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Company profile

DUNE is a Small-Medium Enterprise operating since 1980 in R&D, aerospace, defence, underwater acoustics, robotics, industrial control and communications.

The company is certified ISO 9001:2008 for SW and HW development and since 2004 has been qualified as Research Laboratory by MIUR[*].

Over the last 30 years we have focused our activities in the fields of design, simulation and development of SW processing architectures for hard real-time systems on multi-core and multi-processor platforms (Radar, Sonar and Satellite Systems, Robotic and Industrial Control Systems, Inertial Navigation Systems), management of EU Research Projects (Wireless networks, GSM, UMTS, LTE, LTE-A, femtocells, picocells, broadband communication networks), design and development of dedicated HW solutions for real-time purposes.

Application-ready or dedicated solutions based on a consolidated experience are provided as well as the capability to seek innovative solutions in system analysis.

Flexible processing architectures are exploited to prevent or mitigate the risks related to the obsolescence providing the Customers with systems, easy to be migrated on innovative platforms, which minimize program risks, reduce migration costs and accelerate time to deployment and time-to-market.

The company skill in leading and managing International Research Projects ensures a solid support to the Customers regarding proposal of innovative ideas, international partner contacts, proposal presentation and project management.

The expertise in developing high-performances HW solutions may answer to specific Customers needs not completely met by commercial products.

[*] Italian Ministry for University, Education and Research

Company competences

Acquisition and Processing Systems

- System analysis and requisite definition (performances, timings, computational weights, assessment of system limits and constraints, system behavioural simulations)
- Platform selection support (evaluation, benchmarks)
- Strategies to prevent and mitigate system obsolescence and manage high or not uniform throughputs, run-time errors and failures (flexible multiprocessor architectures, automatic re-configuration strategies, redundancy for fault management, algorithm parameterization)
- Real-time architecture design and development (processor scheduling and affinity management, inter-processor communications, inter-processor communication frameworks, dynamic circular buffering)
- Algorithm definition, optimization, simulation and developing (partitioning, parametric serialization and parallelization, caching and processing optimization, performance assessment)

Communication

- Research consultancy (GSM, UMTS, 3G, LTE/LTE-A, WiMAX, user trials support, test specification, installation and commissioning services, radio parameterization, measurement data analysis, drive testing and post-processing, Key Performance Indicators, survey of the end users, network optimization specification)
- Technical support in the emerging Heterogeneous Networks (HET-NETs, femtocells, picocells and small cells)
- Original algorithm development for wireless communication systems (wireless sensor networks, wireless multi-hop networks, self configurable air interfaces, smart antennas for broadband networks)

HW Solutions

- HW solutions for real-time acquisition/processing purposes on Customer specifications (low-noise and high-gain analog front-ends up to 4 GHz, wideband demodulators, hard real-time data acquisition and processing boards, mechanical infrastructures with special design)
- IMU-based systems (localization and navigation systems, IMU boards)

The company follows the entire project life-cycle (architecture design, requisite and specification definition, timing evaluation, simulation and optimization activities, revision of critical points and project changes, testing and integration in the final environment) and provides the entire SW and HW documentation (requirements, specifications, software, test and manual documents) in agreement with the Standard UNI ISO 9001:2008 and the NATO Standard AQAP-150.

Company technical skills

DUNE has strong internal competences in managing RTOS, exchange protocols, simulation and development tools and the related developing languages under Windows, Linux, Unix, VAX/VMS environments.

Our solid expertise in embedded systems based on FPGAs, DSPs, PPCs and µCs on VME and VXS racks enable us to provide a wide range of solutions according to the Customer needs.

The deep experience in leading and managing International Research Projects certifies the ability of affording innovative solutions and proposals.

More than 85% of the staff has 10 + years of experience.

More than 90% of the staff is graduated in Engineering, Physics or Mathematics.

RTOS	VxWorks, LinxOs, MC-OE and MC-OS Mercury
Protocols	LAN, RapidIO, RACE++, RACE, PCI Express
SW Tools	Matlab, Visual C++, Visual DSP, Mathlink EDS, LabView, Simulink, Analog Devices ADSP21xxx Macro-assembler, Texas Instruments TMS360Cxx Macro-assembler, Quartus II, ISE, UML Rational Rose, Clear Case, Rhapsody, Doors, Word, Excel, PowerPoint
Languages	C, C++, VHDL, Altivec, Assembler, Fortran, Pascal
FPGA	Altera Stratix, Altera Cyclone and XilinxVirtex II, IV, V and VI
DSP	Analog Device ADSP2106x, Sharc, Hammerhead, Tiger Sharc and TI family
PPC	Mercury HCD6100, HCD5220, MCH6, Freescale MPC5200 , ThalesVantage G4, Motorola MV6100, Radstone VANTEGRA-DL, Janz , PowerQUICC MPC8349E
I/O board:	National Instruments, ICS

TABLE OF CONTENTS

Projects co-funded by the European Commission

Digital Wireless Communication

TROPIC (2012-2015)

Distributed computing, storage and radio resource allocation over cooperative femtocells

(FP7, Information Communication Technologies (ICT), contract 318784 - TROPIC)

Femtocell networks are currently seen as the new communication paradigm for the ever-increasing ubiquitous wireless traffic demands. Being pervasive by nature, its proximity to the subscriber opens a new world of possibilities for the development of applications. Among them, cloud computing services demanded by smartphones could be moved from large server farms to HeNBs, provided that these are equipped with computational and storage resources, thus improving user experience on latency and download/upload speed.
TROPIC addresses this scenario by exploiting advanced MP2MP communications schemes, innovative virtualization procedures, and a cross-layer approach to the allocation of resources understood in a wide sense: radio, computational/storage capacity and energy.

FREEDOM (2010-2012)

Femtocell-based network enhancement by interference management and coordination of information for seamless connectivity

(FP7, Information Communication Technologies (ICT), contract 27187 - FREEDOM)

FREEDOM project faces key technical and industrial topics about the foreseen mid-term massive deployment of femtocells. It adopts a new approach based on cooperative/coordination paradigms, enabled by the quality-limited ISP (Internet Service Provider) backhaul link.

The company developed the analysis of:

- advanced interference-aware cooperative PHY techniques,
- improvement of the control plane procedures for seamless connectivity,
- system-level evaluation,
- hardware demonstrator of the proposed femto-based network architecture.

