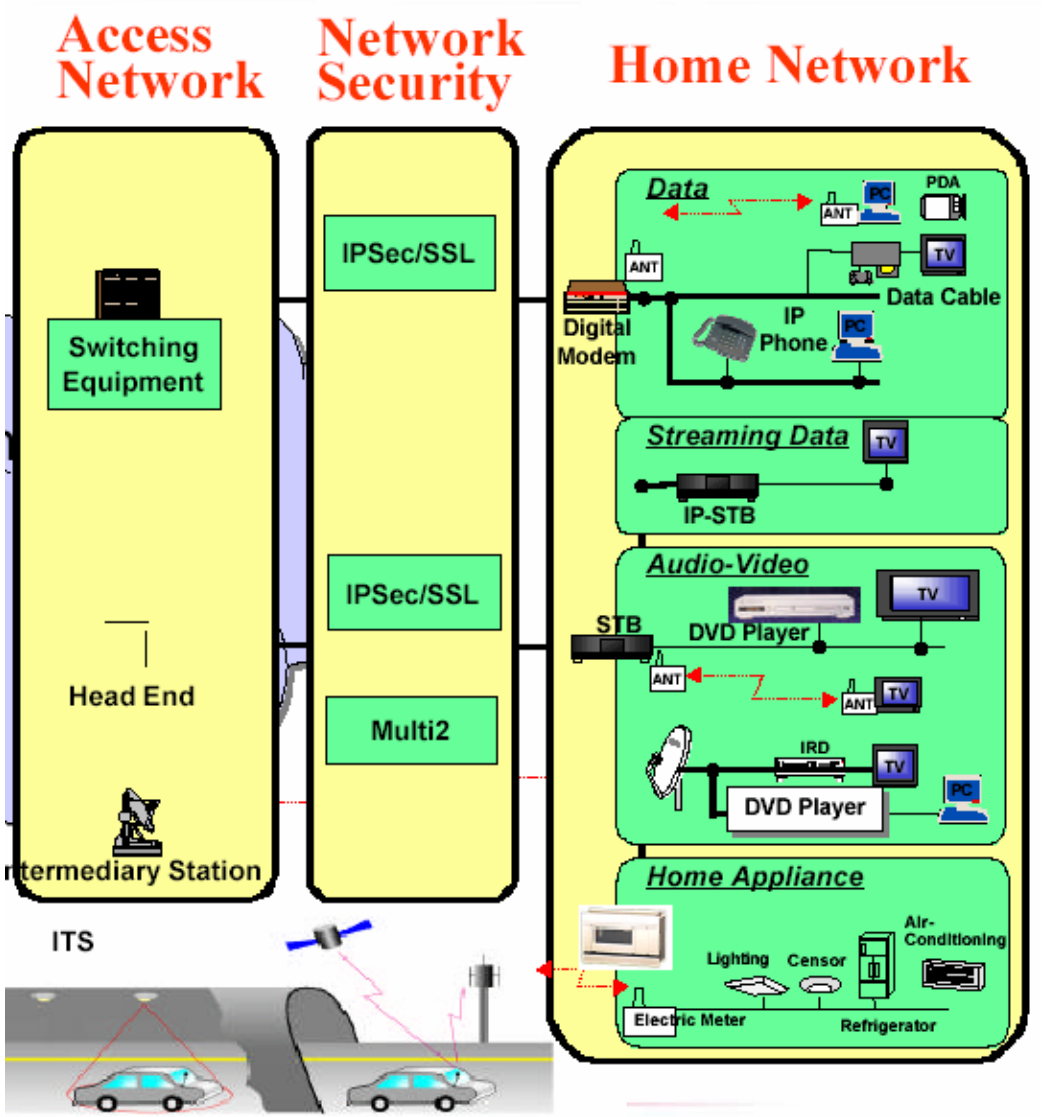
- Engineering, Marketing, Sales & Support >350 people
- Global support for Smart Card, Mobile, Automotive products
- European HQ in Bourne End, near London, UK
- Major centres in Ratingen & Feldkirchen, Germany
- Offices in 11 countries



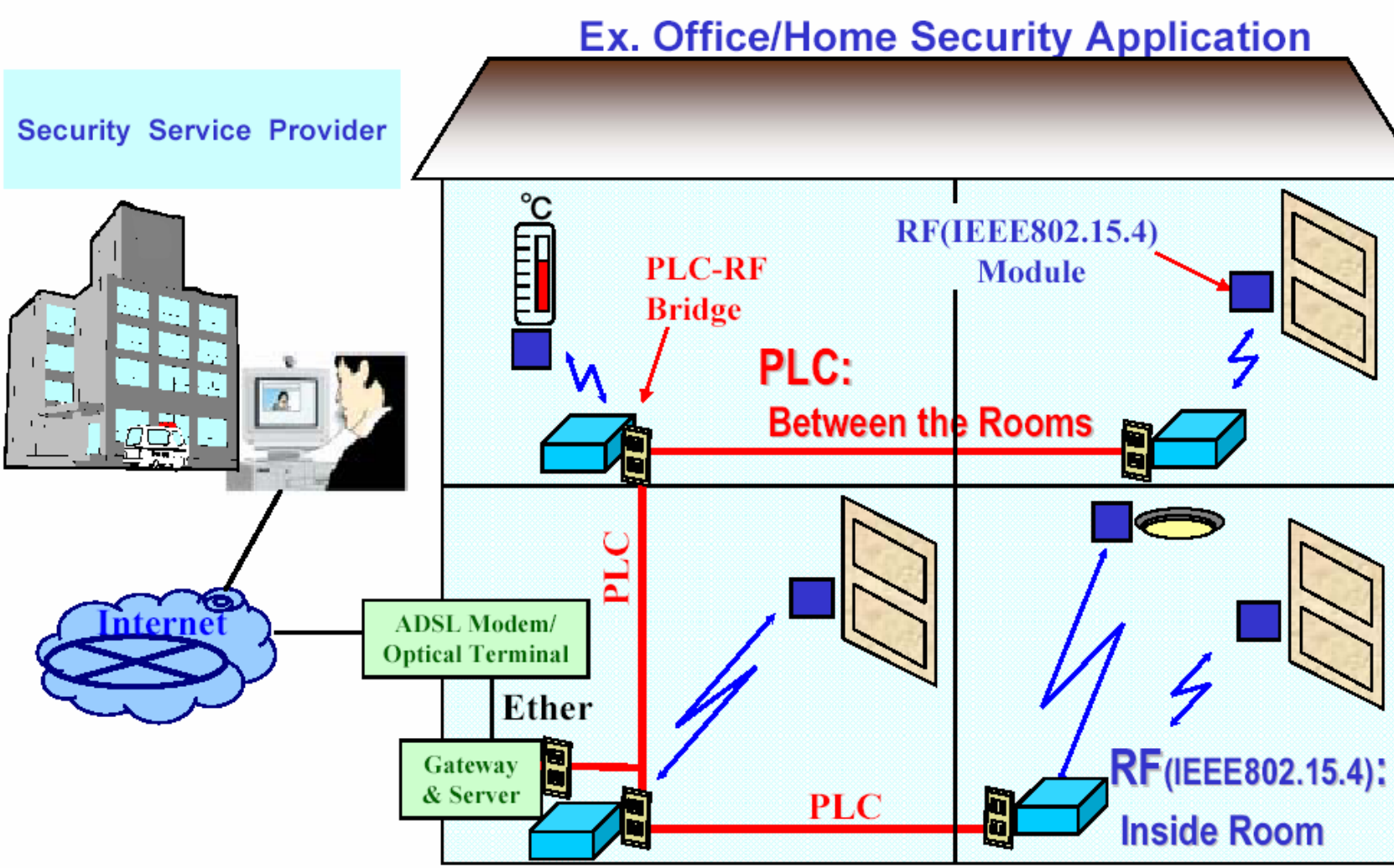
Renesas Distributors in Europe

	Austria	Benelux	Czech	Scandinavia	France	Germany	Greece	Hungary	Ireland	Israel	Italy	Poland	Portugal	Slovakia	Romania Slovenia	Russia	South Africa	Spain	Suisse	Turkey	UK
Abacus									X												X
Acte				X																	
Arrow				X	X		X		X	X			X			X		X		X	X
Avnet Silica	X	X			X	X			X	X								X			
Comprel											X										
Claitron Silverstar											X										
Dätwyler																			X		
Elektro Elektr																				X	
ECC											X										
Glyn	X	X				X															
HiQ																	X				
Mibatron															X						
Melchioni											X										
MSC	X		X			X		X				X		X					X	X	X
Rutronik						X													X		
Sasco		X				X															
Sequoia																					X
Toyo RAM										X											
Venco																		X			

