Roadmapping for a Changing World

White Paper Resulting from Architecture Forum Meeting

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1. Introduction

In today's world, the rate of change can be quite high. Many systems, with vastly different clock speeds (websites, apps can change in an hour if not faster, expensive infrastructure may require years, physical platforms, such as airplanes may take decades), interoperate to create desired functionality. A major challenge for architectures and architects is:

- How do we cope with the variety of concurrent clock speeds?
- How do we cope with the current rate of change?

We asked participants to prepare the meeting by thinking about the following questions:

- Does your organization use living roadmaps?
- What tensions does your architecture experience due to variations in clock speeds?
- What role can roadmaps play in coping with changes in the world?

2. Roadmapping in Practice

Rob Phaal from Cambridge provides the most comprehensive overview of roadmapping at https://www.cambridgeroadmapping.net/ and a bibliography of roadmapping literature at http://www.ifm.eng.cam.ac.uk/uploads/Research/CTM/Roadmapping/Roadmapping_Bibliography_Phaal.pdf.

Several sectors have sector specific roadmaps, such as Air Traffic (FAA, https://www.faa.gov), automotive (ACEA, http://www.acea.be) and semiconductors (ITRS, http://www.itrs2.net/). These roadmaps facilitate transitions across a broad set of organizations.

Philips presented their roadmapping process, quoting the following challenges:

- How do we align the R&D program with both the regular products and the new product introductions?
- How do we maintain a competitive product portfolio?
- How do we make long-term decisions around the architecture, while the market and technology change on such a short notice?
- How do we realize the optimal product architecture, while there are so many uncertainties?

Figure 1 shows the Philips roadmapping process, which works simultaneously at the Market and Technology side. After collecting and ranking market and technology options, product-technology concepts are developed that form an initial draft roadmap. In step 4, business considerations (targets) help to shape a roadmap that balances options and business thinking.

In this process, each step results in a deliverable that is communicated to the stakeholders and the management team. Table 1 shows the deliverables per step. In this way, each step contributes to alignment within the organization.

