THE MOBILE HANDSET OUTSOURCING LANDSCAPE

by

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ABSTRACT

This document describes the handset industry players – component vendors, contract manufacturers, original design manufacturers, OEMs – and explores the shifting roles and relationships between them. Focus is given to ODMs and brands of mobile devices, with particular attention to design models between them. A relationship map represents the industry's outsourcing structure, seeking to identify trends and patterns between successful firms' performances and their partners. Handset designs originate largely from OEMs and ODMs, but innovative firms also gravitate towards certain design flow models. The commoditization of mature technologies and basic reference designs further allows new entrants to develop products with relative ease, creating complementary assets as prized core competencies: OEMs developing key design and feature innovations in-house are found to enjoy stronger brand value, better global sales, and higher profits. ODMs taking their own design lead also rank higher in shipment volumes than those mainly manufacturing client designs.

Keywords: mobile handset; outsourcing; supply chain; OEM; manufacturer; ODM

DEDICATION

While numerous friends and family have been encouraging of my endeavours over the duration of this project document, the following people have been particularly instrumental to its completion.

To my lovely fiancée, Maggie Huang, who has endured my late nights and general neglect in the days throughout this project, and given me the strength to carry on in difficult times.

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GLOSSARY

3GPP	The 3rd Generation Partnership Project (3GPP) is a collaboration between groups of telecommunications associations, to make a globally applicable third generation (3G) mobile phone system specification. 3GPP specifications are based on evolved GSM specifications. 3GPP should not be confused with 3rd Generation Partnership Project 2 (3GPP2), which specifies standards for another 3G technology commonly known as CDMA2000. (Wikipedia, n.d.)
ASIC	An application-specific integrated circuit (ASIC) is an integrated circuit customized for a particular use, rather than intended for general-purpose use. For example, a chip designed solely to run a cell phone is an ASIC, as is a chip designed only to encode and decode audio signals.
CE Marking	The CE marking is a mandatory European marking for certain product groups to indicate conformity with the essential health and safety requirements set out in European Directives. ("CE" has no official meaning as an abbreviation.) To permit the use of a CE mark on a product, proof that the item meets the relevant requirements must be documented. This can be achieved using an external test house or certification body, or can be achieved by a documented, company-internal self-certification process (Wikipedia, n.d.). For mobile handsets, CE marking requirements include certification standards defined according to the Radio and Telecommunications Terminal Equipment (R&TTE) Directive.
CM	Contract Manufacturer. See also EMS.
EMC	Electromagnetic compatibility (EMC) is the branch of electrical sciences which studies the unintentional generation, propagation and reception of electromagnetic energy with reference to the unwanted effects that such energy may induce (Center for Devices and Radiological Health, 2006). EMC of a device means that the correctly operating device is compatible with (i.e., causes no interference in) its electromagnetic (EM) environment and it does not emit levels of EM energy that cause electromagnetic interference (EMI) in other devices in the vicinity.
EMS	An electronics manufacturing service (EMS), also referred to as a contract manufacturer (CM), manufacturers components and/or products for another (client) firm, according to the client's product design and specifications. Generally, the manufacturer is hired on a contract basis, and quotes based on

the bill of materials, plus labour and other costs such as shipping the completed units on behalf of the hiring firm (Wikipedia, n.d.).

FCC — The Federal Communications Commission (FCC) is a United States government agency charged with regulating all non-Federal Government use of the radio spectrum (including radio and television broadcasting), and all interstate telecommunications (wire, satellite and cable) as well as all international communications that originate or terminate in the United States. It is an important factor in US telecommunication policy.

GPS — The Global Positioning System (GPS) is one type of Global Navigation Service (GNSS), and is a navigation and precise-positioning tool that uses satellite technology to enable a terrestrial terminal to determine its position on the Earth in latitude and longitude. GPS receivers do this by measuring the signals from three or more satellites simultaneously and determining their position using the timing of these signals (The Tech FAQ, n.d.).

GSM — Global System for Mobile communications (GSM: originally from Groupe Spécial Mobile) is the most popular standard for mobile phones in the world. The GSMA estimates that 82% of the global mobile market uses the GSM standard (GSMA, n.d.).

GSMA — Founded in 1987, The GSM Association (GSMA) is a global trade association representing more than 700 GSM mobile phone operators across 217 territories and countries of the world. The GSM Association's Board comprises top-level representatives of some of the world's leading mobile operators, such as Cingular Wireless (now AT&T Mobility), China Mobile, Orange, Telefonica Moviles, T-Mobile and Vodafone (GSMA, n.d.).

IC — Industry Canada is the department of the Government of Canada with responsibility for regional economic development, investment, and innovation/research and development.

MMS — Multimedia Messaging Service (MMS) is a standard for telephone messaging systems that allows sending messages that include multimedia objects (images, audio, video, rich text), not just text as in SMS. It is mainly deployed in cellular networks along with other messaging systems like SMS, Mobile Instant Messaging and Mobile E-mail. Its main standardization effort is done by 3GPP, 3GPP2 and Open Mobile Alliance (OMA) (Wikipedia, n.d.).

ODM — An Original Design Manufacturer (ODM) is a firm that manufactures a finished product that will be branded by another firm for sale. An ODM creates the handset based on the customer's requirements or feature requests, or completely based on its own requirements to then be rebranded.

OEM An Original Equipment Manufacturer (OEM) in the mobile handset industry is a firm that rebrands the handset manufactured by a contract manufacturer or original design manufacturer. The OEM possesses the brand name on the final handset that consumers are familiar with. In other industries, this role is called a value-added reseller (VAR) (Everything and the Mobile Software Universe…, 2006).

OED An Original Equipment Designer (OED) designs a handset model or product line according to customer requirements, but does not manufacture the product in-house. The OED works closely with component vendors in the design, and recommends or outsources the manufacturing of the designed handset.

MVNO Mobile virtual network operators (MVNOs) resell mobile services from mobile network carriers, and typically provide additional value-added features and services or offer a different distribution channel than the mobile network carriers. An MVNO provides this mobile phone service but does not have its own frequency allocation of the radio spectrum, nor does it have all of the infrastructure required to provide mobile telephone service (Wikipedia, n.d.).

PTCRB PTCRB was established in 1997 by North American operators to provide the framework within which GSM or UMTS handset certification can take place (PTCRB, n.d.). The PTCRB now includes operators from around the world.

SMS Short Message Service (SMS) is a communications protocol allowing the interchange of short text messages between mobile telephone devices, and the term "SMS" is used colloquially as a synonym for a text message from another person or the act of sending a text message. Most SMS messages are mobile-to-mobile text messages, though the standard supports other types of broadcast messaging as well (Wikipedia, n.d.).

1 INTRODUCTION

The mobile industry has enjoyed increased growth in recent years. A proliferation of increasingly capable wireless devices at more acceptable price points has benefited the consumers. New features in these devices have emerged with the continuing deployment of and access to both developing and mature wireless technologies standards. Together, these hardware and software systems bring about an ever-broadening variety of mobile services and content for the average user.

While the consumer-facing aspects of the mobile industry are undergoing tremendous advancements, so too are the myriad corporations designing, manufacturing, and marketing the devices to their targeted demographics.

This document explores the shifting roles and relationships between the mobile industry players, focusing particularly on the original design manufacturers and the brands of these manufactured mobile products. Where most industry papers describe the component vendors' relationships with mobile phone OEM brands, this paper examines a selection of leading global handset designers and their relations with the manufacturers (brands) with particular attention to the design models between them. Specifically, a relationship map is drawn and introduced to graphically represent a snapshot of the mobile handset industry's outsourcing structure, seeking to identify trends and patterns between successful firms' performances, whom those firms have elected to partner with, and in what capacity.

2 MOBILE HANDSET INDUSTRY

The mobile handset industry comprises a plurality of players and interactions between those players. A brief description of a mobile phone is presented in Section 2.1 ("Mobile Phone"), whereas Section 2.2 ("The Players", page 3) provides an explanation of the types of firms involved in the mobile handset industry. The firms' relationships and recent trends in their cooperative efforts are outlined in Section 2.3 ("From Components to Complete Device"). Section 3 , "Supply Chain Models", continues on to examine the various outsourcing models employed by the various firms introduced here.

2.1 Mobile Phone

The mobile phone is a portable electronic device used for mobile communication. Most current mobile phones connect to a cellular network of base stations (cell sites), which is in turn also connected to the public switched telephone network (PSTN) (Wikipedia, n.d.). According to IDC (IDC, 2008), the vast majority– an estimated 82% – of mobile phones around the world operate on GSM cellular networks on various frequency bands depending on region.

In addition to the familiar voice services (making and receiving telephone calls), virtually all of today's low-end mobile phones are at least "talk and text" handsets, incorporating SMS/MMS text messaging features. The entry-market handsets may also have added features, such as a camera or music player, but the targeted use of these low-

cost models is primarily telephony and perhaps messaging (DiGrande, Netteshim, & Kim, 2005).

Most high-end mobile phones (also referred to as smartphones or PDA phones) now also have integrated functions such as personal information management, multimedia, games, or office applications. The key difference between an entry-level phone and a smartphone is that a smartphone uses two operating systems: one for the real-time critical communications, and the other for applications (Anderson & Jonsson, 2005). To support this difference, high-end handsets typically incorporated a dedicated application processor for running those applications. Email and general or specialized Internet access is also becoming commonplace in these advanced handsets, offering clear productivity advantages for mobile workers, and are increasingly appearing at price points once occupied by more simplistic phones (Vile, 2007). With mobile entertainment gaining popularity, wireless devices are also being developed with more auxiliary features, such as a camera that easily sends photos to be printed or a built-in iPod or gaming engine (DiGrande et al., 2005).

In this document, the devices in question may be referred to by a number of names, including mobile phone, mobile, cellular phone, cell phone, hand phone, handset, mobile terminal, smartphone, mobile device, etc.

2.2 The Players

The numerous players involved in the creation of a mobile handset are described here. Their relations to each other in supplier-client roles are described further in Section 2.3 ("From Components to Complete Device", page 15).

2.2.1 Component Vendor

A component supplier designs and manufactures the various components comprising a mobile handset. The most common such components include the baseband chipset, application processor, software, printed circuit board (PCB), battery, LCD display, memory, camera module, keypad, interconnector and wiring, housing (case), etc. Table 1 below shows sample costing of the components, varying from low-end choices to high-end selections, as well as example vendors of each type of component: the specifications of a mobile phone range greatly with the cost of its constituent parts.

Table 1: Components and Parts of a Mobile Handset

Component / Part	Low-End Cost (USD)	Low-End Description	High-End Cost (USD)	High-End Description	Example Suppliers
DSP / baseband	$5.00	GSM	$14.00	3G	ADI, Broadcom, Freescale, TI, Mediatek, Qualcomm, Skyworks
ASIC / application processor	$15.00		$30.00		Intel, TI, Corelogic, SEC, Renesas, Mtekvision
PCB	$2.00	rigid	$10.00	flexible	Unimicron, WUS PCB, Compeq, Unitech, Flexium, Ichia
Battery	$2.00	NiMH	$3.00	Li-ion	Sanyo, BYD, Samsung SDI, LG Chemical, Sony, MEI
LCD module	$2.50	mono-STN	$25.00	high-res TFT-LCD	SEC, AUO, Innolux, Samsung SDI, Wintek, BYD, Sharp
Memory	$5.00	NAND	$25.00	NAND+DRAM	SEC, Toshiba, Hynix, Fujitsu, Toshiba
Camera module	$4.00	VGA	$10.00	2 megapixel	LITE-ON, Flextronics, Chicony, Altus, SEMCO, Powerlogics
Keypad	$1.00		$3.00		Silitech, Ichia, You Eal, SunArrow, Shin Etsu, BYD, Sunningdale
Connectors	$2.00		$4.00		Hirose, Hosiden, JAE, FIH, Cheng Uei, UJU Electronics
Casing	$2.00	plastic	$6.00	light metal	FIH, TGP, BYD, Foxconn Tech, Silitech, Catcher, Waffer, FuYu
Acoustics	$0.60	speaker + mic	$3.00	handsfree	Hosiden, MEI, Merry, AAC Acoustic
Total	**$41.50**		**$133.00**		

Sources: JPMorgan, 2006, and Kramer, 2007

Suppliers offering the major components of a mobile device system – the baseband, application-specific integrated circuits (ASICs), and other processors – normally provide supporting firmware and drivers, and are generally referred to as

platform vendors, operating system (OS) vendors, and intellectual property (IP) vendors (Everything and the Mobile Software Universe, 2006).

Platform vendors are seen as the main hardware supplier of the supply chain, and supply the essence of the handset: its chipset. The handset chipset consists of a main processor (CPU) and an associated RF baseband processor at a minimum, but platform provider offerings can range from hardware design only (with standard ASICs) to total system solutions that include hardware, software, customer support and customer training, in efforts to help manufacturers quickly start developing their products (Anderson & Jonsson, 2005). These platform suppliers include Texas Instruments, Qualcomm, Philips Semiconductor, and Mediatek.[1] Ericsson Mobile Platforms (EMP) also licenses complete, end-to-end interoperability tested mobile platform designs to other vendors, offering total system solutions for both 2.5G and 3G including hardware and software, reference design, development tools, support and documentation.

Operating system (OS) vendors in the supply chain are focused on providing operating systems specifically for mobile handsets. A typical OS provides a software platform (including various features such as those provided by or licensed from other firms), which is then integrated with the hardware platform of the handset and other custom software. For smartphones, Microsoft and Symbian/UIQ are amongst the largest OS vendors, and Google's open-source platform Android is eagerly anticipated in 2008; even AOL has announced an Open Mobile Platform (Cell Phone Observer, 2008).

[1] Intel, while a leader in computing processors, is not a major player in the mobile handset platform market due to a lack of a mobile network baseband processor.

Other firms, such as intellectual property (IP) vendors, provide (and/or patent) designs and technologies that are then licensed to the above vendors for integration into their component solutions.

Furthermore, some firms supply only a single component to be used in the manufacture of a mobile handset, while others provide several different (related) components. For example, Table 2 lists some part suppliers of components in a Nokia-branded handset.

Table 2: Nokia Supply Chain for Handsets

Category	Supplier
Handset assembly	Foxconn International Holdings (FIH) Jabil Elcoteq
Cases	FIH Catcher Technology Foxconn Technology
Connectors	FIH Foxlink
Cables	Foxlink
Headsets	Merry Electronics
Displays	Wintek
PCBs	Compeq Manufacturing Unimicron Wus Printed Circuit
PCB assembly	FIH
Keypads	Silitech Technology Ichia Technologies
Flexible PCBs	Ichia Technology Career Technology
Camera modules	Largan Precision
Quartz components	TXC

Source: Commercial Times, 2008

From the above table, FIH International Holdings (FIH), Foxlink, and Ichia Technology each provide two or more components into Nokia's handsets, while Merry Electronics, Career Technology, and Wintek each supply only one.

Standard hardware components such as resistors, capacitors, filters, duplexers have long been standardized, but many of these components – such as the displays,

camera modules, memory, and batteries – lacked standardized interfaces and needed to be customized to be used in the handset designs, creating large efforts of designers and manufacturers. As a result, the industry has has pushed for a swing towards developing conditions for modularity: measurability, and predictability of component attributes and interfaces (Anderson & Jonsson, 2005). At the same time, suppliers of cloned or "copycat" components have also driven the development of standardization of components and interfaces, so their developed products can easily replace any "original" component. These conditions imply a greater competitive pressure on the commoditization of these basic components, placing greater bargaining power downstream from the component suppliers, pushing these suppliers to define their competitive edges via other values than simply volume manufacturing.

2.2.2 Electronics Manufacturing Services (EMS)

An electronics manufacturing service company (EMS), also referred to as a contract manufacturer (CM), manufactures components and/or products for another (client) firm, according to the client's product design and specifications. Generally, the manufacturer is hired on a contract basis, and quotes based on the bill of materials, plus labour and other costs, such as shipping the completed units on behalf of the hiring firm (Wikipedia, n.d.). Contract manufacturers operate large-volume factories and typically operate 24 hours a day, usually in low-cost geographies, as profit margins are extremely tight. The mobile handset EMS manufactures the mobile phone and delivers the finished product, complete with client branding (as applicable). Many well-known companies use contract manufacturing as an alternative to operating their own factories; in fact, very few

of the handsets today are manufactured by the same company as the brand name printed on its housing.

As is expected, EMS providers compete fiercely based on cost. Under the added downward pressure from clients' cost requirements, each EMS is fighting to secure larger volume orders amidst dropping profit margins in order to build sufficient economies of scale and to gain an advantage over its peers. It should be noted that most EMS providers do not make only one type of product. Rather, most EMS providers focus on certain groups of similar products – desktop and notebook computers, mobile devices, or portable entertainment consumer electronics – upon which the different product types can still share volume advantages. As discussed later in Section 2.2.4, EMS suppliers facing tightening margins are also seeking other paths to expansion and higher profitability.

2.2.3 Original Equipment Designer (OED)

An Original Equipment Designer (OED), or reference design house, designs a handset model or product line according to customer requirements, but does not manufacture the product in-house. The OED works closely with component/platform vendors in the design – integrating hardware and software components with an operating system into a tested and verified system solution that can be used to build a mobile phone (Anderson & Jonsson, 2005) – and often recommends or outsources the manufacturing of the designed handset. These firms license their designs to both original device manufacturers (ODMs) and original equipment manufacturers (OEMs), being commonly hired by firms who have strong brand image and marketing capabilities but who lack the design and manufacturing expertise needed for creating a handset.

An example OED is Cellon, with design facilities in China, mainly serving Chinese domestic brands and OEMs such as Konka, Haier, and QiaoXing CECT (Wilson, 2004). Elektrobit of Finland and South Korea's Bellwave are also prominent examples.

Small and nimble start-up OEDs are sprouting as experienced designers spin off from large manufacturers (from semiconductor businesses or platform vendors, for instance). While OEDs are relatively few in number compared to their ODM counterparts and the licensees of their designs remain low (and typically tied to the clients of their parent firms), the OEDs' businesses can be seen as supplemental to the parent company's revenue stream.

2.2.4 Original Design Manufacturer (ODM)

An Original Design Manufacturer (ODM) is a firm that designs and manufactures a finished product that will be branded by another firm for sale, in essence both an OED and an EMS combined. A firm in the ODM role creates the handset based on the customer's requirements or feature requests, or creates the design on its own to then be rebranded. An ODM can simultaneously serve multiple competing clients, but some customers are understandably very sensitive about such arrangements.

Most ODMs came about as contract manufacturers developed their own research and development (R&D) divisions, and started to provide in-house design services for conceptual product development and design assistance, to supplement the manufacturing services offered (Wikipedia, n.d.). Well-known handset ODMs include HTC, Quanta, Compal, Foxconn (and its subsidiary CMCS), and BenQ. Some ODM players have

successfully signed long-term, stable contracts with OEMs, such as Compal has with Motorola.

