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Nokia

Technology management and architectures

Master's degree program / Stadia, Helsinki

24.11.2006

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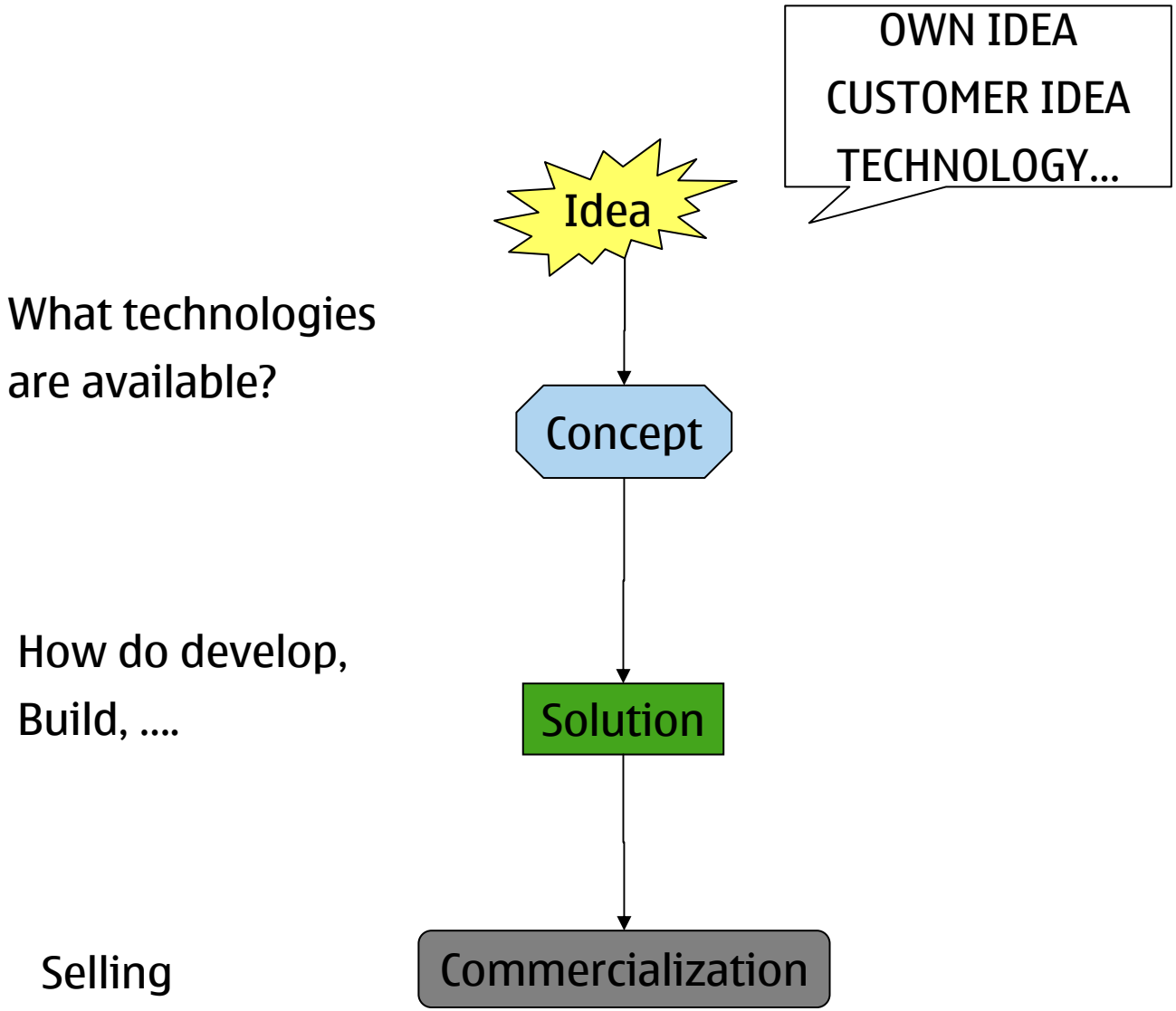
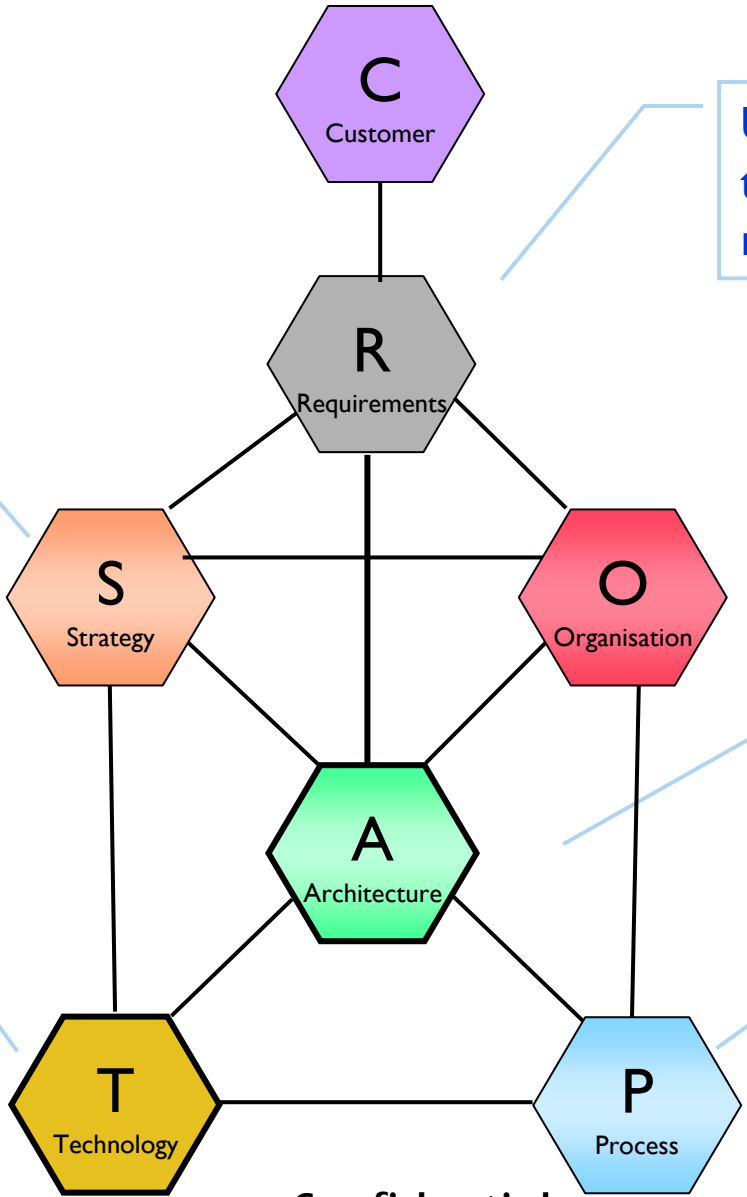


Technology, architecture, and product development



User and technology driven requirements

The way to make profit from the products

Department structures and responsibilities

The Products design that needs to be implemented

The technology that is a the basis of the solution.

The way we build the product and drive architecture

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Source: J.P. LeBlanc

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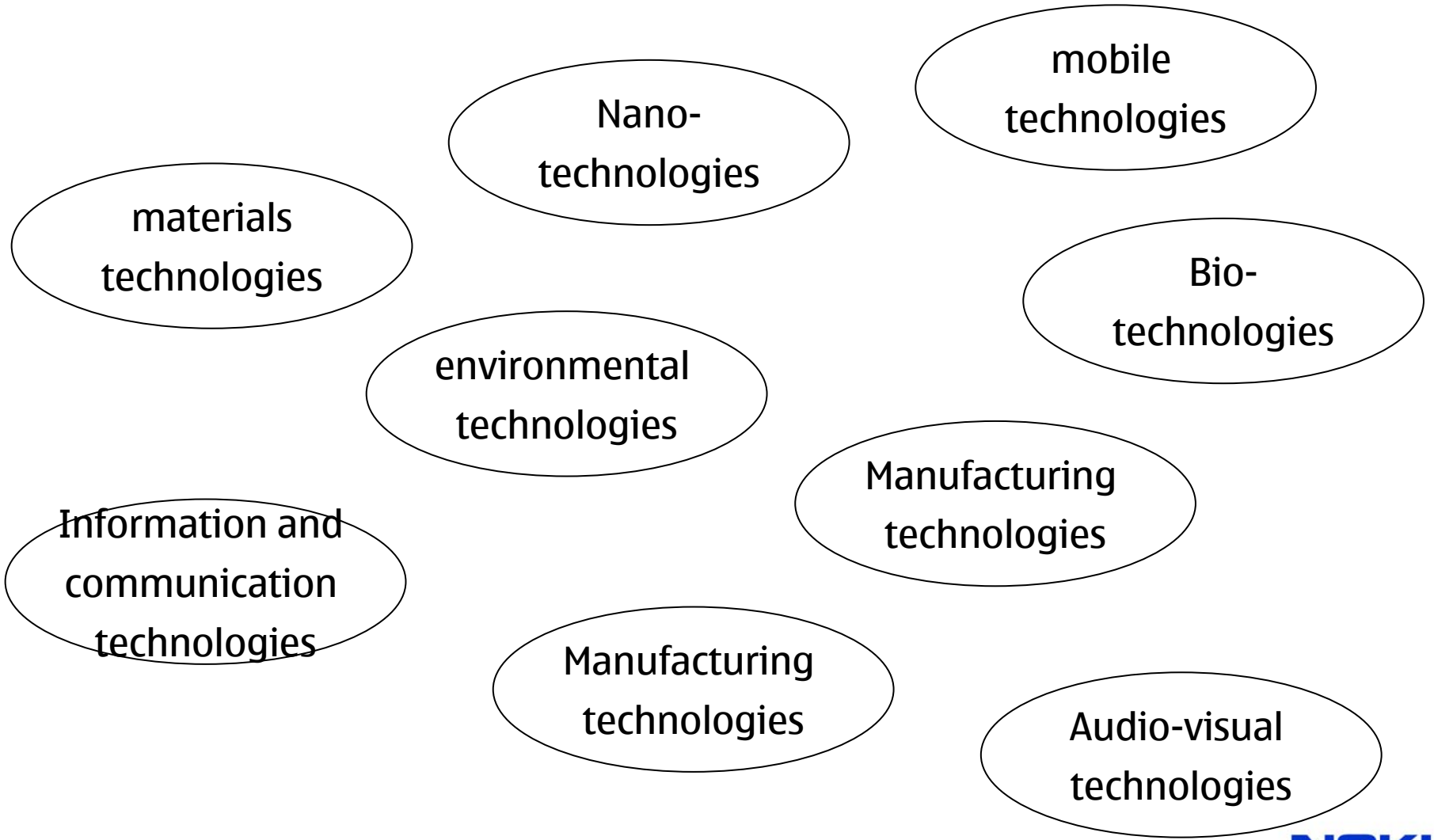
Technology management is about

Ensuring technology portfolio and product technology leadership
that adds value by driving
technology through exploration, creation, evaluation, and implementation
with timely market introduction
to generate profitable business, growth, and customer satisfaction.

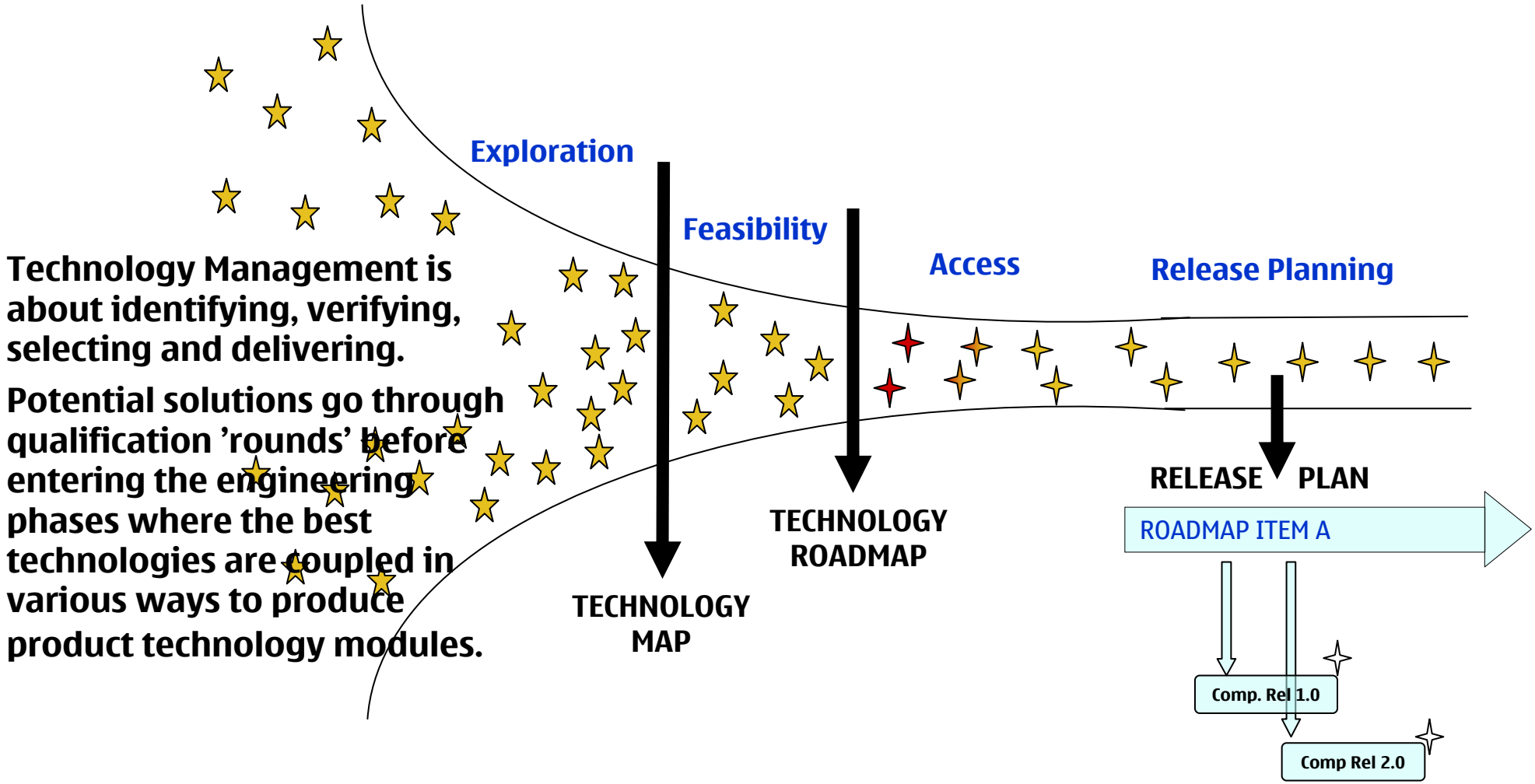
The value of technology realizes
through innovation visible to the users.

