Industry
IT
Category
Hardware, Software
Market Segment
Public Sector, Enterprise, SMB, Consumer
Geography
Global

Emerging Markets

Landscape Analysis of Low-cost Computing Devices

The history of low-cost computing

Manufacturer overview

Operating system choices

Regional and segment availability

December 2008

VITAL WAVE CONSULTING™

Contents

Executive Summary

The information technology (IT) industry has an ongoing fascination with low-cost computing devices. The media and manufacturers alike have brought the topic to the public's attention with new zeal every few years. However, historical interest in the topic pales in comparison to the attention low-cost computing devices have received since early 2007. This fascination was largely built on the stirring announcement of the $100-dollar-laptop initiative by Nicholas Negroponte in January 2005 at the World Economic Forum in Davos, Switzerland and on the subsequent emergence of a new computing device category, the sub-notebook.

This report reviews and analyzes the evolving landscape of low-cost computing devices introduced or in existence between January 2004 and August 2008, with details on 93 devices. The report is based on extensive secondary data on low-cost devices that are currently available, recently discontinued, or projected to be available in the near future. The report examines global trends in this nascent sub-industry, the evolution of low-cost device segmentation strategies, and the roles of major manufacturers, semiconductor and software companies.

- **Part 1** gives an **Introduction to the Low-cost Computing Device Market**, including an overview of recent events and a timeline of device introductions since January 2004.

- **Part 2** provides an overview of **The Low-cost Computing Device Landscape**, including important research findings and insights on the evolution of device types and manufacturers' market strategies. This section examines the reason for the emergence of the sub-notebook device category, and the targeting of specific customer segments by device manufacturers. Special attention is given to the growing interest in technology adoption in emerging markets and the appropriateness for and availability of low-cost devices in those markets.

- **Part 3** offers **Conclusions and Implications** for the Information Technology industry. This section includes key findings and predictions for the near-term low-cost computing device market and the sub-notebook category.

- This report contains two **Appendices**. Appendix A discusses the paper's research methodology including the types of data sources used, the strengths and limitations of the data, the research phases, and the variables selected for investigation. It also contains a selection of useful web sources used in the research and brief descriptions of their content. Appendix B summarizes strategies of the major players in the low-cost market such as Asus, the OLPC initiative, Intel, VIA, and NComputing. This appendix also includes available information about market size and sales projections for selected models.

Vital Wave Consulting has identified five key industry trends that are emerging as the low-cost computing device category develops:

1. **Higher-income consumers are the target market** – While lower-income users in rural areas are often named as the target market for low-cost computing devices, this research shows that manufacturers are targeting higher-income customers (generally wealthy urban dwellers in developing countries or those in developed countries). This focus can lead to higher demands for performance capabilities and less emphasis on alternative, lower-energy consumption options or ruggedization (additional features that help the computing device operate in more extreme environments found more frequently in the developing world, e.g. erratic electricity, power surges, dust, humidity, heat, insects).

2. **Manufacturers are increasingly offering a choice between a Microsoft or Linux operating system** – While the market is showing early indicators that Microsoft uptake in low-cost computing devices exceeds that of Linux, the research shows that manufacturers are continuing to offer both a Linux-based and a Microsoft option to customers. When manufacturers switch from an exclusively Linux offering it is generally to add a Microsoft option to their offering.

3. **Few devices are "ultra low-cost" or priced below $300** – Of the devices reviewed that were launched in the last year (58) only nine have been "ultra low-cost." This trend demonstrates that the ultra low-cost device segment is not a priority to manufacturers.

4. **Of new devices launched, sub-notebooks dominate over commodity desktops** – While desktop computers are more easily designed and configured for lower prices, manufacturers have *most recently* focused on the introduction of sub-notebooks in the low-cost computing device segment. This recent focus on a limited form-factor misses an opportunity to provide increased functionality to consumers at a similar price point. If manufacturers and consumers embraced other form factors, such as the traditional desktop, users could gain additional functionality.

5. **Predominance of small- and medium-sized enterprises (SMEs) leaves an opportunity for multinational corporations (MNCs)** – Even with limited research and development budgets and distribution reach, SMEs are largely responsible for bringing many of the current and past low-cost devices to market. However, SMEs often extend only to local markets, so many new devices are available in select geographies. As a result, the number of low-cost devices on the market does not translate to wide geographical coverage. MNCs are best suited to capitalize on the truly global opportunity presented by low-cost computing devices.

The analyses and conclusions in this report are based on thorough market research of 93 low-cost computing devices. The research results are presented in an accompanying spreadsheet which is current through August 2008.

Key Terms and Concepts

Authorship

This report was compiled by Vital Wave Consulting analysts and researchers. Vital Wave Consulting enables accelerated revenue growth in emerging markets through strategic consulting, market research and business intelligence. Clients include multinational corporations, start-up firms and foundations in the information technology and telecommunications sector. To learn more about Vital Wave Consulting visit www.vitalwaveconsulting.com.

Data Sources

The findings and commentary in this report are derived from Vital Wave Consulting research and the deep expertise and field knowledge of the company's business consultants. Specific findings in this research are supported by extensive secondary research. Where appropriate, data sources are provided. Data with no attributed source(s) are generated by Vital Wave Consulting through direct knowledge, original research and proprietary methodologies.

Key Terms

Vital Wave Consulting utilizes the following definitions for this report. These definitions are derived from common usage, industry research and expert opinion.

Developing/Developed Countries and Emerging/Mature Markets

Throughout this paper, the terms "developing countries" or "emerging markets" are used interchangeably, as are the terms "developed countries" or "mature markets." For the purposes of this report, Vital Wave Consulting follows established World Bank economic benchmarks to define developing countries as countries that have a gross national income (GNI) of $10,725 or less per capita. More information about these terms and segmentations may be found on the Vital Wave Consulting website www.vitalwaveconsulting.com/insights/insights.htm.

Upper Pyramid/Lower Pyramid

The terms "upper pyramid" and "lower pyramid" refer to individuals who reside in the upper and lower halves of the global socio-economic scale. For example, the term "lower-pyramid consumers" refers to the world's population who live at or near extreme poverty, typically in developing countries. "Upper-pyramid consumers" refer to those that earn enough to live comfortably above subsistence and are generally the wealthier individuals in developing countries or the residents of developed countries.

Low-cost Device

The term "low-cost device" refers to notebooks that cost less than $500 and desktop computers (including monitor) that cost less than $400. All of the prices included in this research were converted to US dollars (USD) using current exchange rates (June/July 2008). When more than one configuration for a model was available, the least expensive one is represented in the analysis.

Computing devices

In the context of this research, a computing device refers to a variety of technical devices where the primary purpose of the device is for the manipulation of data. This included desktop PCs, notebooks, sub-notebooks, thin clients, handhelds, mobile tablets, and mobile appliances. High-end handsets with computing functionality such as the iPhone were excluded from this research because the primary application of these devices is voice communication and not computing. These computing devices are defined as follows:

Desktop: a stationary computer that runs only on AC power and requires a separate monitor.

Notebook: a clamshell-style portable computer that can run on batteries, has a screen size larger than 10.2 inches and/or a hard-drive capacity larger than 80GB.

Sub-notebook: a clamshell-style portable computer that can run on batteries, has a screen size 10.2 inches or smaller and a hard-drive capacity no larger than 80GB. Sub-notebooks are also referred to in press reports as mini-notebooks, mini-laptops, ultraportables, netbooks, and ultramobiles.

Thin client: a device and/or software in a client-server network which depends primarily on a central server for processing activities that is separate from the user terminal.

Handheld: a mobile computing device that can be held in the hand(s) and does not require a surface of support for operation.

Mobile tablet: a tablet-style portable computer than that can run on batteries and does not have a keypad or keyboard.

Mobile appliance: a tablet-style portable computer than that can run on batteries and has a keypad or keyboard.

Note: While many information sources use different terms and definitions for similar devices, this report and the accompanying spreadsheet use only the terms defined above.

Early Initiatives

The topic of low-cost computing devices is revisited in the IT industry every several years. While the excitement and discussions generated by the topic fade away, the price advantages for consumers stay. The last instance of such interest occurred from 1998 to 2000, when demand grew for computers (including monitors) priced below $1,000. While many differences exist between the most recent low-cost computing trend and previous episodes, the objectives often remain the same - getting technology into the hands of those that would not otherwise be able to afford it. Independent of recent interest, there have historically been many projects that have aimed to design and distribute affordable computing devices to lower-income users. Such projects are often supported by non-profit organizations or governments in developing countries. Even when successful, these projects typically have small geographic reach.

Predominantly, innovation in the IT industry has been oriented towards making computers faster, more powerful and able to run increasingly demanding applications. A few large companies resisted this trend with innovative low-cost designs specifically for emerging markets. The HP441 Multi-user Desktop Solution and the AMD Personal Internet Communicator were early examples. Nonetheless, the IT industry, in general, has avoided the low-cost computing device market segment and expected the natural downward trend of computing device prices to open new markets for computing technology. In order to achieve a lower price point, some manufacturers have introduced inexpensive computing devices with significantly less computing power than a standard personal computer (PC), often sold through discount outlets. However, these devices lack any significant innovation and are often simply lesser versions of existing models.

In January 2005, Nicholas Negroponte, founder of the Massachusetts Institute of Technology's Media Lab, announced a new non-profit initiative, One Laptop per Child (OLPC), to design a $100 laptop for children in developing countries. This announcement created waves of media attention and gained the support of then United Nations' Secretary General Kofi Annan. Ultimately, the OLPC initiative drove a fundamental shift in the IT industry.

OLPC and the Eee PC

Negroponte's announcement of the OLPC initiative was initially met positively in the press. Early reports cited talks or agreements with key government officials, the support of corporate partners, and the lofty goals of the organization (e.g., the project will "brighten the lives and prospects of hundreds of millions of kids in the developing world"[1]). There were also skeptics. Experts in information and communication technology for development expressed concern about the initiative's distribution and support mechanisms and the development community worried that a focus on technology over basic necessities such as food and healthcare could draw valuable resources from the world's poorest communities. But early critics of the project were often chastised for denigrating a philanthropic organization with altruistic goals.

Major technology companies dismissed the initiative from its inception. Intel's Chairman Craig Barrett called OLPC's sub-notebook, the XO machine, a "gadget"[2] and Microsoft's Chairman Bill Gates encouraged consumers to "get a real computer"[3] instead. However, with increasing attention from the media and, more importantly, interested government buyers, both companies subsequently launched programs and initiatives aimed at reaching lower-income markets.