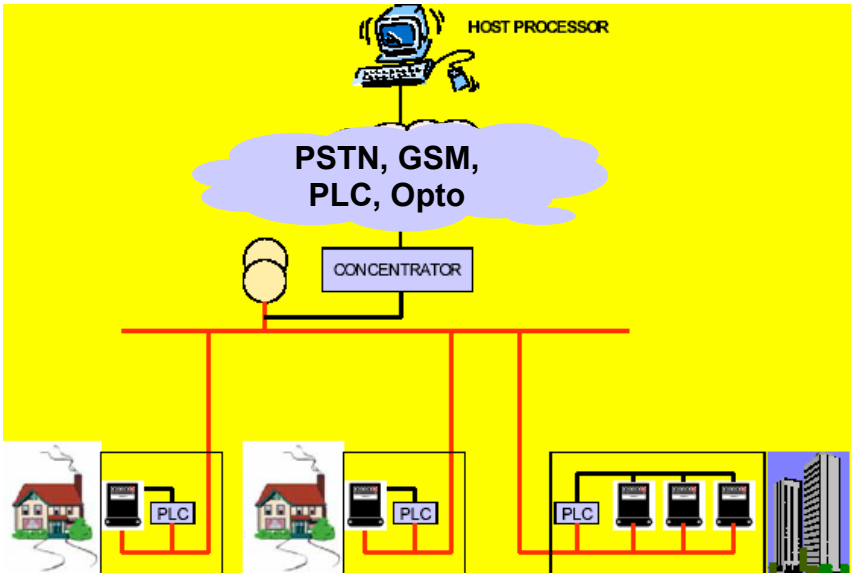
Home Control

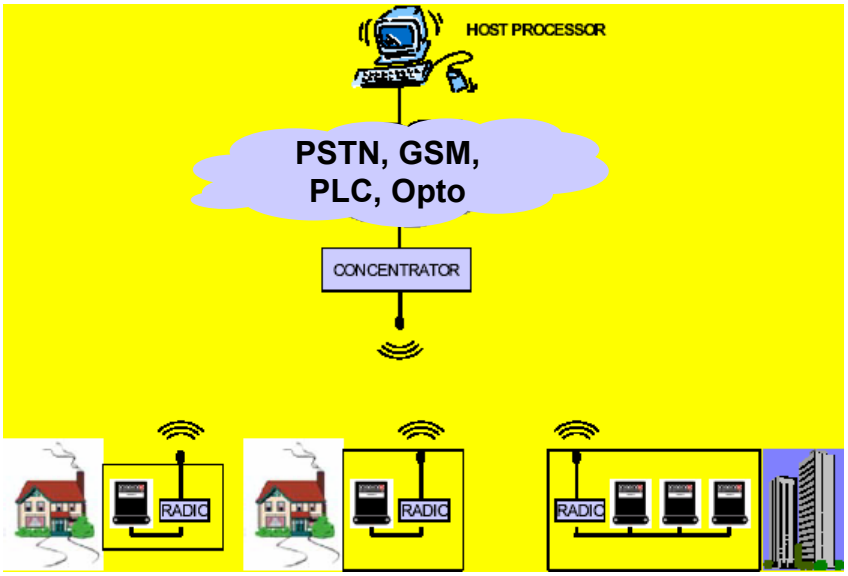


Home Control - Security



Home Control - Metering



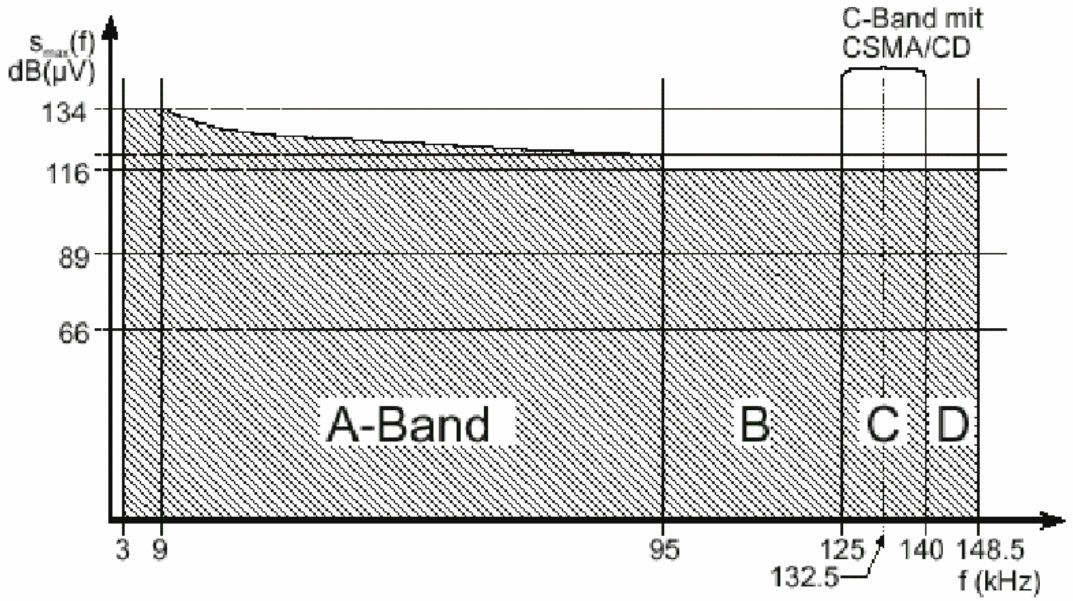


(*)Source: Opera

Requirements to a PLC solution

- **Extremely robust PHY**
  - >60dB attenuation (7Vpp to 7mVpp), ~0dB SNR
  - Immunity against typical noise / signals
  - 2kbps data rate sufficient
  - Coupling to all 3 phases
  - Able to handle unstable and low input impedance (1~10Ω)
- **Full featured DLL**
  - Acknowledgement schemes
  - Handling of multipath frames
  - Security on DLL level
  - Frame fragmentation
  - CSMA/CA (Carrier Sense Multiple Access / Collision Avoidance)
- **Application specific network layer**
  - Support of application specific network topology
  - Automatic network configuration
  - Automatic message routing
  - Security on NW layer level
- **Compliance**
  - PHY: Compliance to CENELEC EN50065 (outdoor: A band, indoor: B/C/D band)
  - Adaptive to global requirements (ARIB, FCC, CENELEC)
  - DLL: Co-existence (no interference issues with other systems)
  - Open solution
- **Reasonable costs**
  - Efficient algorithm implementation
  - No single source

CENELEC EN50065

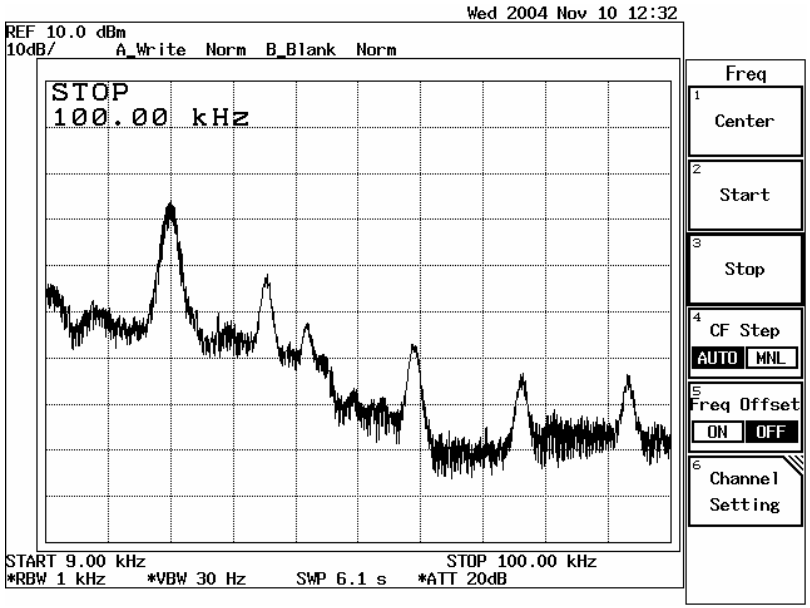


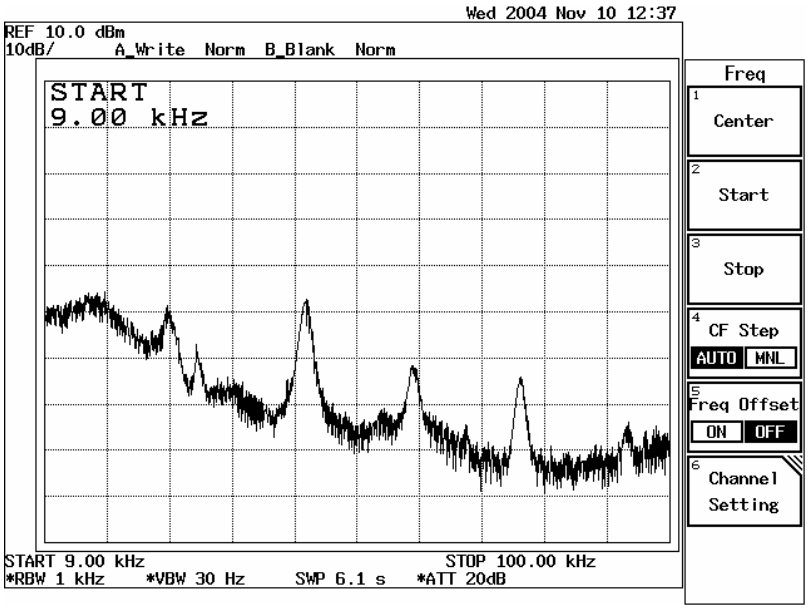
Picture 1: Frequency bands defined by EN50065-1 and max. signal level