Technology management is a way to manage future uncertainty
and to be capable to use technologies.

Technologies - examples



The funnel view on technology management



Technology management

- Systematic technology management requires processes and procedures
- Technology Strategy Process
  - standardization strategy
  - Intellectual Property Management (IPR) strategy
  - technology roadmap
  - technology portfolio (assets)
- Technology management process:
  - explore
  - feasibility study
  - secure access
  - plan releases (implementation)

Technology management

- Is closely related to
  - Intellectual Property Management (IPR),
  - Managing Innovation,
  - Product Development,
  - Project Management,
  - Simulation and Risk Analysis,
  - Supply Chain Management, and
  - Strategy

Technology areas to consider

Technology life-cycle, trends, innovation trajectories...

Business requirements

Market analysis: volumes, pricing, performance & size ...

Market scenarios: low / mid / high

Users & customers: requirements, needs, ...

Competition: benchmarking

Industry landscape: business ecosystem, suppliers,...

Standardization landscape: open / proprietarytechnologies , IPRs, patents & owners, agreements (lincences, royalty) ...

Strategic intent and trade-offs

Investment levels, business case, risks

Technology areas... continues

Technology selection & architecture

Suppliers, partnerships, joint ventures

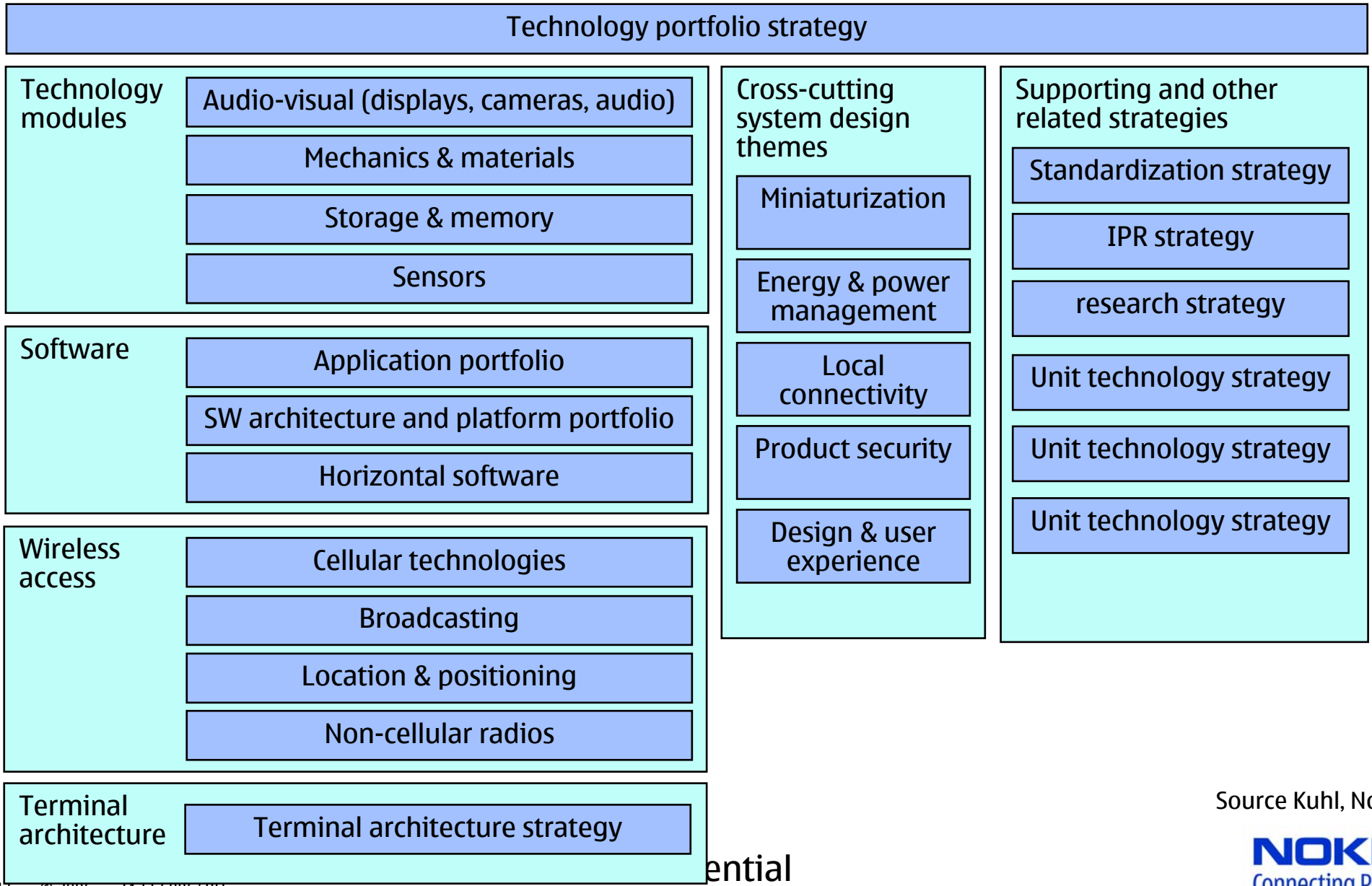
IPR, Openness (sharing & standardization), Research

Actions & owners, follow-up & metrics

Technology roadmap

Implementation resources & capabilities,
operational implications

Technology Areas example, device



Source Kuhl, Nokia

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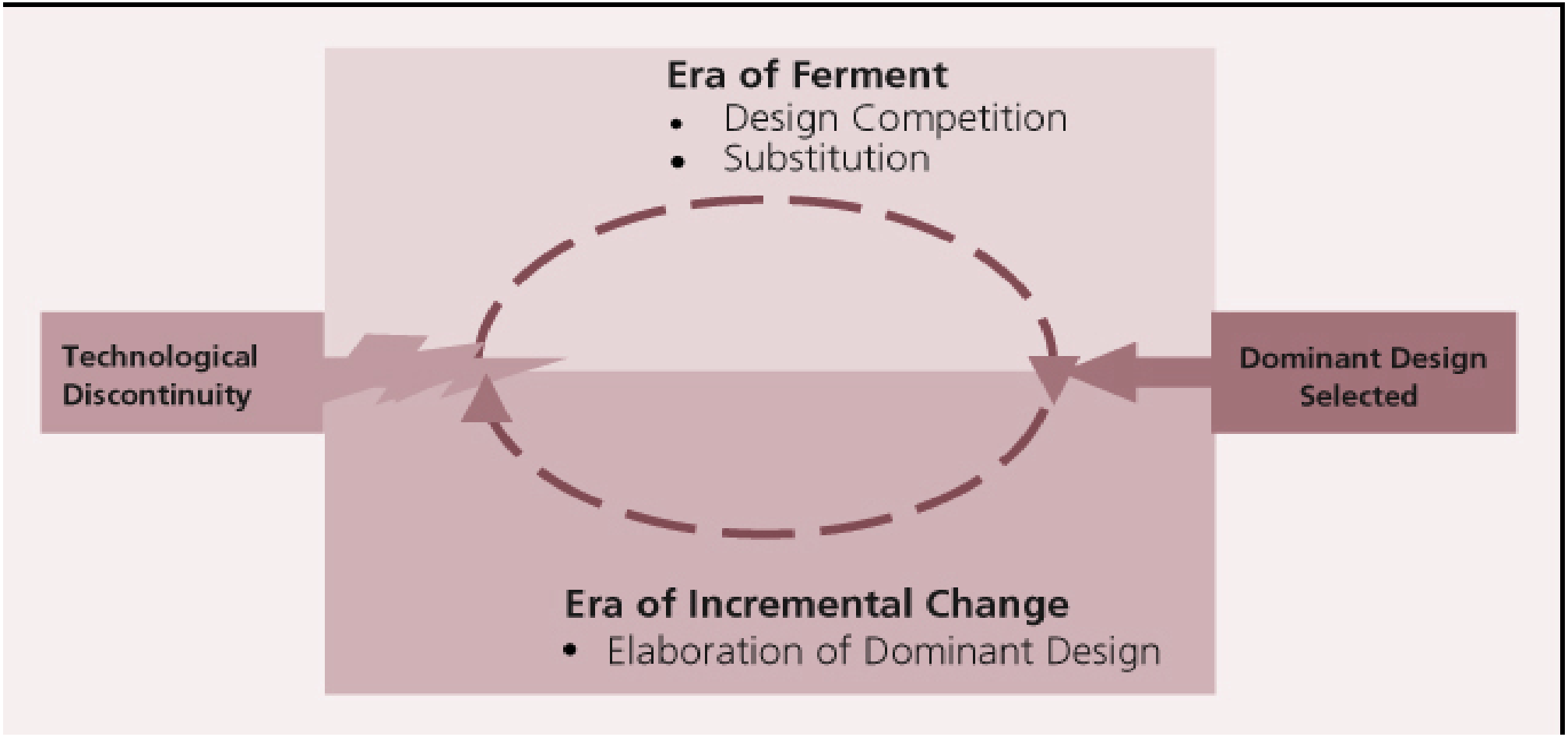
Technology Development	Module Development	Execution
Suppliers	Integrators	Enterprise/ 3rd party
Suppliers	Enterprise	Enterprise/ 3rd Party
Enterprise	Enterprise	Enterprise/3rd Party
….		

