Product & Technology Roadmapping[1] in the Mobile Phone Industry

Martin Karlsson & Ola Dawidson
Department of Operations Management and Work Organization, Chalmers University of Technology, Sweden

Abstract
Ericsson Mobile Platforms (EMP) is a developer of technical platforms for cell-phones. The shift from GSM to UMTS has led to a massive increase in both technological content and possible product functionality, resulting in increasing platform complexity. To handle the increasing complexity, EMP has made efforts to improve its Product & Technology Planning processes.

This paper describes and analyzes how an implementation of Product & Technology Roadmapping (PTR) in this complex context has forced the organization to adapt its organizational solutions, working practices, and communication structure. The presently available theory is fragmented in the sense that it thoroughly describes the *whys* of PTR, whereas the *how-tos* are more of a white area. Regarding organization of PTR, theory argues for the use of a central planning group, but does not consider alternatives to this solution when the number of dependencies between units increases rapidly in highly complex organizations. A central planning group will not in this case be able to dig into the detail needed for efficient synchronization between organizational units. Further, present theory does not take into consideration that different organizational units need different time-horizons, making the goals of PTR differ in a manner that affects communication between the units. These are some of the issues discussed in the paper.

Background
Since the late 1980s mobile phones have developed from being merely instruments for verbal communication into advanced multimedia communications devices. During this period two great shifts in technology have mainly been experienced, first from analogue NMT (1st generation) technology to digital GSM (2nd generation), and later to high-bandwidth UMTS (3rd generation). With the high quality of verbal communication offered by the GSM technology, companies started to look for possible add-ons to the phones both as communication devices and as hand-held computers. Short message service (SMS), phone book, and calendar are just a few of the applications that were built in during the GSM era. Multimedia messaging service (MMS), positioning systems, and video communication are examples among the possibilities with UMTS.

During the period of added functionality, the product complexity grew higher. When the technology shifted from GSM to UMTS it grew too high for one person to understand the whole product in reasonable detail [1]. The lines of program code required increased by several powers, likewise for the number of gates required in the hardware. Possible functionality grew to levels that can be compared with hand-held computers.

[1] A planning tool that aims at aligning Product and Technology Development with business decisions.

In the NMT and early GSM eras, technology advances set the requirements for product development. When the application breadth widened, the consumer's needs became more important to consider early in development, thus making the product requirements shift from technology push toward market pull [2].

The introduction of the 3rd generation also came at a somewhat inappropriate time. The mobile phone market stagnated as the IT boom of the late 1990s came to an end. As a consequence, development resources had to be used sparsely, with an increased market focus as a result.

However, to ensure that technology development is in line with supposed future application requirements, a common plan is needed. Though market needs are pronounced in terms of functionality, the possible technical solutions for each function are virtually endless.

Research aim

The aim of this paper is to analyze how the introduction of Product & Technology Roadmapping (PTR) has forced the organization to adapt with respect to organizational solutions, working practices, and communication structure. Considering that PTR is a rather young research area, the *whys* are thoroughly described by previous research, yet the *how-tos* are relatively unknown. Our aim is thus to describe and examine how the organization has responded to the introduction of PTR by identifying and analyzing problems experienced at the case company, in relation to the present theory.

Methodology

This research has been conducted by studying a single case that stands out in two dimensions. Firstly, the case company is active in a field with very short lead-times concerning technology time-to-market. As this forces the company to have fast planning cycles in order to be up-to-date, it enables the researchers to study a complete cycle of planning during a short time period. Secondly, the product that is developed has become much more complex during recent years, which we believe will have effects on the organizational reaction to PTR implementation.

Ensuring validity in research which aims at finding subjective opinions is hard [3]. The researcher cannot interfere with the respondents beyond making sure that no information is left out. The researchers have to inflict as little obtrusiveness as possible [3]. The interviews conducted were based on an interview guide, but they were also adapted during the discussions. In this sense the interviews were semi-structured.

The interviewees selected consist of a complete selection on departmental level. These in turn selected personnel to whom they had delegated planning responsibility, or else who had previously been involved in planning activities. A total of 17 people were interviewed from the different departments.

Situational description

The development of the 3rd generation of mobile phones has not been a discontinuous jump from the second generation. The standards have been evolving since the late 1990s and the organization to handle the development has simultaneously been changing. However, during late 2001 a larger organizational change started at the case company, and it is the effects of this specific change that will be analyzed.

Company

Ericsson Mobile Platforms (EMP) is a part of Ericsson Consumer Products that develops the technical platform for mobile phones sold to, among others, Sony Ericsson. The company was founded in late 2001 when Ericsson announced the joint venture with Sony. The platforms developed contain the hardware and software basis for building mobile phones. Some technologies, however, are bought from suppliers, like the Bluetooth chip for short-range communication. The platform is adaptable in terms of applications, where the customers can add functionality to fit their products' requirements.

This large change also led to two internal changes within EMP. Firstly, a strong project organization was founded to handle the development of the upcoming platform. Secondly, the Technology Strategy Council (TSC) was founded, within the Technology organization, with the purpose of handling technology planning and prioritization decisions. See Figure 1 below.

