Plataformas WSN/NIMS - I

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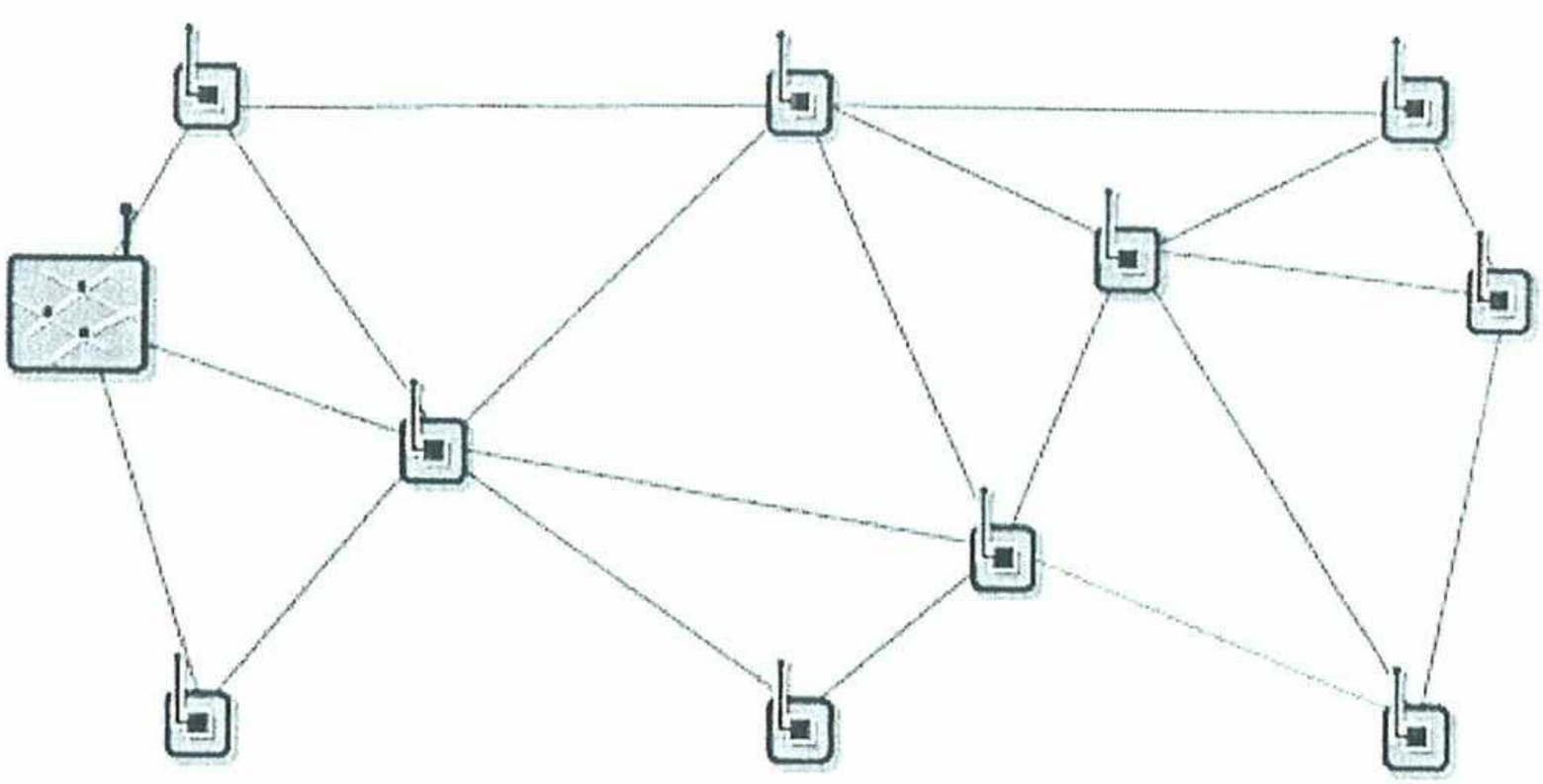

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Centro Internacional de Métodos Numéricos en Ingeniería
Gran Capitán s/n, 08034 Barcelona, España

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Estado del arte: Redes de sensores sin cable

Una de las tecnologías que cambiarán el mundo según MIT Technology Review son las redes de sensores sin cable, redes de nano aparatos autónomos capaces de una comunicación sin cable y que suponen uno de los avances tecnológicos más investigados en la actualidad. A través de redes de sensores, se pueden integrar funcionalidades que antes eran independientes unas de otras, con el fin de lograr máxima eficiencia sobre todo en los campos de consumo y gestión de energía.

Las redes de sensores con cable no son nuevas y sus funciones incluyen medir niveles de temperatura, líquido, humedad, etc. Muchos sensores en fábricas o coches por ejemplo, tienen su propia red que se conecta con un ordenador o una caja de controles a través de un cable y, al detectar una anomalía, envían un aviso a la caja de controles. La diferencia entre los sensores que todos conocemos y la nueva generación de redes de sensores sin cable es que estos últimos son inteligentes, es decir, capaces de poner en marcha una acción según la información que vayan acumulando y no son limitados por un cable fijo.

Pero nuevos avances en la fabricación de microchips de radio, nuevas formas de routers y nuevos programas informáticos relacionados con redes están logrando eliminar los cables de las redes de sensores, multiplicando así su potencial.

Las redes de sensores pueden utilizar distintas tecnologías de sin cable, incluyendo IEEE 802.11, LANS sin cable, Bluetooth e identificación de la frecuencia de radio. Actualmente se trabaja con radios de baja frecuencia con un alcance de hasta 100 metros y velocidades de hasta 300 Kb/segundo.

Las últimas investigaciones apuntan hacia una eventual proliferación de redes de sensores inteligentes, redes que recogerán enormes cantidades de información hasta ahora no registrada que contribuirá de forma favorable al buen funcionamiento de fábricas, al estudio y monitoreo de construcciones, al cuidado de cultivos, a tareas domésticas, a la organización del trabajo y a la predicción de desastres naturales como los terremotos.

En este sentido, la computación que penetra en todas las facetas de la vida diaria de los seres humanos está a punto de convertirse en realidad: los científicos utilizan los sensores sin cable para encontrar y controlar microclimas y plagas en plantaciones de uva, para estudiar los hábitos de aves y para controlar sistemas de ventilación y calefacción, investigadores utilizan las redes de sensores sin cable para recibir información detallada sobre el efecto de los movimientos sísmicos en los edificios.

Si los avances tecnológicos en este campo siguen a la misma velocidad que han hecho en los dos últimos años, las redes de sensores sin cable revolucionará la capacidad de interacción de los seres humanos con el mundo.

Estudio de Mercado

A continuación se detallan algunas de las empresas pioneras en la tecnología de las redes de sensores sin cable.