Band	Frequency	Usage	access protocol	Example
A	3 – 95kHz	Reserved for energy providers	no	
B	95 – 125kHz	Indoor without access protocol	no	baby phone (analog)
C	125 – 140kHz	Indoor with access protocol	CSMA/CD	white goods
D	140 – 148.5kHz	for alarm and security systems	no	

Typical noise in the field

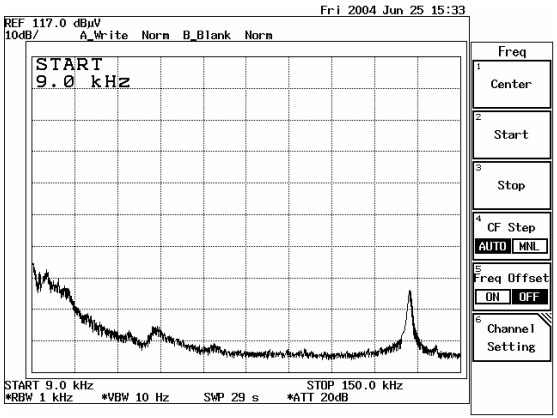
- Non linear impedance / phase response
- The noise is higher at lower frequencies
- The impedance is more unstable at lower frequencies
- Discrete frequency noise by typical loads

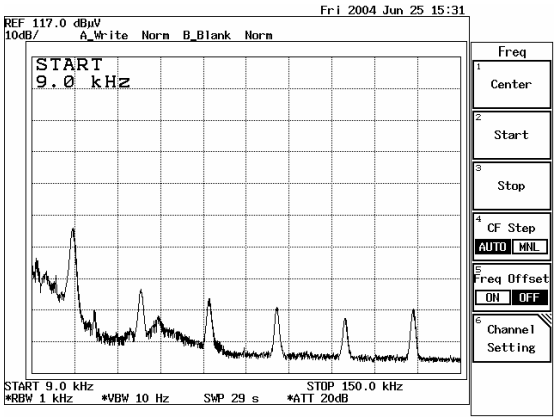




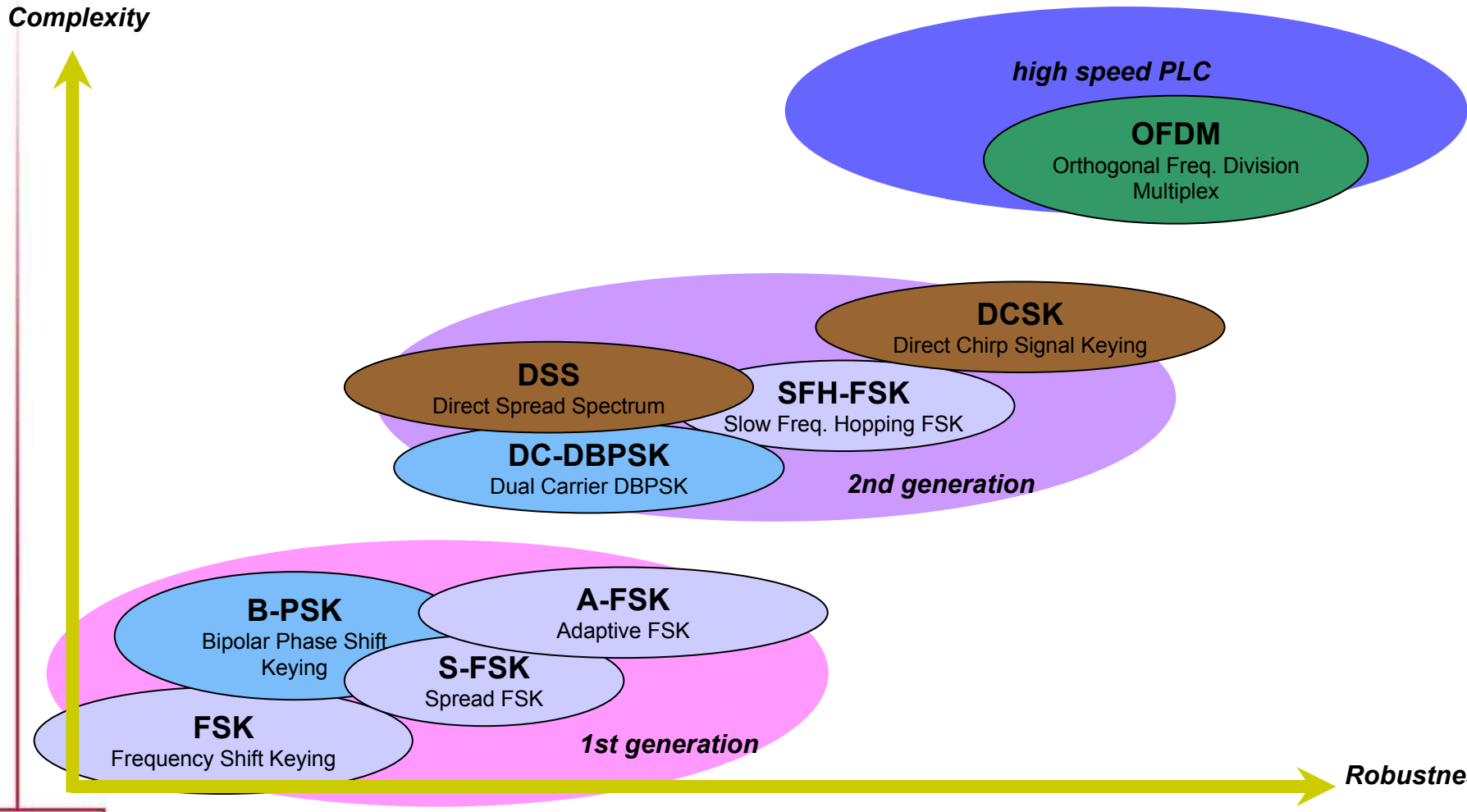
Typical noise in the field

Some typical noise sources:

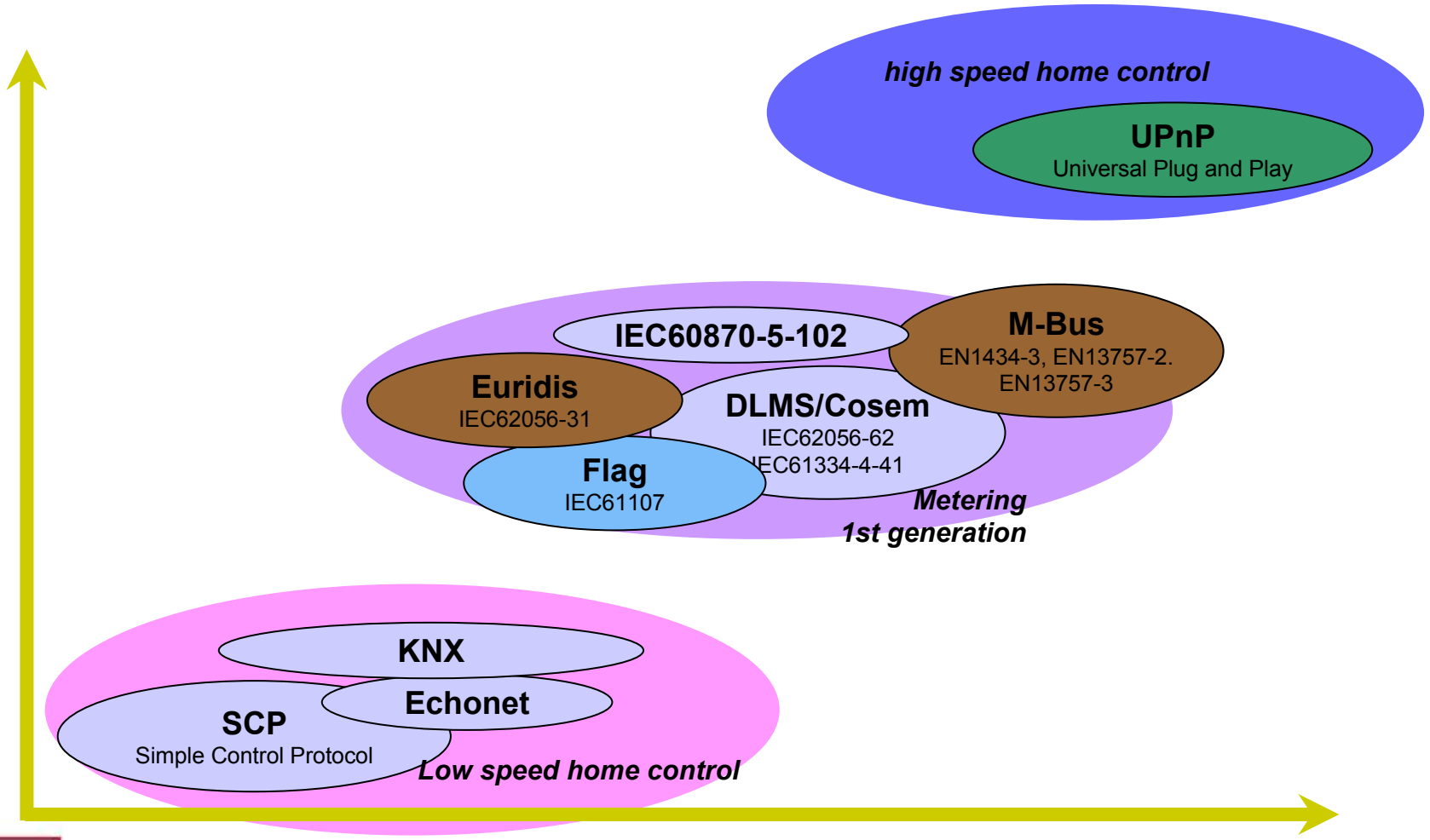




Modulation technologies

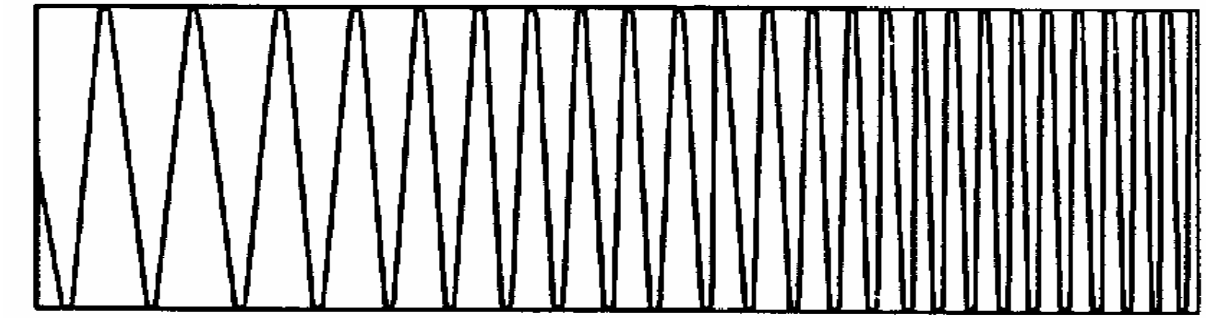


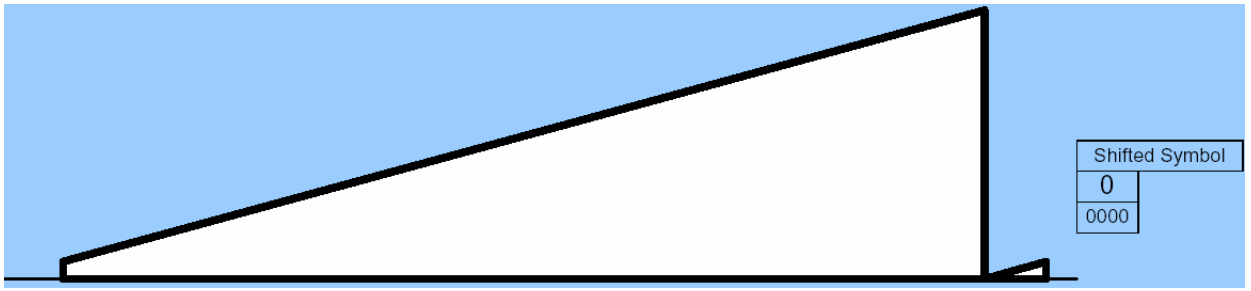
Protocols

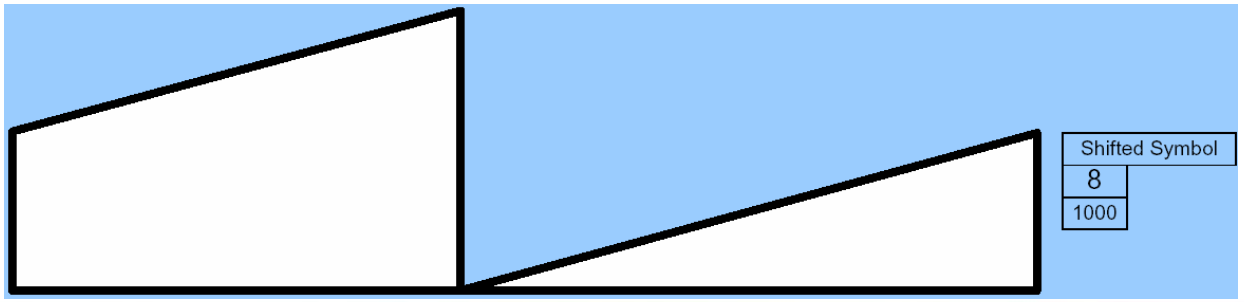

high speed home control
UPnP
Universal Plug and Play
IEC60870-5-102
M-Bus
EN1434-3, EN13757-2.
EN13757-3
Euridis
IEC62056-31
DLMS/Cosem
IEC62056-62
IEC61334-4-41
Flag
IEC61107
Metering
1st generation
KNX
Echonet
SCP
Simple Control Protocol
Low speed home control

DCSK

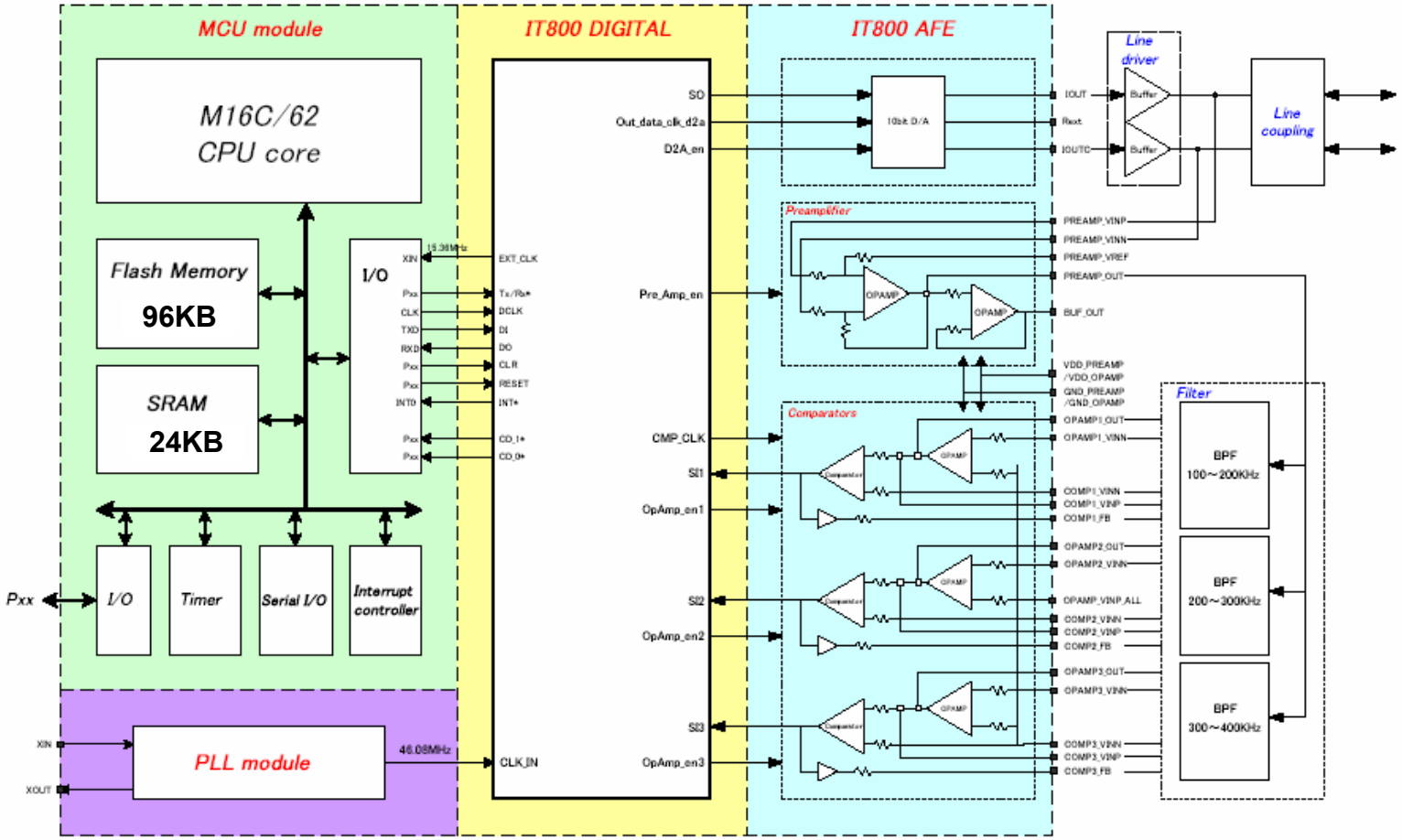
- type of spread spectrum
- time shifts of consecutive rotated chirp waveforms of length T



