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Exposing Technology Impact via Enterprise Architecture

An Intel Active Management Technology Case Study

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MASTER'S THESIS

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"The highest knowledge is to know that we are surrounded by mystery."

Albert Schweitzer - The Spiritual Life (1947)

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This Master Thesis document is my final and last document to finally finish my ICT in Business study! Initially I was apprehensive because the expected outcome from this exploratory research was not clear. Now looking back, I am more than satisfied with my achievements of this research and the impression I leave at Intel.

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It is time for me to move on and dive into the next challenge! As my manager would say: “You will be thrown into the deep (again), learn to swim. Make sure you do not drown!”

Schiphol-Rijk, February 2012

Martine Kea

ABSTRACT

In 2011 an article, posted by Stephanie Overby, on the website of CIO.com announced that "IT Value Is Dead. Long Live Business Value. Business outcomes from technology investments are all that really matter." This Master Thesis presents an example of how business and IT alignment is taken to the next level. To realize this we have to understand our technology and our business. Furthermore we have to integrate the two worlds in the same model to address impact and to recognize or create opportunities. By using an enterprise architectural language, able to integrate these two worlds, we can model business, software and technology in one overall view.

Intel® AMT is a technology that makes client Intel® vPro™ notebooks, desktops and workstations manageable independent of the state of the systems or OS. As it turns out, Intel AMT is a technology which provides more business opportunities then realized before. This result is achieved by modeling the AMT technology together with relevant business processes of the customer, and including even more processes of the reseller (environment). Thus we created an integrated overview to analyze impact on the as-is situation. This leads to three solutions, where business processes of the customer and the business processes of the reseller are changed, impacted. The change creates an opportunity for the reseller to build a business case to offer an additional service to customers and to create an additional revenue stream. By understanding our technology well-integrated into our business, we can create opportunities to bring value to the business and/or business environment.

It is necessary for Intel and an Intel customer, before the customer implements Intel AMT, to study whether Intel AMT can be profitable by creating business value. Until now not every customer makes use of all features of Intel AMT, but it might very well be, they would profit considerably more if using more Intel AMT features in a well-integrated manner.

Keywords: *Enterprise Architecture, ArchiMate, Intel® vPro™, Intel® AMT, business & IT alignment*

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1 Introduction

Organizations depend on other organizations and their customers. To discover business opportunities it is important that the business is understood, but also the behavior of the customers. Questions that could come to mind: “Which services are customers using?”, “Why are they using these services?” and “How are they using these services?”. These questions address two worlds, the business and customer behavior (organizational aspects) and the services provided by software system or information systems (software or IT). It is only recent that we started to model the two worlds together, instead of only modeling the software. Deciding to model these two worlds in the same modeling language, would result in a (well-)integrated model. This makes it possible to analyze mutual impact. This is also introduced as *integration orientation* (Groenewegen, Stam, Toussaint, & De Vink, 2005).

Following the idea of business & IT alignment (Henderson & Vankatraman, 1993), many current modeling languages are limited to model business and IT in one modeling language. There are many modeling languages focusing on different domains of this world. One way to achieve this integration is to gain business environmental insights by using enterprise architecture. Enterprise architecture is an important instrument to address this companywide integration. It is a coherent set of principles, methods and models that are used in the design and realisation of the enterprise’s organizational structure, business processes, information systems, and Infrastructure (Bernus, Nemes, & Schmidt, 2003). (Lankhorst et al., 2005).

In this document we show how ArchiMate, an enterprise architectural modeling language can be used to graphically model business (processes), technology and environment with one modeling language. This allows for visualizing relations and therefore exposing technology impact on business processes. The technology subject of this research is called Intel® Active Management Technology (Intel® AMT) and this is one of the technologies included in the Intel® vPro™ platform (introduced in 2006) on notebooks, desktops and workstations designed for business customers.

1.1 Problem definition

The Intel Benelux team does not have many technical resources to support implementation projects at customers. Even more there is not enough time available for technical experts in the Benelux to continue research on this complex subject of Intel vPro and Intel AMT. Although the team has a clear idea of the advantages for the customers, no further research is performed to identify impact on business processes and making this transparent for stakeholders.

Customers understand that IT is important for the business. Business & IT alignment is encouraged and endorsed for more than a decade by industry analysts and consultants. This is in line with the website CIO.com announced an article posted by Stephanie Overby (May 12, 2011) with the title: "IT Value Is Dead. Long Live Business Value. Business outcomes from technology investments are all that really matter."

The Intel Benelux team is trying to get more insights of how Intel's technology can support the IT department and therefore how to create more value for the business. This study is aimed to initiate the first step of transforming technology advantages to business value, by making graphically visible how technology relates to business processes.

1.1.1 Research objective

The research objective of this exploratory research is to model technology in an enterprise architectural way. Being more concrete, it means modeling Intel AMT technology applications and the impact of these applications on processes, in a combined graphical architectural view.

1.1.2 Research question

The main research question to answer in this study:

> *To what extent can we model the impact of the usage of some unknown Intel AMT technology application on processes in large enterprises in the Benelux by using graphical architectural models?*

1.1.2.1 Subquestions

The research question will be answered with the support of the following subquestions:

Subquestion 1: *What is Intel Active Management Technology?*

This is not a real subresearch question, however the question is still formulated to provide the reader with background information about Intel AMT technology. Current general information about Intel AMT is scattered. The reader needs a proper understanding of the Intel AMT to understand the case study and solutions described in this document.

Subquestion 2: *What can be unknown or undescribed Intel AMT usage?*

Intel AMT provides different features. Intel has a clear idea in which situations these features can be used, and therefore transformed to advantages. This idea is less obvious for Intel Benelux, working with significant less technical experts. Furthermore other situations exist in which the Intel AMT features can be applied to provide advantages to customers.

Subquestion 3: *How can we model the impact on business processes?*

A case study is used to answer this subresearch question and subquestion two. The case study describes an existing problem of an end-customer. This problem is addressed by using a modeling language. This modeling language is able to model business and technology. This combination provides the flexibility to design useful impact visualizations.

1.2 Contribution

Little research has been done to investigate technology impact on business process by using one modeling language. Although there is an enterprise architecture modeling language ArchiMate, not much is written regarding the modeling of the direct relation between technology and business processes. This research will use ArchiMate in a non-standard way as a modeling vehicle to visualize changes in processes (more information in section 3, page 20). Therefore this research provides more scientific information regarding the use of ArchiMate within a case study and will hopefully inspire other researchers in the modeling world to conduct further empirical research to further enrich and enhance the modeling languages, like ArchiMate to expose technology opportunities by studying case studies.

The business contributions exists of two main aspects, firstly the Intel Benelux team takes the step from having relatively shallow knowledge about this particular Intel AMT application and the impact on (core) business of customers (e.g. Intel AMT solving logistical inefficiencies) towards understanding more ample possibilities of the Intel AMT applications and the impact on customers' (core) business processes. Secondly, the research shows that visualizing the as-is situation with a model, is easier to discuss with technical and non-technical customers, identifies in an overview inefficiencies and can be used to establish training material for complex technologies or business situations.

1.3 Scope

One of the predefined boundaries is to only explore the possibilities of Intel AMT technology since there are also other technologies included in the Intel vPro platform. The reason for this decision is that Intel AMT is the core technology of the Intel vPro platform.

The second boundary defined is to execute the research in maximum two companies. This is achievable within available time conducting research at two companies provides further strength to the findings. Furthermore these companies must to be a Small Medium Business (SMB) or a Large Enterprise (LE) customer to be covered by the Sales and Marketing Group Enterprise Solution Sales (SMG ESS) team.

1.4 Thesis structure

This research has five main parts. The first part consists of main research information like general introduction, the problem statement, the research question and the research methodology. This information can be found in Chapter 1 and Chapter 2.

The second part exists of an introduction of the modeling language ArchiMate and the introduction of the Intel AMT technology. This information can be found in Chapter 3 and Chapter 4.

The third part consists of the description of Intel, the internal processes of SMG ESS team and how these processes are related to processes in the ecosystem of Intel. It provides the background information necessary to understand the case study. This information is described in Chapter 5.

The fourth part provides all information regarding the case study, the customer's problem, possible solutions and estimations of costs and savings to provide more insights for management. This information is provided in Chapter 6 and Chapter 7.

The final part exists of three chapters. Chapter 8 introduces some discussions. Chapter 9 reports the conclusions and findings of this research and answers the research questions of Chapter 1. The document concludes with Chapter 10 which presents further research areas.

More information about the process of the establishment of this document and the research questions can be found in Appendix O.

2 Research methodology

This research is performed by gathering information through observations, interviews and informal conversations with customers and colleagues, which is empirical research. Common in empirical research is the use of hypothesis. This research does not use such a hypothesis as the starting point. However the research results can lead to the formulation of a hypothesis or theory. Since this research only focuses on one customer, a single case study regarding time and availability, the hypothesis can be tested in a future research program among multiple companies as a more quantitative research.

This explorative research can be labeled as qualitative research which is done through qualitative data gathering and qualitative data analysis (Aken, Bij, & Berends, 2003). It is qualitative research since it focuses on modeling the impact of the technology Intel AMT on business processes. However during the research also quantitative data can be used and analyzed for this research. To measure, one has to first discover what to measure. The focus of this research is on identifying criteria for measuring and visualizing the potential business impact of unknown Intel AMT Technology applications.

Aken, Bij, & Berends (2003) distinguish four approaches of qualitative analysis based on King (King, 1994); quasi-quantitative, template-driven, grounded theory and immersion and crystallization approach. During this research the immersion and crystallization approach is used.

2.1 Research strategy

2.1.1 The 'immersion and crystallization' approach

This 'immersion and crystallization' approach is an approach where the researcher starts with as little information as possible and immerses himself into the organization and research. To provide some structure, the immersion phase included the immersion in the technologies of Intel vPro (referred as literature review) and the business approach of Intel Benelux. In the meantime a company is found which is willing to cooperating in a pilot of Intel vPro. By using this pilot and company for a case study, the crystallization phase started. This phase can be described as the process to find the fit between the technology and the problem of the customer. The choice of focus is guided by the intuition of the researcher and supervisor.

2.1.2 Literature review

This is not the standard literature review. In this research the literature review is the process of collecting information about Intel and the technologies included in Intel vPro, such as Intel AMT.

This is necessary for the researcher to understand this technology, knowing the advantages and recognizing where this technology can benefit the customer in the case study research. Therefore whitepapers, case studies and other literature within Intel is used to develop knowledge about this technology. Furthermore also practical hands-on experience was part of this process.

2.1.3 Case study research

A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2009). This is the definition of the scope of a case study by Yin, 2009. The basic steps of this case study research consist of:

- General introduction of researcher, objective of the researcher, introduction of the interviewee.
- Discussion about current IT and business situations of the customer, discover issues, problems or inefficiencies which can be used for a case study.
- Using modeling tools to provide several solutions for the identified problem, and to use this for discussion with the customer.

No formal interviews are conducted. Instead, the information is retrieved mostly via informal conversations, business meetings and phone and email communication. The information retrieved and discussed during information conversations and business meetings are noted. It is possible that a bias exists between the minutes made and what the interviewee actually meant. To avoid this bias, the minutes were shared with the interviewee, verified and send back to the researcher.

Having a firm grasp of the technology central in the case study has the advantage of recognizing relevant events and information needed. However since the information is based on marketing information like whitepapers as well, a bias can exist because of having preconceived notions. To avoid this bias information and situations are also discussed with Intel colleagues and University supervisor.

Other aspects which should be taken into account:

- Customer is a non-profit organization.
- Only two persons within the organization are involved in the case study.

2.1.4 Advantages and disadvantages

Performing an exploratory research using the immersion and crystallization approach has several disadvantages:

- It is difficult to control;
- It is difficult to repeat;
- It depends on the intuition of the researcher.

Since the researcher is too inexperienced to rely on her intuition, it is considered a disadvantage in this stage. However when the researcher develops her intuition and experiences, it is considered an advantage since the research has the freedom to choose a direction based on her intuition.

Controllability of research is necessary in order to make it possible to repeat the research. Describing how the research is performed, which steps are taken, how data was collected, how data was analyzed and how conclusions were made, are all part of making the research as repeatable as possible. Exploratory research is difficult to describe and to control, since it is not known from the start what the researcher will experience. Furthermore it is the intuition of the researcher which also determines what is more important and where to focus on, which is a disadvantage for a beginning researcher. These disadvantages are the result of the freedom the researcher had during this explorative research.

2.2 Research data

Various research data has been collected, resulting in the use of primary data as well as secondary data. In some cases primary data could be used, however since gathering primary data can be very time consuming secondary data was used, such that the research timeline would not be jeopardized. Yin distinguishes 6 major sources of evidence: documentation, archival records, interviews, direct observations, participant-observation, physical artifacts(Yin, 2009). These different sources of evidence are complementary, and therefore it is preferred to use as many as different sources possible. Not all sources of evidence are used during this research. The next Table shows the different sources of evidence and its weaknesses and strengths, as used during this research.

Table 1 - Sources of data and their strengths and weaknesses (Yin, 2009)

Source of data	Type of data	Strengths	Weaknesses
Documentation	Secondary	Stable Unobtrusive Exact Broad coverage	Retrievability Biased selectivity Reporting bias Access
Archival records	Primary	[same as those for documentation] Precise and usually quantitative	[same as those for documentation] Accessibility due to privacy reasons
Interviews **(Consulting experts)**	Primary	Targeted Insightful Validation	Bias due to poor questions Response bias Inaccuracies due to poor recall Reflexivity
Interviews **(Business meetings / conversations with customers)**	Primary	Targeted Insightful	Bias due to poor questions Response bias Inaccuracies due to poor recall Reflexivity
Participant-Observation	Primary	Reality Contextual Insightful into interpersonal behavior and motives	Time consuming Selectivity Reflexivity Costs Bias due to participant-observer's manipulation of events

This research uses participant-observation instead of direct observation, since participant-observation is a special mode of observation in which the researcher is not merely a passive observer. This corresponds to this research where the researcher is involved in the case study by supporting the customer during the implementation process. Therefore the researcher is considered a participant as well. Furthermore, the researcher did not use any important physical artifacts.

2.2.1 Documentation

The first step of the research was to understand Intel AMT. Intel offers online information about Intel vPro and Intel AMT. This information helped to create a first understanding of Intel vPro and Intel AMT. This information was merely marketing information available on the Intel website. A public online source: Intel vPro Expert Center was used to gather more technical information about the subjects. This site offers guides, training material, 'how to'-documentation, known issues, white papers, developers information and more.

2.2.2 Archival records

To calculate a possible ROI, as described in a later chapter, the researched collected level two incidents data of the end-customer (subject of the case study) from the past year 2011. This data is used to analyze which incidents could have been solved by using Intel AMT features.

2.2.3 Consulting experts

As not everything is clearly documented regarding Intel AMT, expert knowledge is also used. This knowledge is used for two reasons: gathering information which is not documented or online available, to validate the correctness of information, and the technology parts of this thesis. This information received from experts is not documented. The following two experts have been consulted during the research (regarding Intel AMT):

- Matty Bakkeren, Enterprise Technology Specialist: involved in vPro demonstrations and implementations since 2006.
- Jurgen Eijmberts, Enterprise Technology Specialist: involved in vPro demonstrations and implementations since 2006.
- Marc Beckers, Enterprise Solution Architect at Intel: involved in Intel vPro implementations since 2006.
- Steve Davies, Senior Technical Marketing Engineer EMEA at Intel: involved in the Intel vPro development project since Intel AMT 2.0 (2006), and involved in business implementation of Intel vPro since 2006.

2.2.4 Business meetings

Since the start of the project all business meetings with different customers have been a source of information since it created more insights for the researcher on the business area. Questions such as "*Has the customer heard of Intel vPro and Intel AMT?", "Does the customer understand the possibilities of the technology?", "Is the customer willing to start a pilot?" (or why not?).* These questions seem like interview questions, however they were not asked in an interview setting but during the natural flow of the business conversation. Therefore no interview format was defined in advance of the conversation as almost all discussions were part of a business meeting.

However the information received from these conversations were documented in the meeting minutes and sent back to the customer for validation. This was only done at the meetings for the Hanzehogeschool Groningen (HG) and Bossers & Cnossen (B&C), since those meetings had high impact on this research.

2.2.5 Participant Observations

The vPro project at the HG is a business project in which the researcher was involved to experience the implementation of Intel AMT at a customer. Furthermore, the research increased her knowledge about Intel AMT and issues which are common during implementation projects. This information was then used for the research. This means that the researcher had two roles during this project: *Intel employee*, implementing Intel AMT at a customer's site and *researcher*, discovering information useful for the research. There are two areas of where observations have been performed:

- To discover the way of working of the SMG ESS team within Intel.
- To discover how Intel AMT is implemented at a customer's site and why.

2.3 Validity

Generalizability or external validity refers to what extent conclusions can be generalized to particular persons, organizations, situations and times (Ghauri & Gronhaug, 2005). This research is based on one single customer and the specific problem this customer encounters. Therefore this research does not have the solid base for generalizability. However it is also not the objective of this research. Generalizability can be possible after executing further research, where multiple customers are involved to support a better basis for external validity.

Although multiple sources are used Table 1 for 'construct validity', no information resource is redundant. For example the information received from the reseller is based on the experience and knowledge of the program manager. The same applies for the end-customer.

2.4 Next chapter

With all the background information in mind, we proceed with the base of this research: the modeling language to expose findings. The next chapter provides information to the reader about which modeling language is chosen, why and how to understand basic models.

3 Using a modeling language

The purpose of using a modeling language comes from the statement that a picture is worth a thousand words (Barnard, 1927). The models in this document should reveal the impact of Intel's technology on the (business) processes. Besides the impact on the business, other interesting events or issues can also be revealed. Therefore the models used in this thesis are the main building blocks, supporting the findings and ideas. Models are an abstract representation of reality. It is the modeler who determines which aspects of the real process or real world are of interest and which elements are to be modeled. Therefore it is the nature of models they are incomplete and only focus on simplified specific view or perspective for a particular purpose (Xinming & Haikun, 2005).

3.1 Characteristics

To select the modeling language used within this research project, several characteristics are defined:

1. The modeling language should allow for modeling business processes and business actors involved.
2. The modeling language should allow for modeling technology domains as Intel AMT is central in this thesis.
3. The modeling language should allow visualizing the relation between different domains (from hardware to business processes).
4. The modeling language should be easy to understand because stakeholders involved are not familiar with modeling languages.
5. The modeling language should allow for modeling organizational and environmental aspects which are relevant for the business.
6. The modeling language should allow flexibility in order to adapt models if necessary.
7. [Optional] The modeling language should allow for modeling different views (several stakeholders are involved and they have different perspective or point of views, resulting in different models).

These characteristics come from the concrete problem situation and are already somewhat geared to Architecture Design Languages and Object-Oriented Languages.

3.2 Business process model and notation (BPMN)

Since business processes are key in this research, one widely used notation for business processes is the Business Process Modeling Notation (BPMN). BPMN focuses on providing a comprehensive, integrated notation for (business) process. BPMN is a graphical and informal notation targeted at analysts (Wohed, Aalst, Dumas, Hofstede, & Russell, 2006). It is developed and controlled by the Object Management Group (OMG). The primary goal of BPMN is to provide a notation that is readily understandable by all business users from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes and finally, to the business people who will manage and monitor those processes (The Open Management Group, 2011). This goal is the same across all existing versions (1.0, 1.1, 1.2 and 2.0). Considering the previous, the first characteristic, '*Is able to model business processes'*, is fulfilled since this is the base of BPMN. Furthermore Bruce Silver distinguishes three levels within the modeling language (Silver, 2009):

1. Level 1 – descriptive BPMN: documenting the process flow with the use of a basic working set of BPMN elements.

2. Level 2 – analytical BPMN: leverages the expressive power of the complete notation to describe the activity flow precisely, including the exception paths significant to key performance indicators.

3. Level 3 – executable BPMN: this level is new in BPMN 2.0. It adds XML to the models and transforms the diagrams into an executable model.

Although the lowest level of BPMN is executable (an XML language describing an executable process, similar to BPEL – Business Process Execution Language) and therefore more technical as it is meant for developers, it is about executable processes and not about modeling technology or infrastructure entities. Therefore the second characteristic '*Should allow for modeling technology domains*' does not necessary apply to BPMN.

Domains can be interpreted as pools and lanes used in BPMN. A pool can represent a participant in the process (i.e. an organization). A lane is a subdivision of a pool (i.e. the sales department). It is possible to include multiple pools, for instance processes that require communication to someone outside the organization (i.e. the procurement process of an original equipment manufacturer also called Original Equipment Manufacturer (OEM) - purchasing processors from Intel). The interaction between these different pools (Intel at one side and the OEM at the other side) can also be modeled. Therefore pools could be used as domains. However in the case of the

third characteristic '*The modeling language should allow visualizing the relation between different domains*', the domain particular refers to technology. Taking the latter into account, together with the result of the second characteristic, and the result is that BPMN does not necessary meet the third characteristic as well.

The fourth characteristic is about '*easy to understand*' for all participants. Initially BPMN would score double points here, as the process diagrams are very easy to understand for all stakeholders. However this would only apply for level one modeling as level two and especially level three models are more comprehensive, since more development aspects are involved.

Environmental aspects can be taken into account by modeling pools and lanes. However the BPMN 2.0 specification (2011) states that BPMN is constrained to support only the concepts of modeling that are applicable to business processes. This means that BPMN support for organizational structures and resources is minimal and outside the scope of BPMN. This is also supported by research on the suitability of BPMN for business process modeling (Wohed, Aalst, Dumas, Hofstede, & Russell, 2006). Therefore characteristic five '*The modeling language should allow for modeling environmental aspects which are relevant for the business*' is not covered.

Characteristic six '*The modeling language should allow flexibility in order to adapt models if necessary*' again depends on the different levels. As level one just uses a global set of elements, level two models obey BPMN's defined semantics and are subject to its validation rules (Silver, 2009). This allows the execution of level three next to the detailed description of XML. So considering level one, the user has flexibility to create a model. However when modeling a level two and three diagram, the user can less deviate from the defined rules. This decreases the amount of flexibility.

Each view results in a model. Each view is established by looking from a certain perspective of different stakeholders to a system or organization; this is also called a viewpoint. When combining al views or models result in an architecture (Twynstra Gudde, 2010). The modeling language should allow for modeling different views of the same architecture. BPMN is not a modeling language which focuses on architectural modeling. Therefore, characteristic seven '*The modeling language should allow for modeling different views*' does not apply on BPMN. Table 2 in section 3.4 provides an overview of all requirements in combination with BPMN.

3.3 ArchiMate

ArchiMate is a modeling language which allows us to model more than only the business and its processes. ArchiMate was developed in 2000 by Novay (the former Telematica Instituut) together with Ordina, Radboud University Nijmegen, Leiden Institute for Advanced Computer

Science (LIACS) and the Centre for Mathematics and Computer Science (CWI). After intensive research the results have been validated and applied in practice by business partners as ABN AMRO, the Dutch Tax and Customs Administration (Belastingdienst), and the ABP pension fund. In February 2009 The Open Group published the ArchiMate® 1.0 standard as a formal technical standard. ArchiMate has a strong UML flavor, UML is another well-known modeling language, particularly oriented towards OO software design. We proceed by elaborating some ArchiMate concepts first. After that we compare BPMN and ArchiMate and we shall argue why we prefer ArchiMate for this thesis.

3.3.1 Core concepts

ArchiMate was developed with an enterprise architecture perspective: integrating the different domains and their relations into one modeling language where services play a central role. A service is defined as follows: "a unit of functionality that some entity (e.g., a system, organization or department) makes available to its environment, and which has some value for certain entities in the environment" (Lankhorst & and the ArchiMate Team, 2004). ArchiMate does not restrict services to business services. It distinguishes different services provided by organizations to their customers, or by applications to business process or by the infrastructure to applications. This is a characteristic for enterprise architecture (Hewlett, 2006).

ArchiMate consists of three layers [Figure 1]:

1. The business layer: consisting of business processes which create products and services offered to customers, created by business actors.

2. The application layer: this layer describes software and applications which supports the business processes by application services.

3. The technology layer: this layer describes the infrastructure and infrastructure services which support the application layer. It consists of the hardware components and the communication between the components, to support the upper layers.

The environment is an additional layer which is not explicitly defined by ArchiMate. The definition of service mentions that services are offered to the environment, thus providing value to entities in the environment. This environment layer could be interesting for this research. This makes it possible to model interaction with resellers, OEMs, system integrators and other important entities as well.

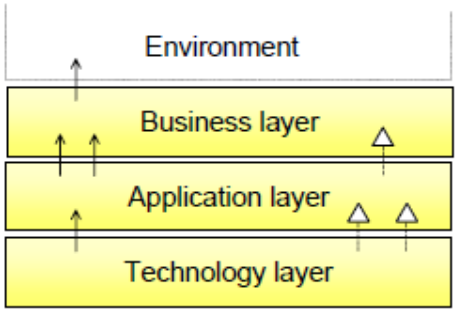

Figure 1 - ArchiMate Layers

Figure 1 shows several relations used between layers. There are two important relations used:

- Use relation: visualize how the higher layers make use of the lower layers (via a service).
- Realization relation: links how higher level elements (like a service provided to it) are realized by lower level elements.

Services, central in ArchiMate, are made possible by the lower levels. The infrastructure layer offers services like customer files service to the application layer. Then the customer file service is used by the customer administration such that it can offer a new service called customer administration service to the business layer. The business layer uses this service during the process i.e. customer registration (Appendix A). Therefore the relations used in Figure 1 show arrows bottom-up. However it is also possible to use relations which are modeled top-down. It depends on the relations the modeler uses.

3.3.1.1 The business layer

The business layer visualizes business processes and the business actors involved. Business processes can be any process i.e. sales process, claiming process, procurement process, manufacturing process. The business people involved are called business actors. They perform behavior that is part of the business process or function. They can be individuals or group of people and resources. Besides the business actor there is also the business role. The modeling language separates the physical person (business actor) and the activities performed for the business (business role). A business role is always connected with at least one business actor. Business roles are mostly defined by the business.

The business roles make use of services offered by the company or they are responsible for certain processes. Visualizing responsibility is done by the assignment relations between a business process and a business role.

3.3.1.2 The application layer

The application layer visualizes application components. This can be entire applications, (reusable) software components that are part of one or more applications, sub applications or information systems, such as CRM system, policy administration or a financial application. Application functions are part of the application components. They describe internal behavior or application functionality needed to provide application services.

3.3.1.3 Technology layer

The technology layer visualizes the hardware elements and the communication in the infrastructures, which support the application layer. The layer mainly consists of nodes, which can be devices (like a server, notebook, desktop) or system software (SQL database or mail server). A system software node is typically used on device nodes. Therefore a node can consist of a number of subnodes. The relation between the nodes is the communication path. Through communication, information is exchanged.

The services created by the infrastructure are called infrastructure services. These services are needed to run applications on the application layer.

3.3.1.4 Relations

Although services are central in ArchiMate, relations are just as important. Relations are modeled between and within the different layers. The important relations are described below [Figure 2] (Lankhorst & and the ArchiMate Team, 2004).

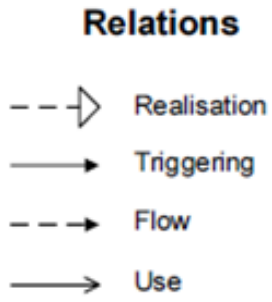

Figure 2 - Relations used in ArchiMate

Basic relations used in ArchiMate:

- The *use* relation models the use of active or behavioral elements, e.g. the use of services by processes, functions or interactions, or the use of interfaces by roles, components or collaborations.
- The *realization* relation links a logical entity with a more concrete entity that realizes it.

An example of these two relations and how they are used is given in Figure 3. The 'CRM application' realizes a service named 'customer administration service'. This service is used by the business process 'register'.

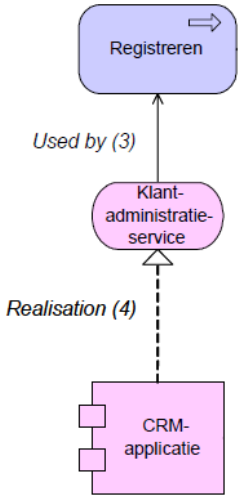

Figure 3 - Example of realization and use (used by) relations

Commonly used in this document:

- The *triggering* relation describes the temporal or causal relations between processes, function, interactions and events. An example is provided in Figure 4.

Figure 4 - Example of the trigger relation

- The *flow* relation describes the flow of i.e. information, value or date between processes, function, interactions and events. An example is provided in Figure 5.

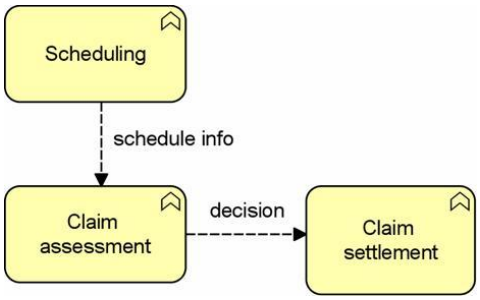

Figure 5 - Example of the flow relation

A complete overview of relations is given in Appendix B.

3.3.1.5 Components

ArchiMate distinguishes three different graphical concepts for modeling elements in a layer (architectural components): behavior, information and structure concepts. For a graphical overview of these notations, see Appendix C.

3.4 Overview modeling languages

Table 2 shows an overview of the characteristics and the modeling languages BPMN and ArchiMate.