Strategy and Technology (2)

Mechanism	Strategic Advantage	Examples
Robust design	Offering something which provides the platform on which other variations and generations can be built	Windows
Rewriting the rules	Offering something which represents a completely new product or process concept and makes the old ones redundant	DVD
Reconfiguring the parts	Rethinking the way in which bits of the system work together	Dell
Others ?	New ways to do things and to obtain strategic advantage	

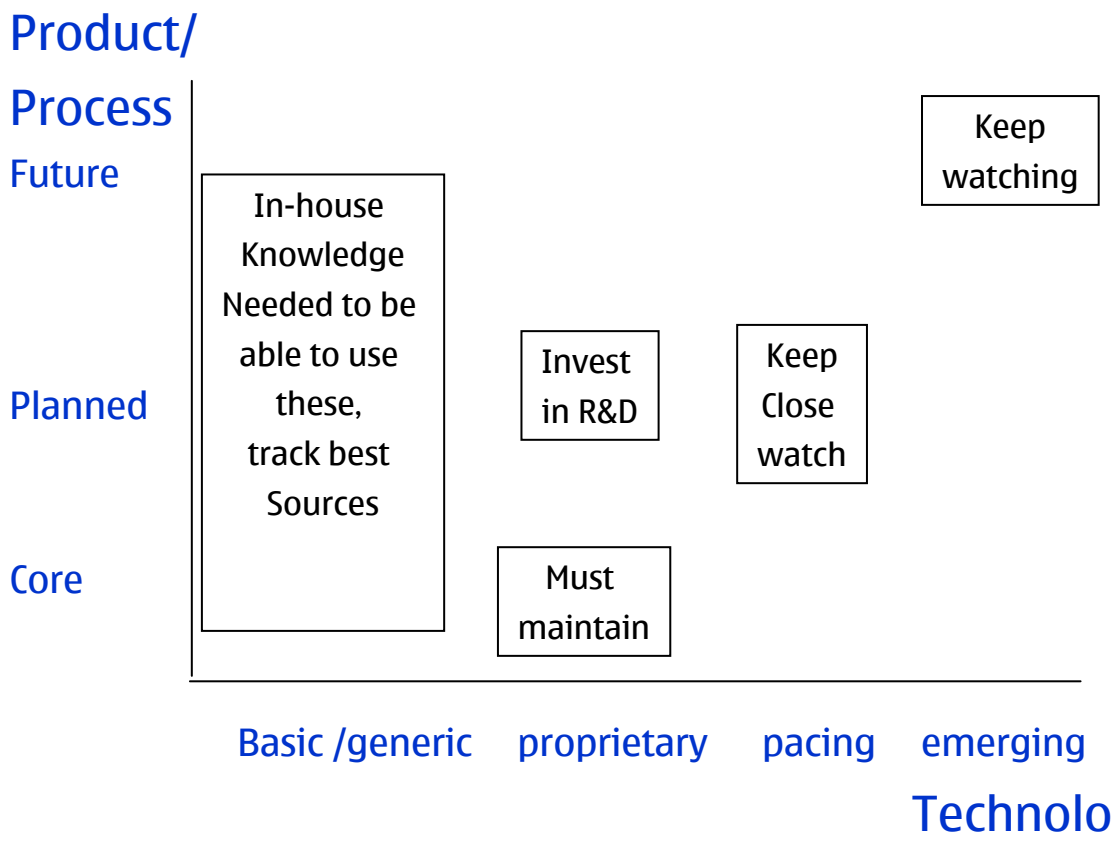
Technology cycles



Based on Anderson & Tushman

Technology portfolio model

- Tool to manage technologies
- Useful in making decisions around product and process development
- Maps technologies involved



Source: Tidd, Bessant & Pavitt (2005)

- ADL matrix by Arthur D Little

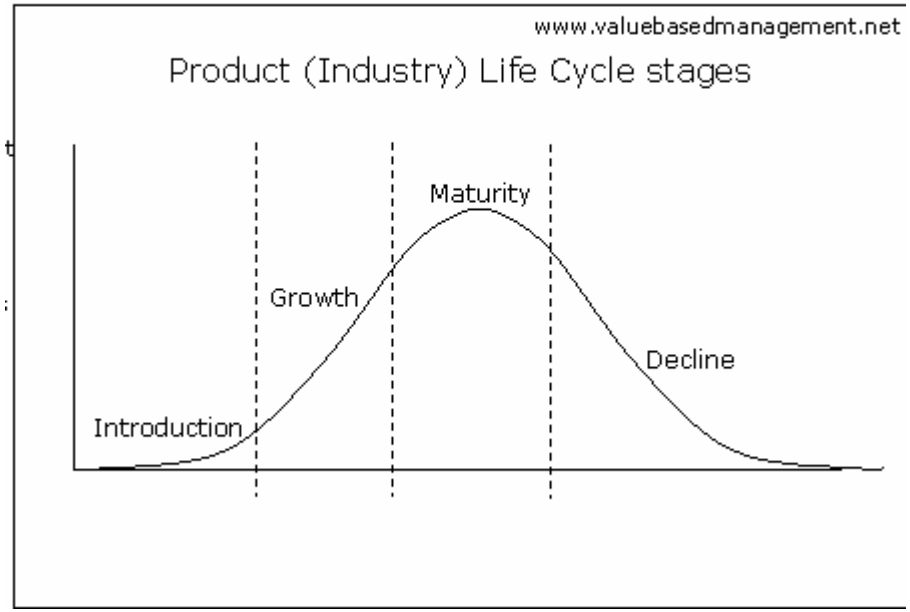
Arthur D. Little

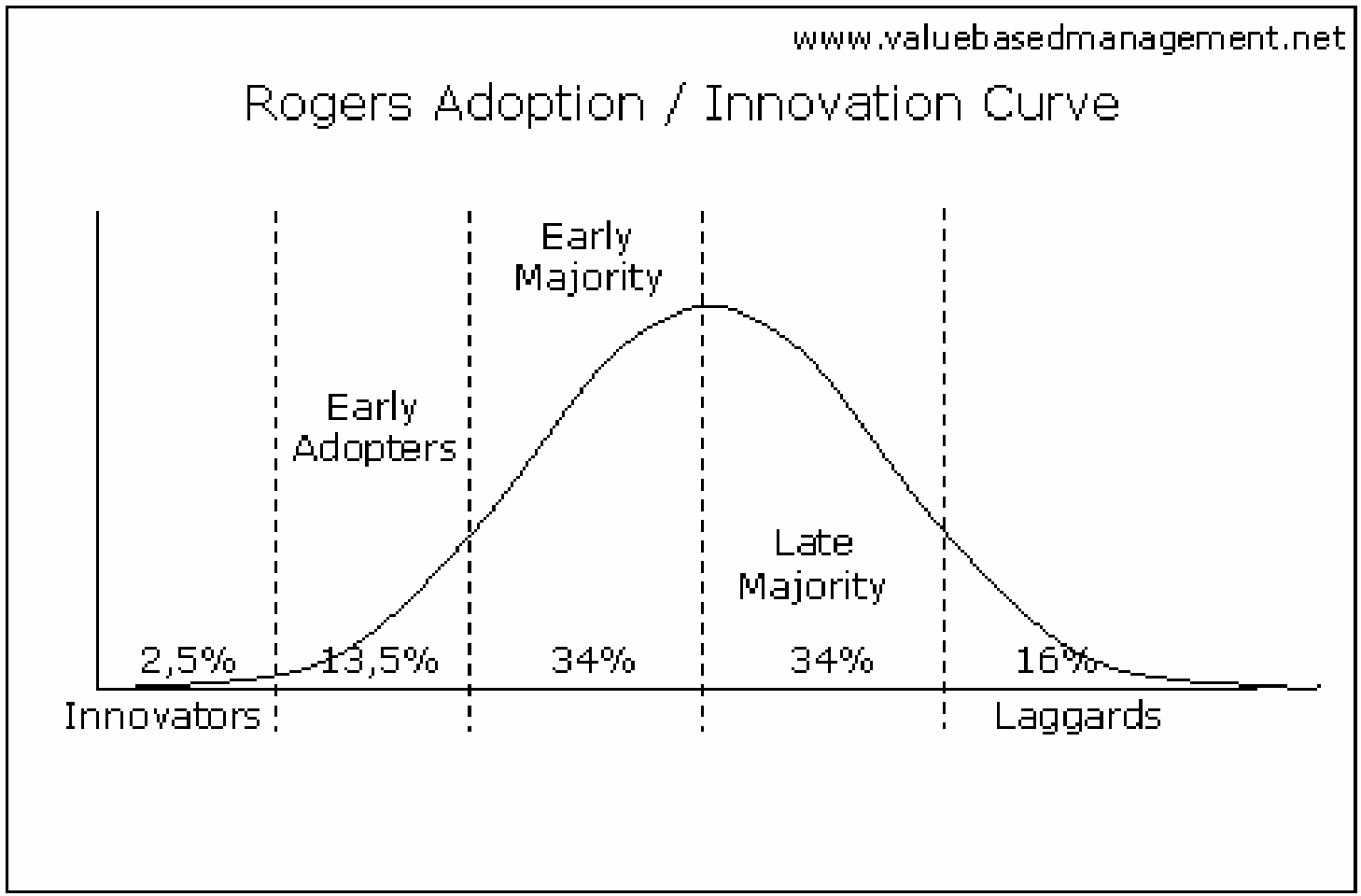
www.valuebasedmanagement.net

ADL Matrix

Competitive Position	Industry life cycle stage: Embryonic	Growth	Mature	Aging
Dominant	All out push for share. Hold position.	Hold position. Hold share.	Hold position. Grow with industry.	Hold position.
Strong	Attempt to improve position. All out push for share.	Attempt to improve position. Push for share.	Hold position. Grow with industry.	Hold position or harvest.
Favorable	Selective or all out push for share. Selectively attempt to improve position.	Attempt to improve position. Selective push for share.	Custodial or maintenance. Find niche and attempt to protect it.	Harvest, or phased out withdrawal.
Tenable	Selectively push for position.	Find niche and protect it.	Find niche and hang on, or phased out Withdrawal.	Phased out withdrawal, or Abandon.
Weak	Up or out.	Turnaround or abandon.	Turnaround, orphaned out withdrawal.	Abandon.

Fox, Wasson, Hofer, Anderson & Zeithaml, Hill & Jones





Technology Refresh Strategy

Technology Refreshment Strategy Development

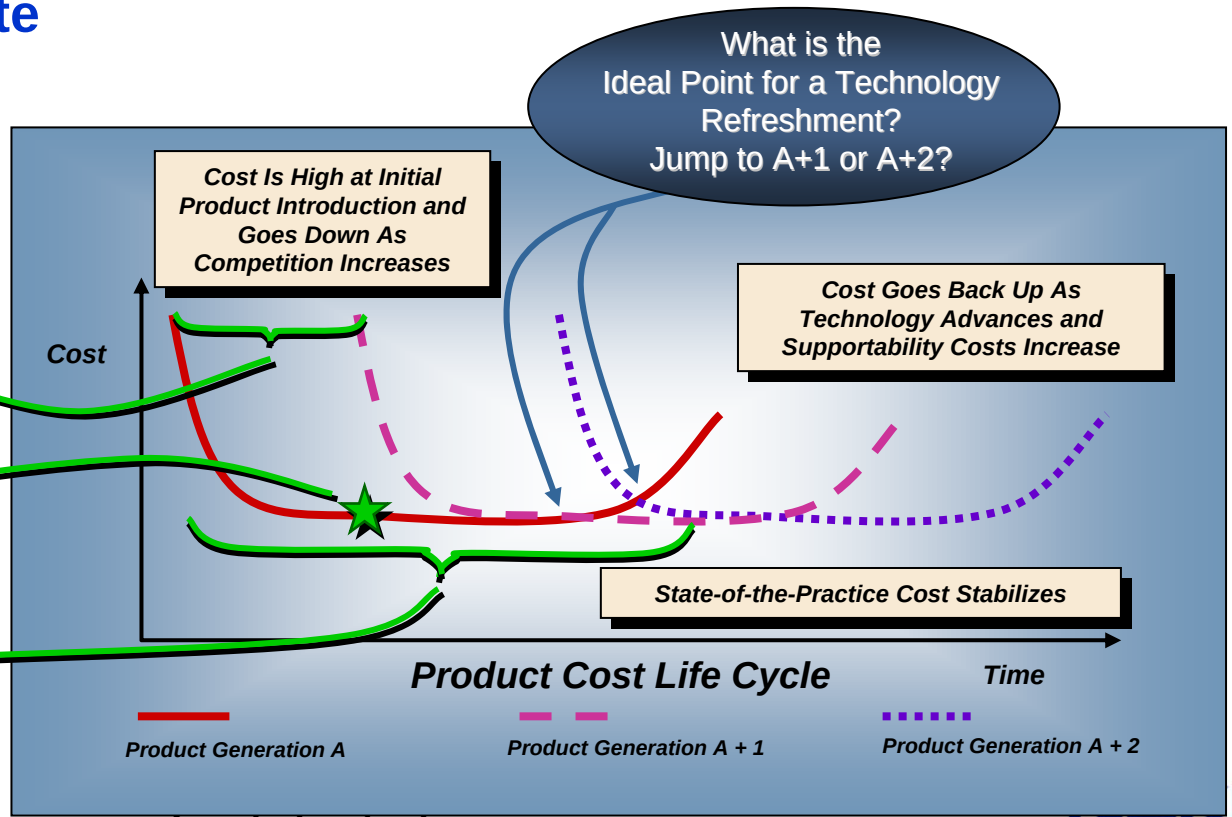
- Technology Life Cycle for Each Product
- Technology Maturity for Each Product
- Technology Change Frequency
- Capacity Doubling Rate

