A WHITE PAPER ON:

NORTH AMERICAN AND WESTERN EUROPEAN MARKET DEMAND FOR RUGGEDIZED/INDUSTRIAL COMPUTER SYSTEMS IN:

COMMUNICATION APPLICATIONS
DEFENSE & AEROSPACE APPLICATIONS
ENERGY, UTILITIES & TRANSPORTATION INFRASTRUCTRURE APPLICATIONS
INDUSTRIAL AUTOMATION CONTROL & INSTRUMENATION APPLICATIONS
MEDICAL, LABORATORY & SCIENTIFIC APPLICATIONS

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February 2004

TECHNOLOGY MARKET RESEARCHERS AND STRATEGISTS SINCE 1971

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Venture Development Corporation (VDC) recently completed a market study on stationary ruggedized/industrial computer systems covering five application market segments:

- Communications
- Defense & Aerospace
- Energy, Utilities & Transportation Infrastructure
- Industrial Automation Control & Instrumentation
- Medical, Laboratory & Scientific

The geographic scope of the study covers North America and Western Europe. Markets for these products are sized and segmented for 2002 and 2003, with forecasts through 2006. This white paper presents an overview of some significant findings in the study.

TYPES OF COMPUTER SYSTEMS INVESTIGATED

This study covered stationary computer systems that are more rugged than office-grade types. These ruggedized/industrial computer systems are hardened and/or performance-enhanced in one or more of the following ways:

- Power supply enhancements (regulation, surge suppression, etc.) and/or redundancy;
- 24 hour/day, 7 day a week operation capability for extended periods;
- Sturdier cases (rack mounted, mil. spec., NEBS, NEMA or IP ratings, etc.);
- Higher resistance to vibration and shock;
- Extended operating temperature ranges;
- Intrinsically safe/explosion proof;
- Liquid splash/cleaning protection;
- Shielding from magnetic fields;
- EMI/RFI filters and shielding;
- Higher humidity toleration;
- Diagnostics and alarms;
- Filtering of cool air;
- Etc.

Included in the studies are computer systems that are purchased:

- Fully Configured, Integrated With Software, and Tested
- Fully Configured and Integrated With Operating System
- Partially Configured and Integrated

MARKET SIZES AND GROWTH

Estimated 2003 shipments in U.S. dollars of the ruggedized/industrial computer systems by vendors to markets in North American and Western Europe for the application segments studied are:

Defense & Aerospace	$635 Million
Industrial Automation Control & Instrumentation	$484 Million
Communications	$341 Million
Medical, Laboratory & Scientific	$97 Million
Energy, Utilities & Transportation Infrastructure	$91 Million
	$1,648 Million

Shipment growth expectation for these markets over the forecast period are modest, ranging from a Compound Annual Growth Rate (CAGR) of 3.5% for industrial automation control & instrumentation applications, to 5% for defense & aerospace applications.

Factors supporting growth in these markets include:

- Changing worldwide political environment which impacts defense budgets, particularly in regards to countries acquiring weapons of mass destruction;
- Displacement of other types of products, such as DCSs and PLCs in applications;
- Expanding use of computers in defense and aerospace systems as controllers and for other functions;
- Expectations of improving economic conditions leading to an upturn in demand;
- New wired and wireless communication system implementations;
- Ongoing development of new defense and aerospace systems, including those for commercial aircraft and space systems;
- Ongoing trend toward greater automation and more sophisticated systems;
- Trend to use of computer controlled equipment which provides better diagnostics, surgery, monitoring, and record keeping, thereby helping to reduce heath care costs; and
- Terrorist threats and the war on terrorism.

Prices for the computer systems vary considerably within each application market, and between these markets. In 2003 the average selling prices ranged from $3,050 for industrial automation control & instrumentation applications, up to $31,392 for defense & aerospace applications. The average prices are expected to decline over the forecast period through 2006. The average declines are expect to range from 1.5% per year for the medical, utilities, & transportation infrastructure market to 2% per year for the communication market.

Some of the more significant factors expected to lead to lower prices are:

- Better production efficiencies with increasing volumes;
- Decline in prices of components such as microprocessors and displays;
- Expanding use of COTS products for defense, & aerospace applications;
- Greater use of common components, and open software;
- New market entrants producing even greater price competition;
- Stronger price competition from low-cost suppliers, particularly Taiwanese vendors; and
- Trend to more energy-efficient microprocessors, which will require less expensive heat-dissipation packaging.