Table 2 - Overview of the characteristics of BPMN and ArchiMate

Characteristics	BPMN	ArchiMate
1. Allow for modeling business processes and business actors.	✓✓	✓
2. Allow for modeling more lower level domains (technical/application domains)	-	✓
3. Allow visualizing relations with the technology domain.	-	✓
4. Easy to understand by experts and non-experts (all stakeholders).	Depends on modeling level Level 1: ✓✓ Level 2/3: -	✓
5. Allow for modeling organizational and environment aspects.	-	✓
6. Allow for flexibility	Depends on modeling level Level 1: ✓ Level 2/3: -	✓
7. [Optional] Allow for modeling different views of an architecture.	-	✓

Given Table 2, it becomes clear that BPMN does not support all demands needed for this research. Looking at the modeling language ArchiMate, we see that all requirements are covered in the table. Although BPMN scores better on characteristics 1 and 4, this is compensated by the IT background of the researcher. Characteristic 5 gives presumably more flexibility for our problem situation, letting us able to modeling organization and environmental aspects. Although at the beginning of the research is was still unclear which characteristics really would be used, we chose ArchiMate as the modeling language during this research. We reflect the use of the modeling language in the conclusion.

The signs provided in the overview (✓✓,✓ and -) are assigned based on literature and the knowledge and experience of the researcher. Furthermore when both languages have the characteristic, for example if ArchiMate has a ✓ and BPMN is significant better, two plus signs are assigned to that specific characteristic of BPMN. There are no strict rules formulated for assigning one or two plus signs. The – sign is assigned if the researcher could not indicate that the characteristic is somehow supported by the modeling language.

3.5 Next chapter

This chapter explained why ArchiMate is preferred as a modeling notation instead of other more process oriented modeling languages like BPMN. Further basic concepts of ArchiMate are explained, such that the reader can continue to read and understand this document.

ArchiMate makes it possible to model the business and its environment in the same modeling language such that we can understand and analyze the mutual impact. (Groenewegen, Stam, Toussaint, & De Vink, 2005). This research focuses on the impact of a technology called Intel AMT. Therefore the next chapter provides the reader with more information regarding this technology and what the relation is with Intel vPro.

4 Introduction of Intel® Active Management Technology

Intel Active Management Technology is a technology embedded in hardware: desktop, notebooks and workstation products which are qualified as Intel vPro systems. Besides Intel AMT, Intel vPro systems contain other technologies as well, at this moment these technologies are [Figure 6]:

- Intel® Virtualization Technology (Intel VT);
- Intel® Trusted Execution Technology (Intel TXT);
- Intel® Anti-Theft (Intel AT).

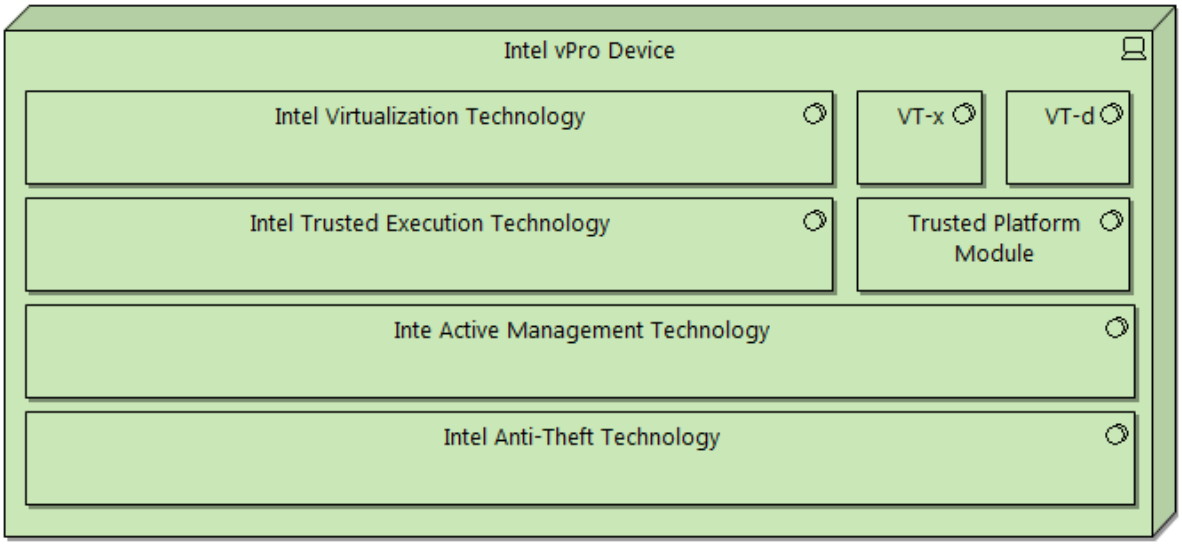

Figure 6 - Overview of technologies included in the Intel vPro platform1

Intel AMT makes it easier for enterprises to manage their systems remotely and from a central point. This chapter explains how this technology works relatively simply: some ArchiMate models will illustrate the explanation.

[1] Note that the different technology objects are using the graphical notations of system software, because ArchiMate does not have an construct for hardware technology. The system software notation is chosen since technology is a combination of firmware, software and hardware and is the notation most close to technology.

4.1 Use-case Categories

Intel AMT can support many use-cases. Therefore Intel provides Use Case Reference Designs (UCRD). UCRDs are step-by-step procedures to implement specific use-cases using Intel AMT. These use-cases can be divided into three main categories (Intel, Architecture Guide: Intel® Active Management Technology, 2011):

- Remote discover computing assets in any operational state;
- Remotely heal computing assets;
- Remotely protect computing assets.

4.1.1 Remote discover computing assets in any operational state

Intel AMT gathers real-time hardware asset information of the host system. It stores this information in the non-volatile memory. The memory used to store this information can be read even if the host system is powered off or if the host OS is not running. Therefore IT can rely on real-time hardware information of Intel vPro systems.

Applied situation: the hard drive of a user fails. The user calls IT to replace the hard drive. IT is not sure if the hard drive information is correct. To solve the problem, the user has to bring his/her notebook to the IT department. IT must then open the system to determine exactly which hard drive was installed exactly. After this, a new order for the hard drive can be placed.

With Intel AMT: the hard drive of a user broke down. The user calls IT to replace the hard drive. IT can establish an OOB connection to the user's system and determine the correct hard drive information such as brand, type and capacity. The information is received and a new hard drive can be ordered so that there is no risk of ordering a wrong type of hard drive. This saves IT a trip to the user or saving the user a trip to the IT department. In the meantime IT can set up a Remote Desktop session for the user, such that the end user can continue working. The hard drive can be replaced when the user is in the office.

4.1.2 Remotely heal computing assets

Intel AMT supports the IT department if hardware or software problems occur and when standard software solutions are not sufficient. Intel AMT offers functionalities like Keyboard, Video and Mouse (KVM), IDE-Redirection (IDE-R) and Serial-Over-LAN (SOL) capabilities for management applications. Furthermore it can log certain events to assists IT to diagnose problems quickly. Solving issues quicker means shorter user down-time.

4.1.2.1 Keyboard, Video display unit, Mouse

Helpdesks within companies are using remote control with KVM support to solve user's issues. However the existing remote control software with KVM support, cannot be used when i.e. hardware or certain software errors arise. The current KVM method can only be used when the KVM agent is running on the OS. As soon as the OS needs to reboot, the remote connection with the management console is disconnected. After the OS is rebooted again, the session has to reconnect. Thus when the OS is corrupt, or when the traditional software agent is not able to run, or when hardware errors rise users have to physically visit the IT department for repair. This is time and cost consuming. Meanwhile the user is not able to work (user downtime) which affects their productivity for the business. RealVNC, known for its remote desktops products as VNC Viewer, offers VNC Viewer to connect to the AMT service via its default port 5900. However using this connection does not offer customers with the possibility to use TLS or ACL. If customers what to use these features, RealVNC offers a products called VNC Viewer Plus. The Plus version can connect to the AMT technology via the AMT ports (16991-16995) and supports ACL and TLS.

4.1.2.2 IDE-Redirection

Besides KVM support, Intel AMT also supports IDE redirect (IDE-R). This feature allows the management console to mount a remote ISO file as CD/DVD on the client. For example if the system is crashed it is possible to mount an ISO file to start up Microsoft Diagnostics and Recovery Toolset (MS DART) remotely.

4.1.2.3 Serial-Over-LAN

SOL is a serial interface for input and output over the network by IP. SOL provides the IT with the possibility to enter the BIOS or other boot functionalities without the necessity to use KVM. SOL is supported for every AMT version, while KVM is only support by AMT 6 and higher.

4.1.3 Remotely protect computing assets

Keeping the company network free from viruses and malware is necessary to guarantee business continuity and to keep information secure. With Intel AMT agent presence checking it is possible to detect which agents are running and which not, based on company policies. The checking is performed locally on the system, where the Intel AMT firmware checks the user agents every 10 seconds. If agents do not respond on the check, the AMT firmware can send an alert to the management console. System defense can react on the result of the agent presence checking based on policies. For example if the anti-virus agent fails, this is detected by the agent presence monitor. As a reaction, system defense can place the system in a remediation network

for upgrading to minimum standards. Besides checking if agents are running on the client, it is also possible to limit network access if the systems do not conform to company policies (called posture checking). This way, users that i.e. have installed older versions of virus protection are not allowed on the network (Limit network access).

By using features as agent presence, system defense and posture checking companies can secure their networks even better, and can set policies to place systems in quarantine if they do not meet company's standards.

Before the next section, where the reader encounters different AMT versions, Appendix D provides the reader with the different versions of AMT up to now, and the features supported by different versions. Intel is continuously extending this firmware i.e. by adding new features or improving existing features.

4.2 In- and Out-of-band communication

Intel AMT works at the firmware level rather than the operating system (OS) level. Intel AMT consists of hardware called the Intel® Management Engine (Intel® ME). This is an isolated and protected computing resource. The ME provides services like the Intel AMT service and the common services [Figure 7]. This means that hardware (a vPro system) enables services which can be used by higher level software.

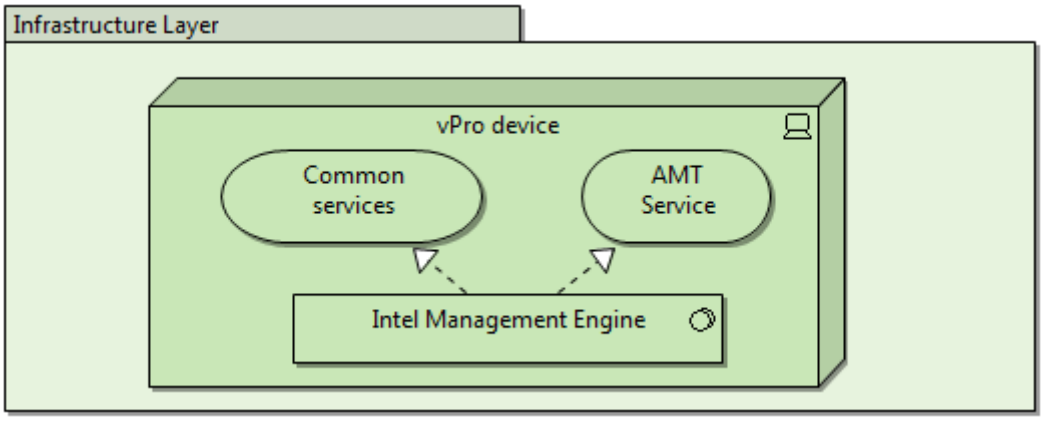

Figure 7 - Management Engine Architecture

The advantage of Intel AMT is that it allows IT to establish an out-of-band (OOB) communication channel. This means that the OS does not need to be running on a system to establish a communication channel with another system, the management console. This is possible because the AMT firmware uses the TCP/IP stack which is part of the common services [Figure 8].

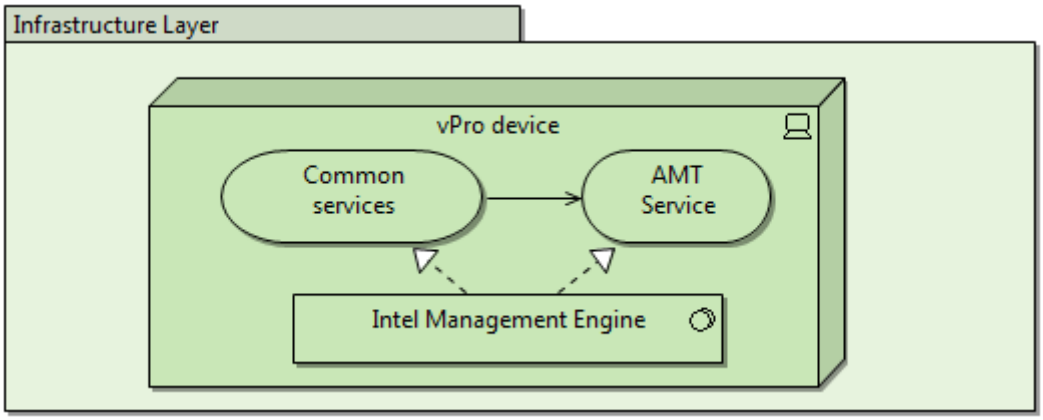

Figure 8 - Intel AMT uses the Common services

Therefore OOB communication makes it possible to communicate with an Intel vPro device even if the OS is inoperable. If communication is still possible with client devices, it also allows IT to manage, diagnose client systems or perform repair proceedings.

Overall, there are two possible ways of communicating with the AMT service[2]:

1. In-band communication between management console and the management agent installed on the client OS [Figure 9]. For example using Microsoft System Center Configuration Manager (SCCM) and the SCCM agent.

2. OOB communication between management console and the AMT service [Figure 10]. For example if the systems are powered down.

Furthermore Intel AMT operates independently of the host's central processing unit (CPU), being available in all client power states (awake, OS works properly; awake, OS unresponsive; asleep and powered off) as long as the power cable and Ethernet cable (or wireless connection) are connected. If a notebook is in asleep state on battery-power, by design the system will not respond.

Figure 9 and Figure 10 also show that to use AMT, the customer is dependent of software like the management console, management agent and drivers. Using the environment of Figure 9, by using more software the customer is able to use more Intel AMT features, than the situation in Figure 10. Therefore software is important to exploit the Intel AMT hardware features. Not only does Intel provide own software solutions, Intel cooperates with other companies to support a wide range of customer preferences (referring to 5.2).

[2] The situation is described based on a wired connection. Establishing communication with AMT via wireless is more complicated.

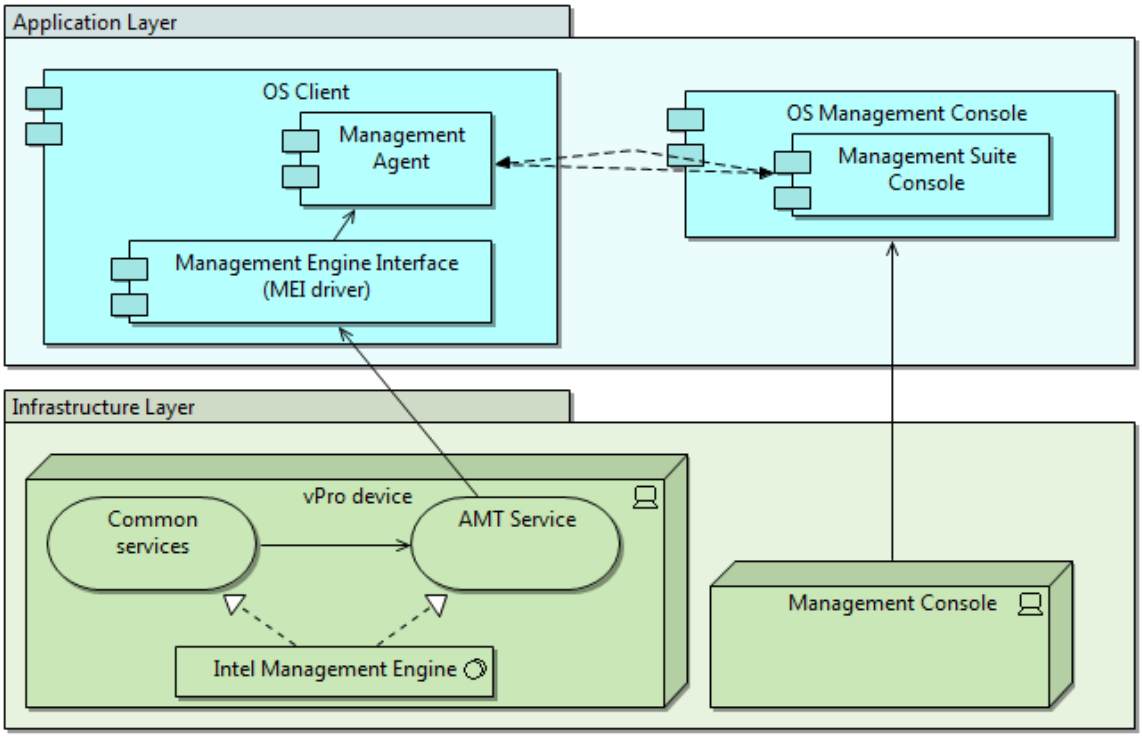

Figure 9 - Intel AMT communication via the management agent

However there are more services and software installed in the OS then presented in Figure 9. Since this can confuse the reader at the start, this is excluded from the previous figure. The detailed description is still available in Appendix E for the more technical persons.

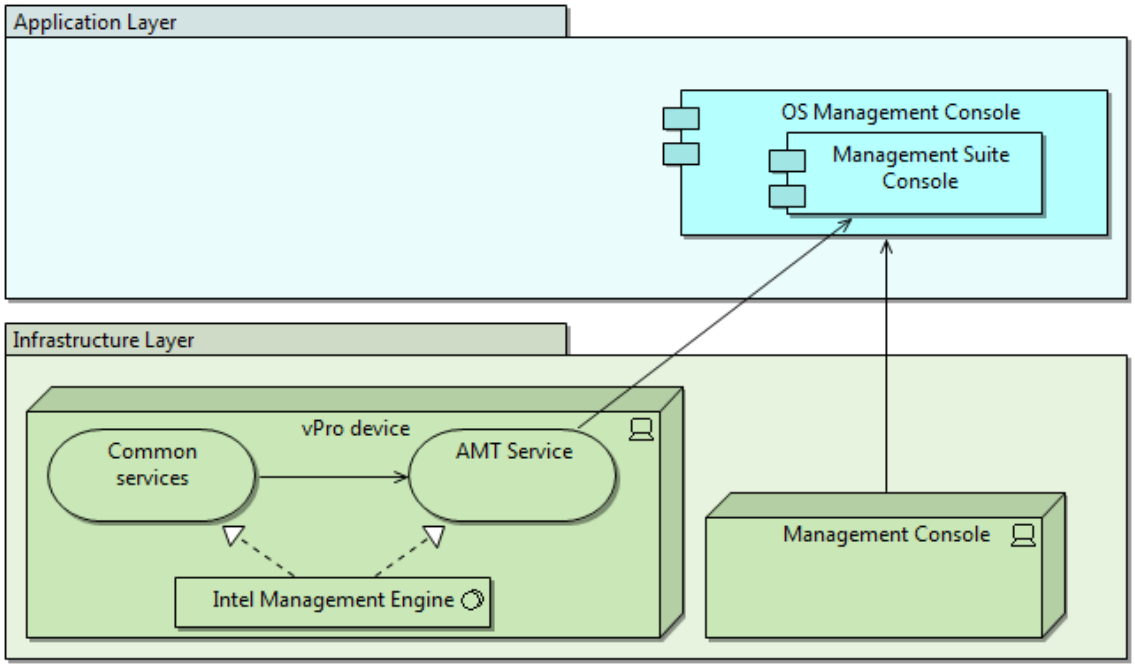

Figure 10 - Intel AMT communication via AMT firmware and management console

As Figure 10 shows when OOB communication is used, that the state of the OS is not important anymore. Therefore the OS component and all components in it, which were located in the application layer, were removed (unlike Figure 9 where the communication is done via the MEI driver in the OS). The common services are important for the AMT service. The common services contain at least:

- Admin services: Configuration provisioning, Access Control List (ACL), Management etc.;
- Core services: Power Manager, Non-Volatile Memory Manager, etc.;
- Management services: Event/Alerting Manager, circuit breaker control, etc.;
- Network services: HTTP, TCP/IP, TLS, etc.

Whereas the AMT services are specific services which contain functionality for:

- Asset Management;
- Third-Party Data storage;
- Remote management.

In order to make use of Intel AMT, the firmware must be configured first. There are different methods of configuration which are be addressed in section 4.3, page 36. The different methods can be split into two groups:

1. Manual configuration: manual configuration is suitable for companies with small volumes of systems like for the SMB market. The configuration is done manually on a one by one basis, and therefore no specific infrastructure is needed.
2. Automated configuration: this group contains configuration methods which are automated and therefore more suitable for larger system volumes like in LE.

Intel offers software that customers can use to configure Intel AMT. This software is called Intel Setup and Configuration Service (Intel® SCS). This software helps businesses which do not wish to use or do not have a management suite.

Intel AMT is OEM or Independent Software Vendor (ISV) independent. Each OEM can decide to provide systems with Intel AMT functionality by selecting the right hardware components for these systems. These systems must contain a vPro qualified processor, chipset and network card [Table 3].

Table 3 - Overview of the current hardware components of the vPro platform

	Desktop	Notebook
Processor	Intel® Core™ i5 vPro™ or a Intel® Core™ i7 vPro™ processor	Intel® Core™ i5 vPro™ or a Intel® Core™ i7 vPro™ processor
Chipset	Q57, Q67	QM57, QM67
Network card	Intel® Gigabit Network (optional Intel® Centrino® Wireless)	Intel® Gigabit Network & Intel® Centrino® Wireless

*Note a Trusted Platform Module (TPM) is also required to support Intel TXT. It is the choice of the OEM how to implement the TPM

Besides OEM independency it is also ISV independent. As mentioned before there are multiple management suites that can work with Intel vPro systems. ISVs can differentiate themselves (although everyone can use it) by integrating the Intel AMT package in their management software solution. For example Microsoft implemented most features in its SCCM 2007 natively, except for KVM-support. The latter was included in Microsoft helpdesk suite called SCSM (Microsoft System Center: Service Manager).

4.3 Intel AMT Provisioning

In order to use Intel AMT, the built-in Intel management firmware needs to be configured, like network connectivity, management features, secure access and authentication. This process is called *provisioning, activation or setup and configuration of the system*. At this moment there are four methods to provision Intel vPro systems [Table 4]:

Table 4 - Intel AMT Configuration Methods, (Intel Corporation, 2011)

#	Configuration method	Intel AMT version
1	Host-based Configuration	6.2 and higher
2	SMB/Manual Configuration	2.1 and higher
3	One Touch Configuration (PSK)	2.1 and higher
4	Remote Configuration (PKI)	2.2, 2.6, 3.0 and higher

There are different ways to integrate Intel AMT with management suites used in LE. Due to complexity (the different management suites, additional options etc.), this document focuses on the provisioning process with the Intel SCS application. This is a standalone application which

can be used by customers to configure Intel AMT if there is no management suite present. The current version of Intel SCS is version 7.1.

There are two states in which systems can be provisioned: systems including an OS and systems without an OS. The latter is called *bare metal*. The provisioning process performed on non-OS systems is called *bare metal provisioning* or *bare metal configuration*. During the provisioning process the actual configuration is done by PKI, PSK or manually. However if the choice is made to provision clients remotely, then the provision process can only be done by PSK or PKI.

Table 5 gives an overview of which provisioning methods can be applied for bare metal systems or systems with an OS.

Table 5 - Different methods for OS systems and non-OS systems

	Systems with OS	**Systems without OS (bare metal)**
Host-based configuration	✓ (local interface)	-
SMB/Manual configuration	✓ (local interface / MEBX)	✓ (local interface / MEBX)
One Touch configuration (PSK)	✓ (remote interface)	✓ (remote interface)
Remote Configuration (PKI)	✓ (remote interface)	✓ (remote interface)

Since SMB/Manual configuration and one touch configuration are not used much (anymore), the descriptions are moved to Appendix F. The remote configuration, host-based configuration and bare-metal method are more important for this document and are therefore described in the following paragraphs.

4.3.1 Remote Configuration (PKI) - Admin Control Mode

Remote configuration together with host-based configuration is the most used method to provision the Intel AMT. Therefore these two methods are described more extensively than the previous methods. Furthermore the explanation of remote configuration with a PKI infrastructure is supported by an ArchiMate model. The modeling language has been explained in the previous chapter with the three basic layers. This model and the next do not only show the three main domains, but these models are expended with the services layers used between the main layers for interaction. This is also visible in the example given in Appendix A.

Using remote configuration with PKI means that the customer needs to have or set up a PKI infrastructure [Figure 11]. And just as in the PSK method, a provisioning server is needed to configure the Intel AMT.

The provisioning is done via network connection, just as the PSK method. The difference between PSK and PKI is the way of creating a trusted connection. While PSK uses keys which are shared between the client and the provisioning server, PKI uses two different keys based on asymmetric encryption. These two keys (private and public keys) are linked to each other such that one key can encrypt the message and the other can decrypt the message.

There are already thumbprints of the root certificates embedded in the hardware of an Intel vPro system. However the provisioning server must have a certificate too. Therefore the customer has to buy a certificate at one of the vendors which have a thumbprint embedded in the hardware. If the provisioning certificate is installed on the server, a trusted connection can be established to provision the client.

4.3.1.1 How it works

- There are two ways to use remote configuration: systems with an OS, and systems without an OS. This paragraph globally describes how remote configuration works by using Intel SCS on the client pc (so using a system with an OS). This is an example of the process of remote configuration. Then the Configurator, located on the application layer of Figure 11, sends a configuration request to the provisioning server (there is RCS service running on the provisioning server). The package is sent to provisioningserver.[yourdomain.com]. The DNS service is needed to translate this alias to the proper IP-address of the provisioning server.

- The RCS service of the Intel SCS (located on the application layer) receives this package and communication messages to set up a trusted connection and executes some checks (i.e. which AMT version, certificate needed).

- The RCS service checks the profile (generated by the profile designer) needed for provisioning and sends the stored profile to this client.

Figure 11 shows that the provisioning process is almost automated. However there is still someone necessary to install all software, to set up the infrastructure in preparation and to create a profile, to create the deployment package and to create the scripts such that the provisioning process can start.

The client system uses the ACU Configurator to initiate communication to the provisioning server. The SCS software (and ACU Configurator) does not need to be installed on the client itself. The ACU Configurator executable should run on the client. This is not visible in the graphical Figure 11.

Provisioning of Intel AMT 7.x systems by remote configuration results in the configuration 'admin mode'. This means that all Intel AMT features are available. This differs when using the host-based configuration method, where a parameter is set to 'client control mode'. This means that the feature system defense is unavailable.

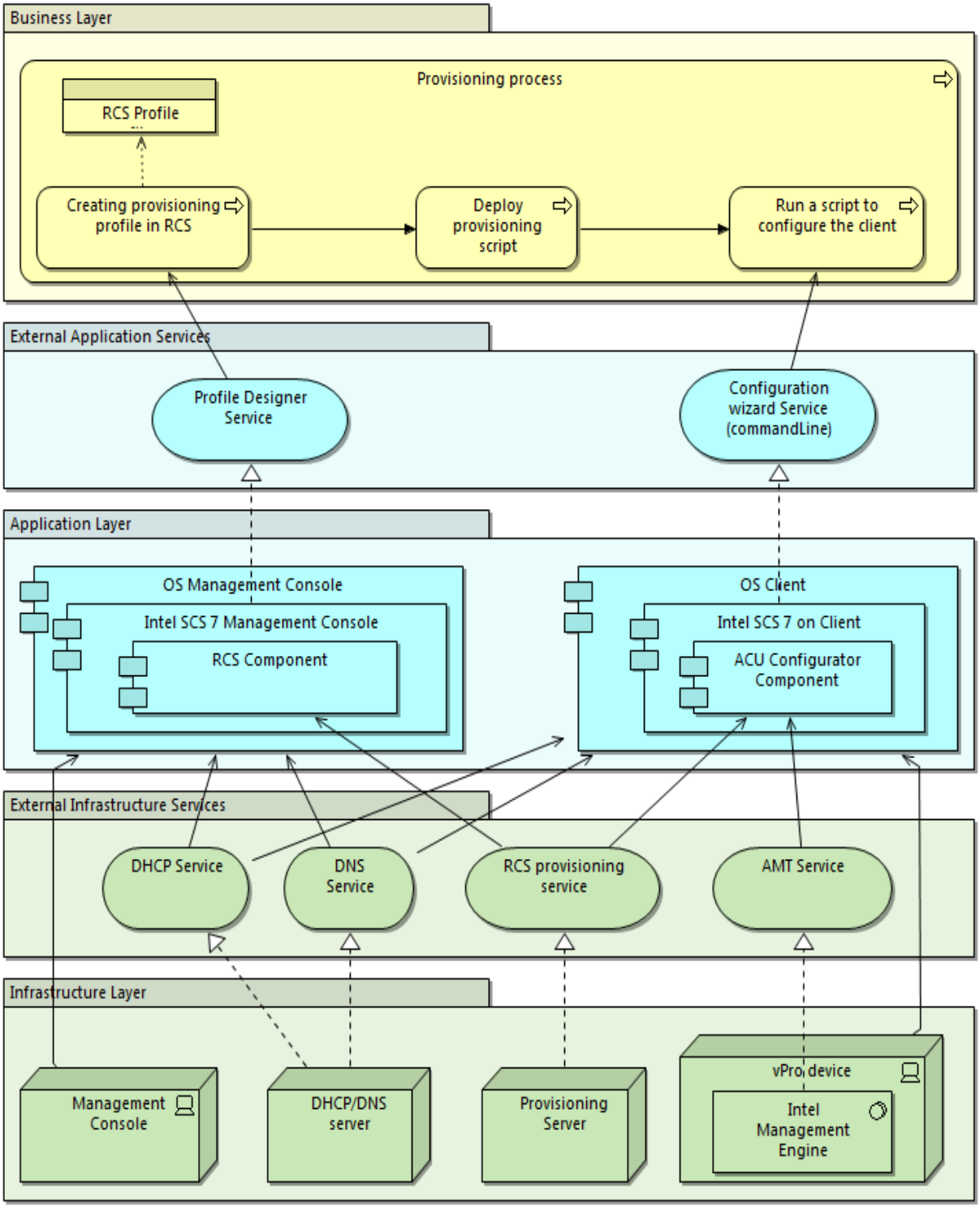

Figure 11 - Remote Configuration with PKI running from an OS

Table 6 gives an overview of the advantages and disadvantages of this provisioning method.