- **Crossbow Technology Inc. (San Jose, CA)**

www.xbow.com

Smart dust motes: MICAz, TinyOS, ZigBee @ 2.4 GHz

Hardware básico: Motas (MPR) MICAZ
Características: 2,4 Ghz, 250 kbps, 75m, 58x32 mm, 150 US$
Sistema Operativo: TinyOS (open source)
Programación: nesC + API (MIB)
Interfaces: PC, Ethernet, WWW
Herramientas de gestión: Stargate gateway, etc.
Alimentación: Baterías
Adicional: Sensores (MTS), adquisición de datos (MDA)
Precio kit de desarrollo profesional: 5000 US$

Ámbitos: Estructural, ambiental, industrial, logística

Distribuidor en España: **Álava Ingenieros www.alava-ing.es**

Crossbow desarrolla y produce *wireless sensor networks* y *wireless data-loggers* basados en el concepto "Smart Dust", utilizando el sistema operativo de UC Berkeley: TinyOS.

Posibles aplicaciones:

Motes en edificios para determinar el comportamiento de éstos frente terremotos.

Compañías de cosméticos utilizan los *motes* en sus almacenes para controlar la temperatura y humedad.

Uso de *motes* para monitorear las piezas de equipamiento de máquinas que forman parte de una línea de montaje. Los dispositivos detectan vibraciones irregulares, indicando una operación anormal y alerta a los técnicos para que puedan solventar la situación, evitando así costosos paros en la línea.

- **Dust Networks**

www.dust-inc.com

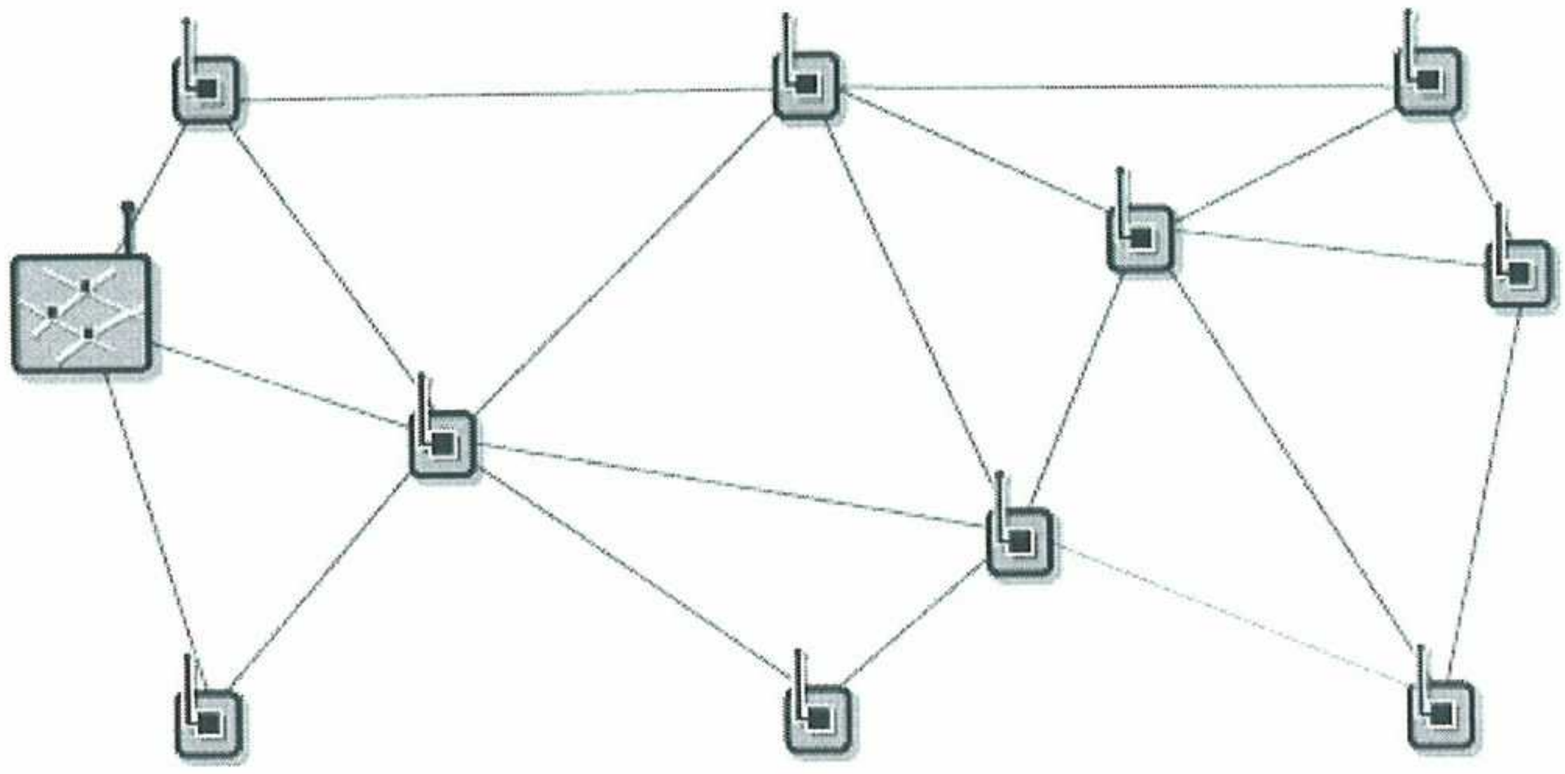
SmartMesh: Frecuencias 902-928 MHz (FCC), XML-RPC API

Hardware básico: Motas M1010
Características: 902-928 MHz, 76.8 kbps, 100m, 32X29 mm
Sistema Operativo: SmartMesh (propietario)
Programación: Blackbox, API Manager
Interfaces: RPC, XML
Herramientas de gestión: SmartMesh Manager

Especialización: Domótica, industrial, seguridad

El sistema SmartMesh emplea tecnología sofisticada para conseguir implantar redes de sensores de bajo consumo que son fáciles de instalar y altamente manejable.

La integración de estas tecnologías con la comunicación inalámbrica de nodos alimentados por baterías, proporciona plataformas resistentes, con un alto grado de autonomía, que pueden operar sin mantenimiento durante años gracias al uso de dichas baterías.



Routing multi salto

Una red SmartMesh consiste en un acoplamiento de dispositivos inalámbricos interconectados. Los nodos de estas redes deben tener, al menos, dos posibles caminos para ser capaces de soportar múltiples saltos entre origen y destino. Gracias a la redundancia de rutas se puede asegurar el correcto funcionamiento de la red, en caso de que deje de operar alguno de los nodos, además de permitir la optimización y simplificación de la instalación.

El *multi salto* también reduce la potencia requerida para transmitir un paquete de información entre fuente y destino. En una red punto a punto, el doblar la distancia de comunicación necesita multiplicar por ocho la potencia requerida. Usando una red con *multi salto* se ahorra energía de la batería transmitiendo los datos de un nodo a otro en vez de transmitir una señal RF de gran potencia.