This role has been dominated by Chinese and Taiwanese firms with manufacturing plants across Asia. Like contract manufacturers, ODM players have shifted and continue to shift production to low-cost geographies in order to leverage low-cost labour and government incentives, and further utilize their economies of scale. The ODMs' design centers remain largely unmoved, however, as ODMs prefer to keep the more difficult task of designing handsets in their R&D headquarters or branches. Between ODMs, unlike the case with their EMS provider roots, competition revolves mainly around the ability to design to OEM specifications and to innovate their own reference designs; in this regard, ODMs must also battle OED firms in the field.

2.2.5 Original Equipment Manufacturer (OEM)

Though the term "Original Equipment Manufacturer" (OEM) normally refers to the company that originally manufactured the product, an OEM in the mobile handset industry is a firm that rebrands the handset manufactured by a CM or ODM (Wikipedia, n.d.). The OEM players bear the well-known brand names – Nokia, Sony Ericsson, Motorola, Samsung, LG, and Apple, to name a few – and are interestingly often called the handset "makers" or "manufacturers", despite not actually performing either of those actions nowadays. Still, OEMs are actively involved in the feature and design requirements of the handsets they commission and brand, and are usually given the credit for the technology and innovation going into their products.

Global OEM brands are facing new competition from local brands as they expand to emerging markets. At the same time, these manufacturers are experiencing increased competition from new entrants in their mature market geographies as ODMs and OEDs become more skilled in the design and specifications of handsets and venture forth into own-brand launches. The major OEMs still enjoy landslide majority market shares, as shown later, leaving lesser-known brands to battle for the remaining share of the pie, but this balance could also shift.

2.2.6 Distributor

Handset distributors provide outlets for consumers to purchase the handsets. The two most common types of distributors for handsets are operators/carriers and retail outlets.

Mobile network operators (also known as "carriers") operate the cellular networks to which handset users subscribe for connectivity service. Network operators offer a selection of handsets and service contracts for consumers. In North America, the handsets are typically subsidized by the carrier to lower the entry cost for a new subscriber, and such costs are recovered over time from the service plan fees. As such, mobile phones in North America are often "locked", allowing the handset to be used only with the operator that has subsidized its purchase cost, to prevent lost service plan revenues. In other parts of the world, however, handsets are generally not subsidized by the operator and can be purchased from any retail outlets and used on any technology-compatible network the consumer chooses. Operators across the globe include AT&T Mobility, T-Mobile, 3, Taiwan Mobile, Telefónica, China Mobile, Vodafone, 02, NTT DoCoMo, SingTel Mobile, and numerous others.

Mobile network operators compete on a number of different facets including cellular coverage and quality, internet data access speeds, entertainment services, and even their selection of subsidized handsets. In the race to provide additional features and services to enlarge their subscriber bases, carriers are also strapped with significant infrastructure costs, both for newly-implemented technologies and older depreciated systems. Mobile virtual network operators (MVNOs) – such as Virgin Mobile, Helio, and Boost Mobile – also fall into this category of player, effectively reselling the mobile services, and typically with additional value-added features and services or offering a different distribution channel, but without the burden of infrastructure building and maintenance.

Retail shops – either general electronics stores or those specializing in mobile products – sell handsets as well, which can be associated with an operator (acting as a VAR), or can be "unlocked" for use with any service technology-compatible provider (operator). Examples of retail shops include Best Buy in the United States, Fortress in Hong Kong, and SoGi (online) in Taiwan.

A third, less-popular method for consumers to acquire mobile handsets is directly from the OEM without a distributor. For instance, Motorola also offers handsets directly through its website. Apple also sells its iPhone handset through its own Apple Store locations, in addition to making them available at AT&T network operator retail outlets in the United States and certain other countries.

2.2.7 Software Vendor

A software vendor integrates various features (of their own design or licensed from other firms) onto the hardware and OS platforms, thus providing additional functionality in the handsets. These features and add-ons can be pre-installed on the handsets (prior to purchase) or can be user-installed later on. Many of the features offered by software vendors also require additional operator-side enhancements (such as co-located servers) to be installed, and thus need service level agreements to be executed between the software vendor and network operator. Carriers are seeking to provide these higher-margin entertainment and productivity service offerings to offset the lower-margin traditional voice services.

Handset software products (aside from the operating system for real-time critical communications) can be divided into two "layers": application engines and applications. Application engines provide the underlying technologies and software components that can be used by applications running over top. For instance, basic software components include codecs (MP3, AAC, Microsoft WMA, Flash video), radio interface protocol stacks (from TTPCom, UbiNetics) and Java engines. The main suppliers of application engines to the GSM market include Nokia Series 60, Microsoft Windows Mobile, Openwave and Sun Microsystems.

Leveraging the application engines underneath, applications can be proprietary, third-party developed (using standardized interfaces), or open-sourced software (Anderson & Jonsson, 2005). Examples of application software vendors include Pocketnet serving multimedia streaming services, Telenav's faux-GPS location capabilities, Opera internet browser, Skype internet telephony, and Omnifone music

downloading services (Thomson, 2008). The software vendor is usually not directly in the flow of goods for a mobile handset and as such is not a focus of this paper.

2.2.8 Testing and Certification Laboratory

Though also not directly in the flow of goods as shown in Figure 1, testing and certification laboratories ("test houses") also play an integral role in approving the release of the handset for regulatory import/export and regional market launch. The test house independently tests the various components and/or final handset according to a multitude of mandatory national, international, and technical standards. Governing bodies include technology consortiums – such as the 3GPP, PTCRB, and GSMA – and regional government agencies – such as the Federal Communications Commission (FCC) in the United States, Industry Canada (IC) in Canada, and CE marking in Europe. The overall objective between the test houses, standards bodies, and industry consortiums is to ensure the technical stability and interoperability of mobile handsets.

Test houses also must be accredited to the DIN EN ISO/IEC 17025 standard in the fields of mobile communications, electromagnetic compatibility (EMC), and radio communications, in order to for test results to be recognized by the regulatory approval bodies. Due to these high barriers to entry, fewer than twenty test houses have been successful in establishing strong market shares. Current market leaders include CETECOM, SGS, 7 Layers, RFI, and Eurofins ETS; most leading test houses have origins in Europe, in traditional technologies and safety testing. Until recently, most test houses established market share by providing high quality of service and expertise, and breadth of test capacity. This, however, has changed as Asian designers placing cost as

priority over service have forced all certification labs to follow suit in a pricing slide to maintain competitiveness.

Several OEMs have acquired test houses, or have grown their own, to integrate the testing function within their business: well-known examples are Research in Motion, Motorola (ADR Labs), and Nokia. Doing so gives the OEM better control over product schedules, but also provides additional assurance for the confidentiality of their designs and intellectual property prior to market announcements and launches.

2.3 From Components to Complete Device

Figure 1 illustrates the general flow of goods from a collection of mobile handset components through to the consumer or end-user. Some firms are also presented as examples of each role within the mobile handset industry, though it is by no means meant to be an exhaustive list.

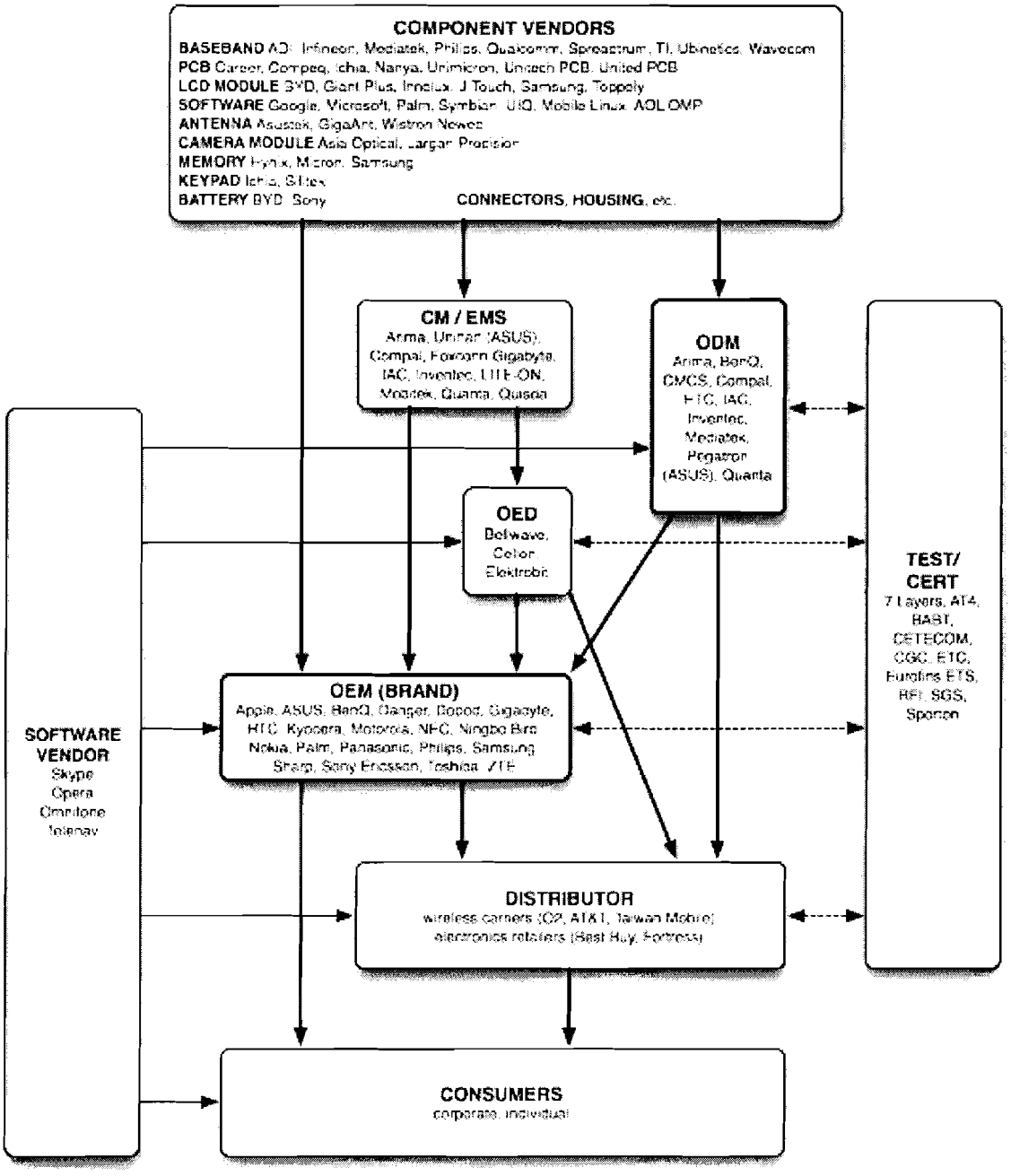

Figure 1: Mobile Handset Industry Flow of Goods

Each type of player as described in Section 2.2 ("The Players") delivers to several different types of players at the next stage in the flow of a handset's creation. The component vendor supplies its components to a CM/EMS, to an ODM (doing both the

design and the manufacturing), and directly to the OEM who has not outsourced its manufacturing. An EMS provides the assembled products according to the design of the OED or directly to the OEM. As a combination of the EMS and OED, the ODM assembles the handset according to its design, and delivers its final product to the hiring OEM.

As seen in the diagram, handset OEMs can source supplies from four different types of firms: components from component vendors, or assembled products from EMSes, OEDs, and ODMs. In most market regions around the world, the OEM supplies the branded (or co-branded) product to distributors (retail stores and network operator channels). In certain business models, the OED and ODM will also directly supply the products to the distributor. Consumers can purchase the product from distributors or directly from the OEM (if this channel is available, such as with Apple Inc.).

From the left side of Figure 1, the software vendor provides additional software to several of the involved levels. Verification and certification activities are conducted by the testing and certification laboratories in collaboration with the ODM, OED, OEM, and distributor (on the right side of the diagram above).

Given the above described sources and supplies, there are several complete paths by which a handset is created, manufactured, and delivered to the final consumer/user.

The most direct path starts with the components from the component vendor being delivered to the OEM to be manufactured in-house, and then delivered as a final product directly to the customer (either from the OEM's retail stores or online). More commonly, however, the component vendors supply to EMSes and ODMs who assemble the components (and likely manufacture some of the custom components themselves),

delivering the final products to the OEM or distributor for branding and resale to the end user.

In the most complex path, comprising the greatest number of individual firms in the chain, the component vendors provide components to an EMS who assembles the device according to the design of an OED, and the completed mobile phone is delivered for the OEM through the chosen distribution channel. Note that the physical products are often shipped directly from the EMS factory to the distribution channel: in such cases, the OEM need not handle inbound and outbound logistics on product shipments, nor product returns and warranty repair work.

Condensing Figure 1 above, Figure 2 shows the same flow of goods limited to (at most) the top ten market share holders of each type.

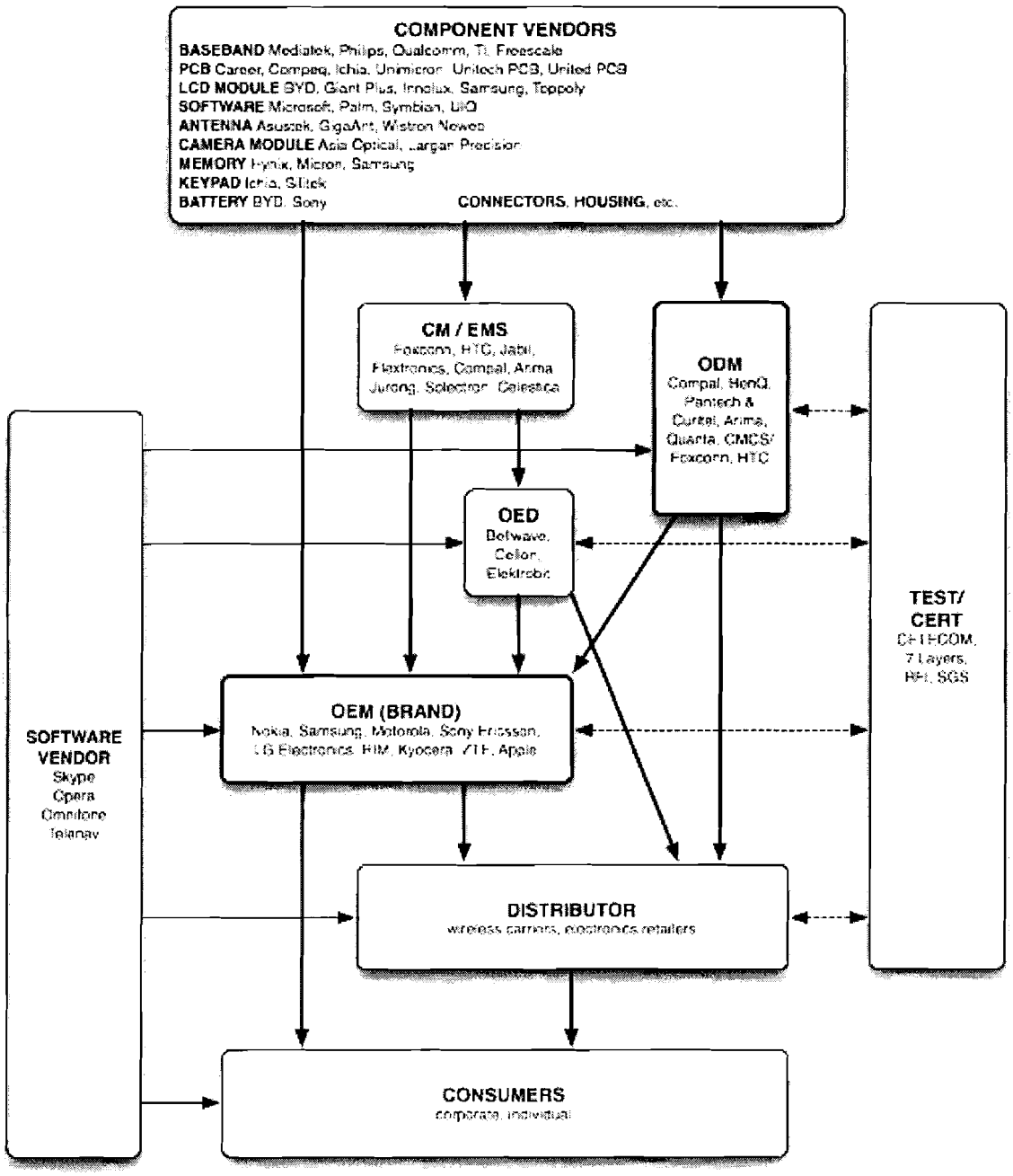

Figure 2: Mobile Handset Industry Flow of Goods, Top Players

3 SUPPLY CHAIN MODELS

The interaction between each of the players described above in Section 2.2 has created an intertwined ecosystem. The flow of goods previously presented (in Figure 1, page 16) shows the supply chain from components to completed product, but the common processes for handset design follow a substantially different direction of flow (Everything and the Mobile Software Universe, 2006). These design flows and some of the driving factors behind their emergences are described in the following paragraphs.

While all firm types are important to the supply chain, it becomes evident from these interactions that handset designs originate largely from firms in one of two roles: the OEM and the OED/ODM. Thus, as detailed later, the currently most notable supply chain movements are: OEM brands outsourcing manufacturing to contract manufacturers, OEM brands outsourcing the design work to ODMs, and ODMs working directly with carriers.

Note that it is often difficult for consumers to discern between handsets designed and developed from the various design flows; these processes are invisible to the handset-buying public.

3.1 OEM In-House Design and Production

Most OEMs with longer histories in the industry began as vertically integrated firms by utilizing in-house design, manufacturing, and marketing for their handset products. The huge sums required in research and development were beyond the means

of most small and medium sized players (Anderson & Jonsson, 2005). As shown in Figure 3 below, all functions from design to production are housed within the OEM.

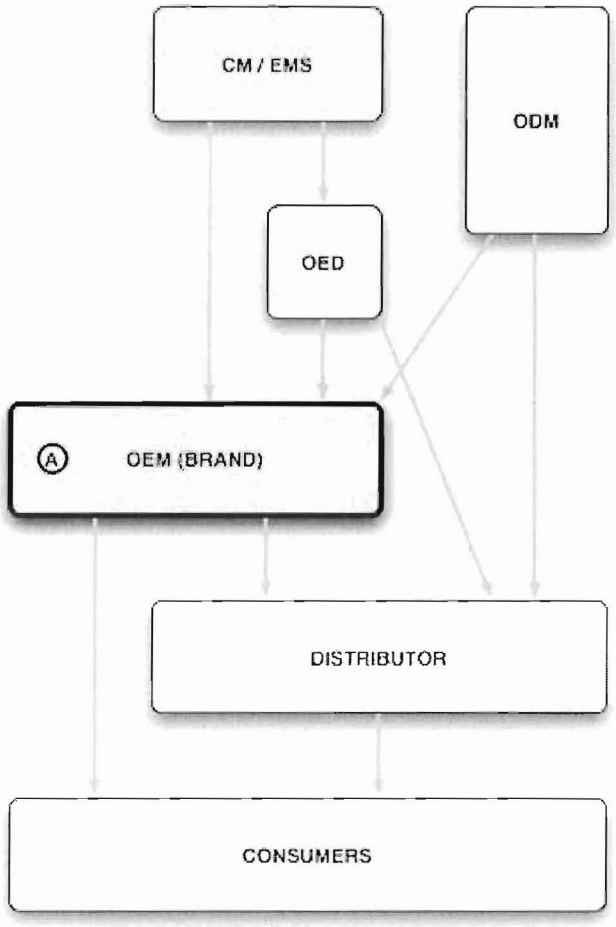

Figure 3: OEM In-House Design and Production

The OEM sources components from vendors: platform vendors for chipsets and silicon, operating systems and software, and other parts. The OEM in this case provides their own hardware design instead of using reference designs offered by component vendors.