Table 6 - Overview of advantages and disadvantages of provisioning via PKI

Advantages	Disadvantages
Supports all Intel AMT features (admin mode)	More complex to understand
Intel AMT 2.2 versions and higher supported	Requires IT infrastructure: Provisioning server (RCS), DNS and DHCP server, as Figure 11 shows. Additional is AD and CA integration.
Securely Performed remotely (no need to physically touch systems)	Need to buy a certificate at an ISV and install it on the server
Useful for high volume deployments, because of complete automated provisioning process	
Can configure all parameters	

4.3.2 Host-based Configuration - Client Control Mode

Host-based configuration (HBC) is a new method that makes use of an XML profile to configure the Intel AMT device. The Intel SCS 7.1 application is used on the management console to create the xml profile as well as on the client to interpret the received xml file and to set the parameters of the ME accordingly [Figure 12]. By default the system is set to client control mode with host-based configuration. One important difference between remote configuration (PKI) and host-based provisioning is security. Host-based configuration does not establish a trusted connection at all, because the provisioning is done locally. In order to provide security between the management console and the client, user consent is included. This means that user consent is required for:

- SOL to redirect BIOS screens and OS Boot text screens;
- IDE-R;
- KVM Redirection;
- To remotely set BIOS boot options;
- To change the source for remote boot (for example, boot from PXE).

User consent is a six digit number which appears on the screen of the client. The user has to communicate this to the person who initiated an action requiring this user's consent. If the six digit number is correct, IT has access to the user's system. It could be questioned if this code is

safe enough for distributed attacks, since it is only a six digit code. However parameters are defined to limiting a code guessing within a certain amount of time (i.e. 3 times in 10 minutes).

4.3.2.1 How it works:

First of all the IT admin has to create an xml profile (a process on the business layer on Figure 12) by using i.e. the ACU_Wizard Component (located on the application layer). If this is done, the deployment package has to include this xml profile together with the Intel SCS executable (or both can be stored on a network share and accessed by the provisioning script). Then:

- A script or batch file runs the Configurator locally on the Intel AMT system (as shown on the right side in the application layer, Figure 12). It checks the Intel AMT version to discover if host-based provisioning is supported.
- It locates the profile and activates Intel AMT on the device. The Configurator sets the Intel AMT device in client control mode and uses the profile to set all AMT parameters.

Table 7 gives an overview of the advantages and disadvantages of this provisioning method.

Table 7 - Overview of advantages and disadvantages of host-based provisioning

Advantages	**Disadvantages**
Easy to understand	Performed locally, therefore system must be on, and OS must be running
No provisioning certificated needed	Not all features are supported (system defense not available)
Also for high volume suited with scripting	User consent needed for several actions (because of client control mode)
Execution of provisioning process is done locally (not dependent of network)	Only Intel vPro devices with AMT6.2 and above are supported
Works with VPN	

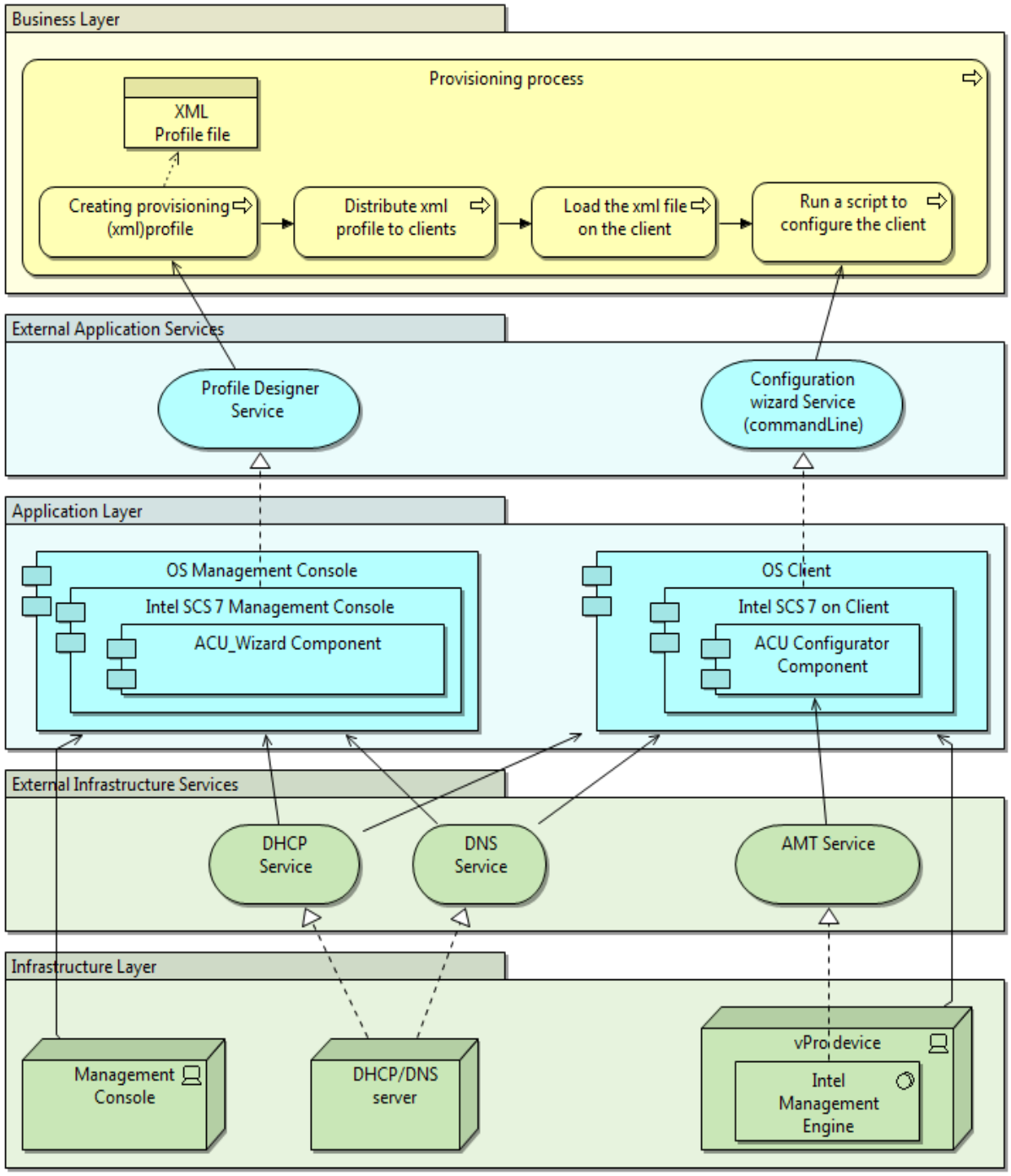

Figure 12 - Host-based Configuration process

4.3.3 Bare Metal Configuration

Bare metal provisioning is the process of provisioning Intel AMT on host systems without an OS. Intel AMT 7.1 does not support bare metal provisioning in default mode. This means that the Intel AMT device is not sending 'hello packages' anymore when power supply cable and Ethernet cable are connected. However it is still possible to activate Intel AMT by bare metal configuration.

There are several ways to do this:

- By using Activator LiveCD software for CD or USB device
- Manually enter the MEBX and start remote configuration. This sends out a 'hello package'.
- Consult the OEM before buying the systems to change BIOS settings in order to send 'hello packages' again.

Actually bare metal provisioning is remote configuration with some settings changed in the RCS. One of the changes is that the RCS has to start a script that identifies the proper profile and which also contains the hostname and domain to set the Intel AMT Fully Qualified Domain Name (FQDN).

4.3.3.1 How it works

Overview of the bare metal process with Intel SCS 7.1 on an Intel AMT 7.1 device:

- Enter the MEBX, or use the Activator LIveCD to initiate the hello-package (not necessary if hello-package is automatically send, however this is not by default).
- First a hello package is sent to the provisioning server including the host's UUID, IP and how it wants to be configured (one touch configuration or remote configuration). The package is by default sent to provisioningserver.[yourdomain.com].
- Then the RCS/provisioning server receives this hello-package and decides if it can support the provisioning request.
- If it can support the request, then a trusted connection is established between the host and the provisioning server using certificates as the default option or using PSK when using one touch configuration.
- Then Intel SCS starts a server-side script, which contains the profile, hostname, domain and FQDN information.

- The RCS/provisioning server sets the hostname and domain name of the client system
- The RCS/ provisioning server parses the profile configured for the Intel AMT devices and sends this to the management controller of the host system to be provisioned.

Table 8 gives an overview of the advantages and disadvantages of this provisioning method.

Table 8 - Overview of advantages and disadvantages of bare metal provisioning

Advantages	**Disadvantages**
Supports all Intel AMT features (admin mode)	More complex to understand
Supports all Intel AMT versions (up to now)	Requires IT infrastructure: Provisioning server (RCS), DNS and DHCP server
Out of the box setup (directly shipped to user at an office location)	Needs to buy a certificate at one of the ISV in case of Remote configuration or in case of using PSK, these keys have to be implemented in the clients (OEM can request a fee for this)
	Needs to physically touch every system by entering the MEBX or using the LiveCD (on USB or CD)
	Issues with FQDN (when using high volume)

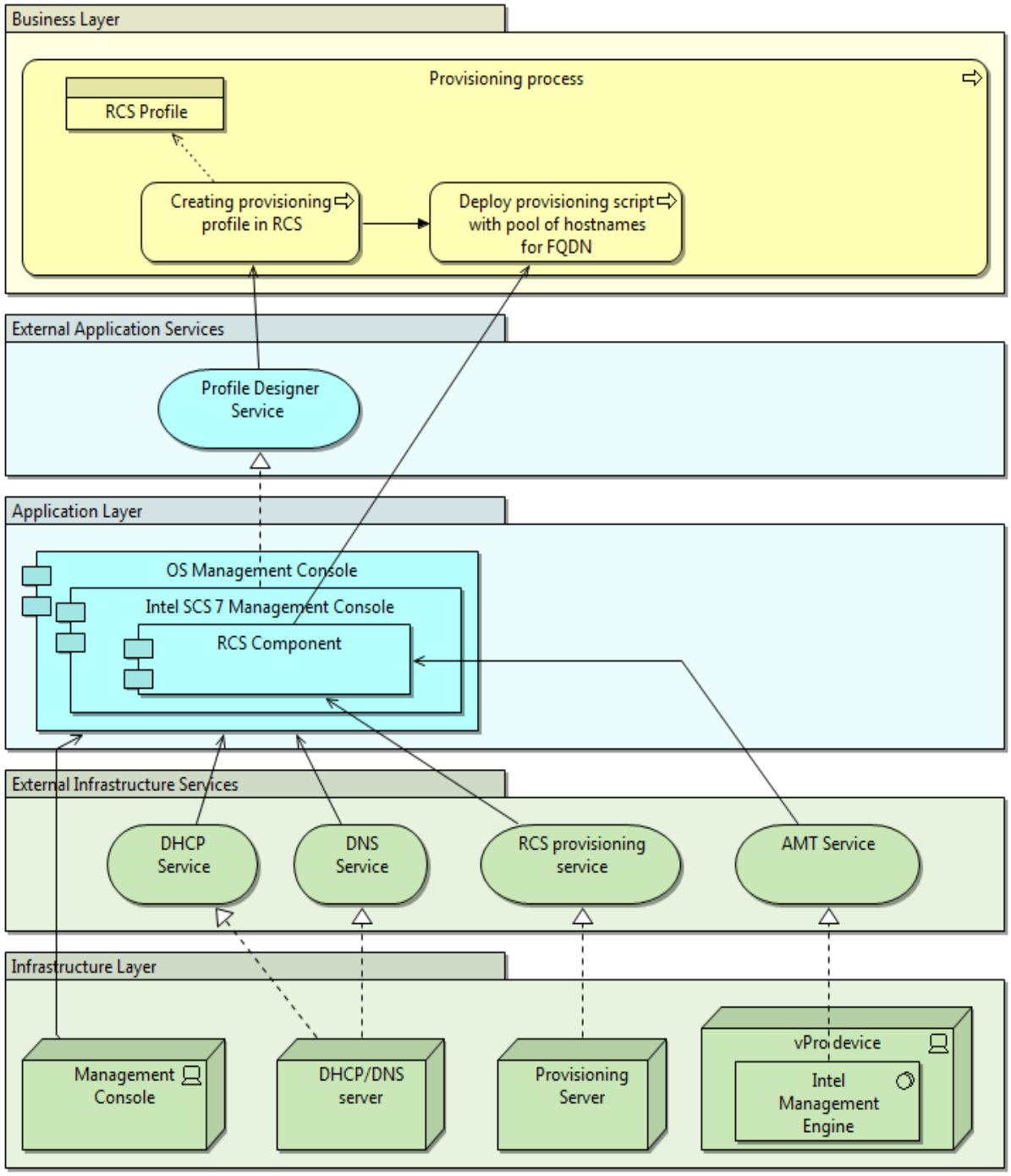

Figure 13 - Bare Metal Configuration via PKI or PSK

4.4 Next chapter

As the reader now has a better understanding of what Intel vPro is and more specific what Intel AMT is, we now dive into the environmental aspects. The next chapter describes the environment of Intel and how this can be modeled by ArchiMate. Furthermore it describes and views the processes within the Sales and Marketing ESS Team, to understand how Intel and its environment cooperate and influence each other.

5 Understanding Intel

5.1 Introduction of Intel

Intel is an American semiconductor manufacturer with approximately 100.000 employees and 300 facilities in 50 countries. The core business of Intel is making chips of silicon. The most known chip is the microprocessor or CPU of a computer system. Intel offers microprocessors with one or multiple cores designed for notebooks, netbooks, desktops, servers, workstations, storage products, embedded applications, communications products, consumer electronic devices and handheld devices(Intel, 2010 Annual Report, 2010). More general information about Intel can found in Appendix G.

5.2 Intel's ecosystem

Intel depends on its ecosystem for most of its products, i.e. the microprocessor built in notebooks or desktops have to be sold to end-customers but this is not done by Intel. Several companies in the ecosystem (or supply chain) work closely together to sell the complete systems to end-customers. On a global level, Intel's ecosystem for LE end-customer systems for example desktops consists of five types of companies as shown in Figure 14. The following figures can also be modeled in ArchiMate as a preparation for the figures described later in the document. However ArchiMate is not used in these case to show the transformation of some of these figures towards ArchiMate models. The following figures can also be modeled in ArchiMate as a preparation for the figures described later in the document. However ArchiMate is not used in these case to show the transformation of some of these figures towards ArchiMate models.

Figure 14 - Intel's ecosystem for end-customer pc-systems

The role of the OEM is to assembler and offer complete products ready to use for end-customers. OEMs work together with distributors, which serve as a central place for storage for their customers: the resellers. Resellers can offer complete solutions and services including the hardware products of OEMs. The hardware supply chain also shows that Intel doesn't have direct contact with the end-customers. However it is important for Intel to understand what the market wants, what is changing and what challenges companies are facing, in short Intel has to

understand its environment. Therefore Intel establishes relationships with all the companies in the supply chain. This is achieved by its sales and technology teams of SMG.

5.2.1.1 Software and solution chain

Intel is working together with other types of companies as well. These other companies are not involved in the product chain [Figure 10], but are still important for Intel. As a system consists of hardware and software (the OS and applications), software has to be aligned with the hardware in order to provide customers with the best results. Therefore Intel has a large number of developers which are working closely together with developers of other software parties, the ISVs, to maximize alignment of Intel products with software products. Among others, ISVs build software on top of the Intel architecture (x86). Considering this software environment, we can identify a software cooperation chain as shown in Figure 15.

Figure 15 - Intel's software cooperation chain

Besides ISVs we can identify one more type of companies, namely the System Integrators (SIs). Where the ISVs are focused on software, the SI is focused on how to combine and transform all the different components like hardware, and software, to offer this as one end-to-end solution to the customer. Next they also help customers to implement their solutions. The SIs are important for Intel to utilize the products as good as possible. Therefore Intel is working together with these companies, sharing information and knowledge, but also providing necessary material such that the companies can test and understand how technologies work. This results in a chain with a main focus of software solutions ready for implementation at the end-customer [Figure 16].

Figure 16 - Intel's solutions chain

5.2.1.2 Intel's influencing perspective

This perspective is about the advisory and influencing role of the SMG ESS team. In order to promote Intel's products, it is necessary to inform Intel's environment about its technology and products. This is even more important because Intel is not visible for end-customers, as it is only a part of the complete product customers buy. As mentioned earlier, Intel established relationships with the different companies in its environment. According to Figure 17 the five types of companies are completely connected. Note that the supply chain route is visible when reading it counter clock wise.

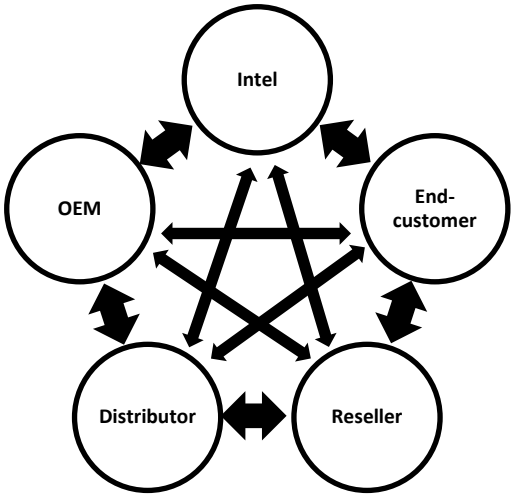

Figure 17 - Five domains in Intel's sales process without hierarchy

Transforming Figure 17 to an ArchiMate model, the first step is to model it from Intel's point of view. Intel has contacts within all other types of companies, and is often a neutral conversation partner. This is because Intel does not sell complete system products to end-customers, and are therefore considered more neutral. Figure 18 represents a global view of Intel's influencing role (based on conversations with colleagues). Since this is a modeled from perspective of Intel, no relations were modeled between the other four types companies. During these conversations two of the three colleagues placed Intel as a pillar, vertically overlapping the other companies in the environment. The reason of Intel presented vertically is that it an Intel's perspective, having relationships with all other companies. However the same could be said from an OEM, a distributor, a reseller, or an end-customer.

Explaining the relationships of Figure 18:

Intel – OEMs: Intel works closely together with OEMs from the perspective of the product supply chain: exchanging information of products and technical requirements to produce notebooks, desktops, workstations etc., and from the perspective of sales: exchanging marketing

information i.e. product features and advantages, providing the sales represetatives with more knowledge to sell more products with Intel technology instide. Furthermore they can attract a larger network of distributors.

Intel – distributor: Intel sponsors events organized by distributors such that Intel can deliver presentations regarding Intel technology. Intel tries to reach more resellers by using these events as an influencing opportunity.

Intel – resellers: Intel works closely together with resellers to outsource implementing activities. Intel wants to educate resellers such that they are able to implement Intel technologies like Intel AMT. Educating sales representatives of reseller could help stimulating the sales of more products with Intel technology.

Intel – end-customer: Intel educates end-customers when implementing Intel technologies, because OEMs, distributors and resellers still lack knowledge. Furthermore Intel exchanges knowledge like roadmap update about coming Intel technologies and can discuss the customer's need for these technologies. This way Intel can analyze market trends for instance.

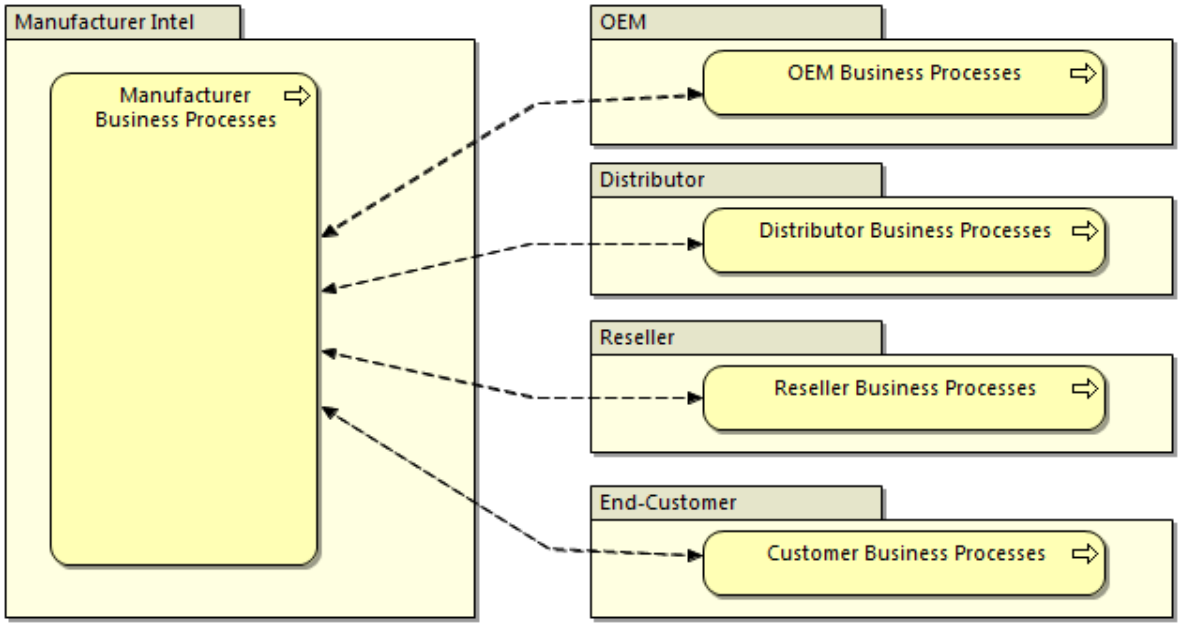

Figure 18 - Intel's influencing perspective of the hardware supply chain

The relations in Figure 18 are necessary to promote the relevance of Intel's products: to enable the ecosystem. Furthermore some of Intel's technologies require activation and configuration, like Intel AMT. Customers need support to implement and configure these technologies. However Intel is operating with a small team in the whole of the Benelux region. Therefore Intel wants to enable partners like resellers and OEMs to engage with customers. This way, customers

can get the support they need to enable Intel technology. To accomplish this strategy Intel is training resellers, distributors and OEM sales persons. This is also a point of concern regarding Intel vPro. Since vPro is complicated, sales persons having difficulties with selling Intel vPro. This could be an interesting topic for other research.

Taking a side step, we can also model Figure 18 for the software chain and for the solutions chain, resulting in Figure 19 and Figure 20.

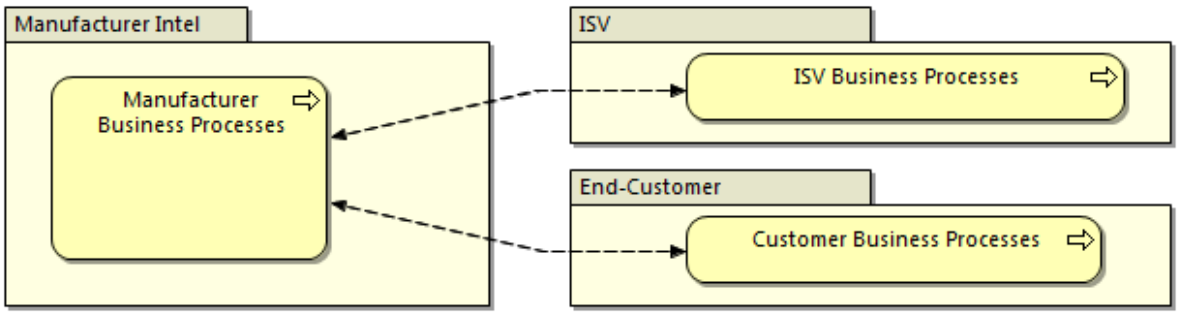

Figure 19 - Intel's influencing perspective of the software supply chain

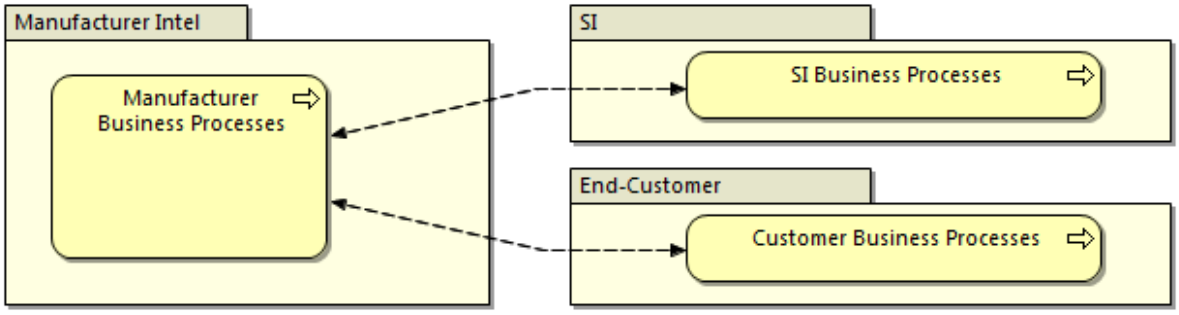

Figure 20 - Intel's influencing perspective of the solutions chain

Returning to Figure 18, the next step is to transform this model into a more layered modeled as described by ArchiMate which results in Figure 21. As the model is still in line with Intel's point of view, the Intel layer is placed at the bottom representing the business layer.

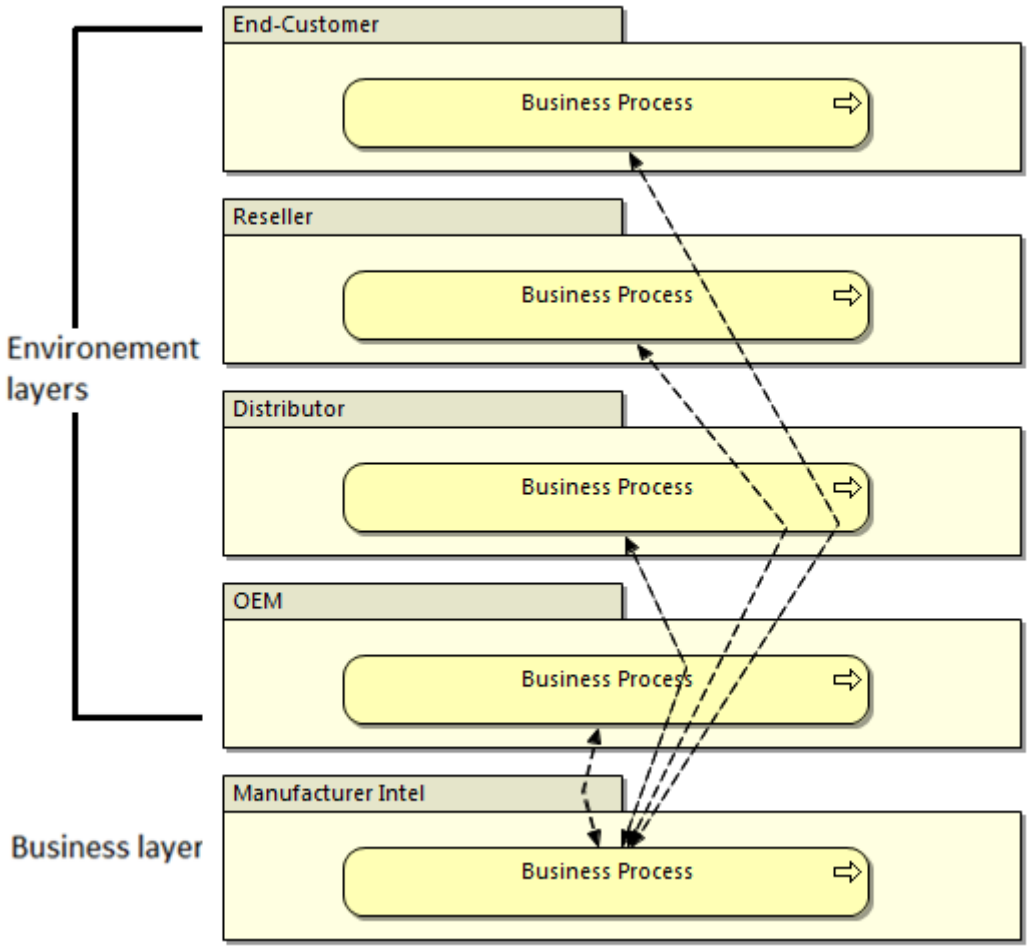

Figure 21 - Intel's environment

Now as a preparation for the next chapters and to remain consistent, the perspective changes towards the end-customer. This change means a shift of the business layer [Figure 22]. Here, the end-customer is placed as the first layer at the bottom. Although hierarchy exists within ArchiMate by using the domains as layers, these layers must not be seen as hierarchical. The word layer is misplaced assuming a certain hierarchy.