- **Ember**

www.ember.com

Hardware básico: Motas EM2420
Características: frecuencias 2.4 GHz (ZigBee), 250 kbps, 75 m, 7x7 mm, 10US$
Sistema Operativo: EmberNet (propietario)
Programación: Ember Studio
Interfaces: EmberNet Stack API
Herramientas de gestión: Ember Studio Network Management
Alimentación: Baterías

Especialización: Domótica, industrial, logística, energía, defensa.

El kit de desarrollo de Ember (Ember Developer Kit) es una potente herramienta, que permite elaborar, de forma rápida, aplicaciones inalámbricas embebidas en sus productos. Este kit incluye hardware, herramientas de desarrollo y software para aplicaciones embebidas, todo lo que se necesita para acoplar inteligentes, robustos y descentralizados dispositivos de red en diversos productos y aplicaciones.

Ember Studio Developer Pack

Ember Studio Network Management Software
Software para ver, testear y controlar los nodos que forman la red, así como parámetros de la red.

Ember Studio Debug Tools
Loggers de depuración y herramientas de monitoreo para facilitar el desarrollo de la red.

EmberNet Stack API
Provee Agregación de Datos, Sincronización de Tiempo, Control de Encendido y ZigBee provisioning.

Ember Developer Kit User Guide
Una API y referencia de hardware, tutorial y guía para el desarrollo de aplicaciones embebidas en redes inalámbricas.

Tabla resumen

	Crossbow	Dust Networks	Ember	Millennial Net
Hardware	Motas Micaz	Motas M1010	Motas EM2420	Motas i-Bean 5324
Velocidad	2,4 GHz	902-928 MHz	2,4 GHz	2,4 GHz
Dimensiones	58X32 mm	32X29 mm	7X7 mm	?mm
Alcance	75 m	100 m	75 m	30 m
Precio	150 U$	?U$	10 U$	?U$
Programación	Open source	Propietario	Propietario	Propietario
Precio kit	5000 U$	?U$	20000U$	5000 U$

Posibles aplicaciones de la tecnología de NIMS

Automatización en edificios

Medición de la energía
Control del clima
Sistemas de control HVAC
Control de la iluminación
Monitoreo de centro de datos
Sistemas de control de instalaciones
Sistemas de seguridad
Control de accesos

Monitoreo industrial

Métricas de uso de equipo
Control de procesos
Monitoreo del ciclo de vida de maquinarias

Seguridad y servicios protectores

Monitoreo de perímetro
Detección de intrusos
Monitoreo de infraestructuras civiles
Protección personal
Vigilancia de habitaciones remotas
Monitoreo de tierras desentendidas

Posibles partners para el desarrollo de proyectos WSN/NIMS

Título del proyecto:

Intelligent sensing, mobile robotics, sensor data fusion

Detalles del proyecto:

We are working on intellligent sensing problems in our laboratory.
The work involves analysis, simulations, and experimental verification.
We have been working with ultrasonic, optical, and inertial sensors and the fusion of information acquired from these sensors
FP6-IST, FP6-MOBILITY

Expira:

20/10/2005

Instrumentos:

IP, STREP, Marie Curie, SMEs-Collective research projects, Cooperative research contracts

Partner:

Bilkent University
Department of Electrical and Electronics Engineering
Ankara 06800
Turkey
Nº empleados > 500
Volumen de ventas: 15 millones €

Persona de contacto:

BARSHAN, Billur (Dr.)
http://www.ee.bilkent.edu.tr/~robotics
billur@ee.bilknet.edu.tr
telf: +90-312-2902161
fax: +90-312-2664192

Título del proyecto:

Artificial Intelligence applied in the built environment. Innovation in the construction industry.

Detalles del proyecto:

Artificial intelligence, machine vision, decision making under uncertainty. Self organising, adaptive, wireless sensor networks in the built environment. Interface design. Interaction design. Sensing and actuating in the built environment. Monitoring how people use workplaces. The application of innovation processes within the construction industry.
FP6-IST, FP6-INNOVATION

Expira:

26/01/2006

Áreas de actividad:

(IST-2.1) Communication and network technologies
(IST-4) Knowledge and interface technologies
(IST-4.2) Intelligent interfaces and surfaces
(INNOVATION-6) Analysing and evaluating innovation in Community research projects
(IST-3.2.2) Advanced displays and sensors
(IST-4.1.1) New semantic-based and context-aware systems
(IST-4.2.1) Natural, adaptive and multisensorial interfaces and interactive surfaces
(NMP-2002-3.4) The creation of "knowledge communities" in production technologies
(IST-2002-2.3.) e-inclusion
(IST-2002-2.3.) Grid based systems for complex problem solving

Instrumentos:

IP, STREP.

Partner:

Arup
United Kingdom
Consultancy, Research, Industry
Nº empleados > 500
Volumen de ventas: 428 millones €

Persona de contacto:

WILSON, Duncan (Dr)
Senior Business Analyst Arup
http://www.arup.com
duncan.wilson@arup.com
telf: +44-2077-552794

Título del proyecto:

Monitoring and Modelling environment and environmental Risks

Detalles del proyecto:

This project is a proposal of environment monitoring, atmosphere and water, and its principal pollutants having regard to the Treaty establishing the European Community, and on the principles there enshrined, concerning to the environment quality and preservation as essential to the populations health and well care.

The work plan concerns four different themes:

1) Sensors research and certification - the prototype of sensors that can gather the information neither chemical pollutants nor climate state like temperature or wind strength. This kind of sensors will be able to monitor air and water in different environmental conditions. Then it will be tested with European Isolations and prepared to commercial production.

2) Informatics signal processing and construction of a wireless network - the sensors have to be connected to one big network system that can gather the data in the real time and send it to central point of the system. To do it more flexibility and well-fitting to all environmental conditions only wireless connections can be used.

3) database and system construction - all the data form the sensors will be gathered in a huge data base and then it will be used to provide the prevision map and online monitoring systems.

4) Data analysis, prevision/risk maps and a Geographical Information System (GIS) construction - the study of the spatial correlation of these variables (environment attributes and pollutants) will allow the understanding of preference spatial relations and support the characterization of environmental pollution. The development of new technologies as well as the construction of a GIS on line will allow updated and easily accessed public information.
ENVNGO 2C; FP6-IST; FP6-SUSTDEV

Expira:

08/08/2005

Instrumentos:

IP, STREP

Target Partner:

We are looking for a coordinator of this project who is an experienced organisation in this area and has already coordinated FP6 projects.