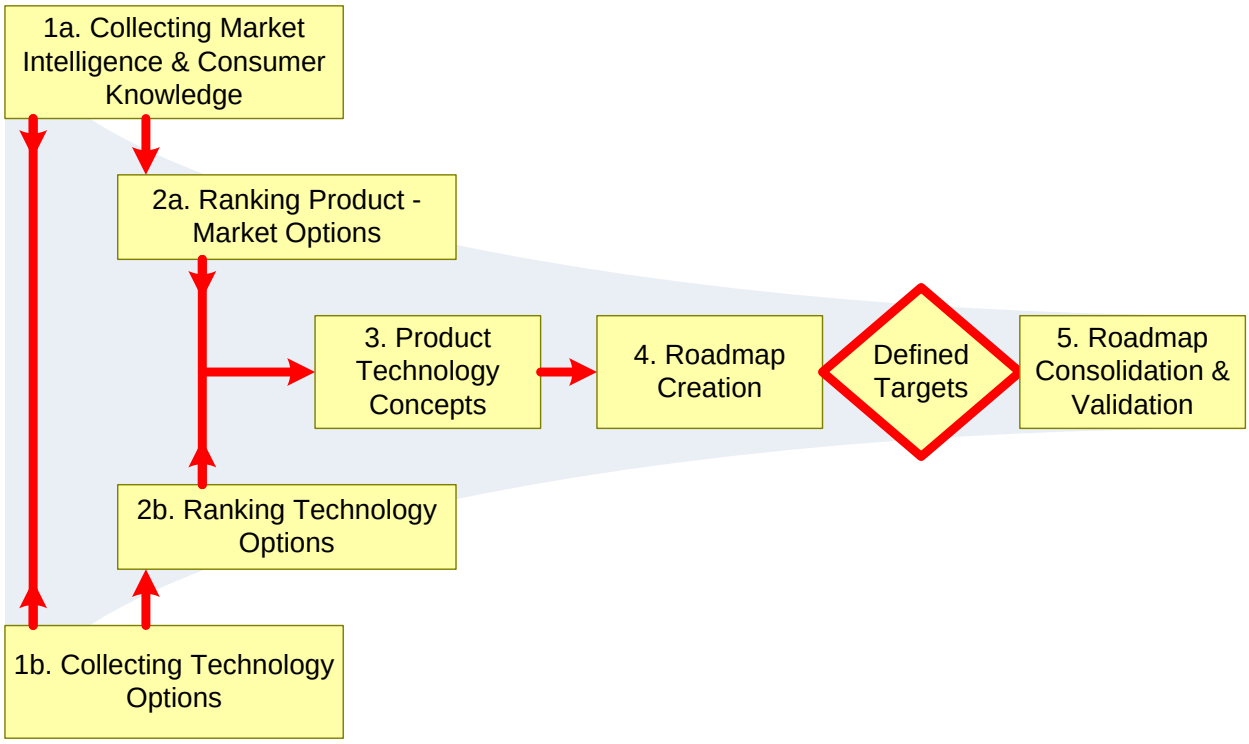

Figure 1. The Philips Roadmapping process

Table 1. Deliverables per process step

1a	Collecting Market Intelligence & Consumer Knowledge	Business drivers Innovation drivers
1b	Collecting Technology Options	Technology Options
2a	Ranking Product Market Options	Product Market Options
2b	Ranking Technology Options	Technology Options Booklet
3	Product Technology Concepts	Draft Roadmap
4	Roadmap Creation	Preliminary Roadmap
5	Roadmap Consolidation & Validation	Final Roadmap

The architecture roadmapping is part of the overall roadmapping process. Figure 2 shows the steps for the architecture roadmapping, linked to the overall process. The “cloud” at the right-hand side shows typical architecture questions for the roadmap, concerning modularity, architecture evolution, and dependencies between options.

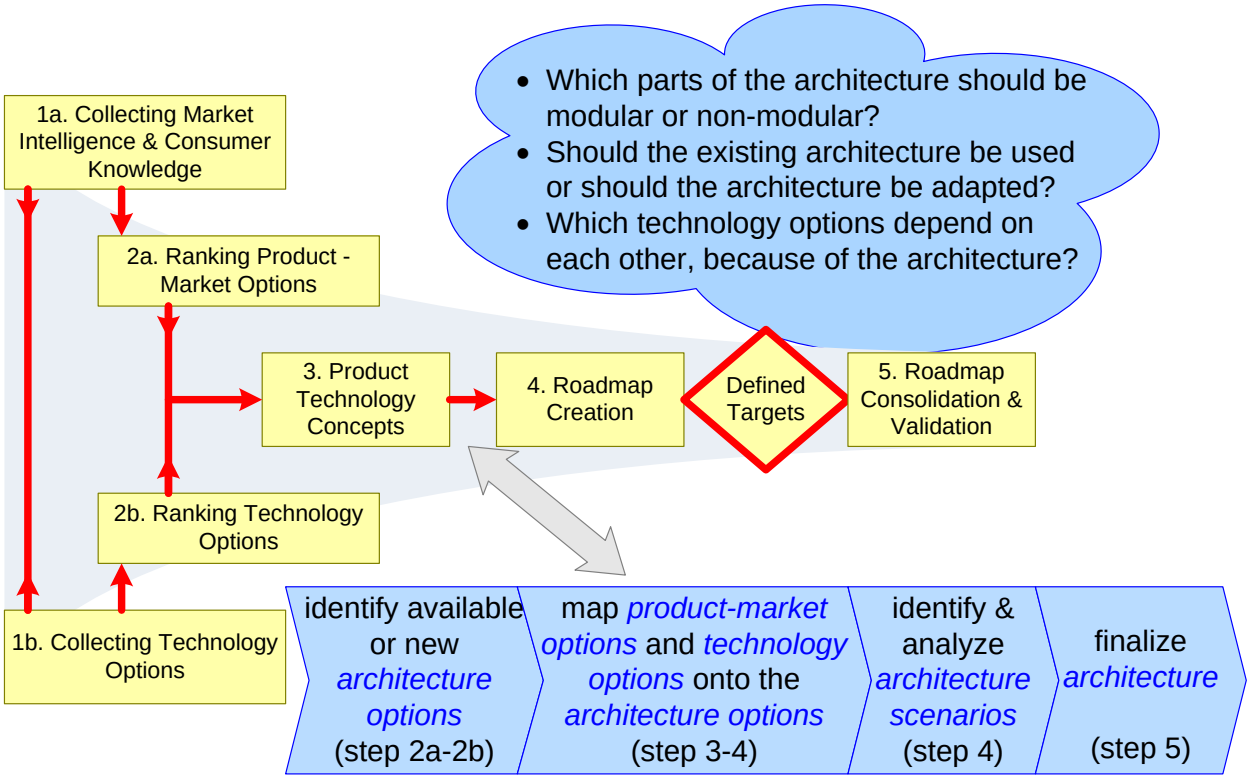

Figure 2. Architecture roadmapping, related to the roadmapping process.

