

Future development of mobile services and applications examined through the real options approach

JAN EDELMANN AND JOUNI KOIVUNIEMI



Jan Edelmann, researcher and PhD Student at Lappeenranta University of Technology (LUT), Finland

The present ICT industry indicates that the mobile services and applications are going to change radically in the future. The future evolution of mobile applications and services means seamless integration both technologically and on application and service level towards more attractive solutions for users. The attractiveness of mobile applications and services in the future relies heavily on comprehensive fulfillment of user needs. In our view, applications and services are bundled together, called Integrated Mobile Applications and Services.

The business environment related to a new paradigm in mobile services and applications is highly uncertain. An individual firm in the mobile industry has to make choices concerning its investments to be prepared for the contingent future. The Real Options Approach tries to explain how a firm is able to achieve the most from the opportunities offered to it and how to avoid the downsides.

1 Introduction

The competitive situation in telecoms is going to change in the countries where the mobile markets are maturing and the competition will make the traditional business models of mobility less attractive. Companies need to seek turnkeys to new sustainable business models, since many of the practiced models have and will become obsolete. At the same time telecom companies' interests in integrating users and their needs more tightly in the development processes have increased. New business opportunities may lie in the area of integrated mobile application and service development, which takes users' overall needs more closely into account.

The Nordic ICT-industry, e.g. Nokia, TeliaSonera, and TietoEnator (in Nets seminar, 2003), have expressed their remarks about the integration on different technological levels expecting that there will be radical convergence in technological layers. We can expect integration on the application and service level as well. This reflects the industrial expectations about the future, where the current way of doing business might become unprofitable.

The development of mobile applications and services in the future may require companies to open their innovation and product development systems more in order to enable close cross-organizational linkages and formation of trustworthy collaborative networks. As the number of collaborative linkages to be managed increases, companies might also need to alter the philosophy of their application and service development from their current internal strategic management and decision-making point of view.

In the new kind of development environment, strategic options thinking might bring a valuable frame-

work for guiding strategic management decision-making and investment analysis in internal development programmes and collaborative undertakings to recognize strategic opportunities and the means for answering them. In this paper we will explain the existing problems in the current mobile applications and services illustrating the future development on a route to a vision of taking the user needs more into account.

The triple play between business, users and technology (see Figure 1) is very important when considering the strategic future options of a firm. A comprehensive view of users' role specific needs may beget a new paradigm in the mobile business – we call it *Integrated Mobile Applications and Services (IMAS)*.

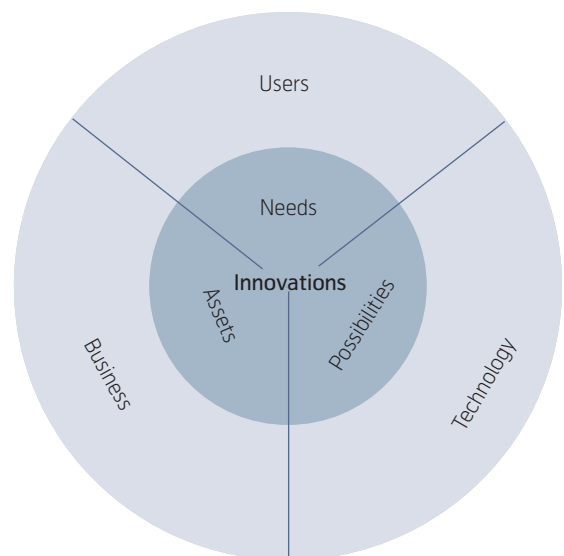


Figure 1 Triple play between business, users and technology

The user needs are only a part of this triple play, however. To achieve our vision, extensive cooperation to create standards and platforms for integrated mobile applications and services is most probably needed. A working triple play model is important to guarantee novel mobile experiences, killer experiences for the users. The approach where companies seek *killer applications* is argued to be wrong; it is just too technology oriented. Companies should seek *killer user experiences* instead (Advani & Choudhury, 2004). Accordingly, the IMAS should be designed based on the user needs, not on the industry needs.

The leverage of cooperation and collaboration over the user, business and technological domains has not been fully utilized. We see that there has been a lack of genuine collaboration in the development of mobile business because the companies' strategic thinking is still too much focused on their own core business, and this does not foster positive future development in the mobile industry from the collaborative point of view.

From the mobile industry companies' point of view the vision about integrated mobile applications and services is one possible future scenario among others. The current dominant way of doing business, i.e. building single applications for specific user needs, may continue, if the users are willing to fund it. From a technological point of view this could be called 'building silos'. On the other hand, successful bundling of services and applications to integrated offerings may increase the users' experienced value so much that the old way of making business may become challenged and obsolete. The problem concerning future development is what kind of steps would be appropriate a) from a single firm's point of view and b) from the point of view of the whole industry towards integrated mobile applications and services?

The Real Options Approach (ROA) may enlighten the issue. Through this thinking the business can be opened up so that the strategic opportunities can be seen and evaluated more naturally than with the widely used capital budgeting methods. The alternative future possibilities can be illustrated and evaluated with the help of ROA, imitating the actual decision-making process.