Next layer is the Intel domain which is an active driver during this research. Therefore Intel is placed on the second layer. The reseller is also participating during this research however is less involved (passive) and therefore placed on the third layer. The OEM is not involved during this research but is still part of the environment and is therefore placed on the fourth layer.

As Figure 21 can be transformed to the viewpoint of an end-customer, it can be transformed for any other customer, like an OEM, reseller or ISV. By doing this, viewpoints are being changed.

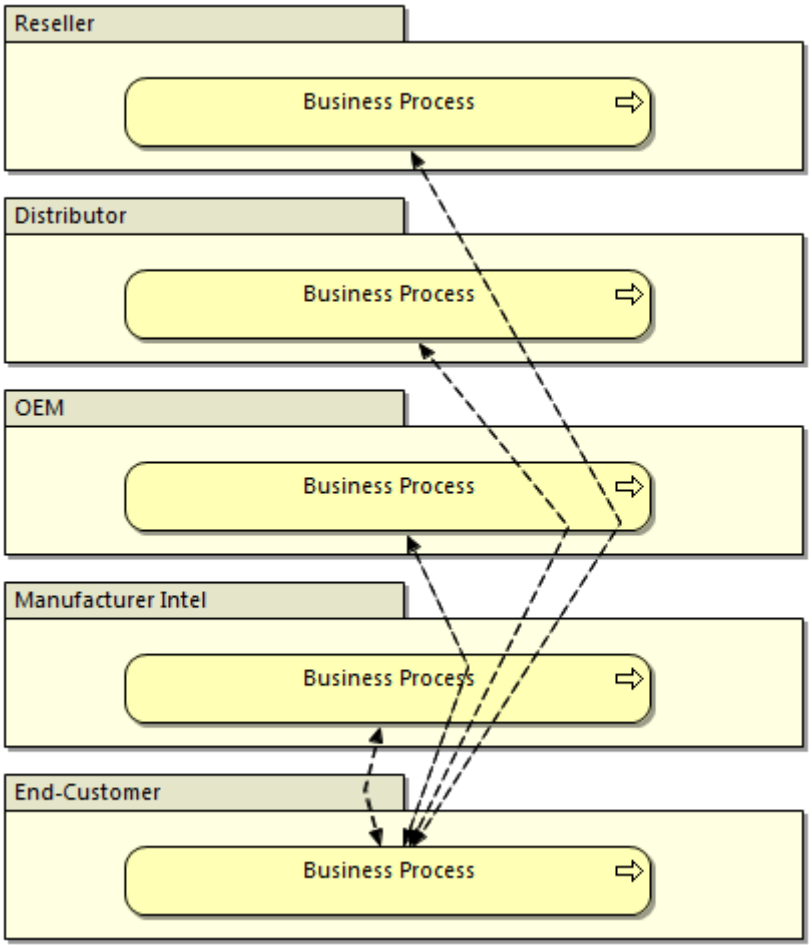

Figure 22 - End-customers perspective

The confidential version of this master thesis describes in the following sections which business processes exists in the Intel Benelux SMG ESS team and how these processes relate to Intel's ecosystem. These processes and relations with the ecosystem are visualized by ArchiMate models. This information is removed from this public version due to confidentiality.

5.3 Next chapter

This chapter provided more information about Intel's environment. The models used in the beginning of the chapter, can now be transformed to a model with a different viewpoint, the customer's perspective. The next chapter introduces the case study of the end-customer. First a short introduction of the customer is provided, then the problem is described and third different solutions are modeled.

6 Intel AMT and the Hanzehogeschool Groningen

6.1 Introduction Hanzehogeschool Groningen

The HG is a University of Applied Sciences in the Netherlands. The University of Applied Sciences originates from end of the eighteenth century. In 1797 the first section of the university was founded. It is the largest university of Northern Netherlands and oldest multi-sectorial University of Applied Sciences in the Netherlands. The HG is located at Groningen (headquarters), Assen, Leeuwarden and Amsterdam. The university has over 25.000 students and 2.700 staff. More information about the HG can be read in Appendix H.

6.1.1 Case study environment in ArchiMate

Figure 23 is the graphical representation of the HG and its environment, based on the ArchiMate language. Placing the HG at the lowest layer (domain) is a choice based on the perspective. Since this is based on the HG's view, this layer is the business layer, coming on top of the application layer and below the environment layer [Figure 1]. The top layer (OEM) is grey because it is not directly involved during this research, however awareness of it might make sense. Furthermore it is the reseller B&C which has the relation with the OEM. However, the OEM can play a role in this research therefore it is included in the environment as a grey component. This means it can be used in views where it is relevant. The distributor is excluded since there was no distributor involved in the project. B&C had direct contact with the OEM regarding the systems for HG, instead of their normal process via a distributor.

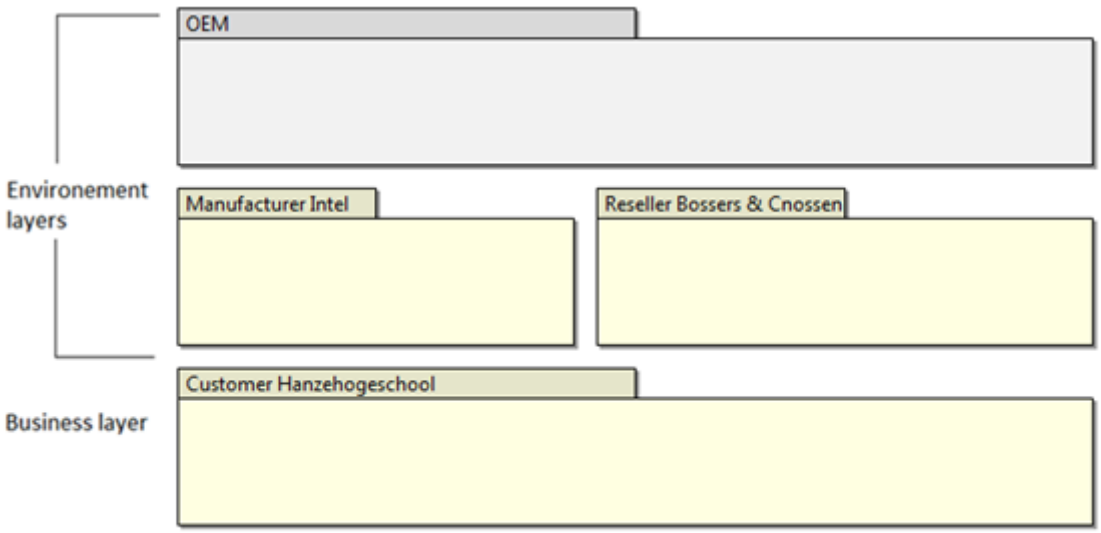

Figure 23 - Environment of the HG within this research

As the reader may have noticed, Figure 23 is almost the same as Figure 18. There are minor changes as Intel is now no longer a vertical domain, it is placed at the same level as the reseller and we did not include the distributor. Intel and B&C are placed on the same level because, in most cases, the customer has direct contact with both, and not so much with OEMs. Therefore the companies having a closer relationship during this project are being placed closer to the business layer of the customer. This also has to do with the more neutral position of Intel than an OEM.

6.1.1.1 Intel

Intel is the semiconductor manufacturer which visits customers regularly to share information and knowledge and visions. Furthermore Intel assists customers in integrating their technology in the customer's existing environment.

6.1.1.2 Bossers & Cnossen

B&C is a reseller, specialist in hardware, infrastructure and IT services for medium to LEs. The services they offer consist of five domains:

- Design: network scans, ICT planning, technical designs;
- Delivery: Hardware &Accessories, software, custom applications;
- Installation: pre-installation, placement, remove old systems;
- Configuration: operating systems, virtualization, management software;
- Maintenance: management (remote and on-site), Preventive, corrective and perfective maintenance, lifecycle management.

6.1.1.3 OEM

The OEM supplies the Intel vPro qualified systems.

6.2 PC-lifecycle challenge

After a conversation with the service planning manager, it seems that the HG has an inefficient pc-lifecycle. One area to explore is how Intel AMT can improve this pc-lifecycle. Gartner distinguishes four stages within the pc-lifecycle, as shown by Figure 24.

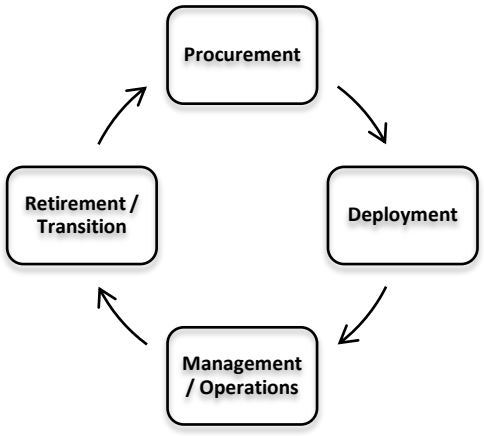

Figure 24 - PC-lifecycle by Gartner (Fiering, 2006)

According to Gartner each stage has its own activities:

- Procurement: requirements planning, vendor selection, Request For Information (RFI)/Request For Proposal (RFP) process, contract negotiations, finance options;
- Deployment: hardware configuration, system image deployment, migration, delivery to user desks;
- Management and operations: help-desk / end-user support, training, asset, configuration, vendor and patch management, security, back-up, break/fix;
- Retirement and transition: asset removal, hard drive sanitization, license reclamation, indemnification, replacement system evaluation.

However the pc-lifecycle by Gartner can be interpreted incorrectly. Considering the perspective of a single or group of desktop or notebook, the circle stops when a (group of) pc(s) is removed for retirement. Therefore the arrow from the retirement process towards the procurement process is not valid of the Gartner pc-lifecycle. Of course for another system or group of systems, it starts all over again. A better illustration of the pc-lifecycle is shown in Figure 25.

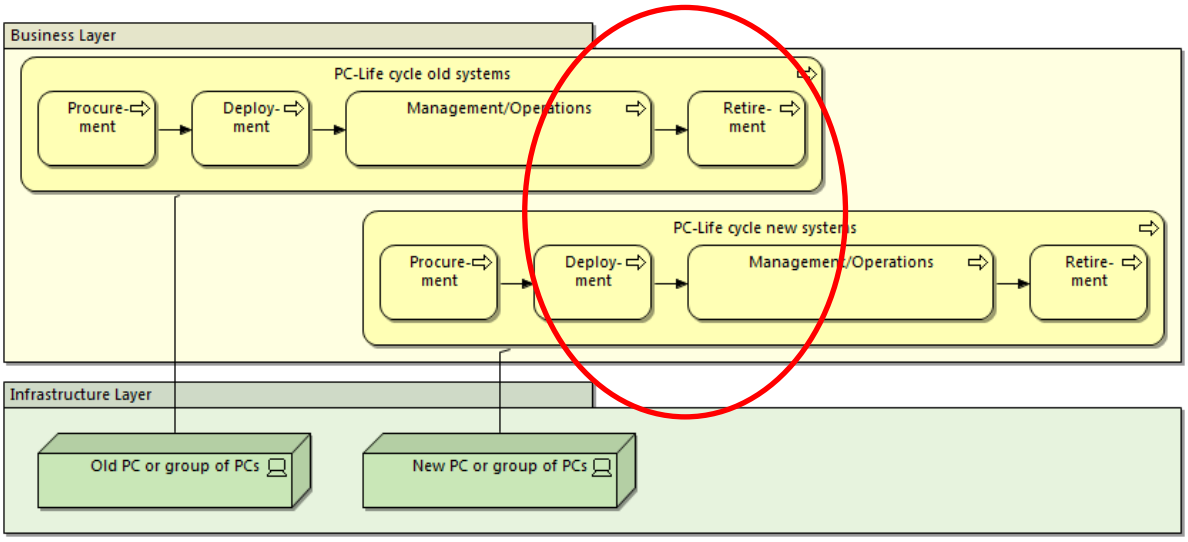

Figure 25 - PC-lifecycle view by ArchiMate

When an old system is being removed it is at the end of its life (i.e. after 4 years), the system is being replaced by a new system. For this particular system a new pc-lifecycle begins. To maintain user productivity, the new system will be placed at user's workplace at the same time the old one is removed. This means that the procurement process is already started before the replacement of the old system. Therefore the two pc-lifecycles, the old and the new are overlapping as shown in Figure 25 by the red circle.

6.2.1 As-is situation pc-lifecycle process of Hanzehogeschool Groningen

The procurement stage, the first process of the pc-lifecycle, is a follow-up processes after the RFP process. All processes before the RFP are focused to influence the procurement stage of the customer: "What systems to buy? Which requirements should it have?"

Figure 26 shows the graphical notation of the as-is situation of the pc-lifecycle process at the HG, and is explained below. Although the below processes can be very complex, we will try to describe it more globally, to provide the reader with an impression of the processes.

Procurement stage: The HG works with framework agreements (call-off agreements?) which are tendered European and have a maximum duration of 4 years. The services of B&C take place within this framework agreement. The framework agreement describes conditions and terms of price, and sometimes quantity. As of February 2013 the HG has to retender again.

The service planning manager refreshes every year 1000 systems in approximately 3 batches of around 400, 400 and 200 systems. There are two situations:

1. Ordering new models: if new models have to be ordered, first a test model is ordered by B&C. After delivery the test model is tested and verified by the Field Service (FS). After approval by FS, more systems can be ordered.

2. Ordering existing models, this means that the models are already approved by FS.

The ordering is done, after consultation with FS. The discussion is about the number of systems to order, regarding the time available for the FS personnel. Furthermore they decide what other accessories are needed like cables, monitors and others.

The HG places an order for 300 to 400 systems at B&C. B&C verifies the order and sends it to the manufacturer OEM as a build-to-order.

Deployment stage: Before the deployment from the HG perspective can be executed, the reseller has to prepare the systems. After the systems are received, B&C has to perform additional steps. One of these steps is to apply a mark on the outside of the system. This mark shows a unique number which are entered in a central database. By this step, systems can be identified by B&C and the HG because of the physical mark. If additional accessories are ordered, B&C adds these accessories to the desktops as well. After the preparation, the systems are packed and transported to FS at the HG. Once delivered at the college, the systems are unpacked and placed in the 'preparation street'.

System image deployment process: In a dedicated room the systems are connected to the power network, LAN network and KVM switch. Then an USB stick is plugged into the systems and the systems are turned on manually. From this moment on, the FS can control the systems remotely by KVM. The next step of imaging the systems is performed in a PXE-environment.

After this stage the systems are packed again and transported to the end user's workplace by FS and B&C. This location can differ. The HG has different locations within the city Groningen and locations in Leeuwarden and Assen. There, the systems are unpacked and installed at the workplace directly. The installed system is powered up in order to start a program called 'Target Wizard'. FS then uses this software to enter details (like the room number, number of pc, department, person etc.). After this configuration, the system is turned off and is ready for usage.

Management & Operations: This stage includes all common daily activities to manage the IT environment. The teams involved during this cycle are the Front Office, Operations 1, Operations 2 and the service and process managers.

Retirement: The old systems are removed and transported back by B&C.

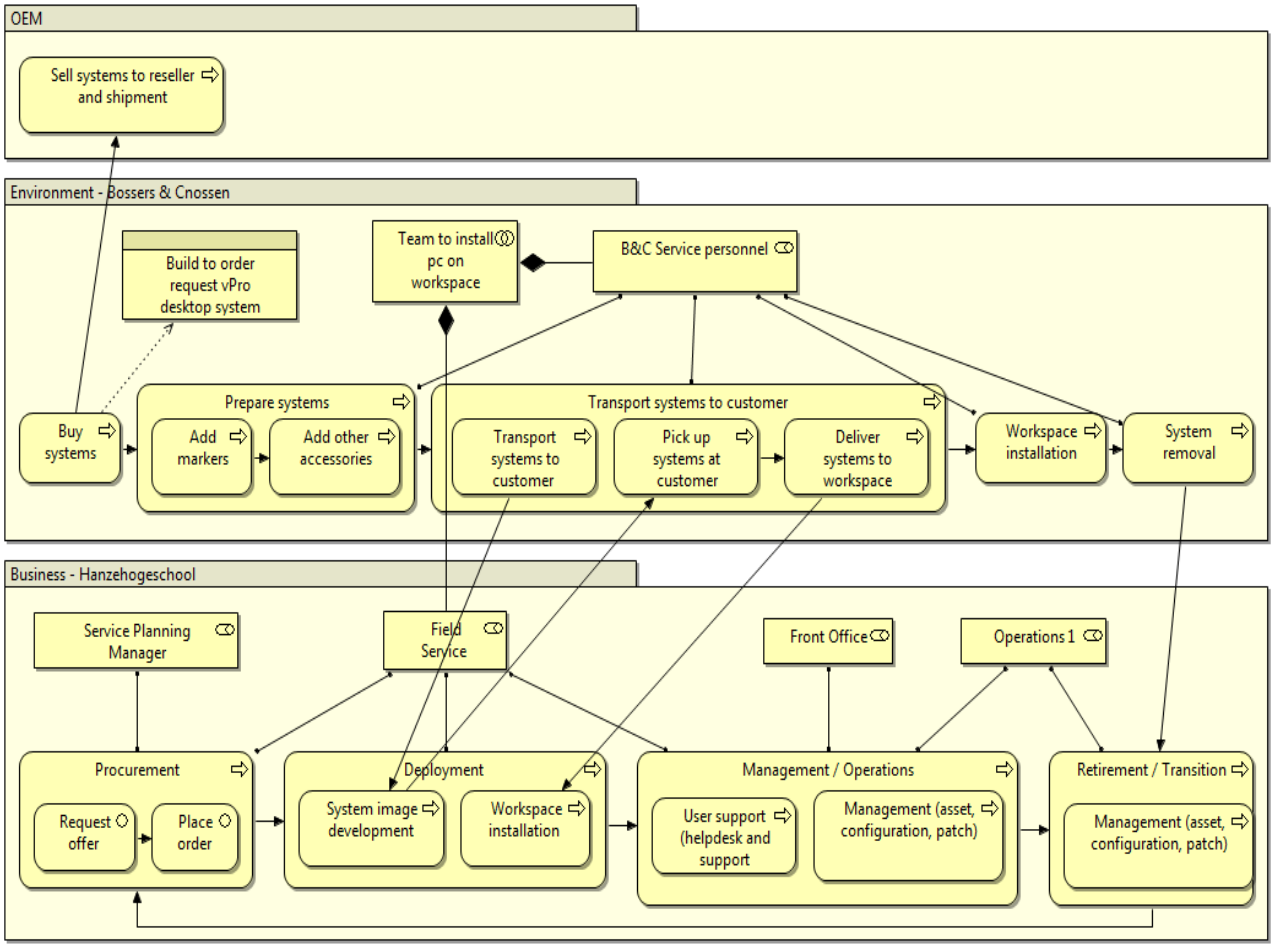

Figure 26 - PC-lifecycle environment of HG (as-is)

6.2.2 Identifying inefficiencies

Considering the pc-lifecycle of the HG shown in Figure 26, we have the impression that the transportation processes and workspace installation process (part of the deployment stage) could be improved. Let us first repeat the global observation we made. Considering the HG as-is situation, there seems to be some inefficiencies in the logistics process of the systems [Figure 27]. First the systems are packed and transported to the main location to IT for system imaging. There, IT has to unpack and image the systems. When finished, the systems are packed again and transported to the workspace location by both parties, Field Service and B&C. On the user's desk the system is unpacked again. The next subsections provide different solutions to solve the inefficiencies we just identified. Furthermore we try to set up a first attempt of comparing these solutions based on costs. The idea was to use the cost-benefit calculation, however to transform all benefits of Intel AMT to a certain amount of savings (in euros) it would require more research and time to be able to do this.

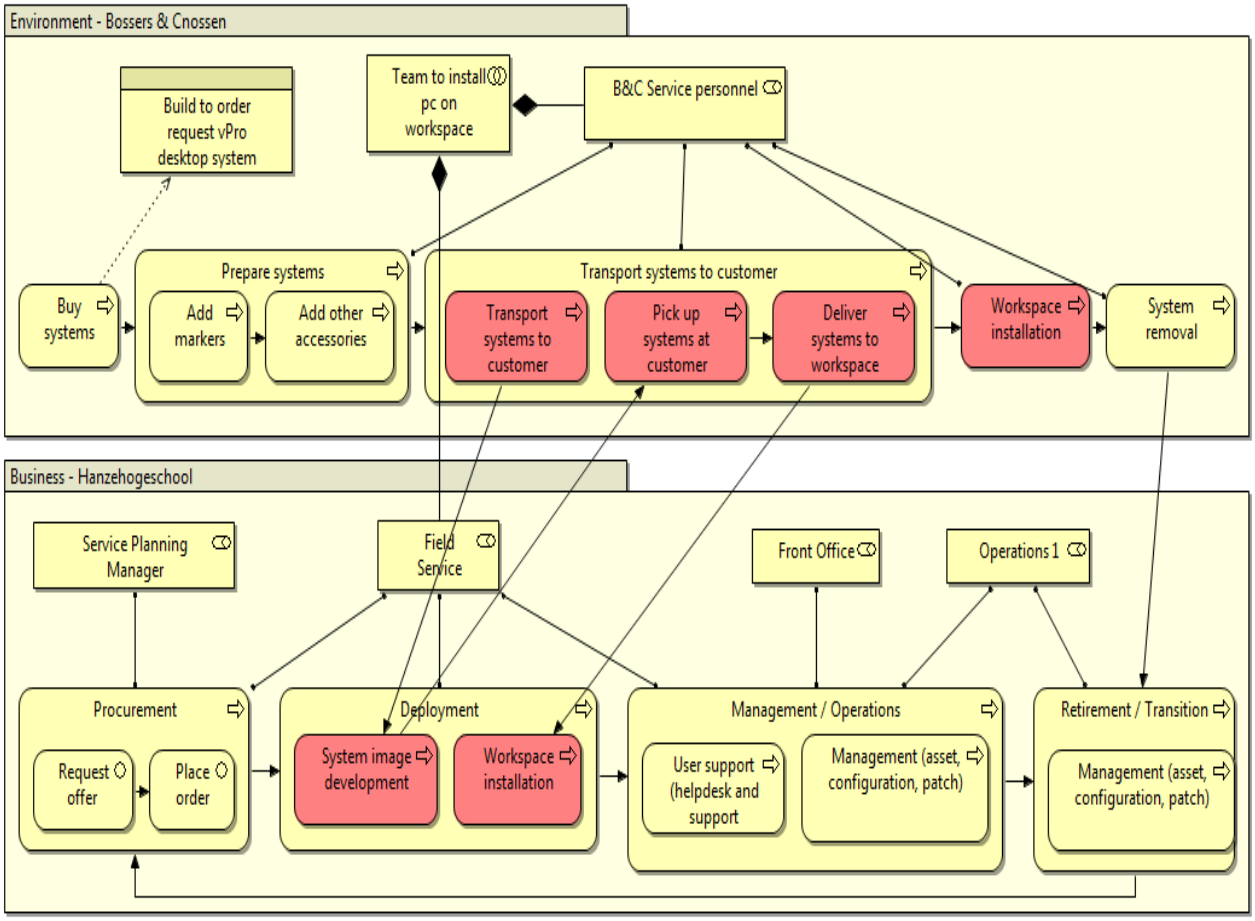

Figure 27 - Inefficiencies in the pc-lifecycle process of the HG as-is situation

6.2.2.1 Calculating costs as-is situation

The purpose is to calculate the delta of the possible to-be situations with the as-is situations. Since some processes do not change, these costs do also not change. Therefore only the processes and activities, that change or being added, are used to calculate costs (delta costs). We only consider changes for optimization of the deployment phase. The processes taken into account are:

- Preparation process;
- Transport systems to HG process;
- Workspace installation process;
- Deployment process.

To be able to estimate costs, several assumptions are made provided in Table 9.

Table 9 - General information costs

General information and assumptions for all calculations	
Scenario based on last offer B&C (Appendix I)	400 systems
The total number of systems are split in 8 batches (each batch is one day work)	50 system per batch
For transportation B&C uses a truck with one driver: *Due to confidentiality the prices are removed from this public version*	
Internal costs Field Service per hour (provided by HG)	€45,00
Field Service deployment hours needed for 400 systems (Source HG time management tool/documentation)	252 hours
Customer (HG) already buys Intel vPro systems no additional costs for a vPro systems	

The next table (Table 10) provides the calculation results for the as-is situation. The detailed break-down calculations are provided in Appendix J. The 400 system calculations are the base to address the costs for one year refresh of systems. The yearly refresh number is approximately 1000 systems.

Table 10 - Costs situation as-is

Activity	1 batch (400 systems)	Total a year (1000 systems)
Due to confidentiality the prices are removed from this public version		
Total costs	**€ 14.957,60**	**37.394,00**
Costs per system	**€ 37,40**	**€ 37,40**

6.2.3 Improved situation 1: Outsourcing without Intel AMT

Making use of the services provided by B&C: one of the services delivered by B&C is the 'installation of software'. The HG can choose to outsource their 'system imaging deployment' process to B&C. This would lead to the following model shown in Figure 29.

Comparing this model [Figure 29] with the as-is model [Figure 27], it is obvious that the 'system image deployment' process is moved from the HG FS, to the B&C environment. Doing this, eliminates transportation activities as well as eliminating unpacking and packing, making logistics simpler. The administration task, normally done by the FS team during the workplace installation, is now also transferred to B&C. This means that B&C has to process administrative information when installing the systems on the user's location: "Which pc is located in which room?"And "Which department uses this system?"[Figure 28]

J22 | 1

	A	B	C	D	E	F	G	H	I	J
1	HGWNUMMER	CODE	TYPE	LOKATIETYPE	LAATSTEUSERLOGIN	ADS	EXTRA	KOSTENPLAATS		
2	HGW001A4BB3F384	0A54h	M7	chpe.ond.a0.06	20110530	Alg,Pers		s.bfab		1
3	HGW001A4B44301E	0A54h	M7	chpe.ond.a0.06	20110530	Alg,Pers		s.bfab		1
4	HGW001A4BB38BDE	0A54h	M7	chpe.ond.a0.06	20110530	Alg,Pers		s.bfab		1
5	HGW001A4BB2D938	0A54h	M7	chpe.ond.stilte ruimte bk	20110527	Alg,Pers		s.sict		1
6	HGW001A4BB38E32	0A54h	M7	chpe.ond.stilte ruimte bk	20110530	Alg,Pers		s.sict		1
7	HGW001A4BB32282	0A54h	M7	chpe.ond.stilte ruimte bk	20110526	Alg,Pers		s.sict		1
8	HGW001A4B429B8E	0A54h	M7	chpe.ond.stilte ruimte bk	20110530	Alg,Pers		s.sict		1
9	HGW001A4B43E6B0	0A54h	M7	chpe.ond.stilte ruimte bk	20110530	Alg,Pers		s.sict		1
10	HGW001A4B442F24	0A54h	M7	chpe.ond.studielandschap	20110530	Alg,Pers		s.sict		1
11	HGW001A4B43E74E	0A54h	M7	chpe.ond.studielandschap	20110527	Alg,Pers		s.sict		1
12	HGW001A4B44301C	0A54h	M7	chpe.ond.studielandschap	20110530	Alg,Pers		s.sict		1

Figure 28 - Administration to keep track of the systems

Although all activities are outsourced, a new process exists for FS. They coordinate with the end-users about the replacement of their system, and communicate this to B&C. In addition FS can focus more on core-activities of the HG.

Since in this situation the Intel vPro systems are not provisioned, the customer cannot use the advantages which Intel vPro can offer. These advantages like reduced time of desk-visits, more efficient patch management, more efficient inventory management, power savings and more can

be calculated back to certain savings for the customer. This is not taken into account and therefore it is difficult to compare this situation with the next situations.

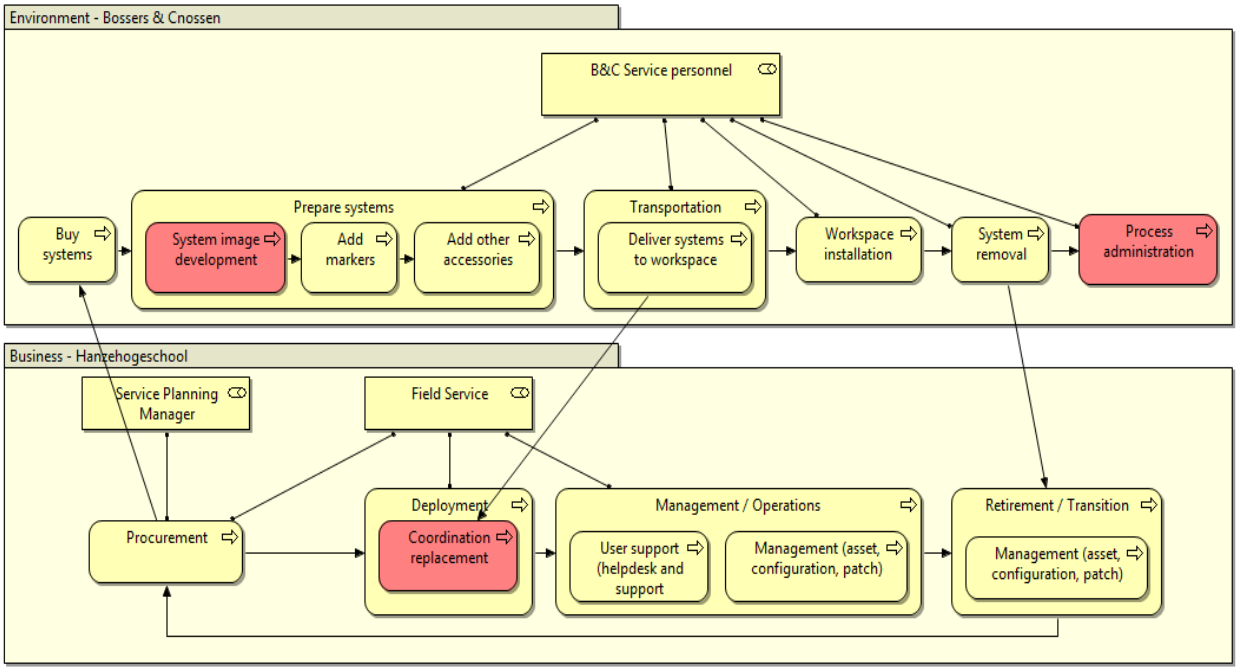

Figure 29 - HG and B&C in to-be situation using the installation service of B&C without Intel AMT.