Figure 3 shows a schematic representation of a final roadmap, with product, architecture, and technology layers, and their mutual relations. Team leaders take ownership for their part of the roadmap. A striking remark in this presentation is that the stakeholders commit to the consolidated roadmap. This statement is in contradiction with [Muller 2011], which explicitly states that a roadmap is shared, but not-committal. The main reason not to commit, is to avoid defensive stakeholder behavior, e.g. stakeholders that “reverse” construct the roadmap to protect their interests.

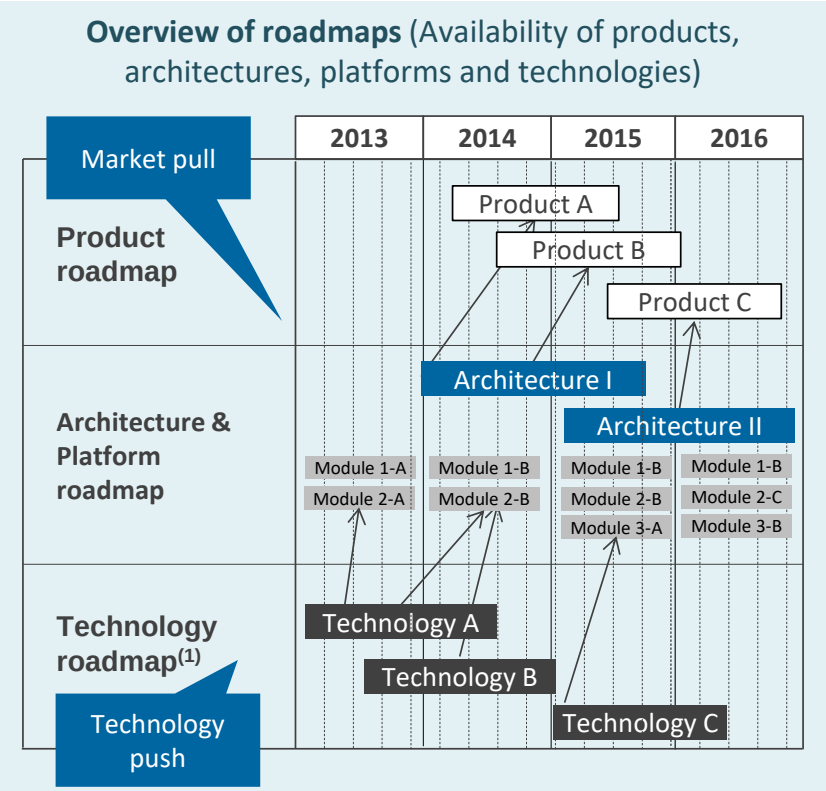

Figure 3. Schematic representation of a final roadmap after Step 5.

3. Information in roadmaps

Figure 3 triggered the first break-out session, with the following questions:

- What information goes into roadmap (as is)?
- What information is needed in roadmap (to be)?

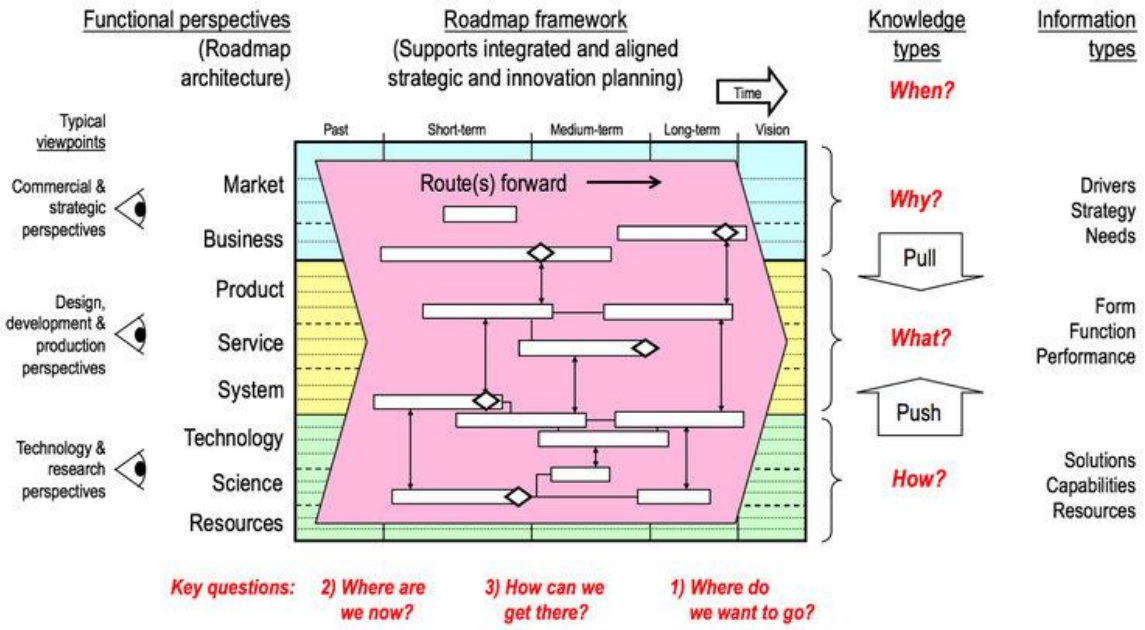

Figure 4. What information should be in a roadmap (Phaal 2009)