Prices decline expectations would be even sharper were it not for offsetting factors that will tend to increase or hold prices steady. These include general inflation of labor and material costs, the introduction of more functionality, along with new and better technologies, and in some applications the need for space saving designs, which are more expensive.

PRODUCT SEGMENTATIONS AND TRENDS

Primary Computer Architectures

The majority of shipments for all the major application markets studied are of passive backplane type computer systems, with active backplane/motherboard types accounting for smaller shares. The largest passive backplane share in 2003 was for communication applications at almost 81%. The lowest share was for industrial automation control, & instrumentation applications at about 52%.

Passive Backplane Computer Systems – The relative use of the various buses in passive backplane computer systems varies considerably by the application markets. The following accounted for the largest shipment shares in 2003 to the market under study:

Communications	CompactPCI
Defense, & Aerospace	VME
Energy, Utilities & Transportation Infrastructure	PCI & CompactPCI
Industrial Automation Control & Instrumentation	PCI & PCI/ISA Hybrid (PICMG)
Medical, Laboratory & Scientific	PCI

VME bus architecture is used on the majority of the passive backplane computer system shipments for defense & aerospace applications, and is expected to continue to do so over the forecast period, although at lower shares. VME has been used in the defense & aerospace markets for many years, and its champions have demonstrated substantial resilience, implementing new variations and extensions on a regular basis. This has the effect of blunting intrusions by other architectures.

In the industrial automation control & instrumentation market, over half the passive backplane computer system shipments in 2003 were of products with PCI/ISA Hybrid (PICMG) or PCI bus architectures. Over the forecast period the share using the PCI bus is expected to increase, with a decline in the share using the PCI/ISA (PICMG) Hybrid bus. The trend is toward lessening need for the Hybrid bus architecture, as more board offerings become available with the PCI bus and fewer with ISA. This also is evident in the shipment decline expected for computer systems using the ISA bus.

In most of the application markets studied a trend toward use of advanced CompactPCI architectures is expected (PICMG 2.16-Packet Switching Backplane, 2.17-StarFabric, 2.18-RapidIO, and 2.20-Serial Mesh). Also, shipment shares are expected to begin and to grow for ATCA (PICMG 3.x Advanced TCA serial interconnect architectures) and for ePCI. Usage of these will be principally for applications with high bandwidth requirements.

Active Backplane/Motherboard Computer Systems – In the active backplane/ motherboard segment of the market, the ATX form factor accounts for the largest share of shipments. Shipment shares with this form factor are expected to decline but to still remain substantial. In the industrial automation control & instrumentation application market segment, custom form factors account for an appreciable share of shipments.

In all the major application markets, forecast trends are toward greater shipment shares of small form factor computer systems. These expected trends reflect the desire for smaller footprint computer systems. Smaller computer footprints allow production of smaller footprint systems/machinery. Depending on the application markets, gains are expected for EBX, MicroATX, PC/104-*Plus*, and small custom form factors.

Enclosure/Mounting Types

Passive Backplane Computer Systems – In these computer systems rack mounting is the most popular. Year 2003 shipment shares with rack mount enclosures ranged from about 61% for defense & aerospace applications to almost 97% for the communication market. ATR type enclosures accounted for 20% of the shipments of the passive backplane computer systems for the defense & aerospace market. These were for aircraft applications.

Active Backplane/Motherboard Computer Systems – Shipment shares for these computer systems to the various application markets are much more varied than for the passive backplane types:

- Communications – The high majority is of rack-mount types.
- Defense & Aerospace – A majority is of rack mount, but there are significant shares in other types, such as vehicle mount, and bench/desk/tabletop products.
- Energy, Utilities & Transportation Infrastructure – The largest share is of panel mount types.
- Industrial Automation Control & Instrumentation – The majority is of panel-mount types.
- Medical, Laboratory & Scientific – The largest share, but not a majority, is of rack-mount types, with a significant share in panel-mount units.

In several of these application markets there is significant demand for ruggedized/industrial computer systems with integrated panel-mount displays. Active backplane/motherboard form factors are convenient for these panel-mount computer systems with displays.

Only slight shifts in shipment shares of these computer systems by types of enclosures/mountings are expected over the forecast period.

Microprocessors

The Intel microprocessor family is used on the majority of shipments to each of the major application markets studied. In 2003, the Intel share ranged from about 52% of shipment for the defense & aerospace market up to almost 89% for the industrial automation control & instrumentation market. The Intel Pentium III was the most popular or among the most popular microprocessor in 2003 shipments to each of the major application market segments.