2 Current mobile services and applications – user perspective

There are a great number of mobile services and applications provided for users, but a very common characteristic among them is that they are separate and not sufficiently interlinked (see Figure 2). The

current mobile business is based on different kinds of services and applications: phone calls, text and picture messages, icons and ringing tones, location-based services, mobile device environments, just to mention a few examples. Mobile applications and services are designed more or less from a technological perspective, not from a genuine user perspective.

In recent years the industry has noticeably concentrated on the so-called rich media (including videos, audio, and pictures), which the industry has expected to be the next money-spinner. From the user's point of view there might not be any sense in concentrating only on a specific communication method because the real user needs probably exist somewhere else. The ultimate need of the user may not be to look at a picture of the other speaker – the need may be for instance to check if the child is at home. Showing a picture could be a part of a full service solution combined with information about the child's body temperature and location.

From the user's point of view a dispersed range of applications and services results in applications and services that are difficult and arduous to use (a multitude of applications for the same purpose, different terminals and devices with limited features), and an isolated set of different network and access technologies with severe problems in interoperability and openness. There are also services and applications

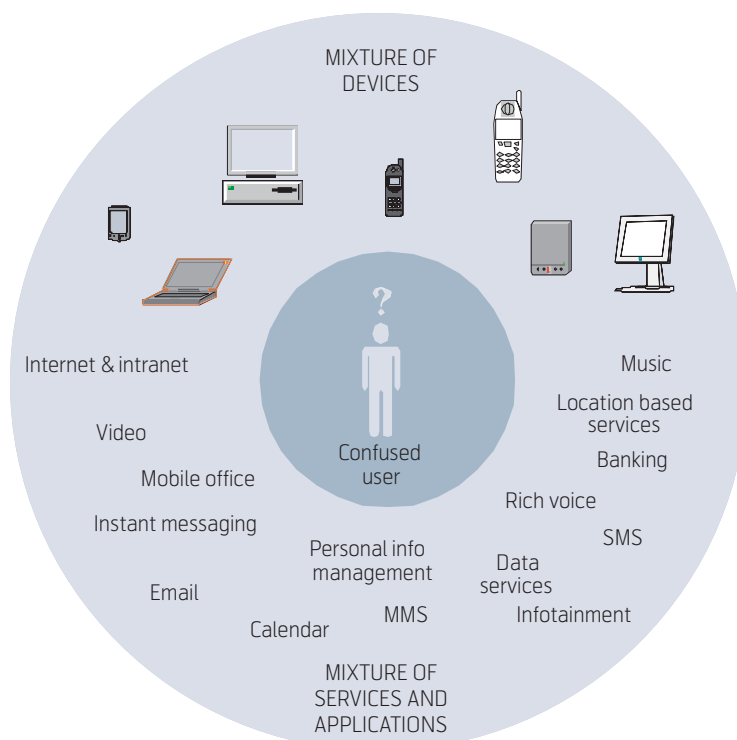


Figure 2 Current service and application space

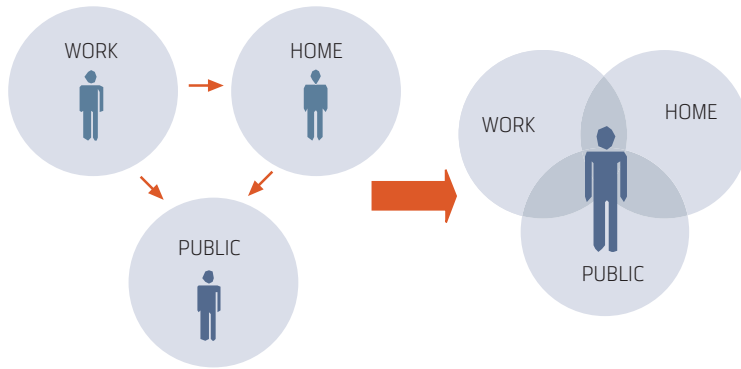


Figure 3 Different user environments and overlapping need areas

that are separated and overlapping even though the same person uses them for the same purposes (e.g. calendar and reservation services). Often the same or interlinked information in different applications and services has to be entered several times (e.g. subscription information in any web service).

When the number of distinct applications and services increases, the situation will get worse – the user’s confusion about appropriate applications for his needs may increase. Workable interconnections and interoperability between access technologies, operating systems, applications and services are needed and the users should be offered appropriate applications and access while ‘being mobile’ – acting actively at work, home and public environments. We claim that the existing applications and services are mainly targeted to fulfill only particular needs in particular areas or environments without the concern of comprehensive understanding about the users’ real needs over different environments.

Good examples of separate services are communication services, such as SMS (Short Message Service) and MMS (Multimedia Messaging Service), as well as location-based services which often fulfill only one part of the overall user need, whereas the combination of these services could fulfill the user needs better. Just to illustrate the situation, consider a business traveler starting his journey from Helsinki city center to the airport, and his flight being two hours late. In the normal scenario he would not know about the delay until arriving at the airport terminal. But, by connecting the flight schedules with the location-based information about the user, he could have received an SMS/MMS message while still staying in the city center telling him “Your flight will be two hours late. There are several fabulous restaurants in the area ...”. These kinds of services are just about to emerge in a large scale.