Partner:

The Academy of Humanities and Economics in Lodz (AHE)
Departamento: Faculty of Computer Science and Management, Division of Networks and Operating Systems.
Region: Lodzkie, M. Lodz
Dirección: ul. Rewolucii 1905r nr 64, Lodz 90-222, Poland
Nº Empleados > 500

Persona de contacto:

GOETZEN, Piotr (PhD. CCNA)
Head of Division of Networks and Operating Systems
The Academy of Humanities and Economics in Lodz (AHE)
goetzen@wshe.lodz.pl
telf: +48-42-6315032
fax: +48-42-6315032

Título del proyecto:

Teleoperated Robot for Demining Contaminated Areas

Detalles del proyecto:

One of the most depressing postwar circumstances is the contamination of large areas with landmines, which threaten thousands of people for very long periods of time. Effective technologies could help to decrease dangers for life and limb of people who live in landmine contaminated areas.

This proposal aims at the construction of a teleoperated robot to be applied for demining landmine-contaminated areas. Such a robot needs to be equipped with adequate sensors and actuators that should be teleoperated in order to avoid dangers for the personnel who carries out mine clearance tasks.
FP6-IST, FP6-NEST

Expira:

21/04/2005

Instrumentos:

IP, STREP, Marie Curie, SMEs-Collective research projects, Cooperative research contracts

Partner:

Fraunhofer Institute for Computer Graphics
Departamento: Communication and Cooperation
Región: HESSEN; DARMSTADT; Darmstadt, Kreisfreie Stadt
Dirección:
Fraunhofer IGD
Fraunhoferstr. 5
64283 Darmstadt
Germany
Nº Empleados: 50-249

Persona de contacto:

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Research Staff
http://www.igd.fhg.de/igd-a9
krafzig@igd.fhg.de
telf: +49-6151-155215
fax: +49-6151-155559

Título del proyecto:

ENISIR. European Network of Information Society Innovative Applications Research and results centres.

Detalles del proyecto:

ENISIR European Network of Information Society Innovative Applications Research and Results centres (http://enisir.net)

It is a big Information Society Technologies (IST) project that we are preparing for next EU-FP6-IST 4th call (now in an active preparation stage, with the publication expected to be in December and the presentation deadline in spring05).

The ENISIR idea started two years ago, with the preparation of C.O.N.S.E.N. Coordinated and integrated Open-source Neural-points Space of pan-European information services e-Centres EU-FP6-IST-2.3.1.9. e-Business and eGovernment networks.

During all this period the ENISIR concept has been gradually improved, due to a CONSEN organization hard work. This evolutionary process has meaning to carry out different projects proposals, CONSEN contributions, forum and workshops participations and presentations done, during the last month. The main strong points of ENISIR are the consistence of the conceptual approach model, the technological cross-disciplinary vision and finally the adaptation to current context to find relevant applications for Europe needs.
YOUTH C; ECONTENT; FP6-SOCIETY; FP6-IST; FP6-SME; FP6-INNOVATION

Expira:

30/04/2005

Áreas de actividad:

(IST-2.1) Communication and network technologies
(IST-4) Knowledge and interface technologies
(IST-1.2.4) Intelligent systems to enhance the protection of people and property and for securing and saveguarding civil infrastructure
(IST-1.2.5) e-Inclusion
(IST-1.3.2) eWork systems
(IST-3.2.2) Advanced displays and sensors

Instrumentos:

IP.

Target partner:

Now CONSEN works:

1 forming an excellent Pan-European consortium
2 Contributing closely and hard in the redaction of the eGovernment networking topic, in order to adapt the proposal to the EU-IST needs.
3 Studying and preparing in advance all the technological, contextual and organizational issues requested to do an excellent proposal.

Required expertise :

We are looking for partners including but not limited to:
- Field experts
- Individual developers and consultants
- Micro to Small size enterprises
- Companies
- National research institutes
- Universities
- Organizations and foundations
- Relevant public bodies and policy makers

with the following skills:
1. Knowledge of information society technologies and open source software in general
2. Knowledge of integration, migration, implementation of IST-FOSS.
3. Knowledge of national IT programmes
4. Knowledge of analysis, test and validation of out coming results.

We would like to form a balanced geographical and sectorial distribution of members.

Work to be carried out:
1. Organizing thematic workshops with the aim of discuss, research, road mapping and disseminate.
2. Building distinct pilot projects (including e-services, e-learning and e-government).
3. Collecting and publishing the gathered knowledge and the results concurrently.
4. Establishment of a common information and communication system.
5. Forming a thematic constituencies.

Partner:

CONSEN (EEIG)
Barcelona
Jaume Fabra 12 1º2ª (08004)
Nº Empleados < 10

Persona de contacto:

Cabrer i Vilagut, Ferran
Coordinador CONSEN (EEIG)
http://consen.org
consen@conse.org
telf: +34-93-4238267
fax: +34-93-3312495

IST Sixth FrameWork Programme 2005-06 Work Programme

Strategic Objectives addressed in Call 4 (closing 22 March 2005)

2.4.1 Nanoelectronics

Use actions should promote the integration and use of micro- and nanoelectronics technologies (limited to reconfigurable systems) in SME products and in application and/or geographical areas where these technologies are insufficiently used. They cover awareness actions, the development and evaluation of industrial test cases, and the dissemination of results for replication.

IPs will be the instrument for *use actions*.

2.4.11 Integrated biomedical information for better health

2. Innovative systems and services for disease prevention, diagnosis and treatment based on integrated biomedical data and information on several levels (molecular, cellular, tissue, organ and person levels). The work should exploit advances in cognitive modelling, grid, mobile, imaging and micro- and nano- technologies (such as wearable health monitoring technologies) and should lead to new approaches in disease prevention, early diagnosis, pharmaceutical research (e.g. drug development, use of information from clinical trials), enhancement of patient safety (e.g. prevention of adverse drug events), and support personalisation of healthcare and lifestyle management. The proposed systems and services should demonstrate measurable benefits, respect all aspects of confidentiality and privacy and be user friendly.

Instruments: IPs, STREPs

2.4.12 eSafety – Co-operative Systems for Road Transport

Research on advanced communications concepts, open interoperable and scalablesystem architectures that allow easy upgrading, advanced sensor infrastructure,dependable software, robust positioning technologies and their integration into intelligent co-operative systems that support a range of core functions in the areas of road and vehicle safety as well as traffic management and control. In addition to this, RTD activities on active safety systems insofar as they contribute to increased performance of integrated safety systems.

Instruments: IPs, NoEs, STREPs.

Strategic Objectives addressed in Call 5 (closing 21 September 2005)

2.5.2 Micro/nano based sub-systems

Integrated systems and tools for point-of-care diagnosis, monitoring, and drug delivery. Activities should follow a multi-disciplinary approach combining device, systems and application RTD. Bio-compatibility, attached or implanted devices, integration of different sensors into diagnostic/therapeutic tools that interface between the cell/chips and the outside world; new bio-microsystems for proteomics, DNA screening, drug screening and delivery and early diagnostics are examples of activities that may be addressed.

These tasks are to be addressed through IPs and STREPs.