ROCKET (2008-2010)

Reconfigurable OFDMA-based cooperative networks enabled by agile SpecTrum use

(FP7, Information Communication Technologies (ICT), contract 215282 - ROCKET)

ROCKET aims at provisioning a ubiquitous wireless solution to achieve bit rates higher than 100Mbps with peak throughputs higher than 1Gbps, based on Reconfigurable OFDMA Cooperative Networks enabled by agile spectrum use.

DUNE was responsible for:

- contributing to the requirement definitions for the spatial radio multipath channel,
- analysing the cooperation strategies proposed by the project team, also providing alternative suboptimal approaches, less demanding for computational effort or signalling requirements,
- supporting the task of the advanced antenna techniques, by carrying on the analysis of optimisation strategies and the relevant performance evaluation by simulation.

SURFACE (2006-2008)

Self configurable air interface

(FP6, Information Societies Technologies Program (EC-IST), contract 27187 - SURFACE)

In the context of 3G medium and long term evolution, synthesis and performance evaluation of a novel generalised self-configurable radio interface for interworking at physical layer among access technologies such as DS-CDMA, MC-CDMA and OFDM.

The company developed:

- complexity vs. performance effective transmission and reception architectures comprising Multiple Input Multiple Output (MIMO) antennas,
- performance evaluation of the proposed architectures when integrated in the whole network,
- air interface emulator,
- hardware optimisation and complexity evaluation.

WINSOC (2006-2008)

Wireless sensor networks with self-organization capabilities for critical and emergency applications

(FP6, Information Societies Technologies Program (EC-IST), contract 033914 - WINSOC)

The aim of the project is to design, build and test an innovative self-organising, highly scalable wireless sensors network prototype. The network is based neither on layered protocols nor on centralised data-fusion, thus avoiding the associated signal overhead, complexity and power consumption.

DUNE was in charge of:

- analysis of bio-inspired sensors and communication concept,
- analysis of the network emergent behaviour,
- estimation capabilities of the network as a whole.

ROMANTIK (2002-2004)

Advanced algorithms for wireless multi-hop networks
(European Commission, Information Societies Technologies Program (EC-IST), contract 32549 – ROMANTIK)

The scope is to demonstrate the performance increase, such as the increased availability in wireless services and increased range, due to the adoption of multi-hop networks, in 3G and 4G wireless communication systems.

The company developed:

- radio resources management algorithms,
- strategies for relaying messages through the multi-hop network,
- innovative radiolink algorithms for CDMA-TDD and OFDM validation.

SATURN (2000-2002)

Technologies of smart antennas for broadband wireless networks
(European Commission, Information Societies Technologies Program (EC-IST), contract 10322 - SATURN)

The goal is to increase, by employing smart antennas, both the availability of broadband services (in two types of networks for mixed voice and data traffic) and the localisation capability. The networks are UMTS and WLAN (local and campus area) based on HIPERLAN-II standard.

DUNE leaded and managed:

- project co-ordination,
- synthesis of space-time codes for adaptive antennas with transmission diversity,
- medium access techniques for packet transmission in WLAN networks,
- experimental evaluation.

Projects co-funded by MIUR*

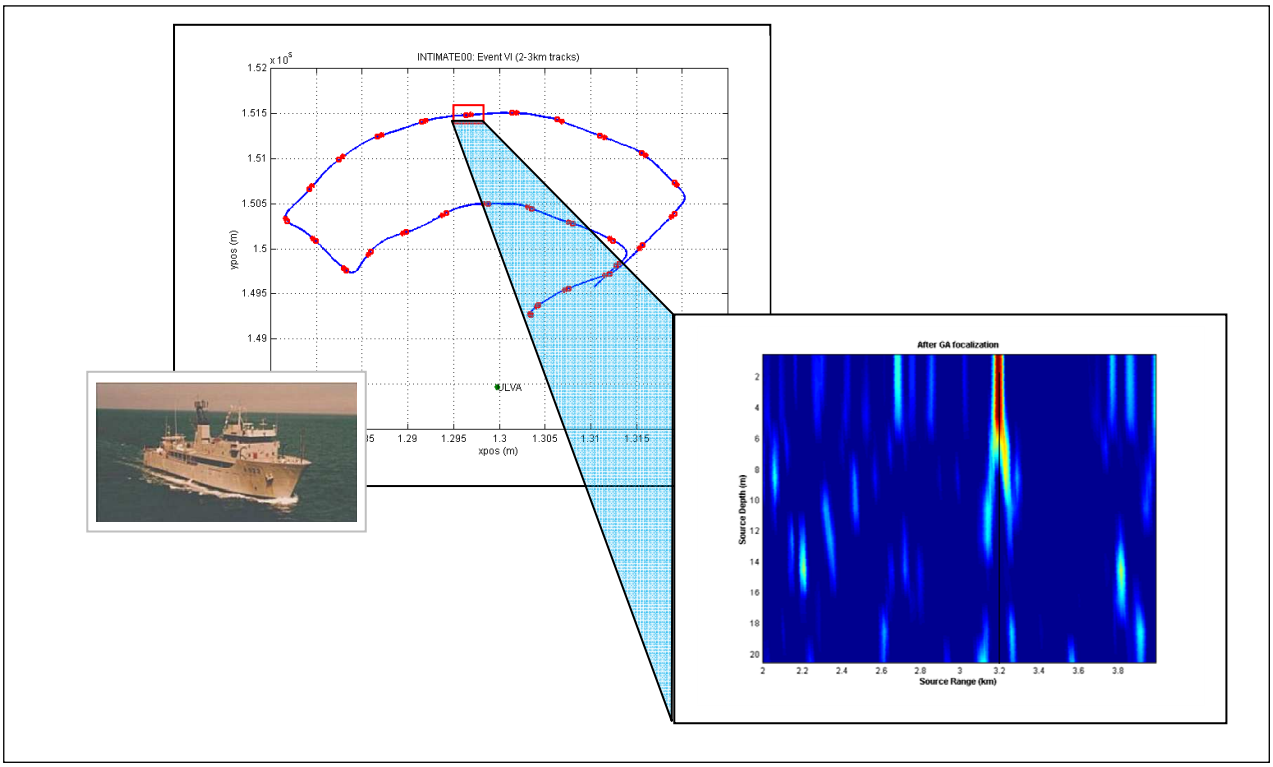
Passive Acoustic Tomography

(TOMPACO project, Ministero Università Ricerca Scientifica e Tecnologica - MURST, Mediterranean Environment Research Program)

The project aim was the marine temperature measurement by means of Passive Acoustic Tomography. The acoustical noise emitted by opportunity ships cruising in a coastal area is received by a 16-elements hydrophone array, vertically deployed in the water column.