The existing business divides customers basically into two groups: business users and consumers. In reality there are no such groups. There are people who are either working or in their free time, but a combination is also possible, i.e. working at home. Nowadays, the mobile services, devices, and applications are targeted to these groups mainly in different price categories. Very often business users are offered mobile devices by their employer, and depending on the firm policy the user is probably allowed to use the same devices for private purposes as well. However, it is not uncommon that people carry many mobile devices, even several of them both at work and at home.

3 Comprehensive understanding of user needs

Users act as members in different kinds of environments (see Figure 3, where they carry out tasks and activities in different roles (e.g. policeman at work, father at home, soccer player in his free time). The users’ needs, which can be either manifested or latent, are derived from the users’ roles and role specific activities. Comprehensive understanding of the users’ needs is crucial in order to develop full service solutions for them. Defining the users’ needs is essential to foster the emergence of easy-to-use integrated mobile applications and services.

The present approach is that the user is offered services distinctly in each user environment instead of an individual approach. Personalization and customization are important aspects in integrated mobile applications and services.

To fulfill the needs it has to be understood how the person could easily use mobile services and applications in everyday tasks in different roles. The roles and needs and their sum may show that the needs and requirements are overlapping in many areas.

The concept of a multi-channel communication model (Henttonen & Blomqvist, 2003) may enlighten the problem. In two different roles, people have different needs based on the external requirements. They could need different types of communication channels even at the same time. They need specific information in specific situations and at specific times in different forms.

4 Future development of mobile applications and services

In the future scenarios the mobile technology enables the integration and bundling of services together in a way that was not feasible earlier. This should lead to

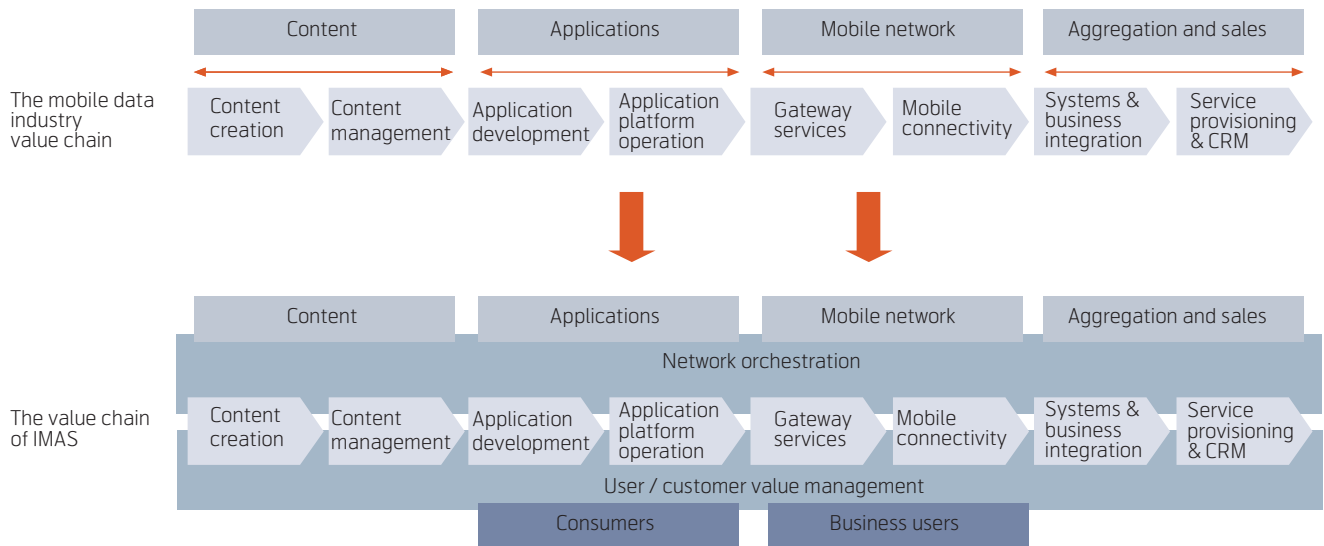


Figure 4 Transition from a mobile data industry value chain to a value chain of IMAS (modified from Karakanovsky, 2003)

more user-oriented business and changes in the current value network. The sustainability of mobile business models in the future is strongly based on the companies' ability to combine the user point of view with a right set of technological building blocks. The scenario may include strategic options for individual firms, which are examined below through the options perspective.

The situation may be that a fundamental prerequisite for IMAS development is a mutual agreement among value chain stakeholders to form collaborative networks, which would lead to 'integrated knowledge spaces' that enable the development of IMAS. In practice this would mean working e.g. in different standardization bodies and formations of heterogeneous development communities. Cooperation makes the integration of internal and external innovation possible, preparing the way for evolutionary and revolutionary development in terms of technology and applications. Another possibility is for a firm to start development work alone and try to develop a solution for this by itself. One single player, even a market leader, may be too weak to do this alone.

The IMAS scenario emphasizes the need for a new kind of players in the value system. The upper part of Figure 4 presents the current mobile data value chain (Siemens, 2001). First, the user value in the IMAS scenario would be the concern of the whole value chain. This would probably be best served by an intermediary actor whose main responsibility is to transform the needs and requirements from the user or customer side to the other value chain actors from the very beginning until service provision and CRM (Customer Relationship Management). On the offer-

ing side, the orchestration of the development network becomes crucial, as unified strategic conceptions of the underlying technological building blocks (e.g. platforms, open standards, protocols) and effective service development and provisioning are needed to provide integrated mobile applications and services.