The shipment shares with Intel microprocessors are expected to increase over the forecast period, in each of the major application market segments. The shipment shares with the Pentium III are expected to decline in each of the major application market segments, with gains in shipment shares for Pentium IV, Xeon types.

Driving this trend is the need for faster speed and more processing power. However, these higher-performance microprocessors generate a lot of heat, which is hard to dissipate. Thus, over the forecast period, growing shares are expected for ruggedized/ industrial computer systems using Intel microprocessors designed for mobile type applications, as these are more energy efficient. Expected use of the Pentium M is particularly interesting. This microprocessor has controls that reduce power usage and dissipation, depending on the level of processing activity.

PowerPCs are used on significant shares of the shipments for communications, defense & aerospace, and medical, laboratory & scientific applications. These shipment shares are expected to decline with the gains for Intel microprocessors.

Although small, the shipment shares with Via microprocessors in communication and medical, laboratory & scientific applications are expected to increase. These are used in less application demanding, low-end units.

Operating Systems

Microsoft PC-based operating systems are being used on the largest share of ruggedized/industrial computer shipments for each of the major application markets under study. In 2003, the shares ranged from about 43% for communication applications to over 75% for the energy, utilities & transportation infrastructure market, and the industrial automation control & instrumentation market. In 2003, Windows NT & 2000 accounted for the largest share of shipments to each of the major application market segments.

The shares of shipments using Windows NT & 2000 are expected to decline with a shift in shipment shares to Windows XP. Also, the overall shipment share with Microsoft operating systems in each of the major application market segments is expected to decline with a shift to use of Linux. VDC forecasts that Linux will account for the largest shipment shares for the communication market and the defense & aerospace market in 2006.

Linux is like UNIX operating systems in that it provides a reliable, scalable platform with many of the desired features of UNIX, but in a truly open system. It is not necessary to purchase expensive "client-access" licenses to apply Linux. The capabilities of Linux continue to expand with thousands of developers collaborating via the Internet to develop new Linux features, including improving reliability and scalability, and to add new applications and tools. Secondly, it is gaining the support of major computer system hardware vendors.

DISTRIBUTION CHANNELS

Sales Organizations

Field sales personnel of the computer system suppliers account for the bulk of the sales for each of the major application markets. The shares of sales by field sales personnel are expected to decline somewhat in each, with larger percentages of sales by manufacturers' representatives and agents.

Historically a complementary tool used by suppliers to expand into new markets, manufacturers' representatives and agents are increasingly being employed to cut costs. Although some firms use manufacturers' representatives extensively and more use by others is expected, the majority of sales are expected to continue to be made by company field sales personnel. They typically can provide a higher level of support and product knowledge to customers, especially large OEMs and systems integrators.

Direct online ordering accounted for a small share of sales in 2003. Sales shares by this means is expected to increase in several of the application markets as users become more comfortable with this means of procurement, and as more vendors provide e-commerce Web sites.

Customer Classes

In each of the major application market segments, the majority of sales are to OEMs. The share to OEMs is expected to increase over the forecast period for the energy, utilities & transportation infrastructure market and for the industrial automation control & instrumentation market. Direct sales to end users accounted for the second largest shares in these applications 2003, and the shares to them is expected to decline, as the trend continues toward more end-user outsourcing of their automation needs.

The same trend is expected in the defense & aerospace application market. Here the reason is an expected increase in procurements for new systems, which are handled through prime contractors.

USER NEEDS AND TRENDS

VDC conducted a Web survey and interviews with users (end users, OEMs, systems integrators, etc.), who purchase ruggedized/industrial computer systems for the applications studied, regarding their current and expected future requirements for these products. The following summarize some of our findings:

Product Selection Criteria

The following ranks the most identified key criteria in the selection of ruggedized/ industrial computer systems for all the major application markets combined:

1. Reliability
2. Quality
3. Durability
4. Speed
5. Tied: Expansion Slots, Form Factors

A great many of the criteria cited deal with the ability of the ruggedized/computer systems to stand up to difficult environments that may be encountered.

Non-Product Vendor Selection Criteria

Overall, for all the application markets combined, price, availability/delivery, and general service/support were the most identified criteria. Price was most identified in each of the major application segments, except for the medical, laboratory & scientific market, where availability/delivery was more identified.

Overall, many of the selection criteria identified relate to service, and to establishing confidence in the vendor.

Configurations

Considerable differences were found among the major application markets regarding how complete the computer systems are when purchased from the hardware vendors. In communications applications, we found only about 15% of purchases to be of products fully configured, integrated with software, and tested, whereas almost 55% were of units partially configured and integrated.