The company developed the Processing Section designed to estimate the sound velocity and temperature fields, along with the position (range and depth) of the vessel, also managing:

- Project co-ordination,
- study of acoustical propagation models,
- tomographic algorithm synthesis,
- experimental validation through data collected in a campaign in the Atlantic ocean.



INTIMATE00 – Event 6: Setubal. Portugal, October 18th 2000. Top: course of the research vessel NRP D. Carlos I (shown on left bottom) and the passive localisation of the vessel in range-depth performed by global genetic optimisation.

* Italian Ministry of University, Education and Research

Laser Range Finder and Passive Stereo Optical System

(Ministero Università Ricerca Scientifica e Tecnologica - MURST, Mediterranean Environment Research Program)

The system integrates an incoherent laser range finder with a visible telemetric system providing a stereo measurement based on image processing from visible spectrum cameras.

DUNE was responsible for the acquisition section both from the laser range finder and from visible cameras and for the processing section also. In these fields we designed and developed:

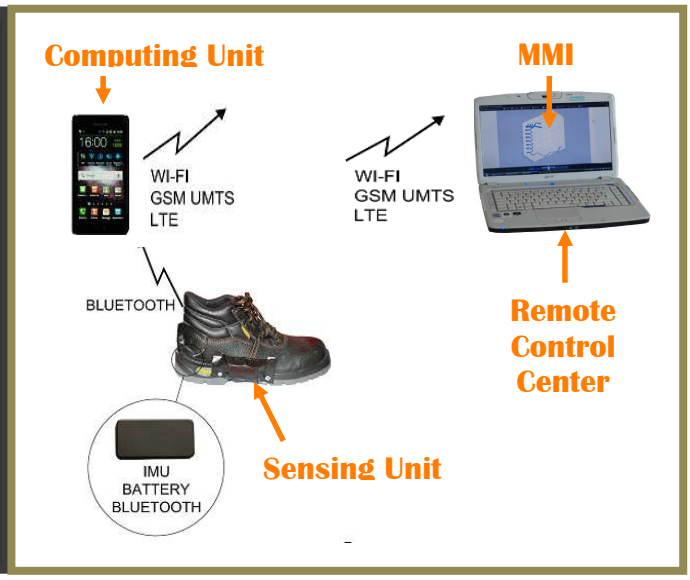
- overall system architecture design,
- study and synthesis of stereo vision algorithms,
- implementation of stereo vision algorithms on a cluster of 8 DSP Hammerhead cores,
- visualisation software.

Inertial localization and navigation

ARIANNA system

ARIANNA is a system for location and tracking of pedestrians based on inertial data completely developed by DUNE both for HW and SW solutions. It has been developed for environments where the GPS signal is unreliable or absent (inside buildings, underground areas, GPS-denied environments).

The ARIANNA system is especially studied for Firefighters and Homeland Security, and more generally it can be used in environments where the satellite signals are absent and where the knowledge of an operator location is an important element to provide security and success of operations. The system can be also used in a range of fields where knowledge of the path travelled is needed for mapping purposes (underground and/or unknown areas, speleological sites, tunnels).



In the full configuration, the system includes:

- the **Sensing Unit**, to be placed on a shoe heel (inside or outside), it provides raw inertial data and compass data to the Computing Unit via Bluetooth connection,
- the **Computing Unit**, a smartphone Samsung Galaxy S2 running on the proprietary app in charge of processing data to provide the remote Control Center with the operator positions via Wi-fi connection or by means of a dedicated Radio-Modem,
- the **Man Machine Interface (MMI) SW**, running on any commercial PC/notebook at the Remote Control Center, in charge of the acquisition, visualization and integration of the walked path data.

Due to the small dimensions and weights involved, the ARIANNA system is easily wearable and it can be used both in real-time mode (Full Configuration) to remotely locate and track operators wearing the system and in off-line mode (Minimum Configuration) for mapping of unknown areas.

The following picture shows real trials performed at the firefighter's premises in Roma.

DUNE is continuously developing new features for the system according to the Customer needs and to extend its fields of application:

- a magnetic sensor has been added in the Sensing Unit to improve the path headings,
- a new waterproof box has been designed and developed to allow the use in critical environments,
- the magnetic charge for the Sensing Unit has been developed to avoid wires and connectors,
- the embedded release of the Computing Unit has been designed and developed to make easy the connection with Radio-Modems and to avoid the use of commercial smartphones,
- the display of the path on existing digital maps has been improved using RFID technologies and Bayesian and Filtering Particle algorithms,
- additional sensors (temperature, pressure, cardiac pulse meters,..) will be added to the Sensing Unit to provide more information on the operator status.

Digital recording systems

FRS

The Fast Recorder System (FRS) is an innovative device suitable for analog signal recording in the band of 10 – 1000 MHz. The maximum sampling frequency used is 2.2 GHz. The recording time supported is 30 minutes but can be easily extended to 60 minutes. The recorder, beyond starting the registration process by manual control, can also operate on trigger or gate basis like any commercial oscilloscope. The main difference that distinguishes it from an oscilloscope is the depth in the acquisition i.e. the length of the recording time.
With the addition of a "down-converter" it is possible to acquire any signal which exceeds the frequency of 1GHz. The FRS system is a complex system that is properly configured according to the needs of the Customer so that the configured product turns out to be exactly in line with the requirements and at the same time the cost does not exceed the allowed budget. For this reason a configuration sheet has been provided, attached, so that anyone interested in this device may request a FRS exactly in line with his needs.
FRS uses are manifold some are shown in the attached flyer. In principle it can be said that this device finds its main use in all those sectors in which there is a need to record rapid and asynchronous events and where the possibility of analyzing with due care the temporal situation of the events themselves and their interrelationship is critical.

Real-Time Emulators and Simulators

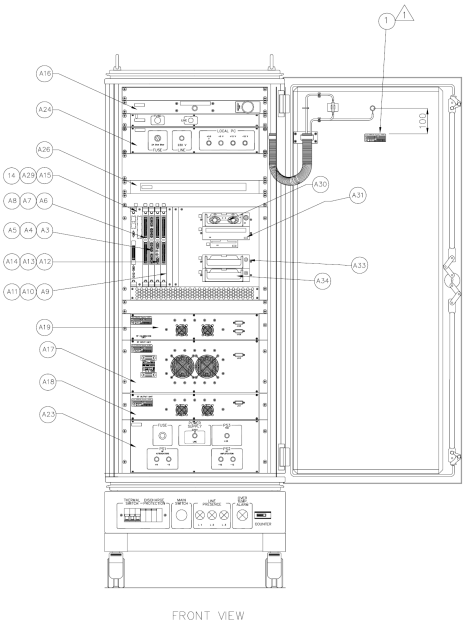
ASU2 Antenna Emulator – TX Section

The TX section of the ASU2 Antenna emulates the behaviour of the phased array antenna mounted on a modern fighter aircraft. The output of the system is a set of analog RF signals emulating those provided by the aircraft phased array.