Conducting the design in-house allows the firm to exert complete control over its internal supply chain. Doing so also ensures retention of proprietary design and

manufacturing know-how, preserving precious intellectual property, and this knowledge accumulation can have direct positive impact on future products and product lines. This design model is typically used for flagship product models where additional R&D efforts can lead to a competitive edge.

Today, while both Samsung and LG still undertake manufacturing in-house, brands with both in-house design and production are becoming scarce as most have embraced the advantages of outsourcing the manufacturing (detailed further in the next section).

3.2 OEM Design, Outsourced Manufacturing

In this process (shown in Figure 4, below), the OEM designs the handset model, again sourcing components and platforms but using its own hardware design. Once the design is stabilized and specifications are clear, the semi-integrated OEM outsources the production to an EMS (DiGrande et al., 2005). Usually, the final product is directly delivered through to distributors and shipping is handled by the EMS. The OEM may hire resources from a design company (such as an OED) to help design the handset, but the project is still managed solely by the OEM (Åhgren & Wierda, 2007).

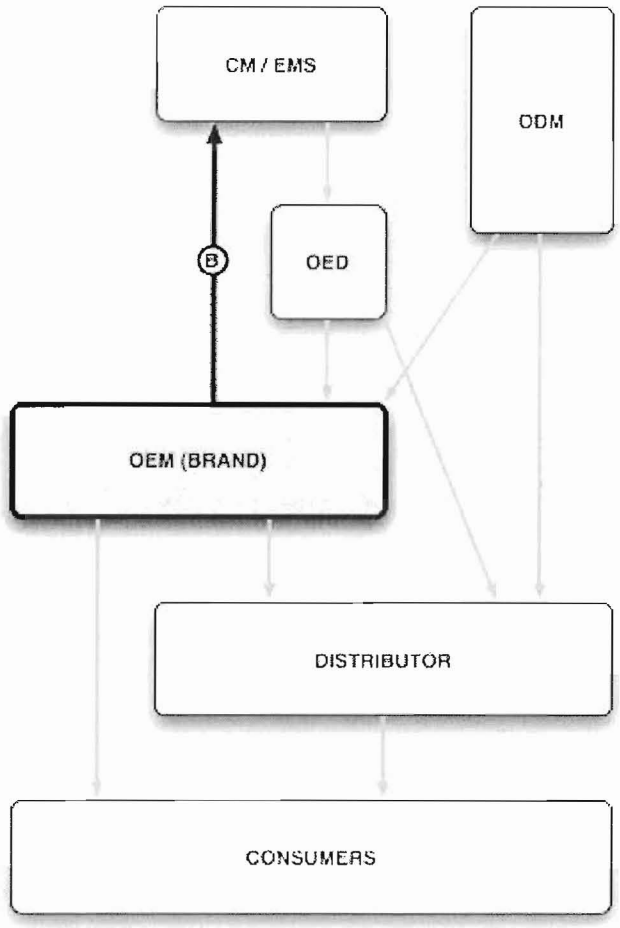

Figure 4: OEM Design, Outsourced Manufacturing

This flow of design has been spurred by several factors: evolving technological standardization (as previously touched on), evolving differences in competitors' specialization and knowledge bases, and trade gains from the emerging differences between specific firms (Anderson & Jonsson, 2005). Powerful buyers like the mobile network operators are also demanding that manufacturers integrate certain standards-based technologies, software operating systems and/or applications, to reduce their own integrations and application porting costs. Moreover, the growing complexity of mobile phone technologies has made it virtually impossible for any single handset manufacturer

to retain industry-leading expertise across all the rapidly evolving spectrum of hardware and software parts, thus pushing OEMs towards outsourcing production.

The numerous benefits for outsourcing manufacturing are clear. Critical time-to-market and time-to-volume (the ramp-up time needed to reach capacity production) are better provided by an EMS whose core competency is managing such resources, including supply chain delivery times. The EMS is also able to provide rapid changes in production capacity to optimize deliverables without accumulating excess inventory. By outsourcing low-cost manufacturing to EMS firms – an extremely competitive activity these days with low cost countries delivering high quality products at a fraction of the price (Cullen, 2007) – the OEM enjoys long-term cost reductions, given suitable partners and arrangements. These arrangements lend themselves to a reduction in the total cost of supporting the product through its lifecycle (rather than simply considering the transfer price of the product), such as avoiding logistics costs by having EMSes ship directly to the OEM's distribution channel. Adopting an outsourced manufacturing approach also allows the OEM is able to focus further on their core competencies and on differentiating their products through product innovation, brand image, and sales strategies (Åhgren & Wierda, 2007).

The EMS market is facing increasing competition from the threat of ODMs, and in order to sustain their presence in the industry, EMS providers must provide value-added services (as ODMs do), an effective supply chain management and create global footprints (Frost & Sullivan, 2008).

3.3 OEM Requirements, ODM Design and Manufacturing

As a result of the mentioned increased EMS competition, the EMS community has acquired substantial value-added design talents in recent years, expanding into ODM territory to supplement their production line businesses. In this model, the OEM is yet another step further from the manufacturing process.

An OEM specifies a handset – in terms of features, requirements, form factor, and cost – and outsources the hardware design and production of the handset to an ODM or to an OED (who would in turn outsource the production to an EMS). Figure 5 shows the OEM providing the ideas/design of the product to the ODM/OED, who will in turn implement those requirements and provide the lower-level technical design to fit. In this arrangement, the ODM manages its design of the project independently under the supervision of the OEM, and the ODM is responsible for the production (Åhgren & Wierda, 2007). Intellectual property from this arrangement usually belongs to the OEM, and the OEM is then able to focus further on strategy and marketing, and sales activities.

For example, in 2005, Palm designers determined the look and feel of their Treo product, picked the key components, specified performance requirements, and focused on developing the PalmOS software platform, whereas HTC did much of the mechanical and electrical design (Engardio & Einhorn, 2005).

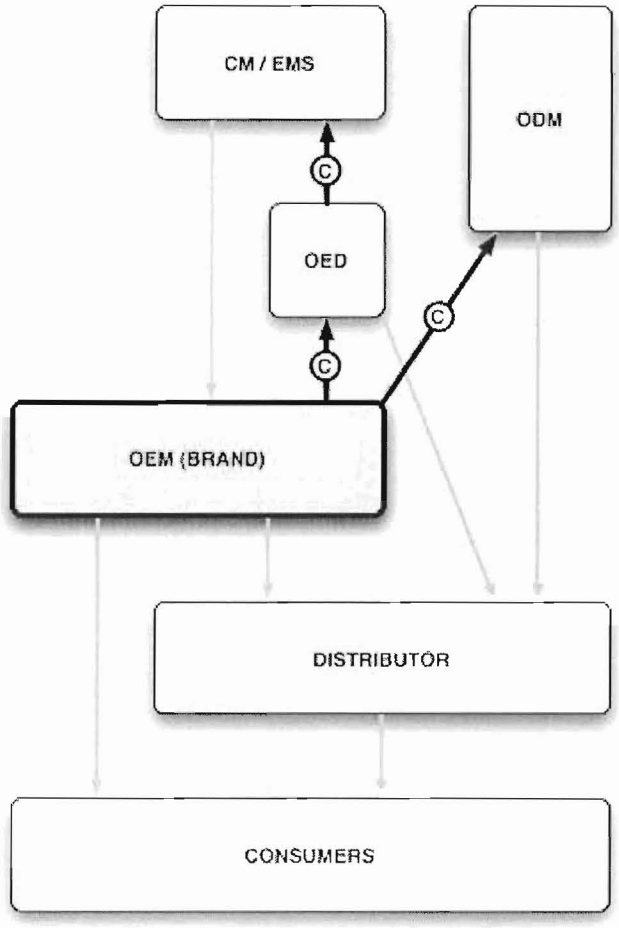

Figure 5: OEM Requirements, ODM Design and Manufacturing

Hiring an ODM provides substantial vertical capabilities, from design through system assembly, test, delivery and logistics. In many cases, the ODM even handles product warranty and repair, software, and customer service (Wikipedia, n.d.).

The constant pressure on OEMs to lower manufacturing costs in order to maintain profit margins can be somewhat alleviated by instead shifting this pressure to their ODMs as suppliers. ODMs enjoying economies of scale in both their design and production efforst are well-equipped to provide cost advantages to their OEM clients. With such advantages, large OEMs continue to outsource handset design and manufacturing to

address certain niches and maintain competitiveness in entry-level mobile phone market segments.

Various OEMs have taken different path along this outsourcing model: among the large OEMs, Motorola and Sony Ericsson are most active in long-term cooperation with ODMs for their low-end products, with CMCS and Compal and with Arima, respectively. On the other hand, Nokia and Samsung are the two best-known examples still slow to move in this direction (ABI Research, 2007). By 2005, Nokia was virtually the only manufacturer still developing reference designs and platforms in-house for all of its product segments (Anderson & Jonsson, 2005), without relying on third-party platforms (though this too has changed since, as pointed to in Section 4.4.1). Causes and implications of the OEMs' approaches will be discussed further in Section 5 , "Design and Outsourcing" (page 52).

3.4 ODM Reference Designs

In some cases, the ODM or OED takes the design lead rather than the OEM, providing what are called "reference designs". Figure 6 illustrates the flow of design initiated by the ODM or OED. In this process, an ODM (or OED) designs a handset and sells the design to an OEM, who may request other optional features to be included. The OEM then specifies an industrial design (mainly cosmetic changes to the handset housing and tweaks to certain software user experience aspects) and rebrands the product.

Here, the ODM/OED owns its design and will reuse and sell similar products to other OEMs or distributors with slightly different industrial designs, affording the ODM a larger volume per unique handset design and further spreading out development costs.

This model also gives the ODM an opportunity to showcase its innovative abilities, technical design acumen (which may also include proprietary or licensed technologies) and generate further business to synergistically occupy its manufacturing capacity.

An example is Haier, whose branded handsets are selling well in China, despite not having its own mobile phone development division: its handsets are conceived and prototyped by the OED Cellon (Wilson, 2004).

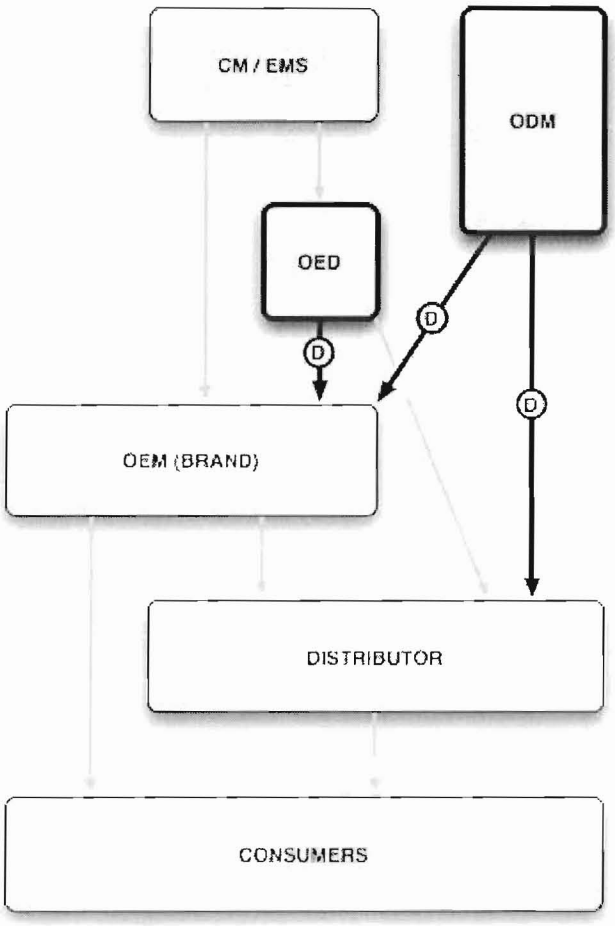

Figure 6: ODM Reference Designs

While OEMs have accepted outsourcing the handset design to ODMs as a manageable solution (both in terms of quality of service and quality of work product),

other factors have also fueled the growth of ODMs in recent years. Platform vendors – including Motorola, Wavecom, and Ubinetics (ARCchart, 2003) – have brought about the commoditization of mature 2G and 2.5G technologies by producing numerous handset reference designs, allowing an ODM to design and develop handsets with relative ease. As such, the trend for ODM business continues to show staggering growth.

3.5 Operator-OEM Collaboration

In the first of two operator-initiated design flows (the second of which is described in Section 3.6 below, "Operator-ODM Collaboration"), the operator specifies the design and feature set for a handset with an OEM and will associate its branding with the OEM. The co-branding often takes the form of carrier logos on the housing and in the display screens, as well as custom applications or services, as described below. The OEM may, however, outsource the actual design and manufacturing to an ODM/OED and EMS as in previous design models.

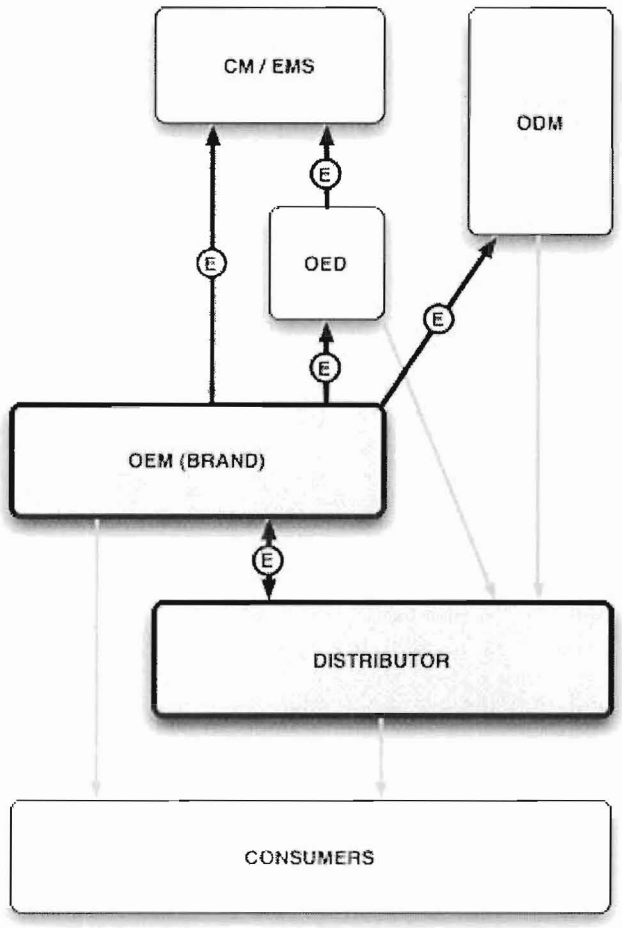

Figure 7: Operator-OEM Collaboration

Network operators around the world are increasingly specifying everything from the hardware to the applications and services included on the mobile handsets they sell, often demanding manufacturers to integrate certain standards-based technologies, software operating systems and/or applications (Anderson & Jonsson, 2005). Manufacturers therefore need to effectively support these requirements and personalise devices for individual operators (Rao, 2003). The requests, whether to define a model to complete its handset selection offering or to launch an advanced flagship handset, are aimed at creating synergies with the carriers' own advanced network services.

Additionally, different carriers offering the same model phone will request certain customized features both to differentiate the model and to provide a somewhat standardized user experience for all phones on that network. Sprint, for instance, demands the model number for handsets on its network be a higher number than the same handset model on other networks in North America, giving the impression that Sprint's customized version is a higher in the OEM product line.

Another significant driver for handset design models is the evolution of the mobile network operator industry, with some MNOs pushing towards working with fewer vendors and a narrower range of OS and application engines to reduce costs and complexity. Vodafone and Japan's NTT DoCoMo have been particularly influential, and several other multinational operators have also begun to implement similar plans. A standardized platform can provide numerous cost savings opportunities for operators through areas such as device verification, service creation, device provisioning, customer care and training: porting applications or services across a platform-based phone can cost 95% less than porting applications across feature phones using proprietary platforms, according to Anderson & Jonsson, 2005.

3.6 Operator-ODM Collaboration

The second operator-driven design chain is a design collaboration between a mobile operator and an ODM. Mobile operators today are placing an increasing importance on strengthening customer loyalty by establishing a prominent brand presence on the handset (ARCchart, 2003). Because most ODMs have modest or no brand ambitions of their own, ODMs are often eager to cater directly to this market; for the

ODM, there is little technical and logistical difference between serving an OEM client and supplying to a carrier as a customer.

In a scenario where the operator is confident in its knowledge of customer needs and brand value, the operator itself defines the device design and requirements and contracts an ODM directly to create the technical design and oversee the manufacture of the handset. The operator brands the product and markets it via its established distribution channels.

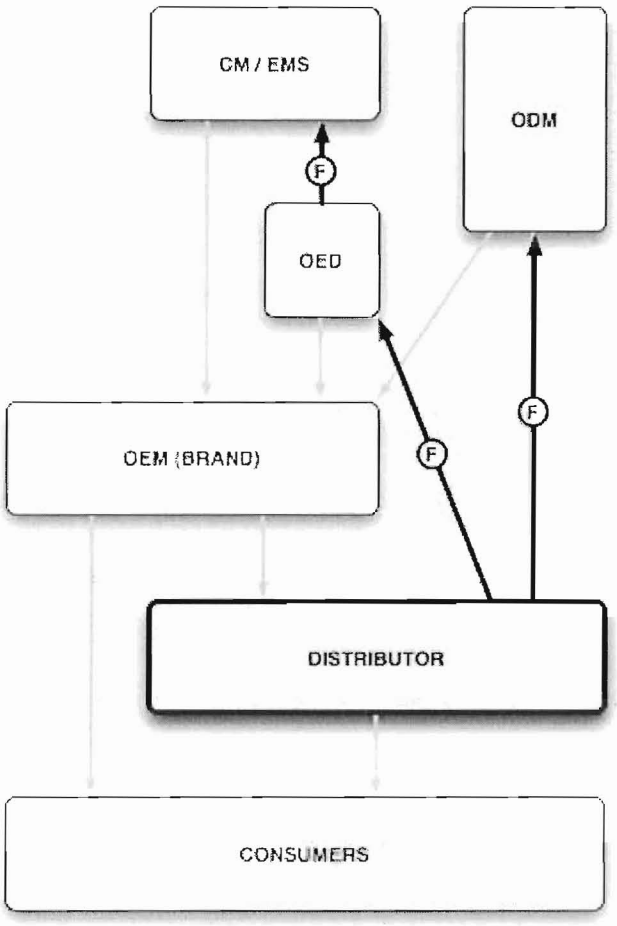

Figure 8: Operator Specified Design

Distributor design requests for ODM handsets has been embraced as a model in some regions of the world. The most popular example of this design flow is HTC from Taiwan, supplying myriad handsets to European network operators like O2 and Orange. (Aside, HTC has also been aggressively promoting its own brand in recent quarters.) NTT Docomo in Japan is another example of a network carrier being the key driver in handset specifications on its network.

