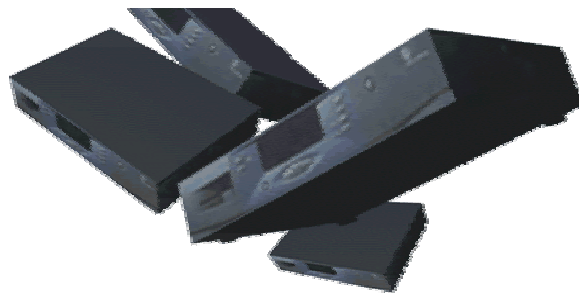


INSEAD

High Technology Strategy and Entrepreneurship

The Digital TV Revolution - Setting the 

Analysis of the Digital Set-Top Box Industry



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1. INTRODUCTION

The Italian physicist Caselli was the first to send an image over long distances in 1862 when applying a technique called “pan-telegraph” (over-telegraph). It was not until 1925 however that the television was invented, allowing consumers to receive moving pictures directly in their living rooms. The early pictures were in black and white, and with the later addition of colour, television became the primary source of in-house entertainment in the western world. Surprisingly, since the invention of the color cathode ray tube in the 1940’s, no major technological innovations took place before the 90’s; the offering to consumers was however improved through better programming, and more channels.

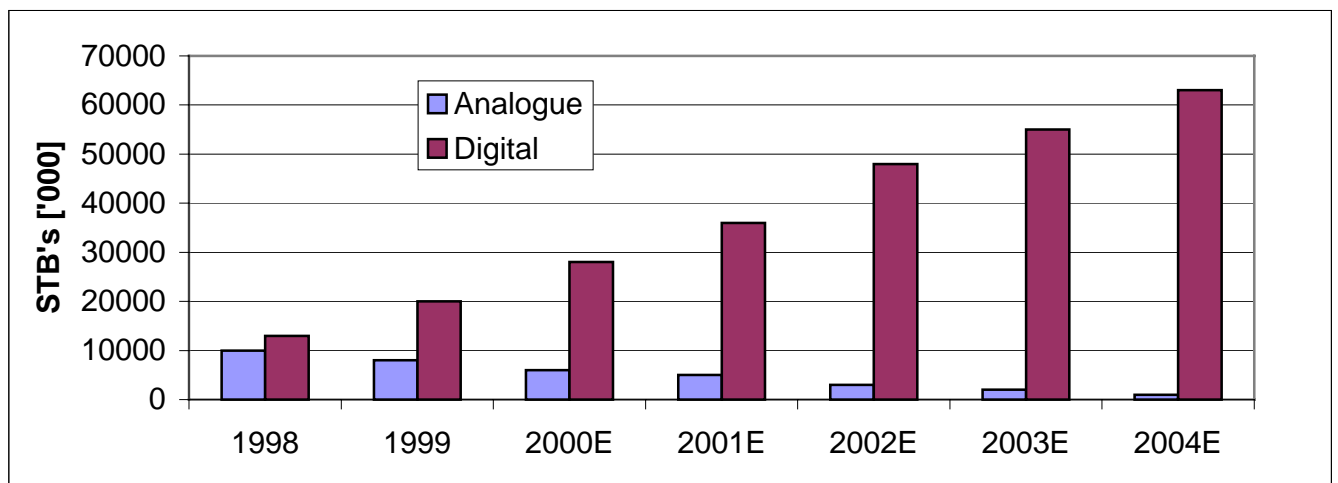
In the beginning, distribution of the signals was through the air as ground-to-ground transmission. As a consequence of poor coverage and a freeze in frequency allocation immediately after WWII, cable evolved as a new and improved source of distributing signals to end users in the US. With the evolution of space technology, the first television satellite was sent into orbit, allowing a third way of distributing signals to consumers. To improve the program offering, the first analogue set-top boxes (STB) were developed in the late 1970’s as decoders for analogue cable networks, allowing for premium offerings and greater content variety.

Jumping ahead to the mid-1990’s, significant advances in data compression and the promise of a radically superior viewing experience have fuelled the development of digital TV. This would allow broadcasters to offer a wider variety of programming tailored to the individual consumer, and construct new business models in the entertainment industry with increased use of pay-per-view and the introduction of interactive features.

The Innovation

In this report, we examine the digital STB as a technical innovation – a device that decodes digital signals, allows greater programme choice and interactivity. Simply put, the digital STB connects the analogue TV set with the enhanced experience that is at the core of the digital TV value proposition.

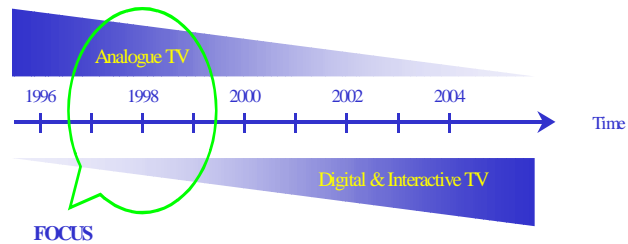
Report Focus



source: Dresdner Kleinwort Wasserstein

The 1998-2000 period is therefore the focal point of our analysis because:

- It constitutes the period when digital STBs began to supplant analogue STBs (as shown in the graph above).
- It coincides with the launch of three major digital TV services in the UK (which became the European leader in digital TV with 33% of the market).
- There was no *established* major player in the digital STB market at the onset, although several companies were already well entrenched in analogue STBs.



We have structured our report as follows:

- Reasons for the emergence of digital TV, both from the perspective of consumers and of network operators.
- Structure of the industry and the resultant inter-relationships.
- Forecasts for market growth.
- Key success factors.
- Analysis of risks and strategic uncertainties facing a digital STB manufacturer.
- Comparison of the evolution and management of Pace, an emerging pure-play STB manufacturer, and Philips, a leading consumer electronics group with the base to take on a leading role in digital STBs on a global scale.

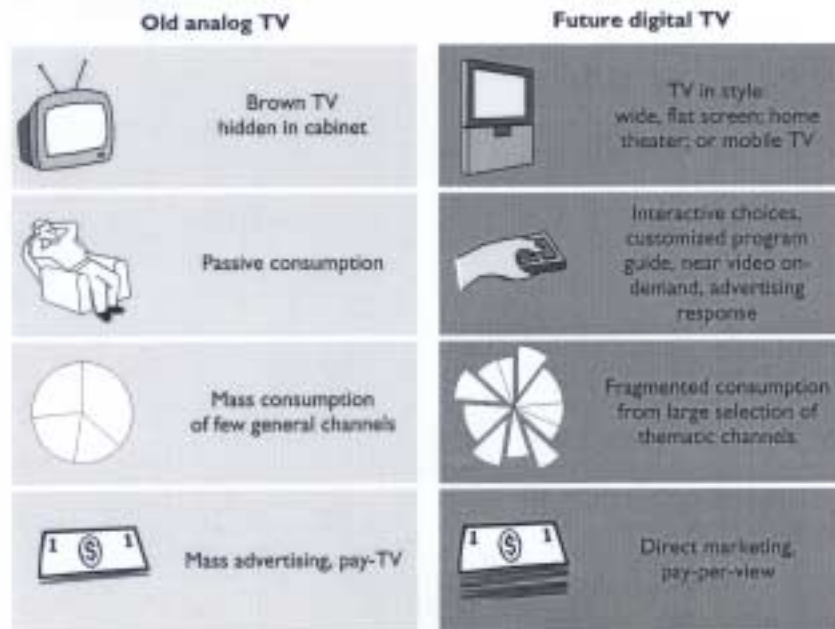
2. DIGITAL TV – ADVANTAGES AND INDUSTRY STRUCTURE

This chapter describes the drivers of the emergence of the digital TV industry, as well as the key players and their roles in order to understand the place of the STB manufacturers in the value chain.

What are the advantages of digital TV for the consumer?