Microsoft dropped the price of its Windows Starter Edition to $3 and chartered a new Unlimited Potential Group to bridge the digital divide with new products and programs. Microsoft later extended the life of Windows XP specifically for the sub-notebook category until 2010. Intel launched its World Ahead program, charged with connecting the next billion people to technology, and debuted the *Affordable PC* for emerging markets. Later, Intel replaced those efforts with an OLPC competitor – the Classmate PC. The original Classmate PC was a reference design for third-party manufacturers to develop low-cost devices under their own respective brands. Intel's release of the reference design began in March 2007 and was initially available in only a few emerging-market countries. More recently, Intel developed the Atom processor, a low-power chip designed specifically for use in sub-notebooks.

At Computex 2007 in Taipei, ASUSTek Computers Inc (hereafter "Asus") announced the first low-cost sub-notebook based on Intel's Classmate PC reference design. The Asus Eee PC started at $199 and drew mass attention from the public and the investor community. In September 2007, the Asus Eee PC was released and sold over 300,000 units in four months. Industry analysts predict that the Eee PC will achieve sales of up to 9 million units in 2008 (see Appendix B for projections by four technology market research companies).

OLPC as Catalyst

While the OLPC's XO computer, a device specifically geared for the developing-world, was the catalyst for the private sector's involvement in developing low-cost computing devices, few devices specifically target lower-pyramid markets. Instead, as the private sector becomes increasingly engaged in the low-cost computing market, devices are more likely to target upper-pyramid consumers. As a nonprofit, OLPC was less concerned with profitability and able to focus more on the social benefits of low-cost computing devices. MNCs hesitation to invest heavily in the lower-pyramid segment could be attributed to concerns over business viability and sustainable revenues.

Changing the Market

The early success of Asus' Eee PC caused the industry to reevaluate the potential of the low-cost market, particularly for sub-notebooks. In mid-2008, Acer, Dell, HP and Lenovo entered the low-cost sub-notebook market. Meanwhile, numerous small- and medium-sized enterprises (SMEs) entered the low-cost sub-notebook market, fueled by reference designs from VIA Technologies and Intel. Table 1 below provides a chronological summary of events and product introductions that shaped the market.

In addition to sub-notebooks, manufacturers gained traction with alternative computing devices such as low-cost desktop PCs and thin-client solutions. Many of these early devices, including the Asus Eee PC, featured a Linux operating system. NComputing, a thin-client computing product, secured some high-profile wins with its non-traditional marketing approach by focusing on cost, maintenance and manageability.

By mid-2008 the OLPC shipped approximately 500,000 XO computers, far shy of its initial target of 100 million units.[4] Had it not set such lofty initial goals, the OLPC organization would have been seen as achieving remarkable success for its first three years as a young entity with no experience in the PC business. Regardless of its lackluster commercial success, the $100-dollar laptop is credited with playing a major role in bringing low-cost computing devices into the public's consciousness and triggering a wave of innovation.

Table 1: Chronological Summary of Significant Events and Device Introductions

Year	Date and Event
2004 and earlier	**Before 2004** – HP (HP 441) and Simputer, early low-cost computing device designs, launch. Both have since been discontinued. **October 2004** – AMD Personal Internet Communicator (PIC) releases as pilot in emerging markets such as Mexico, Brazil, Turkey and South Africa.
2005	**January 2005** – OLPC $100-dollar-laptop initiative announced at the World Economic Forum in Davos. **April 2006** – DTK Computer releases the low-cost Cruiser 5015 targeting the Middle East; Chinese-based YellowSheepRiver releases a community-based $146 Linux desktop PC. Few details are available. **June 2005** – NComputing launches a new virtualization model for terminal-based computing. **July 2006** – Inveneo launches the Inveneo Computing Station, its first low-cost ruggedized PC for rural African deployments. **October 2005** – HCL Infosystems Limited releases the HCL Ezeebee Pride, a now discontinued low-cost desktop for India; Chinese companies Jiangsu Lemote Technology and Sinomanic release the Fuloong Mini-PC 2E sub-notebook targeting education and the Sinomanic Tianhua GX-1C and the Tian Yan GX-2A desktops targeting rural farmers. **November 2005** – "Cowboy" sub-notebook designed by Brazil State University of São Paulo is launched. One of several Brazilian initiatives to develop low-cost computing devices for the masses, the "Cowboy" project is on hold today because of lack of financing and high-level support.
2006	**May 2006** – Intel's World Ahead Program established. **September 2006** – Intel introduces the Classmate PC reference design for third-party manufacturers of low-cost laptops under their own brands. **October 2006** – Fuloong 2E model revealed by Lemote. The computer targets low-income groups in China and was expected to sell 100,000 in 2006. No sales information was subsequently made available. **November 2006** – AMD Personal Internet Communicator discontinued by AMD and sold to Data Evolution.

2007	**January 2007** – Novatium releases the Nova netPC, a thin-client for the Indian market. **February 2007**– Data Evolution relaunches the PIC as the dekTOP. **March 2007** – Dell EC280 desktop is released for first-time PC users in China; Intel launches the Classmate PC. Intel also releases a Classmate PC reference design to manufacturers. **April 2007** – Microsoft makes Windows Starter Edition available for $3 through government-based education purchases. **May 2007** – Palm announces the Foleo sub-notebook (a smartphone companion), expected to reach the market in the summer of 2007. NorhTec MicroClient Jr. becomes available. **June 2007** – The first two Asus Eee PC models announced at Computex in Taipei. VIA NanoBook reference design revealed at Computex. **July 2007** - CompuLab fit-PC releases in developed countries. Low-cost Dell Vostro notebook is announced for SMEs in the US. **September 2007** – Palm Foleo cancelled before going to market. The first two Eee PC models released with revised specifications and prices. **November 2007** – OLPC launches the "Give One Get One" program to allow individuals to purchase the OLPC's XO Computer for $399. With each purchase under this program, the OLPC donated an identical PC to a child in a developing country. Mass XO Computer production begins early (ahead of anticipated early 2008 plans) in order to meet demands expected from the Give One Get One program. Aleutia E1 Mini Computer released through African-based resellers for rural communities. Everex gPC targets US "green" market with low-power desktop. Solar PC launches solar-powered PC for organizations working in the field. **December 2007** – Hacao Classmate becomes available in schools and stores in Vietnam. Hasee Q540X sub-notebook predicted to launch in China but never seems to make it to market.
2008	**January 2008** – Allied Computers International's ACi Ultra Mini for India, Everex's Cloudbook sub-notebook and gBook notebook for developed markets. HCL's MiLeap X-series for India and Mirus Innovations Freespire PC launch. **February 2008** – Pioneer's DreamBook Light IL1 and the Proview Handbook sub-notebooks go live. **March 2008** – GeCube Multimedia2GO Genie sub-notebook targets developing countries and the iDOT CE260 and 261 is released in Canada. Neo Manufacturing and Services launches the eXplore X1 in the Philippines **April 2008** – A busy season for low-cost computing-device launches begins featuring the Airis Kira 100, Aleutia E2 Mini Computer, the Astone UMPC CE-260, Blue Digital Systems' Deep Blue H1, Fukato's datacask jupiter, the HP 2133 Mini-Note PC, Sahara Computers' S-NB522434-EB00, and Zenith's SmartStyle PC.

2008 (cont.)	Second-generation Classmate unveiled and introduced to the United States (US) and the European Union (EU) along with CTL's version of the reference design. **May 2008** – Bestlink's Alpha-400, CTL's DreamBook IL1, the Inventec V10 Netbook, Ndiyo's Nivo, One's A110, and Red Fox Technologies' Wizbook800 are launched. OLPC announces plans for XO-2 to be released in 2010. **June 2008** – VIA OpenBook reference design and several OEM models based on this design revealed at Computex. 3K Computers' RazorBook 400-Mini-Notebook PC, Comes S.A.'s Aristo Pico 640, the Great Wall A81, Tranquil's T7 Atom PC, Acer Aspire, Asus Eee Box B202 mini PC, Aware Electronics' A-Pad Convertible Table, the CherryPalCloud, and Jiangsu Lemote Technology's Fulong Mini-PC are revealed. MSI Wind NB U100 announced and Elonex One expected to be released. Acer Aspire One using Intel's Atom processor is on the market. Acer expects to sell 5.5 million in the second half of 2008.[5] MIU's Hybrid Dual Portable Computer, the Open Pandora, and Pioneer Computers' DreamBook Light IL2 go live. Zonbu's Notebook and Zonbu's Mini expected to hit US markets. **August 2008** – Dell launches Vostro desktop and sub-notebook for Chinese SME market and the Dell E (Inspiron 910) sub-notebook, DTK Computer's eBook i10, Lenovo's IdeaPad, MPC's TXTbook and Zenith Computers EcoStyle PC hit the market. **TBD** – Several devices such as the ECS' J-Series, InkMedia's Olea, Ngai Lik 8010A, NorhTec Gecko Laptop, Omatek C8/E10, OLPC XO-1, HCL MiLeap X-series, Acer Slim Gemstone, CZC Hn1, Newbyte S10, and the TongFan Imini S1 were announced or demonstrated but no launch dates were determined.

Part 2 – The Low-cost Computing Device Landscape

Vital Wave Consulting conducted extensive secondary research examining the low-cost computing landscape. A total of 93 devices met *all* of the criteria below:

- Price not higher than $400 for desktop computers (incl. display) and $500 for all others.
- Computing device as defined on page 5.
- Based on current technology or design configurations *or* based on out-dated technology but with new adaptations specifically for emerging markets. Some computer configurations fit the target price range but are outdated or simply low-end versions of a standard product. This criterion omits desktop PCs and thin-client devices that may fit the required price range but only because they are using outdated components or have been assembled with less computing power than a standard PC.
- Developed or announced after 2004. This criterion ensured reasonable price comparability.
- Currently available, announced or discontinued. *Discontinued devices since 2004 were included in the research in an effort to provide a view of the history of low-cost devices.*

Vital Wave Consulting researchers captured relevant data points for each device as described in Table 2 below.