4 OUTSOURCING MAPS

As can be seen from the outsourcing relationships and the design flows described in previous sections, OEMs and distributors have chosen from several different outsourcing approaches, the most significant of which are: OEM brands outsourcing manufacturing to contract manufacturers, and OEM brands outsourcing the design work to ODMs. Meanwhile, mobile operators are placing increasing focus on branding and customer loyalty, and are becoming increasingly involved in specifying the mobile handsets they sell and defining the customer experience. Because of these movements, the OEM in the middle of this chain segment that seems to be squeezed in maintaining its unique identity. In order to better understand whether the number and nature of certain relationships has had an impact on the success of an OEM or brand, a graphical representation of the relationships for players in the mobile handset industry is presented and analyzed in this chapter.

4.1 OEM and ODM Rankings

4.1.1 OEM Rankings and Profitability

To derive meaningful perspective on the impact of relationships on the success of the major OEM players, the major OEM players' market shares (based on shipment volumes over 4Q 2007) are first presented in Table 3 below alongside their performance across years 2005, 2006, and 2007 (with data summarized from Table 9 through Table 11, pages 63-63).

Table 3: OEM Global Market Share, 2005-2007

OEM	2005		2006		2007		2006-2007		2007
	Volume (millions)	Market Share	Volume (millions)	Market Share	Volume (millions)	Market Share	Change (yoy%)	Growth (yoy%)	Rank
Nokia	265	32.7%	347.5	34.7%	437.1	38.8%	4.1%	11.8%	1
Samsung	103	12.7%	113.7	11.3%	161.2	14.3%	3.0%	26.5%	2
Motorola	146	18.0%	217.4	21.7%	159.0	14.1%	-7.6%	-35.0%	3
Sony Ericsson	55	6.3%	74.8	7.5%	103.4	9.2%	1.7%	26.7%	4
LG	51	6.8%	64.4	6.4%	80.5	7.2%	0.8%	12.5%	5
ZTE	na	na	na	na	30.0	2.7%	na	na	6
RIM	na	na	na	na	13.6	1.2%	na	na	7
Apple	--	--	--	--	4.0	0.4%	na	na	8
Top 5	**620**	**76.5%**	**817.8**	**81.6%**	**941.2**	**83.6%**			
Global Total	**811**		**1,001.9**		**1,125.5**			**12.3%**	

na = data not available

Source: Gartner, Inc. 2008

Besides identifying the top OEM players – the five largest OEM brands in terms of volume are in shaded rows – the numbers in Table 3 above show a number of trends. First, the summed market share occupied by the top five OEMs is steadily increasing. Second, aside from Motorola's recent losses in its Mobile Devices division (Levine, 2008), the largest players are steadily increasing their global market shares, and the higher their global market share position, the greater the absolute gains in their 2007 market share over 2006 performances. These top players therefore warrant further examination of their outsourcing relationships, which will be presented later in the section.

The size of a firm does not necessarily reflect the firm's profitability, of course, and it is worthwhile to present in Table 4, the major identified OEMs' overall revenues and profit margins, and those of their related mobile device divisions.

Table 4: 2007 Revenue & Profit Margin, OEMs

OEM	Overall Revenue (USD mill)	Overall Profit Margin (%)	Mobile Revenue (USD mill)	Mobile Profit (USD mill)	Mobile Profit Margin (%)	Rank
Nokia	$51,058	15.64%	$49,505	$10,131	20.46%	1
Samsung	na	na	$24,488	$3,054	12.47%	2
Motorola	$36,622	1.40%	$18,988	-$1,201	-6.33%	3
Sony Ericsson	$31,389	16.32%	$17,496	$2,080	11.89%	4
LG	na	na	$11,202	$933	8.33%	5
RIM	$3,037	26.54%	$3,918	$1,116	28.48%	7
ZTE	$4,811	6.11%	na	na	na	8
Apple	$24,006	18.37%	$123	na	na	9

na = data not available

Source: Compiled from corporate annual reports, 2007

As shown from the above table, the major global handset makers seem to be divided into groups in terms of their profit capacity: Nokia and RIM enjoy profitability between 20% and 30%, while Sony Ericsson, LG, and others maintain profit margins around 10%. Samsung formerly earned profits around 20-25% in 2004, but has suffered a drop in its margins, joining Sony Ericsson and LG (FPDisplay.com, 2005). An investigation of these groups' outsourcing patterns could reveal a cause-effect relationship in the map of Section 4.3.1.

4.1.2 ODM Rankings and Profitability

From the ODM perspective, Table 5 below lists the shipment volumes of leading ODMs in 2006 and in 2007 (where available). Due to the incompleteness of data, however, a discernable trend cannot be seen from this table alone. Instead, the figures in Table 5 will be taken into consideration when deriving the relationship map on page 40.

Table 5: ODM Shipment Volumes, 2006-2007

OEM/ODM	2006 (millions)	2007 (millions)
Compal	68.7	47.8
BenQ	50.0	na
Pantech & Curitel	27.0	na
Arima	13.1	9.5
Quanta	13.0	na
CMCS / Foxconn	12.3	na
HTC	10.5	11.8
Total	**na**	**114.0**

na = data not available

Source: THT Research, 2007

Below, Table 6 displays the overall revenue and profit margin financials for selected ODMs. The figures are for the consolidated ODM firm, which may include multiple other business lines – these ODMs are commonly also notebook and desktop computer ODMs – not just the mobile handset lines.

Table 6: 2007 Revenue & Profit Margin, ODMs

ODM	Overall Revenue (USD mill)	Overall Profit Margin (%)	Mobile Revenue (USD mill)	Mobile Profit Margin (%)	Rank
Compal Comm	$15,152	4.32%	na	na	1
BenQ	$8,274	-13.68%	na	na	2
Pantech & Curitel	na	na	na	na	3
Arima	$421	-6.80%	na	na	4
Quanta	$21,090	2.68%	$421	na	5
CMCS / Foxconn	na	na	na	na	6
HTC	$7,881	26.49%	na	na	7
IAC	$2,641	4.91%	na	na	
ASUS	$24,667	3.91%	na	na	
Inventec	$7,706	1.31%	na	na	

na = data not available

Source: Compiled from corporate annual reports, 2007

Immediately noticeable from Table 6 is the wide range of profit margins achieved by the listed ODMs, seemingly without relation to the size or ranking of the ODM. Of note are the two extremes: BenQ has suffered losses after being unable to turn around the Seimens handset division it acquired, while HTC continues to make high-margin inroads

to providing ODM services directly to operators and OEMs alike and even breaking into its own-brand product lines. Also of note is Quanta Computer, whose handset business makes up a very small portion of its revenue (which consists mainly of notebook ODM business). Thus, from the list in Table 6, interesting firms include Compal for its top-rank shipment volume and HTC for its impressively high margins, and we shall look particularly at these two firms later, in Section 4.4.2.

4.2 Relationship Map, Global

In conjunction with the above data of Section 4.1 (on page 34), Figure 9 below shows a collection of the major OEMs, ODMs, and test houses around the world, drawn in a relationship map similar in nature to a network map of interconnected nodes.

The relationship map is intended as a living, organic diagram of the mobile phone industry. Relationships are indicated as a connection between the two involved parties: new lines are added as new outsourcing contracts are forged, formed as mergers and acquisitions are signed, and connections are erased as partnerships dissolve or orders are discontinued. Relationship lines between the ODMs and OEMs are drawn in a direction consistent with the flow of goods diagram (Figure 1), from the ODMs to OEMs (such as from Compal to Motorola), but are bidirectional between test houses and testing clients (such as between CETECOM and Samsung). Dotted lines indicate an ownership or subsidiary relation, such as between sister companies Inventec and IAC, and between HTC and its affiliated brand Dopod.

The relationships are determined from online news sources, industry news articles, and forecast analyses, as well as from general OEM and ODM knowledge

collected directly from the responsible managers within the firms, between 2003 and 2007. Note that some information is incomplete as most supplier relationships are kept confidential and typically not publicly announced, particularly in the cases of test houses and their handset developer clients. The top ten OEMs and ODMs are drawn with relative sizes based on handset sales and shipments, respectively, in millions of units (data from Table 3 and Table 5). The top ten OEMs and ODMs each are also represented with names labelled inside of their circles; all others are drawn at a minimum size not relative to scale.

Figure 9 shows a large size discrepancy between the largest players and those not in the top ten – even between the first and fourth players, Nokia and Sony Ericsson, the variance in market share is significant. To the left are eight representative test houses, the major four firms of which are shown larger (though not to scale).

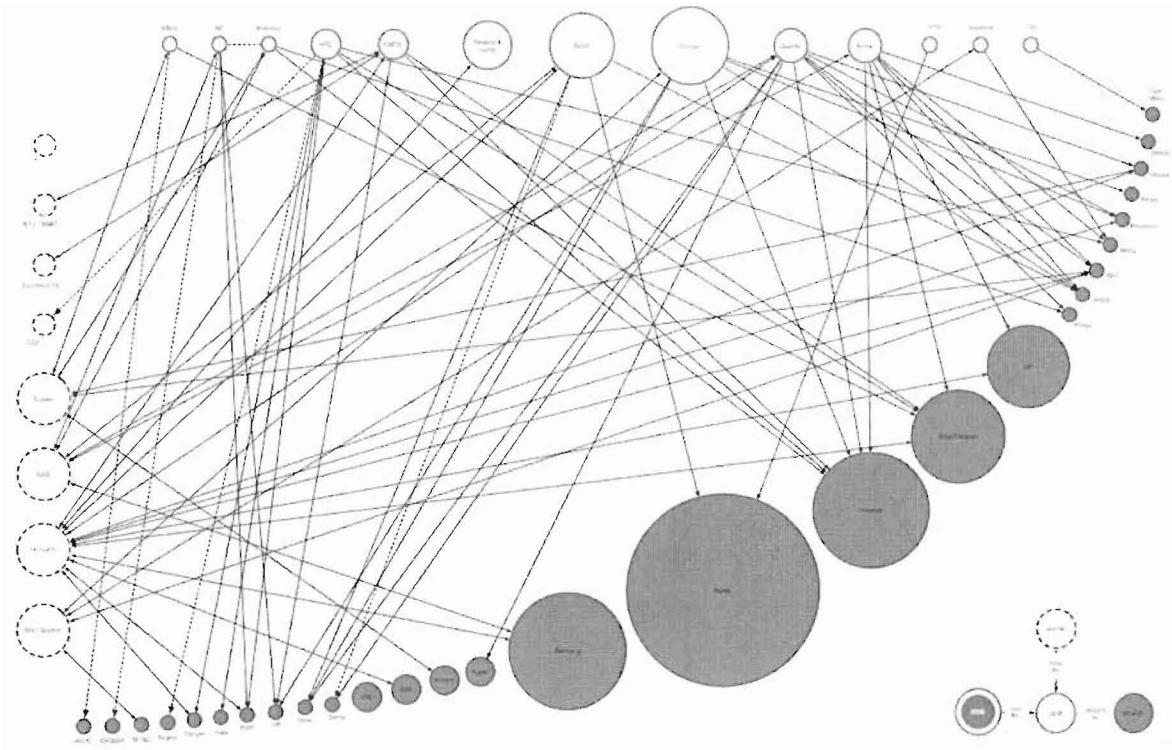

Figure 9: Market Map, Global

In the global market map (Figure 9 above), one notices a "concentration" of relationships around HTC, Quanta, and Arima as ODMs, around Motorola, Sony Ericsson, and NEC as OEMs/brands, and upon CETECOM and SGS in the test house role. A further look into the dominant players is discussed in Section 4.3 ("Relationship Map, Designers and Brands", page 42).

Outside of the larger industry players, however, many of the smaller OEMs each have only a single ODM connection, ranging from one ODM outsource relationship (Panda, Alcatel, for example) to as many as four (in the case of Lenovo). Some possible explanations exist: some brands' order volumes are not yet large enough to seek multiple sources, while other firms more established in other industries (such as HP) are still seeking a foothold in the market, and as such are still searching for an appropriate ODM

partner for a successful long-term relationship. That said, some firms (such as NEC) also seek multiple sources in order to maintain a better bargaining position instead of allowing any single ODM to become too "comfortable" as its supplier. The overall result of these reasons is that most OEMs do not simultaneously maintain many ODM relationships.

Regarding test houses, all ODMs and OEMs in the relationship map should be connected to at least one test lab unless the firm owns its own – Nokia's testing house shares the same name, Motorola developed Motorola ADR, and HTC recently acquired CGC (Shen & Lam, 2007) – or data is unavailable. As illustrated in Figure 9, the remaining OEMs and ODMs tend to hire test houses of like size: bigger test houses are aligned with at least one ODM and one OEM, where smaller labs seem to be aligned only with a single stable ODM relationship. This suggests that OEMs, having a vested interest in ensuring the product quality that has a direct impact on the OEM's reputation and brand equity, are more likely to enlist certification services from an established and stable test house. What's more, smaller test houses are more limited in testing capabilities and capacities, but compensate with lower prices that attract smaller designers and manufacturers on tighter project budgets. Larger certification laboratories, on the other hand, tend to service larger ODM/OEM clients by offering a network of locations, which collectively cover all of the vast test cases required. North American and European designers and brands also tend to favour major test houses over small testing players, whereas Asian-based designers and OEMs shown in Figure 9 do not exhibit such a preference (Palmu, 2008).

In the paragraphs to follow, the relationship map of Figure 9 is modified to reveal further insight to the dynamics between ODMs and OEMs. (Because of the greater recent

movement of EMSes and ODMs towards Asia – Taiwan and China, in particular – data in Appendix B looks at the mobile handset manufacturing industry in China. As the specific Chinese geographic region is outside of the scope of this document, however, the data is provided for the interest of the reader.)

4.3 Relationship Map, Designers and Brands

Reorganizing the global map previously shown on page 42, Figure 10 focuses upon ODMs and OEDs (with their EMS capacities drawn separately) for a further look: certification houses have been omitted. This diagram shows relationships directly between contract manufacturers and OEM brands, particularly involving the major OEMs. Again, the most significant ODMs and OEMs are drawn to a relative scale, whereas smaller players are labelled outside of their circles; EMS circles, however, do not reflect relative size. Bolded lines show relationships between the major players (top nine or ten) in each industry.

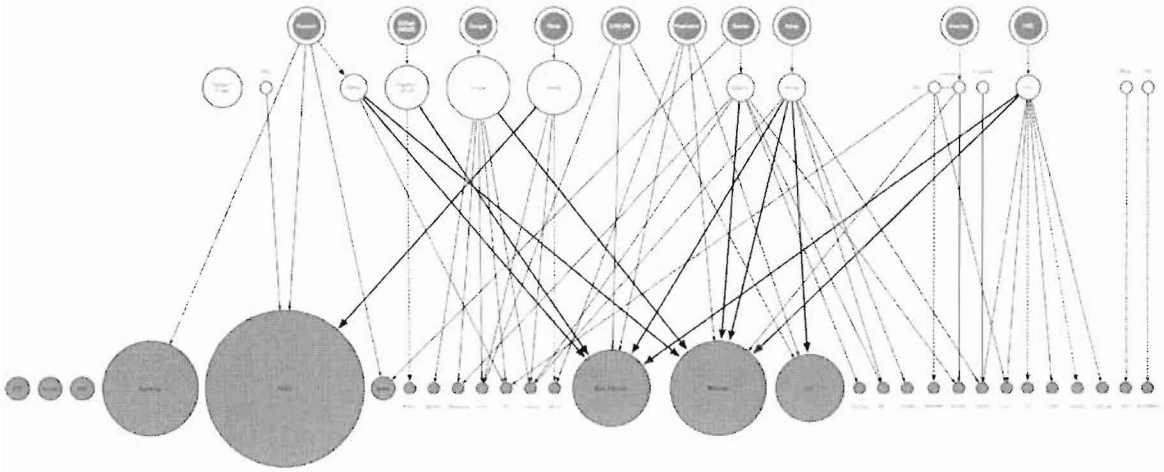

Figure 10: Market Map, ODMs & OEMs

One observation from the above figure is the overwhelming impression of having "one ODM to many OEMs"; that is, each ODM seems to serve many OEMs, more so than the OEMs sourcing from many ODMs. In the next paragraphs, a look at the above figure will be taken from the viewpoint of the OEMs (Section 4.3.1), and from that of the ODMs (Section 4.3.2).

4.3.1 OEM Relationships

Based on Figure 10 above, a list of the OEMs is displayed in Table 7 below, ordered by the number of ODM relationships held with each OEM. A second column lists each OEM's number of relationships with large ODM players, alongside the OEM's ranking (as previously presented, shaded).

Table 7: Number of Relationships per OEM

OEM Brand	All ODM Relationships	Major ODM Relationships	OEM Ranking
Motorola	6	5	3
Sony Ericsson	4	4	4
Lenovo	4	4	
HP	3	2	
Haier	3	2	
MWG	3	1	
LG	2	1	5
Nokia	2	1	1
NEC	2	2	
Palm	2	1	
Panasonic	2	2	
Philips	2	1	
BenQ	1	1	
Toshiba	1	1	
Dopod, HTC	1	1	
Danger	1	1	
ASUS	1	1	
OKWAP	1	0	
Openmoko	1	0	
Mio	1	0	
i-mate	1	1	
Alcatel	1	1	
Panda	1	1	
Apple	0	0	9
ZTE	0	0	8
RIM	0	0	7
Kyocera	0	0	6
Samsung	0	0	2

From Figure 10, Motorola and Sony Ericsson seem to have the most connections to ODMs, both being known to aggressively outsource the designing of both their entry-level and high-end models to Taiwanese ODM firms. And yet, five of the top ten largest OEMs in Figure 9 and Figure 10 – Samsung, Kyocera, RIM, ZTE, and Apple – show little to no use of ODM outsourced services. Furthermore, while Nokia shows two outsourcing connections, the firm utilizes the ODMs for very few of their model offerings: a strategy that has gained this market leader more share than Samsung, Motorola, and Sony Ericsson combined. The remaining (smaller) OEMs have very little market significance, suggesting their outsourcing decisions to forego in-house handset design are based on a necessity to leverage the scales of their ODMs for lower shipment orders.

The major investments in proprietary R&D from the OEMs have given some way to standardization of components and interfaces, as mentioned, allowing those EMS firms to provide cost, time-to-market, and time-to-volume advantages while permitting OEMs to focus on brand and market related efforts. But from Table 7 and the above reasoning, it appears that the OEMs still taking key designs and feature innovations into their own hands, and who have chosen not to outsource design to ODMs, are enjoying stronger brand value and better global sales as a result. These same OEMs – the ones utilizing ODM design services minimally, retaining their proprietary development competencies – are also the more profitable OEMs listed in Table 4 on page 36.