Capacity Doubling Rate: Program Metrics used to Determine

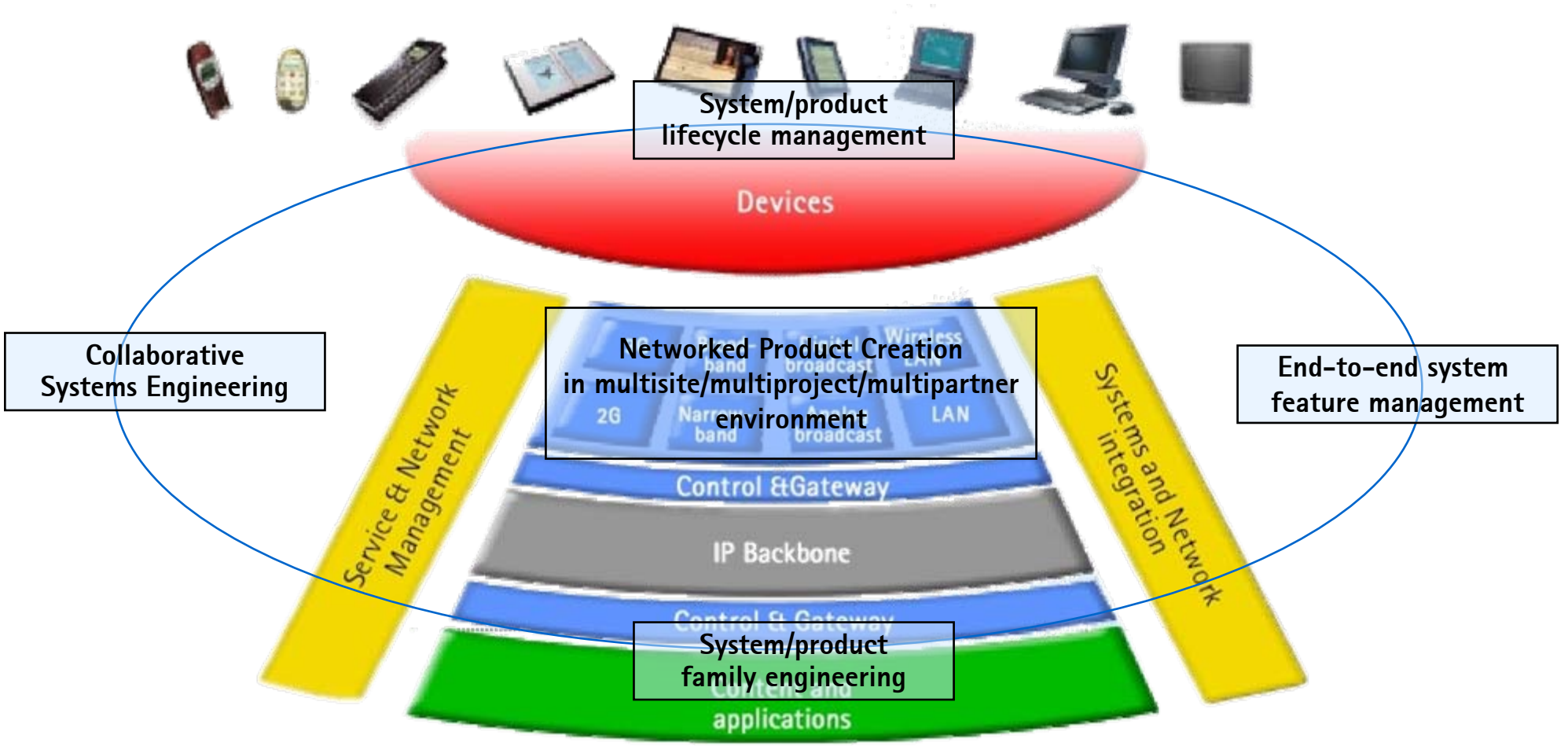
Technology Change Frequency

Technology Maturity = Where is the Subsystem in the Current Technology Life Cycle?

Technology Life Cycle



Networked Product Creation



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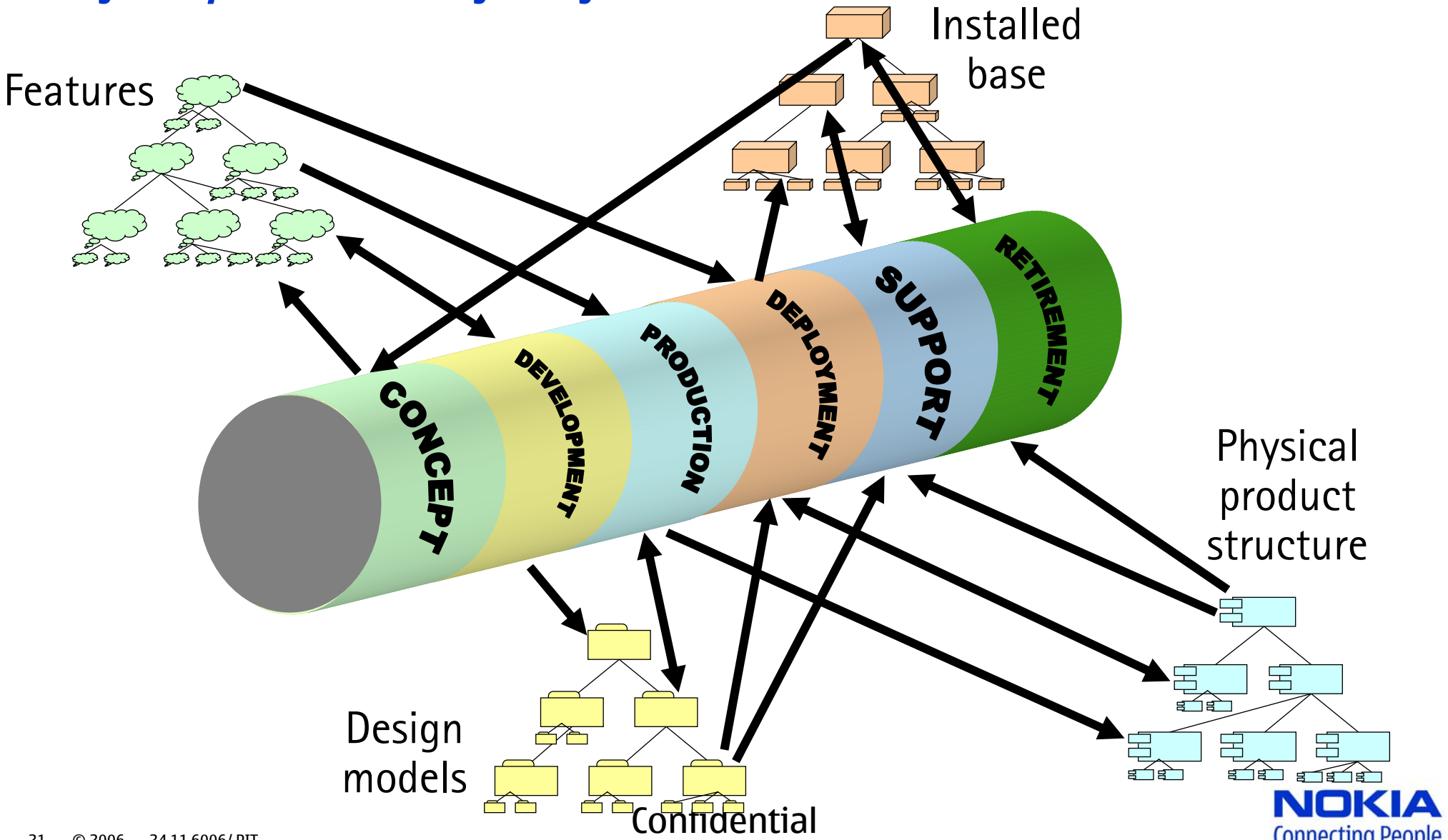
Case - discussion

- How to ensure that your company is capable for technology management?
- What needs to be considered?
- What are the biggest obstacles?

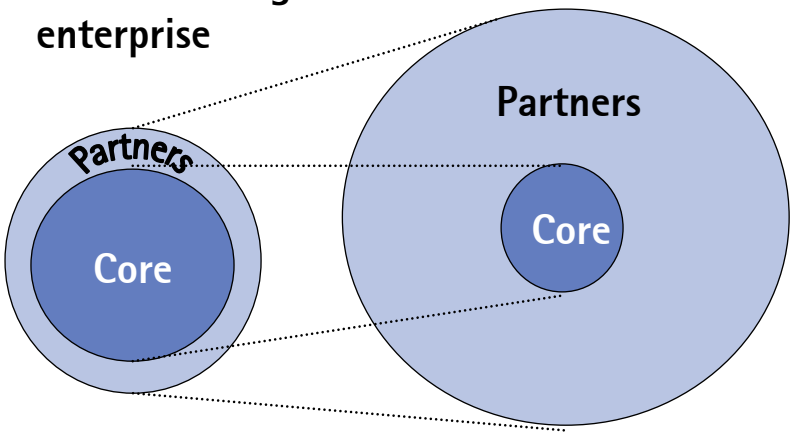
System/Product Family lifecycle



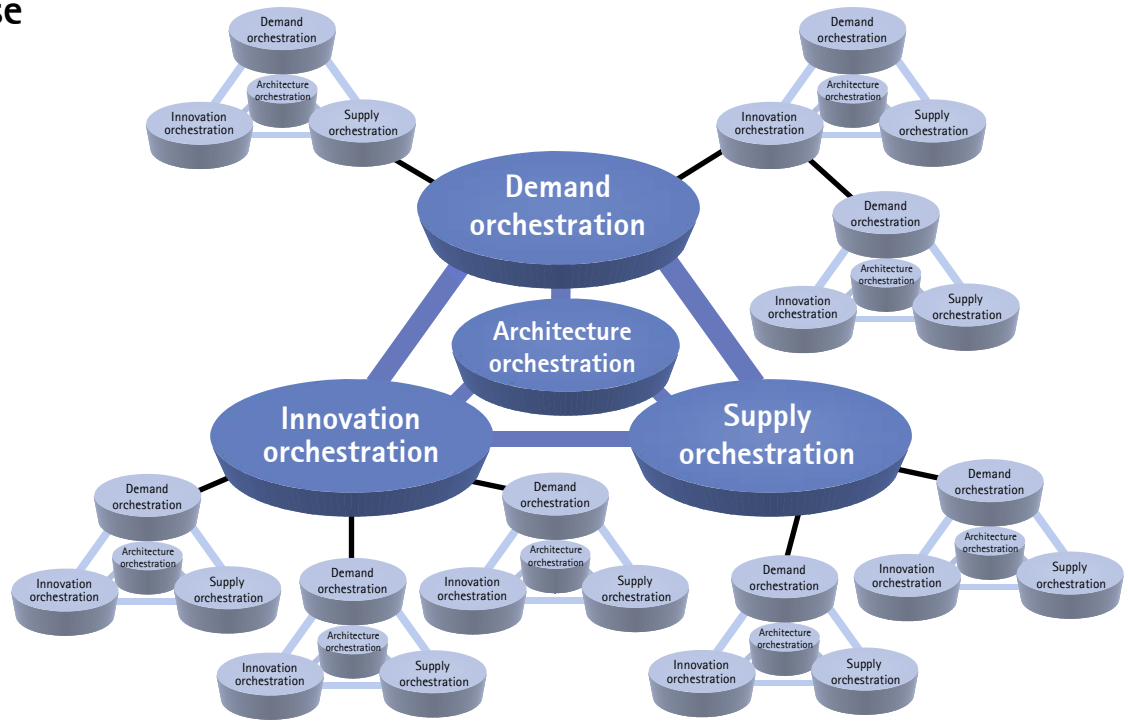
Organizational Evolution

From traditional large enterprise

to extended enterprise



with orchestration capability



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Source: O. Vikman

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Publications

- Journals that focus on Technology Management:
  - IEEE Transactions on Engineering Management
  - IEEE Engineering Management Review
  - Research Policy
  - Journal of Engineering and Technology Management
  - Journal of Product Innovation Management
  - Technovation
  - Journal of Technology Studies
  - Journal of Business Venturing
  - R&D Management
  - Creativity and Innovation Management
  - Research-Technology Management
  - European Journal of Innovation Management
  - Design Management Journal
  - Engineering Management Journal
  - Creativity and Innovation Management
  - IEEE Transactions on Engineering Management
  - International Journal of Innovation Management
  - Journal of Engineering & Technology Management (JETM)
  - Journal of Operations Management (JOM)
  - Journal of Product Innovation Management (JPIM)
  - Journal of Technology Transfer
  - R&D Management
  - Research Policy
  - Technology Analysis and Strategic Management

- Broader journals that include Technology Management topics:
  - Management Science
  - Organization Science
  - Administrative Science Quarterly
  - Academy of Management Journal
  - Academy of Management Review

IAMOT 2007

- Management of Technology for the Service Economy

  IAMOT 2007 will provide an international technical forum for experts from industry and academia to exchange ideas and present results of ongoing research in the tracks listed below.
  • Knowledge Management
  • Green Technologies
  • Social impact of technology development
  • MOT Education and Research / Corporate Universities
  • New Product/Service Development
  • National and Regional Systems of Innovation
  • Small and Medium Enterprises
  • Emerging Technologies
  • Technology Transfer, Marketing and Commercialization
  • Technology Foresight and Forecasting
  • Information and Communication Technology Management
  • The Integration of Technology and Business Strategies
  • R&D Management
  • Project and Program Management
  • Industrial and Manufacturing System Technologies / Supply Chain Management
  • New Forms of Organizations
  • Management of Technology in Developing Countries
  • Technological Alliances, Mergers and Acquisitions
  • Theory of Technology
  • Technology Incubation
  • Management of Technology for the Service Economy
  • Innovation/technological development and productivity
  • Nuclear Technologies