Validation and demonstration of micro/nano systems-enabled tools and subsystems, with emphasis on transferring results between application fields, to enterprises (e.g. SME) and to explore their use to address major socio-economic needs combining the device, tool and subsystem development with the application RTD.

These tasks are to be addressed through IPs.

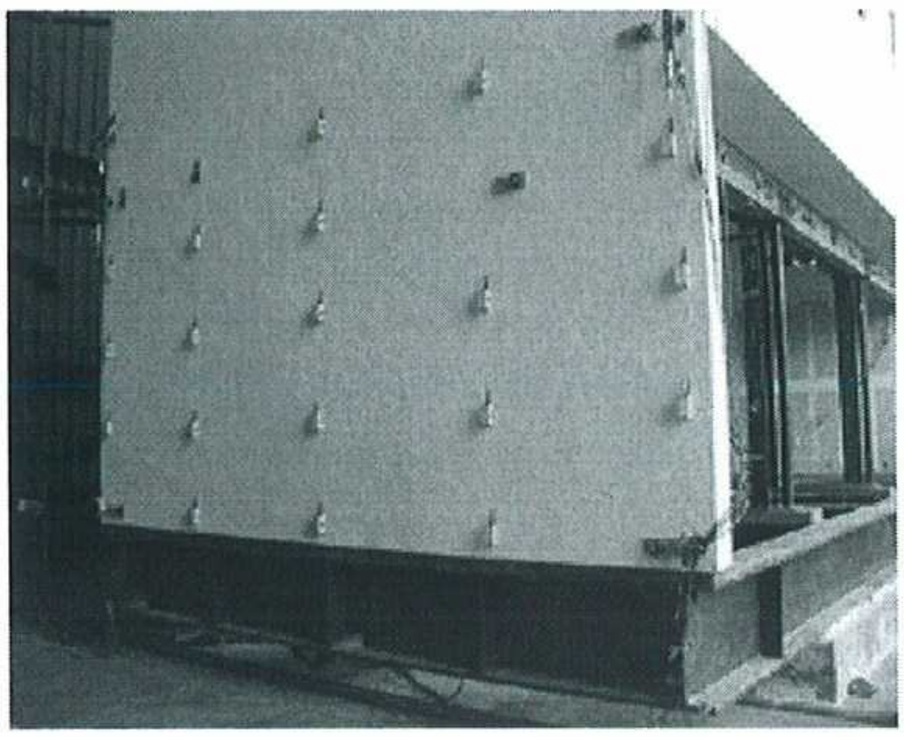
2.5.3 Embedded Systems

Middleware and platforms for building secure, swarming and fault-tolerant *Networked Embedded Systems* where diverse heterogeneous physical objects cooperate to achieve a given goal. While the developed technology must be generic (e.g. regarding computational and programming models, architectures, semantics, new APIs, operating systems, secure kernels etc.), it should be driven by an entire class of ambitious future applications, covering not only information handling but also perception and control (e.g. smart homes, civil security, air and highway traffic management).

Instruments: IPs, NoEs, STREPs, SSAs, CAs

ANEXO

Smarter Sensors for Civil and Structural Monitoring

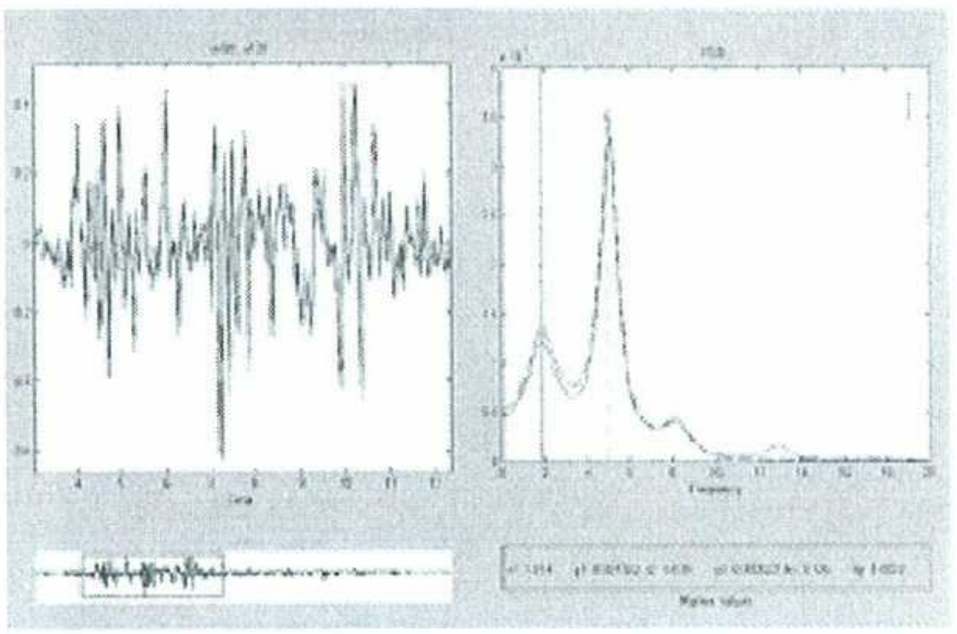


Wireless sensor networks allow for the unattended monitoring of large structures. Structural health monitoring requires that as many measurement points as possible be captured to analyze both the global response and the local response of the civil structure. Traditional instrumentation and sensor solutions are cost prohibitive for monitoring anything more than a modest number of sensor inputs. With nearly 80 billion square feet of commercial and governmental facilities and more than 100 billion square feet of infrastructure, our nation's civil structure cost millions each year to monitor. However, existing solutions are inadequate to provide basic, cost effective monitoring of structural health, safety and integrity. These solutions are also becoming increasingly critical in Homeland Security initiatives.

Using wireless sensor technology available from Crossbow, seismic acceleration, strain, temperature, wind speed, and even GPS data can be monitored and measured. Alerts can be generated when parameters exceed certain thresholds; monitoring data can used with existing analysis tools. Crossbow has developed solutions for customers leading important research initiatives and trials in the area of seismic health monitoring. In one pilot project wireless accelerometers were mounted on a three story house. The house was built on top of California's largest seismic shaker at the Richmond Field Test Center. Data recorded from 50 wireless accelerometers were used to analyze the structural response to a simulated earthquake. The picture at the top of the page shows Crossbow's wireless motes installed on the seismic shaker and scale house built on top of it. Below is a comparison of the mote's accelerometer output, both time and frequency domain, with that of a traditional, more expensive piezo accelerometer used in this demonstration.

MTS400/420 Sensors

The MTS400 has includes on-board temperature, humidity, barometric pressure, 2 axis accelerometer, and ambient light sensor. The 420 unit adds a GPS module for absolute sensor position measurement.