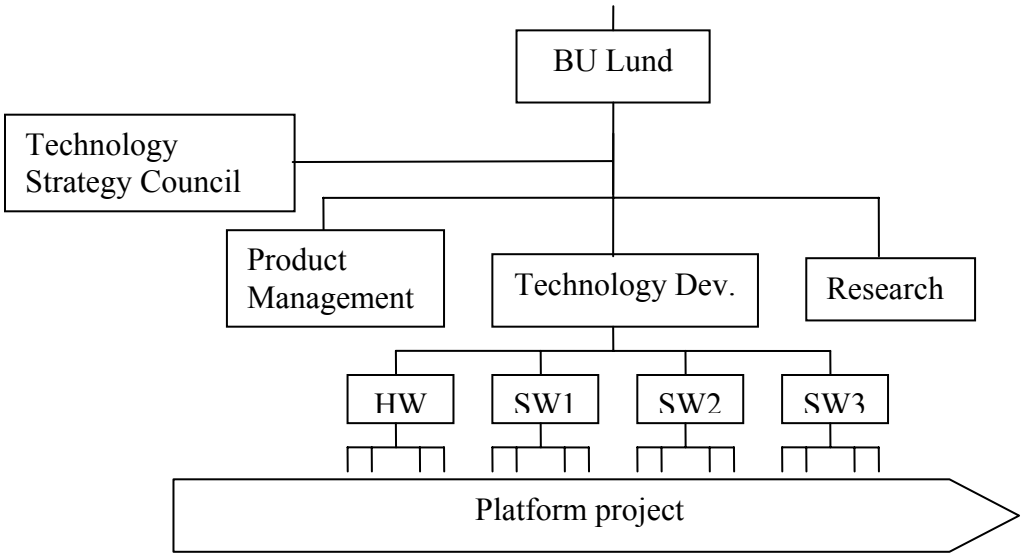

Figure 1 - EMP organization today

The *Research* department is responsible for looking at long-term technological developments in the telecommunications business. A small group of PhDs in different areas investigate future developments as well as improvements of present technologies. The department resources also provide advisors for the planning in the Technology Development Departments.

The *Technology Development* is divided in four main departments, Hard Ware (HW) and Soft Ware 1-3 (SW1-3), which in turn are divided in 3-4 smaller units. The HW department develops the communication and application Hard Ware for the platform. The SW departments are then divided according to the level of Soft Ware developed. These personnel are to a large extent engaged in present development projects.

The platform is developed in the *Platform Project*. This project is staffed from the Technology Departments and occupies about 80% of the personnel from these. The planning scope for the Platform Project is approximately one year, during which the project is controlled by a stage-gate model. The planning for the next-generation platform is also a part of this project. The next-generation project presently involves a small group of personnel primarily with systems competence.

The *Product Management* is the link between the customers and the technology development, responsible for handling information about what the company will be able to incorporate in the future platforms. The department is divided in functional areas, i.e. local connectivity; which concerns short-range radio, IR and connections via cord. The market planning for the next-generation platform is done by a unit at this department.

The *Technology Strategy Council* is responsible for the overall long-term technology planning. The council does not develop any plans of its own but delegates the actual development to the departments. Questions concern trade-offs between goals, prioritization issues, as well as making sure that there are no mismatches between the plans from Product Management and the Functional Department.

Technology planning activities are focused mainly around the four departments, Research, Technology Development, Product Management, and the Technology Strategy Council. The two next-generation platform projects are also part of the planning, but are presently only in a pre-study phase.

Action background

When the Technology Strategy Council was founded in late 2001, it started its work by sending out a "call for plans" to the departments in Technology Development. The purpose of this call was to establish the foundation for long-term technology planning and, at the same time, force the departments to look at the longer term in a situation that is highly pressured by short-term development projects.

Simultaneously the project organization was started. Formal groups to handle the connection between technology and function were established within the project, so-called functional groups. The planning in the project is, quite naturally, focused on the present project.

The Product Management develops roadmaps aimed at market needs. The roadmaps describe functions in terms of use, i.e. what different functional uses the platform will be

able to handle, for example connecting to a PC or turning off a car alarm via Bluetooth. These plans are made with a three-year view in mind.

Frame of reference

The planning concept called roadmapping has been widely used and researched for the last decade, and several companies have found roadmapping to facilitate long-term planning and cross-functional communication. There are generally four types of roadmaps, as described in Figure 2 below.