4.3.2 ODM Relationships

Table 8 below shows the ODMs ordered by the number of relationships (contracts) each has to the various OEMs. Because these arrangements are usually confidential, particularly for lower volume shipments to smaller brands, the number of clients for each ODM can be somewhat higher than the tabulated figures.

Table 8: Number of Relationships per ODM

ODM Brand	All OEM Relationships	Top OEM Relationships	ODM Ranking
HTC	8	2	7
Arima	7	3	4
Quanta	6	1	5
Compal	6	1	1
BenQ	4	1	2
CMCS	3	2	6
IAC	3		
ASUS	2		
FIC	1		
MiTAC	1		
Inventec	1		
BYD	1		
Gigabyte	1		
Pantech & Curitel	0	0	3

Contrary to observations from the OEM relationship table, ODMs exhibiting multiple relationships with OEMs rank higher (in shipment volumes) than those with only a few OEM clients. Almost all of the ten most successful ODMs (top ranking in shipment volumes) enjoy multiple OEM clients. In particular, it also becomes evident from Figure 10 and the above Table 8, that HTC and Compal each serve a large number of minor (non-top ten) mobile phone brands.

A number of explanations lend themselves to these findings, as previously presented in Section 3.4 ("ODM Reference Designs", page 27): ODMs are often hired by firms wishing to launch a small-volume (niche model or limited market) or low-cost

handset, and ODMs are eager to re-sell these designs to many OEMs (in different incarnations) to achieve greater economies of scale on their own designs. To do so requires ODMs to develop unique technical features differentiating their designs from those of competing ODMs. Thus, successful ODMs are typically those able to attract several OEM clients – even if collecting a large number of small volume orders – rather than build large volume shipments concentrated around just one customer. Note that this driving success factor matches the needs of smaller OEMs to leverage the scales of their contracted ODMs for lower shipment orders.

While ODMs appear able to base their successes upon multiple lower-volume OEMs, the relationships between the largest industry ODMs and OEMs bears further investigation. The "top ten" ODM and OEM interactions is covered in the following section.

4.4 Relationship Map, "Top Ten" Designers and Brands

Focusing further on only the major OEMs and ODMs (and their associated EMS, where applicable), Figure 11 shows the top identified OEMs and their outsourcing relationships to the top identified ODMs (plus a number of global EMS players). The firms are arranged such that relationship lines are clearly laid out, and bolded lines show working relationships that are considered stable and long-term.

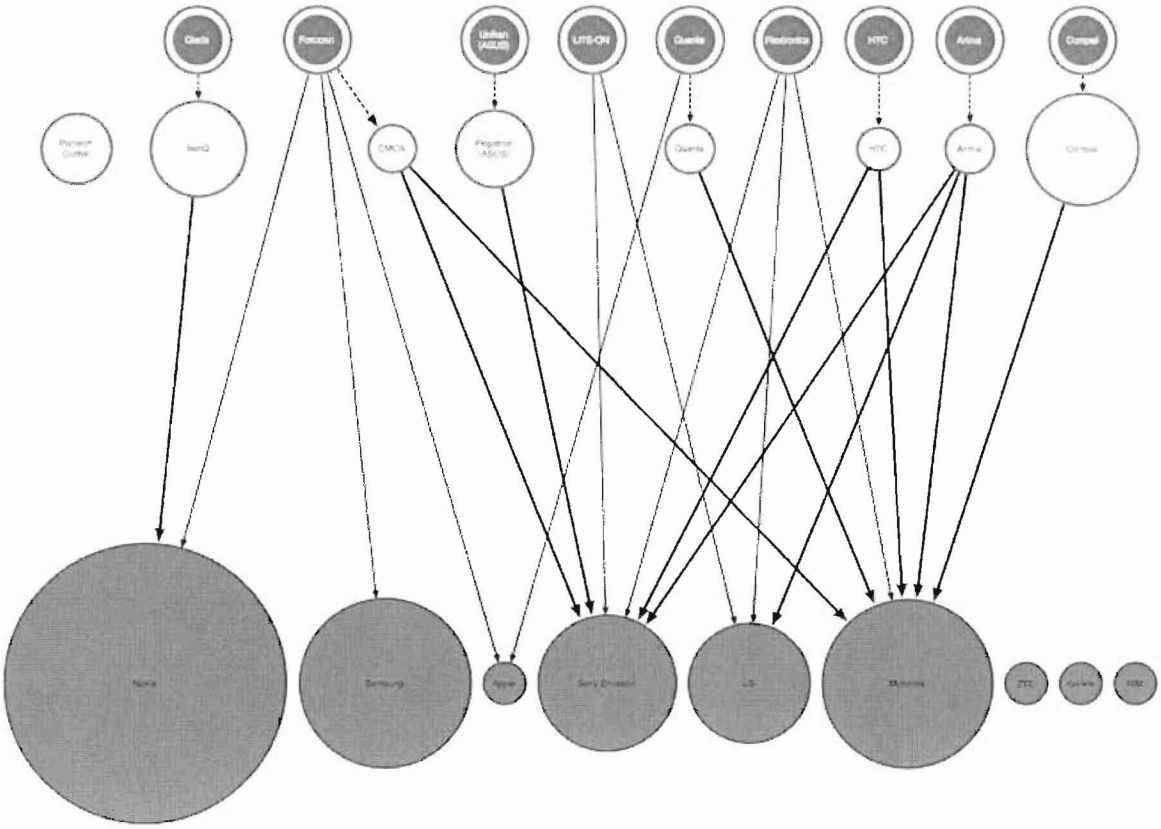

Figure 11: Market Map, Top Ten

Although Figure 10 displayed a "one ODM to many OEMs" pattern, this landscape changes dramatically when restricted to viewing only the "top ten" ODMs and "top ten" OEMs in the above diagram, Figure 11. A closer look to the top ten OEMs (Section 4.4.1) and top ten ODMs (Section 4.4.2) follows.

4.4.1 "Top Ten" OEM Relationships

Referring again to Table 7, larger OEM firms enlisting ODM services tend to select large ODM firms to partner with. Major OEMs shown in Figure 10 outsource to at most a single ODM not placing in the top ten. For example, Motorola outsources design to six partners, five of which are major ODM players in the industry. The reasons are

clear: larger ODMs tend to employ more established design and internal processes, a trait more vital when selecting a firm to contract design work than when selecting an EMS partner. Additionally, ODMs exhibiting solid design procedures and ethics are more likely to gain the trust of leading OEMs, similar to the rationale suggested for OEMs seeking test houses.

Even in this environment, however, some outsourcing is taking place (not shown in these figures), if perhaps reluctantly. For example, to ensure a continuum of innovation in its final products, Nokia has long developed almost everything on its own, even designing its own chipsets (such as the wireless radios for GSM), but this is changing. Nokia's revised chipset strategy is a licensing and multi-sourcing model, having several chipset vendors design and build current- and next-generation chips for the OEM (Taylor, 2007). By outsourcing these activities, Nokia can instead reduce its R&D expenditure, and concentrate on innovating in other core chipset technologies (where, presumably, the know-how is less stable and lends itself to further advancements).

4.4.2 "Top Ten" ODM Relationships

The previous finding in Section 4.3.2 (page 45) revealed the larger ODMs show a preference towards maintaining many relationships with OEM clients. The ODM perspective from the second part of Table 8, however, reveals a different proportion of reliance on major firms: designers working with many OEM clients tend to serve a far larger proportion of smaller brands than top-ten OEMs.

One example is HTC, which serves 8 different brands/clients, but its major clients comprise only Motorola and Sony Ericsson. Likewise, Compal's single major client is

Motorola, but designs handsets for 5 other brands as well. Overall, each dominant ODM serves only one to two dominant clients, with Arima being the sole ODM providing designs for three major OEMs: Motorola, Sony Ericsson, and LG.

While this finding in itself can be misleading as an indicator of ODM success, since even a single major client can make up a substantial percentage of an ODM's revenue. For example, more than 60 percent of ODM Compal Communications' revenue comes from handset business for Motorola (Pick, 2005). Still, accepting mass orders from their OEM client has boosted Compal's shipment volumes to the number one spot, but these orders are focused on low-margin handsets. Worse yet, the Compal-Motorola cooperation places heavy reliance on Motorola for business, at the same time somewhat positioning Compal as an ODM not at the forefront of innovation: an arguably dangerous position.

As such, the current situation as demonstrated in Figure 10 and Table 8 indicates efforts by the ODMs to reduce their reliance on any single client and to spread their fixed costs across multiple OEM brands.

4.5 Outsourcing Design and Market Share Implications

There is a distinction between outsourcing manufacturing, outsourcing design, and outsourcing innovation, as evidenced in the differences between the "Mobile Handset Industry Flow of Goods" (Figure 1, page 16) and the design flows presented in "Supply Chain Models" (comprising Figure 3 through Figure 8). As every design model points to a successful OEM or ODM example, the findings derived in Sections 4.2, 4.3, and 4.4

from investigating success trends are compiled here to provide more cohesive conclusions and commentary.

Successful firms high in market share tend to design their own handsets. As found in Section 4.3.1 ("OEM Relationships"), OEMs retaining key design and feature innovations in-house choose instead to limit their outsourcing to ODMs, and these OEMs seem to be rewarded with stronger brand value and better global sales. At the same time, ODMs managing to promote their own unique designs and handset features – that is, their ability to innovate handset designs, and execute on those innovations – will be able to successfully sell their products to more OEMs, thus garnering increased market share and leveraging greater economies of scale (Section 4.3.2, "ODM Relationships"). A unified conclusion from the above and from previous discussions is that firms nurturing in-house innovation are rewarded with greater success, as indicated by the observed higher market shares (refer again to Table 3 and Table 5, pages 35-37).

Furthermore, firms driven to innovate also logically gravitate towards using specific design flow models. OEMs intent on incorporating proprietary innovations lean towards the "OEM Design, Outsourced Manufacturing" design flow of Section 3.2 (described on page 22). On the other hand, ODMs actively selling their reference handset designs will favour the "ODM Reference Designs" model outlined in Section 3.4 (page 27). Each of these models allows the innovative OEM or ODM to flex its design strengths while leaving the lower-level details to an outsourced company to handle – an ODM for the OEM, or in the case of an ODM designing, to the separate EMS subsidiary or department within.

It should be noted, however, that not all ODMs' and OEMs' core competencies include designing handsets: some are inconsistent in their ability to provide innovative handsets. For example, Motorola designs are hit-and-miss: the StarTAC product lines of the 1990's dominated the market, but Motorola failed to follow up with compelling designs until the release of the flagship RAZR line in 2004, after which the OEM again has not steadily maintained consumer interest. Motorola avidly uses ODMs for complete technical design on its cheapest (entry-level) mobile phones, practically buying the ODM reference designs as in the "ODM Reference Designs" model (page 27). But the OEM's outsourcing of manufacturing and low-level design (the "OEM Requirements, ODM Design and Manufacturing" model of Section 3.3) still relies on Motorola's on-and-off ability to design such winning high-end products.

Additionally, a note of caution is in order: the mass adoption of any invention or innovation requires a common technology. As proposed by some in the industry, over-aggressive implementation of "innovation" can actually be a curse! Innovation is at its core a technical differentiation in a device or method, so it can be argued that innovation commonly acts against technology standards (Raby, 2007), and thus provides a barrier to device interoperability. OEMs and ODMs unable to master the balance between adhering to standards and innovating despite them, may find their efforts backfiring and adversely affecting their reputation and subsequently their market share.

5 DESIGN AND OUTSOURCING FUTURE TRENDS

Given the selected findings of previous sections, this section now turns to the future for a description of trends to come. Driving these movements and trends are the standardization of components and interfaces and the subsequent commoditization of their design and manufacture. EMS providers, OEDs, ODMs, and OEMs alike seek to take advantage of lower-cost productions from the standards and maturing technologies (such as basic handset design). Each seeks to engage further in the creative process to innovate and to build a closer relationship with the end customer, becoming new entrant competitors into the markets of their current clients. OEMs in particular must focus on brand and market related efforts as many are losing their design edges over aggressive ODM talent. In short, all players in the supply chain are slowly evolving and adopting more skills downstream in order to compensate against the simpler, low-margin tasks of their roots.

Comments are presented below on the future of OEMs as designers, of ODMs in their roles as designers and manufacturers, and of handsets as OEM/ODM innovators help their upcoming shapes and functions.

5.1 OEMs as Designers

As previously pointed out, OEMs contribute key technology and at least some design input to all its products but rely on outside partners to co-develop everything else. Many OEMs (such as Motorola mentioned above) simply purchase complete reference

designs from their ODM partners, particularly for cheaper entry-level phones, while reserving their own development and design resources for high-end handsets. At the same time, as described below, OEMs must strive to redefine their brands and themselves as a whole.

5.1.1 Continued Growth in Outsourcing

From the above arguments on the successes of outsourcing manufacturing, one obviously expects the trend to continue. Research estimates that OEMs have already outsourced over 60 percent of their handset production in 2007, but that the bulk of further outsourcing opportunities is still to come for the handset end markets (Åhgren & Wierda, 2007). Despite research showing that OEMs bullish on outsourcing have gained success by doing so, the previous relationship maps illustrates that several of the world's top handset OEMs who are still to start their own outsourcing activities achieve equal or greater success by keeping activities in-house.

As ODMs advance their design skills, it should be expected that OEMs continuously raise their level of outsourcing, even for certain design activities, over the next few years. Some of the giants will shrink their R&D work forces to concentrate on proprietary architecture, setting key specifications, and managing global R&D teams. OEMs may find that different advantages become apparent when outsourcing, including allowing them to be more flexible and capitalize on market opportunities.

As mobile phones increase in function and complexity, a higher degree of specialization within the industry will lower the barrier for new entrants. Firms entering this industry will be able to outsource nearly everything to component and design experts,

from generic component purchases to specific/custom component provisioning, device commissioning (allowing OEDs/ODMs to specify, design, manufacture, and distribute the product directly), and finally even certain end-user brand value activities (Anderson, Jonsson, 2005, Exhibit A). Variable rather than fixed costs will become more significant, and core R&D capabilities will not be a requisite for competitive advantage.

5.1.2 Brand Transformations

With ODM designs resources readily available, what has to be done in-house anymore? As vendors gain access to the same or similar components, competing based on product functionality will become increasingly difficult, and first mover advantages for higher-end components will not be sustainable. Thus, a line can be roughly drawn: skills considered commodity technologies can be outsourced, whereas core intellectual property should remain within the firm. To draw this line, there becomes a stronger need for OEMs to differentiate themselves as re-branders and distributors, or as talented handset designers. The former direction is clear: focus on the brand, the marketing, and the customer relationship of those identified markets. If the latter strategic path is taken instead, OEMs must then closely guard their sustainable competitive advantage and complementary assets, be it their control over the latest technologies, the look and feel of new products, or the customer relationship (Engardio & Einhorn, 2005). Examples of complementary assets in the mobile phone industry include capabilities such as consumer branding, industrial design capabilities, hardware and software customization, time to market and service provision (Anderson & Jonsson, 2005).

An extension of this concept, the Asian-centric ODM industry is becoming increasingly capable of carrying the torch in turning designs into working products and

services to be released. North American and European OEMs can more confidently hand off those tasks to the ODMs, and turn their attention to the highest (creative) levels of product creation.

One may liken this to "left brain" and "right brain" collaboration. The left-brain intellectual tasks are routine and mechanical, and can be disclosed in a well-defined specification to be outsourced to Asian-based ODMs and other rising economies. Meanwhile, western OEMs and brands will push forward with right brain activities, leveraging their proximity to the end markets and cultivating the creativity and artistry that resonates with the end customer.

Because of these factors, the OEM is being squeezed to justify its continued existence amongst these low-cost entrants. The result is thick with irony: those OEMs who have most embraced and utilized EMS and ODM services are the ones being forced into a situation requiring the redefinition of the firm's operations and core competencies. In a manner of speaking, the previously symbiotic supplier-client relationships have helped create another threat of new entrants to the circle of handset brands.

Most leading OEMs with in-house design will continue along this model for innovation. In tandem, one can expect future teams to be very global in nature, involving a network of partners: for instance, European and American product concepts, Taiwanese handset engineers, Indian software houses, and Chinese or Southeast Asian factories! Such a geographical division of labour and regional focus of core competencies can lead to a dramatic leap in overall product development speed and efficiency (Engardio & Einhorn, 2005).

5.2 ODMs as Designers

While ODMs are delivering more compelling mobile phone reference designs, their designs so far have been largely limited to entry-level devices and developing markets. ODMs are making headway in the concept designs and are managing to attract more clients, but even so, ODMs are still some ways from driving truly breakthrough product concepts and core technologies in their design work. How, then, will ODMs grow their businesses and learn the elusive design knack that OEMs have so far hoarded?

Two possible paths are outlined below. The first is to achieve economies of scale, convincing OEMs not to spend vast budgets on R&D to duplicate efforts already put forth into the ODMs' designs. The second sees ODMs breaking out their own brands and competing directly with OEMs, but this strategy is not without its own perils.

5.2.1 The Economies of Scale Dynamic

The ODMs providing economies of scale cost advantages to their OEM clients (as outlined in Sections 3.3 and 3.4) better equip their customers for addressing their markets. But these economies of scale also work against the manufacturer if volume orders cannot be achieved. For example, as Motorola's sales volumes decrease, so does the company's ability to negotiate cheaper costs from its ODM manufacturers, which in turn cycles disadvantageously as Motorola tries to address the cost-competitive and price-sensitive low-end markets (Reardon, 2008).

Furthermore, as emerging markets dominate world mobile phone usage growth, entry-level mobile devices will be the more popular consumer choices, causing the average selling price (ASP) of handsets to drop. This market and OEM pressure also

translates to the ODMs, as many ODMs (and EMSes), already operating on razor thin margins in the production of entry-level phones, will be unable to compete in the low-cost market.

There has been a rush of new entrants from China and Taiwan that have perfected low cost manufacturing of modular products such as consumer electronics and PCs, causing a disruption in the supplier-client balance. As a result, ODM and EMS consolidation is imminent, particularly in the Chinese-based designers and manufacturers: they must either achieve greater economies of scale by joining forces (in the form of mergers and acquisitions), or seek a new strategy. Since OEMs remain very selective in choosing their EMS partners, EMS providers should focus on maintaining long-term relationships with their customers through their value-added services, strategic partnership and alliances (Frost & Sullivan, 2008).

5.2.2 Selected Own-Brand Expansions

Another trend is also apparent: the traditional EMS has encroached on OEM territory! From their low-cost manufacturing roots, EMS players have expanded their service offerings "downward" through the supply chain to encompass low-cost design, in essence becoming ODMs. Some ODM players have even moved to provide their own branded products, oftentimes competing with their clients. While most have strategically limited their branding to local markets, some of the aggressive ODMs, such as HTC and BenQ, have endeavoured to launch their brands globally (with mixed success).