Table 2 - Research Variables

Data points		Description
General	Manufacturer	Name of the company designing and branding the product and official website when available
	Model name	Name of the product model including all known variations. Modified products with alternative names are also included (e.g., Asus Eee PCs - 2G Surf/4G Surf/ 4G/8G)
	Device type (form)	The type of the device according to the established definitions (e.g., desktop, notebook, sub-notebook)
	Image	Image of the product
Sales and marketing	Price	Price of the least expensive configuration in USD. If price in not available (i.e., when the device is not on the market yet) but is announced as "sub-$500," the price is represented as $500
	Price range	The price range if different configurations or modifications are available and the price(s) in local currency
	Date started/ expected	The date when the model entered or is expected to enter the market
	Discontinued	Whether the model is discontinued and the date of discontinuation if available
	Target markets	Customer segment targeted (if announced specifically), e.g., rural consumers, education

Sales and marketing (cont.)	Geographical markets	Countries, continents or areas targeted for the product, or geographies in which the product is already available. Some products target emerging markets worldwide.
	Distribution channels	Channels for distribution, e.g., manufacturer website, retail establishments, resellers
	Sales (units/$ sold, projections)	Information on actual or projected sales and source of information
	Additional comments	Notes or relevant web links
Technical	Display size	Display size in inches (where screen is included)
	Display resolution	Display resolution (where screen is included)
	Touch screen	Touch screen availability (where screen is included)
	Operating System (OS)	Information on bundled OS and other OS compatibility, if available
	Processor	Producer, model, and speed of the processor
	RAM	RAM size for the least expensive model
	Storage, storage type	Storage size and type (e.g., Flash, HDD)
	Preinstalled or advertised compatibility	Preinstalled software and advertised software compatibility
	Power consumption	Power consumption in watts (available only for some models)
	Additional specs	Link to more extensive specifications of the product
	Reference design	Reference design of the model (e.g., Intel Classmate PC reference design)
Company	Company type	• Start-up – small business or nonprofit organization based primarily on one product, (includes non-governmental organizations or university-sponsored programs that meet this criteria) • SME – companies with multiple product lines, under 1000 employees, with local or global reach • Multinational Corporation (MNC) – robust product lines, over 1000 employees, global reach

Little had been done before 2005 to make computers affordable and accessible to the world's masses on a large-scale. Some early initiatives to develop low-cost computing devices gained traction but were discontinued before reaching global scale or achieving broad impact. Since 2005, various initiatives and manufacturers' efforts to design low-cost computing devices have made remarkable advancements, but the industry remains far from accomplishing the goal of making computing technology accessible to the world's poor in developing countries. In fact, this research demonstrates that the majority of the low-cost devices currently on the market are not designed for developing-country markets and are often not even available in those regions.

Market Size versus Opportunity

Vital Wave Consulting estimates that the near-term market for first-time PC purchases (those willing and able to purchase) is approximately 536 million households. Of those, 87% of are in developing countries. This estimate is derived first by identifying the market segment that earns above subsistence-level income (defined by the World Bank at $2 per day per person in purchasing power parity). Assuming that the wealthiest homes in any given country are likely to purchase a PC first, Vital Wave Consulting reviewed PC penetration rates for sample countries and identified those markets that reside below the PC penetration rate and above subsistence. With current sales figures from companies such as Asus at approximately 1-2 million sub-notebook sales per quarter, significant room for growth in this segment remains.

Price

Of the devices reviewed that were launched in the last year only seven have been "ultra-low-cost" when accounting for the added cost of a monitor for a desktop PC. This trend demonstrates that the ultra low-cost device segment is failing to gain traction in terms of the number of devices being introduced onto the market.

Recently computing device manufacturers have begun releasing sub-notebooks labeled "low-cost" but with a suggested retail price well above $500. Such devices (e.g., Maxdata Belinea s.book.1, Gigabyte M912, and Packard Bell Easy Note XS) are essentially "bandwagon" products. Device manufacturers are interested in capitalizing on the recent publicity for low-cost devices and are marketing devices as low-cost when they are more affordable than similar product offerings from the same manufacturer.

Ultra-low-cost segment losing traction

Of the researched devices, only nine of the fifty-eight launched or announced in the last year fell into the sub-$300 price range.

Adoption Barriers in Emerging Markets

In targeting emerging markets with any technology solution, companies face barriers to entry that are unique to those markets. These include price sensitivity, the role of government and other institutions as economic buyers, cultural norms, infrastructure limitations, and the need for localized applications. Many of these barriers are new challenges to developed-country business managers who now strive to grow their business in the developing world. These adoption barriers are discussed further below:

Price Sensitivity

Emerging-market consumers are extremely price sensitive. 51 percent of the population in emerging markets earns less than $2 per day. However, even with very little disposable income, consumers in these markets do make technology purchases. In order to justify a technology purchase the device must meet an immediate basic need such as employment, education, safety, entertainment or healthcare, or provide a means for improving one's economic status. Initial cash outlay also presents a barrier for technology purchases, as few consumers have access to financing services and the initial purchase price generally exceeds a family's savings.

Government as Economic Buyer

Many IT companies do not target lower-income consumers directly; rather, they rely on government- or donor-supported initiatives to deliver technology in developing countries. In such cases, the contracts can reach hundreds of thousands of devices but require a top-down sales approach, high-level connections with local authorities and the ability to deliver in large scale. In addition, many government buyers are influenced by election cycles and will therefore opt for short-term press coverage over actual implementations that require long-term commitments and do not yield near-term results. The OLPC initiative publicly expressed frustration that a handshake and a verbal agreement with a Minister of Education do not necessarily lead to a purchase.[6] Some government-sponsored academic institutions have also launched their own low-cost computing initiatives. A successful large-scale government-sponsored project has been executed in Macedonia where NComputing deployed 180,000 devices in schools[7] and, more recently, Intel reached an agreement with the government of Portugal to install 500,000 Classmate PCs.[8]

Cultural Norms

Cultural norms play a large role in the adoption of technology particularly in developing countries. While technology, especially in an educational environment, is highly valued in most communities, cultures that value wisdom resulting from life experience and the tradition of older community members passing on this wisdom may struggle with the introduction of technologies. For instance, the OLPC initiative's focus on constructivism (learning that is initiated and directed by the learner) challenged cultural practices in some developing countries and was perceived to discredit the role of the teacher, one of the key stakeholders in government education spending. In China, cultural norms affect purchasing power. Financing and credit is not commonly available or considered a mechanism for enabling larger purchases. This makes household computing device purchases more difficult to make as the bulk of the entire purchase is generally expected to be paid up front.

Infrastructure Availability

Infrastructure, such as cables and telephone lines for network and Internet, and access to reliable electricity, remains a critical barrier to the adoption of computing devices in emerging markets. According to the International Energy Agency, with current policies as they stand, 1.4 billion people will likely still lack access to electricity in 2030.[9] Some companies have specially designed solutions that address this issue. Aleutia, for example, has designed and currently distributes its 8-watt ruggedized desktop computer with a battery and a foldable solar panel in rural areas of 18 African countries. Allied Computers International (ACi) is currently planning a 7" sub-notebook with a 12-hour battery that functions with the help of solar power for the Indian market. Inveneo, a San Francisco-based NGO, has a solution for powering computing devices by peddling a bicycle, and

early editions of OLPC's XO computer included both a hand crank which later became a pull-cord generator to run the device off the electric grid and a specially designed antenna for wireless mesh-networking.

Localization Needs and Specialized Software Design

While English, French, Spanish, Portuguese, Mandarin and Arabic serve the needs of most of the world's current technology users, developing-country users often speak less common languages. Technology solutions targeting these markets should be modified for language requirements and localized with appropriate images, names and titles, currency, weights and measures, paper sizes, and defaults for date and time format. In addition, with 98percent of the world's illiterate residing in developing countries, technology targeting these markets may require a simplified icon-based interface.

Target Markets

While the original intention of the low-cost computing device category was to reach children or students in developing countries, research demonstrates that another target market – wealthier residents primarily in developed markets – is emerging for low-cost computing device manufacturers. Further detail on this market segment and trend is provided below.

Market Segmentation

Two groups of customers have proved to be viable target markets for low-cost computing device manufacturers. For the purposes of this study, we defined the two segments as follows:

- *Upper-pyramid*: This segment is comprised of customers in mature markets and in urban or wealthier regions in emerging markets who already have access to computing technology but are interested in a second or spare computing device. Customers in this segment may choose low-cost computing devices, mainly sub-notebooks, as a second computing device for the home, for travel, as an educational tool for their children, to outfit a call center (business users) or a highly mobile employee, or to achieve a 1:1 computing ratio in a school district (government)
- *Lower-pyramid:* This segment is comprised of customers in less-developed or remote areas in emerging markets where access to technology is too expensive or unavailable. This includes the governments of emerging economies. For these users, low-cost computing devices provide the first opportunity to access computing technology and possibly the Internet. Customers in this segment would choose a low-cost computing device when otherwise they would have gone without computer technology.

Table 3 illustrates the number of devices targeting various market segments in both the upper-pyramid and lower-pyramid categories. The categories represented were defined as follows:

- Consumer: Individuals and families that are either part of the top of the world's economic pyramid (upper-pyramid) or world's lower part of the economic pyramid (lower-pyramid)
- SME: Small- or medium-sized enterprises in either mature or emerging economies

- Governments: Government information technology (IT) purchasers in either mature or emerging economies – includes purchases for government employees, information centers and public kiosks (excludes purchases that are primarily for school usage)
- Education: Government purchasers focusing specifically on purchases for school usage in either mature or emerging economies
- Enterprise: Large companies based in either mature or emerging economies purchasing for employee usage
- Rural: Technology users who are specifically interested in rural deployments (where electricity usage and ruggedization are essential) in either mature economies (e.g., for research programs in Antarctica) or emerging economies

Table 3 - Upper or Lower-Pyramid Target by Market Category

Market Segment	Upper Pyramid (Total Unique Devices = 70)	Lower Pyramid (Total Unique Devices = 23)	Totals
Consumer	55	14	69
SME	8	2	10
Government	3	3	6
Education	13	13	26
Enterprise	2	4	6
Rural	1	11	12
Totals*	82	47	

Note: Because some devices target multiple market segments, segment totals exceed the device total.

Product Availability

More than half of the low-cost computing devices on the market today do not target emerging-markets. 37 percent of the 93 devices reviewed target exclusively consumers in mature markets (mainly the United States and to a lesser extent the European Union (EU)). While an additional 17 percent were launched globally and are available in some emerging markets, they were not developed specifically to target developing countries; they demonstrate no hardware or software designs targeting lower-pyramid markets and marketing materials are geared towards upper-income consumers. Therefore, while emerging markets have received considerable attention as the potential market for low-cost computing devices, in fact, few devices target these markets. It is also important to note that 33 percent of the devices available in emerging markets are available only locally (i.e., in their country of origin), essentially inhibiting broad distribution to other regions that can benefit from the device design.