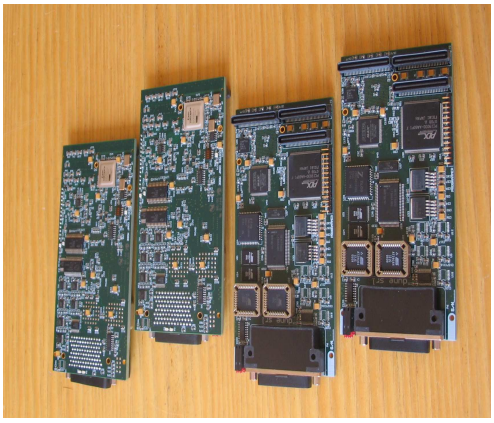
Our company has provided the entire system analysis and design, the Microwave subsystem specifications, high performance real-time FW for several FPGAs and the SW project management.

Dedicated HW products have been also realized (FPGA-based interface boards, interfaces for driving fast attenuators, bridge boards to dispatch multiple LVDS signals).

The entire HW and SW documentation has been also provided (SW and HW description documents, test and validation plans, user manuals) as well as the support to the Customer Project Manager to outline and manage critical points and project changes.



ASU-2 rack implementation



The ASU-2 interface board

ASU2 Antenna Emulator - RX Section

The RX section of the ASU2 Antenna emulates the behaviour of the receiving section of the phased array antenna of a modern fighter aircraft. The system is a hard real-time emulator able to receive and manage four real-time Hot-Link channels (100 bit every 1 ms each).

The incoming data are acquired via AlphaData boards equipped with a FPGA Xilinx Virtex IV. The dedicated MMI (Man-Machine-Interface) can acquire, arrange, display and store on magnetic media the data according to the user needs.

The entire SW documentation (SW description documents, test and validation plans, user manuals) was also provided as well as the full support to the Customer Project Manager to successfully complete the testing and validation phases.

ASU-2 HW emulator main station

Hydraulic Industrial Control System Simulator

The system has been completely designed and developed inside our company to control a set of hydraulic actuators by virtual instruments (function generators, PID control loops, counters, switches of hydraulic power stations, electro valve control actuators) which can be plugged into the system by a dedicated graphic tool.

The system is based on an innovative I/O board developed in-house having optoinsulated channels with parallel sampling and high dynamic range, real-time processing capabilities by means of 4 DSP 21160 cluster arranged on a HHPC Bittware board.

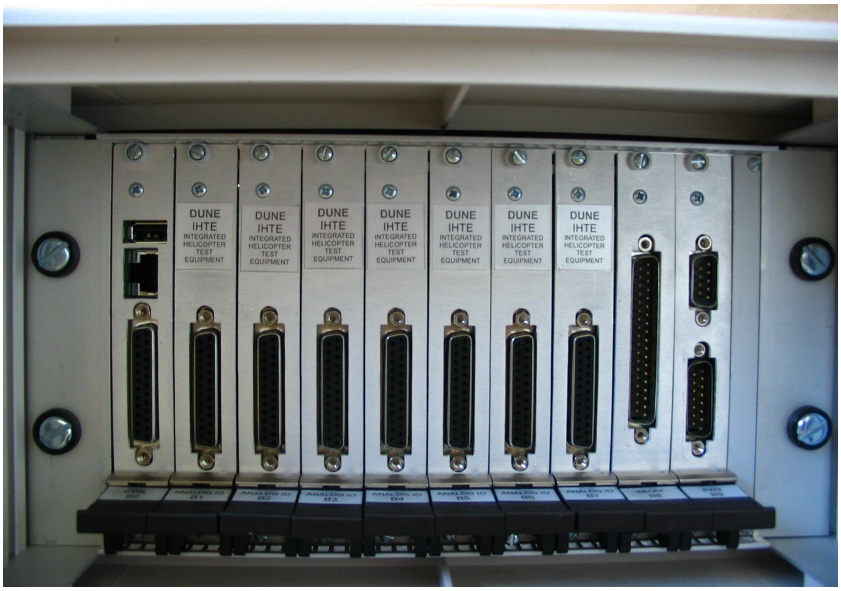
The project has been completed by the control SW allowing the user to change dynamically the duty cycles, the system configuration and behaviour by means of friendly graphic interface.

Integrated Helicopter Test Equipment

The IHTE system emulates signals from the field sensors of a helicopter (engines, rotor and fuel area signals) to be dispatched directly to the helicopter cockpit by means of dedicated probes.

The company has realized the entire SW logic and provided the Customer with the entire product documentation as well as the support regarding the testing and validation phases.

The system has included one control board with a Freescale 32 bit CPU, seven I/O boards generating the output high precision (better than 1‰) analog signals (e.g. pickup, stain gauge, temperature), one relay board and one power supply board.



Helicopter test equipment cage

Acoustic Sensor Array Simulator

The system simulates in real-time the signals/waveforms (CW, linear FM and coloured noise) emitted from multiple simultaneous targets and received by a two dimensional acoustic array equipped with several tens of transducers.

The system has been designed to react with a maximum delay of 5 ms to position variations operated by an external user via a serial synchronous interface. The simultaneously generated signals are transferred to the external environment via an optical fibre using a Hotlink protocol.

The simulator has been realized with two Bittware HHPC processing boards and two PMCs including 16 DSP Hammerhead while the pre-conditioning and optoinsulation of the control signals have been provided by means HW board completely designed and developed inside the Company.

HF Modem

The system has been designed for avionic communication applications.

DUNE has developed the HF modem on Motorola (DSP56309) platform.