Digital TV will sell not because of its technological appeal, but rather because of what additional practical benefits it offers consumers:

- **More channels and more choice** – market studies show that European viewers are willing to pay \$30 a month to upgrade from six free national channels to a package of 30 channels. A network operator can transmit five digital channels in the same bandwidth as a single analogue channel.
- **Better content** – near video-on-demand, premium content (*e.g.*, sports channels), and advertising-free channels all become easily available with digital television. For example, Italy's Telepiu received 1,000 subscriptions a day during the World Cup.
- **Interactivity** – electronic program guides, multimedia games, and illustrated articles can be sent together with the television program being watched. The viewer can still passively watch TV, but may also customize the experience.






Source: Forrester Research, Inc.

Figure 1 – Analogue v. Digital Television

What are the technical advantages of digital TV for network operators?

Digital TV broadcasts are simply long streams of bits that can contain any data a broadcaster wants to add to their signal. Each channel has about 19.2 Mbs of data – most of it video and audio, but some of the signal can be other forms of data.

- **Digital signals can be compressed** – a standard analogue channel takes up 6 MHz of bandwidth, but more than five times as much information can be squeezed to the same bandwidth in digital format.
- **Digital broadcasters are not restricted to just sending a high-definition picture** – instead, they can "multi-cast" four standard-definition pictures instead of only one high-definition picture.
- **Digital TV can broadcast sound using the Dolby Digital/AC-3** – the same digital sound used in most movie theaters, DVDs, and many home theater systems.
- Both analog and digital signals get weaker with distance. However, while the picture on an analog TV slowly gets worse for more distant receivers, **a picture on a digital set will stay perfect until the signal becomes too weak for the receiver to pick it up** because a one is always a one, and a zero is always a zero.

	 Cable	 Satellite	 Terrestrial
Choice (number of channels)	40-200	200-500	15-50
Interactivity	Fast return path, potential Internet access	Return path by phone now, by satellite in 2003	Return by phone or wireless
Cost (per month)	Pay-TV \$20-\$100 plus PPV	Many free channels many premium channels \$0-\$80 plus PPV	Multiple free channels \$0-\$50
Future destiny	Local TV and bundled communications services	Reach to disseminated audience and intermediate delivery to cable head-ends and terrestrial stations	Universal access for all local consumers, mobile TV, and digital audio

Source: Strategic Research, Inc.

Figure 2 – Characteristics of Digital TV Transmission Platforms

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Functionality of an STB

The STB is an important part of Digital TV. The main functions it provides are

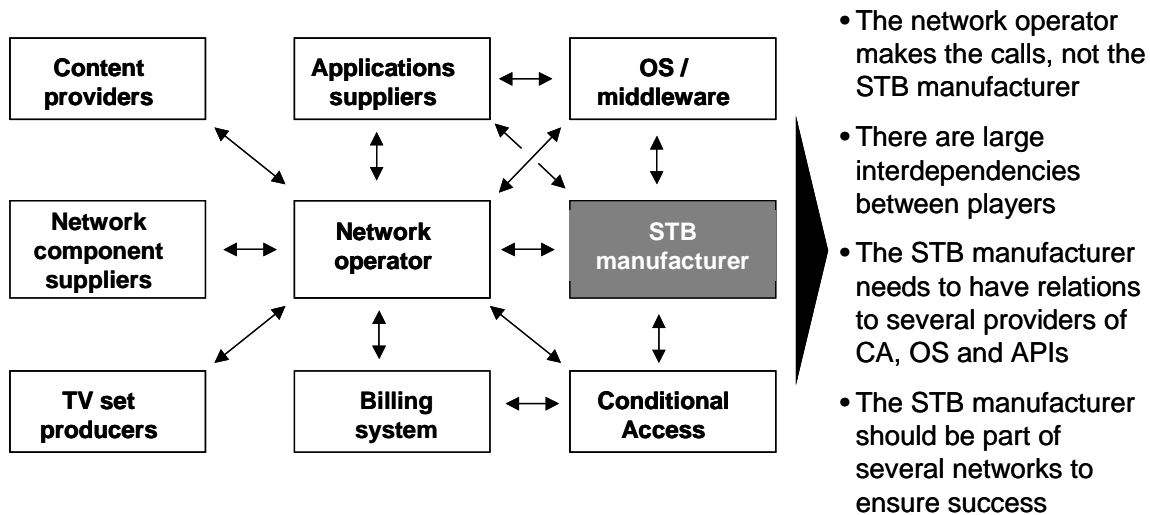
- Decompress and convert digital broadcast signals into a form that regular TV sets can interpret.
- Provide access to premium and pay-per-view channels broadcasted by the network.
- Run software such as the Electronic Programming Guide (EPG) that helps the consumer to select between the offerings.

Going forward, the functionality will extend beyond these basic functions to include

- Hard disk storage.
- Internet connectivity.
- Interaction with the content provider and advertiser (Interactive TV).

Structure of the Digital TV Industry

The dominating player in the network of the digital TV platform is the network operator - the company providing access for content owners to reach the end user.



Source: Press-clippings, group analysis

Figure 3 – Digital TV Industry Structure

The network operator is responsible for building the infrastructure to deliver the signal to the end-users home, and has to integrate a number of players in order to make content delivery possible. An example of active participants in 1998 is included in Table 1. The STB manufacturer is one of the players, but the network operator makes the key decisions.

Network Operators	STB Manufacturers	CA Providers	Middleware Providers
BskyB (satellite) Canal+ (satellite, terrestrial) CWC (cable) DirecTV (cable) DigiCo (terrestrial) Ondigital (terrestrial)	Pace Phillips Thompson Grundig Panasonic Nokia	NDS Media Guard Irdeto Digicipher NagraVision Viaccess	OpenTV MediaHighway PowerTV

Table 1– Example of Industry players, 1998

The type of network operator drives the technological requirements...

Network operators can apply three different methods of delivering the signal to the end user, as outlined in Figure 4. The medium of transmission yields different opportunities for the network operator and therefore has significant implications for the STB manufacturer. For instance, the channel capacity is different for each medium. In addition, the return path for interactivity differs. The return path is needed for the consumer to communicate with the network operator. It is the level and nature of the service offered by the network operator that determines the technical complexity of the STB. As this increases to services such as video-on-demand, the operating software becomes more complex and requirements for hardware are lifted in terms of speed and memory.

...which the STB manufacturer has to comply with

Two major components are particularly important to the STB:

- Conditional Access (CA) is the software that includes the decoding and grants or denies access to each individual STB. The network operator uses the CA to control the usage of the network.
- The middleware is the platform on which the applications run. This cannot be independent of the network operator, since the operator updates the applications on the STB over the network.

The silicon is also very important as this can account for as much as 60% of the costs of a box. Most of the components are standard, but may have a long lead-time. ASICs are also utilized. In order to deliver a product that is compatible with each individual network, the STB manufacturer has to integrate CA, middleware, applications and hardware, amongst others. This is a complicated process, and requires substantial knowledge in addition to commercial licenses (see Appendix B for a more detailed debrief of the technical composition of a STB).

...and the downstream distribution is again dependent on the network operator

Content owners might operate their own network (BSkyB) or deliver content to an independent operator (CWC). The amount and quality of the programming available are important factors to determine the attractiveness of acquiring an STB for the end user. Since STBs are custom-made for each network operator, STBs are generally ordered in large volumes directly by the operator. The operator then distributes the STB to the end users, using different cost models as explained in the figure below.

- Sales – the consumer buys the set-top box, usually through a retailer.
- Lease – the consumer signs a contract on programming, which includes a monthly rental fee for the box.
- Give-away/subsidy – the consumer pays nothing or very little to get the box, usually the box is installed directly by the network operator.

The model is determined by the network operator, and greatly determines the speed in which digital TV is being accepted. As shown by analogue, give-away is thought to be delivering the largest penetration, where leasing and sales are believed to provide lower volumes.