Upper-pyramid consumers are the target market

While lower-income users in rural areas are often named as the target market for low-cost computing devices, manufacturers are appearing to target upper-pyramid customers.

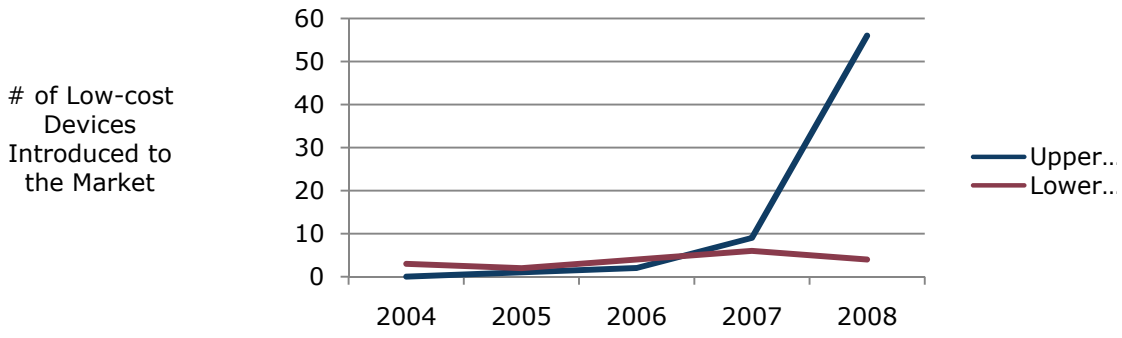
Of the devices reviewed, 37 percent are not available to customers in any emerging-market countries. Figure A demonstrates the product availability of the devices based on the reach of the manufacturer. Multinational corporations operating worldwide (e.g., HP, Lenovo and Dell) and other companies that claim global availability are responsible for 18 percent of the available devices. Companies with devices that are part of a broad initiative that targets emerging markets exclusively (e.g., OLPC's XO Computer, Intel Classmate PC, and AMD PIC) are responsible for 10 percent of the devices on the market. The remaining 36 percent are devices originating from companies, mostly SMEs and start-ups, operating only in local markets in developing countries.

Figure A - Low-cost Computing Device Availability - Manufacturer's Reach

Of the low-cost devices available in emerging markets, 36 percent are available only locally (i.e., in their country of origin). Of the remaining low-cost computing devices, 37 percent are products of companies with a global reach and10 percent are products with global reach but are targeted to emerging-market customers.

While much of the interest in low-cost computing has focused on its value in bridging the digital divide and providing access to technology for the world's developing-country citizens, it is clear that the majority of low-cost devices are available only to more "traditional" users in developed countries – those seeking a second or "spare" computing device. As illustrated in Figure B, initial product announcements in the low-cost device landscape were focused primarily on addressing the lower-pyramid segment. However, soon thereafter, announcements focused on products geared toward upper-pyramid customers. What was once heralded as a new "designing-for-emerging-markets" trend has quickly shifted towards designing lower-cost secondary computing devices for mature-market customers.

Figure B - Upper-Pyramid and Lower-Pyramid Device Announcements over Time



Solutions

After an extensive review of current, previous and announced computing devices, 93 met the criteria outlined in this report and were included in the research. Devices included ranged from NComputing's $80 thin client device (not including monitor) to the HP 2133 Mini-Note PC at $499. Screen size ranged from 4 inches to 19 inches, storage capacity ranged from a 1GB flash drive to a 320 GB hard drive, and the solutions came with a variety of operating systems, some specially designed for the devices (see the discussion on software below).

Common Configurations

While low-cost computing devices vary in processor speeds, hard drive capacity, screen size and price, the most common configuration was the following:

- A sub-notebook form factor
- 1/1.2 GHz VIA C7 processor or 900MHz Intel Celeron M processor
- 512MB-1GB RAM
- 1-4GB SSD or 40-80GB HDD
- 7/8.9" display
- Linux-based operating system.

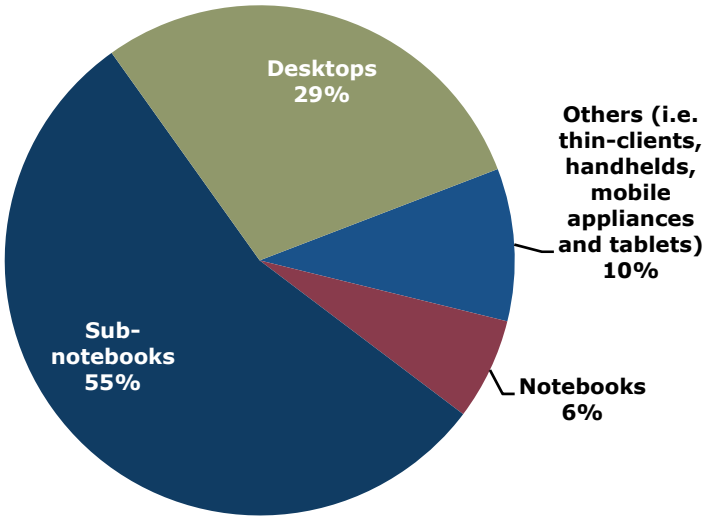
These systems were not generally ruggedized for developing-country use in any way. Ruggedized computing devices have less consistency across designs but common configuration basics include:

- AMD Geode processor (500MHz or less)
- 128 or 256 MB RAM
- Linux-based operating system

Form Factor

As seen in Figure C, the majority of the devices examined (60 percent) were sub-notebooks. Possible explanations for this trend are explored below.

Figure C - Device Types Meeting Research Criteria



The Sub-notebook Phenomenon

IDC predicts that the global, sub-notebook category could grow from fewer than 500,000 in 2007 to nine million in 2012[10] as the market for second computers expands in developed economies. Intel's analysts are far more optimistic and project sales of 40 million sub-notebooks per year by 2011.[11] The Taiwanese Market Intelligence Center forecasts 8.02 million units to be shipped in 2008 and 18.3 million in 2009.[12] Gartner analysts expect that worldwide sub-notebook shipments will reach 5.2 million units in 2008, 8 million units in 2009 and as many as 50 million in 2012. See Table 4 for these estimates in table format. Of the sales projections referenced above, only a small fraction will be sold in emerging markets or have a price below $500. While sub-notebook sales are expected to reach 9 million in 2012[13] according to IDC, this is still less than 4 percent of the total PC market and less than 1 percent of Vital Wave Consulting's estimates of the near-term growth market for computing devices.

Sub-notebooks dominate over commodity desktops

Manufacturers have most recently focused primarily on the introduction of sub-notebooks in the low-cost computing device segment.

Table 4 - Analyst Forecasts of Sub-notebook Market Growth

Analyst Agency	2008	2009	2010	2011	2012
IDC	N/A	N/A	N/A	N/A	9M
Intel	N/A	N/A	N/A	40M	N/A
TMIC	8.02M	18.3M	N/A	N/A	N/A
Gartner	5.2M	8M	N/A	N/A	50M

Innovation and Cost

Recently, most computing device innovations have occurred in the sub-notebook field. In an effort to compete with the price and functionality benchmarks created by the OLPC $100 laptop announcements, companies have been forced to revisit standard designs. The XO Computer dramatically reset price expectations in the low-cost computing category. Price goals were so ambitious that, to date, even OLPC has not been able to meet those new requirements.

Press Bias

The unexpected success of new sub-notebooks such as the Asus Eee PC created an appetite in the media for any news relating to this market. Announcements about forthcoming products were widely reported, including the announcement of intent, speculations on product features, news of an impending release, the actual product release, and subsequent reviews.

Customer Needs

Manufacturers speculate that as more computing functions go online in the form of web-based applications, many basic computer users (e.g., travelers, first-time computing device owners and children) require a computing device mainly for Internet access, email, and the creation of simple documents. Increasing access to wireless Internet capabilities coupled with the ability to store and

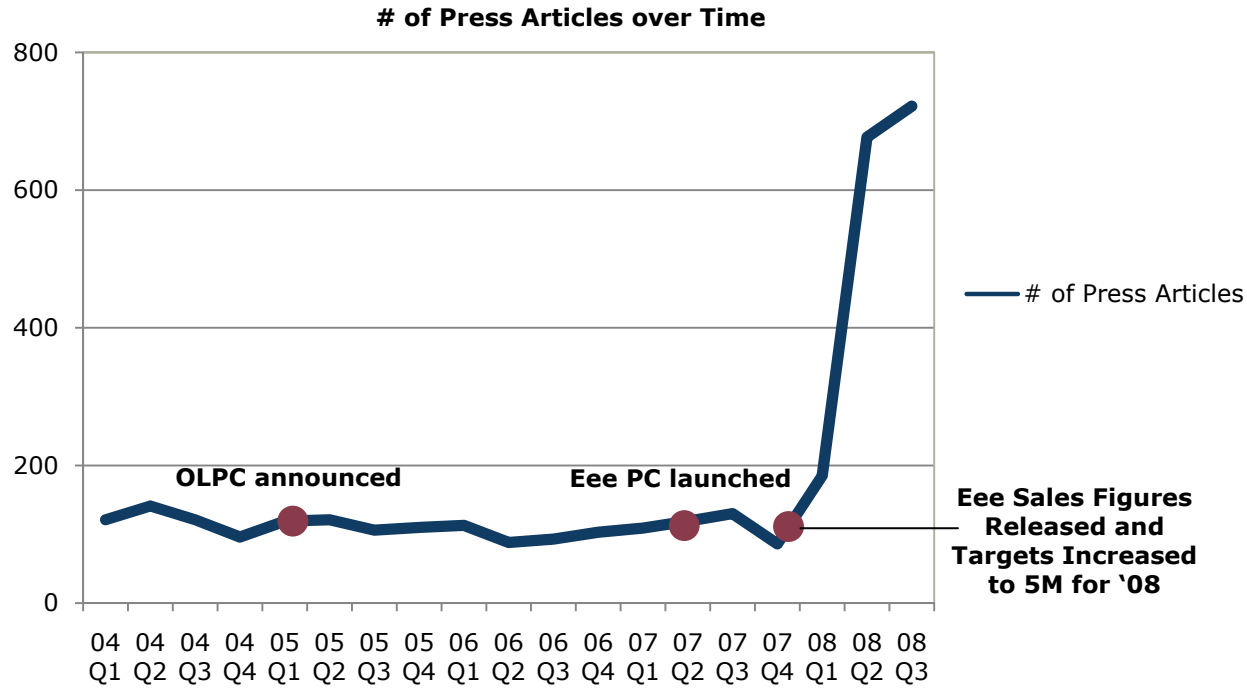
manipulate documents online, make a basic computing device such as a sub-notebook a good fit for a growing segment of the population, both in developed and developing countries.