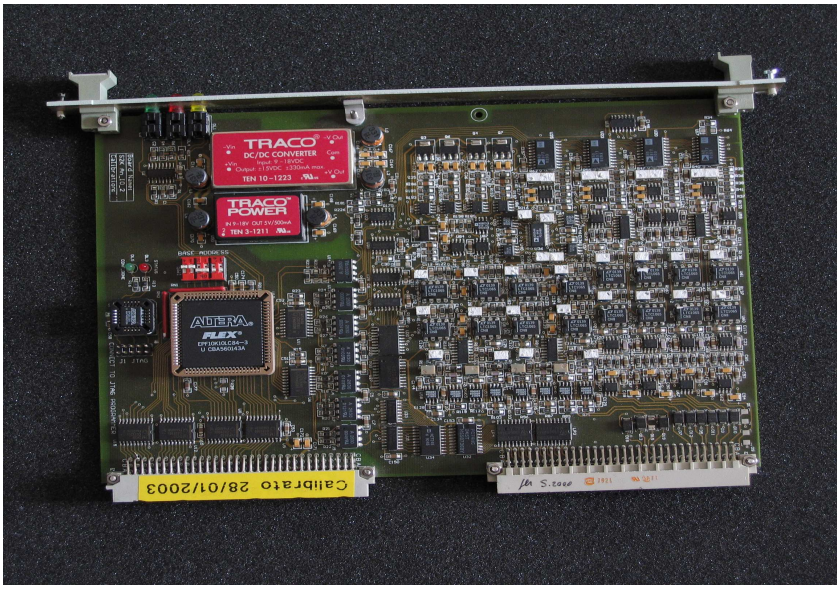
Logical condition of the transmitted signals according to the STANAG 4197 standard, real-time receiving functions, Doppler correction, end-of-frame realignment, demodulation and decoding algorithms have been developed and optimized.

Torpedo Control System Simulator

The system has been developed to check and control the entire logic of a real torpedo head.

DUNE has designed and developed both hardware and real-time software architectures to process, visualize (exploitation of an industrial SIEMENS terminal for user parameter) and exchange raw and graphic data via LAN.

The system has been realized on a VME rack with 1 Radstone PPC board (O.S. VxWorks), 2 commercial I/O boards and 2 interface boards managing low amplitude signals and current intensities greater than 5 A on 115 Vac.

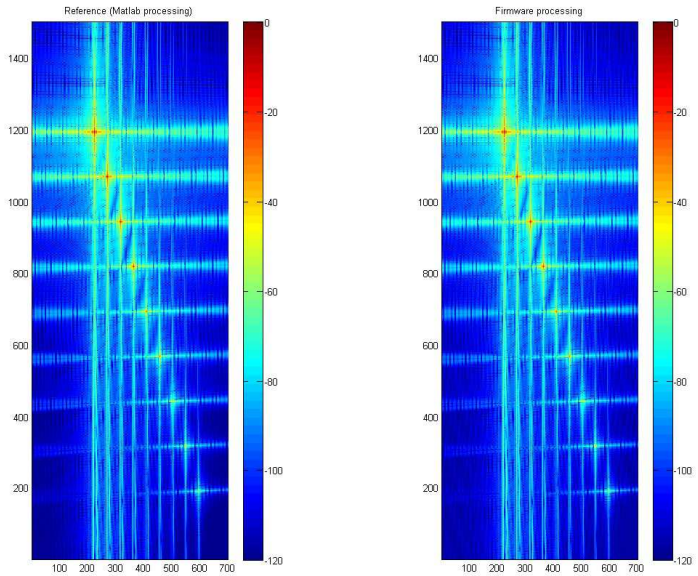


I/O board

Radar Systems

Implementation of SAR processing algorithms on FPGA

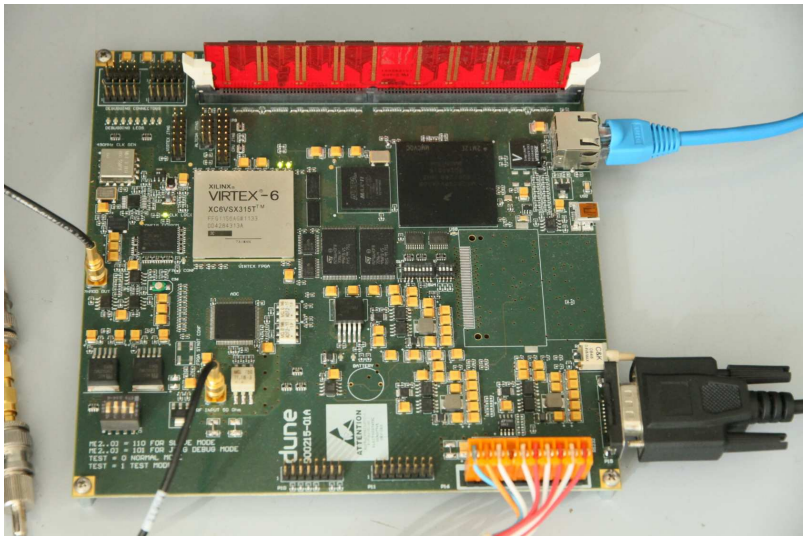
The production of a SAR image from raw data is a task that requires a high computational effort, and is usually performed as post-processing on recorded data. The implementation of the SAR processor in firmware on a fast FPGA board allows performing such computations in real time.
A test bench for these algorithms has been implemented on a commercial FPGA board (Alphadata ADM-XRC-6T1, based on Xilinx Virtex 6 SX315T FPGA).
The processing involves: computation of weighting functions, computation of FFT and IFFT, and on board memory management for reading and writing data and intermediate results row-wise and column-wise. Simulated SAR data have been used for testing the implementation and shows very good accuracy. A SAR raw data image of 2048 columns (range bins) and 4096 rows (radar pulses), is completely processed in nearly 0.76 s.
The Firmware has been developed using System Generator and ISE development Tools from Xilinx.



Sample image: the image shows a reference SAR image (Matlab processing) and the same image obtained from Firmware processing. Eight reflectors with amplitude 0 dB, -5 dB, -10 dB, ..., -40 dB are visible.

Doppler radar emulator

It is a versatile test bed for a radar receiver or a SDR (Software Designed Radio) communication receiver; the high data rate of its ADC is suitable to process wideband signals or to implement sub-sampling techniques.
The HW comprises an analog to digital converter ADS5400IPZP (ADC 12BIT, 1000 MSPS), a core processing implemented with a FPGA VIRTEX VI (6VSX315T) and a Power PC Freescale communicator (MPC8349). The communication processor links the FPGA to an external computer by a fast connection (Gbit Ethernet).