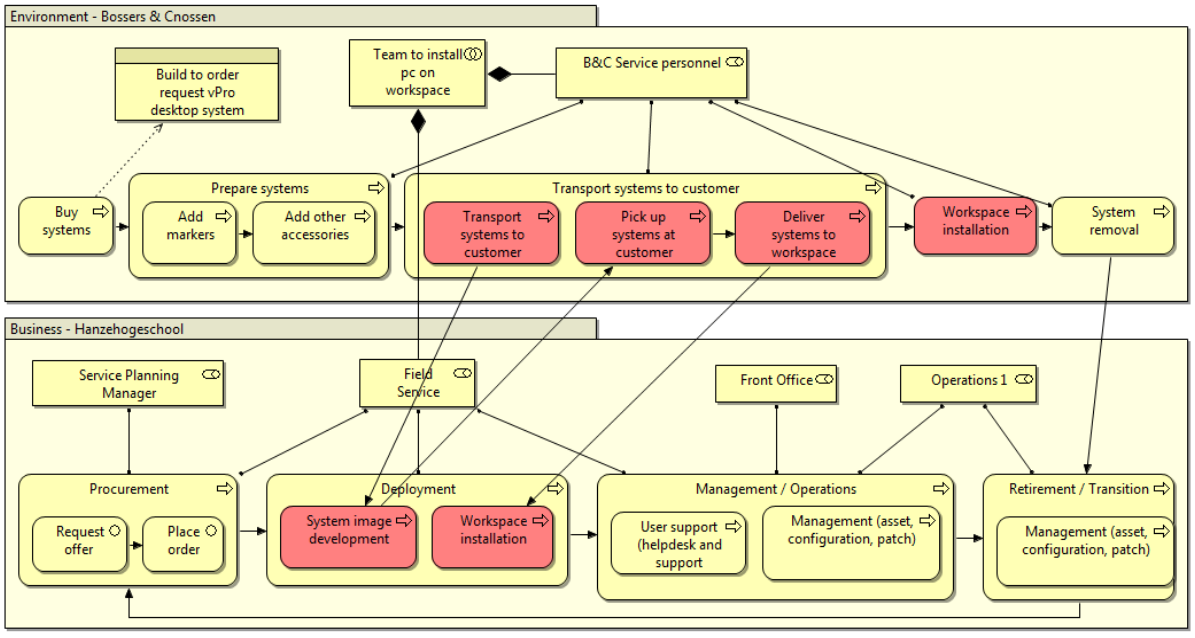

Figure 27 - Inefficiencies in the pc-lifecycle process of the HG as-is situation

However it seems that the error margin of the administrative process increased (research within the HG). As Field Service has the knowledge of which information to use, the service personnel

of B&C sometimes used the wrong names for the rooms. This increases the internal costs of the HG, since FS also has to check the administration.

6.2.3.1 Cost/savings indication to-be situation 1

Table 11 provides an overview of the costs involved for the to-be situation one. The detailed break-down of the costs are given in Appendix J.

Table 11 - Costs situation 1

Activity	**1 batch (400 systems)**	**Total a year (1000)**
Due to confidentiality the prices are removed from this public version		
Total costs	**€ 7.439,60**	**€ 18,599.00**
Costs per system	**€ 18,60**	**€ 18,60**

6.2.4 Improved situation 2: Outsourcing with Intel AMT

Another possibility is instead of outsourcing the 'system deployment image' process, is to outsource the 'provisioning of Intel AMT' process. Although the customer must still execute a provisioning update when using Active Directory (AD) integration or TLS encryption; this possibility combines remote imaging (which can also be performed without Intel AMT) with the advantage of being in control while performing the remote imaging. Considering a normal remote system imaging, it means errors occur during this process, FS has to physically go to the local system (a desk-visit), or the remote imaging process has to start over again. With Intel AMT systems already provisioned, IT is in control and can access the system via the OOB connection. Figure 30 shows the new model applying this solution. Comparing this Figure with Figure 27, it resolves the logistics inefficiencies. However as Figure 30 shows, it means a new administrative process and a change in the work process of the deployment stage.

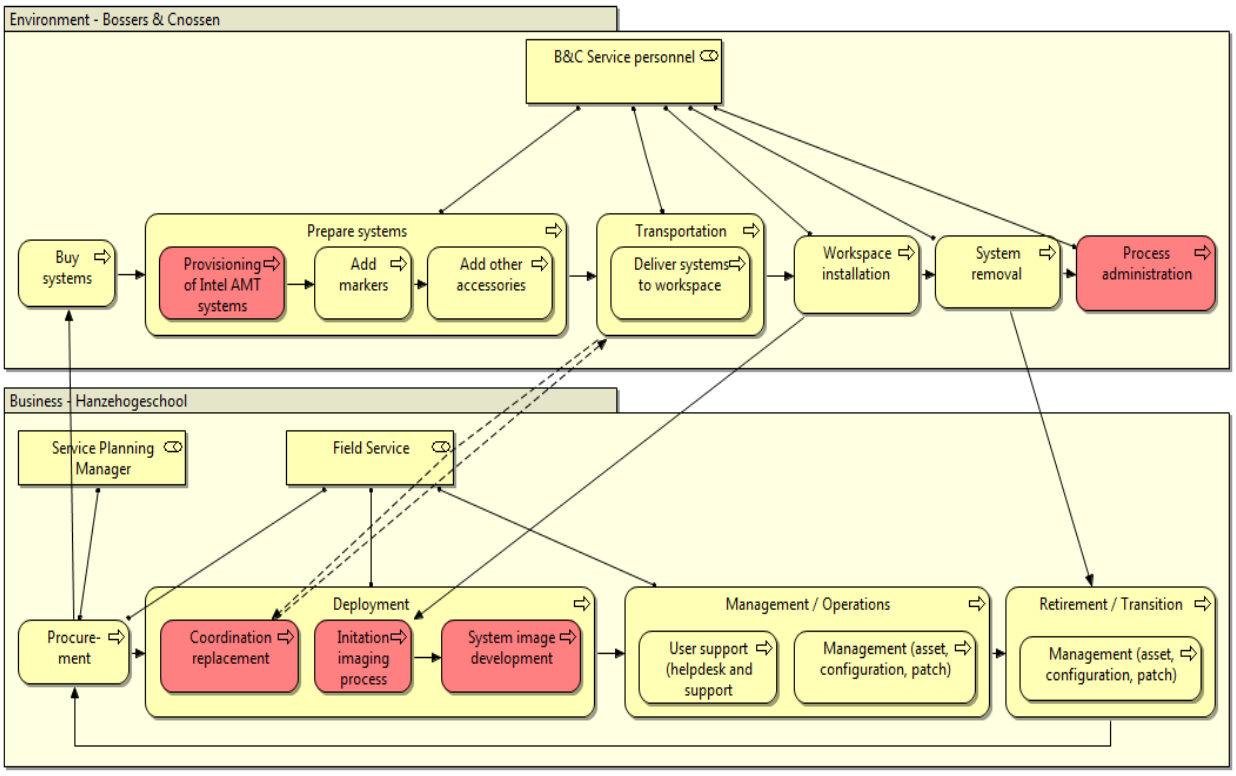

Figure 30 - HG and B&C in to-be situation using a new service of B&C and Intel® AMT

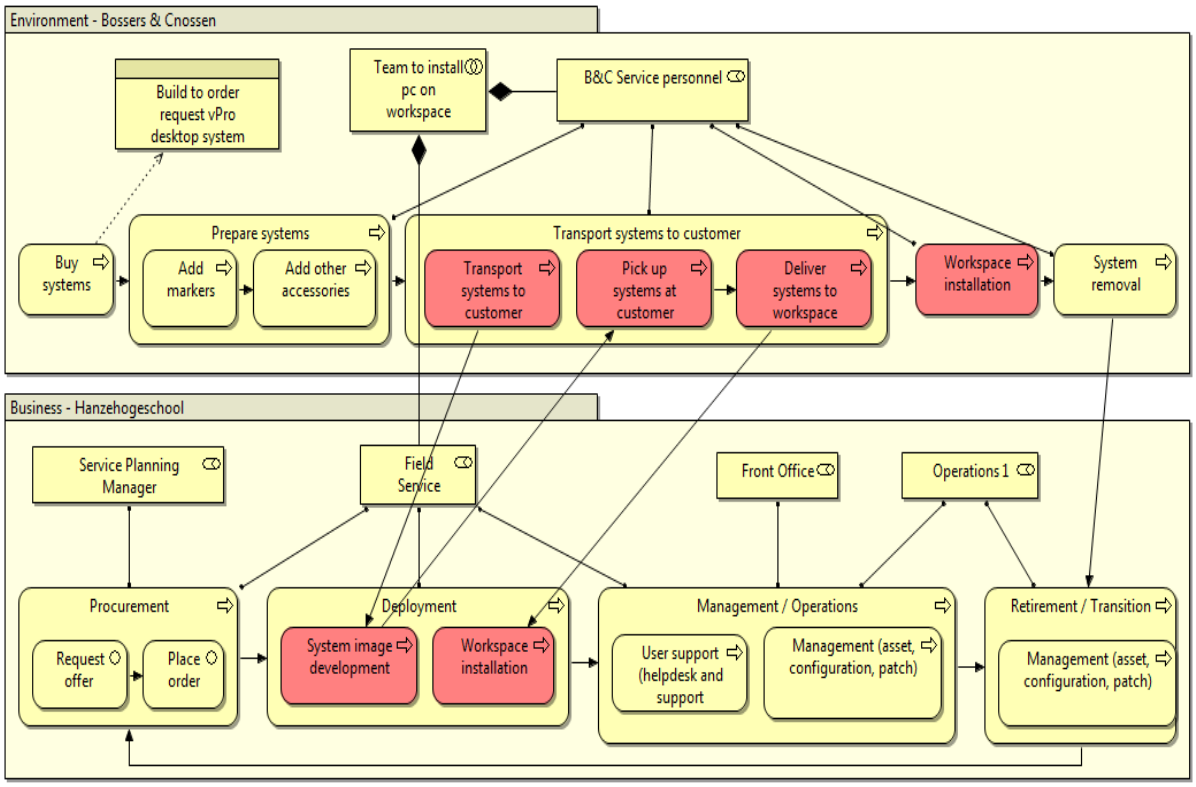

Figure 27 - Inefficiencies in the pc-lifecycle process of the HG as-is situation

The administrative process presented in this situation is a slightly different process than the administrative process in the first scenario. Where B&C in the first situation has to use the software of the HG, this situation does not require this software since there is no OS installed on the client system yet. However the information needed [Figure 28] must still be gathered and presented to the HG.

6.2.4.1 Cost/savings indication to-be situation 2

Table 12 provides an overview of the costs involved for the to-be situation one. The detailed break-down of the costs are given in Appendix J.

Table 12 - Costs situation 2

Activity	1 batch (400 systems)	Total a year (1000)
Due to confidentiality the prices are removed from this public version		
Total costs	**€ 21.184,25**	**€ 30,399.65**
Y1: Costs per system	**€ 53,00**	**€ 39.40**
Y2, Y3, Y4: Costs per systems	**€ 30,45**	**€ 30.40**

6.2.5 Improved situation 3: Insourcing

This situation outlines the scenario of insourcing. The reseller B&C only delivers the systems to the workplace and processes the administrative information towards the HG. After this, Field Service can immediately or on a specific time choose to provision the systems. However this means that FS have to physically be present at the workplace to initiate the 'provisioning of Intel AMT' process by i.e. booting from USB or by entering the MEBX. After this is done, the system is provisioned and the next process can start. This can be initiated physically, but now Intel AMT is working, the process can also be started by remotely taken over the system and initiate the 'system imaging deployment' process. Figure 31 shows the model based on this scenario. In comparison with Figure 27 it solves the logistic inefficiency. However other processes are introduced to let this model work.

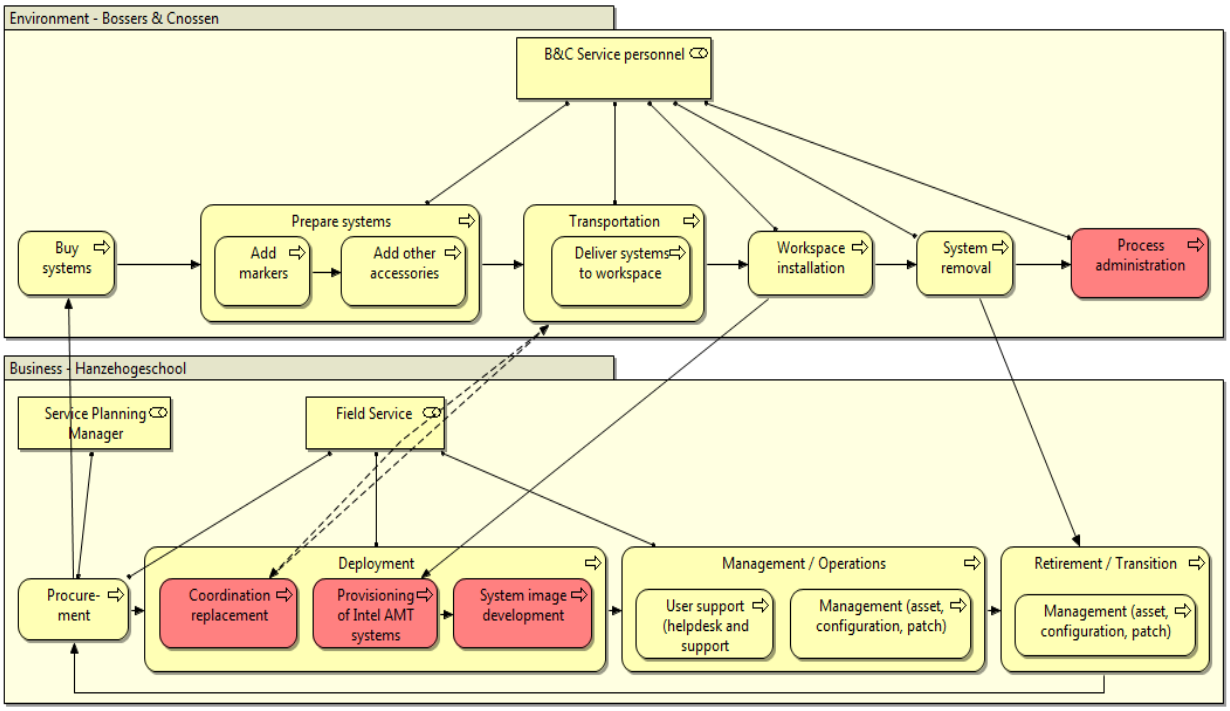

Figure 31 - HG and B&C in to-be situation provisioning of Intel AMT done by Field Service

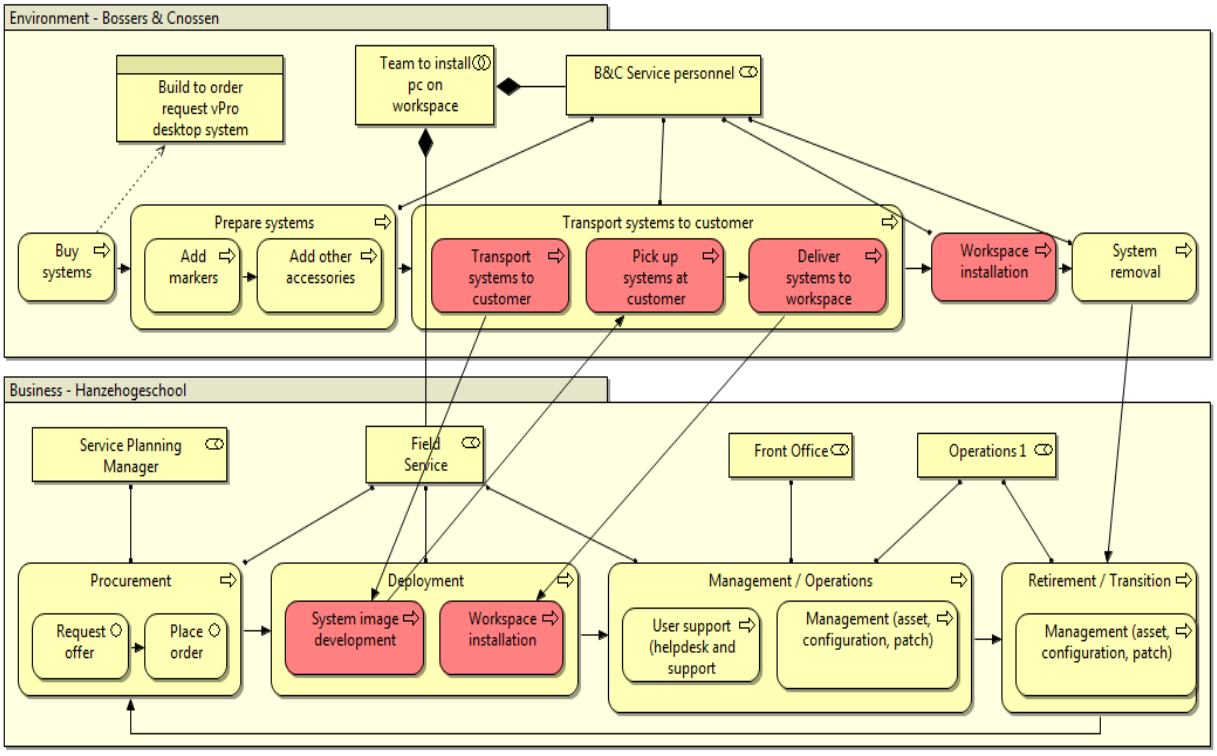

Figure 27 - Inefficiencies in the pc-lifecycle process of the HG as-is situation

6.2.5.1 Cost/savings indication to-be situation 3

Table 13 provides an overview of the costs involved for the to-be situation one. The detailed break-down of the costs are given in Appendix J.

Table 13 - Costs situation 3

Activity	**1 batch (400 systems)**	**Total a year (1000)**
Due to confidentiality the prices are removed from this public version		
Total costs	€ 21.703,25	€ 30,399.65
Y1: Costs per system	€ 54,25	€ 40.70
Y2, Y3, Y4: Costs per systems	€ 31,75	€ 31.70

6.2.6 Transforming AMT benefits to a measurable value

In sections 6.2.3, 6.2.4 and 6.2.5 costs are estimated for the different situations. However these calculations are not used to present to IT management. To justify projects with business cases, management often uses the Return On Investment (ROI) in combination with other calculations such as the Pay Back Period (PBP).

The Intel AMT benefits are not transformed and calculated to savings in the previous calculations. Therefore one Intel AMT use-case is included in the calculations to be able to provide management with a ROI. To provide a complete ROI calculation, all Intel AMT benefits should be expressed in a quantitative value. Since this is complex and time consuming, only the most used feature of Intel AMT: the KVM remote management is included.

6.2.6.1 HG help desk incidents study

The helpdesk of the HG is called Front Office as shown in the composition of the HG organization in Appendix H. The HG has established its IT processes according to the Information Technology Infrastructure Library (ITIL). Therefore the HG has two levels of support, the first-line and second-line help desk. Table 14 provides general information about the number of incidents registered by the HG.

Table 14 - Overview of number of tickets generated in 2011

	number	Percentage
# Total registered incidents in 2011	16905	100%
# Tickets first-line	9142	54%
# Tickets second-line	7763	46%

(Source Rapportage incidenten week 5 OPO - Appendix K)

Not all incidents are part of the study, resulting in studying a sample group. This sample group only exists of 'second-line incidents' as most of these incidents included desk-visits (whereas 'first level incidents' are remotely solved). The sample group resulted in 2424 incidents in 5 relevant categories:

- basic list software (basislijst software);
- other hardware (overige hardware);
- special software (speciale software),
- standard software (standaard software);
- workstation (werkplek).

A total of 61 incidents are marked as incidents in which Intel AMT could have helped to reduce time, for example eliminating the need for a desk visit.

Table 15 shows the results of the incidents study.

Table 15 - Results of 'second level incidents' analyses

	Number	
Total incidents analyzed	2424	100%
Total incidents marked as possible incidents to solve with Intel AMT	61	2.5 % (0.36% van 17.000)
Total time savings (estimation)	1050 minutes	17.5 hours
Average time saving per incident	17.2 minutes	

Transforming time to savings, it results in a total saving of approximately 800 euros (€ 45 multiplied with 17.5 hours) a year. At the time of this incidents study, the HG approximately has 4000 systems to manage.

Table 16 - Savings using Intel AMT for incident solving

	Year 1	Year 2	Year 3	Year 4
Savings by using Intel AMT for incidents	€ 800	€ 800	€ 800	€ 800

6.2.6.2 Process of sample study

The results are analyzed manually, by reading the description of the problem, the communication, and the solution provided in the HG tool. For each situation is indicated:

- If the situation could be resolved more easily by using Intel AMT features.
- A time estimated of saved time by using Intel AMT.

The incidents were divided in three AMT-categories: 'yes', 'no' and 'maybe'. An incident with the AMT-category 'yes' is an incident of which the research thought Intel AMT could help to save time for an incident. An incident marked 'no' means the situation could not have been solved with Intel AMT at all or the technology would not have saved time. An incident marked with 'maybe' indicates that the situation was not clear and that more information was needed to decide if Intel AMT could make a difference.

The incidents marked with 'maybe' where then shared with the HG, with the question how they would interpret these incidents. The IT workstation manager, also working on the Intel vPro Proof of Concept (POC), and has therefore already a good understanding of Intel AMT, agreed to look into these incidents. He studied these particular incidents and replaced some marks with 'yes' or 'no', resulting in a list of incidents with the AMT-category only having two options: 'yes' and 'no'. Furthermore time estimations are provided as a delta: difference between total time of an incident solved without Intel AMT and the incident solved with use of Intel AMT.

Remarkable during this study was that there were quite some incidents in which a desk visit was performed which were not necessary. Intel AMT can be used to reduce these desk visits. However most of these desk visits also could have been solved by the in-house software. Therefore these incidents where not taken into account.

Also not all incidents were categorized properly. Since a number of categories were excluded, it is possible that also incidents were excluded which could have been solved with Intel AMT.

6.3 Next chapter

This chapter described the information collected from the case study, what is used to model the as-is situation and to provide several solutions. Furthermore an incidents analysis is performed to calculate a possible ROI for IT management of the HG. The next chapter transforms the information provided in this chapter into a concrete result, answering the question "What does the information of Chapter 6 mean for Intel, the reseller and the end-customer?

7 Case study results

This chapter describes several results of the case study performed at the HG in cooperation with B&C. The main results are a possible service model for B&C to gain additional revenue streams, an Intel written case study document and money savings from the costs-benefit calculation.

7.1 A B&C service model

B&C can use the gained information to provide training or advice to other customers when implementing Intel AMT. More important, B&C can build a business case to study the additional value of offering new AMT (or vPro) Provisioning services to customers. Figure 32 and Figure 33 offer a complete architectural view of processes performed by the reseller and by the HG. It combines all previous information into two figures separated by location.

Figure 32 provides an architectural overview of the services provided by B&C, how these are connected with the HG and how these are connected with the Intel AMT technology. In this the reseller has installed the required software and service for a provisioning infrastructure. This provides the reseller the opportunity to offer a new service of 'provisioning of Intel AMT'. Implementing the infrastructure only has to be performed once. The IT department at the HG has to know the system names (hostnames or more specific the FQDNs). Therefore the HG and B&C have to exchange information which names to use for the different systems. Furthermore profile settings have to be exchanged by the HG to B&C. the exchange of system names and profile settings are visualized by the flow relation between 'Administration process' and 'Provisioning Intel AMT' process. The preparation process is already been described in the previous section; this process and the 'transportation process' do not change.

Figure 33 visualizes the processes performed at the customer's location. The transportation process does change compared with the as-is situation since the systems are placed directly on the work desk or classroom by B&C. The 'System image deployment' process initiates a network boot. The network boot contacts the imaging server to install an OS and including software on the vPro system. The network boot can be initiated by FS or by the B&C. After the systems are imaged, the systems are ready to be used and enter the 'management and operations' process. IT can use the Intel AMT features when necessary.

7.1.1 Intel's Case Study

Intel used the information gained by this case study and vPro implementation (from B&C and the HG) to write a solution brief. A solution brief is a case study in which a reseller is involved. The solution brief can be found in Appendix L. A solution brief describes the challenges of the

business, the solutions used and the impact on the customer. Intel uses solution briefs to inform customers what is possible with technology.

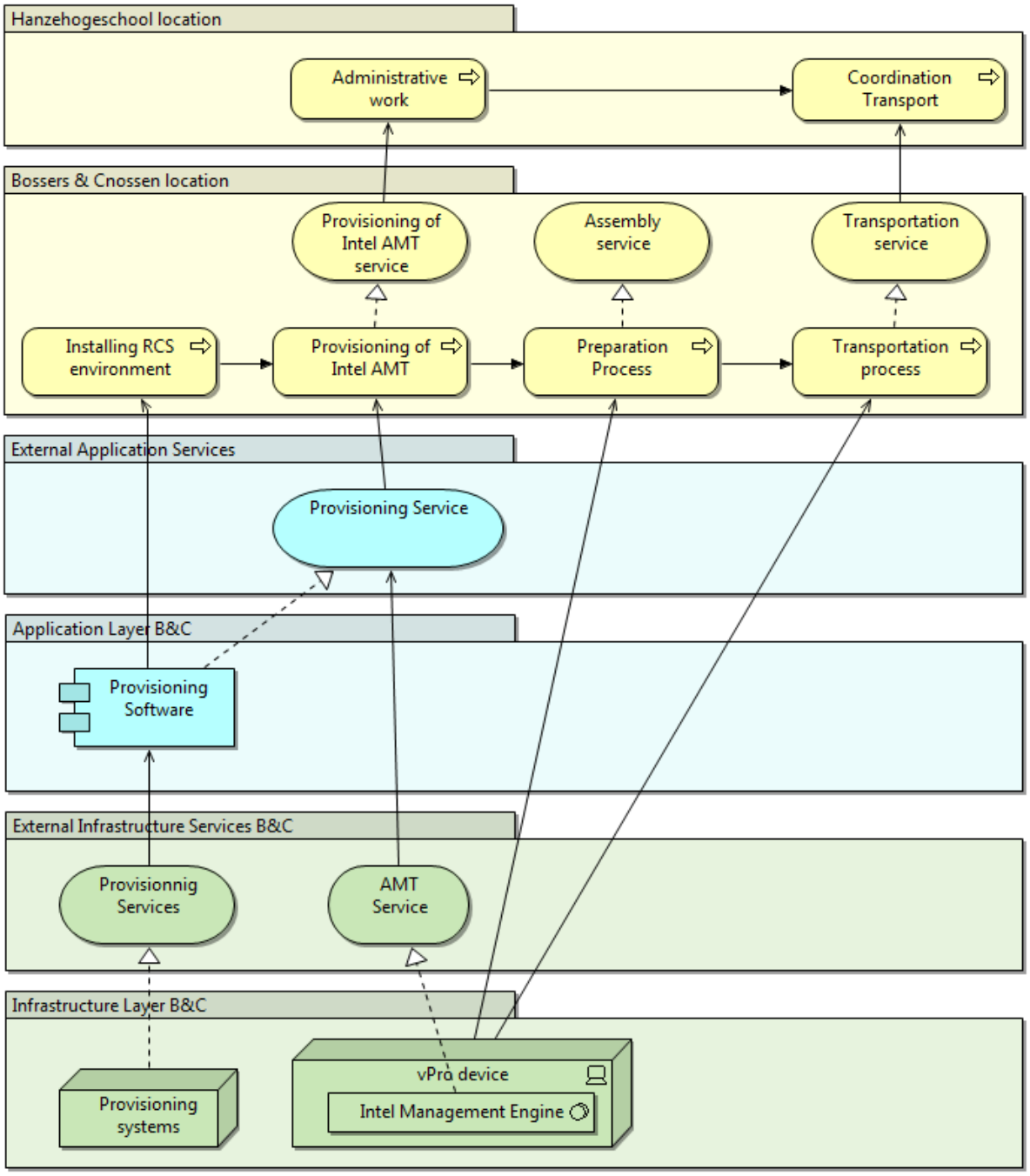

Figure 32 - Total solution of Intel AMT, processes performed at B&C (part 1)

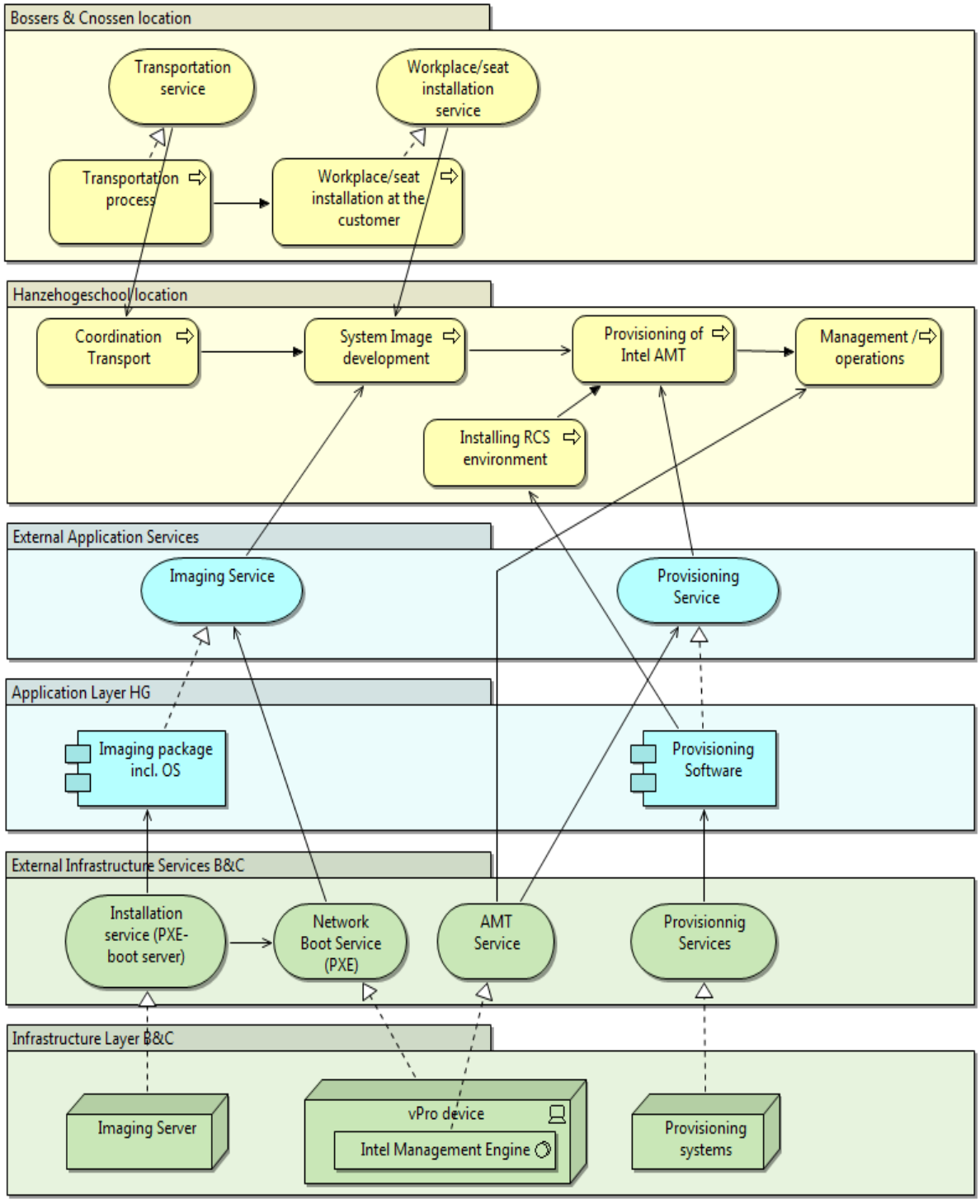

Figure 33 - Total solution of Intel AMT, processes performed at HG (part 2)

7.2 Costs/benefits results

The case study describes three to-be situations for the HG as shown in Table 17. In the as-is situation FS is responsible for the current system image deployment and no Intel AMT capabilities are used.

