15.905 Technology Strategy

Summary of the course

Michael A M Davies

9 May 2007

This course provides you with a framework for the strategic management of technology businesses

Technology businesses

- Complex
- Dynamic - and unstable
- Uncertain

- Co-evolution of technological innovation, demand opportunities and business ecosystems
- Value creation and value capture

This course

- Ways of thinking
- Mental models

- Bring clarity to complexity

- Insights and anticipation
- Better decisions

- Improve (significantly) the odds of success

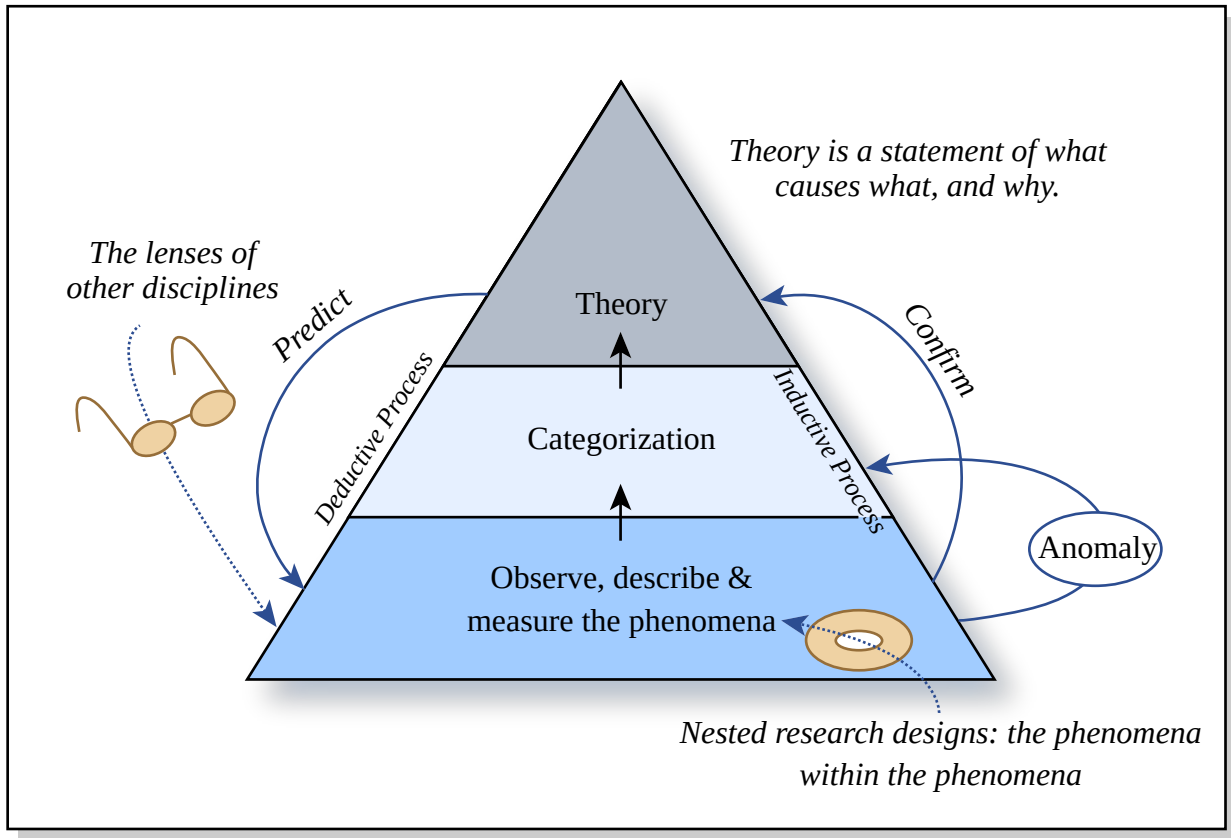
It is focused on domains in which *systems* are important

- Products part of larger and more complex systems
- Products are comprised of multiple (sub-)systems

- Computing
- Communications
  - mobile
  - IP
- Consumer electronics
- Industrial networking
- Automotive
- Aerospace

- ...not so much biotech or pharmaceuticals

The process of *theory*-building



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What is business strategy?