Industry Leaders

Since the inception of the OLPC initiative in 2005, the majority of major software, semiconductor and computing device manufacturers have announced their intentions concerning the low-cost computing device market. These announcements ranged from new product development plans to implicit rejection of the low-cost computing device market. Occasionally, companies have reversed course, stating their intention to avoid the market and then changing their plans. Low-cost computing devices have also been announced but never released to the market (e.g., the Acer Slim Gemstone and the Hasee Q540X). The press has also exaggerated the significance of devices introduced by small, relatively-unknown companies operating at a local level, often referring to these devices as "Eee PC killers."

Figure D shows press mentions relating to low-cost computing devices over time and demonstrates the spike in coverage following the release of sales figures for the Eee PC demonstrated commercial success.

Figure D: Press Coverage of Low-cost Computing Devices



Manufacturers

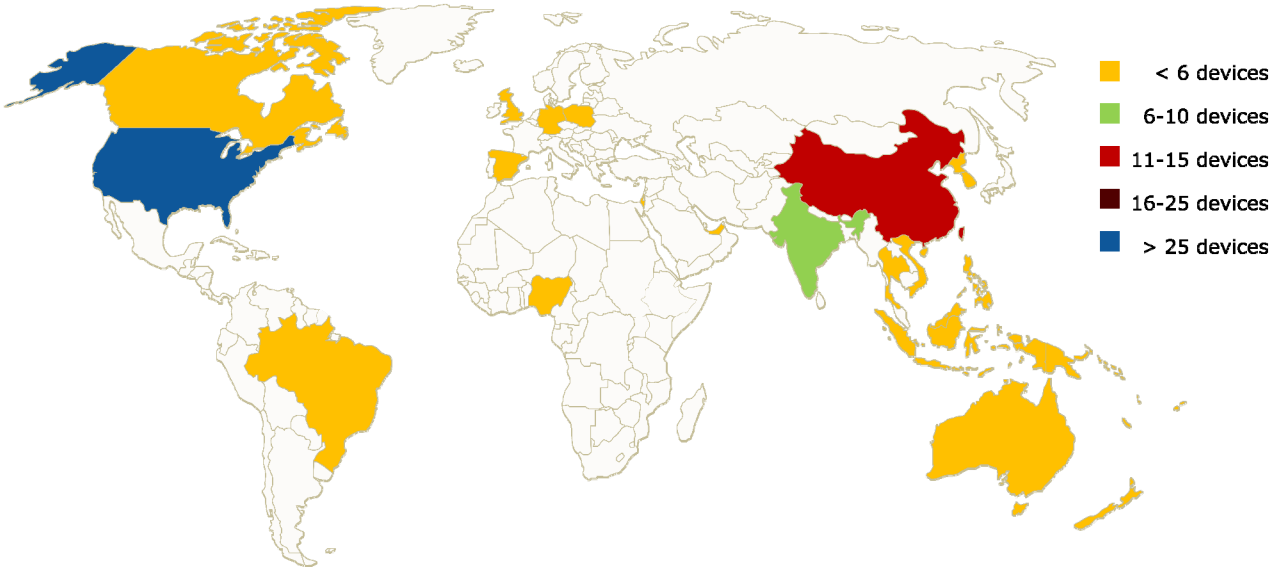
Most major computing device manufacturers have announced their intentions to enter (or in some cases to avoid) the low-cost computing device market, and many smaller and less well-known manufacturers have joined the market, eager to compete in the fast-growing sub-segment. Asus, a popular brand in Asia and a leading producer of motherboards, only became a household name with the introduction of the Eee PC. The company advanced from eighth place last year[14] to the number seven vendor[15] of branded laptops globally in fourth quarter, 2008.

Location

Specific geographies have dominated the manufacturing and marketing of low-cost computing devices. Figure E shows the origins of the 93 computing devices studied. Prominent low-cost computing locations include:

- The United States – the center for innovation in the market and the site of the majority of low-cost device announcements.
- The European Union – Many models are available in countries like Germany, Spain, France and the Netherlands. In the United Kingdom, Elonex One offers an educational solution and expected to ship 200,000 sub-notebooks by the beginning of the '08 school year.
- Asia Pacific – Small, start-up companies are leading, particularly in China and India, but also from the Philippines, Vietnam, Malaysia and Australia. Most of the sub-notebook models available worldwide have originated from these countries. Additionally, Computex in Taipei became the most significant arena for introducing such devices, displacing traditional IT exhibitions like CeBIT in Hannover or the Consumer Electronics Show in Las Vegas.
- Africa – Only one of the devices researched originated from a manufacturer (Omatek Computers) based in Africa. However, many multinational corporations have low-cost devices available in South Africa and OLPC, Intel, Aleutia and Inveneo make their products available in many African nations.
- Latin America – Latin America is the fastest-growing regional PC market. Brazil dominates in the low-cost computing space with government initiatives that support low-cost computing device design. Devices are also available though global initiatives in countries like Peru, Mexico and the Caribbean region.

Figure E: Country-of-origin for Low-cost Computing Devices

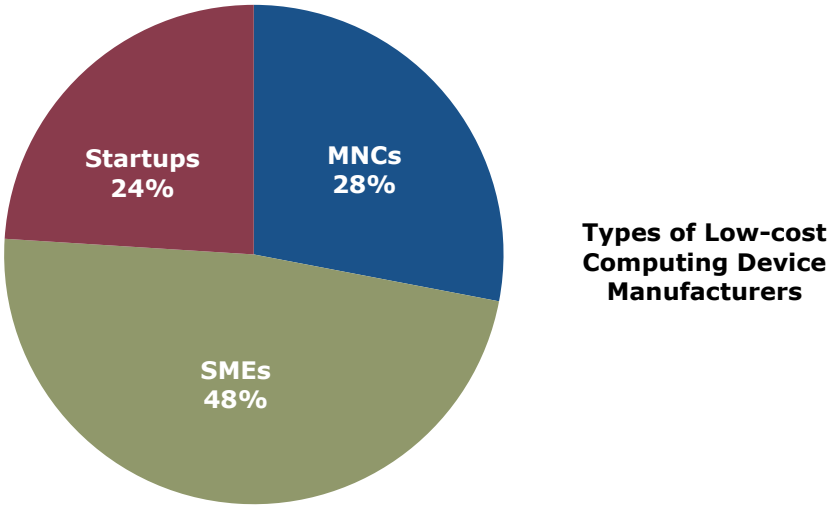


Types of low-cost device manufacturers

Though large companies like Intel and Asus garner a great deal of attention, 72 percent of the 93 devices reviewed originate from SMEs or start-ups whose business plan is often based solely on the low-cost device. Nonprofit and academic organizations, such as OLPC, The Simputer Trust, Inveneo and the Brazil State University of São Paulo, were categorized as start-ups because, while not for-profit, they sell or create one type of device and base their efforts around that technology. While some of these local and start-up businesses use reference designs by Intel and VIA, many bring to market products based on their own proprietary designs and are responsible for a large portion of the innovation in the low-cost device market.

Of the devices reviewed, only 28 percent are from multinational companies. Figure F below shows the percentage of devices introduced by multinational corporations (MNCs), SMEs and start-ups.

Figure F - Prevalance of Types of Low-cost Computing Device Manufacturers (based on researched devices)



Not all major multinational IT companies have decided to enter the low-cost device market. Sony, Fujitsu, Samsung and Toshiba, for example, do not yet have products meeting the research criteria. Other multinational companies were slow to enter this market. Lenovo was slow to release a low-cost desktop PC to target consumers in China's rural areas and now has plans for a sub-notebook release in October, 2008. Similarly, Dell has introduced desktop models which specifically target emerging markets (Latin America, India and China) and only recently entered the low-cost sub-notebook market with the Dell E (or Dell Mini Inspiron) launched in September 2008. HP released its HP 2133 Mini-Note PC in June 2008 to positive reviews and strong early sales.[16]

SMEs dominate

Even with limited research and development budgets and distribution reach, SMEs are largely responsible for bringing many of the current and past low-cost devices to market.

In contrast with multinational companies, many SMEs were quick to introduce products to market. SMEs were able to achieve quick growth in the low-cost computing device category due to their inherent agility and the availability of ready-to-use reference designs from Intel and VIA. These designs provided the backbone for the development of low-cost devices with only a few minor modifications such as the addition of touch screen capabilities. For example, Hacao introduced a version of the Classmate PC in Vietnam after minimal investment in research and development. In many instances, SMEs introduced products well before MNCs launched comparable devices.

Whether these local companies will have any significant impact on the computing device market is still unknown. They initially responded to customer needs faster than MNCs but they still lack a global distribution network and broad brand recognition. Asus successfully capitalized on a time-to-market advantage. But larger MNCs like HP, Dell, and Lenovo, are known for successfully following market trends. Their stronger distribution networks and greater brand recognition have often overcome their second-to-market positions.

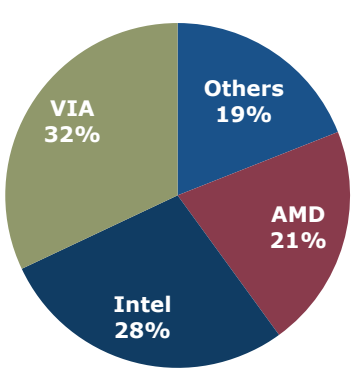
Semiconductor Companies

Semiconductor companies have played a critical role in the development and delivery of low-cost computing devices to the market. Lowering the cost of computing device components such as processors and motherboards is essential to decreasing the overall price of a computing device. Semiconductor companies have also developed reference designs to speed their partners' device development processes. Such reference designs have been used (directly or slightly modified), branded and brought to market by computing device manufacturers including Asus (with the Eee PC) and Everex (with the CloudBook). Processor manufacturers have also developed new chips, such as the Intel Atom, that address low-cost computing device requirements like lower power consumption.