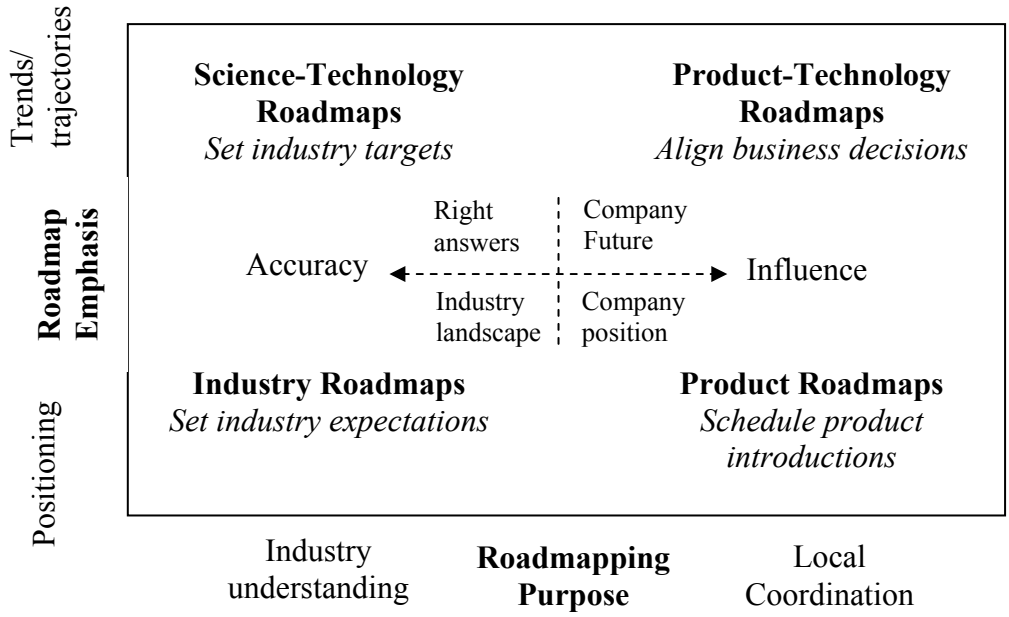

Figure 2 – The four different areas of roadmapping (adapted from [4])

This analysis will focus on the Product-Technology Roadmaps section (hereafter referred to as PTR) since this is the part most applicable to the problem studied. Thus, the purpose of establishing roadmaps at EMP is to coordinate local resources more effectively in order to find long-term trends that will influence the future of the company.

To analyze PTR in this case we need to view prior research from different perspectives. The first perspective concerns the definition of a *purpose* with PTR set up by the companies using it on one side, and the researchers on the other. Secondly, we must observe how companies choose to *organize* PTR. And finally, we need to review how to successfully manage *communication*.

Purpose of PTR

According to EIRMA [5], TRM (Technology Road Mapping) is a living document that is constantly evolving as circumstances change. The purpose is to create a framework for discussion between the functions Marketing, Manufacturing, and Technology, which lead to conscious integration of all aspects of business.

According to Kappel [4], the PTR activity is the creation and communication of the roadmap. When the know-how, know-what, and know-why factors are identified, the process is then threefold: firstly, establishing the relative priorities of these factors; secondly, extending them to produce future forecasts; and finally, linking them to justify R&D investments and coordinate efforts of responsible groups.

Philips Electronic, ABB, and Motorola are a few of the companies that are using PTR. Philips [6] starts by pointing out that defining the purpose of PTR is one of the first issues that the established PTR team has to consider. Further, the purpose is to integrate business with technology and show the interaction between different technologies in both the short and long terms. ABB [5] on the other hand chooses to use PTR as an evaluation aiming at finding projects with high business impact. ABB also aims to foster long-term thinking and avoid overlap by visualizing synergies. Motorola [7] has divided its PTR in eight different parts with different purposes: description of business, business mission, strategies, market share, sales history and forecast, product life cycle curves, product plan, experience curve, and competition.

Summarizing the different aspects of purpose, *synchronization* with other parts of the business, *establishing long-term planning*, and *improved forecasting* are common purposes. Philips adds an important issue when stating that the team should define its own purpose. Hence the question of long-term planning, where the definition of long-term naturally depends on the situation and one's lead-time in development [4].

Synchronization

Synchronization, according to the literature, is established by creating a PTR team with the different parties represented [5]. This organizational group would then represent competencies needed for creating a PTR which considers both synchronization and long-term forecasting issues.

If we consider synchronization from a dependency perspective, another issue needs to be discussed. According to the previous literature, a number of different parts of the business need to be synchronized [4-9]. The dependencies between these parts, however, may not be reciprocal, and thus the synchronization might not need to be done both ways. Thompson [10] defines dependencies as three different ways:

1. Pooled, where each element gives a discrete contribution to the project and each element proceeds irrespective of other elements.
2. Sequential, in which one element's output becomes another element's input.
3. Reciprocal, where each element's output becomes the other element's input and the actions of each element must be modified to the actions of others.

The type of synchronization would thus have an impact on both the type of organization needed for PTR and the necessary communication.

Organization & communication
Previous researchers emphasize the need for a central group responsible for the PTR. This PTR group should consist of personnel representing all relevant business functions, and its size and composition depend very much on the organization of the company [5]. Companies using PTR often choose to apply it on different levels. Philips, for instance, applies it to products, systems, components, and production processes [6]. It is, however, unclear whether there are several PTR teams on these different levels or whether the same central team is responsible for all the different PTRs.

Considering the effects of different PTR teams responsible for planning on different levels, products, modules, part-systems etc., the number of dependencies must be studied. For example, if a company chooses to organize its PTR around a single group, the connections to the other "relevant business functions" will be quite limited. On the other hand, if the company has a product divided in e.g. 10 partial systems and chooses to assign one PTR group to each of these, the number of connections would at first sight seem to multiply tenfold. However, considering that each of the product parts is dependent on at least one other part, the number of connections would increase more. For example, if there are 10 PTR teams that each need to synchronize with at least three other PTR teams, and there are 3 other relevant business functions, the number of connections would be 45. See Figure 3 below.