Table 17 - Overview of options to change the pc-lifecycle

Option	Intel AMT	Using service B&C	Involving FS	Type first provisioning
0 (as-is)	-	-	V	none
Situation 1	-	V	-	none
Situation 2	V	V	-	Bare-metal
Situation 3	V	-	V	Bare-metal

The first situation is provided as an alternative for the customer if decided not to use Intel AMT. According to Table 18 is it also the best (cheapest) solution regarding costs-benefits. However since this study focuses on Intel AMT, situations two and three are more important. These situations describe to-be situations where Intel AMT is used. Both situations address a different implementation of Intel AMT, using a reseller service and using internal resources. Research of the different to-be situations results in different costs and savings compared with the as-is situation. An overview is provided in Table 18.

Table 18 - Overview of cost calculation based on 1000 systems

Option	As-is situation	Situation 1	Situation 2	Situation 3
Costs	€ 37,394.00	€ 18,599.00	€ 30,399.65	€ 31,697.15
Investments			€ 9.000,00	€ 9.000,00
Total costs	€ 37,394.00	€ 18,599.00	€ 39,399.65	€ 40,697.15
Total costs per system (year 1)	€ 37,40	€ 18,60	€ 39,40	€ 40,70
Total costs per systems (year 2,3,4 a year)	€ 37,50	€ 18,65	€ 30,40	€ 31,70
Savings (year 1)	-	€ 18,795.00	-€ 2,005.65	-€ 3,303.15
Savings (year 2,3,4 a year)	-	€ 18,795.00	€ 6,994.35	€ 5,696.85
Comments	No AMT advantages	No AMT advantages	AMT advantages	AMT advantages

The above table shows that situations two and three, where using Intel AMT, have no savings after the first year. This is due to the investment costs estimated on € 9.000. However after the first year the costs are lower for both situations compared to the as-is situation. This results in two break-even points, shown in Figure 34. The estimated costs result in a break-even point of 1.29 and 1.58 for situation two and three respectively. This results in time period of 1 year and 4 months for situation 1 your and seven months for situation three. However notice that this is not the payback time, since the payback time is the time period to cover the investment by incoming returns/benefits. The graph only shows that the costs of situations two and three are lower than the current costs in year after the break-even points.

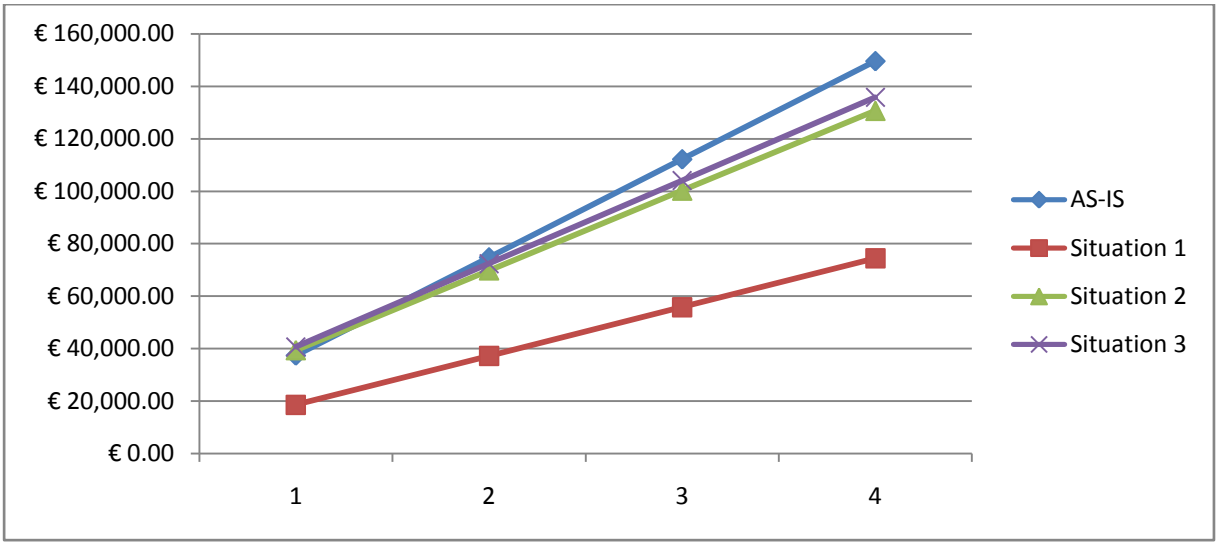

Figure 34 - Graph of cumulative costs

To provide management with a ROI-calculation, the remote control use-case was studied. This study resulted in 2424 number of incidents analyzed of which 61 incidents were identified as, can be solved by Intel AMT quicker. Estimated time of these 61 incidents resulted in a total time saving of 1050 minutes. This time saving is the delta time of total time needed to solve the incident without Intel AMT and total time needed to solve the incident with Intel AMT. More specifically, it saves the traveling time of a help desk employee. The actions (remote or on-site) stay in most cases the same. Transforming time to savings, it results in a total saving of approximately € 800 (€ 45 multiplied with 17.5 hours) a year. Comparing this with the € 9.000 investment costs, € 800 euro is 9% of the total investment. Appendix M provides more information about the calculations used. When including savings of € 800 a year in the costs graph, moves the break-even point down by 2 months (1.15 and 1.39, which is 1 year and 2 months, and 1 year and 5 months respectively).

These results correspond with the calculations of a finance expert presented in Appendix N. Also these calculations show that the situation without AMT is the cheapest solution. However the Intel AMT solution is the interesting solution with qualitative advantages. These calculations include the time value of money (important for finance).

Furthermore if more systems are being refreshed, the cheaper the costs per systems. This is because the investment costs are spread over a larger number of systems. In the as-is situation the costs of adding additional systems are € 37.50 per system, compared to € 30.40 in situation two. The latter is much cheaper.

7.2.1 Limitations

There are limitations on the above calculations:

- Estimations are rough estimations, not based on historical or similar situations.
- The calculations are only focusing on the costs of implementation, investments and savings in the logistical process because of restructuring.
- Costs of redesigning the processes itself are not included.
- Previous calculations do not include time value of money for finance.
- The study is performed in a non-profit organization.
- The € 800 savings are based on time estimations of an average of 17.2 minutes. However having several locations in different cities, would suggest a higher average time.
- Furthermore the HG does not register the time spend on incidents. In previous research of Intel it seems that the small about of incidents (like 61 in this case) would represent 80% of the total time spend on all incidents. However this time is not recorded by the HG.
- The savings calculated in this research are a bit fictitious as it also depend on what other tasks the employees do instead. These savings mean that employees can work more efficient, rearranging the allocation of work and tasks.
- Most important, the benefits of Intel AMT (like energy savings, time reduced by more efficient patch distribution and asset tracking) are not included in these calculations. This means that transforming all advantages of Intel AMT at the customer to a quantitative number (in money) increases the savings and benefits for the customer, resulting in a more realistic ROI.

8 Discussion

The characteristics provided in Section 3.1 are not based on literature or a certain framework. The characteristics were prepared to make a decision which modeling language to use. The characteristics are an inventory of expected aspects based on the problem situation which could and have been encountered during the research. Furthermore the signs provided in Section 3.4 can be discussed since there are no real strict rules.

Reflecting the use of the modeling language, most of the models used in this document could probably also have been made by the modeling language BPMN, for example the models in Chapter 5 and Chapter 6. However some attachments provide organizational structures ArchiMate models, which would not be directly possible with BPMN due to the lack of modeling organizational resources. Furthermore Chapter 4 introduces the Intel AMT technology with ArchiMate models. Since BPMN does not focus on technology and hardware, it is not possible at this moment to model these aspects with BPMN. However in Chapter 4 and Chapter 7 models are provided which exists of business, software and technology aspects. These models could not have been realized with BPMN. A point for discussion is also the construction of the ArchiMate models, since the researcher is not well experienced in using the ArchiMate language. It could well be that experienced ArchiMate modelers (or architects) would create different models.

Making models is time consuming especially when the modeling language is still unknown in the company. However the case study shows that modeling technology and (business) processes in one modeling language can be beneficial for the organization, for Intel and for other stakeholders in the ecosystem. However not in every case or situation is it necessary to start modeling. Furthermore when modeling how to decide what to model and where do you stop? And who should be doing the modeling? Within Intel there are already departments and teams working with modeling languages and modeling software for example logistics, product deployment teams, supply chain management etc. Sharing modeling knowledge between Intel sales teams and teams using modeling languages can be a first step to address these questions.

The case study presented in this document did not address all problems identified of the end-customer. One other problem discussed was how to track systems, when being moved from one room to another. At first sight, Intel AMT technology does not help solving this issue. However since Intel AMT is not the only available technology of Intel vPro systems, it would be interesting to discuss if other Intel technologies could help.

As a result of the cost-benefit calculations, the savings are small but as mentioned before only one use-case is described and expressed into money value. Additional Intel AMT features and applications can increase savings of the customer.

The case study results of 400 systems (Appendix M) implicate that it is not that obvious for customers to implement Intel AMT. The results of 1000 systems show that costs drop between the first and second year. This type of investment is more attractive and more realistic to return your investment before the next refresh cycle of the pc systems. However it is important that the right use-case is selected and that results show that implementing Intel AMT is valuable for the customer. Intel can support the customer in this process in a better way by using the information provided in this document. Furthermore it would be interesting to know if there is a minimum number of systems needed for Intel AMT to make it valuable and a realistic investment. For example the scaling factor can be an important variable, making it much more interesting to implement Intel AMT in organizations with more than 10.000 systems, than an organization with 4000 systems. This is also because LE are more internationally orientated meaning having multiple locations in different countries but with one central IT and helpdesk location. Therefore LEs are more dependent on remote actions than companies only having one location.

9 Conclusion

This master thesis document provides Intel Benelux with relevant information regarding Intel AMT, case study results and how a modeling language can be used to identify technology impact on business processes. It is the first time during an Intel AMT implementation that the business case is graphically modeled.

Introducing a modeling language to document internal processes of Intel and how these processes are linked with Intel's ecosystem, is a source of information for Intel (Benelux) managers to understand the ecosystem and to develop aligned strategy. Furthermore it provides new employees with an overview of Intel's ecosystem and how the Intel SMG ESS team of Intel Benelux is operating. This helps to train new employees.

The modeling language is also used to introduce and describe the Intel AMT technology. This information, all ArchiMate Intel AMT models, can be used in Intel vPro training material for non-technical and technical employees, Intel employees and/or customers.

Furthermore the modeling language also helps to understand the customer's environment, complexity and relations with other organizations. Especially in LE, an architectural overview can help all stakeholders to better understand the situation(s) and to identify inefficient areas more easily. Concluding, graphical models make it simpler to discuss situations with all kind of stakeholders, non-technical or technical and can be used for different purposes.

9.1 Answer to research questions

9.1.1 Answering the research subquestions

1. What is Intel Active Management Technology?

Intel vPro and Intel AMT are complex technologies to discuss with OEMs, distributors, resellers, ISVs, SI and end-customers. Most customers are not fully aware of the possibilities of Intel vPro. However the IT environment is becoming more complex. Intel vPro systems support the IT department with manageability features provided by Intel AMT technology, making it easier to manage systems in a more complex environment.

2. What can be the unknown applications?

Besides existing features of Intel AMT, the case study showed two to-be situations with Intel AMT which made the logistical processes more efficient. This creates new opportunities to apply Intel AMT technology solving process inefficiencies in a manageable way. In both situations the bare-metal configuration method is used to provisioning the Intel vPro systems, and showed its

added value in this particular as-is situation of the end-customer. Moreover by using the bare-metal configuration method the reseller has an opportunity to offer a new service to end-customers. Currently the bare-metal method is not used because little is known about the advantages and disadvantages. This research provides more insight in how bare-metal configuration can still be beneficial for end-customers and their environment such as resellers. In this case the reseller can generate an additional revenue stream by providing the service to provision Intel AMT for customer. Even more, bare-metal in combination with the host-based configuration method would be an interesting opportunity for further research.

3. How can we model impact on business processes?

By using a modeling language which does not restrict us to model only one domain insights are gained in how technology affects supporting processes at the customer and core (business) processes at the reseller during the case study. This is possible because not only the customer's processes can be modeled via the ArchiMate notation but also environmental organizations and therefore reseller's processes. It also provides Intel the opportunity to not only focus on Intel AMT deployments of end-customers but also involve their environment into this implementation process, to provide even more efficient solutions. This results in additional value for the customer, but also for other organizations, making Intel a more valuable business partner.

9.1.2 Answering the main research question

To summarize using a graphical architectural modeling language to model case studies exposes the relations of an organization with its environment, internally and externally. Furthermore ArchiMate allows to model business processes and technology, graphically showing relations between these two domains. When changes occur, the relations show which other processes, software or technology can be impacted directly or indirectly by this change. This helps organizations to understand which technologies are connected to which processes. If technologies are changing, it might be necessary to change business processes, or the other way around. Organizations can prepare changes in a better way knowing where they have to pay attention to, which processes have to be secured or which technology should be improved. Not using ArchiMate could well lead to a loss of overview of how technology and business processes are connected or related, unless the ArchiMate model is literally translated into a less structured but similarly rich and general modeling language like UML; see e.g. Lankhorst et al. 2005.

Furthermore for complex LE ArchiMate provides a high level overview, which Intel can use to better understand the customer's situation. This can result in offering the right solution.

10 Further research

There are plenty of researches possible in this area. This chapter offers different suggestions to conduct further research on this topic.

This research is not suitable for generalization. Therefore applying this research to other similar companies could result in more reliable results to generate a theory or hypothesis. It can also identify if other companies address the same issues regarding the pc-lifecycle. The case studies can provide researchers with a better understanding of impact and therefore also the different variables of Intel AMT. Combining all these variables can result in better calculations and can after further research result in a detailed template to calculate real benefits for Intel AMT implementations of Intel vPro.

Modeling business and technology can also impact the Business and IT alignment on strategic level. For example “How well does technology supports the IT strategy of the business?”, and “Does the added value increase when using models to address technology impact?”.It would be interesting to study which relations exists between these two domains of modeling impact and Business and IT alignment.

Software and/or services (referring to cloud) are important for businesses to perform their daily activities or even for their core business. The choice which hardware to use is determined by the software used, which combination of software and hardware has the best performance, stability and reliability? Further research can perhaps reveal the impact of Intel vPro (so hardware) implementation to for instance ERP software (used for business processes).

11 Glossary of Terms

ACL	Access Control List
AD	Active Directory
AMT	Active Management Technology
AV	Audio and Video
B&C	Bossers & Cnossen
BPEL	Business Process Execution Language
BIOS	Basic Input Output System
BPMN	Business Process Modeling Notation
CA	Certificated Authority
CPU	Central Processing Unit
CRM	Customer Relationship Management
CWI	Centre for Mathematics and Computer Science
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
EA	Enterprise Architecture
EMEA	Europe, the Middle East and Africa
ETS	Enterprise Technology Specialist
FQDN	Fully Qualified Domain Name
FS	Field Service
GPU	Graphical Processing Unit
HBC	Host-based Configuration
HG	Hanzehogeschool Groningen
HTTP	Hypertext Transfer Protocol
ICT	Information Communication and Technology
IDE-R	Integrated Drive Environment Redirection
IM	Information Management
ISO	International Organization for Standardization
ISV	Independent Software Vendor
IT	Information Technology
ITIL	Information Technology Infrastructure Library
KVM	Keyboard, Video and Mouse
LE	Large Enterprise
LIACS	Leiden Institute for Advanced Computer Science
ME	Management Engine
MEBX	Manageability Engine Bios eXtension
MEI	Management Engine Interface
MS DART	Microsoft Diagnostics and Recovery Toolset
NIC	Network Interface Controller
OEM	Original Equipment Manufacturer
OMG	Object Management Group
OOB	Out-Of-Band
OS	Operating System
PBP	Pay Back Period
PID	Provisioning ID
PKI	Private Key Infrastructure
POC	Proof of Concept
PPS	Provisioning Passphrase
PSK	Pre-Shared Key
PXE	Preboot Execution Environment

RCS	Remote Configuration Service
RFI	Request For Information
RFP	Request For Proposal
ROI	Return On Investment
SCCM	System Center Configuration Manager
SCS	Setup and Configuration Service
SCSM	System Center Service Manager
SI	System Integrator
SMART	Specific Measurable Acceptable Realistic Time-bound
SMB	Small Medium Business
SMG	Sales and Marketing Group
SMG ESS	Sales and Marketing Group Enterprise Solution Sales
SSD	Solid State Drive
SOL	Serial Over LAN
SQL	Structured Query Language
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport Layer Security
UCRD	Use Case Reference Designs
USB	Universal Serial Bus
XML	eXtensible Markup Language

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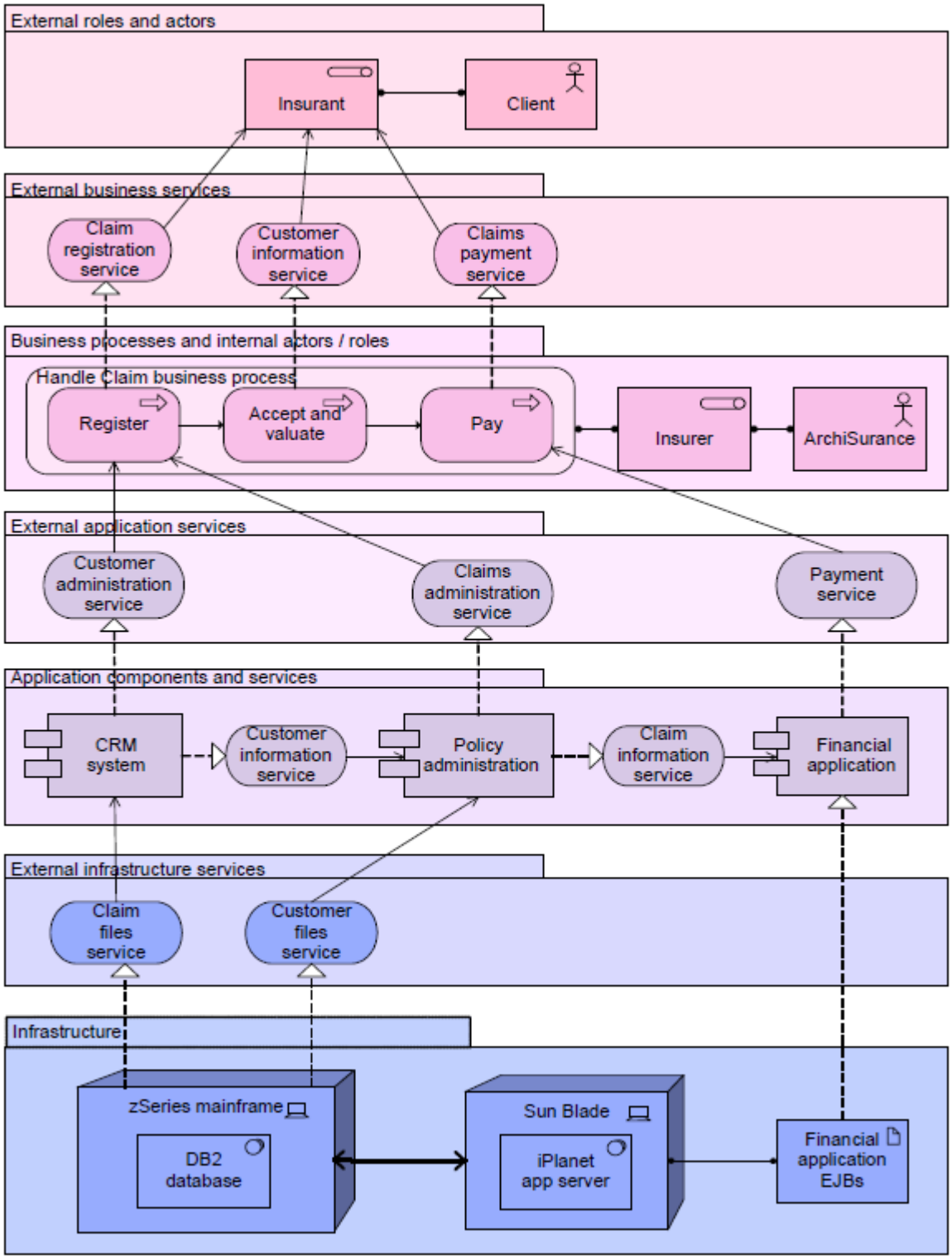
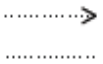
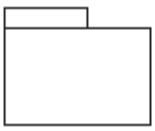
Appendix A - ArchiMate example of Enterprise Architecture



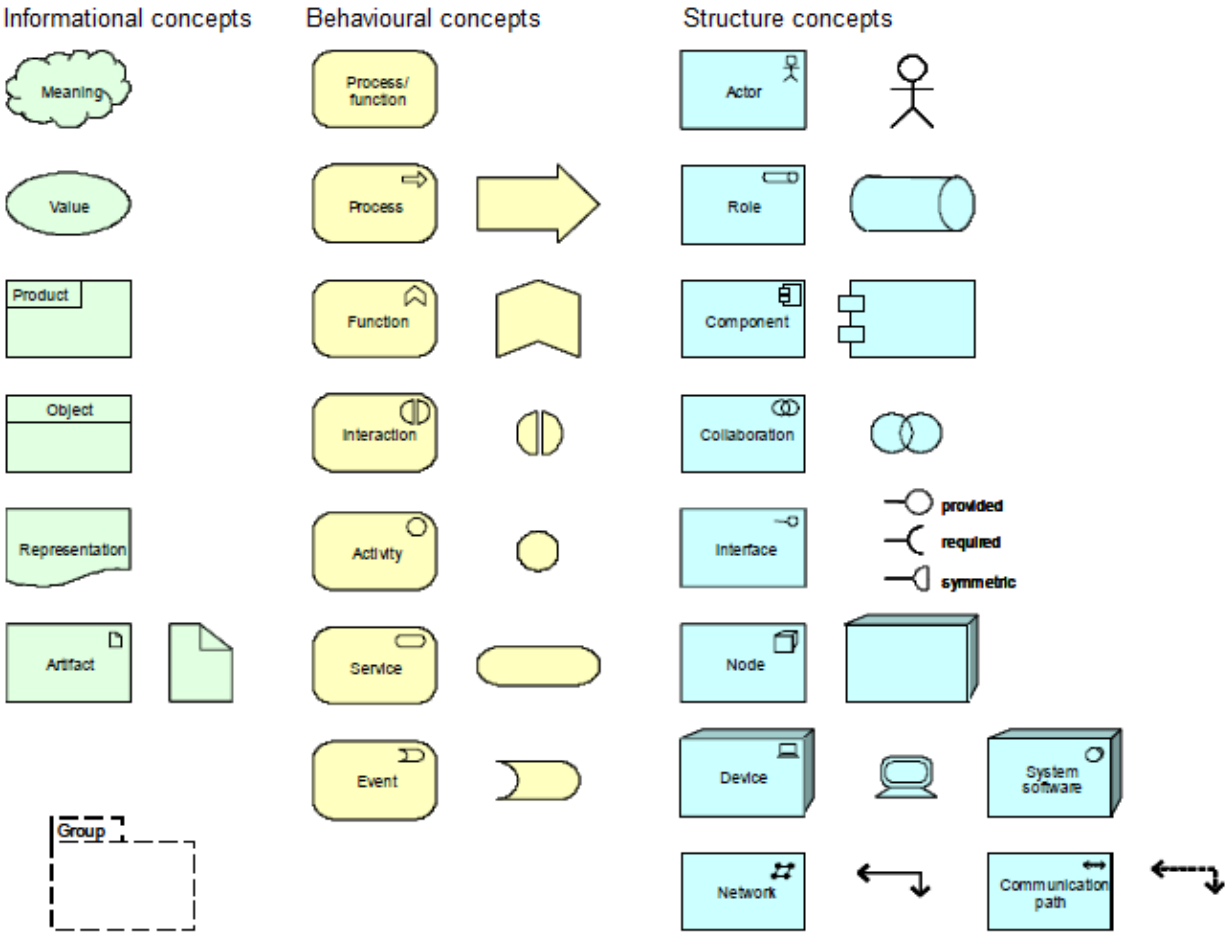
Source: (Lankhorst & and the ArchiMate Team, 2004)

Appendix B - Overview relationships ArchiMate

Structural Relationships		**Notation**
Association	Association models a relationship between objects that is not covered by another, more specific relationship.	
Access	Access The access relationship models the access of behavioral concepts to business or data objects.	
Used by	The used by relationship models the use of services by processes, functions, or interactions and the access to interfaces by roles, components, or collaborations.	
Realization	The realization relationship links a logical entity with a more concrete entity that realizes it.	
Assignment	The assignment relationship links units of behavior with active elements (e.g., roles, components) that perform them, or roles with actors that fulfill them.	
Aggregation	The aggregation relationship indicates that an object groups a number of other objects.	
Composition	The composition relationship indicates that an object consists of a number of other objects.	
Dynamic Relationships		**Notation**
Flow	Flow The flow relationship describes the exchange or transfer of, for example, information or value between processes, function, interactions, and events.	
Triggering	The triggering relationship describes the temporal or causal relations between processes, functions, interactions, and events.	
Other Relationships		**Notation**
Grouping	Grouping The grouping relationship indicates that objects, of the same type or different types, belong together based on some common	
Junction	A junction is used to connect relationships of the same type.	
Specialization	The specialization relationship indicates that an object is a specialization of another object.	