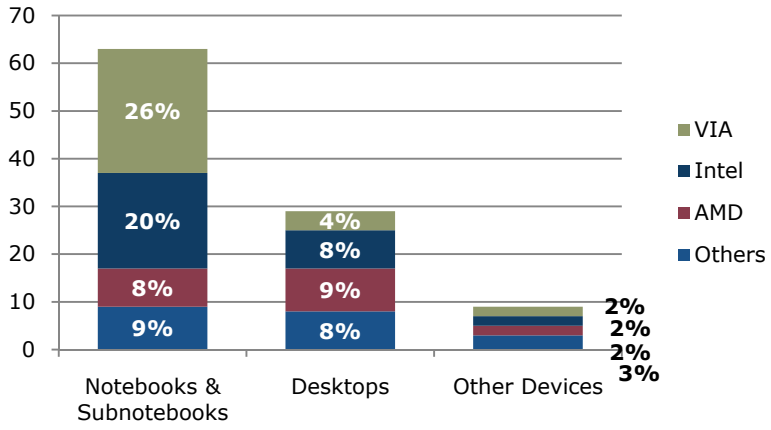
Share of devices

While Intel's Atom processor was recently introduced specifically for use in ultramobile PCs, smart phones and other portable and low-power applications, Intel has not been the favored choice for low-cost computing designs historically introduced to the market. Of the devices reviewed, VIA processors are the most common choice for low-cost computing devices. This data, however, does not represent market share where Intel may still maintain leadership. Figure G below shows the current number of new devices featuring processors by the leading processor companies.

Figure G - Processor Manufacturers/Types per Model



Share of Devices by Processor Manufacturer



Share by Device Category

In the combined notebook and sub-notebook category, VIA leads as the processor of choice for 32 percent of devices. VIA's strong performance in this area is attributed mainly to its Ultra-Low-Voltage processors (VIA C7-M ULV), used in VIA NanoBook and the VIA OpenBook sub-notebook reference designs, as well as in some desktop and handheld devices. VIA was an early entrant into the low-cost computing space and focused aggressively on this area when it was not being addressed by its primary competitors, AMD and Intel.

In the desktop category, AMD leads with its Geode LX processors, used mainly in ruggedized fan-less computing devices. AMD's 50x15 initiative – aimed at bridging the digital divide and providing computing technology access to 50 percent of world population by 2015 – has driven AMD's commitment to the low-cost computing space.[17]

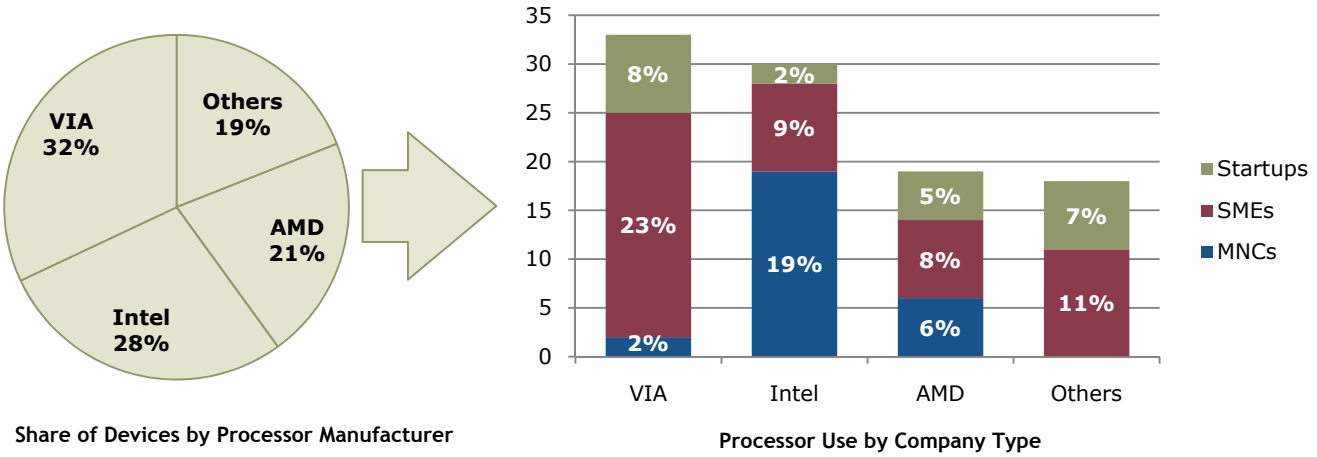
Of the 93 devices reviewed in this research, Intel processors represent 28 percent of these low-cost computing devices. Considering Intel's dominance in other sub-verticals of the computer industry, this number is low.

Other processor manufacturers, not including Intel, AMD, or VIA, account for 19 percent of all devices. Most notable are the Reduced Instruction Set Computer (RISC), Advanced RISC Machine (ARM) and other x86 processors. Devices with these processors include XBurst and Loongson (aka Godson), developed in China but used in multiple devices in other countries including the US and EU. While the XBurst CPU is designed by Ingenic Semiconductor for mobile multimedia portable products, Loongson was developed at China's Institute of Computing Technology as a part of a government project for low-cost computing devices for China's rural students and low-income population.

Utilization by company type

Of the 93 devices reviewed, AMD, VIA and Intel were the primary choices for processor-type. Figure H below shows the major processor companies share of the study's devices in relationship to the type of organization developing the device.

Figure H - Processor Use by Company Type



Share of Devices by Processor Manufacturer

Processor Use by Company Type

AMD represents the most balanced spread across types of organizations employing its processors. MNCs using the AMD processor include:

- **Dell –** Vostro 1000/1500/1510 models, a low-cost notebook series targeting SMEs
- **DTK Computers –** Cruiser 5015, a low-cost desktop computer for the Middle East (part of the AMD 15x50 initiative)
- **Proview –** Proview Handbook PC-81002, a low-cost sub-notebook available in Brazil. (Proview is a MNC, but it does not specialize in computer technology.)
- **AMD –** Personal Internet Communicator (PIC), a low-cost Internet device that was bought and rebranded as the Data Evolution decTOP

AMD Geode processors have enjoyed success largely in ruggedized PCs, which are primarily produced by SMEs and start-ups. Most notably, this includes the OLPC initiative's XO machine.

VIA's NanoBook and VIA OpenBook sub-notebook reference designs are enjoying success mainly with SMEs, many of which are in emerging markets. At the official announcement of VIA Openbook design at Computex 2008, SMEs demonstrated 20 new sub-notebook models using this design. Recently HP began using a VIA processor in its sub-notebook, the HP 2133 Mini Note. Official sales data is still unavailable but projections are that this device may outperform Asus Eee PC.

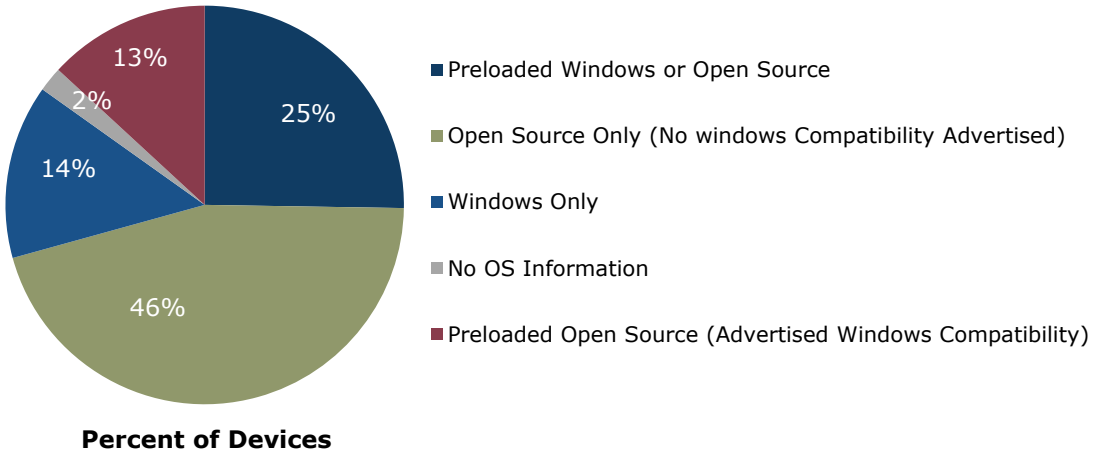
Intel is strong with both MNCs and SMEs. Among the MNCs, Intel processors are used with Asus' leading Eee PC, Acer's sub-notebook, Aspire One and Dell's Inspiron sub-notebook recently released in September 2008. Intel's Classmate PC is distributed both by Intel directly to governments in emerging markets and via SMEs through detailed reference designs. Other processors (besides AMD, Intel and VIA) are mainly used by SMEs, such as Everex, Aware Electronics, and HCL, and start-ups such as Inveneo and Novatium.

Software Trends

The emergence of sub-notebooks and the goal of achieving lower prices has led to an operating system (OS) landscape that differs greatly from that of mainstream mature markets.

As shown in Figure I, a significant portion (46 percent) of the devices reviewed come preloaded with an Open Source OS, while only 14 percent have Microsoft Windows as the primary OS. The strong performance of Linux in the low-cost computing device market can be attributed primarily to its lower price point and its ability to effectively function with limited hard drive capacity.

Figure I - Pre-loaded Operating System



Percent of Devices

Among the Open Source operating systems found on the low-cost computing devices in the study, there are more than 15 different Linux distributions, some of which have been developed specifically for the device on which they are loaded (e.g., Hacao Linux for the Hacao Classmate sub-notebook, gOS and gOS Rocket for Everex's low-cost desktops, notebooks and sub-notebooks).

Twenty-five percent of the devices have been announced as compatible with both a Linux and Windows operating system. True compatibility may be higher as some devices are preloaded with Linux and information about Windows compatibility is not available. For example, both VIA and Intel reference designs are compatible with either operating system. However, device manufacturers using these designs do not always provide information about whether their devices have been tested with a Windows OS.

Research data shows that Microsoft is increasingly becoming an option for low-cost computing devices. From early July, 2008 to late August, 2008, the percentage of devices offering only Linux preloaded dropped from 65 percent of the reviewed devices to 46 percent. Some of Acer's low-cost computing devices either switched their preloaded option from Linux to Windows or began to offer a choice of OS. In terms of distribution channels, Windows-based Eee PCs were pushed into mass-market retailers while Linux-based ones will be sold only by resellers capable of providing the support needed.[18] Even the OLPC XO machine is expected to be offered with Windows in Fall 2009, despite the initiative's early commitment to free software and easy localization.