There will be a transition from a mobile data industry value chain to a value chain of integrated mobile applications and services.

The new value chain with a new kind of actors would be better tuned to bundling applications and services together in the form of full service solutions that are capable of maintaining users' access to required services and information in any way, anywhere, and at any time. End-to-end management of applications and services would be easier as well, as a single actor takes the responsibility.

The value chain of IMAS emphasizes the fact that the fulfillment of users' needs should be the dominant factor – not the development of technologies even though the technological development is important in the fulfillment of user needs. When the number of services and applications increases, overlapping increases and the competitive business position can be improved by the full service way of thinking. Understanding the user and new unexpected uses of technology is a major continuous challenge and possibility for all companies in the mobile services business.

The development of integrated mobile applications and services requires challenging integration on many levels. Technological integration is needed in order to structure the platforms for applications and services

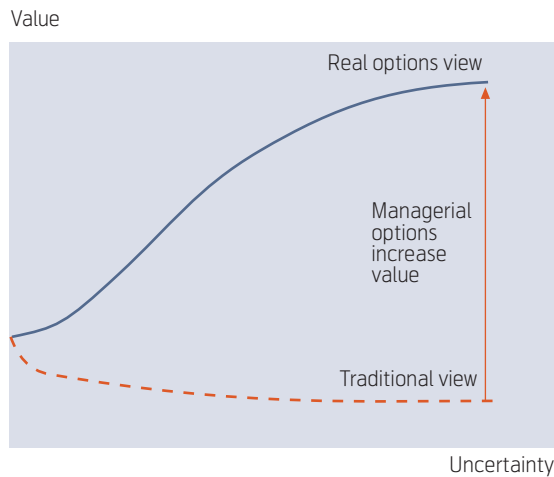


Figure 5 Uncertainty increases value

to ensure interoperability. To link applications together, there has to be common interfaces on different technological layers. The mobile market player and the whole industry require platforms and standards which enable an easy bundling of functions and components of services and applications. To create new technological platforms and standards, the industry can agree upon building a platform together or compete in building it. For instance, OSA, Open Service Architecture is one possible way to approach integration in mobile environment. The OSA specifications define an architecture that makes it possible to service application developers to make use of network functionality through an open standardized interface, i.e. the OSA APIs (ETSI, 2003).

The technology architectures behind the telecoms are so huge, rigid, and heavy that it is very difficult for one player to do anything else than try to live with it. The telecom operators have been in the position of a doorman. They have controlled critical network functionalities very effectively. For this reason the operators have a crucial role in promoting the development work of integrated mobile applications and services, as well as in the provision of the required technological backbone. This is a strategic option where the right steps and timing are critical. It may take years or decades, depending on the efforts of the whole industry.

5 Decisions about the future

A sporadic strategic investment may radically change the entire business environment. The business and the firm may be at the source of something unequalled, which may offer better or worse possibilities from the perspective of the company's current stage. When a possible new business model is presented, the decision maker may feel somewhat insecure. A strategic investment may create possibilities that were not

detected earlier – because of the human incapability to follow a complicated and slightly accidental path that will become apparent in the future.

Technological development often depends upon the path of the past – despite the fact that there are discontinuities that have radical influence on history – at least in a short time scale. A threat that a decision maker may face is that a new business concept or a business factor may have a radical influence on their current business. This is hard to evaluate beforehand, because there is nothing that it could be compared with, or data that could support the decision.

A new technology platform investment in the ICT industry may be a strategic investment whose value lies in growth opportunities or options. To be able to see the business opportunities and the options that the firm has, one has to understand the strategic perspective and opportunities that can be achieved through the innovative investments. The key question is to identify the opportunities and their possible value for the firm.

The decision-making concerning strategic future investments is difficult to rationalize on the basis of accurate information, because that is not available. A common situation is that the decision-making is based on qualitative information and strong intuition only (Kyläheiko et al., 2002). A common situation in business is that a great idea or invention is seen as a great possibility for the firm, here IMAS – a strategic opportunity. The traditional budgeting and pricing methods are incapable of properly binding the possibilities and flexibility in calculations. Figure 5 illustrates how the traditional view operates the uncertainty versus the real options approach which says that when uncertainty increases, the value of the managerial options increases.

An increase in market uncertainty and technological uncertainty increases the real option value (Boer, 2000; Perlitz et al., 1999). As an example we can say that the greater the variance in the possible market value, the greater is the possibility to achieve great wins or losses. If the technological uncertainty is high, the risk can be decreased only by investing time and money. On the other hand, high technological uncertainty will not increase the possibilities to be successful in the current business, but will increase the potential upside.

6 Real option approach theory

The real option¹⁾ approach is a language to describe the possibilities the firm has so that the world can be opened up as a map of opportunities. On the other

hand, the ROA is purely a real world option valuating system to define mathematical values for alternative courses of action.

This approach is about investing now to exercise the right to develop a technological and market competence portfolio in the future (Vasudevan, 2001). Real options are options that are entrenched in real assets where the firm may have an option to expand a project, abandon it, or defer the investment, for instance.