An important consequence of this is that the market is unstable and discrete for the STB manufacturer. Orders are few and scattered in time, but provide high volumes, leading to fluctuations in activity and revenues.

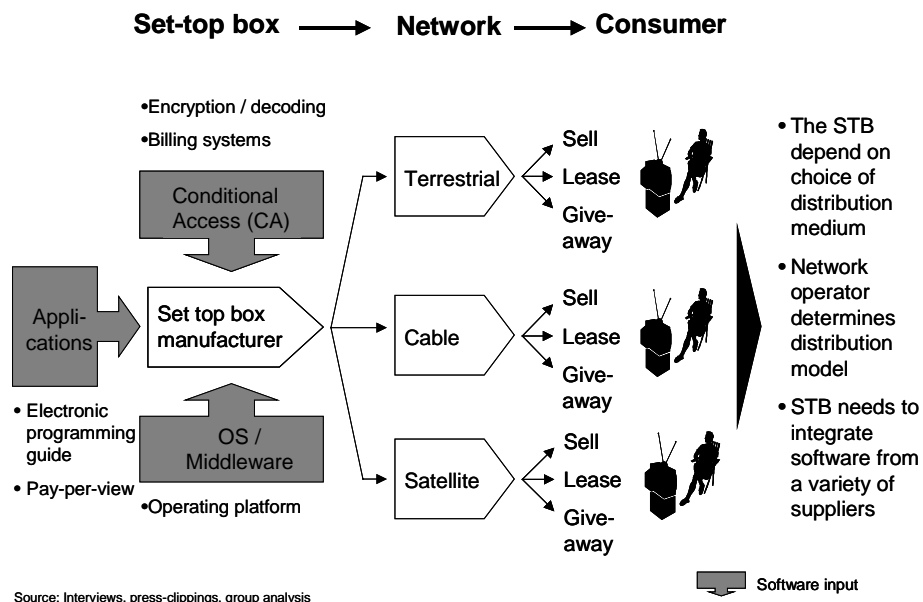


Figure 4 – Business Model

3. MARKET ANALYSIS

Market Expectations in 1998

Digital TV is expected to grow substantially in Europe and the rest of the world from 1998 and onwards in the next 10 years. Depending on the country, analogue TV will be switched off between 2005 and 2020, creating a huge market for STBs and the STB technology/functionality.

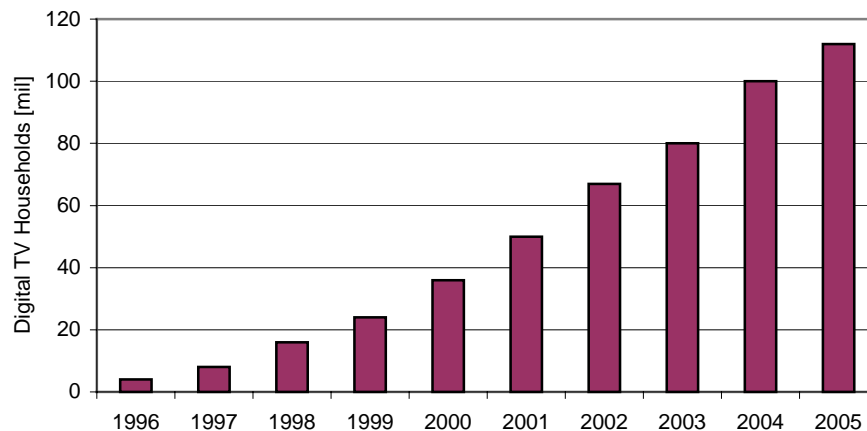


Figure 5 – Total Digital TV Households

Forecasts project a rapid growth of digital TV – Figure 2 presents world market figures (excluding Japan and China). With only 10-15 millions households having digital TV in 1998, the market is expected to grow ten times over the next 7 years (source: Screen Digest, Digital Technology Consulting).

The switch off date of analogue TV will differ from country to country. Italy and the US have settled for 2006, whereas a number of large European countries are aiming for 2010 (UK, France, Germany, Spain, Sweden). Although it is inevitable that digital TV will dominate the world market by 2020, as long as analogue TV is available, consumers can choose not to have a STB; the rate of emergence therefore remains uncertain.

The selling price of an STB in 1998 is about \$300. Going forward, some sources expect average prices to fall, causing the monetary value of the world market to grow less quickly than the unit size of the market (source: ABN Amro). As low cost manufacturers from Asia try to capture market share, margins are expected to come under pressure.

A closer look at the UK market is prudent since it is the largest market in Europe for digital TV short term:

- The penetration of cable is low (compared to Germany for instance)
- Much of the premium programming rights like football, rugby and golf are held by independent operators, in particular BskyB, that are eager to capitalize on this

- Several companies in addition to BskyB were expected to launch Digital TV in 98 and first half of 99

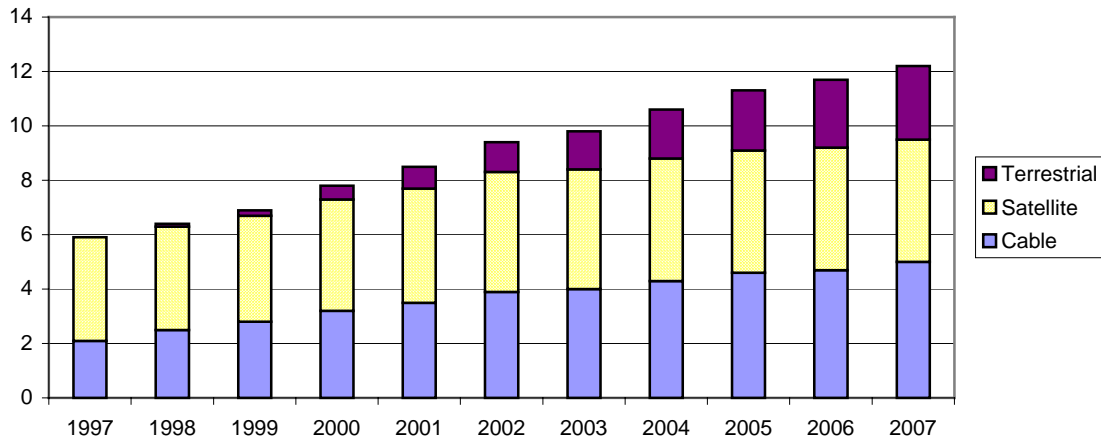


Figure 6 – Digital TV Distribution Channels for the UK

Breaking down the market evaluation in detail (see Figure 6), it is found that satellite transmission is likely to dominate in the early years; however, cable transmission is expected to win through in the long term due to its greater interactive potential (source: Screen Digest). The STB manufacturer is therefore likely to benefit more from working with satellite networks, such as BskyB, in the early years, and spending fewer resources on terrestrial networks.

Key Success Factors in 1998

From the analysis and assessment of the digital TV industry in general, and more particularly the place of the STB manufacturer in the value chain, we can draw some emerging key success factors in 1998. These can be categorized into two levels:

At a product level:

- **Competitive cost:** Because of the distribution model and the buying power of the networks, manufacturers of STBs, as in many other consumer electronics products, will have to compete fiercely on price. Companies need to trade off between the efficient mass production (in the cheapest geographical location) and the fast response time to the rapidly changing product requirements.
- **Flexibility:** Modularization of the box will bring great flexibility to enable rapid implementation of new technologies and enable customization to different network operators. The ability to introduce different models to fit each of the three channels of digital TV (satellite, terrestrial, cable) is crucial to capture the fragmented market. Demands of the consumer market need to be met quickly and cost effectively.
- **High performance:** The architecture of the STB needs to be designed such that the STB is responsive in a manner acceptable to the consumer. For example, immediate response from the remote control unit is critical. This is challenging the technical

solutions for the return path. Compared with the PC where 90% up time is often regarded as good, the STB needs to have telecom level reliability, at 99.99% availability.