Manufacturers are increasingly offering a choice between a Linux or Microsoft OS

While the market is showing early indicators that Microsoft uptake exceeds that of Linux, manufacturers are continuing to offer both a Linux-based and a Microsoft option to customers.

Microsoft's strategy in low-cost computing devices (and emerging markets in general) is evolving. Several years ago, Microsoft began selling Windows Starter Edition, a lower-cost edition of Windows

XP now available in 139 countries and 24 languages.[19] Starter Edition is limited to lower-end hardware, runs a maximum of three programs at a time, and has certain standard Windows' features removed.

In May 2008, as part of their response to the low-cost computing trend, Microsoft announced new special prices for devices with limited hardware capabilities – $26 for Windows XP Home on a low-cost machine in emerging markets and $32 for developed markets.[20] The price of a Windows license for the OLPC XO Computer will be as low as $3,[21] underscoring Microsoft's commitment to winning the education market in developing countries. In June 2008, Microsoft extended the life-cycle of Windows XP until 2010 but only as a pre-installed OS in low-cost computers.[22]

Linux gained recognition with the success of Asus' Eee PC. Shortly after its initial launch, the Eee PC became available with a Windows option, and those models now outsell the Linux version. Hugo Ortega, principal of Tegatech, an Eee distributor, estimated that Linux accounts for approximately 20 percent of Eee PC sales and less than 5 percent of all ultramobile PC sales.[23]

Part 3 – Conclusions and Implications

The computing industry has made considerable progress driving down the cost of computing technology in the last two years. Technological innovation, a shift in customer expectation, and the media attention afforded low-cost computing initiatives were all responsible for this industry shift.
While lower-income users in rural areas continue to be named as the target market for low-cost computing devices, access to technology is still limited for mass-market consumers in emerging markets. Poor infrastructure, challenging distribution channels, and limited purchasing power of consumers make developing countries a lower-priority market for technology companies. This research shows that low-cost devices being introduced into the market are increasingly targeting upper-income consumers that have higher performance requirements. These new devices also have less emphasis on ruggedization or alternative energy options.

Linux initially enjoyed increased publicity and greater acceptance among companies introducing low-cost computing devices. New software pricing strategies for low-cost devices and consumer demand appear to be causing an increase in Windows XP as a preloaded or post-market option for new devices.

While the OLPC initiative fell short of its ambitious goal to outfit each child in developing countries with a laptop, the organization has had a considerable impact on current and future technology users. The selection of devices under $500 has increased substantially since 2004. However, few devices are being introduced below the $300 price point made popular by OLPC's goals.

Many emerging markets experienced an upsurge of local SMEs developing low-cost devices. However, SMEs often lack the resources to expand beyond local markets, so many new devices are not available to a global audience. Companies with broader global reach have a greater potential for achieving scale with their low-cost devices. The limited geographic availability of many SME-driven products, especially in emerging market, presents global manufacturers with a strategic opportunity to address distribution gaps. Through direct business or strategic partnerships, global manufacturers would do well to ensure that low-cost computing designs are available in under-represented regions.

Manufacturers have most recently focused on the introduction of sub-notebooks in the low-cost computing device segment. This form-factor has received a great deal of attention, particularly since the Asus Eee PC demonstrated market viability in November 2007. The recent attention given sub-notebooks by the media and early sales results from companies like Asus demonstrate that the clamshell design style is considerably more popular than other form factors. This is being observed in both low-cost and more traditional markets worldwide. Because sub-notebooks are mainly being purchased by mature-market customers, it remains to be seen if the clamshell form factor will see wide adoption in emerging markets as well.

The market for low-cost devices will continue to expand as local SMEs and multinational computer companies seek continued growth. With saturated markets in wealthier segments in the developed world (and the top of the economic pyramid in the developing world), lower-pyramid markets demonstrate a ripe growth opportunity for technology companies. However MNCs are still perfecting the formula for profitable, sustainable growth in these new markets. "Low-cost" products do not necessarily mean "affordable" or "accessible" in emerging markets. For accelerated revenue growth in the developing world, a well-designed, low-cost computing device needs to be accompanied by an appropriate and well-designed delivery value chain, go-to-market strategy and business model that complement the low-cost device.

Appendices

Appendix A: Data and Methodology

Data Sources

Vital Wave Consulting conducted a comprehensive review of press releases, news websites, specialized websites containing information about low-cost computing devices and initiatives, and the official websites of device manufacturers. This included in-depth analysis of IT news websites which provided official press information from IT-related publishers (e.g., PC World, ComputerWorld, eWeek), authors' comments, and readers' posts. The official websites of device manufacturers served as a dependable source for product specifications, and online technology stores provided more current pricing details in some instances.

Vital Wave Consulting maintains a public bookmarks website (http://del.icio.us/vwc) with numerous links to low-cost computing and mobile device articles. A selection of useful web sources and brief descriptions of their content are also provided below.

Challenges and Caveats

While news of low-cost computing devices and, more specifically, sub-notebooks has been readily available since 2007, the reliability of data is often questionable. Information reported in the press is often not available from manufacturers' websites. For example, a company may announce its interest and intention to enter the low-cost computer market but fail to report any concrete plans or product launches. Vital Wave Consulting validated product information from multiple sources.

Because this research relied primarily on news-related sources, the prevalence of sub-notebooks in the research may be impacted by the timing of the research, press bias, and the manufacturers' choice to announce. There has been a recent barrage of announcements of new entrants to the sub-notebook market forcing a disproportionate amount of media coverage of the topic. The press has dedicated considerable coverage to what has been seen as the innovative designs often present in sub-notebooks. And, in an effort to capitalize on public interest in the topic, manufacturers may have opted to publicize sub-notebook releases over traditional computing device releases.

Press releases and news websites

- Technorati (www.technorati.com)
- X-bit labs (www.xbitlabs.com)
- DigiTimes (www.digitimes.com)
- Laptop-Computers (laptopcom.blogspot.com)
- Engadget (www.engadget.com)

Specialized websites

- UMPC Portal (www.umpcportal.com/products) – a list of 100+ notebook, sub-notebook and handheld devices some of which are in the "low-cost" price range

- French-speaking Linux and Free Software Users' Association (http://www.aful.org/metamorphose/ultra-portables-umpc) – a list of 80+ notebooks and sub-notebooks, updated regularly
- Tom's Guide (http://www.tomsguide.com/us/mini-notebook-asus,review-1087.html) – profiles and comparison chart of 12 sub-notebooks
- Liliputing.com (http://www.liliputing.com/2008/04/over-past-six-months-or-so-asus-everex_24.html) – a comprehensive list of computing devices with profiles of the most popular low-cost sub-notebooks
- Cloudbook UMPC (http://cloudbookumpc.com) – a resource for Everex Cloudbook & other sub-notebooks with regularly updated news, reviews, guides and discussions
- AMD 50x15 initiative website (http://50x15.amd.com/en-us/sol_tech.aspx) – contains AMD supported initiatives for bridging the digital divide, including low-cost computing devices targeting emerging markets
- Infodev's Quick Guide: Low-cost computing devices and initiatives for the developing world (http://www.infodev.org/en/Publication.107.html) – a summary of early low-cost computing device projects

Official websites of producers and online stores

- Amazon.com
- PConline.com.cn
- Alibaba.com

Research Methodology:

The research was executed in three phases:

Phase 1: Extensive secondary research examining potential sources of data and drafting a list of 93 qualifying devices. Qualifying devices included all computing devices labeled as low-cost, falling below $500 (or $400 for desktop computers), or targeting emerging markets. This phase included the creation of a spreadsheet and an initial capture of relevant data points as described in Table 2 on page 11.

Phase 2: Data gathering and short-listing. A comprehensive scan of data sources yielded additional details on targeted devices. Devices were then "short-listed" if they met *all* of the following criteria:

- Price not higher than $400 for desktop computers (incl. display) and $500 for all others.
- Computing device as defined on page 5.
- Based on current technology or design configurations *or* based on out-dated technology but with new adaptations specifically for emerging markets. Some computer configurations fit the target price range but are outdated or simply low-end versions of a standard product. This criterion omits desktop PCs and thin-client devices that may fit

the required price range but only because they are using outdated components or have been assembled with less computing power than a standard PC.

- Developed or announced after 2004. This criterion ensured reasonable price comparability.
- Currently available, announced or discontinued. *Discontinued devices were included in the research in an effort to assess the history of low-cost devices not what is available only today.*

Appendix B: Market Leaders

This appendix contains brief overviews of the major market players including the available data about sales and projections. Sales projections for many of the devices in the research are premature, speculative or unavailable. Since many of the devices have been on the market for less than one year, existing sales numbers and projections are not indicative of future growth. As a result, this research focuses exclusively on the number of devices and attributes equal weighting in the analysis to devices by MNCs with global reach and SMEs or start-ups with a single product serving a local audience.

Asus (Eee PC)

Asus Eee PC sub-notebook was introduced in June 2007 and its success attracted many others to the market. Initially, the Eee PC was offered with 2GB and 4GB SSD built-in storage, 512MB RAM, 900MHz Intel Celeron-M processor, a 7" display and Xandros Linux OS for $299-349 in the US market. Currently, four Eee PC models are available below $500, with variations primarily in storage capacity – up to 8GB SSD and up to 1GB RAM. Later modifications above $500 include models with 8.9" and 10.2" displays, larger storage space (up to 80GB HDD), a 1.6GHz Intel Atom processor and an option to choose between Xandros Linux OS and Windows XP.

The Asus Eee PC benefited from being first-to-market and by offering a variety of models that appealed to a broader customer segment at different price levels. Initially, the Eee PC targeted the education market and first-time laptop users. But the company quickly responded to general interest in the consumer space in a second or travel computing device.

Asus sold 350,000 sub-notebooks in the first eight months of wide market availability (July 2007 to February 2008)[24] and projected sales of 2 million in H1 2008 and 3 million in H2 2008. According to DigiTimes, 1.7 million devices were shipped in the first half of 2008, which was 300,000 less than expected.[25] While no year-end sales figures have been released, analysts expect Asus to lead in sub-notebook sales globally in 2008. However, indicators show that Asus' competitors are aggressively targeting the sub-notebook space. Acer intends to sell 5-6 million Aspire One sub-notebooks in 2008,[26] and in February 2008 HP ordered 2 million units of its 2133 Mini-Note from its supplier.[27] Dell predicts sales of 2-3 million units of the Dell E.[28]

One Laptop per Child (OLPC XO)

Announced in January 2005, the OLPC initiative aimed to provide a laptop for every student in developing-country schools. Production of the XO sub-notebook began in November 2007 but did not achieve the targeted $100 price point. The non-profit organization claims that each machine costs $185 to manufacture, but the price point will fall as production volume increases. The project fell far short of founder Nicholas Negroponte's initial target of selling 150 million laptops[29] by the end of 2008, as well as Quanta's (XO Computer manufacturer) more modest estimate of 10 million units for 2007. However, credit is still given to the initiative for pushing other computing device manufacturers into designing for the low-cost sub-notebook category.