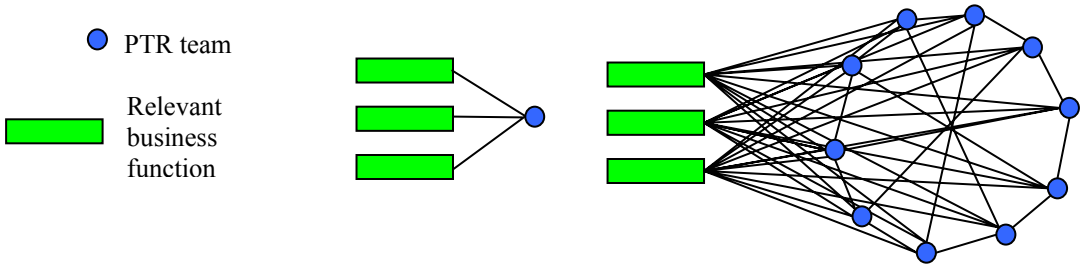

Figure 3 - Dependencies with respect to PTR organization, central PTR vs. dispersed PTR

The resulting effect is that the company has to choose an organization of PTR which not only enables the PTR team(s) to plan at sufficient detail, but also ensures that the complexity within the PTR planning does not grow to levels where synchronization becomes difficult. One might argue that a central unit placed within the circle of PTR teams with the purpose of managing this network will be able to handle even the large number of interactions [11]. This, however, assumes that the central group can grasp the complete set of plans down on the detail level where synchronization is needed. In terms of long-term planning, this level might be high enough in detail for a central group to manage. But when the planning horizon closes in and more detail is needed, the group might not be able to dig into the detail needed for synchronization.

Case discussion
The purpose of PTR at EMP was firstly to get a clearer grasp of how the different departments viewed the future in terms of technological and functional developments in their area. Further, the purpose of establishing a central PTR group (TSC) was to acquire

input from the departments on how the actual PTR planning should be done. Somewhat separate from the TSC organization are the next-generation projects. The purpose of these (market & technology) is to survey functional and technological developments in the next generation. Also, these plans aim at giving an early look at the interrelations between functionality and technology.

The first plans from the departments in this new planning organization did not meet the TSC group's expectations of what they believed long-term plans were. Especially the SW departments had problems in looking further than the present development project, with a few exceptions. Figure 4 below shows the responses from the different departments[2].

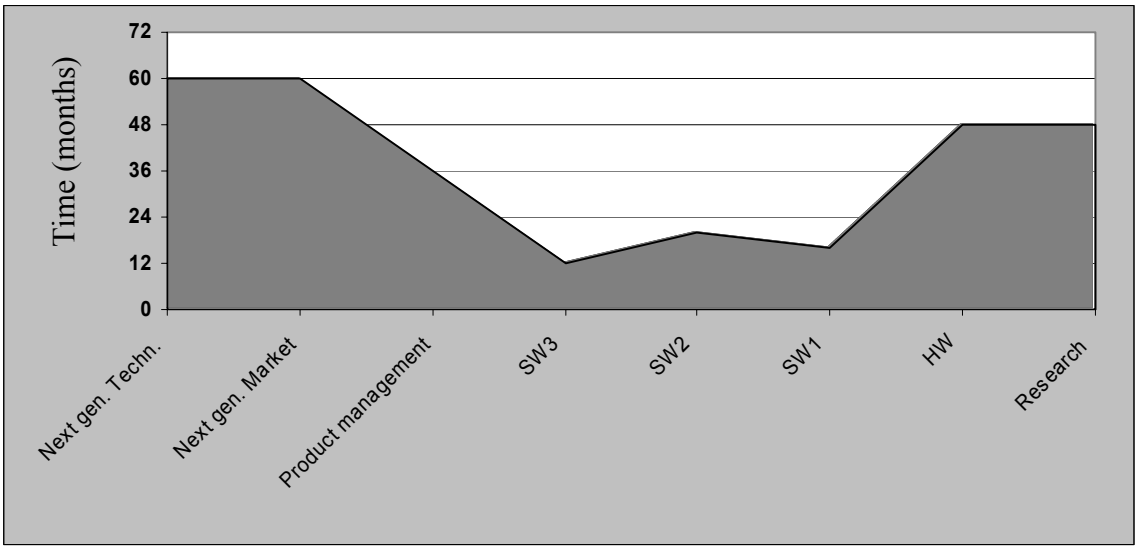

Figure 4 - Time scope in planning compared with closeness to market

The next-generation technology and market are departments responsible for planning for next platform release. In this sense, the department is not involved in the platform project. SW1,2,3 and HW on the other hand, as mentioned above, are mostly working within the project. However, the HW department has reached a time in the project where most of its work has been finished. According to the interviews, the longer time-horizon in the HW department has traditionally been necessary due to the long development times for the technology developed.

Interviews with the SW departments show that the planning horizon should be 24-36 months, depending on the type of SW developed. Considering the short lead-time in SW development, ranging from 3-6 months, the present plans might however not be too short in some cases. Most employees relate this presently much shorter horizon to lack of resources, due to a very time-consuming platform project. The TSC group has called for plans, but since there is a strong project organization, this has to be down-prioritized in

[2] Research does not develop any specific plans, but its staff are involved as advisors in projects and aim for the time-horizon noted below.

favor of the project. The importance of having management support is a key issue according to several researchers in the area [5, 6].