At a company level:

- **Time-to-market:** Early availability of the next generation of products is a key area for competitive advantage, as well having the ability to quickly deliver boxes to the network operator when digital TV is launched. The cost structure of a digital TV network is highly fixed, therefore a quick roll-out to reach critical mass is important in order to attract both consumers and content providers.
- **Strategic alliances:** Success also relies on the ability to set up and maintain good and long-term alliance relationship with players in the STB value chain, including conditional access owners, middleware developers, and application operators. The strong interdependency in this industry determines that the collaborative effort among all the value chain companies is important to the cultivation of consumer market.

4. RISK AND STRATEGIC UNCERTAINTIES

Having identified the key success factors for a manufacturer of digital STBs, we can now evaluate some of the risks and strategic uncertainties that manufacturers would face in its industry.

5-1 Risk Analysis

The 5-1 Risk framework is designed to map out some of the risks and expected outcomes of investing in new technology – many of the key success factors are in fact parameters for product design (impossibility risk). The table below summarizes the other risks.

RISK	ISSUES	UNCERTAINTY	NOTES
<u>Impossibility</u> technical feasibility of developing a product within specific parameters	Integration of CA technologies	Low	Technically easy – need to acquire licenses for CA technologies
	Integration of middleware	Low	Not technically difficult
	Reliability	Medium	Need to achieve 99% reliability (like TV)
	Cost	Medium - High	Currently \$300 – needs to be below \$200
<u>Incentives & Controls</u> organisational design issues that allow a firm to be competitive	CA technology licenses	Medium	Identify key CA technologies
	R&D to develop software solutions	Low	Ensure compatibility between CA and middleware platforms and hardware, e.g. modems
	R&D/ Production – in-house v. out-sourcing	Medium	In-house quality and investment v. out-house flexibility
<u>Initial Market Choice</u> market assumptions	Channel choice	Medium-High	Development cost v. potential markets
	Analogue television switch-off	Medium-High	Timing is highly uncertain, depends on regulatory framework
	Digital TV delivery media	Medium	Quite likely that satellite will dominate early on; cable and terrestrial to follow but timing uncertain
	STB sold or subsidized to end-user	High	Likely to be subsidised early on, depends on the possible emergence of dominant standard (CA or middleware) or operator
<u>Interdependence</u> successful development of complementary assets	Satellite distribution	Low	Not significantly different from analogue
	Cable distribution	Medium - High	Existing analogue cable network needs to be upgraded (high cost) but well suited for interactivity
	Terrestrial distribution	High	Regulatory framework yet to be put in place; achieving 100% network coverage very expensive
	Product offering	High	Pure-play v. vertical integrator

<i>Integration</i> time to market of downstream intermediaries	Digital TV rollout	Very high	Timing varies greatly from country to country
	Integrated television/STB sets	High	Depends on the possible emergence of dominant standard (CA or middleware) or operator

We have focused particularly on the integration risk, the most crucial and difficult to quantify. For any given market, the rollout of digital television is driven by four main factors:

1. **Appetite for pay-TV** – customers have to pay for subscribing to pay-TV services and possibly pay-per-view programming as well as STBs, so existing pay-TV cultures (such as in France or the UK for example) and attractive income profiles would facilitate digital TV adoption.
2. **Existence/absence of an analogue cable infrastructure** – a lack of an existing analogue cable infrastructure leaves consumers generally underserved. In such a receptive market, satellite digital TV would be relatively easy to launch, especially in light its ease of deployment versus the difficulty of installing a new cable network (or upgrading an existing one).
3. **Time required to deploy the digital broadcasting infrastructure** – although satellite digital TV have no deployment problems per se, cable digital TV requires heavy investments to upgrade the existing network; terrestrial digital TV is even more problematic in that a fundamental re-structuring of terrestrial TV frequencies (regulated by the government) is required.
4. **Regulatory framework** – various governments have announced differing official dates for switching off analogue broadcasts (2007 in Sweden for example, or 2010 in Germany), affecting the confidence level among consumers in their decision to switch to digital TV. As well, some governments are thought to have an interest in promoting digital TV across the three distribution platforms in order to free up bandwidth for sale to mobile telephone operators; in that respect, government efforts to stimulate the terrestrial TV in particular would facilitate deployment of digital TV as that service could be a free one for consumers.

Thus, the deployment of digital television, while inevitable, is difficult to forecast. The UK market illustrates this fact perhaps most clearly: despite the UK being a very attractive market with vast economic potential and limited analogue cable access, in the two years prior to its introduction of Sky Digital, BSkyB delayed the launch several times citing technical reasons. Many industry experts however attribute the delays to the fact that BSkyB wanted to exploit its dominant position in analogue pay-TV as long as possible.

Most other components of the digital TV value chain (*i.e.*, CA technology, OS platforms) do not have a roll-out time of their own as they are relatively simple technologies, either developed by or sold to the network operators. As such, network operators are really the key player in terms of digital TV being deployed.

The content providers also need to be seriously considered – indeed, whether broadcasters (*e.g.*, interactive game-shows) or retailers (*e.g.*, on-line banking) are ready to exploit the advantages of *interactive* TV considerably affects the economics of rolling out simple digital TV broadcasts vis-à-vis lazy or full interactive TV.

5. NEW ENTRANT V. ESTABLISHED PLAYER

The previous section presented the risks and expected outcomes of investing in the new digital STB technology – a firm can however manage much of the risk through strategic and operational choices. For example, the integration risk can be mitigated by choosing which markets to enter. This section therefore analyses different approaches for managing the digital STB innovation and related uncertainties – these varying methods are demonstrated by two industry players:

- young emerging business - Pace Micro Technologies (UK)
- established industry player - Philips (Netherlands)

PACE AND PHILIPS - SITUATION IN 1998

Pace – since the mid-1980s, Pace had a good foothold in the European analogue STB market. At the same time, from as early as 1995, Pace had managed to make some early headway in the digital STB market, by signing a number of early low volume international customers including Galaxy in Australia (satellite), Stream in Italy (cable) and Canal+ in France (satellite). In 1998 however, the analogue STB industry suffered a major decline (38% drop in unit sales 1997-1998). As a result, following a series of profit warnings and a change in management, the company was forced to effect a rapid and widespread restructuring. As it positioned itself for the growth in digital STBs, the emerging company faced a raft of strategic, financial and operational challenges.

Philips – Philips was a dominant force in consumer electronics, with a wide product range and a global presence. As an extension of its existing analogue STB business, Philips appeared to be well placed for the emergence of the digital STB industry. Its global reach, brand strength and high technology competence meant it was well positioned to build on its position as no.4 European and no.2 worldwide supplier of analogue STBs. Like Pace, Philips managed to secure a number of early satellite customers in 1996-1997, the most significant of which was a satellite STB contract with Canal+, at the time the only significant European player in digital TV. The STB practice in Philips was located within Digital Networks, a division specialising in advanced audio/video network solutions.

...AND IN 2000

1998-2000 proved to be a period of huge growth for digital TV market, particularly in Europe, due in part to its highly successful launch in the leading edge UK across all three transmission networks. The huge subscriber growth drove global STB units sales up from approx. 3m in 1997 to 27m in 2000.

So how did Pace and Philips fare? Below we have set out some of the key parameters for evaluating the companies' respective performance:

(as of 2000)	Pace	Philips
	Pace	Philips
Unit volume	2,208k	2,111k
\$ volume	€620m	€590m
Sales growth %	147%	45%

Ranking (Europe)	1	2
Market share (Europe)	20%	18%
EBITA margins	7.3%	0-1%
Source: Dataquest, Gartner and analyst estimates		

In line with the market explosion, both Pace and Philips managed to expand their unit volumes significantly. Remarkably, it was the ‘young pretender’ Pace that succeeded in replicating its early success in the European analogue market by becoming the market leader in European digital. While Philips emerged as a close 2nd in Europe, in global terms it fell from no.2 to no.5 position, due in part to losing out to competitors in the US.