In the defense & aerospace market, we found over 41% of procurements to be of units fully configured and integrated with an operating system, but only about 17% also integrated with application software and tested. Here, most of the integration with application software and testing is done by the prime contractors to whom the computer systems are principally sold.

Procurements in the industrial automation control & instrumentation market and the medical, laboratory & scientific market also were found to be heavily weighted to units partially configured and integrated. These account for about 50% and 52% respectively of the unit purchases.

At the other extreme almost 49% of the computer systems purchases for energy, utilities & transportation infrastructure applications are units that are fully configured, integrated with application software, and tested. Procurement of turnkey systems is common in these applications.

Cooling Methods

Fan cooling with circulation of exterior air is used in a high majority of the ruggedized/ industrial computer systems shipped for all the major application markets studied. Lesser but still significant usage is made of conduction cooling, particularly in defense & aerospace applications. Other means of cooling used in some applications include sealed units with internal fans, external fans blowing air through the units, external fans blowing air over heat sinks, and liquid cooling.

Other Features

It is estimated that 70% or more of new ruggedized/industrial computer system implementations in 2003 had the following features:

	Application Market
Ethernet Connectivity	Communications Defense & Aerospace Energy, Utilities & Transportation Infrastructure Industrial Automation Control & Instrumentation Medical, Laboratory & Scientific
Video/Graphics	Defense & Aerospace Energy, Utilities & Transportation Infrastructure Industrial Automation Control & Instrumentation Medical, Laboratory & Scientific
USB Connectivity	Communications Energy, Utilities & Transportation Infrastructure Industrial Automation Control & Instrumentation Medical, Laboratory & Scientific
LCD Displays	Energy, Utilities & Transportation Infrastructure Industrial Automation Control & Instrumentation Medical, Laboratory & Scientific

New implementation shares for certain features are expected to increase over the forecast periods in some of the major application markets, and not others. However, new implementation shares for the following are expected to increase in all five:

- LCD Displays
- Touchscreens
- RAID Memory
- DVD Mass Storage
- DSP I/O
- Ethernet Connectivity
- Network Processors
- Firewire Connectivity
- USB Connectivity
- Redundant Power Supplies
- Uninterruptible Power Supplies

New implementation shares for CRT displays and floppy disc memory drives are expected to decline in all the major application markets. New implementation shares for CRTs are already small, and these are being further displaced by LCD displays. New implementation shares for floppy disc memory drives were found to range from 32% for defense & aerospace applications up to over 68% for energy, utilities & transportation infrastructure applications in 2003. Significant share declines in new implementations of floppy disc memory drives are expected in all the major application markets over the forecast period. Contributing to this decline is the ease of using flash memory with USB connectivity for data transfer.

COMPETITIVE ENVIRONMENT

The five largest suppliers of ruggedized/industrial computer systems in 2003 to markets in North America and Western Europe for each of the major application segments studied were, in alphabetical order:

Communications:

- Appro
- Force Computers
- Kontron
- Motorola Computer Group
- Radisys

The Motorola Computer Group was the largest supplier by far for these applications. They concentrate on telecom/datacom markets, and these account for the bulk of their ruggedized/industrial computer system shipments.

Defense & Aerospace:

- General Dynamics Advanced Information Systems (AIS)
- General Dynamics C4 Systems
- Lockheed Martin Marine Systems and Sensors (MS2) Division
- Mercury Computer Systems
- Raytheon Computer Products

General Dynamics (AIS) had by far the largest market share for defense & aerospace applications. Their shipments were principally for military aircraft, with some for satellites, and a small share for use on surface ships.

Energy, Utilities & Transportation Infrastructure:

- Force Computers
- GE Fanuc Automation
- Gespac
- Siemens Automation and Drives
- Xycom Automation

Gespac was the leading supplier to this segment in 2003. Gespac shipped these computer systems principally for rail/transit transportation system applications.

Industrial Automation Control & Instrumentation:

- Advantech
- Elektro Beckhoff
- GE Fanuc Automation
- Rockwell Automation Control Systems (Allen Bradley)
- Siemens Automation and Drives

Siemens was by far the largest supplier to this market segment. Siemens is a large supplier of these products, and the bulk of their shipments are for industrial automation control & instrumentation applications.

Medical, Laboratory & Scientific:

- Advantech
- Force Computers
- GE Fanuc Automation
- Mercury Computer Systems
- Motorola Computer Group

Force Computers was the largest supplier to this segment in 2003. Force Computers provides ruggedized/industrial computer systems for use in image processing for MRI, CT, Digital X-Ray, Ultrasound, and PET equipment. Other applications include patient monitoring and patient data management.