Phaal and Muller (2009) offer a roadmapping framework as shown in Figure 4 with three main perspectives: commercial and strategic, design, development, and production and technology and research. The commercial and strategic perspective defines the "why" by defining the drivers, strategy, and needs for the products, services, and systems that need to be developed. There ought to be a "pull" from the commercial and strategic perspective. The design, development, and production perspective defines "what", in terms of form, function, and performance for the products, services, and production. The technology and research perspective offers the "how" in terms of technology, science, and resources; the potential solutions, capabilities, and resources ought to generate a "push" by offering options and opportunities.

During the breakout session, the participants made an inventory what should be included in roadmaps. While doing this they had seen the Philips framework, but not yet the Phaal and Muller framework.

The discussion resulted in additions and deviations to the roadmapping framework, as shown in Figure 5.

commercial and strategic perspective
• a vision • legislation • geographical and branding aspects • exhibition and conference milestones • competitor analysis
design, development, and production perspective

• potential formats to capture form, function, and performance, for instance
  • one liners and unique selling points
  • “strawman” product descriptions

technology and research perspective
• technology maturity in terms or readiness level (TRL) • platform or building block development, which is an intermediate step between technology and systems • quality level of components, technical debt, refactoring moments, obsolescence • software feeds into systems, products, and services • opportunities: disruptive technologies or enabling technologies • (people) competencies • gap analysis • methods, processes, and tools

Figure 5. Additions to the roadmapping framework

A vision is kind of prerequisite to work on roadmaps. In fact, a roadmap is an elaboration how to work toward the vision. In practice, the roadmap discussion influences the vision. Legislation and trends in legislation (e.g. environmental, privacy, accountability and traceability, etc.) form boundary conditions for the entire roadmap. The geographical and branding aspects, the exhibition and conference milestones, and the competitor analysis have a practical nature, and their use will depend on the domain.

In the technology and research inputs, we see several architecture concerns popping up, such as platforms, building blocks, software feeds, assessments of technology readiness or

obsolescence, and future technological threats and opportunities. A second set of inputs addresses the resources, such as people, their competencies, and their means (methods, processes, tools)

Finally, a number of general aspects pop-up for the integral roadmap:

- Relations and rationale
- Gap description between roadmap perspectives
- What is excluded (make explicit what is not roadmapped)
- Alignment with partners
- Vision from the artist

The first two items relate to the need for an integral roadmap, where the value is in the relations and rationale. A gap description captures what is missing in this integration. A positive formulation of the third bullet is the need for scoping, where “what is in” and “what is not in” defines the scope.

Partners can play a role in all perspectives, from strategic partners in customer space, to partners in the product-system ecosystem, to partners providing technologies, tools, or capabilities.

The vision from the artist is a reminder of the relevance of the creative, emotional, inspirational input.

4. Change and rate of change

This first discussion resulted in more questions than answers. Appendix 1 shows an overview of all questions at the end of the first breakout.

Based on all these questions, the second breakout addressed change, the rate of change, sources of change, and clock speeds. The question to the participants was to discuss change in all these aspects based on own experience and using examples.

One of the challenges is the variety of clock speeds in the systems, their context, the organizations, and technologies. Large systems and organizations tend to be inherently slower. Organizations try to solve this by flexibility in the “leaves”, e.g. at component or module level. A roadmapping challenge is then how to cope with relations between components, the system,

and its context. The rate of change in some technologies (e.g. electronics and software, apps and related devices and infrastructure) may be that high that explicit anticipation of obsolescence and evolution is essential.

The architecture answer to coping with change is interface management; stable interfaces ought to enable local changes. However, on the roadmap time-scale even interfaces evolve. A roadmap is a means to guide interface (and architecture) evolution. Standardized interfaces (e.g. open instead of proprietary) serve this goal too. The architecture challenge is to offer guidance beyond interfaces, such that other dependencies (e.g. resource sharing) will evolve according to the various changes.