Organization
The organization of the planning activities is presently, as mentioned above, centered around the TSC group. This group then calls for plans from four technology departments, and simultaneously from the Product Management, where the plans are divided in functional areas. The next-generation projects are formally parts of the Platform Project and the Product Management respectively. As parts of the planning organization, however, they are separate units, and should be treated as such. See Figure 5 below.

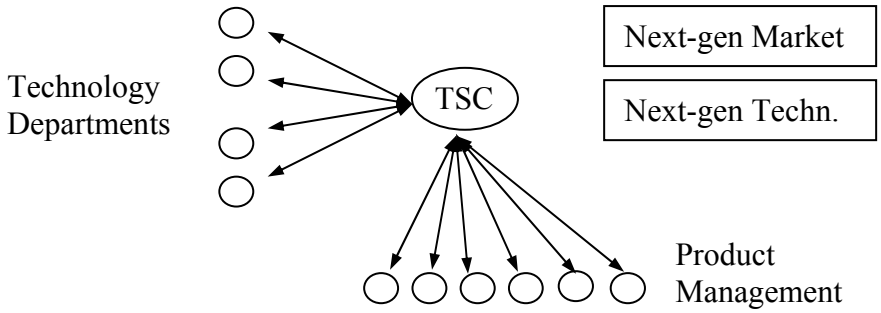

Figure 5 - The planning organization

EMP has thus chosen to divide PTR into several distinct smaller units. A large difference from the cases described in the literature is that the technology and market are separately planned, at least concerning the main focus in each area. Considering each of the plans at the technology department, these aim of course at being synchronized with the corresponding functions on the market side.

Synchronization & Communication
Synchronization is needed between a number of different organizational units in the planning organization. See Figure 6 below.

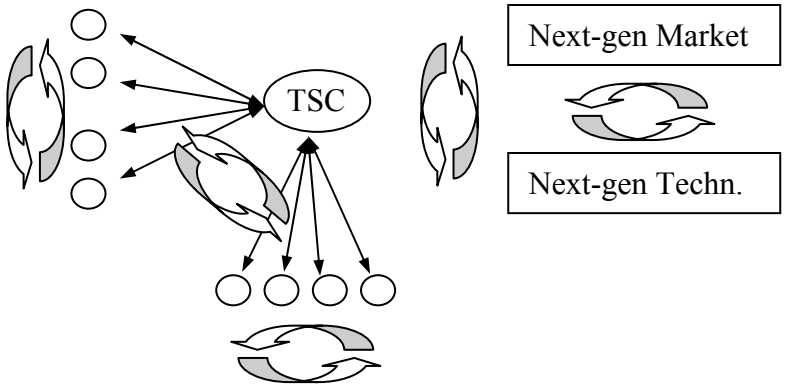

Figure 6 - The need for synchronization

Firstly, there is a need for synchronizing the product management and technology development departments internally, due to the architectural layout of the technical

product and the interdependence of functionality. Secondly, technology needs to be synchronized with functionality, i.e. between the Technology Development departments and product management. Thirdly, the same synchronization is needed between the next-generation planning groups, where one is situated at the Product Management department, and one in the Development Project. And lastly, synchronization is needed between the next-generation planning and the planning done within the TSC frame. The simple model of dependencies presented before is thus even more complicated in this practical case. The number of dependencies from the Technology Departments' view to relevant business functions would seem to be four, assuming that the next-generation plans are dealt with as one combined plan. However, as the Product Management also has divided its plans into sub-plans by functionality, the dependencies grow as functionality requires coordination between the Technology Departments, and become even more complex as the functionality can be solved in different ways.

The organizational solution to the need for synchronization is the TSC group. However, from the interviews one can see that it is unclear to the personnel where the responsibility for synchronization lies. The dilemma is that part of the personnel feel that it must be the responsibility of those developing the plans (the departments), and part believe that it is a TSC matter.

Regarding how much synchronization is actually done at this stage, the answers are quite similar to that concerning time-horizon. See Figure 7 below.

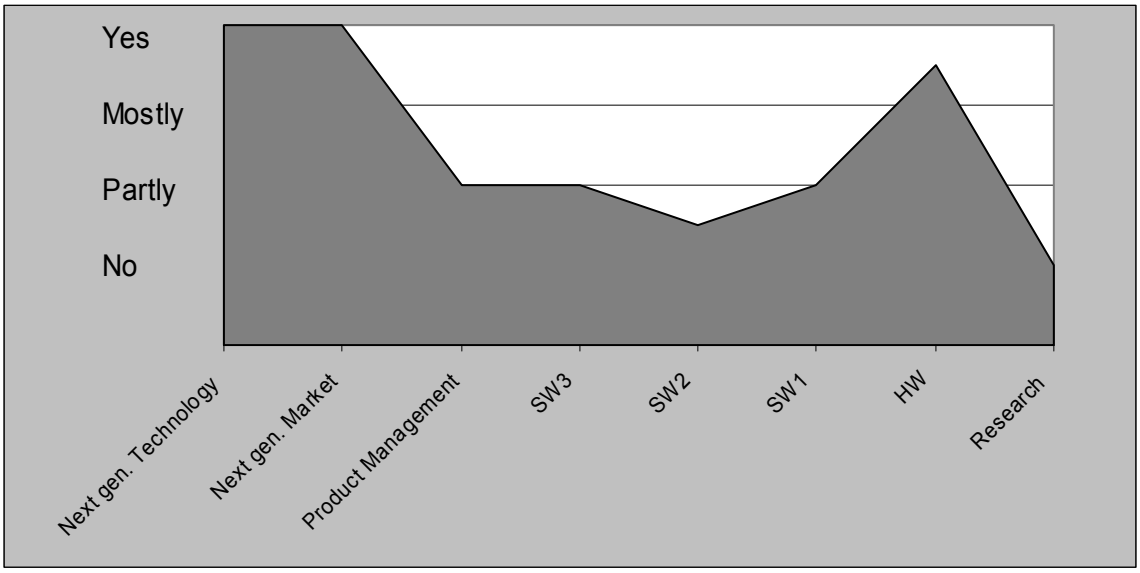

Figure 7 - To what degree do you synchronize technology and functional demands?