The OLCP XO is recognized industry-wide for its innovative technical design. Designed for use in rural areas where electricity is often unstable and network infrastructure unavailable, the XO is ruggedized, consumes only 2W per hour, has mesh-networking capabilities, works with a generator, and is less expensive than the Classmate PC. The sub-notebook comes with Fedora Linux and Sugar

GUI developed exclusively for the OLPC initiative with the intent of localizing each distribution for the country in which it was being deployed. The XO has a 433 MHz AMD Geode LX-700 processor, 256MB RAM, 1GB flash storage and a 7.5" display.

The XO Computer is being sold to governments and institutions or directly to consumers through the "Get One, Give One" program. Pilots in several developing countries have been completed and the first non-pilot deployment started in 2007 with 100,000 units in Uruguay. Sales figures are currently estimated at 700,000 units. Some expected deals (e.g., 1 million units for Nigeria and 1.2 million units for Libya) were lost to Intel's Classmate PC. Possible reasons for the OLPC's marginal success are the lack of corporate experience in building a PC business and inferior distribution and support networks. In this regard, critics say that the comparable cost of the XO Computer is far above $200 when support, deployment and other costs which are normally included in its competitors' pricing are considered.[30] While OLPC was originally committed entirely to free and Open Source software, many governments have purportedly asked for a Windows option. A version of the XO-1 with Windows XP was announced in May 2008.

In 2008, OLPC announced the successor to XO (or XO-1), the XO-2 – a book-model appliance device with touch-sensitive displays projected to cost $75 and be available in 2010.

Intel (Classmate PC reference design)

Intel Classmate PC reference design, a ruggedized educational laptop designed as an alternative to OLPC's XO Computer, was released in September 2006. Sub-notebooks using Intel's design but produced by SMEs entered the market in 2007 and targeted local markets exclusively, primarily in developing countries. Additionally, Intel started selling (and donating small numbers of) its Classmate PCs directly to governments and institutions. The largest deals to date are:

- Libya: pledge to buy 150,000 [31]
- Pakistan: pledge to buy 700,000 [32]
- Portugal: pledge to buy 500,000 [33]
- Mexico: pledge to buy 300,000 [34]

Of these pledges, only the Portugal deployment is fully underway. In April 2008, Intel announced a second generation Classmate (2goPC) and made it available through partners in the US and EU. Both Classmate designs use 900MHz Intel Celeron processor, 256/512MB RAM, 1/2GB flash memory (and a 30GB HDD for 2goPC), 7"/9" displays and can be ordered with Linux Mandriva or Windows XP. The price for 2goPC in the US is $399[35] while the price for bulk purchases might be as low as $200.[36] In addition, Intel's Atom processor series has accelerated its adoption in low-cost computing devices. While the timeframe of this report (researching ending August 2008) did not allow time for manufacturers to fully adopt the new low-cost processor, expectations are that it will dramatically increase Intel's market share in low-cost computing devices.

VIA (NanoBook and OpenBook reference designs)

While Intel and AMD competed in designing increasingly powerful processors, VIA concentrated its efforts on making processors smaller and more efficient. As a result, as sub-notebooks increased in popularity, VIA was best prepared with the most robust offering in this category. The Taiwanese chip manufacturer's NanoBook and OpenBook designs, released at Computex in June 2007 and June 2008 respectively, are used in many of the devices currently on the market and 33 percent of the 93 devices reviewed in this report.

The NanoBook features a 1.2GHz VIA C7-M processor, 512MB RAM, 30GB HDD storage and a 7" display. The OpenBook's processor is 1.6GHz, memory is increased to 1GB RAM and 80GB HDD, and the display is 8.9". The sub-notebooks can run both Windows XP and Linux OS.

The success and abundance of VIA designs can be attributed to both technological and business factors. VIA processors have been designed specifically for smaller devices such as handhelds and sub-notebooks and are, therefore, more efficient. VIA has also broadened its business to support new designs and a broad network of partners worldwide to bring those designs to the market. Since many of these partners are local SMEs in developing countries, this provides a global footprint for VIA products. Recently, HP launched the HP 2133 Mini-Note using the VIA OpenBook design. In some geographies, the HP Mini-note is outselling the Eee PC twenty-to-one.[37]

NComputing

Founded in 2003, NComputing is a start-up dedicated to providing low-cost computing access based on the thin-client model. The company serves 15,000 institutional customers in 80 countries worldwide and targets sales of 1 million seats in 2008. Another 1 million deployments have been completed, mainly in educational institutions, making NComputing more successful in terms of units sold than the OLPC initiative. Among these deployments is the computerization of the schools in Macedonia with 180,000 NComputing L-Series seats.

Technologically, NComputing sells thin-clients without a processor, RAM or storage space. Client terminals connect to and use the resources of a host computer. The number of devices connected to the host depends on its configuration, but NComputing claims that a standard PC can host up to seven devices. In this way, NComputing provides a very energy-efficient and easily manageable solution at a price below $200 per seat. Moreover, the device is a box without any moving parts, making the solution inherently ruggedized for industrial settings – the second largest customer segment for NComputing after education.

According to NComputing, 35 percent of its sales come from the US, and 50 percent from developing countries. India's share currently is only 7 percent, but expectations are that it will rise to 35 percent after the first successfully executed deployments. NComputing claims its success can be attributed to the local presence of the company. While OLPC negotiates directly with governments and leaves deployment, support and maintenance to the buyer, NComputing has a large network of local distributors, value-added resellers and a successful sales force.

Publication Details

This report is produced by Vital Wave Consulting. Vital Wave Consulting enables accelerated revenue growth in emerging markets through strategic consulting, market research and business intelligence. Clients include multinational corporations, start-up firms, and foundations in the information technology and telecommunications industries. The findings and commentary herein, and in all associated reports produced by Vital Wave Consulting, are derived from original research and authoritative sources. They are actionable at the reader's discretion, and Vital Wave Consulting shall have no liability for errors, omissions or inadequacies in the information contained in this report. The opinions expressed herein are subject to change without notice. Vital Wave Consulting disclaims all responsibility for losses, and waves all rights to profits, incurred as a result of following the conclusions or recommendations of this or any other Vital Wave Consulting report.

Rights and Permissions

Licensing Agreement

Links to Supporting Data

[1] http://community.seattletimes.nwsource.com/archive/?date=20050404&slug=btvolkscomputer04
[2] http://arstechnica.com/news.ars/post/20051210-5735.html
[3] http://www.washingtonpost.com/wp-dyn/content/article/2007/11/17/AR2007111700180_pf.html
[4] http://www.technologyreview.com/Biztech/20711/?a=f
[5] http://www.digitimes.com/news/a20080407PD204.html
[6] http://www.newsweek.com/id/41724
[7] http://www.ncomputing.com/Casestudies/Education/RepublicofMacedonia/tabid/92/Default.aspx
[8] http://www.intel.com/pressroom/archive/releases/20080730corp.htm
[9] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTENERGY2/0,,contentMDK:21456528~menuPK:4140673~pagePK:210058~piPK:210062~theSitePK:4114200,00.html
[10] http://www.informationweek.com/news/hardware/desktop/showArticle.jhtml?articleID=207601175
[11] http://www.nytimes.com/2008/07/21/technology/21pc.html?_r=1&ref=business&pagewanted=all&oref=slogin
[12] http://mic.iii.org.tw/english/press/research_PR.asp?func=press&Doc_sqno=6256
[13] http://www.informationweek.com/news/hardware/desktop/showArticle.jhtml?articleID=207601175
[14] http://www.marketnews.ca/news_detail.asp?nid=2636
[15] http://www.asus.co.nz/news_show.aspx?id=13020
[16] http://apcmag.com/linux_not_essential_to_eee_pc_success_asus.htm
[17] http://15x50.amd.com
[18] http://apcmag.com/linux_not_essential_to_eee_pc_success_asus.htm
[19] http://www.microsoft.com/presspass/newsroom/winxp/WinXPStarterFS.mspx
[20] http://www.pcpro.co.uk/news/195915/microsoft-to-slash-price-of-xp-for-lowcost-laptops.html
[21] http://www.nytimes.com/2008/05/16/technology/16laptop.html?partner=rssnyt&emc=rss
[22] http://news.bbc.co.uk/1/hi/technology/7435278.stm
[23] http://apcmag.com/linux_not_essential_to_eee_pc_success_asus.htm
[24] http://www.nytimes.com/2008/07/21/technology/21pc.html?_r=1&ref=business&pagewanted=all&oref=slogin
[25] http://www.digitimes.com/systems/a20080709PD220.html
[26] http://www.infoworld.com/article/08/07/31/Acer_scales_down_Aspire_one_netbook_shipment_target_1.html
[27] http://www.engadget.com/2008/02/26/hp-so-confident-in-the-umpc-2133-its-building-2m-units/
[28] http://eeepc.net/dell-hints-on-the-release-of-dell-e-netbook-by-august/
[29] http://blogs.zdnet.com/BTL/?p=7135
[30] http://government.zdnet.com/?p=3828
[31] http://www.ifiwasamillionaire.com/index.php?s=libya
[32] http://www.app.com.pk/en_/index.php?option=com_content&task=view&id=7442&Itemid=2
[33] http://news.wired.com/dynamic/stories/C/CLASSMATE_PC_PORTUGAL?SITE=WIRE&SECTION=HOME&TEMPLATE=DEFAULT&CTIME=2008-07-30-07-02-28
[34] http://arstechnica.com/news.ars/post/20070522-olpc-miffed-by-shameless-competition-in-emerging-markets.html
[35] http://www.amazon.com/gp/product/B0016ONIS0/sr=8-1/qid=1211725602/ref=noref?ie=UTF8&s=electronics&qid=1211725602&sr=8-1
[36] http://pcworld.about.com/od/notebooks/Intel-s-Classmate-PC-Enrolls.htm
[37] http://apcmag.com/linux_not_essential_to_eee_pc_success_asus.htm