3-D Multifunction Radar System

It is a multi-function radar operating at C-band, performing concurrently 3D detection, multiple target tracking and missile guidance. It is designed to be on board medium and large tonnage vessels having full volumetric search coverage, low altitude and surface search, multiple target tracking.

DUNE has developed the Signal Processing section (Electronic Counter Counter Measures, Main Beam Cancellation, Sidelobe Cancellation, Sidelobe Blanking, Clutter Cancellation algorithms, Advanced anti Multi path techniques, fault tolerance and automatic reconfiguration) on a VXS rack including 2 Mercury RapidIO Switches and 7 Mercury PPC boards (HCD5220) including 4 processors each.

The real-time architecture has been designed, simulated, optimized and realized using a cluster of 26 processors operating with parallel, serial and round-robin scheduling supporting automatic architecture reconfiguration according to the incoming signal characteristics (duration, signal types, required processing and error presence).

Land Based and Ship-borne 3-D Radar System

It is a 3D multi-role C-Band radar with a full solid state active phased array antenna used both in land based and ship-borne configurations at medium range having an extended 3D coverage for search, tracking and auxiliary activities.

DUNE has realized a first version of the Signal Processing section in a cluster of DSPs and in the following it has managed and developed the system migration and porting on a multi-processor PPC architecture in order to prevent platform obsolescence and upgrade performances.

DSP version: DUNE has developed the Signal Processing section (Digital Down Conversion, Digital Pulse Compression, Real Time Weight Selection, Moving Target Detection, Constant False Alarm Rate, OSGO/CAGO, thresholds application and Jammer filtering algorithms) on a rack including 2 Bittware TS6U equipped with 8 Tiger SHARC DSP and a Xilinx Virtex-II FPGA.

PPC version: DUNE has developed the Signal Processing section (Main Beam Cancellation, Sidelobe Cancellation, Sidelobe Blanking, Clutter Cancellation algorithms, fault tolerance and automatic reconfiguration) on a VXS rack including 2 Mercury PPC boards (HCD5220) with 4 processors each.

2-D Medium Range Radar

It is a 2D medium-range air detection system designed for vessels.

DUNE has developed the digital processing architecture (digital compression, platform motion and sensitivity time control compensation, automatic frequency, gain and real-time weight selection, moving target detection, constant false alarm rate and clutter management) on a Bittware PCI board with 8 DSP Tiger Sharc operating with parallel and serial scheduling.

Sonar Systems

Surface Ship Sonar System

The system is a bow mounted, lightweight active sonar for surface ship designed to detect and localize moored mines and submerged moving or stationary small objects and to assist the navigation in both deep and shallow waters.

DUNE has developed the Data and Signal processing section of the transmitting and receiving Unit (A/D and D/A conversion, digital beamforming in RX, digital signal and data processing, inverse beamforming for signal generation), the Host management section and the Console Unit Graphic Software (sonar raw-data display format, synthetic data presentation for tracked object, readout information, management for the input data/command).

The system has been realized on a VME rack equipped with 1 Radstone PPC board (O.S. VsxWorks), A/D and D/A boards and 4 Mercury PPC boards with 4 processors each. The real-time architecture has been designed, simulated, optimized and realized using a cluster of 12 processors operating with parallel and serial scheduling.

Vessel Traffic System

The system is both passive and active sonar operating in underwater environments designed to survey and detect moving or stationary objects in a port area.

DUNE has developed the Data and Signal processing section (A/D and D/A conversion, digital beamforming in RX, digital signal and data processing), the Host section and the Console Unit Graphic Software (sonar raw-data display format, synthetic data presentation for tracked object, readout information and management for the input data/command).

The system has been realized on a VME rack equipped with 1 Radstone PPC board (O.S. VsxWorks), A/D and D/A boards and 4 Mercury PPC boards with 4 processors each. The real-time architecture has been designed, simulated, optimized and realized using a cluster of 10 processors operating with parallel and serial scheduling.

Towed Array Antenna

The system has been designed for identification, classification and localization of underwater acoustic sources for surveillance and tracking purposes.

DUNE has designed and developed a real-time processing architecture (design, simulation, optimization and coding of processing algorithms, architecture and processors control, interface management, testing and integration) on a VME rack including 1 Motorola PPC board and several Mercury PPC boards with 4 processors each.

Active/Passive Torpedo Acoustic Head

The system is an active and passive acoustic head for modern torpedoes operating at medium and high frequency and having spatial and frequency filtering and multi-frequency capabilities.

DUNE has developed the Signal Processing section of the acoustic head (beamforming, CW and FM signal generation, detection, FM signal compression, Demon and Classification algorithms) on a rack including 3 Radstone boards (VANTEGRA-DL) and a cluster of 36 DSP Sharc processors.

The system migration and upgrading on a new environment including 1 Thales board (2 PPC processors) and 1 Mango board equipped with Hammerhead DSP has been successfully performed.

3-D Seabed Mapping

The system is a multi-beam sonar designed for submarine vehicles having 3D mapping capabilities.

DUNE has designed and developed the whole system (processing HW design, multi-processor real-time architecture definition, acoustical data acquisition, beamforming and processing algorithms) on 5 FASP-2 boards with 4 DSP Sharc each.

Wireless Communications

High performance airborne modem

Dune has developed and implemented the main functions of a high performance modem in an innovative board to be used for drones or missiles. The system implements wideband frequency hopping and a high compression spread spectrum on the instantaneous transmission band. Several post processing algorithms are implanted as LDPC, Turbo-code and Viterbi decoder. All the digital algorithms are implemented inside a high power FPGA that is in charge of managing the device and commanding the elementary functions of the board as DDS, ADC, DAC, etc.

Blind Classification

Algorithm study, design, implementation, and evaluation of an end-to-end system for blind analysis and classification of digital wireless signals by passive listening. Development of nonlinear approaches for the classification of unknown received signals, such as SC or OFDM, blind estimation of the baud rate and channel, carrier offset compensation, channel equalization, signal features extraction and estimation of the employed constellation.

Smart Jamming

This jammer is a stealth jamming method which relies on specific PHY-level (or MAC layer) features of a digital communication standard, targeting at jamming only the most vulnerable parts of the communications, insuring a reduced probability of interception of the jamming action. DUNE designed the protocols and paradigms for smart jamming of communications of a known standard. In addition, our firm designed and developed a system-level simulator for performances evaluation of a single or multiple smart jammers over a single cell or multi-cell radio network, confirming the effectiveness of the approach.