The high specialization of the personnel at Research makes them answer that they do not synchronize. However, since Research is supporting the planning at the departments, the personnel are active to some extent in the synchronization activity. The low rate at the SW departments can be explained by the strong Project Organization. These departments do synchronize, but mostly within the functional groups established in the Platform

Project. Of all personnel, 100% specifically state that it is important to consider the Technology / Functionality connection in the longer term.

At present, the only formal forums for synchronization, besides the TSC group, are the functional groups within the Platform Project. The interviews showed that there have been problems in getting the Product Management's personnel to attend these meetings. Product Management, on their side, have also felt that there is a need for more long-term connections to the Technology Departments, and have consequently started what they call Reference Groups. These Reference Groups, however, are not formally established but are meetings called by the Product Management with personnel that the respective functional area feels are connected to that functionality. These groups, though, are still in a tryout stage and the knowledge about them is limited.

As the Technology Departments also have felt the need for more communication forums, there are other informal forums. These are formed by the departments as connections to other Technology Departments that there is a dependency towards. In some cases the Technology Departments have also invited personnel from Product Management to participate. Such contacts, however, have been less successful and always based on informal connections, resulting in down-prioritizing by Product Management due to lack of resources.

Analysis

There is a great deal of overlap and synergetic effect between the different outlooks on PTR. Each area will be discussed separately but with the synergies exposed.

Purpose of PTR

Since the TCS group called for plans from Technology Development, part of the purpose was to find a suitable way to work continually with PTR, thus making the Technology Departments define part of the purpose for themselves. As shown by previous data, the Technology Departments have not fully been able to accomplish their own goals of long-term planning and synchronization. The opinions within the departments differ regarding how long a time-horizon the planning should have. Hence the problem is twofold. Firstly, the appropriate time-horizon must be agreed upon as a common purpose. Secondly, this time-horizon must be met. The technologies developed and maintained within the departments are of course also different; for example, even if the majority of technologies are well-known to the department, some are less-known, and thus might have to be planned with a longer time-horizon. These differences also need to be defined when discussing an appropriate time-horizon.

Defining the purpose of PTR also involves defining the scope from a value-chain perspective. Even though the Roadmapping might fall into the PTR box in Figure 2 above, the actual Roadmapping needed at the company may differ from the definition of PTR. For instance, the PTR developed probably needs to be synchronized with future product releases, and should probably also consider the future industry targets, even if the type of synchronization is more of a sequential nature. Although the definitions might be clear from a theoretical standpoint, the practical translation should be defined by the

company. Considering the present theory, it would seem that awareness about the complete value-chain is required in PTR. A sequential dependency is thus acknowledged, but the need for reciprocal synchronization is unclear. In the case of EMP, the reciprocal dependencies would look like Figure 8 below.

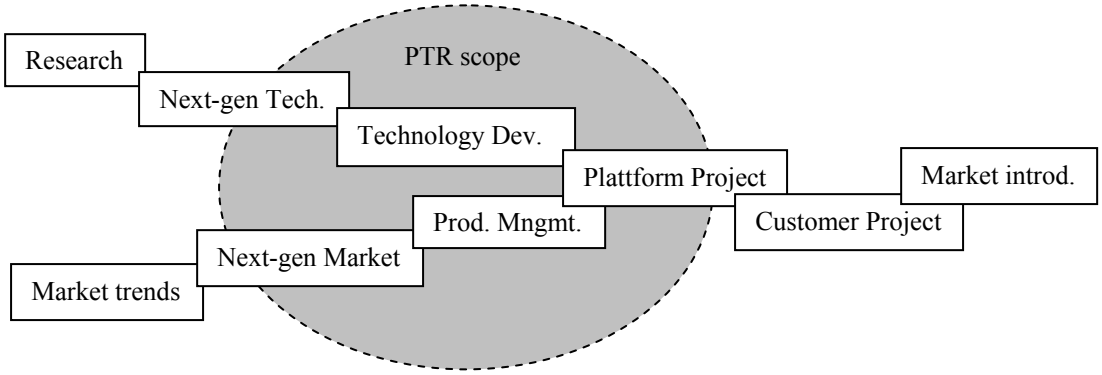

Figure 8 - Defining the proper scope of PTR

It might not be feasible, possible, or even necessary to synchronize reciprocally with the earliest or latest parts in the value chain. Long-term is, as stated before, also a matter of development lead-time, and as such it must be defined in the purpose of PTR.