OEMs imparting their technologies and know-how to their outsourcing firms did so to nurture successful long-term relationships with their suppliers. ODMs partners are

consequently learning from their OEM clients, while component vendors began supplying tools for OEDs, ODMs, and OEMs alike to more easily apply designs for handset components. The result? One example is where Motorola had once hired BenQ for its ODM services, ordering millions of mobile phones. But BenQ began selling phones last year under its own brand, directly competing with Motorola in the prized China market, prompting Motorola to pull its contract (Engardio & Einhorn, 2005).

ODMs are perhaps as technically experienced in the integration of mobile device technologies as their clientele, but ODMs expanding into their own brands face a tough battle ahead. Not only do they risk alienating their traditional OEM customer base, but also the ODMs' expertise have historically been in designing and manufacturing goods for other companies, but not stepping into the limelight themselves. To be a successful product company and brand requires intimacy with the customer in their markets, and because ODMs are generally located in lower-cost geographies, this is a difficult organizational endeavour, especially in broader global markets. In the mobile industry, HTC is about the only ODM successfully navigating tricky transition from anonymous ODM to global brand.

Still, ambitious ODMs are looking to establishing a global brand presence, and more success stories are expected to surface in the coming future of handsets.

5.3 Handsets 2008 and Beyond

The future for handsets and handset sales is mixed. Analysts expect a growth in global handset shipments, but a decline in total handset revenues as the ASP of mobile phones is anticipated to continue its downward fall (Informa UK, 2007). The demand for

low-end phone models (in emerging markets) and high-end devices (in mature markets) could create an M-shaped distribution of price points, still heavily weighing towards entry-level designs.

Instead, OEMs and industry players are looking to several other methods of profiting in the changing arena, including new and different mobile services. Meanwhile, as will be detailed below, the nature of the mobile handset is changing as technologies emerge and mature.

5.3.1 More Services, New Services

The drop in the global handset ASP is wearing profit margins thin. Firms, particularly distributors such as carriers, are thus seeking other revenue streams to maintain profitability and growth. One such revenue source with potential is mobile service, but beyond simple SMS and MMS and basic mobile internet browsing, network operators must rollout new paid services.

Style and price of the handset will dictate its included functionality, of course, but a lack of a minimal compatibility limits the network operator's accessible market. Fortunately, the advancement of mobile phone technology promotes the use of additional services for the end user to utilize. Subscribers are increasing buying handsets with advanced features, and mobile content is becoming technically more accessible. A popular recent example would be the location-based services (LBS), leveraging real-time GPS readings from a GPS-enabled mobile phone, offering such things as promotional items or restaurant guides near the user, or even directions and maps of the user's

immediate vicinity. Another example is the ability to offer a mobile content (music and video, streaming and downloadable) experience from the phone.

Whatever the new services, they must be simple, reliable, and available to the mass market (to justify the carriers' implementation and maintenance efforts). Additionally, the services should strive to be competitively differentiated between competing operators and various handset brands, while still being interoperable. Getting the right balance of interoperability and differentiation is key to the next stage in mobile service development (Raby, 2007).

5.3.2 Hardware as a Service

Alongside the mobile data services being rolled out by network operators, the handset design and features are key to the overall user experience: the mobile device in hand provides the user's interface!

Traditional models entailed a purchased hardware that was static in its features: the capabilities included in the phone when a consumer purchased it were the capabilities it carried through to the end of its useful life. This original model is also evolving into the hardware being offered almost like a service: periodic updates to the device's firmware breathe new life into its functions, increasing its usage value over the life of the product's support lifecycle. One well-publicized example of this hardware-as-a-service is the Apple iPhone, launched in June 2007: its firmware has undergone over four revisions in the six months following its launch, each time adding considerable functionality to both the units in store and those already purchased and in use!

In this model, hardware purchased becomes increasingly capable with firmware updates pushed to consumers over time. And though most software updates have been free improvements and bug fixes to the purchased units in the field, there is great potential to leverage this push channel and offer over-the-air software upgrades for network services as well as enhanced entertainment features.

No doubt, the future of handset design, innovation, and manufacturing is interesting, and warrants a close watch.

APPENDICES

Appendix A: OEM Global Market Share Data, 2005-2007

The following tables contain raw data for OEM market shares (by shipment volume) from 2005 through 2007. They provide the basis for Table 3 (page 35) and other references in the body of this document.

Table 9: OEM Global Market Share, 2005

OEM	1Q05	2Q05	3Q05	4Q05	2005	2005
	Market Share (%)	Market Share (%)	Market Share (%)	Market Share (%)	Volume (millions)	Market Share (%)
LG	6.5%	6.6%	7.8%	6.5%	51	6.8%
Motorola	16.7%	18.5%	19.5%	18.4%	146	18.0%
Nokia	31.3%	33.2%	33.5%	34.3%	265	32.7%
Samsung	14.3%	13.4%	13.5%	11.0%	103	12.7%
Sony Ericsson	5.5%	6.5%	6.9%	6.5%	55	6.3%
Top 5	**74.2%**	**78.2%**	**81.1%**	**76.7%**	**620**	**76.5%**
Global Total	**na**	**na**	**na**	**na**	**811**	**100.0%**

na = data not available

Table 10: OEM Global Market Share, 2006

OEM	1Q06		2Q06		3Q06		4Q06		2006	
	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)
LG	15.6	7.1%	15.3	6.5%	18.5	7.4%	17.0	5.9%	64.4	6.4%
Motorola	46.1	21.0%	51.9	22.1%	53.7	21.5%	65.7	22.9%	217.4	21.7%
Nokia	75.1	34.1%	78.4	33.4%	88.5	35.4%	105.5	37.0%	347.5	34.7%
Samsung	29	13.2%	26.3	11.2%	30.7	12.3%	32.9	11.2%	113.7	11.3%
Sony Ericsson	13	5.9%	15.7	6.7%	19.8	7.9%	26.0	9.1%	74.8	7.5%
Top 5	**178.8**	**81.3%**	**187.6**	**79.8%**	**211.2**	**84.5%**	**247.1**	**86.1%**	**817.8**	**81.6%**
Global Total	**219.0**		**234.0**		**249.0**		**293.0**		**1,001.9**	

Table 11: OEM Global Market Share, 2007

OEM	1Q07		2Q07		3Q07		4Q07		2007	
	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)	Volume (millions)	Market Share (%)
Apple	--	--	--	--	1.1	0.4%	2.3	0.6%	4.0	0.4%
LG	15.8	6.3%	19.1	7.3%	21.9	7.8%	23.70	7.1%	80.5	7.2%
Motorola	45.4	18.0%	35.5	13.5%	37.2	13.3%	40.90	12.3%	159.0	14.1%
Nokia	91.1	36.2%	100.1	38.1%	111.7	39.9%	133.50	40.2%	437.1	38.8%
RIM	?	?	3.1	1.2%	3.1	1.1%	4.00	1.0%	13.6	1.2%
Samsung	34.8	13.8%	37.4	14.2%	42.6	15.2%	46.40	14.0%	161.2	14.3%
Sony Ericsson	21.8	8.7%	24.9	9.5%	25.9	9.3%	30.80	9.3%	103.4	9.2%
ZTE	?	?	?	?	?	?	?	?	30.0	2.7%
Top 5	**208.9**	**82.9%**	**216.98**	**82.5%**	**239.3**	**85.5%**	**275.3**	**82.9%**	**941.2**	**83.6%**
Global Total	**251.0**		**260.0**		**284.0**		**332.00**		**1,125.5**	

na = data not available

Appendix B: Relationship Map, China

The flourishing Chinese market deserves particular attention as it has given birth to a significant group of new mobile handset OEMs and brands. Table 12, below, shows a ranking of the top ten mobile handset brands in the Chinese market over the fourth quarter of 2007, with a calculated market share of the region.

Table 12: Chinese Market Share, 4Q07

Ranking	OEM	4Q07	
		Volume (millions)	Market Share (%)
1	Nokia	14.1	35.3%
2	Samsung	5.3	13.2%
3	Motorola	4.7	11.7%
4	Lenovo	2.4	6.0%
5	K-Touch	1.6	4.1%
6	Sony Ericsson	1.5	3.8%
7	Ningbo Bird	1.2	3.0%
8	Amoi	1.1	2.8%
9	LG Electronics	1.0	2.6%
10	GiONEE	0.7	1.7%

Source: Analysys, February 2008

The top three brands in China – Nokia, Samsung, and Motorola – match those in the global rankings of Figure 9. Note that the top five global OEMs all make the top ten Chinese list, but that Sony Ericsson and LG specifically are out of the top five, giving way to two local Chinese brands, Lenovo and K-Touch. Furthermore, whereas the next five global brands (ranking sixth to tenth in Table 3, page 35) are predominantly North American based firms, the Chinese market shares are refilled with only local Chinese brands: RIM, ZTE, and Apple do not rank in this list! Five of the top ten brands in China are local Chinese brands, however, indicating that the growing market seems able to support the entrance and sustenance of more branded players.

The significant EMS and OEM players in the Chinese market are shown in Figure 12 below (OEM sizes based on figures from Table 12). The top ten market shareholders are arranged in the lower semi-circle.

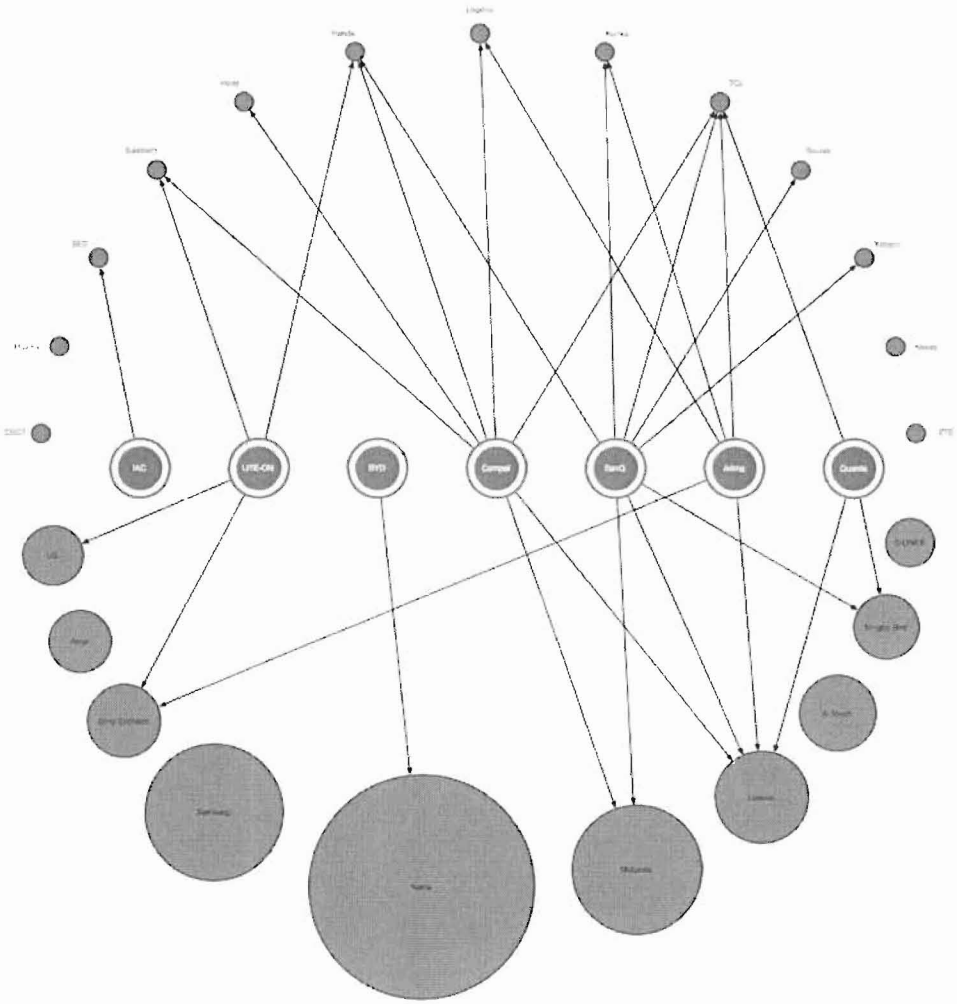

Figure 12: Market Map, China

From Figure 12, the dominant global brands seem to utilize EMS services of only one or two contract manufacturers, whereas some local brands (such as Lenovo, Panda, and TCL) have enlisted up to four different EMSes. It is also evident from Figure 12 that most of the shown EMS players in China are subsidiaries of Taiwanese ODMs, with one

of the exceptions being BYD: Taiwanese EMSes have been aggressive in relocating their factories to lower-cost geographies in China, at the same time bringing fine-tuned manufacturing know-how to serve the local Chinese mobile handset market. As such, local brands tend to utilize EMS services at least as much as the major brands, as shown in Figure 12.

BIBLIOGRAPHY

Works Cited

Åhgren, P. & Wierda, F. (2007, November 14). *The growing need for handset outsourcing.* Retrieved from EE Times Asia web site: http://www.eetasia.com/ART_8800488911_480200_NT_4c5fd21c.HTM

Anderson, J. L. & Jonsson, M. E. (2005, June 01). *The mobile handset industry in transition.* Retrieved from web site: www.jamieandersononline.com/uploads/The_Mobile_Handset_Industry_in_Transition.pdf

Cullen, N. (2007, October 01). *Creative outsourcing.* Retrieved from SupplyChainStandard.com web site: http://www.supplychainstandard.com/liChannelID/12/Articles/1118/Creative+outsourcing.html

DiGrande, S., Netteshim, C., & Kim, S. (2005, August 01). *The future of the mobile handset.*

Engardio, P. & Einhorn, B. (2005, March 21). *Outsourcing innovation.* Retrieved from Business Week Online web site: http://www.businessweek.com/magazine/content/05_12/b3925601.htm

Levine, B. (2008, January 23). *Motorola's sales of mobile devices plunge 38 percent.* Retrieved January 23, 2008 from Mobile Tech Today web site: http://www.mobile-tech-today.com/story.xhtml?story_id=57985

Palmu, O. P. (2008, January 29). Interview (email).

Pick, Adam (2005, January 01). *The rise and rise of ODM handset manufacturing.* Retrieved from Electronics Manufacturing Asia web site: http://www.emasiamag.com/article-76-theriseandriseofodmhandsetmanufacturing-Asia.html

Raby, T. (2007, May 15). *Handset innovation: Blessing or curse?*

Rao, M. (2003, January 01). *Battle of the brands: Mobile operators and handset manufacturers vie for consumer mindshare.* Retrieved from techsparks.com web site: http://www.techsparks.com/Battle-of-the-brands.html

Reardon, M. (2008, January 24). *Nokia's success tied to emerging markets.* Retrieved from News.com web site: http://www.news.com/8301-10784_3-9857676-7.html

Shen, D. & Lam, E. (2007, May 02). *HTC acquires handset certification company.* Retrieved from DigiTimes web site: http://www.digitimes.com/NewsShow/MailHome.asp?datePublish=2007/5/2&pages=PD&seq=216

Taylor, C. (2007, August 10). *Nokia revises chipset strategy: Will outsource chip development.* Retrieved from The Register web site: http://www.theregister.co.uk/2007/08/10/nokia_chipset_strategy/

Thomson, I. (2008, February 12). *Omnifone takes on handset giants*. Retrieved from vnunet.com web site: http://www.vnunet.com/vnunet/news/2209433/omnifone-takes-handset-majors

Vile, D. (2007, July 04). *Mobile handset selection: Function, features, features and functions*. Retrieved from The Register web site: http://www.theregister.co.uk/2007/07/04/mobile_handset_selection/

Wilson, D. (2004, July 06). *The future of design*. Retrieved from Electronics Supply & Manufacturing web site: http://www.my-esm.com/print/showArticle.jhtml?articleID=21800178

Wikipedia. (n.d.). *3GPP*. Retrieved from http://en.wikipedia.org/wiki/3gpp

GSMA (n.d.). *About the GSM Association*. Retrieved from GSM World web site: http://www.gsmworld.com/about/index.shtml

Cell Phone Observer. (2008, February 12). *AOL announces new Open Mobile software platform*. Retrieved February 12, 2008 from http://www.cellphoneobserver.com/992437_aol_aol_announces_new_open_mobile_software_platform

ARCchart. (2003, August 21). *Blueprint: Rise of the handset ODMs* . Retrieved from http://www.arcchart.com/blueprint/show.asp?id=335

Wikipedia. (n.d.). *CE Mark*. Retrieved from http://en.wikipedia.org/wiki/CE_mark

Wikipedia. (n.d.). *Contract manufacturer*. Retrieved from http://en.wikipedia.org/wiki/Contract_manufacturer

Center for Devices and Radiological Health (2006, December 29). *Electromagnetic Compatibility - EMC.* Retrieved from U.S. Food and Drug Administration web site: http://www.fda.gov/cdrh/emc/index.html

Wikipedia. (n.d.). *Electronics manufacturing services.* Retrieved from http://en.wikipedia.org/wiki/Electronics_manufacturing_services

Gartner, Inc. (2008, February 27). *Gartner says worldwide mobile phone sales increased 16 per cent in 2007.* Retrieved from http://www.gartner.com/it/page.jsp?id=612207

Informa UK Ltd.. (2007, February 01). *Global telecommunications services and hardware retail revenue in market share percentages for 2006, and forecast for 2007 to 2011.*

Frost & Sullivan. (2008, February 13). *Growing demand for consumer electronics driving the outsourcing trend in the electronics industry.* Retrieved from http://www.reuters.com/article/pressRelease/idUS141825+13-Feb-2008+BW20080213

GSMA (n.d.). *GSM facts and figures.* Retrieved from GSM World web site: http://www.gsmworld.com/news/statistics/index.shtml

FPDisplay.com. (2005, December 19). *Handset manufacturing industry of China Mainland in 2004.* Retrieved from http://www.fpdisplay.com/news_info/Shtml/20051219_10344.htm

IDC. (2008, January 25). *IDC finds slower growth in the mobile phone market in 2007 while Samsung captures the number two position for the year.* Retrieved from http://www.idc.com/getdoc.jsp;jsessionid=LTQOIV4H4ODDCCQJAFICFFAKBEAUMIWD?containerId=prUS21053908

Wikipedia. (n.d.). *Mobile phone.* Retrieved from http://en.wikipedia.org/wiki/Mobile_phone

Wikipedia. (n.d.). *Multimedia Messaging.* Retrieved from http://en.wikipedia.org/wiki/Multimedia_Messaging_Service

Wikipedia. (n.d.). *MVNO.* Retrieved from http://en.wikipedia.org/wiki/MVNO

ABI Research. (2007, January 02). *ODM handsets will dominate Taiwan handset shipments in 2008.* Retrieved from http://electronics.ihs.com/news/abi-taiwan-handsets.htm

Wikipedia. (n.d.). *Original Design Manufacturer.* Retrieved from http://en.wikipedia.org/wiki/Original_Design_Manufacturer