Source: (The Open Group, 2009)

Appendix C - Graphical Notation ArchiMate



Source: (Lankhorst et al., 2005)

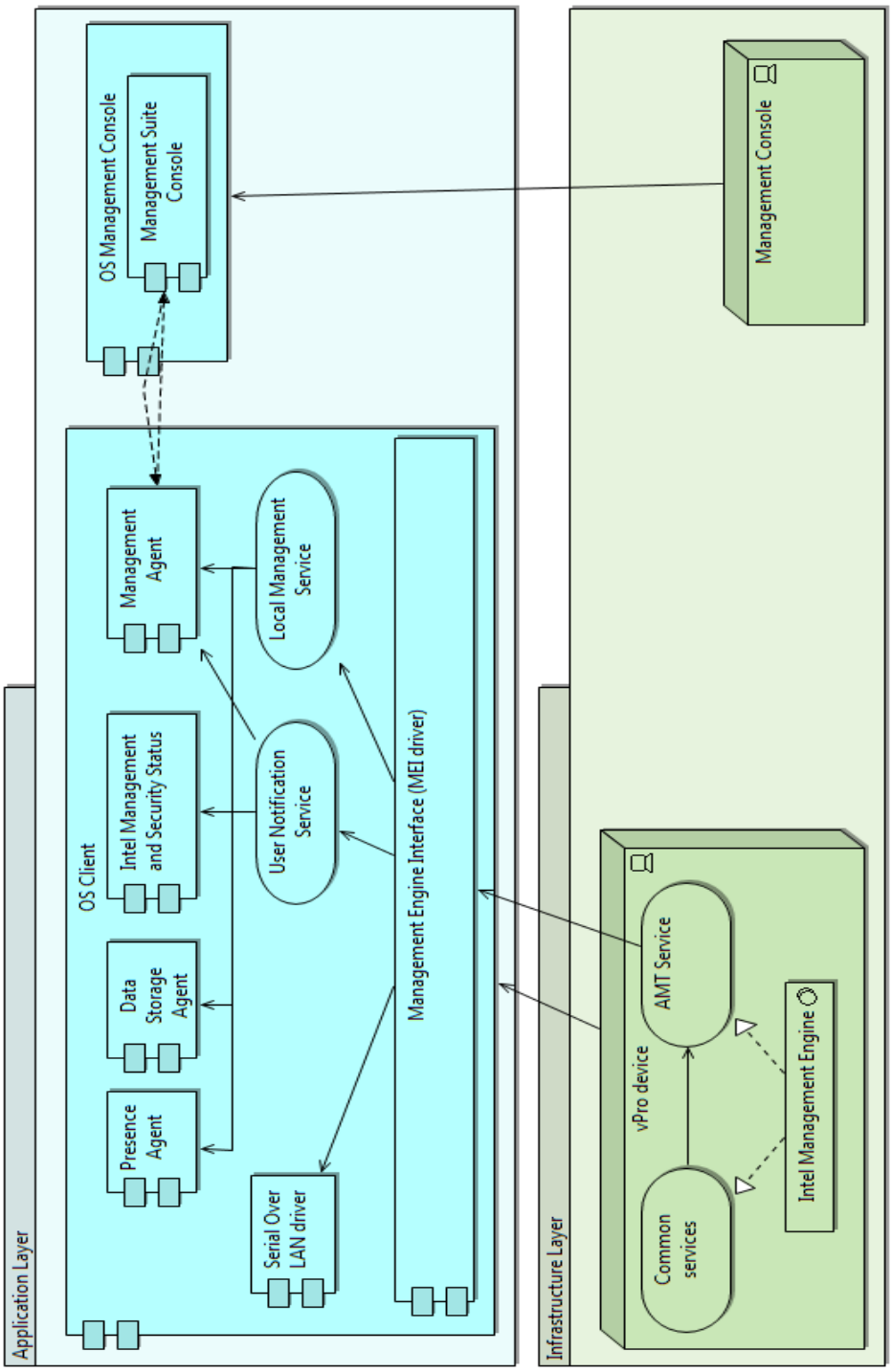
Appendix D - Intel AMT versions and features

	Intel® Core™2 processor with vPro™ technology (2006)	Intel® Centrino® with vPro™ technology (2007)	Intel® Core™2 processor with vPro™ technology (2007)	Intel® Centrino® 2 with vPro™ technology (2008)	Intel® Core™2 processor with vPro™ technology (2008)	Intel® Core™ vPro™ processor family (2010)	2nd Gen Intel® Core™ vPro™ processor family (2011)
Intel® Active Management Technology (AMT) Version	2.2	2.6	3.0	4.0	5.0	6.0	7.0
Boot Control Power State Management HW & SW Inventory HW Alerting	X	X	X	X	X	X	X
Serial Over LAN, IDE Redirect	X	X	X	X	X	X	X
Non Volatile Memory	X	X	X	X	X	X	X
Agent Presence	X	X	X	X	X	X	X
System Defense Filters	X	X	X	X	X	X	X
ME Wake on LAN	X	X	X	X	X	X	X
Remote Configuration	X	X	X	X	X	X	X
Cisco SDN/NAC		X	X	X	X	X	X
Access Monitor Operation				X	X	X	X
Wireless Management in Sleep States				X	n/a	Laptops*	Laptops*
Microsoft NAP				X	X	X	X
Fast Call for Help, Remote Scheduled Maintenance, and Remote Alerts from outside corporate firewall				X	Wired LAN	Wired and Wireless LAN	Wired and Wireless LAN
HW KVM Remote Control						X	X
ME Firmware Rollback							X
Host Based Configuration							X

Source: Intel vPro expert center

(http://communities.intel.com/community/openportit/vproexpert)

Appendix E - Intel AMT in-band communication and other services



Appendix F - Description of older methods of Intel AMT provisioning

SMB/Manual Configuration

The SMB/Manual configuration method lets the IT admin configure the Intel AMT device with *basic configuration* settings. Configuration is done locally at the Intel AMT system with a USB device containing a configuration file or manually via the Manageability Engine Bios eXtension (MEBX) interface.

MEBX method

Systems can be configured manually by setting the parameters in the MEBX. This is the interface of the Intel ME to enable IT personnel to configure the settings of the ME manually. The table below gives an overview of the advantages and disadvantages of this provisioning method.

Advantages	Disadvantages
Very simple	Have to physically touch every system (not preferable for large amount of systems)
	Have to set parameters manually
	Not possible to set all parameters

USB Thumb drive method for one system (Intel AMT 4.0 and higher)

The configuration file used on the USB drive can be created with the ACU Wizard of the Intel SCS application. This configuration file is specific for one Intel vPro system because of the given hostname in the file. The configuration file is wiped after the system has set the Intel AMT parameters. The table below gives an overview of the advantages and disadvantages of this provisioning method.

Advantages	Disadvantages
Very simple	Still have to physically touch every system with the USB
Reduces risk of misconfiguration in the MEBX	Not possible to set all parameters
	Have to make a configuration file for each system (time consuming)
	Not supported by all AMT versions

USB Thumb drive method for multiple systems (Intel AMT 6.0 and higher)

Applying the USB thumb drive method for a single system is however not convenient for larger volumes. Therefore Intel SCS provides a way to configure multiple systems by USB key. The table below gives an overview of the advantages and disadvantages of this provisioning method.

Advantages	Disadvantages
Very simple	Still have to physically touch every system with the USB
Reduces risk of misconfiguration in the MEBX	Not supported by all AMT versions
Quicker in case of large amount of systems	Not possible to set all parameters

One Touch Configuration (PSK)

The One Touch configuration method uses Pre-Shared Keys (PSK) and the Remote Configuration Service (RCS) of Intel SCS. The RCS must be installed on one of the systems in the network called the provisioning server. The provisioning process is performed via an OOB connection. Therefore a secure communication has to be established in order to create trust between the host system and the provisioning server. This trust is established based on PSK or symmetric-key cryptography, using one key which can encrypt and decrypt the messages.

The ACU Configuration command line interface can be used to create these pre-shared keys. The PSK (which consists of an identifier: pid and the key: pps) must be stored on the Intel AMT system. The installation of the pre-shared key must be done in every Intel vPro device manually by the MEBX, by USB or by the OEM.

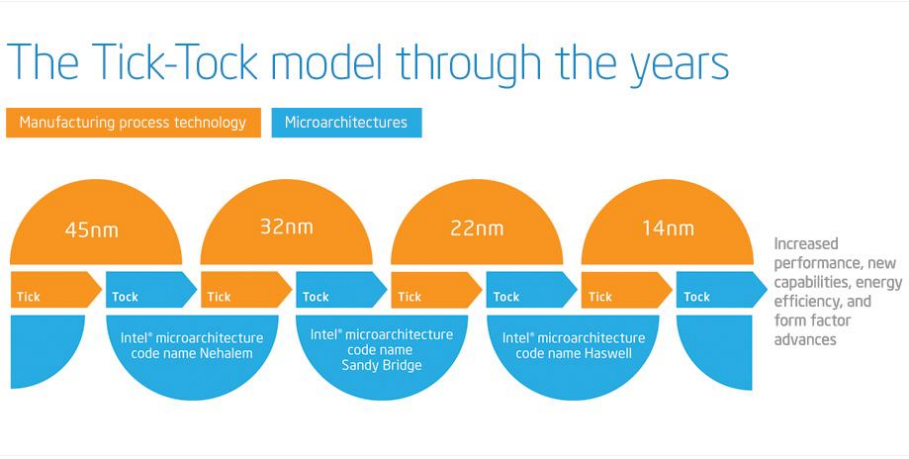
If the OEM has stored the pre-shared key in the device already, then the customer should get the list with all pre-shared keys used, and only has to store this in the provisioning server yet. The next table gives an overview of the advantages and disadvantages of this provisioning method.

Advantages	Disadvantages
Supports all Intel AMT features	More complex to understand (then previous method)
Supports all versions of Intel AMT	Still have to physically touch every system if USB or MEBX method is used to store the pre-shared keys.
Can configure all parameters	Pre-shared keys must be created if not received by the OEM.
	Requires IT infrastructure: Provisioning server (RCS), DNS and DHCP server. AD integration is possible.

Appendix G - General information Intel

Intel is an American semiconductor manufacturer with approximately 100.000 employees and 300 facilities in 50 countries. The core business of Intel is making chips of silicon. The most known chip is the microprocessor or CPU of a computer system. Intel offers microprocessors with one or multiple cores designed for notebooks, netbooks, desktops, servers, workstations, storage products, embedded applications, communications products, consumer electronic devices and handheld devices (Intel, 2010 Annual Report, 2010). In December 2010 Intel introduced the 2nd generation Intel® Core™ processor family, codename Sandy Bridge. However Intel produces also chipsets, controllers like the network interface controller (NIC) and other processors like the integrated graphical processing unit (GPU), are made of silicon. In matter of fact Intel is the largest manufacturer of CPUs, integrated GPUs and integrated NICs. Furthermore Intel does not only manufacture microprocessors but also motherboards, wireless and wired connectivity products, NAND flash memory, solid state drives (SSDs) and software products including operating systems, middleware and tools. Intel is also known through its efforts of standardization like its participation in the Universal Serial Bus (USB) standard and NAND flash memory.

Intel drives its technology leadership by a regular two-year upgrade cycle. This is referred as the "tick-tock" development model, shown in the figure below. Every "tock" introduces a new microarchitecture to improve energy efficiency and performance, as well as functionality and density of features such as hardware-supported video transcoding, encryption/decryption and other integrated capabilities. With every "tick" cycle every two years Intel increases its transistor density (based on Moore's Law) which enables new capabilities like higher performance levels and greater energy efficiency all within the same microarchitecture (Intel, Intel Tick Tock Model).



Mission and objectives

Intel's mission: "Delight our customers, employees, and shareholders by relentlessly delivering the platform and technology advancements that become essential to the way we work and live." (Intel, General Company Information).

Intel's objectives(Intel, General Company Information):

- Extend our silicon technology and manufacturing leadership;
- Deliver unrivaled microprocessors and platforms;
- Grow profitability worldwide;
- Excel in customer orientation.

Organizational structure

This section is removed due to confidentiality.

Appendix H - General information Hanzehogeschool Groningen

The HG is a University of Applied Sciences in the Netherlands. The University of Applied Sciences originates from end of the eighteenth century. In 1797 the first section of the university was founded. It is the largest university of Northern Netherlands and oldest multi-sectorial University of Applied Sciences in the Netherlands. The HG is located at Groningen (headquarters), Assen, Leeuwarden and Amsterdam. The university has over 25.000 students and 2.700 staff. Courses offered by the HG are:

- Over 70 bachelor studies
- 4 programs for Associate degrees
- 13 master programs

Besides the regular education, the HG offers multiple courses, (postgraduate) studies, trainings and workshops. The University of Applied Sciences consists of 19 academies or institutes called schools. The schools include the related studies.

Mission

The mission of the HG is: “To become the main partner, from a European perspective on higher education, for companies and institutions in the Northern Netherlands in the training of professionals and development of applicable practical knowledge.” (Hanzehogeschool Groningen) There are four central values included:

1. Individual development;
2. Active respect and tolerance;
3. enterprising;
4. responsibility.

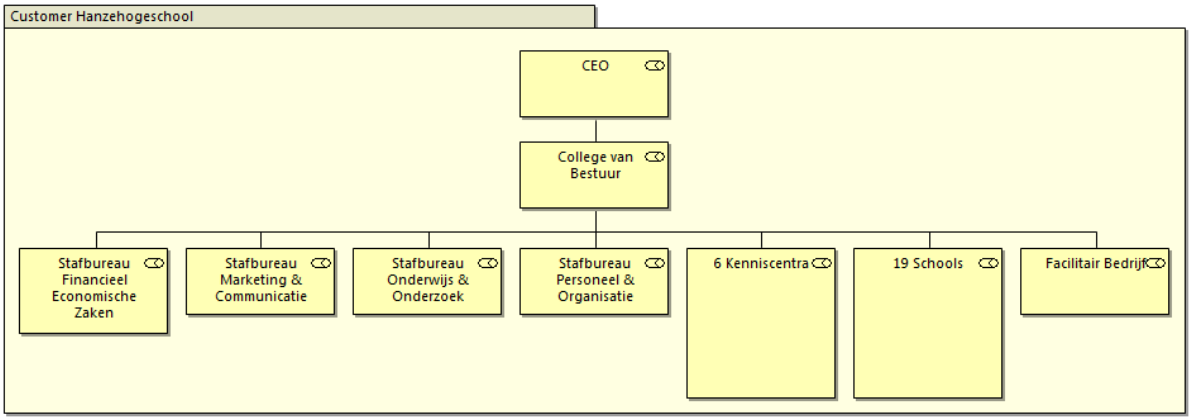
Vission

The vision statement of the HG is the following: “Students and staff are partners in a knowledge community and deliver their own contribution to the common goal of delivering excellent professionals at the highest level to society. The student and his individual development to become a competent professional are central. The cooperation with companies and institutions in knowledge application and innovation, and in the design of education is indispensable” (Hanzehogeschool Groningen).

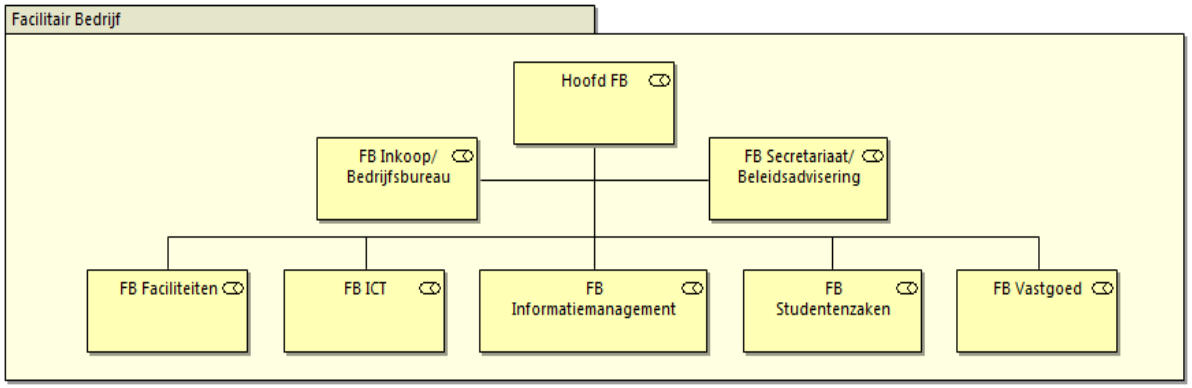
Organizational structure

The modeling language ArchiMate makes it also possible to model the organizational viewpoint by using the role object (The Open Group, 2009).

Besides the top-management layers, the HG has several staff departments, 6 knowledge centers, 19 schools and facility management.



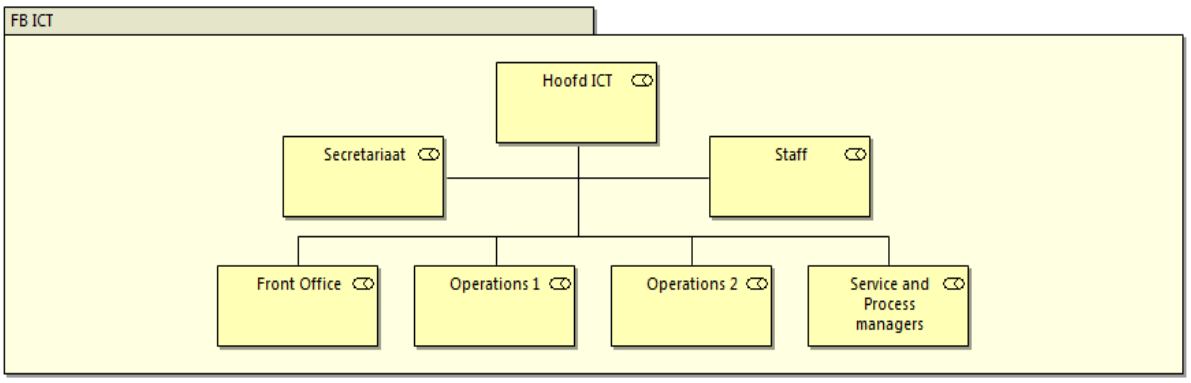
Looking closer to the departments which are relevant for this case study, the Facility management is described in the above figure. The IT related departments are part of the Facilities (Facilitair Bedrijf). The figure below shows the composition of Facilities.



There are two relevant departments: FB ICT and FB Information Management (IM). The FB Information Management department is responsible for creating policies and guidelines. It has to support the decision making process by making choices on how to shape, organize and manage information. The IM-department is engaged in long term and overarching IT matters. The FB ICT-department is responsible for IT and telephony services. The department operates at the operational and tactical levels.

Looking closer to the FB ICT-department, in the next figure, it consists of several teams. The Front Office consists of a support center which supports employees by phone and a helpdesk

office which is for students and employees. The helpdesk also supports and lends ICT audio and video (AV). Operations 1 is responsible for the workplaces, printers and applications. Operations 2 is responsible for the servers, network, backup, storage etc. The service and process manager's team includes the incident manager, problem manager, change manager, configuration manager, service manager etc.



Appendix I - Offer Bossers & Cnossen

Offerte

BOSSERS & CNOSSEN
De kracht van ICT

Hanzehogeschool Facilitair Bedrijf ICT
T.a.v. J. van der Pluijm
Zernikeplein 11
9747 AS Groningen

Bossers & Cnossen BV
Wasaweg 3
9723 JD Groningen
Tel. 050 8506900
Fax 050 8506909

Jaap C. Kommandeur
E-mail:
jaap.kommandeur@bnc.nl
Tel: 050-8506914
http://www.bnc.nl

Datum: 15/12/2010
Offertenummer: 40860

Artikelnummer	Omschrijving	Prijs	Aantal	Subtotaal
Standaard systeem zoals overeengekomen in de aanbesteding:				
999999	HP Compaq 8000 Elite SFF Business PC conform onderstaande configuratie: E8400; 4 GB; 250 GB; DVDRW; Parallel poort; PS/2 keyboard en muis; Win Vista Home Basic; 3 jaar garantie.	€	400	
BNC125751	Plaatje Zwart Hanze PC	€	400	
BNC125459	Werkzaamheden: Plaatsen plaatje	€	400	
220B2CS/00	Philips Brilliance B-line 220B2CS - LCD-scherm - TFT - 22" - 1680 x 1050 / 60 Hz - 250 cd/m2 - 500000:1 (dynamisch) - 5 ms - 0.282 mm - DVI-D, VGA - luidsprekers - zwart, zilver	€	400	
BNC125752	Plaatje Zwart Hanze Monitor	€	400	€
BNC125459	Werkzaamheden: Plaatsen plaatje	€	400	€
BNC118956	Secuplate XL zwart (1 stuk) incl. lijm	€	400	€
BNC132897	HP Displayport naar DVI-cable	€	400	€

Totaalbedrag	€
BTW-bedrag	€
Totaalbedrag inclusief BTW	€

Deze offerte is geldig tot 29/12/2010. Mocht u deze offerte willen bestellen, dan kunt u deze offerte ook openen op www.bnc.nl en vervolgens, met eventuele wijzigingen, online uw bestelling plaatsen. U kunt de offerte openen in het menu "Offertes" onder "Ontvangen offertes".

Alle prijzen zijn onder voorbehoud en exclusief BTW, tenzij expliciet anders aangegeven.
Leveringen geschieden volgens onze leveringsvoorwaarden als gedeponeerd bij de kvk te Groningen onder nummer 974.

Appendix J - Detailed break-down of costs (situation 1 to 3)

Most prices are removed due to confidentiality. This information is or could be a competitive advantage for the reseller and is therefore not shared in this public version.

Detailed break-down of costs situation as-is

Activity	Based on 400 systems
Transportation and storage costs B&C	
Installation of new systems, storage of the new systems, removal of the old systems and storage of these systems on location in a truck.	
Internal costs HG	
Internal activities include: - Unpacking/packing systems - Installing and imaging systems at the IT workspace - Installing systems on the user's desk - Administration with TargetWizard at the user's desk	
Total costs	€ 14.957,60
Costs per system	€ 37,40

Detailed break-down of costs situation 1

Activity	Based on 400 systems
System imaging costs B&C	
Installation of the proper OS and applications on the systems	
Transportation and storage costs B&C	
Installation of new systems, storage of the new systems, removal of the old systems and storage of these systems on location in a truck.	
Internal costs HG	
Internal activities include: - Control of administration (are the systems on the right desk) - Coordination between user and reseller, when to place systems and at which location	

Total costs	€ 7.439,60
Costs per system	€ 18,60

Detailed break-down of costs situation 2

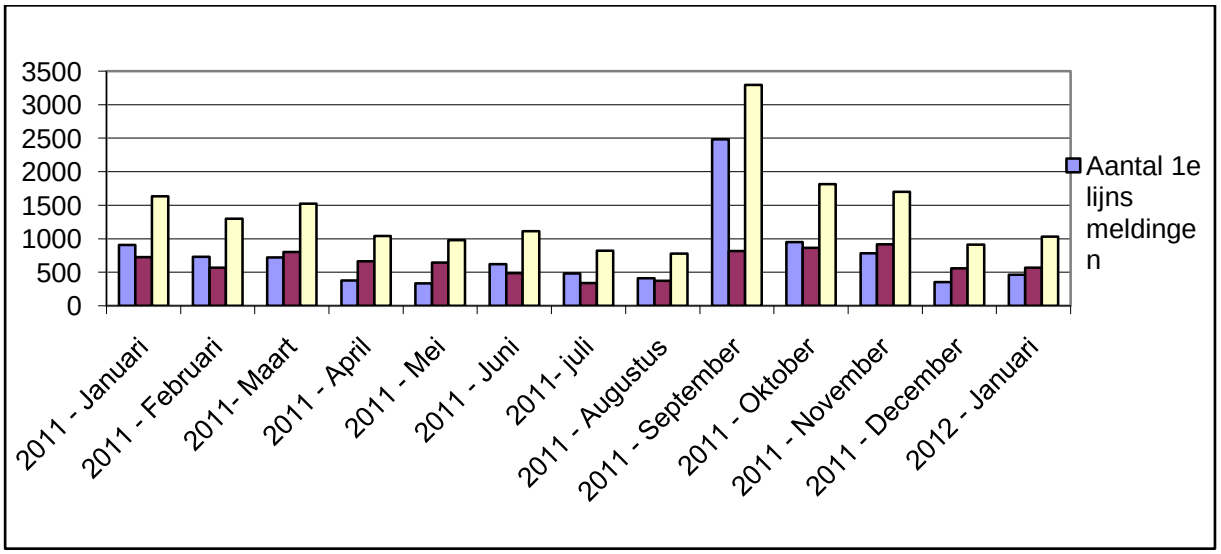
Activity	**Based on 400 systems**
Provisioning of Intel AMT costs (based on uniqueness by B&C)	
Provisioning of OEM systems with Intel vPro	
Transportation and storage costs B&C	
Installation of new systems, storage of the new systems, removal of the old systems and storage of these systems on location in a truck.	
Internal costs HG	
Internal activities include: - Control of administration (are the systems on the right desk) - Coordination between user and reseller, when to place systems and at which location - Prepare image - Remote system imaging	
Investment HG costs	
Includes: - Training - Building Software - Building infrastructure	
Exploitation costs	
Provisioning license per year	
Total costs	€ 21.184,25
Y1: Costs per system (21.200 / 400)	€ 53,00
Y2, Y3, Y4: Costs per systems (12.200 / 400)	€ 30,50

Detailed break-down of costs situation 3

Activity	Based on 400 systems
Transportation and storage costs B&C	
Installation of new systems, storage of the new systems, removal of the old systems and storage of these systems on location in a truck.	
Internal costs HG	
Internal activities include: - Control of administration (are the systems on the right desk) - Coordination between user and reseller, when to place systems and at which location - Provisioning of the systems (initiation on-site) - Prepare image - Remote system imaging	
Investment costs	
Includes: - Training - Building Software - Building infrastructure	
Exploitation costs	
Provisioning license per year	
Total costs	€ 21.703,25
Y1: Costs per system	€ 54,25
Y2, Y3, Y4: Costs per systems	€ 31,75

Appendix K - Incident report of 2011/2012

Aantal 1e en 2e lijns incidenten per maand over 2011/ 2012			
Maand	**Aantal 1e lijns meldingen**	**Aantal 2e lijns meldingen**	**Totaal aantal meldingen**
2011 - Januari	907	726	1633
2011 - Februari	731	570	1301
2011- Maart	719	804	1523
2011 - April	375	665	1040
2011 - Mei	335	644	979
2011 - Juni	622	489	1111
2011- juli	481	338	821
2011 - Augustus	409	371	780
2011 - September	2481	816	3297
2011 - Oktober	948	866	1814
2011 - November	781	917	1698
2011 - December	353	557	910
2012 - Januari	465	567	1032
2012 - Februari	135	78	213



Appendix L - Solution Brief 2nd generation Intel®Core®i5 vPro™processor

SOLUTION BRIEF
2nd generation Intel® Core® i5 vPro™ processor
Enterprise Client

Leading the competition

Bossers & Cnossen looks to Intel® vPro™ technology to boost services revenue

BOSSERS & CNOSSEN
De kracht van ICT

"This project enabled our consultants to get hands-on experience with an Intel® vPro™ technology activation and the benefits this can bring to a large not-for-profit organization like Hanze UAS. They will now be better able to build a business case and advise other customers in similar situations."

Jaap Kommandeur,
Program Manager
Bossers & Cnossen

CHALLENGES

- **Move to services.** IT reseller Bossers & Cnossen was looking for new revenue streams by focusing on value-added services
- **Activating management.** Tasked, together with Intel, with overseeing a large Intel® vPro™ technology activation project at Hanze University of Applied Sciences (Hanze UAS)

SOLUTIONS

- **Test and trial.** Ran a small proof of concept on six desktops highlighting benefits of Intel vPro technology and best practices in activating remote management capabilities
- **Impressive feat.** PoC findings helped Hanze UAS activate 95 percent of its desktops in just four weeks

IMPACT

- **Hands-on experience.** Gained first-hand experience of an Intel vPro technology activation project, meaning Bossers & Cnossen can better build a business case for future customers
- **Future fit.** Stands to benefit from additional revenue stream thanks to Intel vPro technology, supporting a wider business strategy to offset decreasing margins from hardware sales with value-added services revenue

Changing landscape

One of the largest IT resellers in the Netherlands, Bossers & Cnossen provides hardware and IT services to medium and large not-for-profit and private enterprises. Its expertise extends from the design, delivery, and installation of the physical infrastructure to ongoing maintenance and management.

Most of Bossers & Cnossen's revenue comes from hardware sales, but as the IT market segment evolves (e.g., toward cloud computing), it is becoming increasingly difficult for IT resellers to rely solely on hardware sales to maintain current revenue – nevermind increase market segment share.

Jaap Kommandeur, program manager at Bossers & Cnossen, explains: "Around 85 percent of our gross turnover comes from hardware sales, but these margins are starting to diminish. To remain competitive in the reseller market segment, we must place greater emphasis on value-added services, where margins are much higher. To succeed in this, we need to make sure that our consultants have the skills and experience to sell value-added services to our customers."

It is for these reasons that Bossers & Cnossen jumped at the chance of working with Intel and long-standing customer Hanze UAS on an Intel vPro technology[1] activation project.

Sprawling infrastructure

Hanze UAS is located in Groningen in the Netherlands. It has over 25,000 students from all over the world, enrolled in numerous international programs, from chemical engineering to applied psychology and fine arts.

It is spread across several locations – the main Zernike Campus site near Groningen comprising four main buildings, four additional locations in the center of Groningen, plus three more sites in Amsterdam, Assen and Leeuwarden. The university's IT/AV department is tasked with managing clients, networks, and servers across these different locations, as well as running a central IT/AV helpdesk.

Bossers & Cnossen stands to benefit from additional revenue thanks to Intel® vPro™ technology

On the client side, the IT department is responsible for managing and maintaining 4,100 desktops used by students and administrators, as well as for maintaining 200 more unmanaged laptops used primarily by teaching staff. It manages the desktops using the LANDesk Management Suite*, but limitations with this software make managing the sprawling client infrastructure time-consuming and costly.