6.1 Mathematical perspective

Through this thinking the business can be opened up so that the strategic opportunities can be seen and evaluated more naturally than with the widely used capital budgeting methods, such as the Discounted Cash Flow (DCF) (e.g. Zhu, 1999), which ignore the inborn flexibility the management carries out all the time (Campbell, 2001). Myers (1984) suggests that the ROA can be a helpful tool between finance and corporate strategy.

According to the Black-Scholes model, when there is high uncertainty and flexibility to respond to uncertainty, real options are important. Very often the real options value is high when the Net Present Value (NPV) shows that the value is close to zero (Copeland & Antikarov, 2001).

Dai et al. (2000) argue that the option pricing methods help management properly evaluate the opportunities that IT-investments create, and they also state that these methods are suitable for assessing the value of different types of IT-projects, including infrastructure projects, software prototyping, decision support systems, and technology standard-based projects.

The real options related to strategic IT-investments are usually so-called compound options (a combination of options), and only the Binomial and Geske models are able to handle these kinds of options (Perlitz et al., 1999). A common feature for all these models is that they are unrealistic from the managerial point of view. To value the options accurately, they should be reliably identified. They expect the manager to know for instance the maturity of the option, which in the case of real options is usually impossible to know beforehand. The models also require that the cash flows and expenses are known exactly.

So far the ROA has not been as simple and streamlined as most of the known decision-making and evaluating methods, and the option value may be based too much on uncertain estimates, which de-

crease the reliability of the calculations. The dilemma of the estimates about cash flows and volatilities must be solved before the valuation method can be absorbed directly into the firms' strategy process. We claim that the philosophy behind the ROA has a lot more managerial value than solely the option valuing, at least nowadays.

6.2 Philosophical perspective

The ROA helps the management to take into account the multiplicity of the future, in contrast to the traditional investment evaluating systems. The management is usually more capable of identifying threats than opportunities, and the ROA helps to see whether an investment contains some exceptional possibilities. To have option value, the investment project should be sizeable enough, strategic by nature and it should not consist of an up-front, irrecoverable cost (Brabazon, 1999).

The ROA is a way to tackle uncertainty that is related to the investment proposals where greater uncertainty means a possibility of greater wins or losses, meaning that the ROA offers flexibility through restricting the downside risk while preserving access to the upsides (Belanger, 2001). Flexibility is what matters. Keeping the options portfolio unbound and recoverable, the management may have a possibility to attain the goal. The ability to delay and wait for further information before making an irreversible decision has value (Herath & Park, 2001). If the investment would result in a loss in any likelihood, the opportunity to delay the decision of keeping the option alive has value (Dixit & Pindyck, 1995).

The ROA also allows the management to try things out and wait when the alternatives seem too uncertain. The small steps made may give the firm an advantage over competitors by being better prepared for the future than them. The logic behind the real options approach is illustrated in Figure 6, which is a way to communicate and even argue different alternatives and decisions of the firm.

When an opportunity is detected in the firm, it has to make decisions on future actions. It has different kinds of real options, for instance the option to defer or stage the investment in smaller steps. If the real options are bypassed, the firm will probably commit itself to the investment totally.

6.3 Classification of options

The firm can have different kinds of real options, some of which have been listed in Table 1. There are

1) The real option is a right but not an obligation to take action at a predetermined cost called the exercise price, for a predetermined period of time, which is the life of the option (Copeland & Antikarov, 2001).