Wikipedia. (n.d.). *Original Equipment Manufacturer.* Retrieved from http://en.wikipedia.org/wiki/Original_equipment_manufacturer

PTCRB. (n.d.). *PCS Type Cerification Review Board.* Retrieved from http://www.ptcrb.com/

Wikipedia. (n.d.). *Short Message Service.* Retrieved from http://en.wikipedia.org/wiki/Short_message_service

Everything and the Mobile Software Universe.... (2006, February 23). *The Mobile handset market ... Actors and interactions (part I).* Retrieved February 23, 2006 from http://tmenguy.free.fr/TechBlog/?p=49

The Tech FAQ. (n.d.). *What is GPS?* Retrieved from http://www.tech-faq.com/gps.shtml

THT Research. (2007, January 01). Retrieved from http://www.thtresearch.com/

Works Consulted

Hellawell, A. (2008, March 10). *ZTE Corp: Upgrading to hold into NPC, reporting season.*

Nam, K. (2008, February 14). *Samsung Corporation.*

Suva, J. (2008, March 05). *Motorola Inc (MOT).*

Suva, J. (2008, March 25). *Research In Motion Ltd (RIMM).*

Uskola, J. (2008, March 11). *Nokia: Still resilient.*

CIBC World Markets. (2008, January 10). *2008 handset market outlook.*

Rider Research. (2007, January 27). *A billion mobile phones shipped in '06.*

MasterLink Securities. (2006, July 18). *Arima Communications (8101 TT).*

Research and Markets. (2006, November 01). *China Mobile Handset Manufacturers Report, 2006.*

Reed Business Information. (2004, November 03). *Communications processors find their niche: It's still survival of the fittest, as the market discovers the limitations and opportunities of these processors.*

Asia Pulse Pte Ltd.. (2006, March 09). *Domestic Brands Take 6 Top 10 in China's Mobile Phone Market.*

China Telecom. (2005, October 01). *Forecast of mobile phone production by China's local handset OEMs in 2005.*

Reed Business Information. (2006, June 15). *Global handset sales sets new record.*

Informa UK Ltd.. (2007, February 01). *Global mobile communications handset sales by geographic region in units for 2005 to 2006, and forecast for 2007 to 2011.*

Informa UK Ltd.. (2006, September 01). *Global percentage of in-house and outsourced handset manufacturing for 2005, and forecast for 2006 to 2011.*

Informa UK Ltd.. (2007, February 01). *Global top seven telecommunications equipment companies ranked by handset sales in units and market share percentages with industrywide comparison for 2004 and 2005, and through first half of 2006.*

Accenture. (2006, January 01). *Handset industry evolution: Navigating a path to high performance.*

Datamonitor. (2007, November 01). *Marketwatch: Telecoms, industry update.*

Datamonitor. (2003, November 01). *Mobile phones in Canada: Industry profile.*

Datamonitor. (2007, May 21). *Motorola, Inc.: Company profile.*

Oppenheimer. (2008, February 25). *Motorola, Inc.: Losing sum-of-the-parts support; Downgrading to perform.*

SourceMedia, Inc. (2008, January 30). *NFC: when will the breakthrough come?*

Oppenheimer. (2008, March 11). *Nokia Corporation: Concerns create opportunity; Upgrading to outperform.*

NYU Stern. (2001, August 31). *Outsourcing at Ericsson.*

JPMorgan, Global Equity Research. (2006, November 22). *Tech hardware supply chain industry and product analysis, 2006-07 fourth annual edition.*

Research and Markets. (2006, January 01). *The new age of handset customisation: 2006 - 2011.*

Strategy Analytics. (2008, January 01). *Understanding the mobile ecosystem.*

Cowen and Company. (2007, November 30). *Worldwide mobile forecasts 2005-2010E: Trends for 2008 and beyond.*

Websites Consulted

Bhatnagar, S. & Tan, J. (2006, March 01). *Global handset makers locked in merger dance*. Retrieved from Reuters web site: http://www.reuters.com/articlePrint?articleId=USSP18022420060301

Brown, J. (2008, January 07). *Under the hood: Low-cost phone is rich in features.* Retrieved from techonline.com web site: http://www.techonline.com/product/underthehood/205210470

Chao, C. & Chan, R. (2008, January 29). *Analog IC designer GMT margins to be buoyed by notebook and handset segments*. Retrieved January 29, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080129PD204.html

Chao, C. & Chan, R. (2008, January 15). *MediaTek 1Q sales expected to drop 25%.* Retrieved January 15, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080114PD214.html

Chao, C. & Chan, R. (2008, January 22). *Wi-Fi chip suppliers racing to offer cheap 802.11n single-chip solutions*. Retrieved January 22, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080121PD213.html

Chao, C. & Lam, E. (2008, January 30). *Commentary: MediaTek and Spreadtrum key stepping stones for handset chip deployment in China*. Retrieved January 30, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080130PD212.html

Chao, C. & Lam, E. (2008, January 31). *MediaTek sees some warming from white-box handset customers*. Retrieved January 31, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080131PD213.html

Chao, C. & Shen, S. (2008, January 24). *Elan shipments of handset touch screen chips soar in January*. Retrieved January 24, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080124PD209.html

Chen, S. (2008, January 28). *Taiwan makers to ship 7.47 million smartphones in 1Q08.* Retrieved January 28, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080128PB204.html

Cheung, K. (2008, February 21). *Q4 2007 global handset market share*. Retrieved from EDA Blog web site: http://edablog.com/2008/02/21/nokia-strategy-analytics/

Chuang, E. (2008, January 22). *Taiwan-based handset LCM makers to see orders drop in 1Q*. Retrieved January 22, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080122PB200.html

Chuang, S. (2008, February 04). *Compal Communications looks to ship 60m mobile phones this year*. Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_22297.html

Chuang, S. (2008, January 22). *HTC foresees rosy handset sales prospects for Q1, 2008*. Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_22147.html

Chuang, S. (2007, December 04). *HTC to set new November revenue high of NT$14b*. Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_21517.html

Chuang, S. (2007, July 30). *MIC projects Taiwan handset makers to suffer declining shipment this year*. Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_20023.html

Chuang, S. (2007, December 11). *Taiwan`s communications output value to hit record high of NT$1.4 trillion in 2008: III*. Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_21583.html

Chuang, S. (2007, November 13). *Taiwan's shipment of smartphones reaches 4.896m units in Q3*. Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_21324.html

Clark, R. (2008, February 04). *Lenovo spins off mobile arm for $100m*. Retrieved February 04, 2008 from Telecom Asia web site: http://www.telecomasia.net/article.php?id_article=7090&id_sector=21#TOP2

Clendenin, M. (2007, May 16). *Asia EMS/ODM market to more than double by 2011*. Retrieved from EE Times web site: http://www.eetimes.com/showArticle.jhtml;jsessionid=C3L1KFOOEHIVKQSNDLPCKHSCJUNN2JVN?articleID=199601370

Clendenin, M. (2007, April 30). *BenQ refocuses on ODM business to survive*. Retrieved from EE Times web site: http://www.eetimes.com/showArticle.jhtml;jsessionid=C3L1KFOOEHIVKQSNDLPCKHSCJUNN2JVN?articleID=199202010

Clendenin, M. (2006, December 21). *Taiwan handset ODMs face pressure from EMS players*. Retrieved from EE Times web site: http://www.eetimes.com/rss/showArticle.jhtml?articleID=196701350&cid=RSSfeed_eetimes_newsRSS

Elliott, J. (2007, May 23). *Nokia: Manufacturing success in India*. Retrieved from CNN Fortune web site: http://ridingtheelephant.blogs.fortune.cnn.com/2007/05/23/in-india-nokia-makes-manufacturing-a-success/

Ericsson (2008, February 04). *Ericsson provides built-in HSPA modules for Lenova ThinkPad notebooks*. Retrieved February 04, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/02/04/120531.html

Gardiner, B. (2007, December 21). *iPhone sales: 5 million down, 5 million to go?* Retrieved from Wired Blog Network web site: http://blog.wired.com/business/2007/12/iphone-sales-5.html

Garmin (2008, January 31). *Garmin enters mobile handset market*. Retrieved January 31, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/01/31/125416.html

Gohring, N. (2007, May 03). *RIM, Nokia debut high- and low-end phones: Cell phone makers try to appeal to new buyers in a saturated market*. Retrieved from ComputerWorld web site: http://www.computerworld.com/action/article.do?command=viewArticleBasic&articleId=9018601

Goldstein, S. (2008, January 24). *Motorola's market share falls to lowest since 2001*. Retrieved from MarketWatch web site: http://www.marketwatch.com/news/story/motorolas-handset-share-falls-apples/story.aspx?guid=%7B8673D4BE-10F1-4D36-8602-E9DC9F08E338%7D

Han, S. & Shen, S. (2008, January 17). *Taiwan production of handset-use camera modules totals 193 million units in 2007*. Retrieved January 17, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080116PD209.html

Han, S. & Wu, G. (2008, January 11). *Mainstream LED pricing for handset backlight applications to fall 15% in 1Q*. Retrieved January 11, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080111PD210.html

Howe, C. (2007, October 08). *Apple's iPhone will sour consumer Blackberry results*. Retrieved from Blackfriars' Marketing web site: http://blackfriarsinc.com/blog/2007/10/apple-iphone-will-sour-consumer

Huang, E. & Chan, R. (2005, August 15). *Taiwan's handsets – 1Q 2005*. Retrieved February 19, 2008 from DigiTimes web site: http://www.digitimes.com/reports/ShowPrint.asp?datepublish=2005/5/31&pages=RI&seq=400

Huang, K. T. & Shen, S. (2008, January 21). *Connector maker Sinbon expects revenues and profitability to grow 15% in 2008*. Retrieved January 21, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080121PD204.html

Huang, K. T. & Shen, S. (2008, February 01). *Keypad maker Silitech set to see strong shipments growth in 2008*. Retrieved February 01, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080201PD213.html

Huang, R. & Shen, S. (2008, February 15). *India-based Spice unveils movie-enabled handset*. Retrieved February 15, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080215PD222.html

Huang, R. & Shen, S. (2008, February 15). *Qualcomm cooperates with Taiwan companies to develop new mobile consumer products.* Retrieved February 15, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080215PD221.html

Hwang, Adam (2008, February 01). *China market: Nearly 40 million GSM and CDMA handsets sold in 4Q07.* Retrieved February 01, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080201PR201.html

Hwang, Adam (2008, February 01). *China mobile phone user base tops 547 million in December 2007.* Retrieved February 01, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080201PR200.html

Jakobsson, H. (2007, April 12). *The headaches of being a handset OEM.* Retrieved February 19, 2008 from VisionMobile Forum web site: http://visionmobile.com/blog/2007/04/the-headaches-of-being-a-handset-oem/

Juniper Research (2008, January 30). *Mobile phone financial transactions to generate over $587 billion by 2011.* Retrieved January 30, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/01/30/130714.html

Kazakoff, M. (2007, May 18). *Why market share doesn't tell the whole story.* Retrieved February 19, 2008 from CompeteInc web site: http://www.competeinc.com/research/newsletters/vantage-wireless-handset-oem-conversion-vs-marketshare/

Kharif, O. (2008, February 18). *Chinese cell brand makes U.S. debut.* Retrieved February 18, 2008 from Business Week Online web site: http://www.mobile-tech-today.com/story.xhtml?story_id=58391

Koman, R. (2008, February 06). *Apple's iPhone takes third of global market.* Retrieved February 06, 2008 from MobileTechNews web site: http://www.mobile-tech-today.com/story.xhtml?story_id=58214

Kramer, R. (2007, March 01). *Global handset outlook: More than meets the i.* Retrieved from arete web site: http://www.slideshare.net/pacificleo/mobile-handset-value-chain

Kuittinen, T. (2007, January 26). *Low-end line holds at Nokia.* Retrieved from theStreet.com web site: http://www.thestreet.com/print/story/10334899.html

Lam, E. (2008, January 28). *WPG said communication IC demand bottoming out.* Retrieved January 28, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080128PB201.html

Lee, I. & Chan, R. (2008, January 17). *Handset PCB makers brace for sharper-than-expected sales decline.* Retrieved January 17, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080117PD210.html

Lee, I. & Lam, E. (2008, January 31). *Unimicron guides double-digit sequential sales decline in 1Q.* Retrieved January 31, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080130PD227.html

LiMo Foundation (2008, February 11). *First LiMo platform handsets unveiled.* Retrieved February 11, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/02/11/151905.html

Liu, K. (2007, October 02). *Smart phones forecast to be hot product for Taiwan's contract suppliers.* Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_20884.html

Long, M. (2008, January 21). *Kyocera to buy Sanyo's mobile-phone business.* Retrieved January 21, 2008 from Mobile Tech Today web site: http://www.mobile-tech-today.com/story.xhtml?story_id=57919

Long, M. (2008, February 01). *Tough market slashes Ericsson's profits.* Retrieved February 01, 2008 from DigiTimes web site: http://www.mobile-tech-today.com/story.xhtml?story_id=58154

Mah, E. (2008, January 25). *Handset shipments up nearly 16% to 1.15 billion in 2007, says ABI Research.* Retrieved January 25, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080125PR203.html

MontaVista Software (2008, February 11). *ACCESS Linux platform integrated with MontaVista Mobilinux OS.* Retrieved February 11, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/02/11/135143.html

Motorola, Inc. (2008, January 31). *Motorola to explore structural and strategic realignment of its businesses to enhance shareholder value.* Retrieved January 31, 2008 from Motorola web site: http://www.motorola.com/mediacenter/news/detail.jsp?globalObjectId=9233_9162_23&pageLocaleId=2026

Nag, D. S. (2008, January 23). *Motorola to design Qualcomm chipsets into some UMTS 3G handsets.* Retrieved January 23, 2008 from Reuters web site: http://www.reuters.com/article/marketsNews/idUKWNAS729620080123?rpc=44

NXP Semiconductors (2008, January 31). *First sub-$100 3G Linux mobile phone unveiled.* Retrieved January 31, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/01/31/121922.html

Pan, S. & Chuang, E. (2008, February 01). *Giantplus seeing China white-box handset orders rebound.* Retrieved February 01, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080131PD220.html

Pick, Adam (2007, October 24). *Innolux cracks iSuppli's top-10 ODM rankings.* Retrieved from iSuppli web site: http://www.emsnow.com/npps/story.cfm?id=29740

Poropudas, T. (2008, February 05). *Apple surprises while Nokia stays in command of smart phones.* Retrieved February 05, 2008 from MobileMonday web site: http://www.mobilemonday.net/news/apple-surprises-while-nokia-stays-in-command

Qualcomm (2008, January 30). *Mio and Qualcomm to develop PNDs.* Retrieved January 30, 2008 from MobileTechNews web site: http://www.mobiletechnews.com/info/2008/01/30/131049.html

Quincy (2006, September 26). *Major IT, electronics players intent on sharing mobile devices pie.* Retrieved from CENS web site: http://cens.com/cens/html/en/news/news_inner_5414.html

Raf, I. (2008, January 01). *Wireless/mobile statistics.* Retrieved March 11, 2008 from Imran's Everything Cellular web site: http://www.mobileisgood.com/statistics.php

Reardon, M. (2006, October 19). *Cell phone shipments hit highs, but profits sag.* Retrieved from ZDNet Tech News web site: http://news.zdnet.com/2100-1035_22-6127736.html

Reardon, M. (2007, February 14). *Emerging markets fuel cell phone growth.* Retrieved from News.com web site: http://www.news.com/Emerging-markets-fuel-cell-phone-growth/2100-1039_3-6159491.html?tag=item

Reuters (2008, January 21). *Phone with fold-away screen to launch in mid-2008.* Retrieved January 21, 2008 from Reuters web site: http://www.news.com/Phone-with-fold-away-screen-to-launch-in-mid-2008/2100-1041_3-6227035.html?tag=html.alert.comp

Schenker, J. L. (2008, February 18). *Mobile-phone startups shine in Barcelona.* Retrieved February 18, 2008 from Business Week Online web site: http://www.mobile-tech-today.com/story.xhtml?story_id=58390

Shen, D. & Chuang, E. (2008, February 01). *Compal Communications aims to ship 60 million handsets in 2008.* Retrieved February 01, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080131PD217.html

Shen, D. & Chuang, E. (2008, January 25). *HTC to ship CDMA handset to Reliance directly.* Retrieved January 25, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080124PD213.html

Shen, D. & Lam, E. (2008, January 24). *Kyocera-Sharp mobile phone consolidation to benefit Qisda.* Retrieved January 24, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080123PD215.html

Shen, D. & Lam, E. (2008, March 13). *LG aims to ship two million handsets in 2008; Arima to be direct beneficiary.* Retrieved from DigiTimes web site: http://www.digitimes.com/news/a20080312PD223.html

Shen, D. & Shen, S. (2008, January 28). *Arima Communications handset shipments to peak at 5-6 million units in 3Q08.* Retrieved January 28, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080128PD207.html

Shen, D. & Shen, S. (2008, February 13). *BenQ steps up cooperation with MediaTek in 2G handset segment.* Retrieved February 13, 2008 from DigiTimes web site: http://www.digitimes.com/telecom/a20080213PD213.html

Shen, D. & Shen, S. (2008, March 12). *China-based ZTE aims to become a global top-five handset vendor.* Retrieved from DigiTimes web site: http://www.digitimes.com/news/a20080312PD217.html

Shen, D. & Shen, S. (2008, January 29). *E-Ten to showcase mobile TV-supporting PDA phone at GSMA congress.* Retrieved January 29, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080129PD210.html

Shen, D. & Shen, S. (2008, January 25). *Fight for second place among top-tier handset vendors to intensify.* Retrieved January 25, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080125PD218.html

Shen, D. & Shen, S. (2008, January 31). *HTC forecasts revenues up 20-30% in 2008; new products to launch in 2Q.* Retrieved January 31, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080131PD210.html

Shen, D. & Shen, S. (2007, January 15). *HTC handset OEM/ODM orders taking hit from other Taiwan makers.* Retrieved from Digitimes web site: http://www.digitimes.com/telecom/a20070115PD202.html

Shen, D. & Shen, S. (2008, January 29). H*TC share of Windows Mobile smartphone segment declinin*g. Retrieved January 29, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080129PD208.html

Shen, D. & Shen, S. (2008, February 15). *Mobinnova to begin shipping Ultimate 8502 and 9502 to i-mate.* Retrieved February 15, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080215PD217.html

Shen, D. & Shen, S. (2008, February 18). *OpenMoko to unveil second open source handset in March-April.* Retrieved February 18, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080218PD213.html

Shen, D. & Shen, S. (2008, January 28). *Sony Ericsson reportedly outsources production of new handsets to Taiwan-based makers*. Retrieved January 28, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080128PD206.html

Shen, S. (2008, February 12). *HTC lands Sony Ericsson Xperia X1 handset orders*. Retrieved February 12, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080212PB200.html

Shen, S. (2008, January 17). *MWG, i-mate and Palm switching smartphone orders back HTC*. Retrieved January 17, 2008 from DigiTimes web site: http://www.digitimes.com/news/a20080117PB204.html