Pace’s success is evident in particular in the number of high volume (100k+ units) contracts it had managed to secure -five- all in the UK. While this certainly drove unit growth, it may have also impacted profitability, given the significant difference in EBITA margins. Philips appears to be making hardly any money at all with the product and its margins appear to be at the bottom of the STB peer group.

Having seen the outcome of the early race in digital STBs, we will now attempt to explain the difference in performance by analysing the evolution of the two companies and comparing their approaches to the digital STB market.

FRAMEWORK TO COMPARE PACE WITH PHILIPS

In order to compare the evolution and the management decisions of Pace and Philips in the digital STB market, we chose the generic structure of a business system as frame for our analysis:

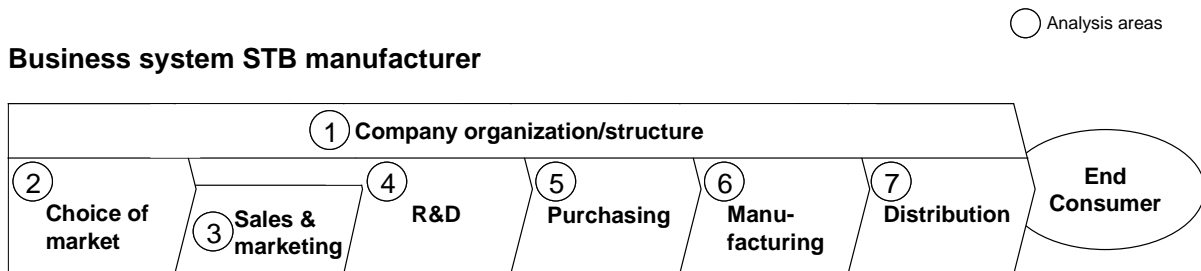


Figure 7 – Business System

Our analysis reveals the commonalities as well as differences in the two companies’ approaches towards the digital STB market. It also evaluates the companies’ actions with regards to the risks from the 5-I framework.

① ORGANISATION / COMPANY STRUCTURE

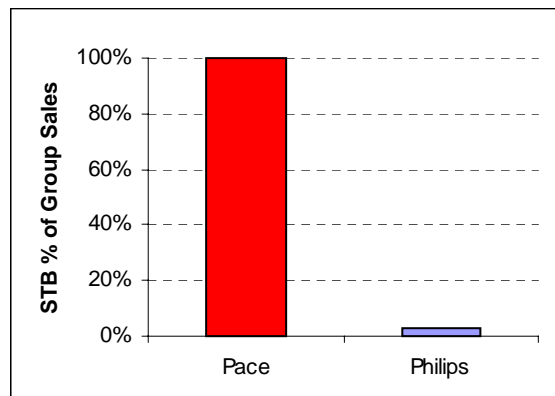
From the beginning, the two companies’ very different organisational set-ups created a significant difference in focus.

Pace – 100% focus on STBs. Having sold its modem business earlier in the 1990s, in 1998 Pace was entirely focused on the STB market. Furthermore, faced with the rapidly declining analogue market one of the key restructuring decisions taken by Pace’s new

management in early 1998 was to take the risk of focusing entirely on digital STBs. In retrospect, this proved a well-calculated risk given the UK market growth in 1998.

The result was a highly focused, streamlined organisation with a strong leading-edge B2B engineering focus (the engineering staff grew from 400 in 1998 to 500 in 2000) and a high-growth culture. While this lack of diversification was a risk, it also created ‘must succeed’ company culture based on client focus, speed to market and product quality.

Philips - <5% group focus. Despite having the benefit of group diversification for access to capital and the ability to sustain losses, as one of dozens of product groups, Philips’ STB operation never received the focus of that of Pace (it was originally comprised of 4 staff in 1993, but has since grown to 800 in 2000). Furthermore, Digital Networks was made up of 3 product areas: STBs, digital TV infrastructure and an internal digital networks software development group. These three groups effectively shared a pooled engineering team – this proved a benefit in terms of cross-product knowledge transfer (i.e., from the infrastructure development), but often a conflict when STB needed devoted engineering project teams, resulting in longer product development times than the competition (2 years versus 12-15 months for Pace).



Source: Analyst estimates

Figure 8 – STB% of Group Sales

5-I Risk Evaluation

In our view, Pace adopted the higher risk strategy, but one that paid off in terms of the significant benefits it delivered – focus and ‘best-of-breed’ culture, driving fast time to market.

Incentives & Controls	Pace	Philips
Organisational design	Streamlined	Diversified
Key strength	Commitment & focus Time to market	Lower risk; cross-product know-how
Evaluation	✓✓	✓

② CHOICE OF MARKETS

(A) POSITIONING IN THE VALUE CHAIN

Pace – pure STB. Pace chose to focus purely on the STB rather than to provide a broader product offering through vertical integration. Due to the wide variety of technologies for the different network operators (in terms of transmission channels, billing systems, CAs, and middleware), Pace took a significant technology interdependence risk, i.e., that it could make its STBs would work with these different delivery technologies. To succeed, rather than being a pure box-builder, Pace was forced to become a specialist technology integrator. In fact, Pace's ability to offer the operator complete flexibility in terms of technologies and to deliver reliably this specialist integration 'service' actually became a competitive advantage, allowing it to supply such a broad range of operators (as discussed in the Key Customers/Alliances section)

Philips – vertically integrated. Given the significant interdependence risk, Philips took the decision to reduce this risk by vertically integrating into the high margin (according to Philips) satellite delivery infrastructure. This allowed it to offer a bundled product incorporating the STB, the infrastructure to be housed at the operator head-end, the CA, and the middleware. It called this end-to-end offering 'glass-to-glass' – from the glass of the camera to the glass of the TV.

The bundled product proved popular among small and mid-sized operators who valued the simplicity of an end-to-end solution and was successfully sold to operators such as Measat in Asia. However, the glass-to-glass solution worked against Philips with the large operators (like BSkyB) who insisted on controlling every piece in the chain, thereby demanding full flexibility with respect to technology rather than an end-to-end package. This made it considerably more difficult for Philips to secure the high volumes by signing up large operators, resulting in a lower return on investment, given the requirement for greater resources and investment. In some cases however, Philips modified its product offering, providing only STBs but not infrastructure nor CA technology.

5-I Risk Evaluation

Interdependence Risk	Pace	Philips
Product Offering	Pure STB	Vertically integrated Inflexible in delivering STBs only
Key strength / weakness	Turns interoperability risk into core offering - specialist integration Broad customer base	Lower interdependence risk BUT, approach restricted customer base and volumes Conflict
Evaluation	✓✓✓	✓

(B) CHOICE OF CHANNEL

Of the three digital transmission technologies – satellite, cable and terrestrial – in terms of subscriber numbers it was satellite that was the dominant. By the end of 1998 in the UK, Sky Digital had been launched for three months, had already sold 200,000 subscriptions and was looking toward another 1.2m-1.3m STBs in 1999. While satellite's early dominance meant most STB manufacturers concentrated on satellite, it also raised an interesting question – should you concentrate wholly on satellite or also address the other two

transmission technologies? This decision constituted a trade-off between increased R&D cost/engineer time and the access to a potentially broader (although unpredictable) target market.

Pace – all 3 channels. Given that it was technology-independent and developing into a specialist technology integrator, it suited Pace's business model to target all three channels.

'We will support broadcasters using any transmission technology, including satellite, cable, terrestrial and telephone lines.' Pace 1998 Annual Report

Indeed, in the UK, Pace was the only STB manufacturer to supply both the launch of Sky Digital's satellite and ONDigital's terrestrial service at the end of 1998. The tri-channel approach proved highly attractive when each of the three UK cable operators (CWC, NTL and Telewest) announced plans to launch a digital service in 1999 and began to make significant STB orders. Pace consequently benefited from a significant portion of this business and became the only STB manufacturer to supply the launch of all three transmission channels in the UK.