TECHNOLOGY MANAGEMENT COURSES

- **Intellectual Property Management**
  How do firms compete with ideas? How do they create, exploit and vindicate intellectual property ("IP") assets and capabilities in competition with others at home and abroad? We will address these critical questions, and gain a better understanding of what IP is, how firms nurture its creation, protect and meter its use, and integrate it into the broader competitive strategy of the firm. We will also investigate different types of IP legal regimes around the world, and investigate how multinational firms manage these regime differences for competitive advantage globally. We will do this through review and discussion of published legal decisions, international agreements, business case studies and in-class exercises designed to highlight practical challenges that managers face when deciding how best to protect, transfer and or exploit IP within and across markets. Students should come away from this course with practical management insights and techniques for dealing with IP issues and helping the firm compete with ideas more effectively.
- **Managing Innovation**
  One of the primary tasks of management is making decisions about policies, practices, procedures, and structures that facilitate accomplishing organizational goals. In other words, a manager's responsibility is the creation and maintenance of organizations; delegating tasks, devising strategy, creating routines, monitoring performance, resolving disputes, and managing people so that the organization can best achieve its goals. The implications of these managerial tasks are magnified when performed amidst the uncertainty associated with managing the development of new products, technologies, and other organizational innovations, or when competitors innovate.
- This course is designed to consider the problems that arise in managing organizations for innovation. This course will explore each week a different managerial issue or dilemma that can occur when organizations attempt to innovate, are unable to innovate, or are faced with decisions to innovate. Using the principles of organization theory and design, a range of actions available to managers faced with these dilemmas and the role of organization design in helping or hindering innovation efforts will be investigated.
- **New Product Development**
  New product development is a strategic activity for most firms. Success in new products becomes vital as product life cycles shorten due to increased competition and quickly changing consumer preferences. This course is intended to provide students with the ability to manage new product development through participating in a real development project for a client firm. In addition, we will be exploring marketing research methods, current critical topics in new products, and organizational issues through readings, case discussions, and project assignments.
- **Project Management**
  The objective of this course is to master the principles of efficient project planning and control – needs analysis, work breakdown, scheduling, resource allocation, risk management, and performance tracking and evaluation – within the timeframe and cost projections stated in the overview section. Concepts and techniques will be developed by navigating through a recent textbook in project management and through a popular project management software package. In addition, task teams of five members each will have the opportunity to hone skills through homework problem sets and a comprehensive project plan.
- **Simulation and Risk Analysis**
  This course provides quantitative tools for solution of management problems involving risk, competing objectives, and complex constraints. The course will provide hands-on experience with techniques for solving these problems, with a particular emphasis on models and methods that enable managers to proactively manage and mitigate risk, obtain insight, and support decision making. Models are illustrated with applications to operations management, finance, and marketing, with a particular emphasis on issues associated with project portfolio management. Hands-on modeling skills are developed using spreadsheet-based software tools. We will consider challenges that executives and organizations encounter when implementing these approaches, and demonstrate how mathematical models can improve on "seat of the pants" methods.
- **Supply Chain Management**
  Fierce competition in today's global markets, the introduction of short life-cycle products, and heightened customer expectation have forced the business enterprises to invest in, and focus attention on, their supply chains like never before. This course focuses on managing material and information outside of the factory walls including aspects of demand planning and forecasting, inventory deployment, distribution system design, channel management, procurement, and logistics. We explore order fulfillment strategies and the impact of the Internet on distribution and back-end supply chain processes. We also examine strategies for enterprise integration. Stumbling blocks for supply chain integration such as high transaction costs between partners, poor information availability, and the challenges of managing complex interfaces between functional organizations have been rapidly dissolving on the web. We study the impact of these changes on traditional supply chains and on the creation of virtual chains.
- **Technology Strategy**
  The course on Technology Strategy deals with those decisions that determine future directions of the technology intensive organizations and effective implementation of the directions chosen. Technology Strategy will addresses the organizational structure, resources & capabilities, and strategic positioning of the firm to create, capture, and sustain competitive advantage in high technology industries. In this course, students will develop skills at understanding how firms gain and sustain competitive advantage, analyzing strategic business situations and formulating strategy, and implementing strategy and organizing the firm for strategic success. It includes not only some of the traditional elements of strategic management such as industry analysis, competitor analysis, generic strategies, and diversification, but also subjects that are directly relevant for technology intensive organizations such as sources of innovation, types and patterns of innovation, standards battles, timing of entry, collaboration strategies, and protecting innovation.
- **Technology Practicum**
  The dynamics of technology-based competition are driven by unique uncertainties from the market, from technology, and from society. Therefore, technology managers need to be proficient in managing at the interface of technology, business, and society. The technology practicum provides practical experience in understanding the dynamics of technology-based competition.

Wikipedia on Business Technology Management (BTM)

- BTM is a management science that seeks to unify business and technology decision-making at every level in an enterprise. BTM delivers a set of guiding principles, known as BTM Capabilities. These capabilities are combined to form BTM solutions, around which a company's practices can be organized and improved. BTM also defines the expected characteristics of an organization according to five levels of a maturity model.
- BTM builds bridges between previously isolated tools and standards for business technology management by strategically incorporating both operational and infrastructure levels of technology management to ensure that an enterprise's business strategy can be realized by the technology it deploys. This structured approach is used by enterprises to align, synchronize and even converge technology and business management for the purpose of ensuring better execution, risk control and profitability.

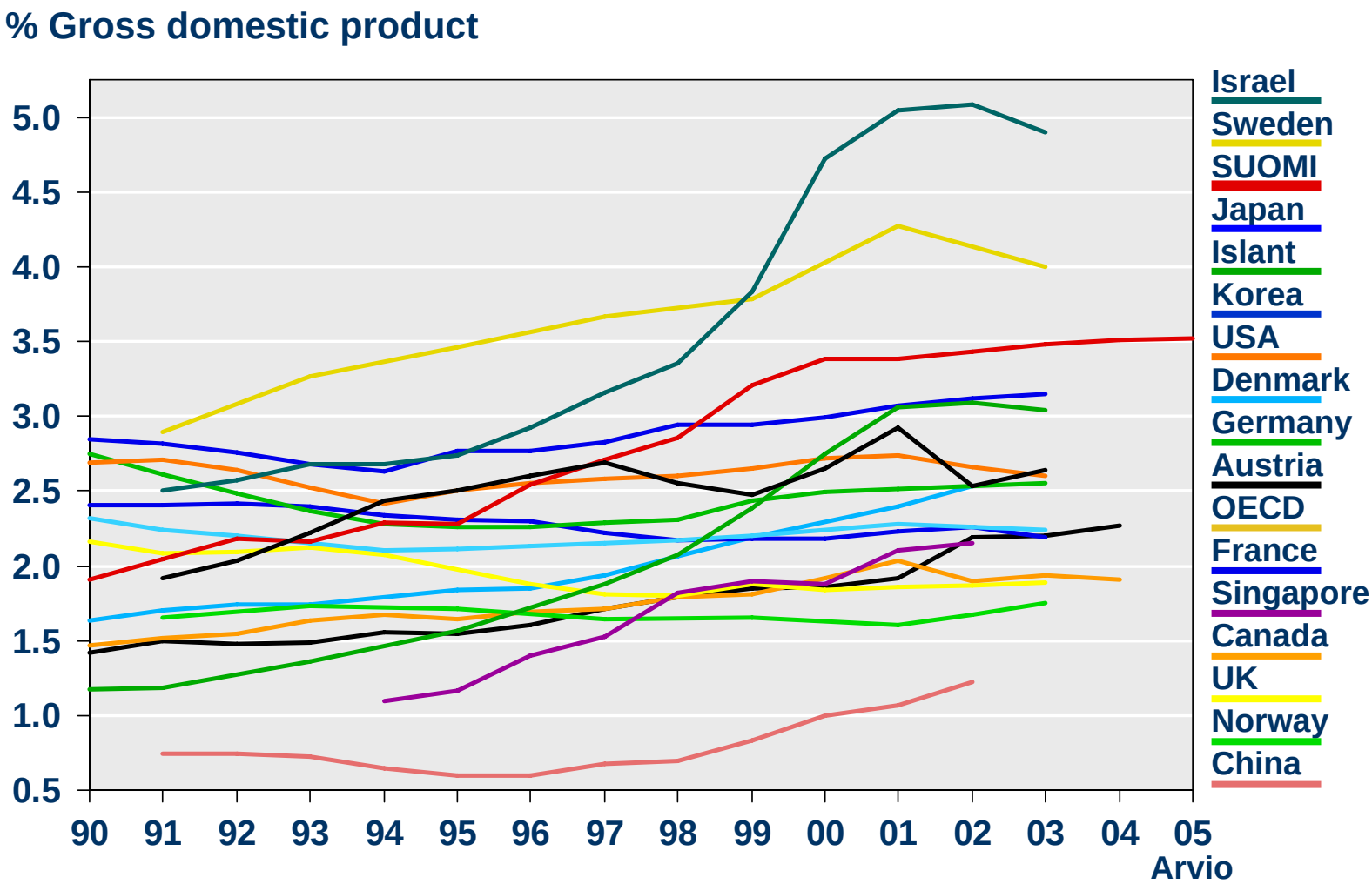
Where does Business Technology Management (BTM) fit? Source: wikipedia

- Most companies employ a number of methodologies and techniques to improve business and technology alignment. While many of these methods have acknowledged strengths, they typically represent piecemeal solutions. Disparate islands of practice exist within the technology management domain, particularly in the areas of operations and infrastructure. These range from the Project Management Body of Knowledge (PMBOK) and Balanced Scorecard to the Software Engineering Institute's Capability Maturity Model (CMM). However, none of these approaches focuses on integrating and enabling the capabilities necessary to achieve strategic business technology management and the sustainable value that follows. The danger of relying solely on "downstream" technology management methodologies is that by the time alignment problems become apparent, they may be irreversible. Furthermore, when methodologies are borrowed from the business domain, there are often deficiencies with respect to focus, goals/objectives and adaptability. For example, Balanced Scorecard is a performance measurement methodology originally designed for the HR function, and Six Sigma is a quality improvement methodology first applied to the manufacturing function. These methodologies are often applied to technology operations with varying degrees of success, but they may not be comprehensive enough to address the unique needs of business-technology integration.
- BTM addresses this challenge by providing a set of guiding principles around which a company's practices can be organized and improved. It harmonizes and integrates and elevates previously isolated tools and standards for "IT" management to deliver a seamless strategic management approach that begins with the concerns of Board and CEO and connects that all the way through business technology investment and implementation.

Suomen tutkimus- ja kehityspanostukset ovat alle prosentin maailman panostuksista.

Suomen on tehtävä strategisia valintoja, millä aloilla haluamme ja voimme olla maailman parhaita.

R&D investments in some OECD countris



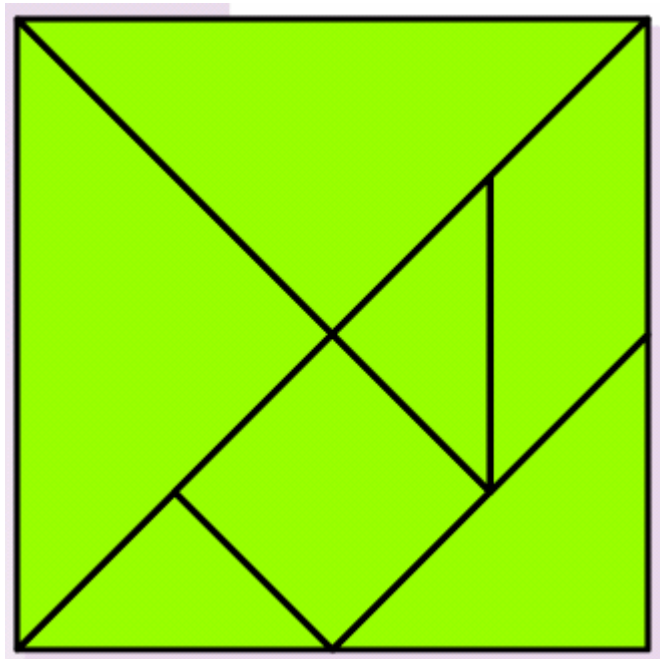
Sources: OECD, Main Science and Technology Indicators ja Tilastokeskus

Tangram exercise

7 pieces

Represent 7 technologies

Solution - architecure



Business
drives
Architecture
drives
Development

From technology management to architectures

Subsystem Architecture

- What is the high level hardware and software architecture for the technology area subsystems?
- What is the integration level of hardware: components, subassemblies, modules, integration to baseband and each other?
- What are the key hardware interfaces? Are they proprietary or open?
- What is the strategy for related software APIs ?
- Who will develop relevant software drivers – Nokia, supplier or 3rd party?

Product architecture

- What are the product architecture changes that we are driving though this technology area, and which ones are we not driving, and which ones are we opposing? Are there any disruptions to be expected?
- What other technologies support /block / slow these product architecture changes?
- How will these architecture changes change the importance of this and other technology areas?

Why architecture ?

- Would you build a house without an architecture sketch?
- Would you like to have an estimate how much your new house is going to cost?
- If you hired a set of constructors from all over the world to build your house, would you like them to have a common language?
- Would you like to verify the proposals of the construction team before the work gets started?
- If it was a great house, would you like to build something rather similar again, in another place?
- Would you drill into a wall of your house without a map of the plumbing and electric lines?