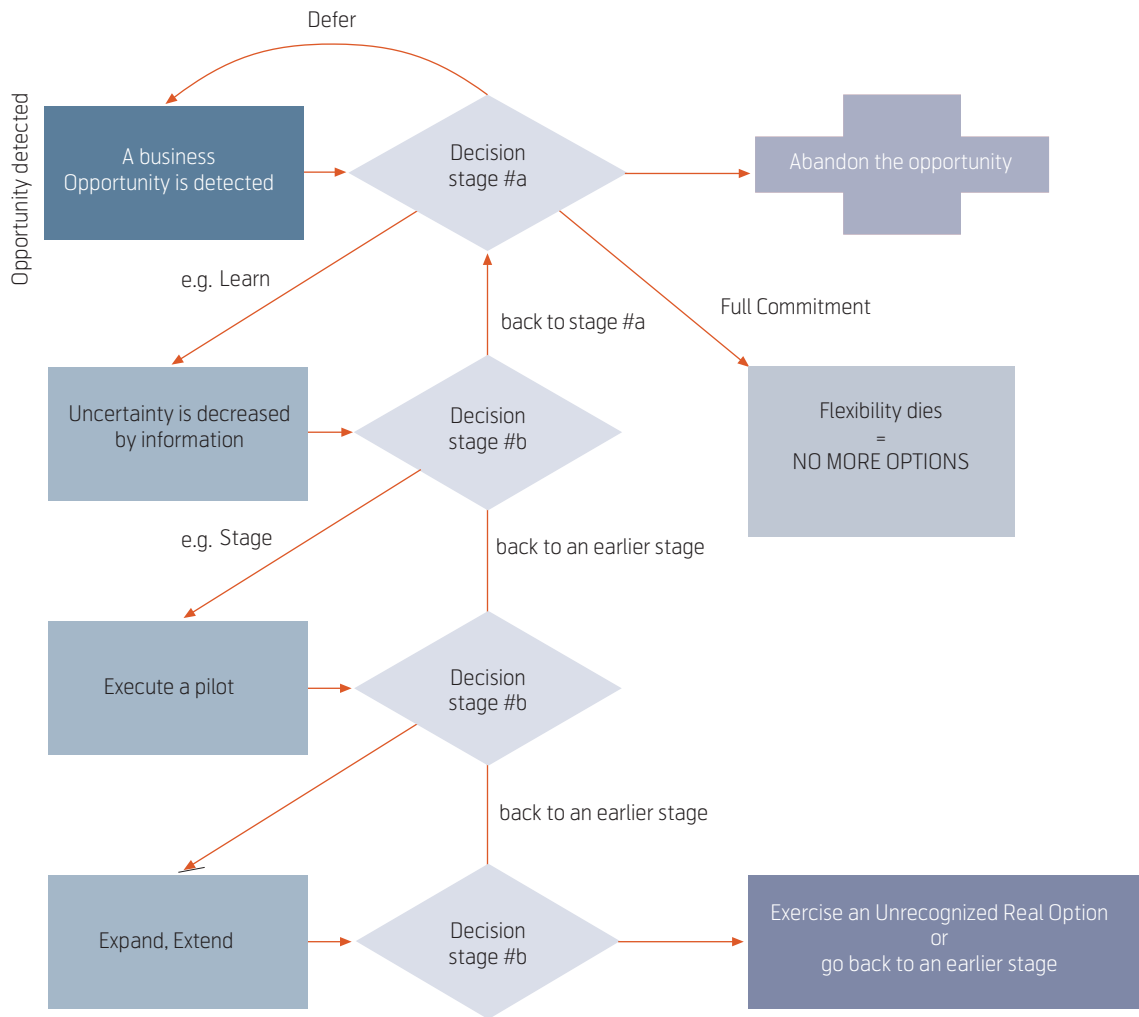


Figure 6 The logic behind the real options approach

options that the firm has in all situations (Määttä, 2002), such as *deferral* and *abandonment options*, meaning that the investment can always be deferred for instance in order to learn or the investment can be abandoned to avoid further *ex post* costs. The *option to contract*, *option to expand*, *option to extend*, and *option to switch* are options where the investment project can be scaled, switched, or scoped up. More complex option types are *switching options*, *compound options*, *rainbow options* and *compound rainbow options*. Instead of this classification, Latimore (2000) divides options simply into *growth options* and *flexibility options*. The first group concerns how the firm is able to increase its future business and the second group concerns how the firm is able to change the course of its plans in the future.

7 IMAS and ROA

The question of what kinds of real options the firm may have concerning the IMAS scenario is very relevant. We will now take a closer look at the options the firm may have when thinking about investing in

- | | |
|----------------------|----------------------------|
| ⇒ Deferral option | ⇒ Switching options |
| ⇒ Option to abandon | ⇒ Compound options |
| ⇒ Option to contract | ⇒ Rainbow options |
| ⇒ Option to expand | ⇒ Compound rainbow options |
| ⇒ Option to extend | |

Table 1 Different types of real options (Copeland & Antikarov, 2001). The firm may have different kinds of real options for each decision situation

IMAS. When the firm has a right to delay the investment or the investment can be temporarily set aside, the firm owns a *timing option* (a deferral option) to accumulate its knowledge to reduce the uncertainty instead of committing itself (Brabazon, 1999), remembering that additional information combined with prior information does not completely eliminate the uncertainty (Herath & Park, 2001). Because the integration of mobile applications and services is technically difficult (the possibility of success is low)