Philips – 2 channels. Given its commitment to the glass-to-glass satellite offering, Philips concentrated most of its efforts within the dominant channel – satellite. However it did also develop a STB for the other over-the-air channel – terrestrial – and succeeded in being one of the two manufacturers to supply the UK ONDigital launch (alongside Pace). Its concentration on over-the-air did however mean that it was not in a position to compete for the UK cable contracts in 1998-1999.

	Satellite	Cable	Terrestrial
Pace	X	X	X
Philips	X		X

5-I Risk Evaluation

The greatest uncertainty for digital STB relates to integration. In essence, the rollout of digital TV drives the STB industry. While the STB manufacturer does not control factors such as appetite for pay-TV or regulatory framework, it could mitigate much of the uncertainty through a careful selection of partners. This is basically what Pace has done by associating itself to a variety of network operators.

Initial Market Choice	Pace	Philips
Channel choice	All three	Two - focused on satellite (terrestrial not widespread)
Key strength / weakness	Large market, but requires very high technology competence	Focused, but smaller target market
Evaluation	✓✓	✓

③ SALES & MARKETING – KEY CUSTOMERS

In 1998, given the STB manufacturer's indirect route to market, winning contracts with large volume network operators was absolutely key to realise economies of scale and recover fixed upfront R&D costs incurred for each customer. The UK market proved particularly important in this regard due to the significant volume potential offered by the launch of digital services across all three channels during 1998-1999:

- satellite (BSkyB) – Oct 1998
- terrestrial (OnDigital) – Nov 1999
- cable (CWC, NTL and Telewest) – Jan to May 1999

European digital subscriber numbers grew from approximately 2m in at the end of 1997 to 13m by the end of 2000. This growth was largely driven by a very successful launch in the UK, which as a result became the European leader in digital TV (33% of the market).

Key success factors for winning these contracts included:

- ability to meet technological requirements
- time to market
- low cost
- local proximity
- and occasionally, luck

Pace – the snowball effect. There is no doubt that Pace's success in the STB market in 1998 and beyond was largely a result of securing one of the three or four STB contracts for the SkyDigital launch. At the October launch, Pace was the only STB supplier able to supply BSkyB. The huge success of the launch not only meant exclusive large volumes for the rest of 1998 (300,000) and early 1999 but established a reputation for Pace as a valuable partner with superior technological integration skills and time to market reliability. These reputation factors were further enhanced one month later when Pace proved to be one of only two STB manufacturers to supply the OnDigital launch, this time in the terrestrial channel.

Pace's third major customer in 1998 was the cable operator CWC. While its previous contract wins were driven by its technology integration skills, time to market, cost and local proximity, luck also played a role in this case. CWC felt that the return path of the European DVB technology was not ready and therefore elected for use the US MCNS alternative. In an unsuccessful attempt to win TCI's digital cable business in the US from General Instrument, fortuitously Pace had already developed an MCNS box – this now put it in an excellent position to win the CWC business of 100k boxes (raised to 300k by the end of 1999). Following this, Pace went on to win the two other cable contracts (NTL and Telewest), each for volumes of 100k.

Philips – fragmented customer base. Philips, in contrast to Pace, won few of the very high volume contracts in Europe in 1998-99. Philips' major European satellite customer was Canal+, which it managed to secure very early on in 1996, partly thanks to its local Paris office. However, despite securing a major European customer, Philips found potentially substantial volumes diluted by Canal+'s multi-vendor strategy. Instead of being selected as a lead STB manufacturer backed up by one or two others, by 1998, Philips found itself supplying alongside Thomson, Sagem, Nokia and Pace.

Philips' major success in the UK was winning the OnDigital contract alongside Pace. However the volumes from OnDigital were not of the same magnitude as those of BSkyB and UK cable.

5-I Risk Evaluation

Integration Risk	Pace	Philips
Channel choice	All three	Two - focused on satellite (terrestrial not widespread)
Key strength/weakness	Large market, but requires very high technology competence	Focused, but smaller target market
Evaluation	✓✓	✓

④ Research & Development

From an R&D perspective, the key issues facing Pace and Philips in the early stages of digital STB evolution were as follows:

- concentrating on integrating components in STBs versus developing STB-components in-house
- how much to invest in R&D capacity (including number of engineers)
- how much capacity to allocate between software and hardware expertise
- whether to design each new product from scratch or develop a product platform and subsequently create specific derivatives.

Pace

Integrator focus. At the time of the restructuring in 1997/8, Pace took the decision to retreat from manufacturing and to focus on its product development expertise as the main driver of profitability. Pace aimed to become the leading integrator of digital STB hardware and software components. As a result R&D spend increased dramatically from 2-3,5% of sales to 6,0% of sales in 2000 and the headcount of engineers increased from 140 in 1998 to 250 in 1999 and 510 in 2000, increasing from 20% to 50% of the headcount. In addition, the emphasis shifted from hardware to software integration expertise: from 60% software in 1998 to 90% in 2000. The process of integrating the big number of different hardware and software systems is highly complex and requires R&D capabilities as well as a broad experience base. Pace build a track record of being able to integrate any CA system, any middleware and any hardware technology. When in 1998 BskyB selected a STB manufacturer one of the key reasons to choose Pace was its openness and ability to provide a tailored solution.

Pace does not believe that its focus on STB integration will over time render it a pure assembler of STBs. On the contrary, increasing product complexity means that its role is becoming more valuable (STB development time has doubled since 1998 to 20 man-years). Pace argues that this trend is likely to continue as we move towards an internet-based home gateway product.

Bespoke customer solutions, limited platforms. In terms of product development, Pace reoriented itself as a provider of bespoke engineering solution, focusing on developing tailor-made products for each customer. Pace made little use of product platforms/configurations as basis for derivatives for specific customers. Pace's rationale for that approach was that

lifecycles (approximately 9-12months) for STBs are too short to justify investment in platform R&D. Given the speed of the industry, Pace replaced a product platform with an expertise platform that proved to be a key attraction to broadcasters. The accumulated knowledge provided the ability to understand and meet the specific needs of network operators in markets all over the world.

Limited in-house development. The digital STB is typified by a lack of standards in CA systems and middleware, resulting in many products offered by a wide variety of suppliers. Pace did not invest in the development of either an own CA or own middleware solution. Likewise the development and production of the major processing hardware is done by suppliers. Pace's lack of vested interests in pushing the use of in-house components enables it to have a unique open approach to all potential suppliers and solutions.

Alliances key – since it did not control the development of the STB technology components, in order to stay at the cutting edge of innovation and to be prepared for future trends in TV, it was key for Pace maintained relationships with key technology providers. For pace this included Cisco, Microsoft, Lucent, Hitachi, Oracle, Broadcom, LG, Liberate, C-Cube, and BellSouth. More recent joint development projects include topics like integrated digital TV sets (iDTV), broadband wireless internet services, or advanced video server software for interactive TV.

Current software partners for CA and middleware

Software	Pace	Philips
CA	General Instrument (DigiCipher II) NagraVision Canal+ (Mediaguard) NDS Scientific-Atlanta (Powerkey) Irdeto	Cryptoworks (Philips) INCAS (Philips)
Middleware	OpenTV Microsoft Liberate Canal+ (Mediahighway) PowerTV	OpenTV Microsoft Liberate Canal+ (Mediahighway)

Source: Dresdner Kleinwort Wasserstein

Focus on time to market at expense of patents. Given the speed of the industry, in the early years of digital TV, Pace filed limited patents, preferring to build up a reputation for time to market at the expense of IP protection.

Philips

In-house development focus – Philips decided to develop an own conditional access (CA) and middleware system in an attempt to capture additional value. This increased the number of engineers required in the Networks division, given the fact that they were shared not only between core STB and satellite infrastructure, but also software development. By 2000 the number of engineers had reached approximately 800.