- **Architecture is the sketch of the product to be built.**
- **Architecture gives you a very good idea of how demanding the implementation work is going to be!**
- **Architecture is the common language e.g. for the program team, including external consultants and subcontractors.**
- **Architectures can be reviewed before implementation work is started.**
- **It is possible to re-use portions of the implementation on different products using the same architecture.**
- **Architecture makes life easier for implementation, maintenance and support**

Consistent architecture

- Foundation for
  - Architecture-driven implementation
  - Architecture evolution, its enforcement and compliance checking
  - Industry product architecture leadership across the domains
  - Industry end-to-end architecture leadership across the domains
- Enabler for
  - R&D productivity
  - Future model-based engineering, testing, simulation, consistency checking
- Provides consistent architecture visibility for all stakeholders
- Provides connection between functionalities, logical partitioning and implementation
- Enables make/ buy decisions and efficient utilization of the newest technologies

Consistent Architecture

- Foundation for
  - Architecture driven implementation
  - Architecture evolution, its enforcement and compliance checking
  - Industry product architecture leadership across the domains
  - Industry end-to-end architecture leadership across the domains
  - Requirement management, engineering, testing and error management
- Enabler for
  - Model Based Engineering
  - Model Based Testing
  - Model Based Simulation
  - Model Based Consistency Checking
- Provides consistent architecture visibility for all stakeholders
- Provides connection between functionalities, logical partitioning, and implementation
- Enables make / buy decisions and efficient utilization of the newest technologies

Example of architecture views and layers

House building example

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Illustration of the architectural views

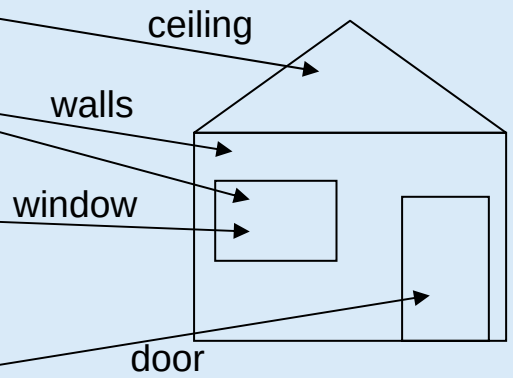
Functional architecture

Feature tree

- **Protect from environment**
  - Keep rain out
    - UE requirements
  - Keep wind out
    - UE requirements
  - Let sunshine in
    - UE requirements
- **Easy accessibility**
  - Enter the house
    - UE requirements

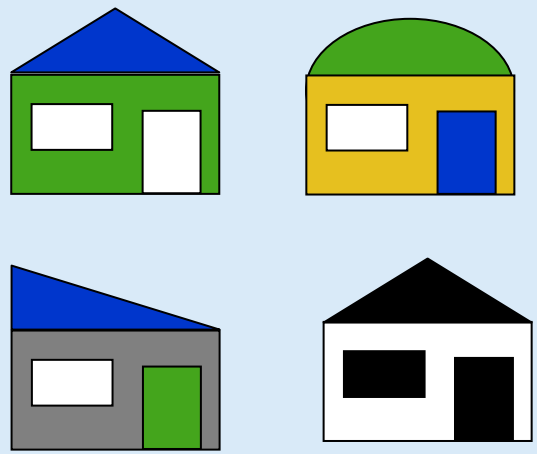
Logical architecture

Logical component structure that defines components and their interfaces



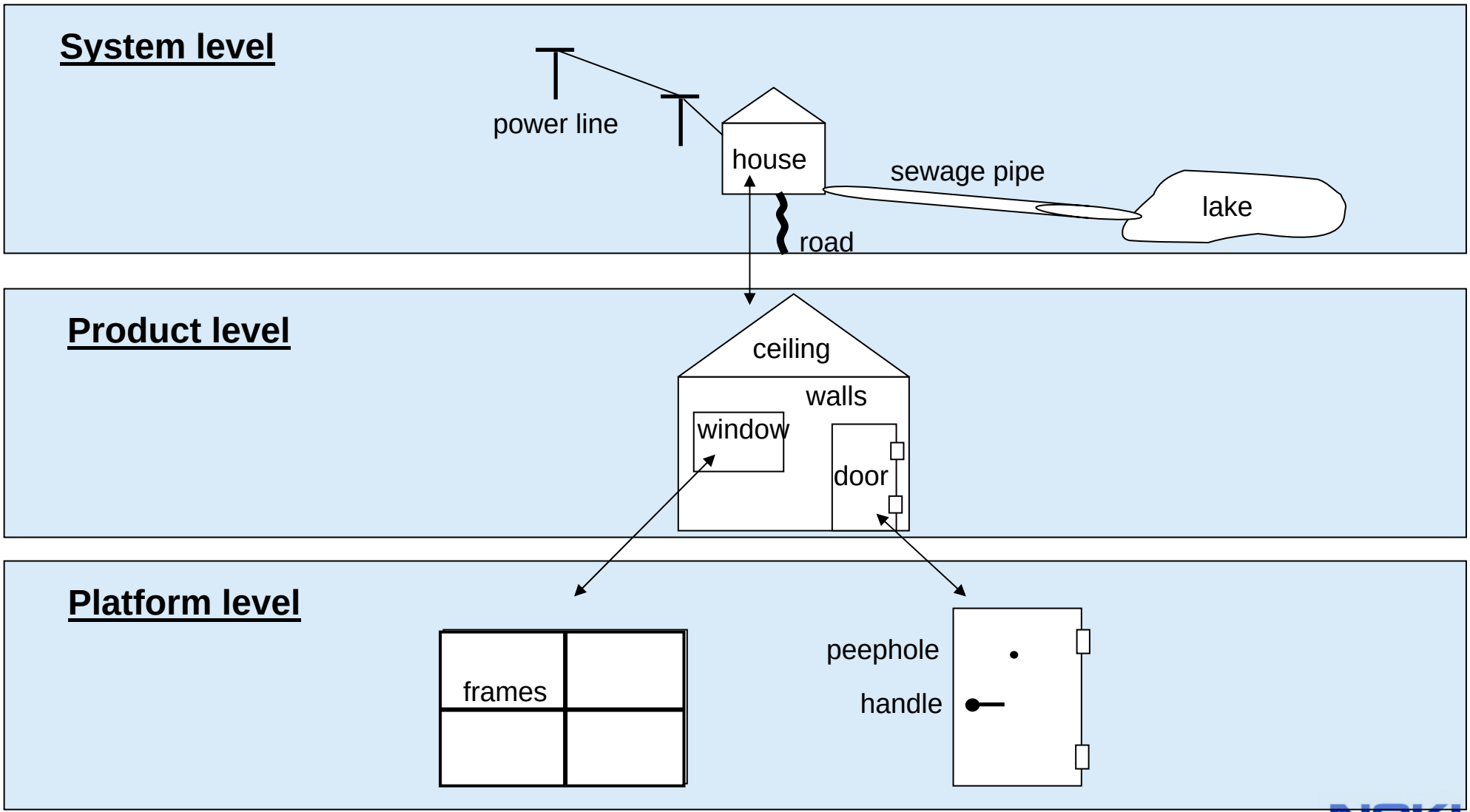
Implementation architecture

Freedom to implement the components however wanted, but the implementation must comply to the logical architecture.

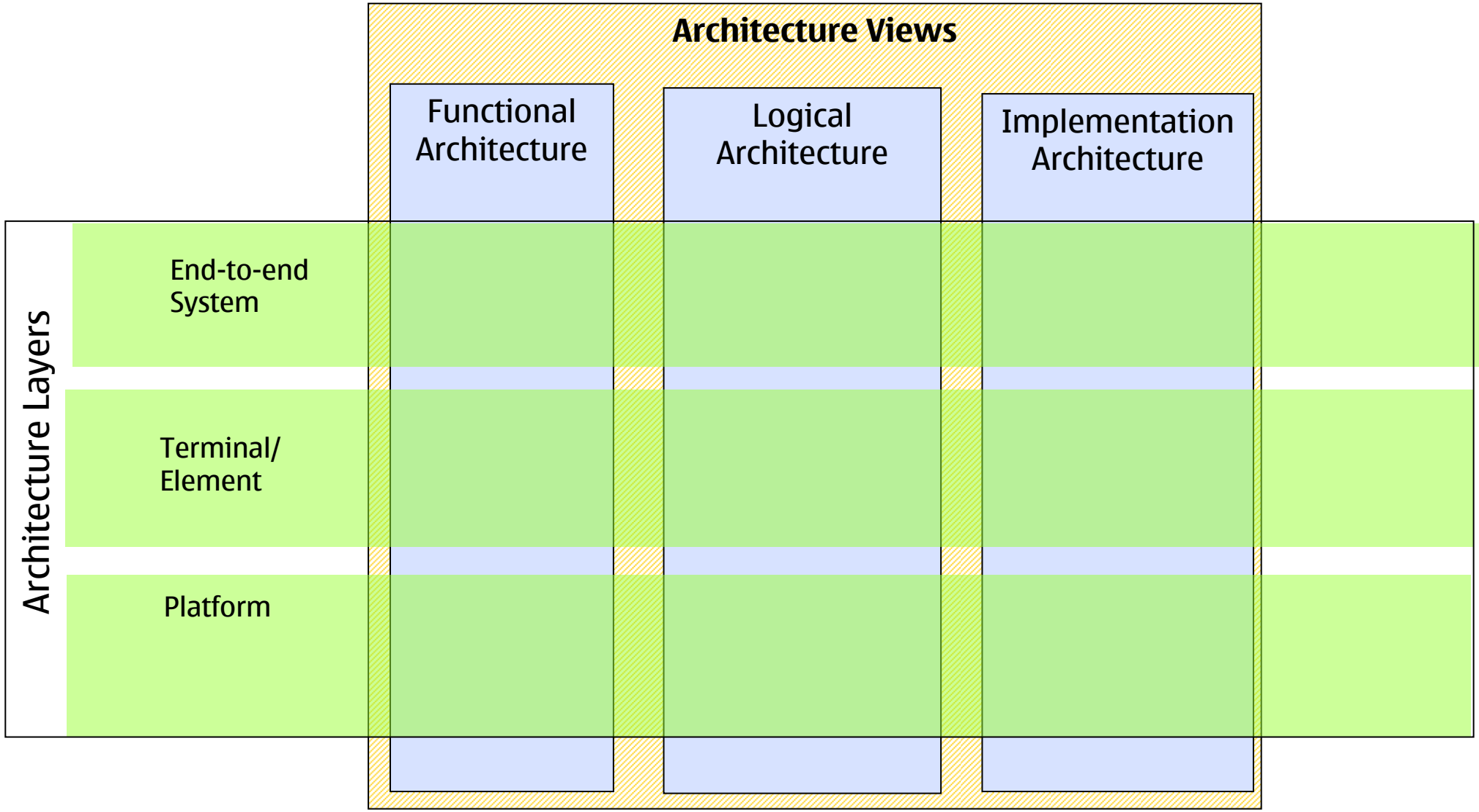


In order for a house to have the feature "*Keep wind out*", it needs to implement the logical components "*walls*" and "*window*" which interface with house according to the logical architecture.
In addition, the feature has User Experience requirements which also need to be fulfilled.