A problem arises when the different departments that are supposed to be synchronized have different purposes of the PTRs. Product Management, for example, is developing its PTRs with the purpose of showing customers what EMP will be able to offer three years from now. If the SW Departments' PTRs have a 12-month horizon, that synchronization is simply not possible. Thus, Product Management has made efforts to get the needed information through Reference Groups.

The HW department, on the other hand, does not experience the same problem. Since HW traditionally has been far ahead of the other departments, partly because of the longer development lead-times in HW, the other departments have adapted to the solutions developed. The purpose of PTR at the HW department is thus more internally focused. The external part consists largely of informing the other departments what HW will develop. The synchronization need from HW's viewpoint is thus mostly sequential.

The purpose of the actual plan differs somewhat between the departments, considering three points. Firstly, the departments have different opinions regarding whether the functional connections should be displayed in the plan. Secondly, regarding to what degree it should be the control tool by which development activities are measured. And lastly, regarding whether the plan should display the most likely path of development, or should also include more unlikely paths of future technology/functionality.

As for the first point, previous theory seems only to plan for technologies or products; functionality is not, in this respect, incorporated in the visual plans. If the purpose is to

synchronize technology with market functionality, it would appear necessary to display the connections in the plans.

The second point is likely to depend on the degree of management attention given to the PTR. According to theory, this is one of the most important initial aspects that need to be ensured [5]. The problem in the studied case is that line managers and project managers differ on the prioritizations regarding PTR. The line managers, who have established the TSC group, are giving PTR a high priority. On the Project side, however, the Platform Project has higher priority. This will be further discussed under the organizational topic.

Regarding the last point, whether alternative development routes should be included in the visual plans, previous theory is scattered. In the EIRMA report [5], no alternative routes seem to be displayed. Philips also seems to disregard this information in the plans. Motorola, on the other hand, deals with the alternative routes in what are called minority reports. Since, in any case, the group conducting PTR at a department is likely to investigate the alternative routes for its own purpose; the ultimate question here is whether it is required to share information about possible deviations with the departments that it synchronizes with. This has to be weighed against the development lead-time at the departments that do not get information about possible deviations.

Organization

As in many other companies, the functional structure supporting the product development has similarities with the product architecture. Organization of PTR in this sense is thus also governed by the product architecture. As the product, during the shift towards 3rd generation, grew too complex to handle, a project organization was devised to focus on the imminent release of the platform. However, PTR is still conducted within the very complex functional organization. The establishment of a central organization to handle PTR, the TSC group, can be compared with the establishment of a project organization in terms of focus. But since the resource prioritization decisions are made in the former, it may not carry enough weight. Two problems can be seen that support this statement.

1. The responsibility for conducting PTR at the Technology Departments has mostly been delegated to a single person, and thus not a group of personnel which might have broader competencies.
2. Product Management personnel focus on attending the project-supported Functional groups. As these groups focus on short-term planning, it does not give any information to Product Management's own plans that span another 24 months into the future.

The large number of dependencies between the parts conducting PTR makes it difficult to see if any dependencies have been missed out. The most efficient information-processing organization according to Scott [11] is the central group discussed in the theory section. However, the dependencies between Technology Development and Product Management demand detailed planning of how to solve different functional aspects, e.g. what technology to choose in order to supply customers with a functional need, such as choosing a positioning technology to fulfill the positioning need, or choosing a video

technology. The detail in this sense cannot, with the present technology breadth, be supplied by one central group.

The need for singling out specific functions, and connecting or translating this into a technology, can be seen from the Product Management's side as the attempt to start Reference Groups. According to Galbraith [12] this kind of lateral processes must, however, fulfill certain criteria to be successful. Firstly, the participants will only commit themselves if they feel that the group will satisfy their needs, which in turn depends on how important they feel that the groups' task is. Secondly, at least a substantial minority of the group must participate in order to be responsible for implementing the results. Thirdly, the group must jointly possess the information needed to solve the task they are set to do. Fourthly, if an action decision is made, the participants must have the authority to commit their department to the task. In this case only the fourth point is met by the Reference Group, but the results have not yet been seen as these groups are fairly new.

Synchronization & Communication
Since Product Management is maintaining PTRs that aim 3 years ahead, it would seem reasonable that the departments which are supposed to develop the functionality in these plans have the same time-horizon. The need from the Product Management side might, on the other hand, be of a sequential nature, e.g. getting a technical view of the functional planning. However, this is only true during the planning period where the Technology Departments' development lead-time is shorter than the planning horizon, since the Technology Departments in that case would have time to adapt. See Figure 8 below.

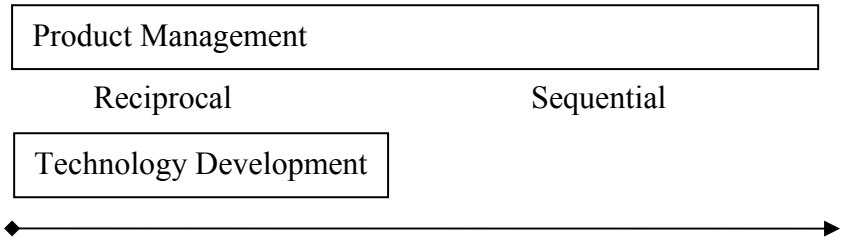

Figure 9 - Type of synchronization over time

When the Technology Development "catches up" with the plans made at Product Management, the previously sequential synchronization becomes reciprocal. And since the Product Management have developed their plans as sales arguments toward customers, it is important that the previous information does not deviate in a manner which will leave customers disappointed. One should also consider the points made by Galbraith regarding lateral processes compared to the type of synchronization. In the case of reciprocal communication, it is much easier both to show that a group's task is important, and to get proper management involved in order to implement the results.