However as mentioned by Philips, in retrospect, because the market is so fragmented, these software products have proven rather unattractive and unprofitable. Philips discovered that it is not that easy to sell the own software in a package with the STB and that this could be in conflict with customer needs, particularly as a number of network operators developed their own CAs. When Philips sold its first digital STBs to Canal+ in 1996 it wanted to provide its own Cryptoworks-CA software, but Canal+ naturally insisted on its own Mediaguard system. Today Philips sells only approximately 25% of its STB-units equipped with its own Cryptoworks CA software, which raises the question whether this volume is sufficient to guarantee a satisfactory return on the software R&D investment.

Platform approach – as is typical of its heritage as a consumer electronics industry, Philips pursued a platform-oriented R&D approach. It developed single universal STB platforms, which would be adapted for multiple markets. This difference in approach can be seen by comparing the products on the Philips and Pace websites – Philips lists universal products, Pace lists customer specific products (eg Sky Digibox). In the fast moving market for STBs in which the potential customers might have strong views on specifications, it appears that Philips was less favorable given the short lifespan of platforms, the limits in flexibility and Philips' longer time to market compared with Pace (2 years vs 12-15 months).

.... **contribute to higher R&D cost?** The industry R&D comparison below indicates that Philips is spending significantly more than both the industry average and than Pace per unit of sales. This is likely to be a result of two factors:

- its platform approach requiring disproportionate R&D relative to the product lifecycle
- reduced engineer efficiency due to being spread too thin across STB, software and satellite infrastructure product development

This may be one of the key contributors to Philips' lower STB margins

R&D spending as a percentage of sales in 2000 (STB business units)

Company	Spending (in % of sales)
Nokia	14,4
Philips	12,0
Sagem	7,5
Motorola	7,0
Thomson	6,5
Pace	6,0
Scientific-Atlanta	6,0

Source: DresdnerKleinwortWasserstein estimates

Alliances key but Philips not dependent - Philips has a close alliance with Microsoft and together they try to develop advanced digital STBs but given its in-house products is not as reliant on these partnerships as Pace.

It limited the flexibility and time to market of Philips, which is approximately 2 years

Risk Evaluation

Incentives and Control	Pace	Philips
Scope of R&D	Integrator of components and software mainly from outside sources	In-house development of main components
5I: Integration risk		
Product approach	Bespoke engineering solutions, no product platform	Universal product platform
Number of suppliers to integrate	Many – high risk	Fewer – lower risk
Technical alliances	Many	Few
5I: Interdependence risk		
Time-to-market	Proved shorter	Proved longer
Key strength / weakness	'Expertise platform' proved unique Multiple relationships R&D spending in line with industry Flexible product approach	Few relationships to maintain Legacies in CA/middleware Over-spending compared to industry Less flexible product approach
Evaluation	✓✓✓✓	✓✓

⑤ PURCHASING - RELATIONSHIPS WITH SUPPLIERS

Cost is a key success factor in the STB industry, particularly as the network operators buy large volumes and subsidise the STBs. By 1998, the price of a digital STB had fallen from its entry price of \$500 down to below \$300. Typically, prices fall 10% every 9-12 months, putting significant pressure on the manufacturer. Given the significant portion of the STB cost tied up in the hardware (66%), relationships with suppliers have proved key in reducing the cost of the STB:

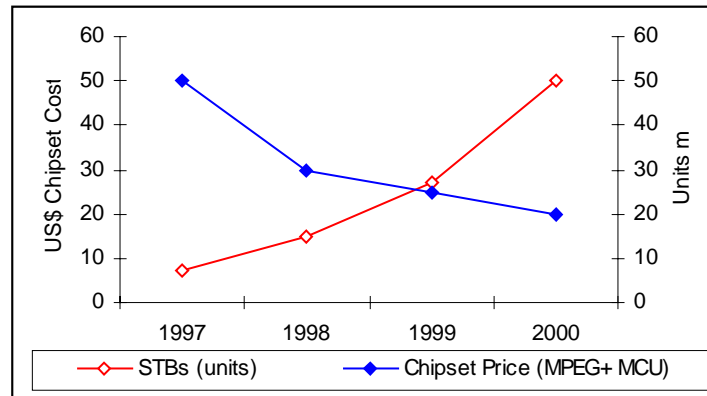
**Breakdown of typical STB value
(for a successful player)**

Sales Price	100%
Hardware	66%
Assembly	8%
Licences (CA, API)	6%
Gross Margin	20%
R&D	6%
Overhead	6%
Operating Profit	8%

Source: Lehman Brothers

In particular, due to the continuous improvement in silicon (approximately 10-12% cost reduction per annum), the ability to integrate the latest silicon into the device can deliver a crucial cost advantage.

Relationship between chipset cost and STB unit sales



Source: ST Microelectronics

In addition, close integration with suppliers has proved key for delivering time to market advantages.

Pace – supplier relationships drive time to market and innovation. Pace puts huge emphasis on its relationships with suppliers. As digital TV emerged, in order to meet its strategic objective of being consistently first to market in each transmission technology and with subsequent next generation products, Pace needed to become the leading STB innovator. To achieve this Pace made it a strategic imperative to create very close relationships with the providers of all the technology components it needed to integrate, including semiconductor manufacturers, API, CA and application developers, i.e., Thomson (MPEG, audio-video decoder), LSI logic (front-end converter chip), Lucent (DSP) and Philips (smart card interface).

Pace's relationship-building ensured

- smooth integration and therefore rapid time to market
- access to the latest and most cost-effective hardware/chipsets as soon as they are designed, and
- constant innovation through capturing ideas generated by technology providers.

As Pace became gained a unique reputation as a consistent first to market manufacturer for high volume digital launches (such as Sky Digital), the relationship became reciprocal. Suppliers began to trust Pace's ability, as a lead innovator, to predict customer needs with high reliability and therefore began to integrate Pace's R&D into their own product development processes.

Philips – supplier relationships important. Philips stressed to us the importance of its relationships with suppliers as key to ensure low cost, rapid time to market and smooth technology integration for new product releases. Relationships with semiconductor players were highlighted given the need to understand and co-ordinate with the silicon roadmap on future product introductions. However it appears that these outside relationships are not as vital or as mutually beneficial for Philips as for Pace given Philips' ability to source some of its supplies in-house – approximately 25% of units contain their own CA technology and

Philips has sourced its chips both in-house as well as from ST Micro. Product development cycle is roughly 18-24 months.

5-I Risk Evaluation

Integration Risk	Pace	Philips
Supplier relationships	'Partnership' - strong and reciprocal	One-way and important, but not vital
Key strength / weakness	Access to latest and lowest cost technologies low cost, fast time to market (9-15 month development cycle)	Smoother integration but no competitive advantage (18-24 month development cycle)
Evaluation	✓✓	✓

⑥ MANUFACTURING STRATEGY

As cost is one the key success factors in the market for digital STBs, the manufacturing strategy is paramount. The common and most sensible approach is to combine some in-house capacity and outsource for peak volumes, since this can realize cost advantages. It also reduces for a STB-manufacturer the risk of holding overcapacity and provides flexibility regarding production location, which often has a big impact on fulfilling local content rules or getting preferable tax and import duty treatment. Moreover outsourcing allows to minimize the production lead time for taking products from concept to market, since it is not necessary to set up new production facilities. However through outsourcing it is more difficult for a STB manufacturer to keep control over product quality.

Pace - in 1998, the company outsourced 30% of its production, increasing to 70% in 2000. Pace has developed an extremely efficient manufacturing system that attenuates the impact of ebbs and flows, which is an inevitable result of the large and discrete contract structure in the industry. In the near future Pace will not invest in own production facilities and additional growth in volume will be given to sub-contractors.