Wireless Traffic Analysis

Study and design of novel algorithms for the traffic analysis of a known communication Standard, solely based on passive listening. Design of the metrics for the reconstruction of the information flow across the network and for the estimation of the hierarchical levels of the units in the network. Design and implementation of the system-level evaluation simulator for the performances assessment of the devised traffic analysis algorithms in a wireless network.

Large Integrated Systems Simulator

Feasibility study, solutions, market analysis and specifications for an interactive simulator of large integrated system (LIS), compliant with the paradigms of the Network Centric Operations (NCO). The activity included solutions for the following investigation areas:

- multi-layer simulation architectures for a LIS;

- definition of the metrics for the Measure of Performance (MOP) and Measure of Effectiveness (MOE) for each domain of the NCO (physical, cognitive and social);
- definition of operative and scalable vignettes for Defense and Border control LIS in which all the aspects of the NCO are exploitable;
- merging of cyclic-time and event-driven simulators into an unique architecture;
- management of crowds behaviour via multi-agent simulation.

Wireless Local Loop (WLL) with the DECT system

Feasibility study for mixed voice and data traffic:

- ISDN with basic access,
- fast Internet, asymmetric and connectionless, with variable data rate,
- symmetrical and isochronous broadband services for videoconference,
- DCA analysis (Dynamic Channel Allocation),
- traffic analysis and optimisation by simulation.

GSM Voice Quality Monitoring

Implementation of a software module for a real time voice processing according to the ITU-860 standard on a hand-portable system based on a notebook. The system:

- measures micro interruptions in the channel,
- detects the presence of multipath,
- provides quantitative information of the voice quality according to the PSQM and MOS parameters.

Two different products are available: a standard version, using the audio boards available on the transportable system and an enhanced performance version, employing hardware interfaces developed by the company and plugged into a parallel port.

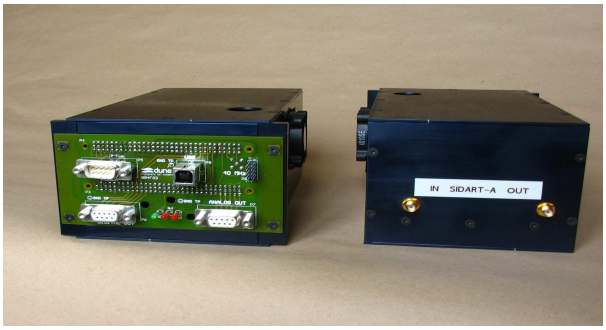
Industrial Control

Phase Shift Measurement Module

The electronic module has been realized for laser range finding as well as for electronic measurements where high precision in phase measurement is essential.

The company developed the entire electronic module designed to measure the phase shift of sinusoidal signals with frequency ranging from 5 to 230 MHz with a maximum precision of 0.001 degree. The module deliver from 10 to 1000 measurements per second (independently of the working frequency) and it can be interfaced via a standard USB port.

The company was in charge of synthesising a robust algorithm for achieving the required precision and of designing and developing each part of the system: RF and digital boards, FW for the processing cores (DSP ADSP21160M, 2 FPGAs), mechanical components and the MMI SW.



Phase shift measurement equipment

Heating Laser Head Control System

(European Commission, BRITE Program)

The control system has been designed to drive a heating laser head used to weld steel sheets.

DUNE has designed and developed the algorithms to process the images from a thermal camera (extraction of the scene main features) and to setup and track the welding profile along steel sheets.

Steel Sheet Bending Control System

(European Commission, EUREKA/FASP Project, Flexible Automation in Ship Pre-fabrication)

The control system has been designed to drive the laser steering and welding on large steel plates used in ship building in order to reach the desired bending without cut them.

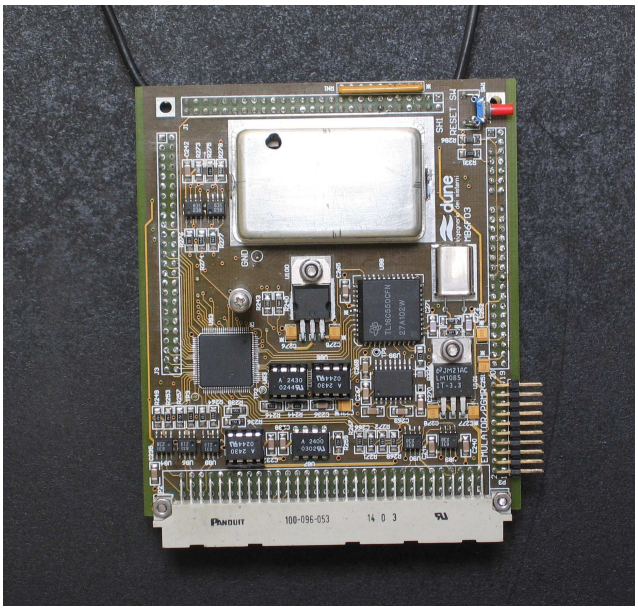
DUNE has designed and developed real-time processing architecture and algorithms to plan the welding and shrinking phases and to control the actuators for the heating laser head steering.

Laser Telemetry for Automatic Control Systems

(European Commission, EUREKA/FASP Project, Flexible Automation in Ship Pre-fabrication)

The system is conceived to perform real-time measurement of large metal plate surface deformations in automated assembling of ship hulls.

The company designed and developed the beam steering subsystem, innovative algorithms for the measurement of the echo signal phase shift produced by laser telemetry and the entire filtering and processing SW on DSP cores.



A phase shift measurement board

Environmental Monitoring

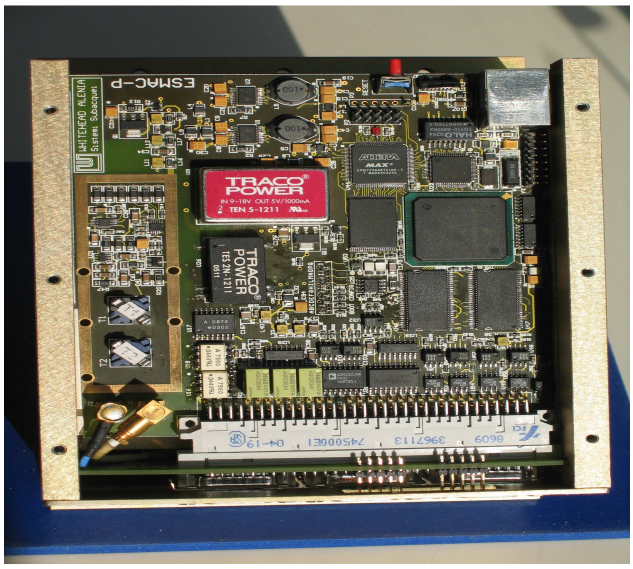
Acoustic modem

The system is an acoustic modem having both digital and analog sections.