To compound this matter, the IT department must ensure it charges the right department for managing and maintaining desktops. It keeps track of this using an in-house tool called TargetWizard* – but again, there are limitations with this software. For example, there would be no way of knowing if a desktop had been moved from one department to another. Hanze UAS was hoping that the hardware-assisted manageability features of Intel vPro technology would help it to resolve these issues.

Activating Intel® vPro™ technology

Jeroen van der Pluijm, manager of service planning at Hanze UAS, explains: "We installed our first desktops with Intel vPro technology back in 2007. We always wanted to take advantage of its remote management capabilities, but for simplicity's sake decided to wait until all our desktops had processors with Intel vPro technology. We reached that stage a few months ago as the last of our old desktops were replaced with new HP models powered by 2nd generation Intel® Core™ i5 vPro™ processors."

He continues: "We got in touch with Bossers & Cnossen, who together with Intel helped us run a proof of concept on six desktops. This was designed to showcase the benefits of Intel vPro technology to the Hanze UAS IT team and also to explain to us how it works and how best to activate remote management capabilities across our entire desktop fleet. The information we got from Bossers & Cnossen and Intel was invaluable, helping us to achieve activation across 95 percent of our desktops in just four weeks."

Benefiting remotely

Intel vPro technology enables the Hanze UAS IT department to switch desktops on and off remotely from the management console. This has several benefits: first, it reduces energy consumption since desktops are switched off when they are not in use; second, it makes it easier for Hanze UAS to meet the terms and conditions of its insurance policy which state that all desktops and peripherals must be switched off overnight; and third, it enables the IT department to switch on desktops 10 minutes before lessons start so students don't waste time waiting for their computers to boot.

Remote management capabilities also allow the IT department to quickly deploy security patches and software upgrades across all PCs. Since Intel vPro technology is embedded into the hardware, technicians are also able to diagnose hardware problems remotely and resolve more issues from the central helpdesk, reducing the number of deskside visits. This saves valuable time, reduces downtime, and improves the end-user experience. Hanze UAS also plans to record event logs into the Intel vPro technology capability, enabling them to record and analyze them centrally.

Maintaining an advantage

By working with Intel on this project, Bossers & Cnossen gained first-hand experience of a large-scale Intel vPro technology activation. Kommandeur explains: "This project enabled our consultants to get hands-on experience with an Intel vPro technology activation and the benefits this can bring to a large, not-for-profit organization like Hanze UAS. They will now be better able to build a business case and advise other customers in similar situations."

With regard to Hanze UAS, Bossers & Cnossen now stands to benefit from an additional revenue stream from installation services thanks to Intel vPro technology. "When we buy a new round of desktops, Bossers & Cnossen have to send them to us to install the images centrally, so it then makes sense for us to install the machines as we have them on site. However, Intel vPro technology makes it possible for us to install the images remotely. This means Bossers & Cnossen could now take charge of installing the desktops, as well as provisioning them, while we install the images remotely," says van der Pluijm.

Bossers & Cnossen hopes to replicate this sort of project to sell additional value-add services to both existing and future customers. This is a key component of its strategy to increase revenues from services in the face of diminishing returns from hardware sales.

Hanze UAS now plans to work together with Bossers & Cnossen to investigate the potential benefits of Intelligent desktop virtualization and the areas where it would bring business advantage. Intelligent desktop virtualization and Intel vPro technology together can maximize the outcomes of centralized management and delivery without compromising the user experience and mobility.

Spotlight on Bossers & Cnossen

Founded in 1987, Bossers & Cnossen is one of the largest hardware and IT service providers to not-for-profit and private enterprises in the north of the Netherlands. It designs, delivers, installs, and manages IT infrastructures for organizations with 50 or more users. These environments include workstations, servers and storage, data communications, printing and scanning, sound and vision, and Web development.

Visit Intel's Technology Provider website at **www.inteltechnologyprovider.com** and Business Success Stories for IT Managers at **www.intel.com/itcasestudies**

[1] Intel® vPro™ technology: Intel® vPro™ Technology is sophisticated and requires setup and activation. Availability of features and results will depend upon the setup and configuration of your hardware, software, and IT environment. To learn more, visit http://www.intel.com/technology/vpro.

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Appendix M - Calculation costs situations

The first table provides the reader an overview of the data given in chapter 7. The second two tables provide information about the costs per year, cumulative costs, savings a year and cumulative savings for 400 systems and 1000 systems. The third table shows the same information however these costs include the yearly savings of € 800 a year. The specific prices in the Tables are removed due to confidentiality.

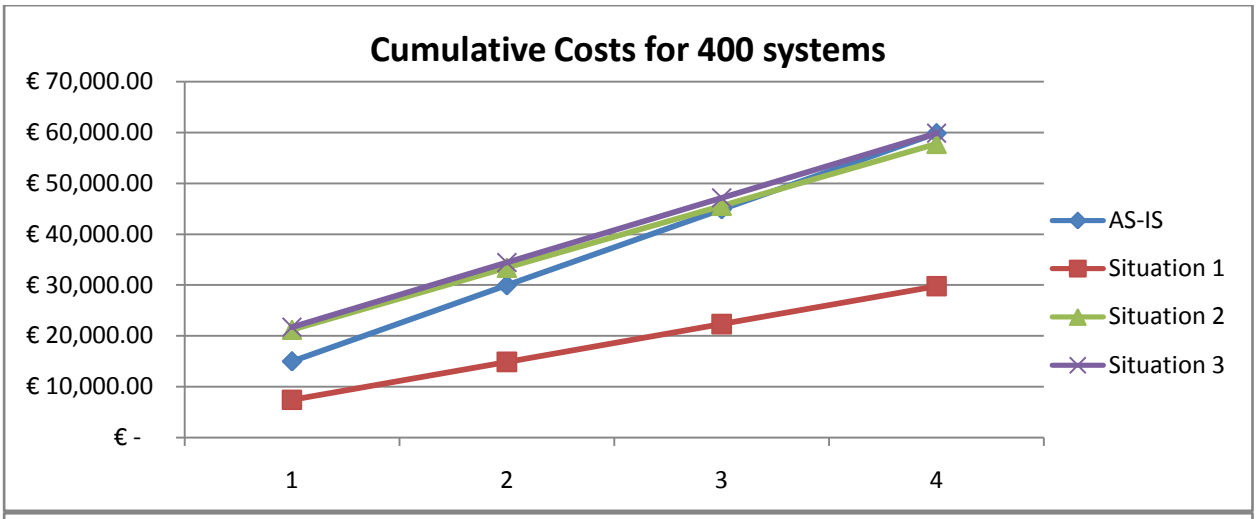
Situation	AS IS		SITUATION 1		SITUATION 2		SITUATION 3	
Number of Systems	400	1000	400	1000	400	1000	400	1000
Provisioning costs Imaging costs Transportation costs Internal costs Expl costs								
Investment								
Total	**€ 14,957.60**	**€ 37,394.00**	**€ 7,439.60**	**€ 18,599.00**	**€ 21,184.25**	**€ 39,399.65**	**€ 21,703.25**	**€ 40,697.15**
Costs per system Y1	€ 37.39	€ 37.39	€ 18.60	€ 18.60	€ 52.96	€ 39.40	€ 54.26	€ 40.70
Costs per system Y2,Y3,Y4	€ 37.39	€ 37.39	€ 18.60	€ 18.60	€ 30.46	€ 30.40	€ 31.76	€ 31.70

BASED ON 400 SYSTEM (CALCULATIONS)				
Year	**1**	**2**	**3**	**4**
AS-IS	€ 14,957.60	€ 14,957.60	€ 14,957.60	€ 14,957.60
Situation 1	€ 7,439.60	€ 7,439.60	€ 7,439.60	€ 7,439.60
Situation 2	€ 21,184.25	€ 12,184.25	€ 12,184.25	€ 12,184.25
Situation 3	€ 21,703.25	€ 12,703.25	€ 12,703.25	€ 12,703.25
Year CUM	**1**	**2**	**3**	**4**
AS-IS	€ 14,957.60	€ 29,915.20	€ 44,872.80	€ 59,830.40
Situation 1	€ 7,439.60	€ 14,879.20	€ 22,318.80	€ 29,758.40
Situation 2	€ 21,184.25	€ 33,368.50	€ 45,552.75	€ 57,737.00
Situation 3	€ 21,703.25	€ 34,406.50	€ 47,109.75	€ 59,813.00
Savings	**1**	**2**	**3**	**4**
Situation 1	€ -7,518.00	€ -7,518.00	€ -7,518.00	€ -7,518.00
Situation 2	€ 6,226.65	€ -2,773.35	€ -2,773.35	€ -2,773.35
Situation 3	€ 6,745.65	€ -2,254.35	€ -2,254.35	€ -2,254.35
Savings CUM	**1**	**2**	**3**	**4**
Situation 1	€ -7,518.00	€ -15,036.00	€ -22,554.00	€ -30,072.00
Situation 2	€ 6,226.65	€ 3,453.30	€ 679.95	€ -2,093.40
Situation 3	€ 6,745.65	€ 4,491.30	€ 2,236.95	€ -17.40

BASED ON 1000 SYSTEM (CALCULATIONS)				
Year	**1**	**2**	**3**	**4**
AS-IS	€ 37,394.00	€ 37,394.00	€ 37,394.00	€ 37,394.00
Situation 1	€ 18,599.00	€ 18,599.00	€ 18,599.00	€ 18,599.00
Situation 2	€ 39,399.65	€ 30,399.65	€ 30,399.65	€ 30,399.65
Situation 3	€ 40,697.15	€ 31,697.15	€ 31,697.15	€ 31,697.15
Year CUM	**1**	**2**	**3**	**4**
AS-IS	€ 37,394.00	€ 74,788.00	€ 112,182.00	€ 149,576.00
Situation 1	€ 18,599.00	€ 37,198.00	€ 55,797.00	€ 74,396.00
Situation 2	€ 39,399.65	€ 69,799.30	€ 100,198.95	€ 130,598.60
Situation 3	€ 40,697.15	€ 72,394.30	€ 104,091.45	€ 135,788.60
Savings	**1**	**2**	**3**	**4**
Situation 1	€ 18,795.00	€ 18,795.00	€ 18,795.00	€ 18,795.00
Situation 2	€ -2,005.65	€ 6,994.35	€ 6,994.35	€ 6,994.35
Situation 3	€ -3,303.15	€ 5,696.85	€ 5,696.85	€ 5,696.85
Savings CUM	**1**	**2**	**3**	**4**
Situation 1	€ 18,795.00	€ 37,590.00	€ 56,385.00	€ 75,180.00
Situation 2	€ -2,005.65	€ 4,988.70	€ 11,983.05	€ 18,977.40
Situation 3	€ -3,303.15	€ 2,393.70	€ 8,090.55	€ 13,787.40

BASED ON 400 SYSTEM INCLUDING YEARLY SAVING 800 EUROS				
Year	**1**	**2**	**3**	**4**
AS-IS	€ 14,957.60	€ 14,957.60	€ 14,957.60	€ 14,957.60
Situation 1	€ 7,439.60	€ 7,439.60	€ 7,439.60	€ 7,439.60
Situation 2	€ 20,384.25	€ 11,384.25	€ 11,384.25	€ 11,384.25
Situation 3	€ 20,903.25	€ 11,903.25	€ 11,903.25	€ 11,903.25
Year CUM	**1**	**2**	**3**	**4**
AS-IS	€ 14,957.60	€ 29,915.20	€ 44,872.80	€ 59,830.40
Situation 1	€ 7,439.60	€ 14,879.20	€ 22,318.80	€ 29,758.40
Situation 2	€ 20,384.25	€ 31,768.50	€ 43,152.75	€ 54,537.00
Situation 3	€ 20,903.25	€ 32,806.50	€ 44,709.75	€ 56,613.00
Savings	**1**	**2**	**3**	**4**
Situation 1	€ -7,518.00	€ -7,518.00	€ -7,518.00	€ -7,518.00
Situation 2	€ 5,426.65	€ -3,573.35	€ -3,573.35	€ -3,573.35
Situation 3	€ 5,945.65	€ -3,054.35	€ -3,054.35	€ -3,054.35
Savings CUM	**1**	**2**	**3**	**4**
Situation 1	€ -7,518.00	€ -15,036.00	€ -22,554.00	€ -30,072.00
Situation 2	€ 5,426.65	€ 1,853.30	€ -1,720.05	€ -5,293.40
Situation 3	€ 5,945.65	€ 2,891.30	€ -163.05	€ -3,217.40

BASED ON 1000 SYSTEM INCLUDING YEARLY SAVING 800 EUROS				
Year	**1**	**2**	**3**	**4**
AS-IS	€ 37,394.00	€ 37,394.00	€ 37,394.00	€ 37,394.00
Situation 1	€ 18,599.00	€ 18,599.00	€ 18,599.00	€ 18,599.00
Situation 2	€ 38,599.65	€ 29,599.65	€ 29,599.65	€ 29,599.65
Situation 3	€ 39,897.15	€ 30,897.15	€ 30,897.15	€ 30,897.15
Year CUM	**1**	**2**	**3**	**4**
AS-IS	€ 37,394.00	€ 74,788.00	€ 112,182.00	€ 149,576.00
Situation 1	€ 18,599.00	€ 37,198.00	€ 55,797.00	€ 74,396.00
Situation 2	€ 38,599.65	€ 68,199.30	€ 97,798.95	€ 127,398.60
Situation 3	€ 39,897.15	€ 70,794.30	€ 101,691.45	€ 132,588.60
Savings	**1**	**2**	**3**	**4**
Situation 1	€ 18,795.00	€ 18,795.00	€ 18,795.00	€ 18,795.00
Situation 2	€ -1,205.65	€ 7,794.35	€ 7,794.35	€ 7,794.35
Situation 3	€ -2,503.15	€ 6,496.85	€ 6,496.85	€ 6,496.85
Savings CUM	**1**	**2**	**3**	**4**
Situation 1	€ 18,795.00	€ 37,590.00	€ 56,385.00	€ 75,180.00
Situation 2	€ -1,205.65	€ 6,588.70	€ 14,383.05	€ 22,177.40
Situation 3	€ -2,503.15	€ 3,993.70	€ 10,490.55	€ 16,987.40


Cumulative Costs for 400 systems
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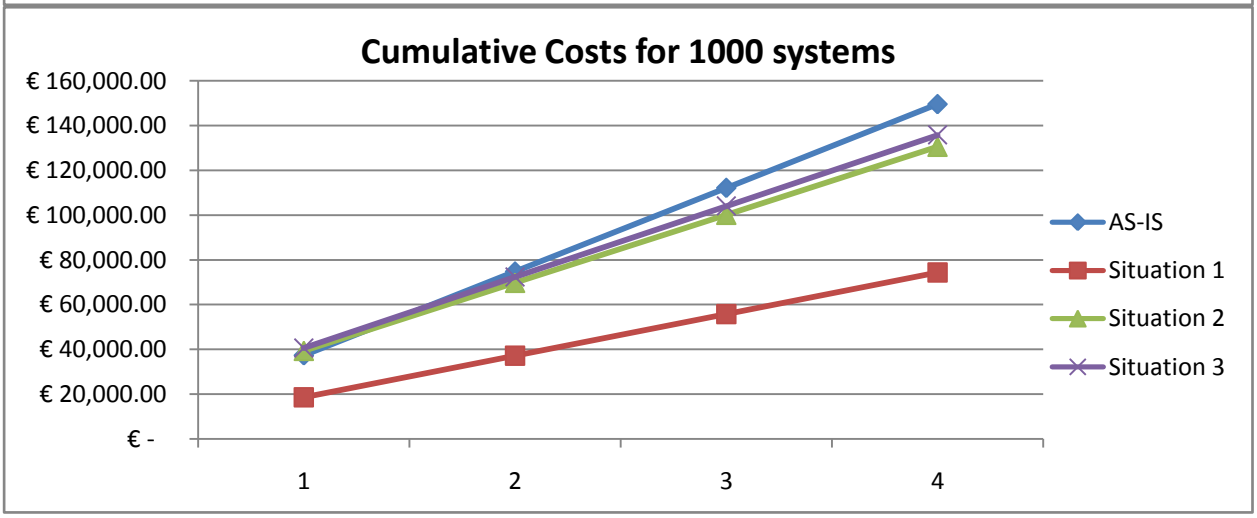
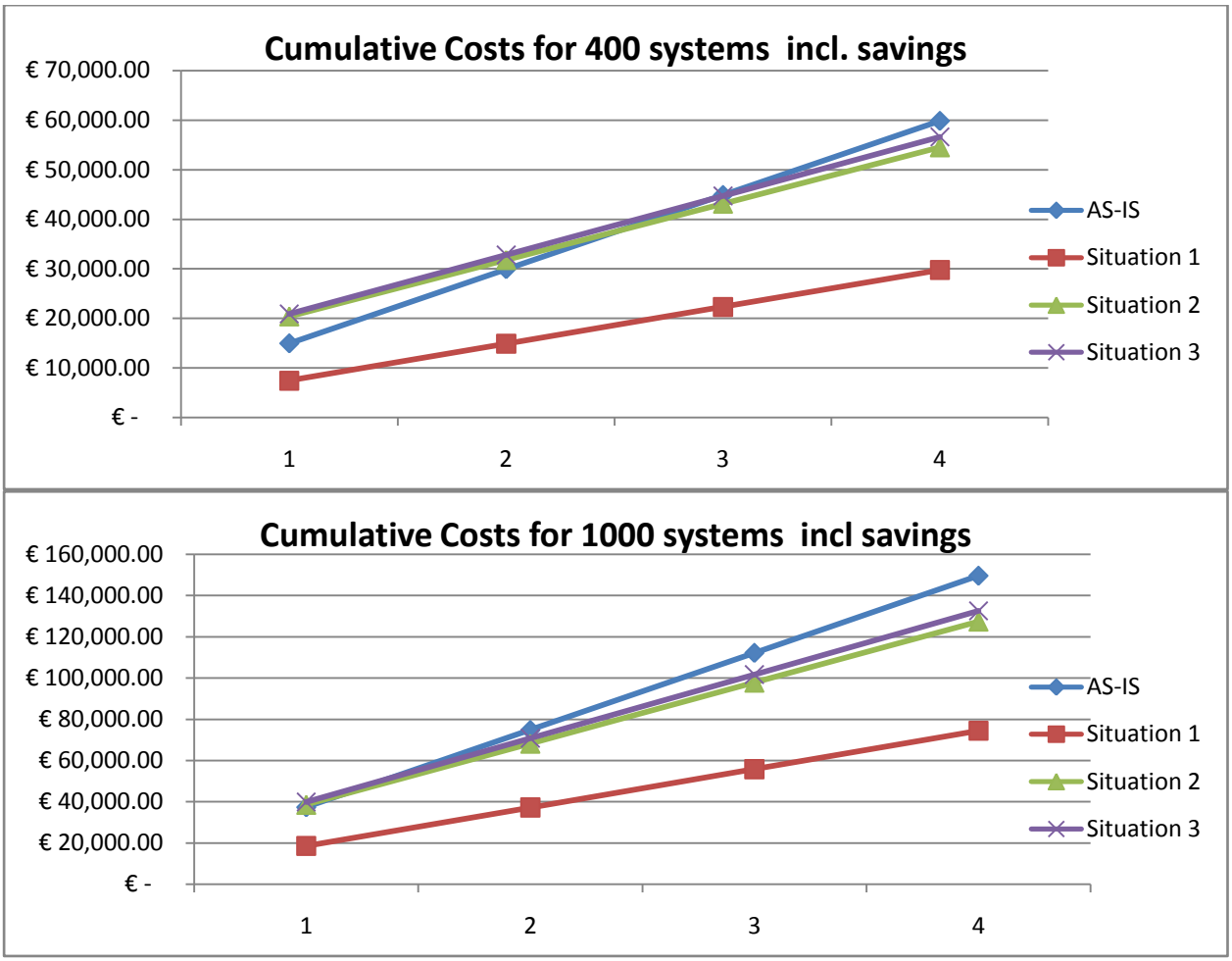
€ 60,000.00
€ 50,000.00
€ 40,000.00
€ 30,000.00
€ 20,000.00
€ 10,000.00
€ -
1
2
3
4
AS-IS
Situation 1
Situation 2
Situation 3


Cumulative Costs for 1000 systems
€ 160,000.00
€ 140,000.00
€ 120,000.00
€ 100,000.00
€ 80,000.00
€ 60,000.00
€ 40,000.00
€ 20,000.00
€ -
1
2
3
4
AS-IS
Situation 1
Situation 2
Situation 3

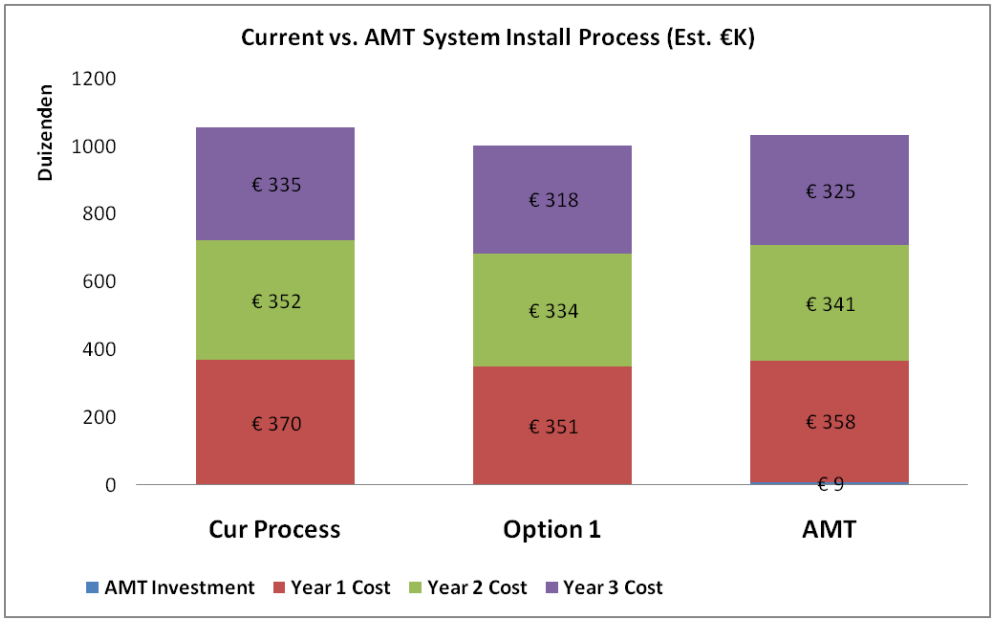

Cumulative Costs for 400 systems incl. savings
€ 70,000.00
€ 60,000.00
€ 50,000.00
€ 40,000.00
€ 30,000.00
€ 20,000.00
€ 10,000.00
€ -
1
2
3
4
AS-IS
Situation 1
Situation 2
Situation 3
Cumulative Costs for 1000 systems incl savings
€ 160,000.00
€ 140,000.00
€ 120,000.00
€ 100,000.00
€ 80,000.00
€ 60,000.00
€ 40,000.00
€ 20,000.00
€ -
1
2
3
4
AS-IS
Situation 1
Situation 2
Situation 3

Appendix N - Calculation costs from finance expert

Some prices are removed due to confidentiality.

Fixed Input (Δ #'s here)	Impacts all 3 options
Total install base	4,000
Yearly replacement rate	1,000
Reseller Labor Cost (per Hour)	
Field Service Labor Rate (per Hour)	€ 45
Daily Truck Cost (per Day)	
Reseller Imaging Costs (a system)	
Total incidents (#)	17000
Avg per incident (min)	-
Incidents marked for vPro (#)	61
Time saved vPro incidents (min)	1050
Avg. time saved vPro incidents (min)	17.21
Risk Free Rate for School	5%
VAT	19%

Variables (Δ #'s here)	Current Process	Proposed 1 (FS + Reseller)	AMT	Note
Batch count	8	6	6	Number of batch counts to deliver all 400 systems in given year
Physical Imaging (per unit in minutes)	0	0	0	Imaging on it self is probably not faster (depends on network cap
Packing/Unpacking (per unit in min)	6	3	3	Approximate time to pack/unpack each system, as-is 2 times vs F
System Boot up time (in min)	2	2	2	
System Prep by FS (in min)	37.8	18.9	30.24	Proposed 1 50% less time imaging is now done by reseller, AMT
Avg patch work per year	5	5	5	AMT would be faster, but no real data
Avg patch work time req (per min)	5	5	5	AMT would be faster, but no real data
Avg System Upgrade per year	1	1	1	AMT would be faster, but no real data
Avg System Upgrade time req (min)	10	10	10	AMT would be faster, but no real data
Avg Help Desk call per year	4.25	4.25	4.25	Data indicated 16905 tickets (including both students and employ
Avg Help Desk time req (min)	17.2	17.2	17.1	Vpro calculation
AMT Investment				Investment
AMT Building Software				Investment
AMT Building Infrastructure				Investment
AMT License per year				Yearly charge. Only need 1 certificate



Cost Summary	Current Process	Proposed 1 (FS + Reseller)	AMT	Note
Transportation prior to end user				Suppliers are currently absorbing the cost except the final leg
Transportation to End User				Truck cost only
Imaging service costs				
Physical Imaging				
				CR: Unpack/pack at the reseller, FS, and end user location PR1: Unpack/pack at the reseller, unpack at user location, AMT:
Packing/Unpacking				Unpack/pack at the reseller, unpack at user location
System Boot Up				System boot up at each location
VAT				
System Prep Time				
System Install Cost/Year	**€ 45,331**	**€ 26,221**	**€ 34,309**	
Patch work cost per year	€ 75,000	€ 75,000	€ 75,000	
System Upgrade Cost per Year	€ 30,000	€ 30,000	€ 30,000	
Help Desk Cost per Year	€ 219,300	€ 219,300	€ 218,513	
Sustaining Cost per Year	**€ 324,300**	**€ 324,300**	**€ 323,513**	
AMT Initial Investment			**€ 9,041**	

Cost Summary	Cur Process	Option 1	AMT	
AMT Investment			**€ 9,041**	
Year 1 Cost	**€ 369,631**	**€ 350,521**	**€ 357,822**	
Year 2 Cost	**€ 352,030**	**€ 333,829**	**€ 340,822**	TVM Adjusted
Year 3 Cost	**€ 335,266**	**€ 317,933**	**€ 324,631**	TVM Adjusted
Total NPV	**€ 1,056,927**	**€ 1,002,283**	**€ 1,032,315**	

Appendix O - Process description

Establishment of the research question

The base of the research question was established during one of the first meetings. That meeting was attended by colleagues with different jobs and backgrounds. Several components and interests were brought together: Intel wanted to expand their knowledge about the use of Intel vPro systems and the researcher wanted to investigate the impact on customer's processes. Since Intel was not familiar with a clear business impact of the technology, the decision was made to combine the two subjects. After a couple of weeks we were able to elaborate the research question.

Since Intel vPro platform contains four technologies at the moment of writing, it needed focus to make the research question more SMART. After reading and training on Intel vPro, it became clear that the Intel AMT technology is the core technology of the vPro platform. The next step was to decide how the impact on processes could be described for this research. During the 'ICT in Business' study several classes were dedicated to models, especially modeling Enterprise Architecture and building Petri Nets. This created the opportunity to research the possibility to model a specific technology and its impact on business processes with one modeling language. All these aspects together resulted in the main research questions, described in the section of 1.1.

The research question is not a standard research question as it is not a 'real business problem which should be solved. The fundaments of this research are curiosity and exploration. A standard research first tries to identify the fundamental problem by analysis using an ishikawa diagram, interviews or other techniques. This is an exploratory research question which did not involve an in-depth analysis phase.

The original main research question, proposed in the research proposal document was:

How can Intel AMT change the customer's business and processes in a positive manner?

The positive manner can be interpreted as an improvement in IT-efficiency or an increase in the quality of IT-services. IT-efficiency can be measured by a cost-benefit analysis and the quality of services can be measured by customer survey.

The main research question changed during this research, when it seemed possible that not all features were known and documented. In order to extend the value of this research, we decided to focus on possible unknown features and its impact on business processes. This resulted in a new research question:

What are the undiscovered features of Intel AMT and what impact do these features have on customers' business processes?

During the research it became clear that the undiscovered features were no undiscovered features at all. However it was an unknown application of Intel AMT, by using a known feature. Furthermore in order to visualize the impact of this technology, we needed a modeling language which is capable of visualizing the processes and the change in processes. Therefore a more "strategic" goal was formulated as a more concrete research question, which is the current research question in 1.1.2.

Thesis structure information

The first document structure reflected the process the researcher followed. The first step was to get familiar with the technology Intel AMT. The next step was to search a modeling language which could be used for this research. Having knowledge and experience of the technology and the modeling language made it possible, with several attempts, to create some models. After this, the researcher focused on the process and environment of the Intel SMG ESS team, trying to understand how the team works and why. Then it was possible to visit some customers and to start the next part of this research.

However, the document structure could be improved after 8 months, due to a better understanding. This increased insight meant a switch of the introduction of the modeling language and the introduction of the technology. It reflects a switch from emphasis on the technology towards the emphasis on the modeling language. This resulted in the new document structure, starting with the introduction of the modeling language followed by the introduction of the technology. In addition, this change better supports the models already provided in the technology chapter.

In the moment before finishing, this document was very large, containing all information. This did not improve the readability of this document for especially Intel reviewers. Therefore parts of the document were better off in the appendix, since this involved background information. Information that was moved to the appendix is: less important parts of the technology, the introduction of Intel and the introduction of the (case study) customer. Furthermore also process descriptions are not part of the main master thesis. Therefore also descriptions about the process of establishing the research were moved to the appendix. This involved: the establishment of the research question, and the change information about the document's structure.