MDA300 Data Acquisition Modules

The MDA300 is used for civil and structural monitoring data acquisition applications. The MDA300 sensor board interfaces directly with a host of external sensors, storing calibration parameters on-board (in EEPROM). The data acquisition unit includes numerous analog and digital input and output channels plus selectable sensor excitation voltage.
Both the MTS400 and the MDA300 are compatible with MICA2 and TinyOS, providing open-source mesh networking and signal processing capabilities. Custom sensor configurations are available which include integral strain gauges.

Cricket Project
http://cricket.csail.mit.edu
MIT Computer Science and Artificial Intelligence Lab

Introduction

You will also find the project useful if you plan to write location-aware embedded wireless sensor computing applications on the Mote platform. Writing such applications will not be difficult because the Cricket embedded software is written in TinyOS [6], the software platform for the Motes.

System Overview

Cricket is an indoor location system. It provides two forms of location information—space identifiers and position coordinates—and can be as accurate as between 1 cm and 3 cm in real deployments.

Space identifiers are user- or application-specified names associated with spaces such as rooms or parts of rooms. The position coordinates are (x, y, z) Cartesian coordinates in some coordinate system.

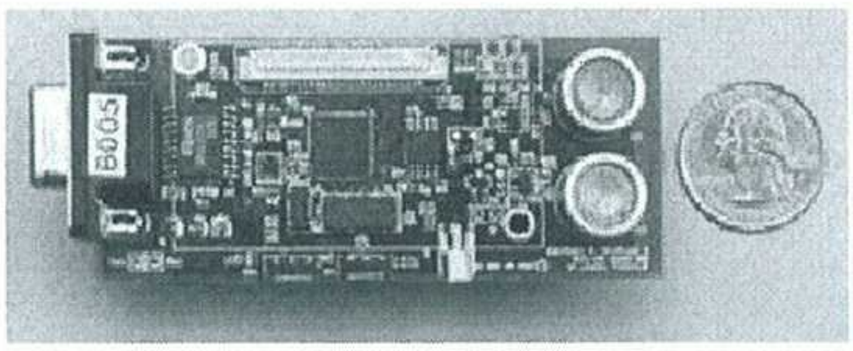


Figure 1.1: A Cricket hardware unit; this unit can function as either a beacon or a listener under software control, and can also be used in a more symmetric way as both listener and beacon.

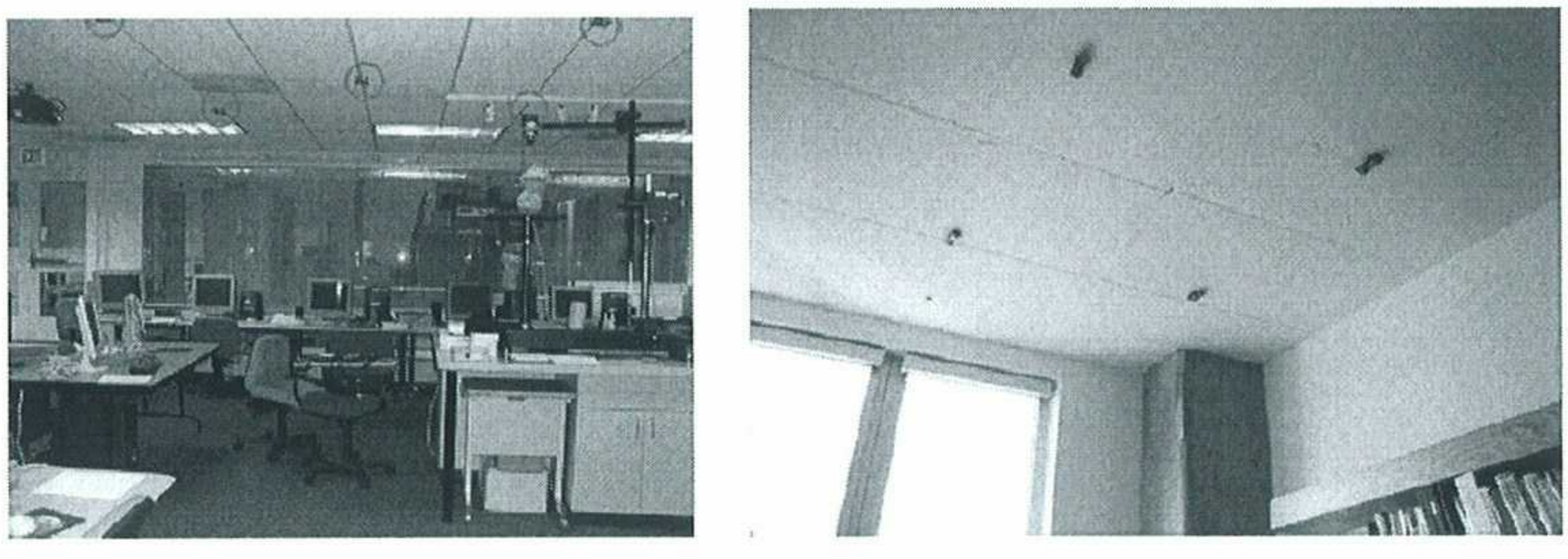


Figure 1.2: Example deployments of Cricket beacons. Multiple beacons may advertise the same space identifier if they are in the same space, but each beacon has a different position coordinate consistent with its location in space.

The most common way to use Cricket is to deploy actively transmitting beacons on walls and/or ceilings, and attach listeners to host devices (handhelds, laptops, etc.) whose location needs to be obtained. See Figures 1.1 and 1.2.

The listener (or software running on the host device) infers its position coordinates based on distances from multiple beacons whose positions are known, and software running on the host device can associate itself with the space corresponding to the nearest beacon.

Cricket is intended for use indoors or in urban areas where outdoor systems like the Global Positioning System (GPS) don't work well. It can provide distance ranging and positioning precision of between 1 and 3 cm, so applications that benefit from better accuracy that the cellular E-911 services and GPS will also find Cricket useful. Cricket is designed for low-power operation and can be used as a location-aware sensor computing node (running TinyOS), to which a variety of sensors can be attached.

Cricket hardware details

Cricket uses time-difference-of-arrival between RF and ultrasound to obtain distance estimates. Its radio runs at a frequency of 433 Mhz, with the default transmit power level and antennas providing a range of about 30 meters indoors when there are no obstacles.2 The maximum ultrasound range is 10.5 meters when the listener and the beacon are facing each other and there are no obstacles between them.