The company was in charge of designing and developing the boards and the mechanical infrastructure as well as the real-time processing SW.

The analog module, operating in the frequency range (70-100) KHz, includes a TX section able to transmit a number of 15 W power waveforms and a RX section able to amplify up to 80 dB very weak signals.

The digital module, realized with a Freescale Semiconductor MPC5200CBV400, drives several peripherals (e.g. RS-232, RS-422, IrDa, Ethernet, SDRAMs, Flash memory, ADC, DAC).



Acoustic modem equipment

Surface Deformation Monitoring System

The system is an unattended on-line system designed to measure the surface deformation of compact structures (rocks, building), employed also for the early detection of landslides.

The system is composed of a set of linear extensimetres (up to 16), a data collection unit and a remote control unit connected via modem to the data collecting subsystem.

The company realized the design and development of:

- the whole of the hardware and the self-management of low-power consumption state (on-line /stand-by),
- the SW modules used for data acquisition, displaying, storage and communication with a remote station,
- SW modules used for data filtering and analysis, alarm management, data transmission, self diagnostics.

Satellite Systems

Communication Satellite Simulator

The system emulates the satellite payload front-end, including the realistic behaviour of the radio frequency components and of the spatial nulling network.

DUNE developed the design of:

- geo-referenced graphical tool for the scenario design,
- definition and implementation of the actual radio frequency behaviour of the processing chain, along with the algorithms for the interference suppression.

Satellite Radar-Interferometer for the remote sensing of the rain fall

(European Space Agency ESA - WINTER-F Project)

The system has been conceived for the remote sensing of the rain fall. It includes two satellites in tandem along the same orbit. One of them has a transmitter and a receiver while the other has just a receiver.

The company was in charge of:

- the feasibility study,
- the synthesis of the signals at the two receivers,
- the definition of the processing algorithms exploiting the interference between the two echoes.

Synthetic Aperture Radar: X-SAR, ERS-1

(I-PAF Project, Italian Processing and Archiving Facility)

The company designed and developed the signal processing algorithms and their development, optimisation and validation.

ERS-1 Satellite - Images Extraction

(I-PAF project for the ERS-1 satellite)

The system has been conceived to provide the ERS-1 satellite image on Unix and VAX/VM graphic workstations with a reduced amount of resources.

The company designed and developed the 2-D software portables on a wide range of platforms, development of a two-dimensional visual program in X Windows/Motif environment.

Underwater Systems

Acoustical Communication Network

(European Commission, D.G. XII, MAST-3 Program, MArine Science and Technology, EC-MAS3 Contract-CT97-0107)

The system has been conceived to create a digital communication network in shallow waters where synthesis of robust digital communication techniques for non stationary transmission channels affected by severe multipath is essential.

The company was responsible for:

- project co-ordination,
- synthesis of algorithms for multi-channel identification/equalisation and symbol estimation,
- symbol estimation in the absence of training signals (cycle stationary and blind processing),
- network access protocols in a high latency environment,
- experimental verification by collecting data in the continental shelf, offshore the Dutch coast.

Remote Sensing of Sea Current Velocity

(European Commission, D.G. XII, MAST-1,-2 Program, MArine Science and Technology, contracts EC-MAST1-0058-C and EC-MAS2-CT91-0007)

The system has been designed to allow the remote estimation of the sea current (Doppler analysis, multistatic correlation profilers), of the refraction index and of the concentration of suspended particles.

DUNE developed model studies and original processing algorithms:

- scattered field modelling,
- design, optimization and development of broadband signal processing algorithms,
- generation of synthetic echoes.

Active Acoustical Camera

(European Commission, D.G. XII, MAST-1 Program, MArine Science and Technology, contract EC-MAST-1-0005-C)

The system is an active acoustical camera designed for submarine vehicles.

The company designed and developed a broadband sonar with high resolution 3-D imaging, having the capability to identify and classify buried objects and map and classify the seabed.

DUNE has developed the entire processing section and the optimization and validation phases:

- algorithms for echo and image data classification, also in turbid waters,
- performance evaluation,
- synthesis of an innovative classification method based on stereo-correlation,
- experimental validation in an anechoic camera.

Italian Program for the Research in the Antarctica

SODAR Array Antenna

The system is a 2-D array (transmitting and receiving) of acoustical transducers designed for measuring the remote wind velocity fields, able of enduring the severe climate of the Antarctica.

DUNE designed an innovative architecture of conditioning and processing the echo signals on DSP Sharc cores.

Sodar array acoustic antenna

RAS - Surface Robot - Ice Detection and Classification

It is a surface robotic system designed to detect and classify ice in Antarctica using GPS and inertial data, analogical and digital radio-communications for remote commands and television image transmission and millimetre wave radar for obstacle avoidance.

DUNE has designed and developed in-house the subsystems:

- millimetre wave radar for obstacle avoidance employing 77 GHz components, analog front-end and DSP commercial boards,
- data fusion from a GPS and from an inertial sub-system for autonomous navigation,
- radio communication of analog and digital data and television images.

RAS - Surface Robot - Remote Guidance System

It is a surface robotic system designed to detect and classify ice in Antarctica using GPS and inertial data, analogical and digital radio-communications for remote commands and television image transmission and millimetre wave radar for obstacle avoidance.

DUNE developed the remote guidance system allowing the user to remote guide the vehicle via radio-communications (when available) or allowing the vehicle to follow pre-programmed tracks and avoid obstacles without direct operator intervention.

The remote guidance system has been realized on a VME rack with 3 Motorola 6100 (PPC) boards under VxWorks O.S.

SARA - Submarine Robot

It is a submarine robotic system designed to explore the Antarctic sea.

DUNE has designed and developed remote sensing sub-systems and navigation algorithms:

- look ahead sonar for scene surveillance and obstacle avoidance,
- inertial and Doppler unit integration for navigation and related algorithms,
- sea current Doppler gauge.

STARMATE - Optical Communication

(European Commission, D.G. XIII, IST Program, Information Societies Technologies, IST contract 1999-2002)

The system is a broadband system (> 100 Mbit/s) for voice and image data transmission between two users, one of which is mobile, inside an industrial environment.

The company designed and developed the system with multimode optical fibres. Evolution and migration toward wireless system was envisaged.

Increased reality helmet

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