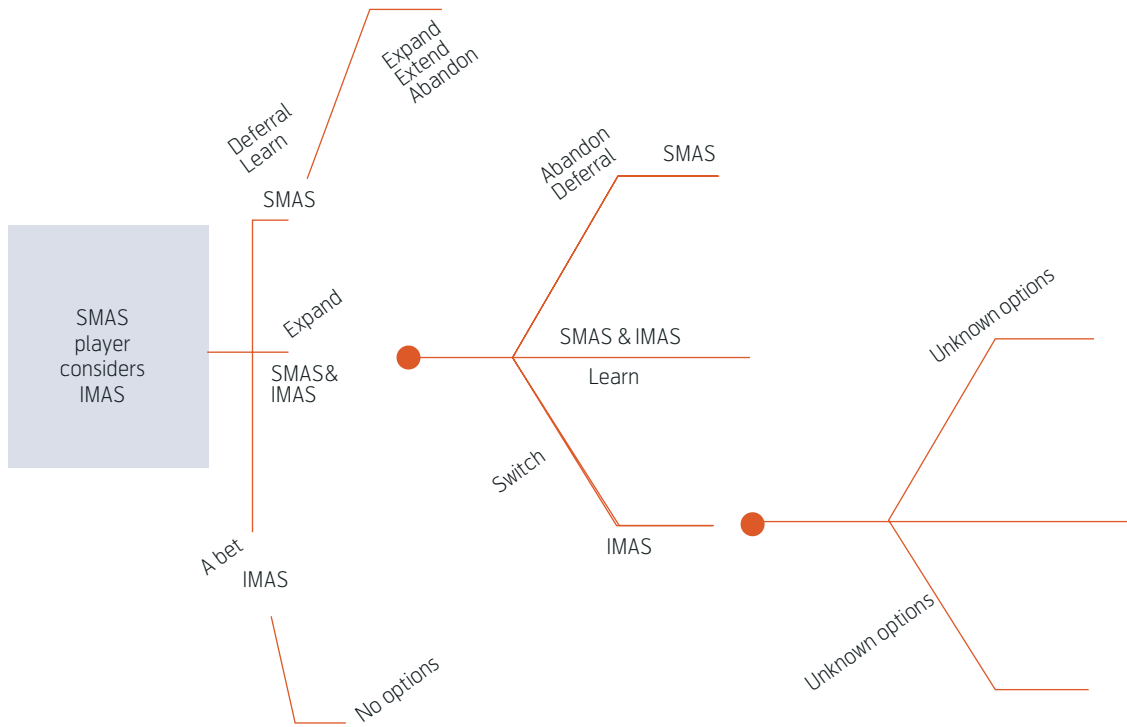


Figure 7 Illustration of some options the SMAS player may have
 SMAS player is considering taking the IMAS in the business portfolio. It can form a map of its options as presented in this illustration

the value of deferring and learning is high. Learning more about IMAS can lead the company to form a coalition with another firm to think about IMAS, for instance.

It is a question of *growth option* when an investment can be scaled up if new, favorable market information emerges. This kind of option means that the firm has already found out how the IMAS works. If it has had some successful pilots, the firm is able to extend its investments. This means that the firm will later extend or expand its business to new areas.

When the firm has an ability to switch the inputs or the outputs from an investment, we say it has particularly valuable *switching options* in a situation where competitor actions and market demand are difficult to forecast.

When the firm has an opportunity to shut down the project before the end of its lifetime the firm holds an *abandonment option*, having an ability to prevent any further losses. This option is crucial as the IMAS is concerned. The chance of success in a relatively short time is not likely but possible. The experiences may lead to a success, but on the other hand, the firm has to be prepared to abandon the idea for an indefinable time. An abandonment option may also be executed if the market potential of the selected application area of IMAS is considered infeasible.

In the case of the firm having a bundle or a sequence of merged options we can talk about *Compound/Rainbow options*. In addition to the above mentioned options, the firm may have firm specific options that have to be recognized.

Based on the above, we can identify a range of different option types that are related to the future IMAS business. The mentioned options are general options, and the real options are very often firm specific and have to be considered in the scale of the firm or the industry.

The decision-making process and pondering on an innovation with the ROA start by identifying the real options of the investment, and then evaluating the investment's real opportunities and challenges instead of any numeric values or probabilities. When the tree of choices has been built, it is time to think how much money is related to each opportunity and real option. If we end up using the binomial model, we can also think about the possibilities of each step. In Figure 7 a 'Separated' Mobile Applications and Services (SMAS) industry player is considering its options concerning business in the area of IMAS.

A company that is doing business with separated and distinct mobile applications and services basically has three alternatives. It can stay in the present SMAS business, or it can switch directly to the IMAS busi-

ness. The third and most recommended alternative is to take the IMAS into the business portfolio, as a growth option. All three choices include real options, of which the most important are the option to defer, the option to stage, and the flexibility options. With these options the company is able to decrease the uncertainty related to the IMAS and avoid unnecessary losses. The timing of executing the option is important. Both internal and external developments have to be taken into account. The options are not alive for ever and their value decreases over time.

From an individual firm's point of view, for instance the interest in the possibility to collaborate depends on the rate of technological and market uncertainty and needed investments. If the technological solution for the IMAS is relatively easy to find, there is no so-called real option value concerning technological uncertainty, but there might be extremely high market uncertainty that has value. A common platform for bundling mobile applications and services is seen to be a way to collaborate and save development costs. The gain for those who are in the front line will be the first-mover-advantage. They can take advantage of the standards faster than those who are not collaborating.

8 Conclusions

This paper has offered new ways of thinking for the development of the next generation mobile applications and services. The statements concerning the current mobile applications and services have mainly been made from the user point of view. The paper has provided ideas for the future directions of the development of mobile business, which we call Integrated Mobile Applications and Services (IMAS), from the Real Options Approach (ROA) point of view.

The market for mobile services and applications is rather young, but already there are a lot of different kinds of services and applications. As the number of different kinds of mobile applications and services has increased, there is a need for IMAS to make them less complex and more attractive to users.

The mobile business is today concentrated in 'silos', dividing users in groups based on the environments they operate in. Within these environments and groups different kinds of services and applications are offered, which have been developed for particular purposes only – these applications and services have no interfaces which would link them together.

Changing the concept of user (or customer) can crash the silos. The environments the user moves in should be handled as one area where the user regardless of role or situation maintains appropriate access to ser-

vices and applications without the irritation of distinct and separated services and applications. Comprehensive understanding of ultimate user needs requires new kinds of user integration mechanisms.