The market shares of the top 5 suppliers in 2003 ranged from about 39% for industrial automation control & instrumentation applications, up to about 52% for the communications market. Force Computers and General Electric Fanuc were among the top 5 suppliers in three of the major market segments, with Advantech, Mercury Computer Systems, Motorola Computer Group, and Siemens Automation and Drives among the top 5 suppliers in two.

ABOUT THE STUDY

VDC's market study, **North American and Western European Market Demand for Ruggedized/Industrial Computer Systems**, covers five application market segments: Communications; Defense & Aerospace; Energy, Utilities & Transportation Infrastructure; Industrial Automation Control & Instrumentation; and Medical, Laboratory & Scientific. The geographic scope of the study covers North America and Western Europe. Markets for these products are sized and segmented for 2002 and 2003, with forecasts through 2006. Trends are identified, markets analyzed, and strategies recommended.

The report is available for purchase at $3,540 per application market.

Each volume contains the following exhibits, as is pertinent to that specific application market:

INDUSTRY STRUCTURE

Industry Structure for Ruggedized/Industrial Computer Systems

Vendors of Components and Subsystems Identified as Being Most Important to Suppliers of Ruggedized/Industrial Computer Systems (Chipsets, Displays, Hard Memory Drives, Microprocessors)

MARKET SIZE, SEGMENTATIONS AND FORECASTS

Shipments and Shipment Forecasts

Trend in Shipment Shares of Ruggedized/Industrial Computer Systems by Architectures to Markets in North America and Western Europe

Trend in Shipment Shares of Passive Backplane Ruggedized/Industrial Computer Systems by Bus Architectures to Markets in North America and Western Europe

Trend in Shipment Shares of Active Backplane/Motherboard Ruggedized/Industrial Computer Systems by Form Factors to Markets in North America and Western Europe

Trend in Shipment Shares of Passive Backplane Ruggedized/Industrial Computer Systems by Types of Enclosures/Mountings to Markets in North America and Western Europe

Trend in Shipment Shares of Active Backplane/Motherboard Ruggedized/Industrial Computer Systems by Types of Enclosures/Mountings to Markets in North America and Western Europe

Trend in Shipment Shares of Ruggedized/Industrial Computer Systems by Types of Microprocessors to Markets in North America and Western Europe

Current and Forecast Sales Shares of Ruggedized/ Industrial Computer Systems by Types of Sales Organizations and by Customer Classes

USER REQUIREMENTS AND TREND ANALYSES

Most Important Product Selection Criteria (i.e. Durability, Quality, Reliability, Size, Speed, etc.)

Configurations in Which Ruggedized/Industrial Computer Systems are Purchased

Purchase Price Ranges of Fully Operational Ruggedized/Industrial Computer Systems

Representative Features and Prices Cited for Fully Operational Ruggedized/Industrial Computer Systems

Trend in Height and Depth of Rack Mounted Ruggedized/Industrial Computers

Trend in Shares of Ruggedized/Industrial Computer Systems by Operating Systems Being Used

Trend in Shares of Ruggedized/Industrial Computer System New Application Implementations Having Various Features

Installation Sources

Shares of Ruggedized/Industrial Computer System New Application Implementations Having Video/Graphics by Types

Statistics on Ruggedized/Industrial Computer System New Application Implementations Having Mass Memory Storage by Sizes

Most Identified Safety Certification Requirements

Means of Cooling

Expected Technical Trends

Most Important Non-Product Vendor Selection Criteria (i.e. Availability/Delivery, General Service/Support, Price, Reputation, Past Experience, etc.)

Information Sources

COMPETITIVE ANALYSIS

Vendor Shares of Ruggedized/Industrial Computer System Shipments

Vendor Shares of Passive Backplane Ruggedized/Industrial Computer System Shipments

Vendor Shares of Active Backplane/Motherboard Ruggedized/Industrial Computer System Shipments

Vendor-Identified Key Success Factors as Suppliers of Ruggedized/Industrial Computer Systems (i.e. Customer Service, High-Quality/Reliability Products, On-Time Delivery, etc.)

STUDY SOURCE

Venture Development Corporation is a technology market research and strategy firm serving the worldwide electronics industry. It was founded in 1971 by graduates of the Harvard Business School and MIT. VDC offers in-depth market research, as well as proprietary consulting services in the areas of embedded computing, industrial automation, electronic components, computers and peripherals, and communications.

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