Both architecture and interfaces tend to extend outside the own organization. Consequently, the roadmap has to deal with neighboring systems in the customer context, partners, and suppliers. All of them have their own clock speeds in their organization, system, and technologies. The roadmap challenge is to include the most relevant information, while the own organization typically is not in control of what will happen. In many cases, the future oriented information from suppliers, customers, and partners is confidential and sensitive. They may not be willing to share this information, forcing the roadmap team to second guess what may happen when.

5. What problem does a roadmap solve for whom?

The third breakout session revisited the objectives of a roadmap and its effectiveness. The questions for this break out were:

- What problem does a roadmap solve? For whom?
- How can these stakeholders cope with changes and various clock speeds, and inherent uncertainty?

From the discussion, the following main objectives of roadmapping emerged:

- Capturing and concretizing the strategy
- Creating and sharing the overview, e.g. the big picture over time and across products and business functions

- Aligning efforts to be effective in the market and as business (in all its functions such as supply chain, manufacturing, service)
- Focusing (limited) resources on strategic activities
- Defining and realizing synergy across products, for instance by roadmapping platforms and architectures
- Facilitating autonomy of concurrent R&D teams
- Anticipating long-lead activities, such as competence, process, and technology development
- Coping timely and efficient with foreseeable changes, such as obsolescence and regulations
- Providing context for research
- partnerships, acquisitions, industry alignment (e.g. C02 reduction trucking industry)

With these objectives, many stakeholders benefit from or are influenced by roadmapping, both internal (marketing, sales, R&D, supply chain, manufacturing, customer support, etc) and external (suppliers, customers, partners).

The confidentiality and sensitivity of the information in roadmaps means that organizations find it difficult to share the roadmaps with external parties (customers, partners, suppliers) and internal parties (for example, sales or engineering). However, to achieve the above objectives from a roadmap, many of these stakeholders need access to the roadmap. One of the suggestions is to use a private and a public version of the roadmap.

The question on how to cope with variations in clock speeds was only touched. Participants had a few suggestions:

- Partition the roadmap such that the parts have similar clock speeds
- Update the roadmap in accordance of the rate of change of the topics in that roadmap
- Use Readiness Levels, e.g. Technology (TRLs), Integration (IRL), and Manufacturing (MRL) Readiness Levels, both internal and external, e.g. suppliers.

6. Conclusions

Roadmapping is a strategic tool that helps internal and external stakeholders to share overview and direction, align their efforts, create synergy (platforms), work autonomous, and anticipate long-lead activities. Roadmaps have three main perspectives: commercial and strategic (why), design, development, and production (what) and technology and research (how). Each perspective may have a further partitioning in layers. However, an essential part of the value comes from the relations between layers. The roadmap as a whole provides the value.

One of the main triggers for roadmapping where the architecting challenges:

- How do we cope with the variety of concurrent clock speeds?
- How do we cope with the current rate of change?

Participants discussed the rate of change and the sources of change, without firm conclusions. The last breakout session did not result in answers to the follow-up question “How can these stakeholders cope with changes and various clock speeds, and inherent uncertainty?” We will discuss the topic “Architecting for asynchronous developments and life cycles” in a separate forum meeting.

Appendix 1. Questions at end of day 1:

- What is the impact of accelerating markets, applications, and technologies on roadmapping approach?
- What is the governance and leadership model for roadmaps?
- Does roadmapping drive the business (poor roadmapping may harm the business)?
- Who makes the "final" roadmaps?
- How can roadmap teams:
    - apply an agile way of working with roadmaps?
    - include scenarios in Roadmaps?
    - include uncertainty?
    - cope with risks?
    - prevent that a roadmap is a compromise (democratic average) instead of a vision?
    - deploy?
    - keep roadmap going?
    - cope with organization changes?
    - balance effort and benefits?
- What problem does a roadmap solve and for whom?
- To whom shall a roadmap communicate?
- What are the participants' experiences with various clock speeds in roadmapping?
- Is there value in shared semantics in roadmaps?
- Is there an architecture roadmap?
- Who validates market inputs?
- When should organizations not use a roadmap?
- Who validates technology?
- What are the favorite tools?
- How can the organization or business use roadmaps for benefits?
- How to change roadmaps? How rigorous?
- Can we derive a rule of thumb for the time horizon based on increment duration?
- Shall form-fit-function compatibility be visible (obsolescence management)

- How does innovation relate to roadmapping?
- What is the relation between strategy and roadmap?

Literature

Muller, G. (2011), '*Systems Architecting; a Business Perspective'*, CRC Press, Boca Raton, USA

Phaal, R. and Muller, G. (2009), '*An architectural framework for roadmapping: towards visual strategy*', Technological Forecasting & Social Change, 76 (1), pp. 39-49