In order to maintain product-quality on a high level despite of heavy outsourcing Pace first uses pre-production runs in its principal facility in Saltaire, UK to learn and improve. Only after quality and productivity reach an acceptable level the production is transferred to the facility of a manufacturing partner.

Philips - its approach to manufacturing also contains outsourcing as a key element. Philips manages one own facility in Belgium and outsources the remaining production volume to contract manufactures. In case of a new product introduction Philips carries out test-runs in its own production site before the assembly is transferred to a manufacturing partner.

5-I Risk Evaluation

Regarding manufacturing Pace and Philips pursue a similar approach of having only one own facility and outsourcing the remaining production volume. However we have the impression that Pace's approach is more radical and the speed of outsourcing in 1998-2000 was faster at Pace.

Incentives & Controls	Pace	Philips
Manufacturing flexibility and outsourcing	Radical shift towards outsourcing and therefore extremely flexible production system, growth in volume will be covered by contract manufacturers	Heavy outsourcing and therefore extremely flexible production system
Cost control and cost reduction	Pace known for rigorous drive to reduce cost, outsourcing	Outsourcing
Strength/weaknesses	Flexible, low cost	Flexible, low cost
Evaluation	✓✓	✓

⑦ DISTRIBUTION CHANNELS

The market for STB in the last couple of years could be described as a vertical market, which means that the STB manufacturer sells not to the consumer but to the network operator, who distributes the STBs to the consumers. This distribution mechanism is based on the fact that no industry standards for STBs exist and that each network has its own STB specifications. Therefore the consumer usually has only to choose the network and then receives the appropriate STB from the network operator.

Direct distribution is favored where competition amongst network operators is very high (*e.g.*, UK) whereas retail is used to a larger extent where there is less competition – *e.g.* Germany and the Netherlands. Brand value will be a crucial factor of success if the market moves towards more retail distribution.

Pace - In the emergence of digital TV Pace deliberately decided to focus on building a strong brand in business-to-business trade in particular with broadcasters and technology providers. Pace considers network operators as key customers, and has invested little in building a consumer brand.

Pace has therefore preferred the subsidized and rental markets for STBs where the network operator controls the distribution

Philips tries to leverage its strong brand, the superior world-wide distribution network and its broad experience in retail consumer electronics to increase its presence in the STB market. When for example OnDigital distributed different STB through Dixons - a consumer electronics retail chain - Philips gained considerable market share due to its brand awareness. When BskyB decided to give away their STB for free to the consumer, OnDigital had to follow suit and Philips advantage disappeared when distributed directly by the network operator.

In order to achieve a horizontal market mechanism where Philips can leverage its competencies, Philips is heavily engaged in the definition of industry standards.

5-I Risk Evaluation

While Pace tried to build a strong trade brand in order to target the network operators as key buying decision makers Philips based its activities on the existing consumer brand image. Philips, in contrast, is waiting for a shift of the market towards a horizontal

mechanism in which the consumer has more influence and Philips brand and experience would help to be successful.

Initial Market Choice	Pace	Philips
Appropriateness of distribution for vertical market	Focus on building strong btb brand, little retail experience of Pace no disadvantage	Strong consumer brand, however no leverage of brand value through vertical market possible
Preparedness for shift towards horizontal market with standardization	High risk for Pace if market shifts towards horizontal mechanism, since Pace undertakes no preparation and believes that vertical market model is stable	Philips pushing for standards and shift to horizontal market in order to be able to leverage brand value
STB sold or subsidized to end-user	Pace prefers rental or subsidized distribution, as long as no distribution through retail no disadvantages for Pace	Promoting own CA software and middleware restricts openness to other solutions
Evaluation	✓	✓✓

6. CONCLUSION

Pace wins the early round...

Although Pace being a considerably smaller player than Philips it ended up being more successful in the emergence of the digital STB in the period of 1998 to 2000. Despite there not being a huge difference in unit volume between the two players (not wholly unsurprising given Philips' market-reach), Pace appears to have outstripped Philips in terms of profitability. This is likely to result from Pace having secured major volume contracts in contrast Philips' highly fragmented customer base.

Pace's ability to secure the contracts resulted from its more optimal approach to product offering and product development:

- In comparison to Philips' approach of vertical integration Pace decided to be a pure STB integrator
- Pace focused on single customer bespoke engineering solutions (customer-orientation), leveraging an "expertise platform". On the other hand Philips tried to apply universal product platforms (product-orientation) for multiple markets.

This more optimal approach delivered key advantages in terms of product customisation, cost and time to market.

In summary while Philips' model did not suit the complexity and non-standardization of the industry, Pace was able to turn this into a unique offering - complex multi-company integration.

... but things could change rapidly

Despite Pace's early progress, there are a number of important issues that could tip the balance in favour of Philips. These factors include:

- standardisation – likely to reduce significantly the industry's complexity and therefore the value of Pace's integration expertise
- retail channel – likely to emerge on the back of any standardization, thereby benefiting Philips' brand value
- STB/TV set integration – also likely to play to Philips' strengths

... and a brand new game is just beginning

With the convergence of digital video broadcasting and Internet data communication, the emergence of the next generation home gateway product is imminent. This digital black box will be able to control remotely all appliances in the home. Those who can harness STB and internet expertise into a successful commercial release are likely to be among the next generation of winners in the digital media industry. The STB manufacturer is well positioned, but like the digital STB market, this is once again a brand new game - this time with even more contenders.

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APPENDIX A – BACKGROUND ON PACE MICRO TECHNOLOGY



Pace Micro Technology was founded in 1982 by David Hood selling mail order Apple software. In 1985, Pace started to manufacture low cost modems and launched its first analogue satellite receiver in 1987. Following the launch of Sky TV in 1989, Pace introduced its first analogue receiver/decoder or set-top box (STB) in 1990 and the business grew as the company secured Conditional Access (CA) licenses from key broadcasters around the world. The modem business was disposed of in 1995, leaving the group virtually 100% focused on set-top box and home networking.

Pace became a public company in June 1996; however, despite initial success in markets like Thailand, Australia, South Africa and Hong Kong for both Pace and digital TV, the take-up of digital TV in Europe and the USA proved to be much slower than expected - essentially due to a period of rapid consolidation amongst the broadcasters that caused confusion and delay in the market place. This caused Pace to issue a series of profit warnings in 1997, leading to a disastrous share price performance and the subsequent resignation of the CEO and CFO. They were replaced late the same year by the current management team who restructured and refocused the group in an attempt to address more effectively the emerging digital broadcasting opportunity.

Headquartered in Saltaire, Yorkshire, today Pace has offices across the world including France, Spain, Hong Kong, North America (Miami), and Latin/Central America - Brazil, Argentina, and Mexico. Pace Micro Technology is the purest player in the global set-top box market.

APPENDIX B – WHAT IS A SET-TOP BOX?

A set-top box (STB) is designed to receive television signals and pass them to a television set. It was originally developed as a decoder for analogue pay TV signals, although it has evolved over time to perform more complex functions (*e.g.*, near video-on-demand, internet access hub, IP telephony).

The basic hardware components of the STB are:

The computing sub-system, which handles basic computing functions, and is itself made up of two components, the processor and the memory, much like a computer. Some STBs are also equipped with flash memory components, as well as high-speed ports (to connect to other devices).

The TV sub-system, which processes digitally encoded signals and allows television sets to understand them. As analogue television sets are and will still be by far the majority, this component is crucial in converting the signal (in MPEG-2 format) to a format that analogue television sets can interpret.

The conditional access (CA) sub-system, which allows or denies permission to view programming depending on the customer's digital TV package. This component also includes the de-scrambling hardware facilities.

The STB had three layers of software:

The hardware drivers, which provides an interface between the software and hardware (these are supplied by the STB manufacturer)

The core software, which provides a platform for the applications and includes the operating system, middleware, and CA.

The applications, which include the Electronic Programme Guide (EPG) and a variety of interactive TV applications such as web-shopping, internet browsing, and voting on game-shows for example.