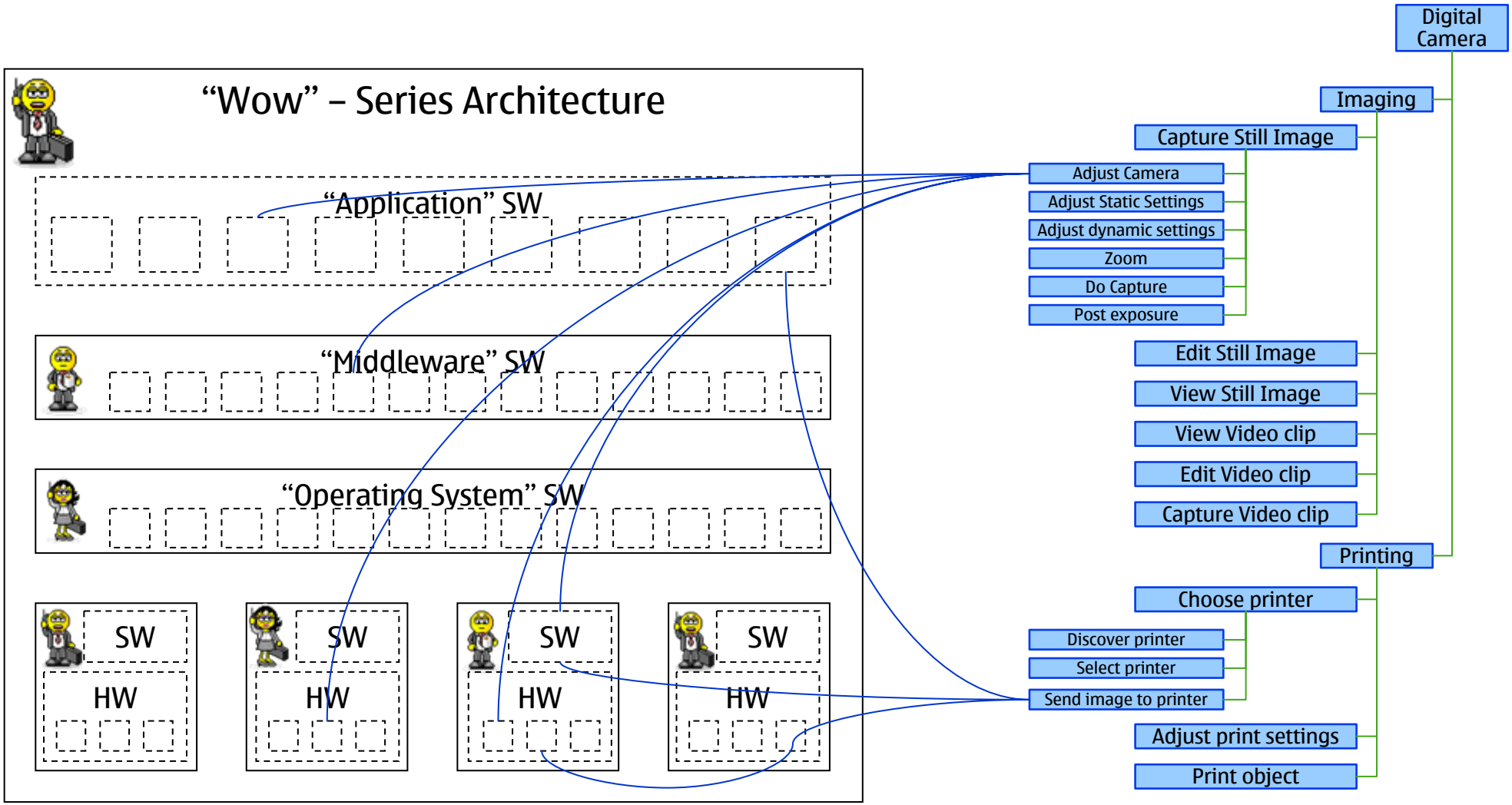
Illustration of the architecture layers



Target is to create Matrix of 3 Architecture Views and 3 Architecture Layers

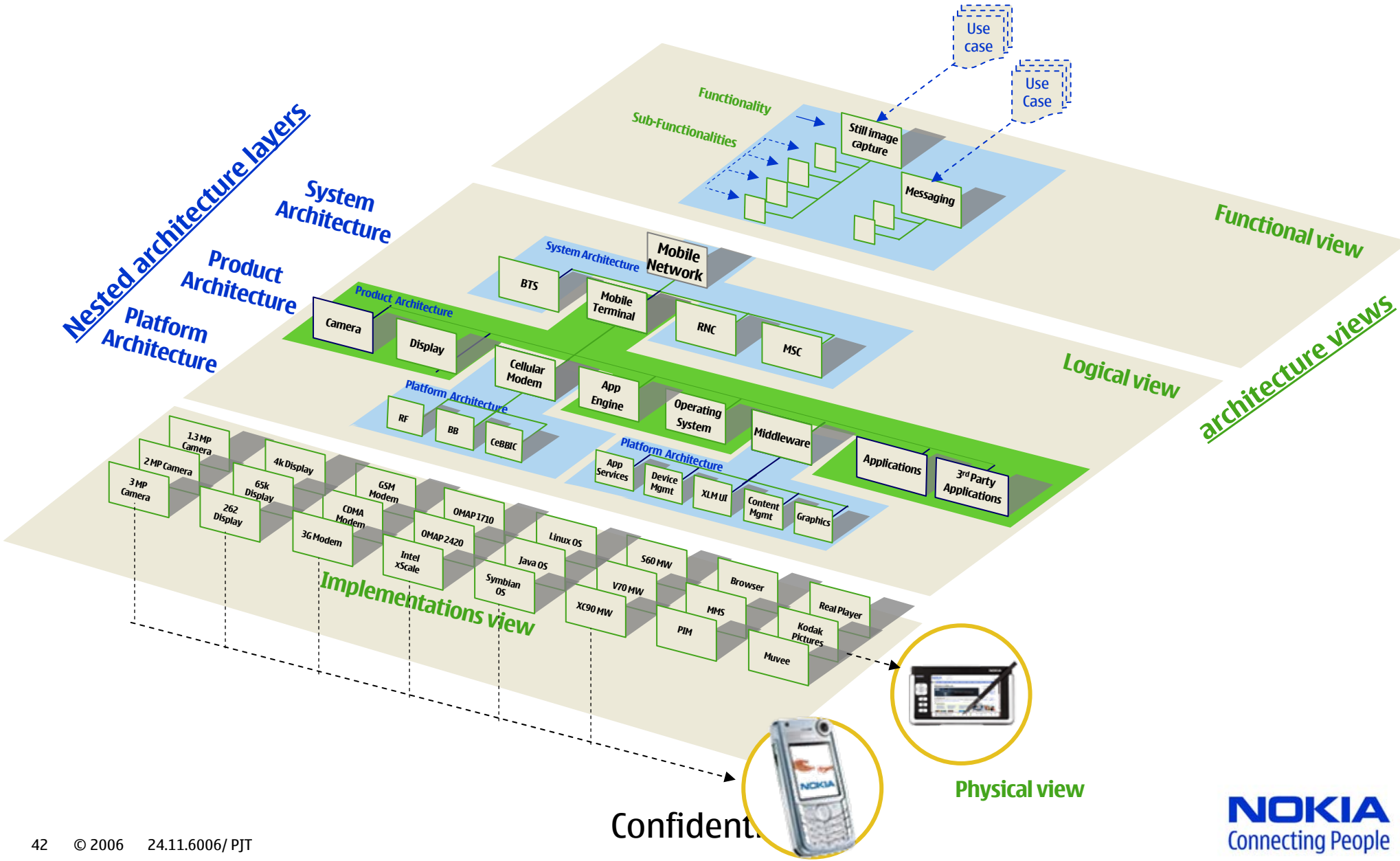


Logical & Functional views



Logical view ***Functional view***

Example of architectural views



Purpose of Architecture Management Process

To give guidance

How to create and maintain architecture structure, interfaces, design rules, and functionality of components in order to drive system, product, platform, and technology creation.

How to enforce architectural changes and monitor compliance of the architecture implementation.

How to manage architecture releases and give support related to architecture implementation.

Architecture Management Process Structure

	Purpose	Inputs	Main Tasks	Outputs	Team Roles
Architecture Strategy Creation 	To create architecture strategy that supports business strategies and steer architecture development.	• Business strategies • Technology trends • User experience • Business roadmaps • Standards	• Identify trends and assumptions • Define architectural vision • Define architecture strategy • Define architecture strategy roadmap • Share architecture strategy	• Approved architecture strategy • Approved architecture strategy roadmap	• Chief Architect • Architecture Council • Architecture Management Team
Architecture Creation and Evolution 	To systematically create and manage evolution of architecture (logical and functional architectures) by defining structure, interfaces, design rules and functional behavior based on architecture strategies and architecture change needs (exception handling).	• Approved architecture strategy • Approved architecture strategy roadmap • Approved architecture release roadmap • Architecture release (structure, interfaces, rules) • Architectural change need	• Manage architecture creation as a release and its evolutionary changes with formal review and approval procedures • Manage creation and lifecycle of design rules with formal review and approval procedures	• Approved architecture • Approved design rules • Architecture guidelines	• Chief Architect • Architecture Council • Architecture Management Team • Architecture Creation Team
Architecture Enforcement and Compliance 	To ensure use of architecture in the implementation and to verify the technical implementation against the architecture.	• Implementation support • Architecture release (structure, interfaces, rules) • Technical implementation design • Technical implementation release	• Manage architecture implementation in program (e.g. making sure the chosen architecture release is properly implemented in the program) • Verify compliance with architecture by comparing technical implementation Design and actual technical implementation with architecture release • Manage escalation and decision making in any architecture violation or non-compliance implementation	• Architectural change need • Compliance / non-compliance report	• Program Architect • Program Steering Group • Architecture Review Team • Chief Architect • Architecture Council
Architecture Release Management and Support 	Communicating and managing the different architecture releases. Supporting the implementation programs in use of architecture and collecting feedback and proposals from the developers. Maintaining and distributing a collection of architecture reference designs and the architecture simulation environment.	• Approved architecture strategy roadmap • Architectural change need • Implementation architecture • Architecture guidelines • Approved architecture • Approved design rules • Compliance/non-compliance report	• Formal documentation of architectural assets (e.g. structure, interfaces, design rules) with rigorous asset change management • Create and formally approve architecture release roadmap • Communicate changes to all relevant stakeholders • Launch architecture release to each area which needs architectural information • Active implementation support on architectural issues • Creation of architecture simulation environment • Integration of architecture implementations as a collection of best practices • Check architecture documentation consistency	• Approved Architecture release roadmap • Architectural change requirement • Architecture release (structure, interfaces, design rules) • Implementation support	• Management Team • Chief Architect • Architecture Council • Chief Architect's Office

Architecture Management Principles

1 Ownership

- Nominate one responsible person (i.e. a Chief Architect) for architecture components in each layer.

2 Awareness

- Document architecture assets (e.g. structure, interfaces, design rules).

3 Enforcement

- Execute architectural changes in implementation with proper timing (architecture drives implementation).

4 Compliance

- Verify implementation consistency against architecture release.

5 Exception management

- Provide escalation and decision making structure for architecture violation or non-compliant implementation.

6 Change control

- Create architecture as releases and manage rigorously their evolutionary changes with formal review and approval procedures.

7 Lifecycle

- Classify and manage the different phases of architecture assets.

8 On-line visibility

- Provide on-line visibility to critical architecture information.

9 Support

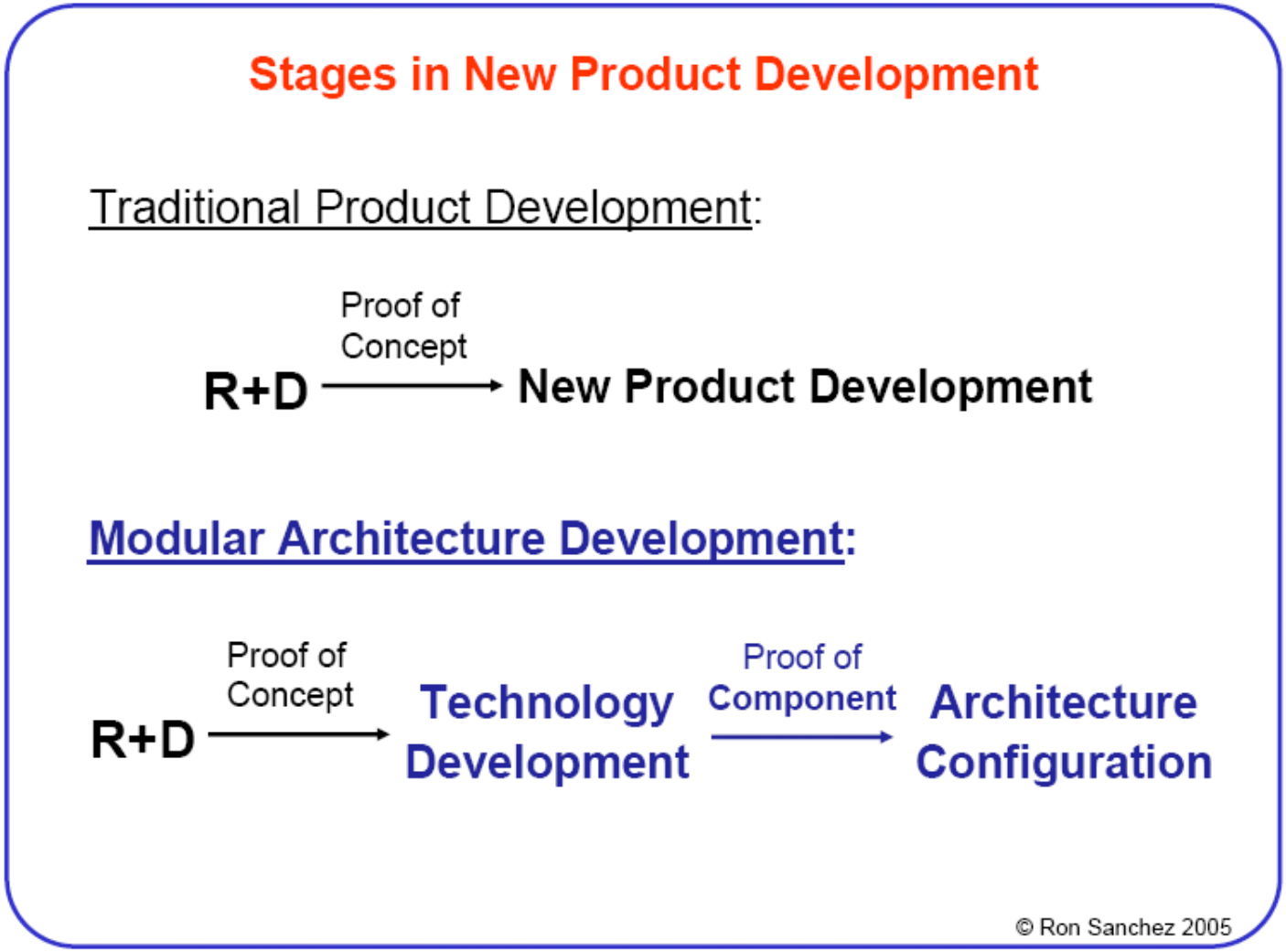
- Provide active support on architectural issues.

