EtherealMind

Network Design Documents

Whitebox Networking in 2014

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EtherealMinds Design Document Series

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1 Overview of COTS and Whitebox

The arrival of low cost network equipment seems to have happened overnight. In fact, the process has been years in the "making" as the networking industry has reached a stage in evolution. In the last two decades the volume of network equipment means that the design, production and manufacture of networking hardware has moved from custom-built to mass manufacture. And, like many other manufactured products, this means commoditisation of technology.

Common Off The Shelf (COTS) is a term used describe electronic components. In years past, the electronics engineer could assemble a product from standard products that were available from electronic catalogs or at the local electronics store. Today, the progress of miniaturisation and reduction means that assembling digital electronics is based on using products like Raspberry PI or Arduino computers which are "commoditised" pre-assemblies.

A modern x86 server is made from a number of common components. The CPU, PCI Bus, memory chips (DRAMs) and power supplies are similar for all servers. In many cases, CPU and DRAMs are interchangeable and self upgradeable and are examples of COTS components in modern technology.

Whitebox The term "whitebox" is used to describe a technology product that is built from COTS components by a relatively unknown manufacturer, usually based in China or Taiwan. Whitebox products may be sold though a local business who place a sticker on a self-assembled product. For other markets, such as groceries, the terms include "own label" or "home brand" have similar meaning.

The report takes a comprehensive view of the entire ecosystem of Ethernet switch and how low cost, commodity products will establish into the networking market. This includes considering the technology inside the device, the optical components and cabling as well as the market impacts, change to corporate policy and practices.

2 Commodity Markets

In this section, I explain that commoditisation is a fundamental economic occurrence that happens to mature markets. This transition in normal in any maturing market when a product reaches enough volume and at high profit margins that draws other companies to compete in the market. Whitebox networking is a result of a commoditising market.

3 What is Commoditisation

A product, either goods or a service, becomes a commodity when there is a lack of differentiation between competitive products and services. Commodity products are regarded as standardised and common technology that invites more suppliers to enter the market. This cycle of low barriers to entry, high volume and limited differentiation leads to limited and decreasing profit margins over time.

Commoditisation is a form of market physics that happens in all marketplaces where products or services are popular, profitable and both.

3.1 Process Cycle of Commoditisation

This section examines three aspects of the cycle - Product, Production, Manufacture.

Product Commoditisation Cycle

At the outset, the product [1] is valuable for it's uniqueness. This value is derived by the price that a customer is willing to pay for the product to solve a problem using a new technique or method.

services but this book focusses on products so I'll narrow the discussion.

The Product Commodity Cycle

Production Cycle

A new product or service starts out as a concept or research and development project before moving to early production using "custom built" process. The custom process often uses small batch manufacturing using equipment or processes that are readily available or adapted from existing manufacturing capability.

[1] Commoditisation applies equally to product and

A successful product will move from the initial production run to a factory process that is specifically designed to make the product uniform, in volume and more profitably. Early stage products typically have high profit margins on limited volume that reflect the risk taken to develop them and higher cost of production.

Product Cycle From Inception to Mass Manufacture

Manufacturing/Production Efficiencies

The higher profit margins of a successful product or service will attract competitors who will reproduce the product or service and offer at lower price and undercut the product in the market. With enough competitors and volume, products tend to become it as uniform, plentiful and affordable as possible. As a result of technological innovation, broad-based education and product iteration, goods and services become commoditised and widely available.

Over time the production process will move from unique and complex to repeatable and simple. Repeatability is important to volume production and successful products will become simpler to make mass production more practical.

Manufacturing Cycle - Complexity to Simplicity

3.2 Case Study - Smartphones

When Apple debuted the first iPhone it was a technological leap. Apple had effectively created a computer in a phone sized unit that lasted most a day and ran software that was appealing to customers. The first iPhones were hard to manufacture and availability was limited. Following generations of Apple iPhones improved the processing power, battery life and software continued to advance.

Google released the Android operating system as an open source and enabled any company with the resources to manufacture a competitive product. Over time, Android-compatible hardware has iterated rapidly to an acceptable level of quality and similar price point to Apple.

Microsoft has also entered the market with the Windows phone while other competitors have failed (HP/Palm) or are close to failing (Blackberry) as the market competition judges those products.