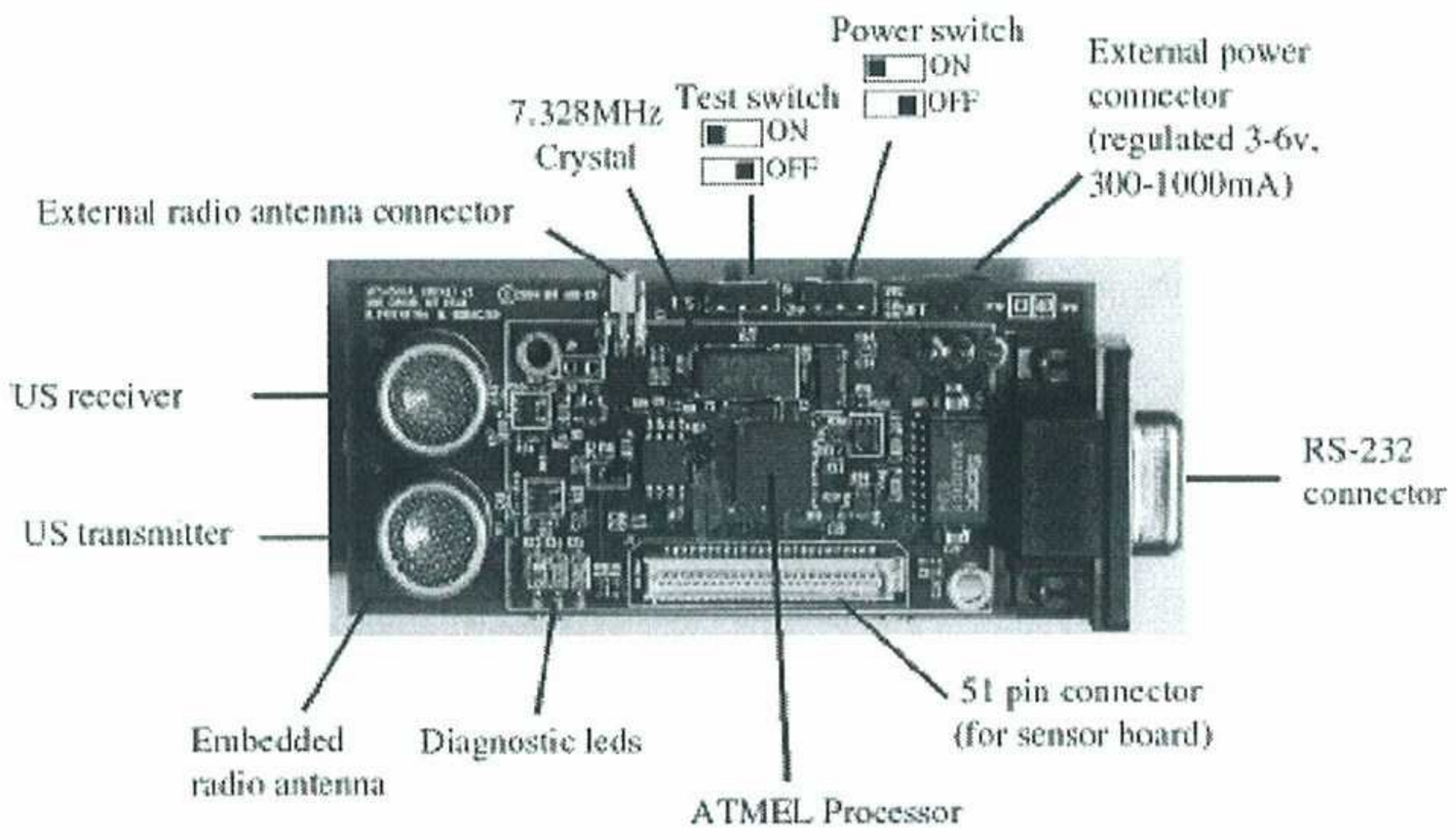
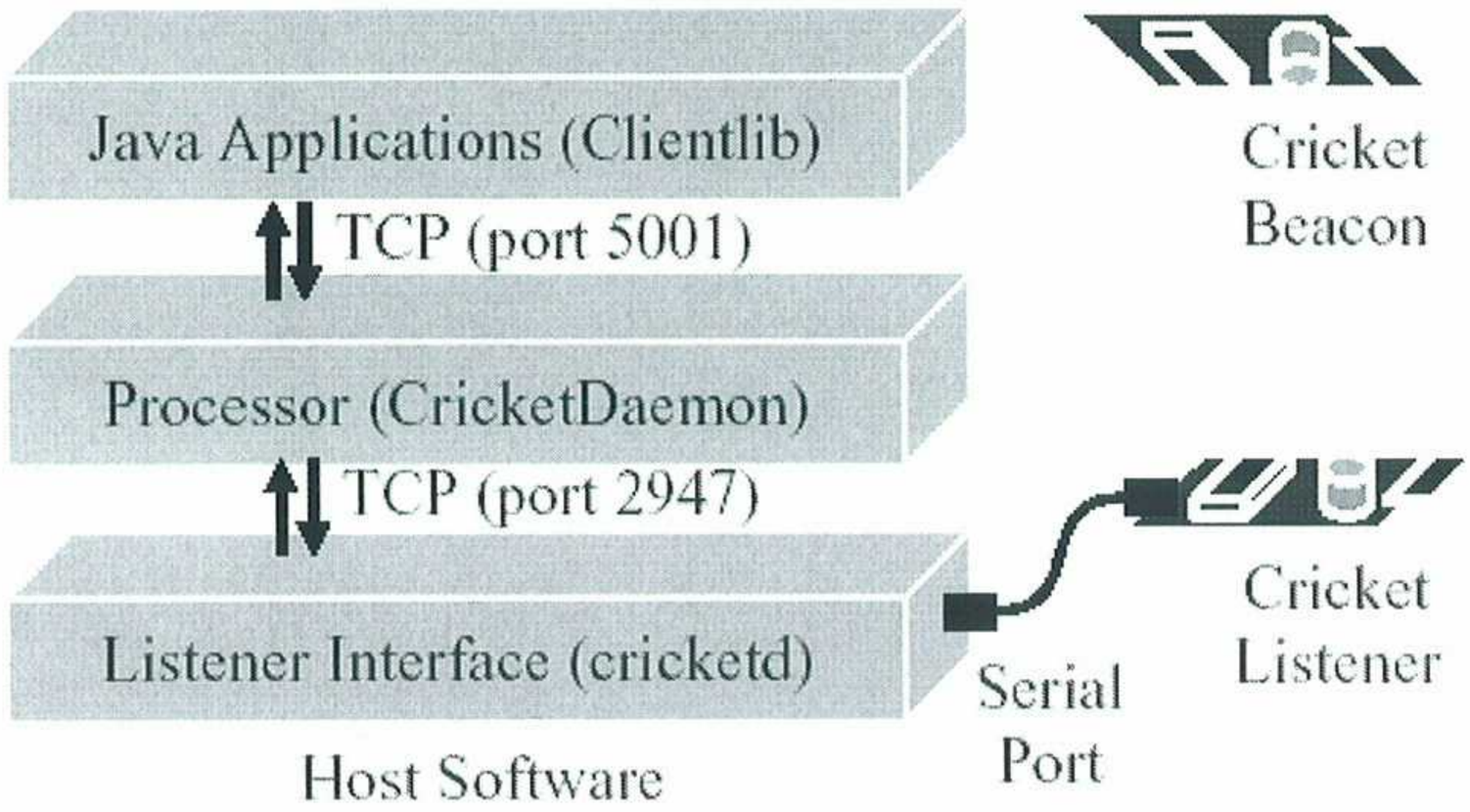


Figure 2.1: Cricket v2 hardware components and layout.