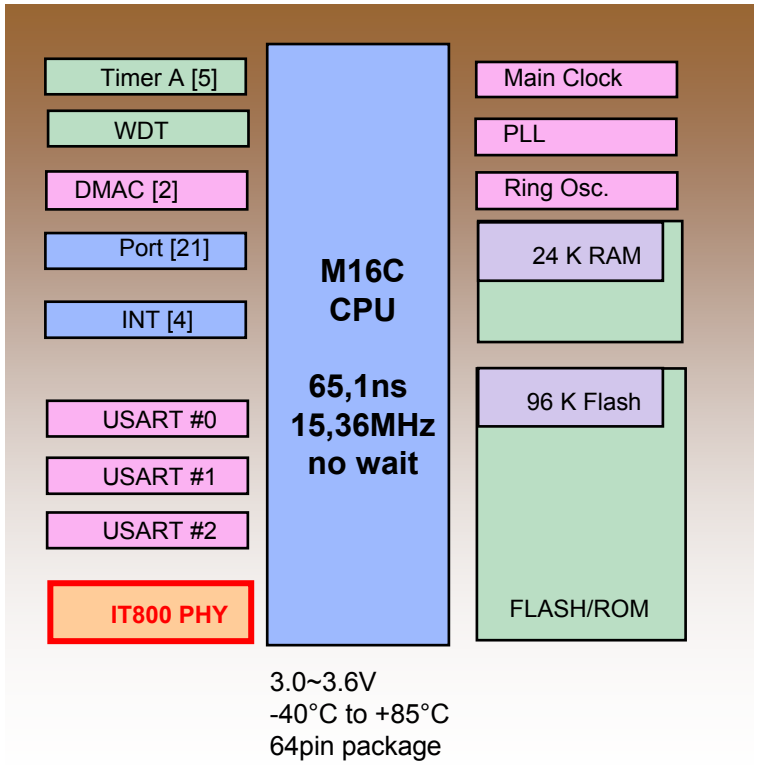


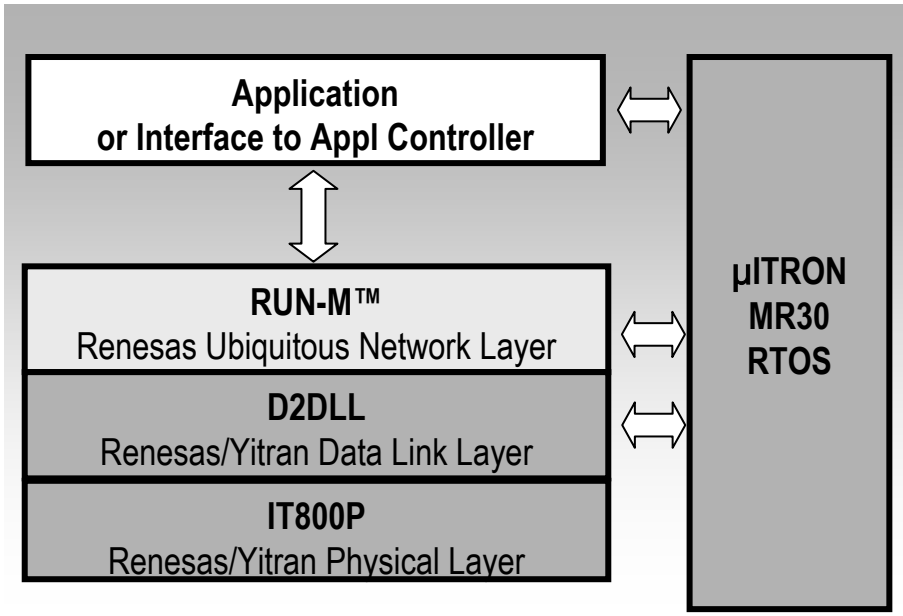


MCU + PLC one chip integration



M16C/6S

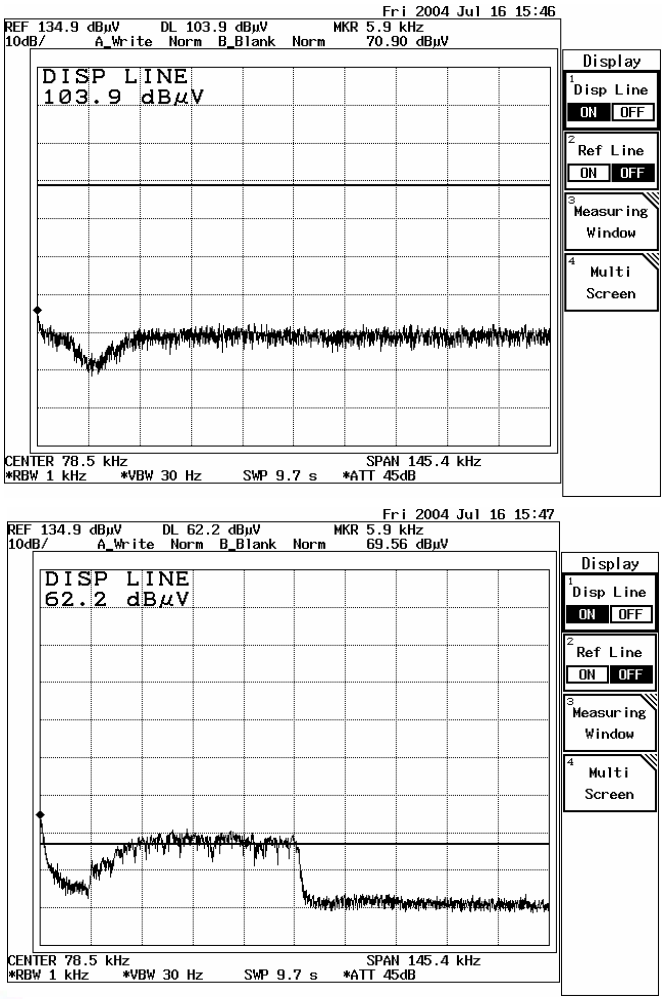

Timer A [5]
WDT
DMAC [2]
Port [21]
INT [4]
USART #0
USART #1
USART #2
IT800 PHY
M16C
CPU
65,1ns
15,36MHz
no wait
Main Clock
PLL
Ring Osc.
24 K RAM
96 K Flash
FLASH/ROM
3.0~3.6V
-40°C to +85°C
64pin package


Application
or Interface to Appl Controller
RUN-M™
Renesas Ubiquitous Network Layer
D2DLL
Renesas/Yitran Data Link Layer
IT800P
Renesas/Yitran Physical Layer
µITRON
MR30
RTOS