In Finland, some leading companies such as Nokia, have created scenarios (Ojanperä, 2003) about future mobile applications and services, which support the vision of IMAS. However, the scenario of IMAS is risky from one firm's perspective. To integrate applications and services there should be technological solutions that would bundle the applications and services together. As the development of IMAS may require a strong collaboration at value chain level (including users), a great part of the options related to investment opportunities should be evaluated together with other value chain actors.

The ROA provides a means of structuring and managing complex decision-making situations on how to keep options open while taking steps towards future business environment. The ROA can be used as a decision-making framework or 'philosophy' to handle competing strategic investments – in our case the use of ROA was illustrated through the IMAS case, which could be one potential future track in mobile business.

The use of ROA in strategic decision-making concerning future business should be started in practice from applying the philosophy itself. Once the basic ideas are understood and applied, it is appropriate to try to apply the valuation principles of ROA.

A rich landscape of integrated mobile applications and services is upon us as soon as the underlying mechanisms have been researched and developed in terms of technological integration, converged business models, role-centered user needs and user integration mechanisms.

References

- Advani, R, Choudhury, K. Making the most of B2C wireless. *California Management Review*, 12 (2), 39–49, 2004.
- Belanger, K L. Real Options are not the cure-all: When managers use flexibility in investment structures. *The 21st Annual International Conference of the Strategic Management Society*, San Francisco, CA, 2001.
- Brabazon, T. Valuing flexibility in capital investment decisions. *Accountancy Ireland*, 31 (6), 16–18, 1999.
- Campbell, J A. Identifying an Optimal Start-Up Date for Information Technology Projects: A Real Options

Approach. *Portland International Conference on Management of Engineering & Technology*, Portland, USA, 2001.

Copeland, T, Antikarov, V. *Real Options: a practitioner's guide*. New York, NY, Thomson Texere, 2001.

Dai, Q, Kauffman, R J, March, S T. *Analyzing Investments in Object-Oriented Middleware: An Options Perspective*. Anonymous publisher, 1–28, 2000.

Dixit, A K, Pindyck, R S. The Options Approach to Capital Investment. *Harvard Business Review*, 73 (3), 105–115, 1995.

Open Service Access (OSA); Application Programming Interface (API); Part 1: Overview. Final Draft. ETSI ES 202 915-1 v.1.2.1. Final Draft. June 9, 2004 [online] – URL: http://webapp.etsi.org/action%5CMV/MV20030801/es_20291501v010201m.pdf.

Henttonen, K, Blomqvist, K. Managing Distance and Diversity in a Dynamic Environment – The Role of Trust in Virtual Teams. *The 2nd Workshop on Trust within and between Organisations*, Amsterdam, the Netherlands, 2003.

Herath, H S B, Park, C S. Real options valuation and its relationship to Bayesian decision-making methods. *The Engineering Economist*, 46 (1), 1–32, 2001.

Karakanovsky, E. Mobile Services Evolution, Seminar Presentation. *ITU Seminar IMT-2000*, Sofia, 21–24 January 2003.

Kyläheiko, K, Sandström, J, Virkkunen, V. Dynamic Capability View in Terms of Real Options. *80 International Journal of Production Economics*, 65–83, 2002.

Latimore, D. Real options: Another way to value Internet initiatives. *Financial Executive*, 16 (3), 23–27, 2000.

Myers, S C. Finance Theory and Financial Strategy. *Interfaces*, 14, 126–137, 1984.

Määttä, A. *Assessing Strategic IT Investments of Forest Industry by Means of Real Options Approach*. Lappeenranta University of Technology, Finland, 2002. Masters thesis.

Ojanperä, T. Tietoliikenneteollisuuden tutkimusnäkömiä (The Future Aspects in ICT-Industry). In: *Nets 2003 Annual Conference*, Helsinki, May 21, 2003.

Perlitz, M, Peske, T, Schrank, R. Real options valuation: the new frontier in R&D project evaluation? *R&D Management*, 29 (3), 255–269, 1999.

Vasudevan, A. *Shaping the Future with a Portfolio of Real Options*. CommerceNet. March 9, 2001 [online] – URL: <http://www.commerce.net>

Zhu, K. Evaluating information technology investment: Cash flows or growth options? *11th Workshop on Information Systems and Economics – WISE'99*, Charlotte, NC, Dec 11–12, 1999.

Jan Edelmänn (27) is working as a researcher at Telecom Business Research Center, and at the Department of Business Administration at Lappeenranta University of Technology, located in Lappeenranta, Finland. He holds M.Sc. (Econ.) degree from Lappeenranta University of Technology. He is currently carrying out his doctoral thesis on the subject of Managing strategic technology investments under uncertainty with the real options approach. His main research interests include information and communication technologies and options approach in strategic innovation evaluation and selection.

email: edelmann@lut.fi

Jouni Koivuniemi (32) is working as a project manager and a researcher at Telecom Business Research Center, and at the Department of Industrial Engineering at Lappeenranta University of Technology, located in Lappeenranta, Finland. He holds M.Sc. (Tech.) degree from Lappeenranta University of Technology. He is currently carrying out his doctoral thesis in Management of Technology on the subject of product innovation management in networked environments. His main research interests include innovation management systems and processes, front end of innovation and strategic evaluation and selection of R&D projects.

email: jouni.koivuniemi@lut.fi