Most commentators would agree that Blackberry has failed to transition to a commoditised market with lower profit margins, large volumes and new features. In fact, Blackberry still deliver the same number of handset as five years previously before the iPhone was shipping.

All smartphones are assembled from components that are readily available from existing factories. Smartphones manufacturers use components that are openly available and can be assembled. Existing silicon factories can produce the ARM CPU under license to their own design and feature set. Touch sensitive displays are made in display factories while sound, motion and graphics processors have existing packaging for use in other devices and were readily updated for use in mobile phones.

Today, the differences between smartphones is relatively small. They all have cameras, roughly the same battery life, operate software at about the same level. Some people would perceive that Apple has an overall lead but Android phones are competing strongly. While the size of the market and the strong growth brings new manufacturers, investment in factories and production processes, ultimately the product is converging towards a universal standard that all smartphones are roughly the same.

Pricing on product is reducing over time and differentiation is becoming limited. This is an example of a market that is well into the process of commoditisation.

3.3 Factory Costs and Investment

Takeaway

There are several factors that drive improvements in manufacturing to improve profitability. The most significant for manufacturing is the increasing volumes of products which drives larger production facilities to meet the demand. Larger factories scale up to produce more product at a lower cost.

At the same time, the complexity of the components are increasing and chaining rapidly.

The cost of building factory are ever increasing. The tooling and machinery is increasingly complex and thus more costly. There are serious environmental concerns about siting factories and consumption of resources.

Production Complexity

This means that the size of the factories must increase to match volume. At the same time, production processes are becoming more complex. The silicon process have shrunk from 200nm to 40nm over the last 5 years with an exponential increase in the cost and complexity of the equipment that can produce the chips.

Board on which chips are mounted are growing in complexity. Today 12-layer board are common where just five years ago 5-layer boards where in use. Equipment power supplies are required to be much higher in power efficiency (requiring hard to manufacture components) and much more accurate in voltage and current delivery as chips become smaller and are susceptible to small power fluctuations.

Factory Investment

Factories have geographic constraints and require specific resources, human, natural and financial. As factories get larger and more complex, the workforce requires additional resources. Locating a factory close to potential pool of human resource at low cost is a strong influence and has suited the Asian markets for the last 20 years. Other issues include available electricity and water. Silicon fabs require vast amounts of fresh water for cooling and washing in addition to large amounts of electricity. In addition, the sources of water and electricity must be highly reliable to ensure production volumes are predictable and reliable. Waste from silicon production is usually toxic and noxious which requires special handling.

Once a geography has been identified then two significant time factors are at play. First is raising a significant financial commitment in the order of billions of dollars. Preparing the research and plans to support this level of investment can take years. Second the time to build the plant itself is often 3 to 5 years.

Case Study - Intel "Fab42" in Arizona, USA

As a case study, consider that intel build an additional factory to manufacture chips in Chandler, Arizona. Plans were announced in 2009 to build the facility. Construction started in 2011 and plant construction finished in early 2014 (after project slowdowns, previously planned to finished in 2013) at an estimated USD $5.2Billion cost. This WSJ Article[2] covers the key issues that intel does not have enough demand to start the production there.

This article at Bloomberg[3] highlights the water consumption:

> Yet each day, 2 million gallons of industrial wastewater – enough to fill at least 30,000 bathtubs – are piped from Intel plants in Chandler, Arizona, to a facility a mile away

[2]http://blogs.wsj.com/digits/2014/01/14/intel-arizona-plant-to-remain-idle/

[3]http://www.bloomberg.com/news/2013-09-15/intel-plant-replenishes-aquifer-for-thirsty-arizona-city.html

> where it's treated, then returned to an underground aquifer. Intel, the city's largest employer, recycles about 60 percent of its water and is expanding the treatment facilities and increasing the amount it reuses as the company finishes a $5 billion plant that will build more efficient computer chips.

The Fab 42 plant would draw existing labour from the town around it where there are existing plants. The Bloomberg article highlights that population has doubled since 1990 to 245000 people.

3.4 Silicon Economics

3.5 Improving Production

In the previous we briefly summarised the costs and challenges of building and running a factory that builds components used in networking equipment. In this section we consider how the output of these factories can be improved to offset the cost of investment cost.