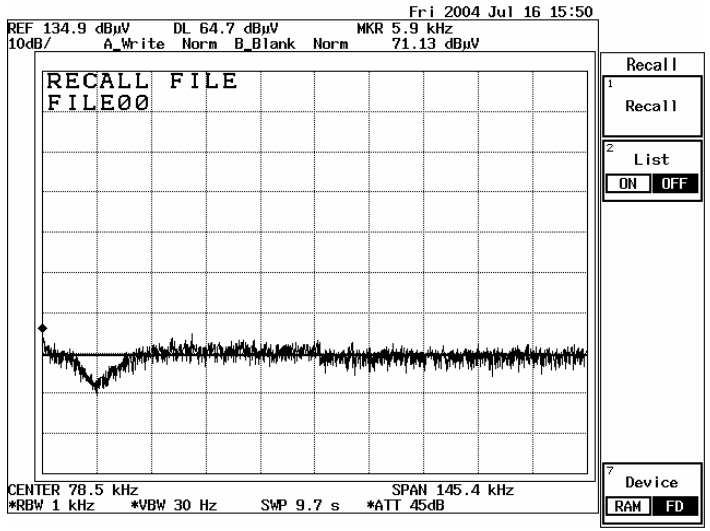
PHY features

- DCSK modulation technique
- Error Correction Code (ECC)
- Packet Detection Schemes (CRC, Line Quality, etc.)
- 3 Transportation Modes: Standard, Robust, Extreme Robust
- Max. data rate 7.5kbps (CENELEC: 2.5kbps)
- Extremely high In-phase and Cross-phase reliability.
- Carrier Detection (incl X-10 carrier)
- Adaptive to global requirements (FCC, ARIB, CENELEC A/B) by ext. BPF
- 0% packet error rate at >90dB attenuation
- White Noise SNR ≈ 1

SNR



SNR≈1 at PER≈1%

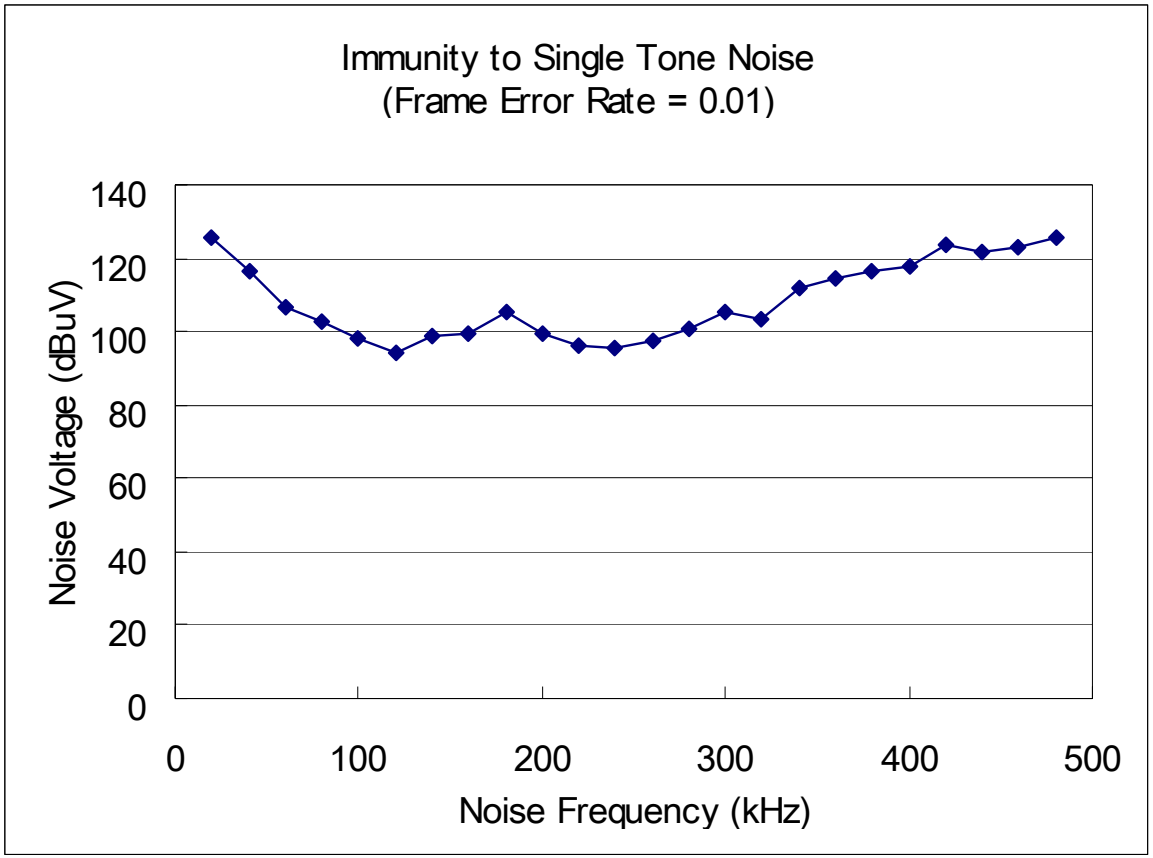


Attenuation

100% Success at 90dB attenuation

Operation Mode	Attenuation (by Agilent 355D Attenuator)	DUT A 500 packets sent received		DUT D 500 packets sent received:	
		Total	Ok	Total	Ok
TUT => RUT Robust Mode	70dB	500	500	500	500
	80dB	500	500	500	500
	90dB	500	500	500	500
	100dB	79	0	264	18
	110dB	0	0	0	0
TUT => RUT Extremely robust mode	70dB	500	500	500	500
	80dB	500	500	500	500
	90dB	500	500	500	500
	100dB	184	112	340	275
	110dB	0	0	0	0

Noise immunity



DLL features

- Max. 2048 nodes in one network (up to 1024 networks)
- CSMA/CA (Carrier Sense Multiple Access / Collision Avoidance)
- Channel prioritization
- Adaptive back off
- Acknowledgement schemes
- Re-transmission schemes
- Broadcast and Multi-hop broadcast
- Frame fragmentation and re-assembly
- Packet filtering (by network, node, duplication, etc.)
- Imposter alarm mechanism

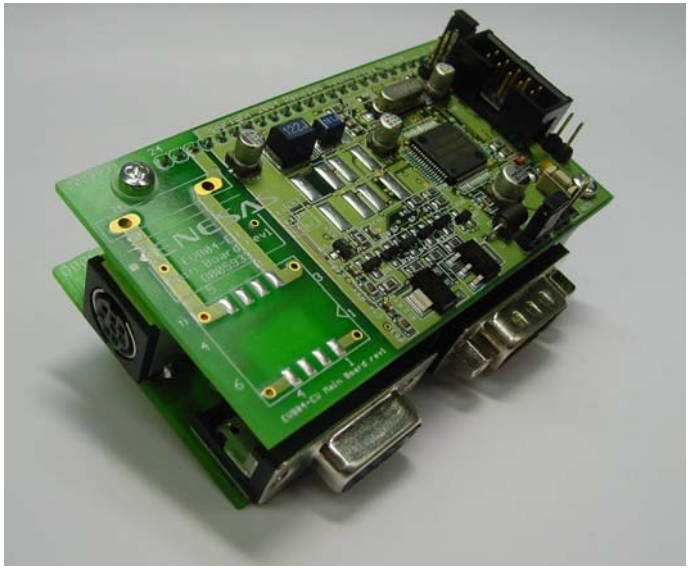
RUN-M features

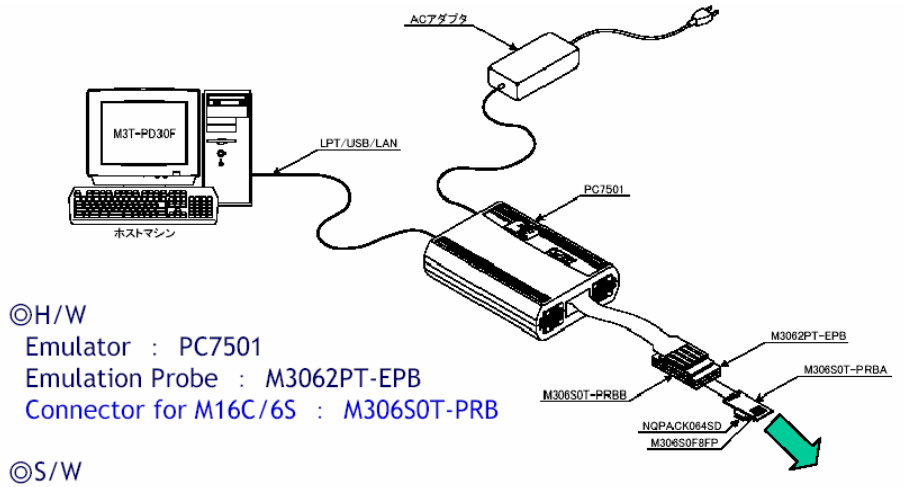
- Dedicated for (European) metering applications
- Star/Tree topology (up to 7 levels)
- Automatic join-on power-on
- Graceful removal
- Automatic address assignment
- Routing of frames (7 stages)
- Route discovery
- Shortcuts
- Encryption

RUN-M is currently under development.
This is to show one of our typical engineering activities
Co-operation with universities is appreciated

Tools

- **Evaluation boards**
- **High End Emulator system**
- **Low End Debugging environment**





◎H/W
Emulator : PC7501
Emulation Probe : M3062PT-EPB
Connector for M16C/6S : M306S0T-PRB