In essence, the flexibility of a modular architecture to configure a range of strategically desired product and service variations and upgrades should happen by architecture design — as a matter of strategic intent—

not by luck.

- R. Sanchez -

Technology development vs. architecture configuration



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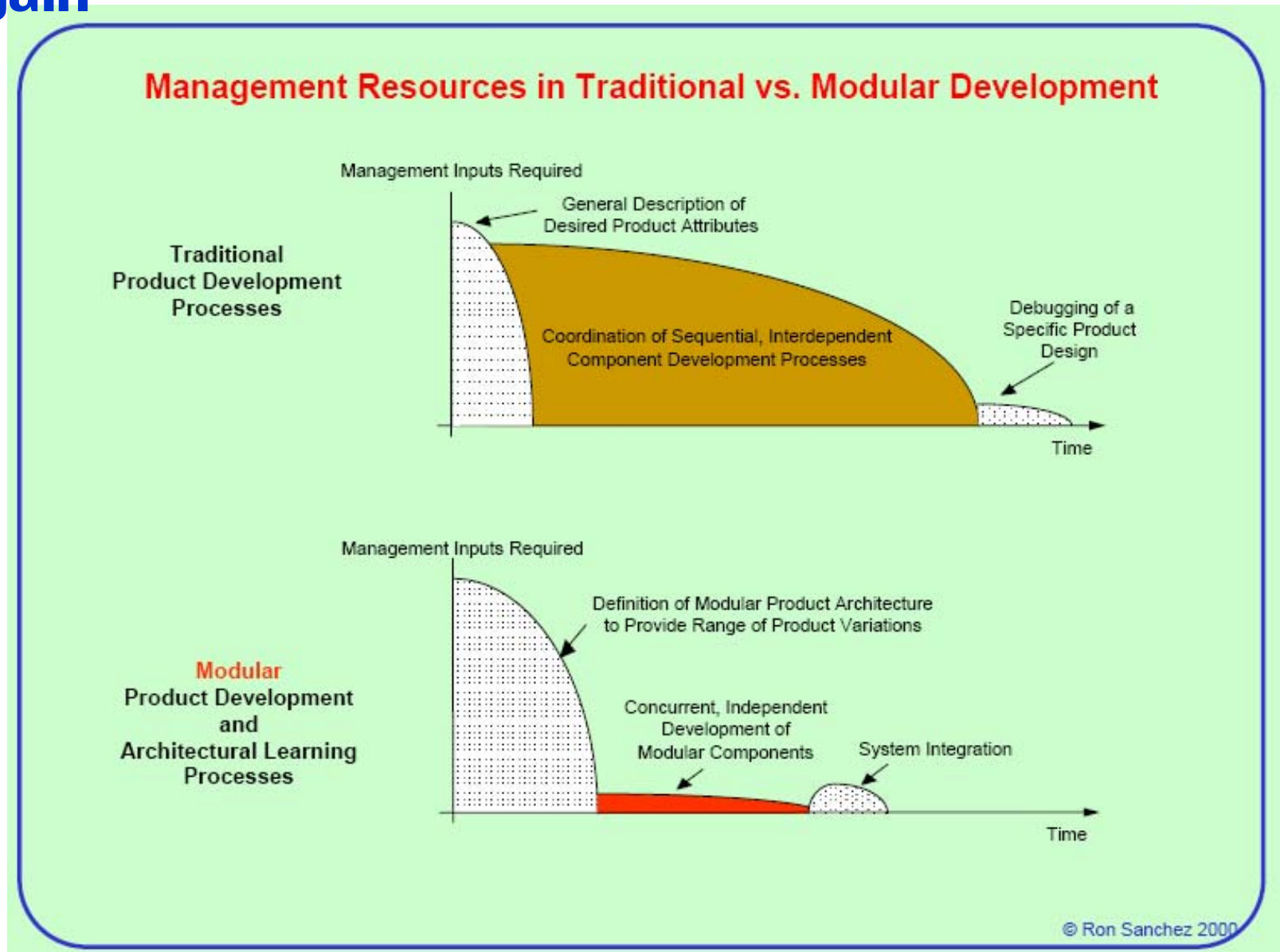
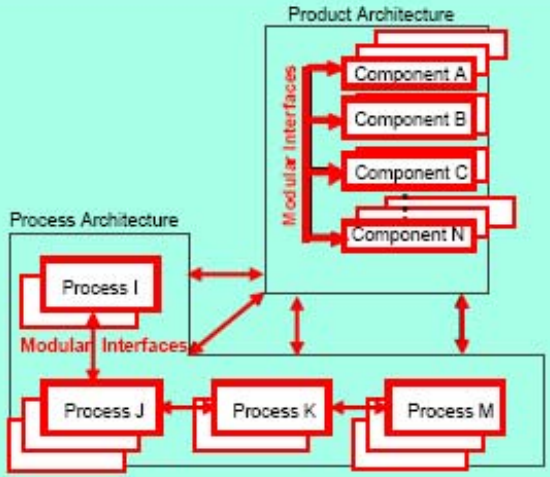




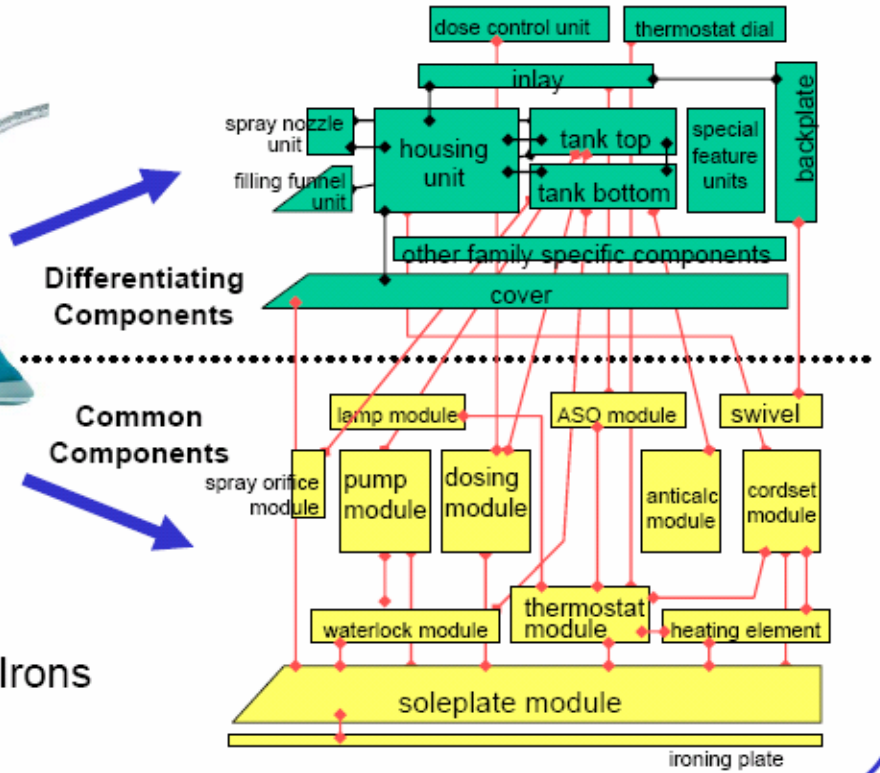
Product and Process Architectures become ***modular*** when

(i) Architectures are ***strategically partitioned*** to
- Achieve a "One-to-One Mapping" of perceived benefits into specific modular components
- "Contain" product variety and technological change in specific modular components

and

(ii) The interfaces between components are
- specified to allow the ***substitution*** of a range of component variations
- ***standardized*** (i.e., not allowed to change) for some period of time

Strategic Partitioning of a Modular Platform into Mass-Produced Common Components and Differentiating Components enables a broad range of product variety to be produced *at Low Cost*



Example:

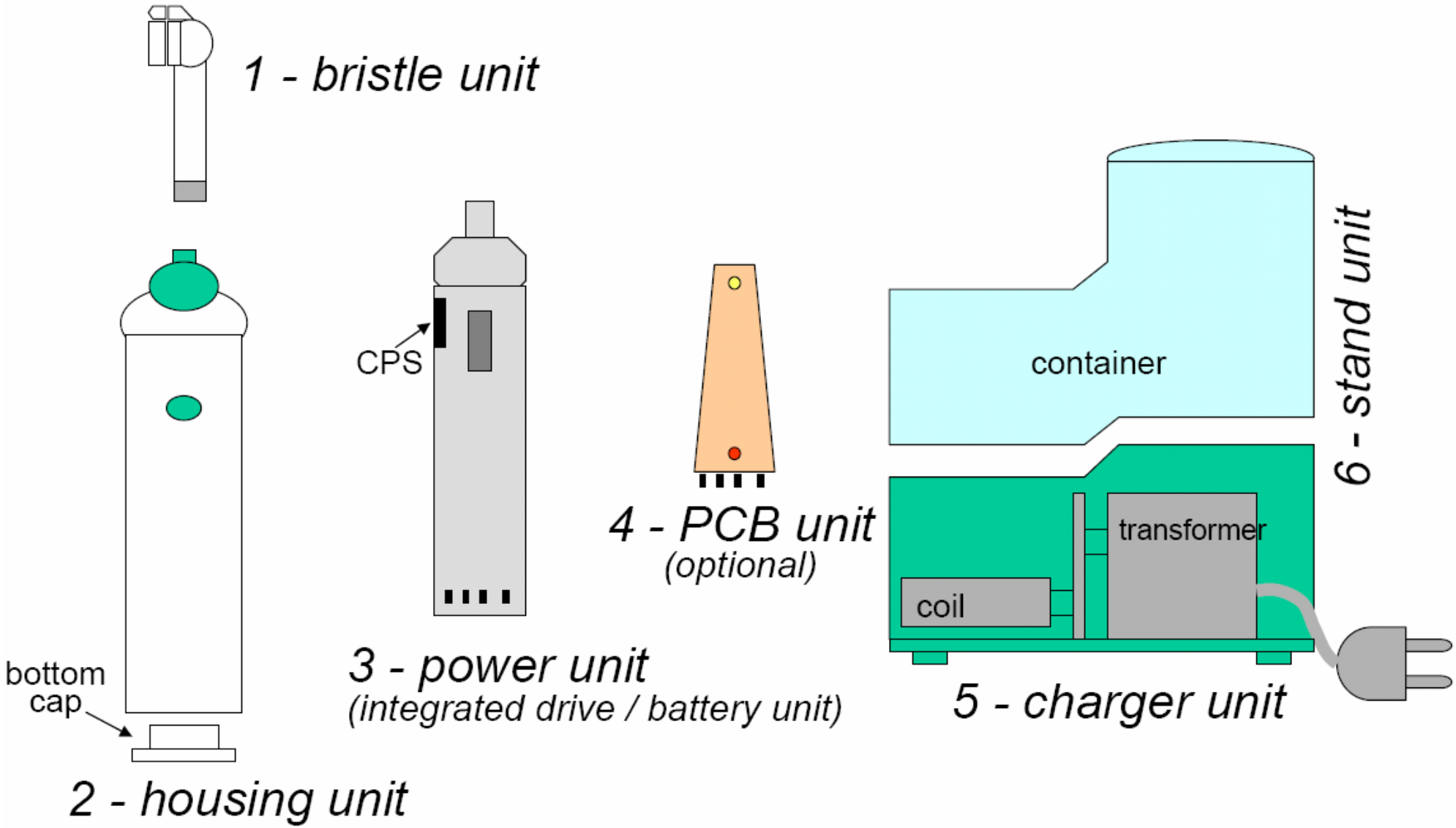
Philips Elance and Mistral Irons

The power of good architecture

- Philips oral healthcare (Sunshine -project)
- Sensiflex models
- Results of applying modular platform design
  - Product variations increased from <100 to >300+
  - Reduction in costs/ delivered unit 48%
  - Lead time reduction from 6 weeks to 5 days
  - Order fulfillment increased from 80% to 99%

Source: Sanchez

Physical components – Sunshine product architecture



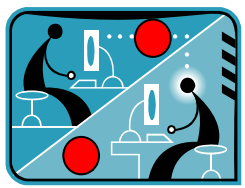
Summary of Architecture Vision

Open software platform

Built for growth

Tuneable

Dynamic



Common System Elements

Source: J.P. LeBlanc

Case 2 - discussion

- What is the relationship between technology management and architecture management?
- Why architecture is important in product development?
- What are the benefits in investing architecting?

Thanks!

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