Shilov, A. (2007, July 04). *Four million Apple iPhones to be sold in 2007 – Research firm*. Retrieved from Xbit Laboratories web site: http://www.xbitlabs.com/news/mobile/display/20070704234141.html

Siegler, M. G. (2008, February 12). *Yahoo continues to consolidate the mobile web experience with oneConnect*. Retrieved February 12, 2008 from VentureBeat web site: http://venturebeat.com/2008/02/12/yahoo-continues-to-consolidate-the-mobile-web-experience-with-oneconnect/

Starrett, C. (2008, February 28). *Apple joins world's top 10 cellular manufacturers in Q4 2007*. Retrieved from iLounge.com web site: http://ilounge.com/index.php/news/comments/apple-joins-worlds-top-10-cellular-manufacturers-in-q4-2007/

Thomson Financial (2008, January 30). *China's Lenovo Group sells handset business for 100 million US dollars*. Retrieved January 30, 2008 from Trading Markets web site: http://www.tradingmarkets.com/.site/news/Stock%20News/1047589/

Mobile Gazette. (2007, December 28). *2007 wrap up. 2008 predictions*. Retrieved December 28, 2007 from http://www.mobilegazette.com/2007-wrap-up-1-07x12x28.htm

MobileTechNews. (2008, January 17). *A look at the mobile phone market in ten years*. Retrieved January 17, 2008 from http://www.mobiletechnews.com/info/2008/01/17/135723.html

ems now. (2007, June 04). *Arima aims for Taiwan's No. 1 ODM maker of PDA phones*. Retrieved from http://www.emsnow.com/newsarchives/archivedetails.cfm?ID=19287

DigiTimes. (2007, November 05). *Arima Communications lands more handset orders from LG; sees strong shipments in October*. Retrieved from http://mphonefrenzy.com/search/arima

DigiTimes. (2007, December 13). *Arima Communications targets strong annual handset shipments in 2008 on Sony Ericsson and LGE orders*. Retrieved from http://mphonefrenzy.com/search/arima

Mobile Tech Today. (2007, December 10). *Asia's new foray into U.S. wireless*. Retrieved December 10, 2007 from http://www.mobile-tech-today.com/story.xhtml?story_id=57143

DigiTimes. (2007, December 31). *Asustek to launch four new handsets in January and MID PDA phone in mid-2008*. Retrieved December 31, 2007 from http://www.digitimes.com/news/a20071231PD211.html

DigiTimes. (2007, December 27). *Asustek to relocate sales and marketing to Singapore.* Retrieved December 27, 2007 from http://www.digitimes.com/systems/a20071226PD216.html

DigiTimes. (2007, December 14). *Chi Mei Communication Systems lands ultra-low cost handset orders from Motorola.* Retrieved December 14, 2007 from http://www.digitimes.com/news/a20071214PB203.html

Research in China. (2006, November 01). *China mobile handset manufacturers report, 2006 (Chinese version)*. Retrieved from http://www.researchandmarkets.com/reportinfo.asp?report_id=363280&t=t&cat_id=

Research in China. (2005, May 01). *China mobile phone manufacturer report (Oversea market exploration), 2005*. Retrieved from http://www.researchinchina.com/report/Telecommunications/153.html

DigiTimes. (2007, December 18). *Commentary: Thrust by fab-lite IDMs in handset and TV chip markets to plunge prices in 2008*. Retrieved December 18, 2007 from http://www.digitimes.com/news/a20071218PD209.html

DigiTimes. (2007, December 04). *Compal Communications and Arima Communications to have mixed shipment performance in 1Q08, says paper*. Retrieved December 04, 2007 from http://www.digitimes.com/news/a20071204PB201.html

DigiTimes. (2007, October 26). *Compal Communications may see handset shipments improve in 4Q*. Retrieved from http://mphonefrenzy.com/search/compal

3G.co.uk. (2007, October 17). *Consolidation strikes the mobile handset baseband semiconductor market*. Retrieved October 17, 2007 from http://www.3g.co.uk/PR/Oct2007/5296.htm

Accenture. (2005, June 01). *Convergence is now: Accenture mobile handset study*. Retrieved from http://www.accenture.com/xdoc/industries/communications/access/mc44.pdf

DigiTimes. (2007, December 18). *Dopod China reportedly to introduce low cost CDMA handsets in China*. Retrieved December 18, 2007 from http://www.digitimes.com/news/a20071218PD206.html

Mobile Tech Today. (2007, December 12). *EU clears Sony Ericsson for UIQ deal*. Retrieved December 12, 2007 from http://www.mobile-tech-today.com/story.xhtml?story_id=57190

prlog.org. (2007, December 13). *Europe mobile handset market analysis (2007)*. Retrieved December 13, 2007 from http://www.prlog.org/10041984-europe-mobile-handset-market-analysis-2007.html

DigiTimes. (2007, December 26). *Foxlink reportedly lands handset OEM orders from China Mobile*. Retrieved December 26, 2007 from http://www.digitimes.com/telecom/a20071225PD225.html

DigiTimes. (2007, December 20). *Growth in handset LED market to slow in* 2008. Retrieved December 20, 2007 from http://www.digitimes.com/news/a20071217PD208.html

DigiTimes. (2008, January 09). *Handset component makers see bright outlook for 2008 despite sequential declines in 1Q*. Retrieved January 09, 2008 from http://www.digitimes.com/news/a20080109PD208.html

DigiTimes. (2007, December 26). *Handset makers to hit both high- and low-end markets in India*. Retrieved December 26, 2007 from http://www.digitimes.com/telecom/a20071225PD223.html

DigiTimes. (2008, January 07). *Handset shipments from Compal Communications and Arima Communications down sharply in 2007*. Retrieved January 07, 2008 from http://www.digitimes.com/news/a20080107PD212.html

MobileTechNews. (2008, January 16). *Helio introduces Mysto handset*. Retrieved January 16, 2008 from http://www.mobiletechnews.com/info/2008/01/16/235445.html

MobileTechNews. (2007, December 04). *Hop-on brings back disposable cell phone*. Retrieved December 04, 2007 from http://www.mobiletechnews.com/info/2007/12/04/014904.html

DigiTimes. (2007, December 26). *HP teams up with Taiwan makers to offer more iPAQ handheld devices*. Retrieved December 26, 2007 from http://www.digitimes.com/news/a20071226PD213.html

DigiTimes. (2007, December 25). *HTC denies that operations in 1Q08 will be affected by Qualcomm chipset shortages*. Retrieved December 25, 2007 from http://www.digitimes.com/news/a20071225PD218.html

DigiTimes. (2008, January 03). *HTC mulls adding additional 3G chipset supplier*. Retrieved January 03, 2008 from http://www.digitimes.com/news/a20080103PD213.html

Mobile Magazine. (2007, December 07). *HTC November 2007 sales hit record high again*. Retrieved December 07, 2007 from http://justamp.blogspot.com/2007/12/htc-november-2007-sales-hit-record-high.html

DigiTimes. (2007, December 24). *HTC revenues to decline over 38% sequentially in 1Q08 due to chipset shortages*. Retrieved December 24, 2007 from http://www.digitimes.com/news/a20071224PB201.html

MobileWhack. (2007, December 28). *Huawei handset debuts in the U.S.*. Retrieved December 28, 2007 from http://www.mobilewhack.com/huawei-handset-debuts-in-the-us/

MobileWhack. (2008, January 04). *HUAWEI U1215 mobile phone*. Retrieved January 04, 2008 from http://www.mobilewhack.com/huawei-u1215-mobile-phone/

DigiTimes. (2007, December 18). *Intel introduces ultra-small SSD for handheld devices*. Retrieved December 18, 2007 from http://www.digitimes.com/news/a20071218PR200.html

China Mobile Phone. (n.d.). *Kejian, Konka, Lenovo, Ningbo Bird, Eastcom, ZTE, CECT, Panda*. Retrieved from http://www.chinamobilephones.net/manufacturers.htm

DigiTimes. (2007, December 12). *Leading handset vendors may review cooperation with BYD on pending FIH-BYD lawsuit*. Retrieved December 12, 2007 from http://www.digitimes.com/news/a20071212PD210.html

DigiTimes. (2008, January 10). *MediaTek delivers 3G chip samples ahead of schedule.* Retrieved January 10, 2008 from http://www.digitimes.com/news/a20080110PD202.html

DigiTimes. (2007, December 31). *MediaTek subsidiary expected to gain orders from another Top-4 handset vendor*. Retrieved December 31, 2007 from http://www.digitimes.com/news/a20071231PB202.html

DigiTimes. (2008, January 09). *Mitac sees slight drop in revenues performance in 2007.* Retrieved January 09, 2008 from http://www.digitimes.com/news/a20080109VL200.html

MobileTechNews. (2008, February 12). *Mobile internet device prototype showcased at Mobile World Congress*. Retrieved February 12, 2008 from http://www.mobiletechnews.com/info/2008/02/12/004952.html

TechnaBob. (2007, December 19). *mobile-phone-offers-nes-emulation-mystery-windows-key*. Retrieved December 19, 2007 from http://technabob.com/blog/2007/12/19/mobile-phone-offers-nes-emulation-mystery-windows-key/

modu mobile. (2008, February 07). *modu launches world's first concept phone*. Retrieved February 07, 2008 from http://www.mobiletechnews.com/info/2008/02/07/120610.html

DigiTimes. (2007, December 18). *Motorola said to be targeting 2Q08 for next-generation Linux-based Ming handsets*. Retrieved December 18, 2007 from http://www.digitimes.com/news/a20071218PB202.html

DigiTimes. (2007, December 17). *Motorola to increase outsourcing of handsets in 2008*. Retrieved December 17, 2007 from http://www.digitimes.com/news/a20071217PB205.html

DigiTimes. (2007, December 12). *Motorola to restart cooperation with Taiwan smartphone makers*. Retrieved December 12, 2007 from http://www.digitimes.com/telecom/a20071211PD218.html

Mobile Tech Today. (2007, December 28). *Motorola's pain Is Samsung's gain*. Retrieved December 28, 2007 from http://www.mobile-tech-today.com/story.xhtml?story_id=57406

MobileWhack. (2008, January 06). *MSI unveils myriad of portable navigation and multimedia devices*. Retrieved January 06, 2008 from http://www.mobilewhack.com/msi-unveils-myriad-of-portable-navigation-and-multimedia-devices/

MobileWhack. (2008, January 04). *Neonode N2 mobile phone for US markets*. Retrieved January 04, 2008 from http://www.mobilewhack.com/neonode-n2-mobile-phone-for-us-markets/

China Daily. (2006, November 15). *New Nokia CEO to keep up China push.* Retrieved from http://english.peopledaily.com.cn/200611/15/eng20061115_321590.html

Strategy Analytics. (2008, January 24). *Nokia achieves 40% global handset market share.* Retrieved January 24, 2008 from http://news.ecoustics.com/bbs/messages/10381/439497.html

Mobile Monday. (2008, January 13). *Nokia and Qualcomm to talk about cease-fire.* Retrieved January 13, 2008 from http://www.mobilemonday.net/news/nokia-and-qualcomm-to-talk-about-cease-fire

Device Arena. (2007, October 30). *Nokia and Samsung continue gains as mobile phone volume rises 13.8%.* Retrieved from http://devicearena.com/2007/10/30/nokia-and-samsung-continue-gains-as-mobile-phone-volume-rises-138/

Mobile Tech Today. (2007, December 04). *Nokia details mobile strategy shift.* Retrieved December 04, 2007 from http://www.mobile-tech-today.com/story.xhtml?story_id=57061

MobileWhack. (2008, February 05). *Nokia preps the iPhone rival.* Retrieved February 05, 2008 from http://www.mobilewhack.com/nokia-preps-the-iphone-rival/

Mobile Monday. (2007, December 26). *Nokia Siemens negotiates to Siemens Communication shares.* Retrieved December 26, 2007 from http://www.mobilemonday.net/news/nokia-siemens-negotiates-to-siemens-communication-shares

China Sourcing News. (2008, March 11). *Nokia Signs US$2 billion mobile phone deal in China*. Retrieved from http://www.chinasourcingnews.com/2008/03/11/14171-nokia-signs-us2-billion-deal-mobile-phone-deal-in-china/

DigiTimes. (2008, January 02). *NPC and Unimicron to be affected less by 1Q seasonality than fellow PCB competitors*. Retrieved January 02, 2008 from http://www.digitimes.com/news/a20080102PD202.html

SlashPhone. (2008, February 06). *NXP and Purple Labs unveil first sub-$100 3G Linux mobile phone*. Retrieved February 06, 2008 from http://www.slashphone.com/77/9237.html

DigiTimes. (2007, December 13). *NXP expects strong growth in HDTV and handset chips in 2008*. Retrieved December 13, 2007 from http://www.digitimes.com/news/a20071213PD205.html

MobileWhack. (2008, January 04). *OpenMoko Neo FreeRunner phone*. Retrieved January 04, 2008 from http://www.mobilewhack.com/openmoko-neo-freerunner-phone/

InformationWeek. (2008, January 03). *OpenMoko to unveil open source smartphone*. Retrieved January 03, 2008 from http://www.informationweek.com/news/showArticle.jhtml?articleID=205207789

DigiTimes. (2007, December 18). *Optical zoom to become a standard feature of 5-megapixel camera handsets*. Retrieved December 18, 2007 from http://www.digitimes.com/news/a20071218PD205.html

Mobile Tech Today. (2007, December 17). *Palm and Verizon Wireless Announce Treo 755p*. Retrieved December 17, 2007 from http://www.mobile-tech-today.com/story.xhtml?story_id=57268

DigiTimes. (2007, December 21). *Panel makers: China white box handset market to still grow in 2008*. Retrieved December 21, 2007 from http://www.digitimes.com/news/a20071221PD208.html

DigiTimes. (2007, December 12). *Phones with zoom and 5-megapixel resolution may become mainstream, say Taiwan makers*. Retrieved December 12, 2007 from http://www.digitimes.com/news/a20071212PD203.html

MobileWhack. (2007, December 05). *Porsche P9521 mobile phone in stores December 2007*. Retrieved December 05, 2007 from http://www.mobilewhack.com/porsche-p9521-mobile-phone-in-stores-december-2007/

MobileWhack. (2008, February 07). *Qualcomm announces 4G chipsets*. Retrieved February 07, 2008 from http://www.mobilewhack.com/qualcomm-announces-4g-chipsets/

MobileTechNews. (2008, January 02). *Qualcomm announces new UMTS products for U.S. market*. Retrieved January 02, 2008 from http://www.mobiletechnews.com/info/2008/01/02/122534.html

Mobile Tech Today. (2008, January 02). *Qualcomm hit with new chip ban*. Retrieved January 02, 2008 from http://www.mobile-tech-today.com/story.xhtml?story_id=57493

DigiTimes. (2008, January 11). *Quanta and Asustek to no longer produce handsets for MWG*. Retrieved January 11, 2008 from http://www.digitimes.com/news/a20080110PD215.html

Mobile Tech Today. (2007, December 21). *Research In Motion defies conventional wisdom*. Retrieved December 21, 2007 from http://www.mobile-tech-today.com/story.xhtml?story_id=57339

Cell Phone Observer. (2007, December 05). *RIM introduces BlackBerry Pearl 8120 smartphone in Singapore*. Retrieved December 05, 2007 from http://www.cellphoneobserver.com/992326_rim_rim_introduces_blackberry_pearl_8120_smartphone_singapore

MobileWhack. (2007, December 12). *RoverPC C6 GSM GPRS phone*. Retrieved December 12, 2007 from http://www.mobilewhack.com/roverpc-c6-gsm-gprs-phone/

Strategy Analytics. (2007, October 25). *Samsung and Nokia outperform sluggish mobile phone market in Q3 2007, says Strategy Analytics*. Retrieved from http://ce.tekrati.com/research/9591/

IDC. (2007, August 02). *Samsung beats Motorola for no. 2 spot as Apple joins the handset vendor club with iConic device, notes IDC*. Retrieved from http://www.businesswire.com/portal/site/google/?ndmViewId=news_view&newsld=20070802005658&newsLang=en

DigiTimes. (2008, January 08). *Samsung expected to step up cooperation with FIH for handset assembly.* Retrieved January 08, 2008 from http://www.digitimes.com/news/a20080108PD205.html

MobileWhack. (2008, January 14). *SoftBank 920SC phone.* Retrieved January 14, 2008 from http://www.mobilewhack.com/softbank-920sc-phone/

MobileTechNews. (2008, January 16). *Sony Ericsson sells over 100 million handsets in 2007.* Retrieved January 16, 2008 from http://www.mobiletechnews.com/info/2008/01/16/233345.html

EvertIQ. (2007, December 13). *Sony Ericsson to cut down Arima orders.* Retrieved December 13, 2007 from http://www.evertiq.com/news/read.do?news=9652&cat=1

DigiTimes. (2008, January 02). *Spreadtrum, Amoi and Kuro jointly launch music phones with copyright protection in China.* Retrieved January 02, 2008 from http://www.digitimes.com/news/a20080102PR202.html

DigiTimes. (2007, December 28). *Taiwan handset shipments to rebound in 2008, growth of 30% expected.* Retrieved December 28, 2007 from http://www.digitimes.com/news/a20071228VL202.html

DigiTimes. (2007, December 14). *Taiwan-based touch panel maker J-Touch to further expand capacity; develops new technologies.* Retrieved December 14, 2007 from http://www.digitimes.com/news/a20071214PD203.html

Allyn Hall, In-Stat. (2007, October 01). *Ten trends influencing the European mobile phone market 2007-2012*. Retrieved October 01, 2007 from http://www.electronics.ca/reports/mobile_phones/european_market.html

MobileWhack. (2008, January 02). *Turtle Wireless TWP-800: Wearable tri-band GSM mobile phone*. Retrieved January 02, 2008 from http://www.mobilewhack.com/turtle-wireless-twp-800-wearable-tri-band-gsm-mobile-phone/

Venture Outsource. (2008, February 26). *Wall Street on EMS vs. ODM market share and market segments*. Retrieved from http://www.ventureoutsource.com/contract-manufacturing/trends-observations/2008/wall-street-on-ems-vs-odm-market-share-and-market-segments

DigiTimes. (2008, January 02). *Wanshih reportedly lands mini coaxial cable orders from Motorola and Nokia*. Retrieved January 02, 2008 from http://www.digitimes.com/news/a20080102PD207.html

DigiTimes. (2007, December 21). *Wintek tops in mobile phone main display market for first time in 3Q07*. Retrieved December 21, 2007 from http://www.digitimes.com/news/a20071221PR202.html

MobileWhack. (2008, January 12). *Wistron GW4 smartphone -- first Google Android Phone?* Retrieved January 12, 2008 from http://www.mobilewhack.com/wistron-gw4-smartphone----first-google-android-phone/

DigiTimes. (2008, January 09). *Wistron NeWeb to join Android club, but not all Taiwan handset makers to follow suit.* Retrieved January 09, 2008 from http://www.digitimes.com/news/a20080109PD207.html

modu mobile. (2008, February 07). Retrieved February 07, 2008 from http://www.modumobile.com/