According to Tushman [13], communication between organizational units which have different goals and time-spans is most successfully managed via so-called gatekeepers. This formalization of communication becomes even more desirable when the groups'

task is extremely complex or has a fast-changing environment [14]. Hoogovens has chosen an external facilitator to hold this role.

Conclusions and discussion

The aim of this paper was to analyze how the organization has responded to the introduction of PTR. Our objective was to describe problems that were experienced at the case company and relate these to flaws in current theory. Based on this analysis, we aimed at shedding some light upon the how-to area, which is where the present theory fails with respect to the case studied. The main problems concern differences in Purpose of PTR, Organization of PTR in a complex organization, and communication & synchronization.

A vaguely defined purpose of PTR will unavoidably result in different opinions regarding how PTR is conducted. Differences within departments have proved to result in PTR work where some participants expect synchronization to be externally managed, and some believe it to be their own task – the result being plans with vague connections to related areas outside the department. Differences in purpose between departments have shown similar results. The latter case might, however, be unavoidable due to differences in the departments' purpose within the organization. Informal groups have in these cases turned out to be down-prioritized, and formal groups that force personnel to interact might be more successful here.

A dispersed PTR organization is required since the product complexity is too large for any individual to handle. But as the product architecture is divided in terms of technical parts of the product, the functional areas create dependencies that are more difficult to manage. An early "translation" between technical and functional demands then becomes necessary. Since there are no formal groups today to handle this translation, the personnel have to rely on informal communication channels. The lateral processes created here, however, are likely to fail since, firstly, the communication in many cases is based on the need for sequential information, a win-lose situation resulting in down-prioritization as discussed above. And secondly, informal communication by its own nature does not involve managers who can ensure that the decisions made are implemented.

TSC	Function 1	Function 2	Function 3	Function 4	Function 5	Function 6
Technology 1	■			■	■	
Technology 2		■		■	■	■
Technology 3		■	■	■	■	
Technology 4	■	■		■		
Technology 5				■	■	
Technology 6		■	■	■		
Technology 7				■	■	

Figure 10 - Schematically mapped dependencies between technologies and functions

Informal Reference Groups also fail if the planning horizons are different between the departments that are exchanging information. Sequential synchronization is asked for where reciprocity would be needed.

Product Management defines its demands on future products in a functional sense, but the possibilities to realize this functionality technologically are virtually endless. Since it is impossible for the TSC group to synchronize with such detail, the translation activity must have an organizational solution on the lower levels of PTR, i.e. within the PTR at the Technology Departments. Further, a strong Platform Project with shorter time-horizon down-prioritizes long-term planning. Since structures for lower-level communication are lacking, personnel will use the project organization for this communication, which in turn makes the focus on short-term coordination stronger.

To support the synchronization in this case of complex product architecture and complex organization, a formal communication structure would be needed. The need for a formal structure is even more emphasized by the down-prioritization that is imposed when departments, as in this case, have differences in PTR purpose.

References

1. Ekelund, B., *CTO Ericsson Mobile Platforms*, M.K.O. Dawidson, Editor. Lund, 2000.
2. Curtis, T., *Technology driven or market led – the new product development trap.* Engineering Management Journal, 2000 (August).
3. Tashakkori, A.T.C., *Mixed Methodology*. Applied Social Research Method Series. Vol. 46. SAGE Publications, 1998.
4. Kappel, T.A., *Perspectives on roadmaps: how organizations talk about the future.* Journal of Product Innovation Management, 2001. **18**: p. 39-50.
5. EIRMA, W.G., *Technology Roadmapping – delivering a business vision*, in *Management Summary*. European Industrial Research Management Association, 1997.
6. Groenveld, P., *Roadmapping Integrates Business and Technology.* Research Technology Management, 1997 (Sep-Oct): p. 48-55.
7. Willyard, Charles H. and McClees, Cheryl W., *Motorola's Technology Roadmap Process.* Research Management, 1987. **Sep-Oct**: p. 13-19.
8. Metz, P.D., *Integrating technology planning with business planning.* IEEE Engineering Management Review, 1996. **24**(4): p. 118-120.
9. Probert, D. and N. Shehabuddeen, *Technology road mapping: the issues of managing technology change.* International Journal of Technology Management, 1999. **17**(6): p. 646-661.
10. Thomson, J.D., *Organizations in Action*. New York: McGraw-Hill, 1967.
11. Scott, W.R., *Organizations, rational, natural, and open systems*. 4th Edition. Prentice Hall, 1998.
12. Galbraith, J.R., *Organization Design*. Addison Wesley Publishing Company, 1977.
13. Tushman, M.L., *Work Characteristics and Subunit Communication Structure: A Contingency Analysis.* Administrative Science Quarterly, 1979. **24**.
14. Lekander, P.L.K., *Sociotechnical analysis of R&D work (in Swedish)*, in *Industrial Management and Economics*. Chalmers University of Technology, Gothenburg, Sweden, 1989.