◎S/W
Emulator Debugger : M3T-PD30F
Compiler : M3T-NC30WA

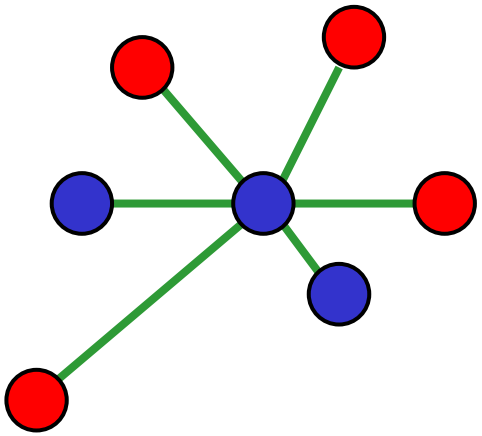
To the targe

ZigBee

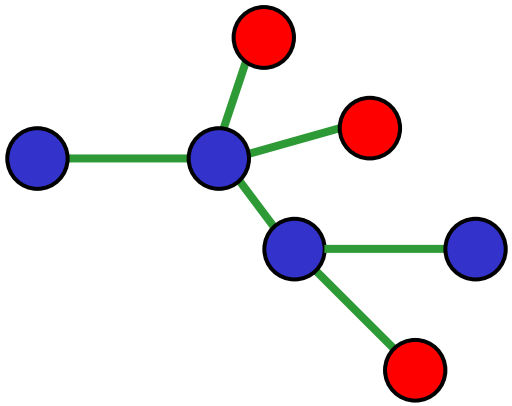
- Wireless technology working in the 2,4GHz ISM band and 868/915MHz band
- Applications: Home and industrial control, sensor networks, AMR
- MAC layer based on IEEE 802.15.4
- Sometimes regarded as “Bluetooth Light”, but
  - Lower data rate (250kbps versus 1Mbps)
  - Bigger network (65k nodes versus 8)
  - No synchronous (voice, audio) link, data only
  - Higher distance (100m versus 10m)
  - Lower power consumption
  - Today: Similar stack size (64KB), similar price (5USD)
- Founders: Philips, Invensys, Mitsubishi, …
- Specification V1.0 released eof 2004

ZigBee™ Alliance
Wireless Control That Simply Works

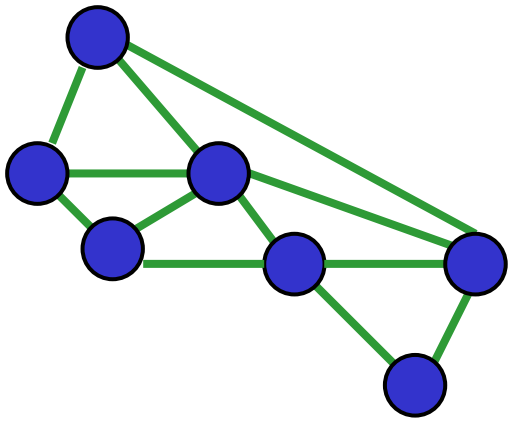
Star topology



(Cluster) Tree topology



Mesh topology

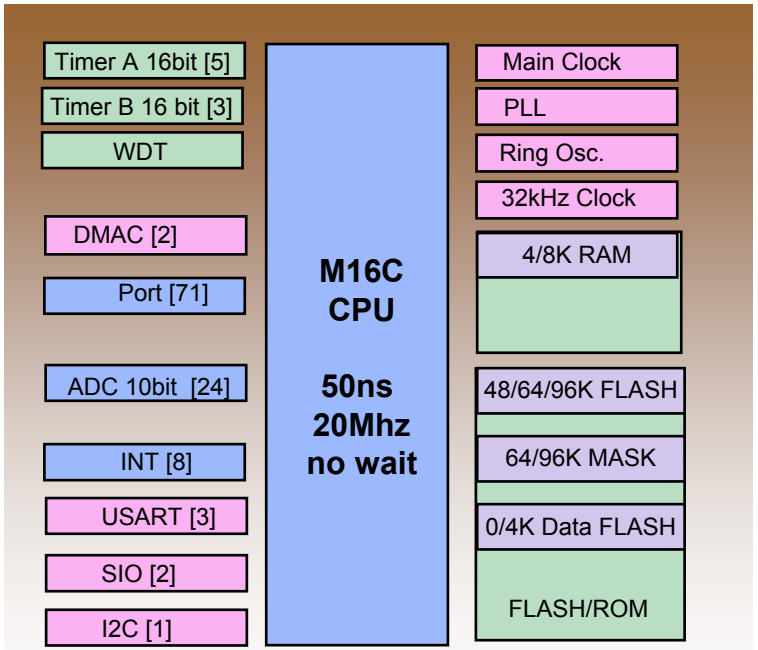


FFD (full function device): Router capability, router or PAN coordinator
RFD (reduced function device)

Requirements to a ZigBee MCU

- **Enough resources to run ZigBee**
  - 48KB to 96KB ROM depending on device type
    (solutions with <32KB ROM are not ZigBee compliant)
  - 4KB to 8KB RAM depending on device type
    (solutions with <3KB RAM are not ZigBee compliant)
  - ~10MHz operation to drive RF chip (depend on RF)
  - SPI interface 1Mbps or more
  - features to support RTOS (3 timers, flexible interrupt priorities, fast context switch, etc.)
- **Strong power down features**
  - Typical applications require 10 years battery life (2 AA cells)
  - 32kHz subclock (RTC counting in wait mode
  - <1µA (typ.) current consumption in stop mode, event counter running
  - switch off / wake up features for MCU and RF
  - low voltage supply: Vcc = 2.2V ±10%
  - Efficient CPU core with rich peripheral functions
- **Tiny and flexible**
  - small package (BGA preferred)
  - >32 pins
  - Easy scalability depending on device type and application
  - Flash version with the opportunity to update the firmware in the field
    (ZigBee specification is not mature yet)
  - Reasonable costs
- **Compliance**
  - Certification process just started and not mature
  - Specification still under change (FW updates required)

M16C/28 ZigBee MCU



-20C/-40C to +85C
64pin QFP package (10mmx10mm)
80pin QFP package (12mmx12mm)
85pin FLGA package (7mmx7mm)

Low power consumption:

0.7µA @3V in stop mode.
- All oscillators are stopped.
- Event counter (Timer B) operates counting external events
- CPU wake up after a number of events.

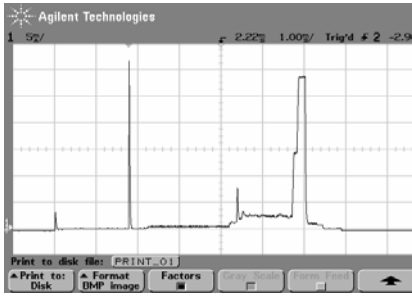
3.0 µA @3V 32kHz wait mode
- sub clock running
- 1ms pulse as count source for timer
- timer cascadation possible
- CPU wake up after 1s/1min/1h or 1day

25 µA @3V 32kHz run mode
- RAM operation (e.g. for RTC)

8 mA @3V 10MHz run mode

Intelligent Flash module:
- 3 programming modes (serial, parallel, re-write)
- EW0 re-write mode: re-write from RAM
- EW1 re-write mode: re-write from Flash
- 4 blocks (+Data Flash, +Bootloader)
- word program / block erase
- 5 flash control commands
- read/write protection features (block/serial/parallel)
- 10.000 block E/W cycles in data Flash
- extension to more E/W cycles by sequential write
- 20 years data retention

Power consumption example

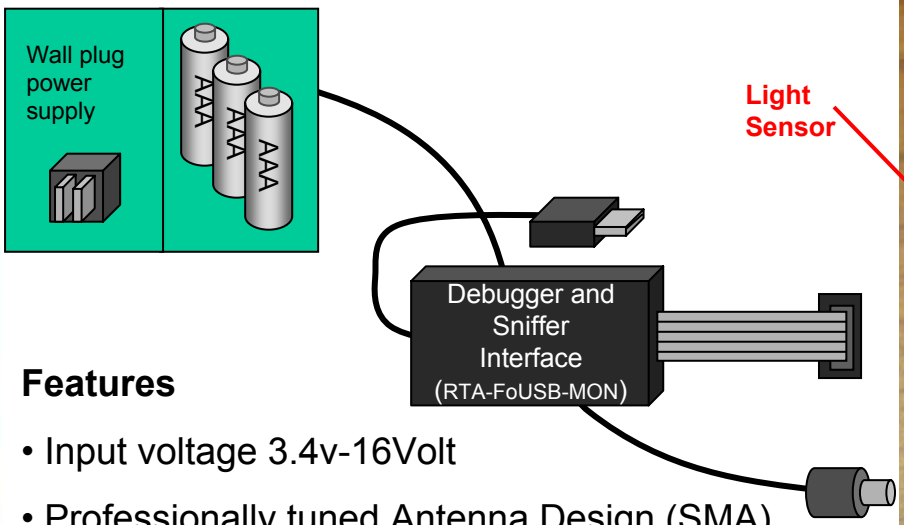


CPU in stop mode, RF off
Counting time pulses by timer B0 (event counter mode)
Counting measurement pulses by timer B1 (event counter mode)
Once per hour: wake up, send frame, receive answer
Example setup: M16C/28 + CC2420, 3V