You need a *programming board* (also called a "programmer") to program Cricket units with the TinyOS-based software image. Cricket can be programmed using the same programmers as Mica2 motes. We use the MIB510CA model.

To test your Cricket hardware unit and to configure some of its parameters. You will need a serial communication terminal program such as HyperTerminal or minicom.

Architecture



At the lowest layer, cricketd allows a Cricket host device to access the Serial Port API to configure low-level Cricket parameters and obtain raw measurements from the Cricket hardware device. The software package includes a CricketDaemon server application that connects to cricketd to filter and process raw Cricket measurements to infer the listener's spatial location and compute its position coordinates.

Java applications may access the processed location information via the Java Cricket client library (Clientlib), which interfaces between the application and the CricketDaemon. At runtime, one CricketDaemon processes location information for exactly one Cricket device.

A CricketDaemon may serve location information of a Cricket device to numerous applications at the same time.

Crossbow®
TECHNOLOGY INC.

Smart Dust Training Seminar
April 19 – 20, 2005
Crossbow Technology Headquarters
4145 N. First St., San Jose, CA 95134

Pre-Seminar/TinyOS Install Session: Mon., April 18, 2005 @ 6:30PM to 8:30PM
Location: Training Room

Customers who have never before installed TinyOS are welcome to attend the TinyOS install session free of charge (provided they sign up for the two day seminar). Crossbow's customer support engineers will guide them thru an install on the customers' PC/Laptop. We will also help users update existing systems to the latest version of TinyOS.

Please bring your mote-kit to the TinyOS install session and bring a laptop running Windows 2000 or Windows XP with at least 1 serial port or 1 USB port AND a USB-serial converter. You must have administration privileges to your laptop and you must have at least 1 GB of free space.

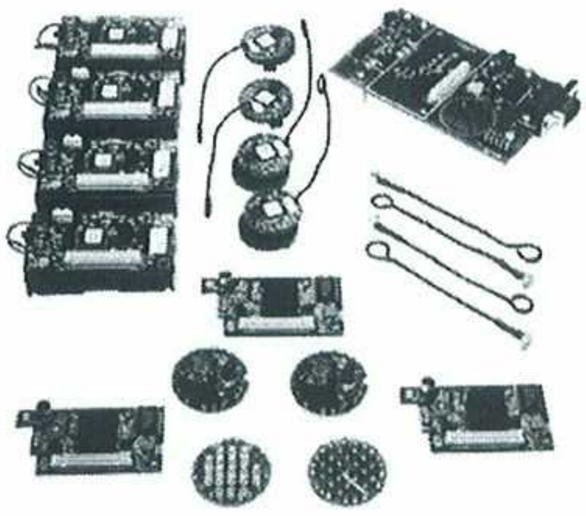
Day 1: Tues. April 19, 2005 @ 7:00AM to 5:00PM; Dinner @ 7:00PM

Breakfast Hosted by Crossbow 7:00AM to 8:00AM
Location: TBD

General Session 8:00AM to 5:00PM
Location: Training Room

Topics

- Introduction to Smart Dust and Motes
- Hardware Overview
- TinyOS Overview
- Wireless Communications
- Multi-hop Mesh Networks



Lunch 12:00PM to 1:30PM
Location: Lunch Room

Dinner 7:00PM
Location: TBD

Snacks and Lunch Provided
Morning Break
Lunch 12:00PM to 1:30PM
Mid-Break

Option 1 – Developer's Session

Day 2: Wednesday, April 20, 2005 @ 7:00AM to 5:00PM

Breakfast Hosted by Crossbow 7: 00AM to 8:00AM
Location: TBD

Developer's Session 8:00AM to 5:00PM
Location: Training Room

Targeted to customers interested in TinyOS programming and embedded software development.

End of day objectives are to write from scratch custom application that uses a "custom" sensor board, and to learn how to connect the user's application to the radio stack and multi-hop routing. Also includes a presentation of TinyOS and nesC fundamentals.

Topics*

- Over the Air Programming (Joint Session)
- Intro to MOTE-VIEW (Joint Session)
- Introduction to Programming (part 1)
- Introduction to Programming (part 2)
- Writing Device Drivers & Debug
- Enabling Mesh Networking for Device Driver, Connecting to MOTE-VIEW
- Debugging

Snacks & Lunch Provided
Morning Break
Lunch 12:00PM to 1:30PM
Mid-Break

* Subject to change without notice

Option 2- User's Session

Day 2: Wednesday, April 200, 2005 @ 7:00AM – 5:00PM

Breakfast Hosted by Crossbow 7:00AM to 8:00AM
Location: TBD

User's Session 8:00AM to 5:00PM
Location: Everest

Targeted to customers interested in deploying sensor networks in industrial, commercial, or for research purposes.

Topics*

- Over the Air Programming (Joint Session)
- Intro to MOTE-VIEW (Joint Session)
- Environmental Monitoring Overview
- Stargate and Remote Access Server Tutorial
- Antennas, Sensors, Batteries, & Packaging
- Localization
- Industrial & Building Automation, Security

Snacks & Lunch Provided
Morning Break
Lunch 12:00PM to 1:30PM
Mid-Break

* Subject to change without notice

Referencias

Crossbow Wireless Sensor Networks
http://www.xbow.com
http://www.davidson.com.au/products/wireless/crossbow/micaz.asp

Referencia de posibles aplicaciones de la tecnología de Crossbow
http://www.xbow.com/Industry_solutions/Industrial_Vibration.htm
http://www.xbow.com/Industry_solutions/Civil_Structural.htm
http://www.xbow.com/Industry_solutions/Environmental.htm

Referencia a los diferentes **kits de desarrollo** de la tecnología Crossbow
http://www.xbow.com/Products/productsdetails.aspx?sid=61

Dust Networks
http://www.dust-inc.com/flash-index.shtml

Ember Company
http://www.ember.com

The Cricket Indoor Location System
http://cricket.csail.mit.edu

Proyectos Europeos/Partners
http://www.cordis.lu

NescC:
Página de referencia al lenguaje de programación para el desarrollo de aplicaciones embebidas en los NIMS:
http://nescc.sourceforge.net

The nesC Language: A Holistic Approach to Networked Embedded Systems,
David Gay, Phil Levis, Rob von Behren, Matt Welsh, Eric Brewer, and David Culler.
In *Proceedings of Programming Language Design and Implementation (PLDI) 2003*.
http://nescc.sourceforge.net/papers/nesc-pldi-2003.pdf

TinyOS
Sistema operativo *open source* para plataformas WSN
http://www.tinyos.net/