Status	M16C/28	CC2420	Other circu	Total [mA]	Time per polling period [ms]	mAh avg per polling period
MCU: stop mode, event counter counting RF: Vreg OFF	0,0007	0,001	0,0008	0,0015	3599978,70	0,001499991
MCU: wake up, main clock start in 1/8 mode RF: Vreg ON, Power Down mode	1	0,02	0,0008	1,0008	0,1	0,000000028
MCU: switch to 1/1 mode RF: switch to IDLE mode, wait for xtal stabilization	8	0,42	0,0008	8,0008	1	0,000002222
MCU: process protocol, send data to RF RF: send data (0dBm)	8	17	0,0008	8,0008	10	0,000022224
MCU: process protocol, receive data from RF RF: receive data	8	19,7	0,0008	8,0008	10	0,000022224
MCU: 1/1 mode, switch RF off RF: IDLE mode	8	0,42	0,0008	8,0008	0,2	0,000000444
Total						0,001547135
Polling interval [h]	1					
Battery [mAh]	1800					
Lifetime with battery [years]	**132,8129**					

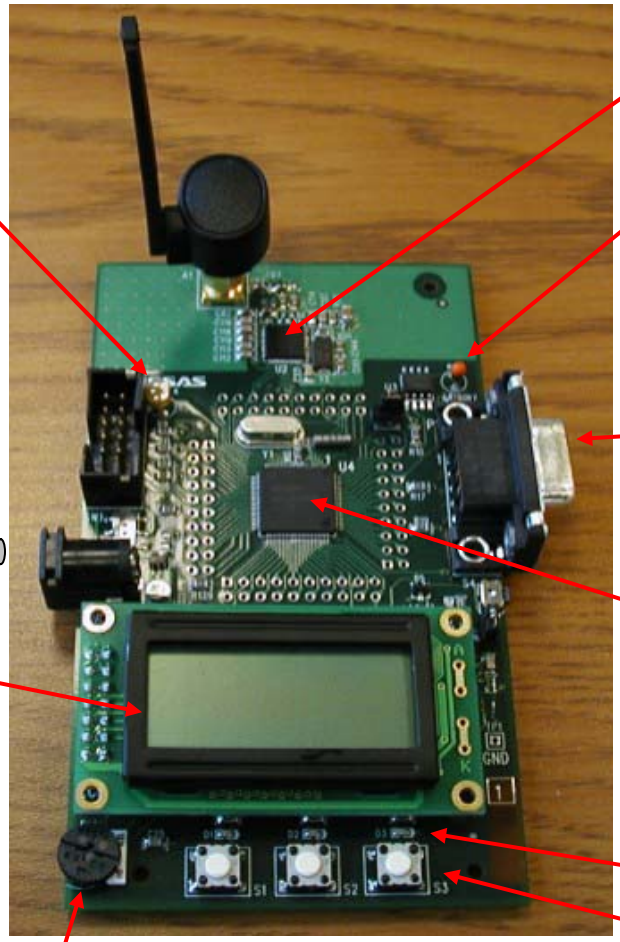
- Most current is used in Rx mode, but only short time
- Time is wasted during xtal stabilization => select oscillators with short stabiliazion time
- If polling interval is big, power consumption in non-active mode is most important for battery lifetime
- Not regarded: Power consumption of application (ADC may consume 1~7mA)

ZigBee development boards



Features

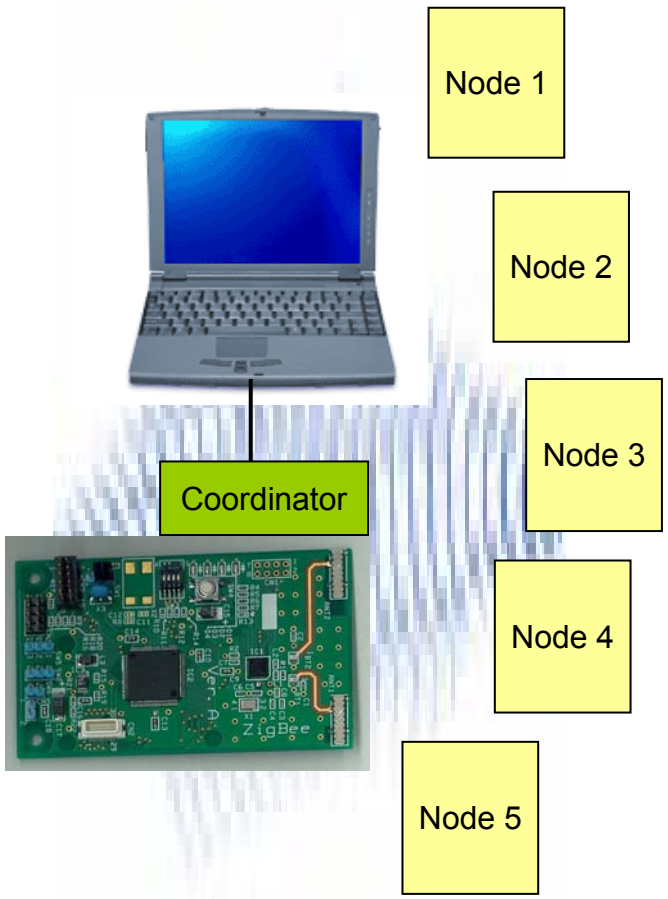
- Input voltage 3.4v-16Volt
- Professionally tuned Antenna Design (SMA)
- Light & Temperature Sensors
- Potentiometer
- RS232 interface
- Power to analog sensors are fed a via a FET so that they can be turned off for low power mode demos.
- USB Debugger / 802.15.4 Sniffer Interface
- Available November 2005



M16C/28 + Chipcon Radio Board

Identical system for 900MHz using ZMD44101

ZigBee metering system demo



RenesasZigbee

File COM Port Zigbee

Topology Type: Star / Tree / Mesh

Error Status: No Error

COM Port Status: Closed

Node Type: Coordinator

PAN Initialisation: Start PAN

PAN Status: No PAN Formed | Ch | Id: No PAN ID

Network Parameters: Cm H' 00 Rm H' 00 Lm H' 00

Power Level: Node 1 | 3.6 dBm (default) | Go

Remove Node: Node 1 | Go

Channel Number

Scan All Channels

0x0B 2405MHz	0x13 2445 MHz
0x0C 2410 MHz	0x14 2450 MHz
0x0D 2415 MHz	0x15 2455 MHz
0x0E 2420 MHz	0x16 2460 MHz
0x0F 2425 MHz	0x17 2465 MHz
0x10 2430 MHz	0x18 2470 MHz
0x11 2435 MHz	0x19 2475 MHz
0x12 2440 MHz	0x1A 2480 MHz

Request Data: Node | No. of Bytes H' 00 | Tariff | Go

Send Data: Node | No. of Byes H' | Tariff | Go

Scheduling Options

Node 1	1 Packet every 1 min
Node 2	1 Packet every 1 min
Node 3	1 Packet every 1 min
Node 4	1 Packet every 1 min
Node 5	1 Packet every 1 min

Node	Status	Short Address	64 Bit Long Address	LQI	TxPower
Node 1	No Association				
Node 2	No Association				
Node 3	No Association				
Node 4	No Association				
Node 5	No Association				

Time Stamp	Node (Short / Long Address)	LQI	Data Length	Data Packet	% Error

Clear Log

Save Log

Conclusion

- **Renesas** is the number one Microcontroller supplier worldwide
- **Renesas** is working to provide advanced communications solutions for the ubiquitous generation
- **Renesas** has dedicated force of highly qualified engineers specialized in Home Automation & Metering Applications
- **Renesas** is not only designing and manufacturing semiconductors, but also developing firmware, middleware, tools, etc.
- **Renesas** is looking for co-operation partners

Internet Links

Renesas global website: http://www.renesas.com

Renesas Interactive training (M16C/R8C/H8S)
http://www.renesasinteractive.com/renesas/guest/course_index.htm

Renesas eLearning (M16C/SH3/H8S):
http://download.renesas.com:/eng/e_learnig/m16c.html
http://download.renesas.com:/eng/e_learnig/superh_e_learning/00/index.html
http://download.renesas.com:/eng/e_learnig/h8_300henglish/index.html

Thank you!

Renesas Technology Europe