- Pursuing choices amongst competing options
  - a **different** system of activities that creates unique value and captures it
  - not operational effectiveness or improvement
- Planned and intended, pursued and realized
  - deliberate
  - emergent
- Pattern recognition
  - building the prepared mind
  - capable of making sound decisions

Michael Porter, "What is Strategy", Harvard Business Review, November-December 1996, pages 61-78
Henry Mintzberg, "Crafting Strategy", July-August 1987, pages 66-74
Sarah Kaplan, "The Real Value of Strategic Planning", MIT Sloan Management Review, Winter 2003, pages 71-76

Technology strategy (very often) determines who survives and thrives

- IBM (mainframe computers)
- Sun Microsystems

- DEC, Wang, Unisys and many others
- Apollo Computer and others
- Sony (Betamax)

- Matsushita, and many others (VHS)
- Sony (transistor radios)
- Nikon (in semiconductor capital equipment)
- Canon (in photocopiers)
- Canon, Nikon and others
- Nokia

- RCA
- Cobilt, Canon, Perkin-Elmer and GCA
- Xerox
- Polaroid and Kodak
- Motorola

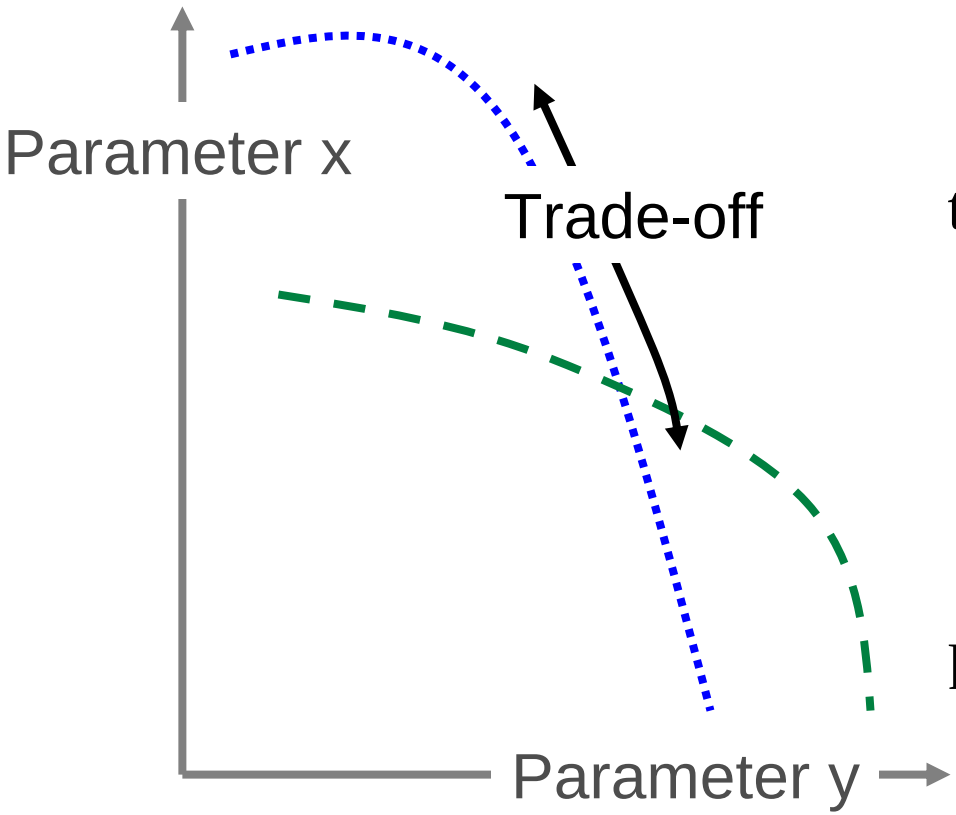
A roadmap of the course

A: Innovation, Diffusion and Transitions	B: Creating Value	C Capturing Value	D Deciding and Delivering
Demand opportunity			
Co-evolution, life-cycles, eras and transitions	Business ecosystems, niches and co-opetition	Value capture, standards and modularity	Ambiguity and scenarios, uncertainty and real options
Technologies and innovation			

Technologies and technological innovation

- Technologies emerge
  - can be push - supply, driven by new knowledge - or pull - demand, driven by demand opportunity
- Learning takes place
  - either or both of over time, or as a result of accumulated experience
  - driven by what's possible - technological feasibility - and by what's worthwhile - commercial viability
- Over time, performance improves and unit costs fall
  - along which *parameters*
  - at what rate
  - locally, or causing system change

Technology envelopes and trade-offs



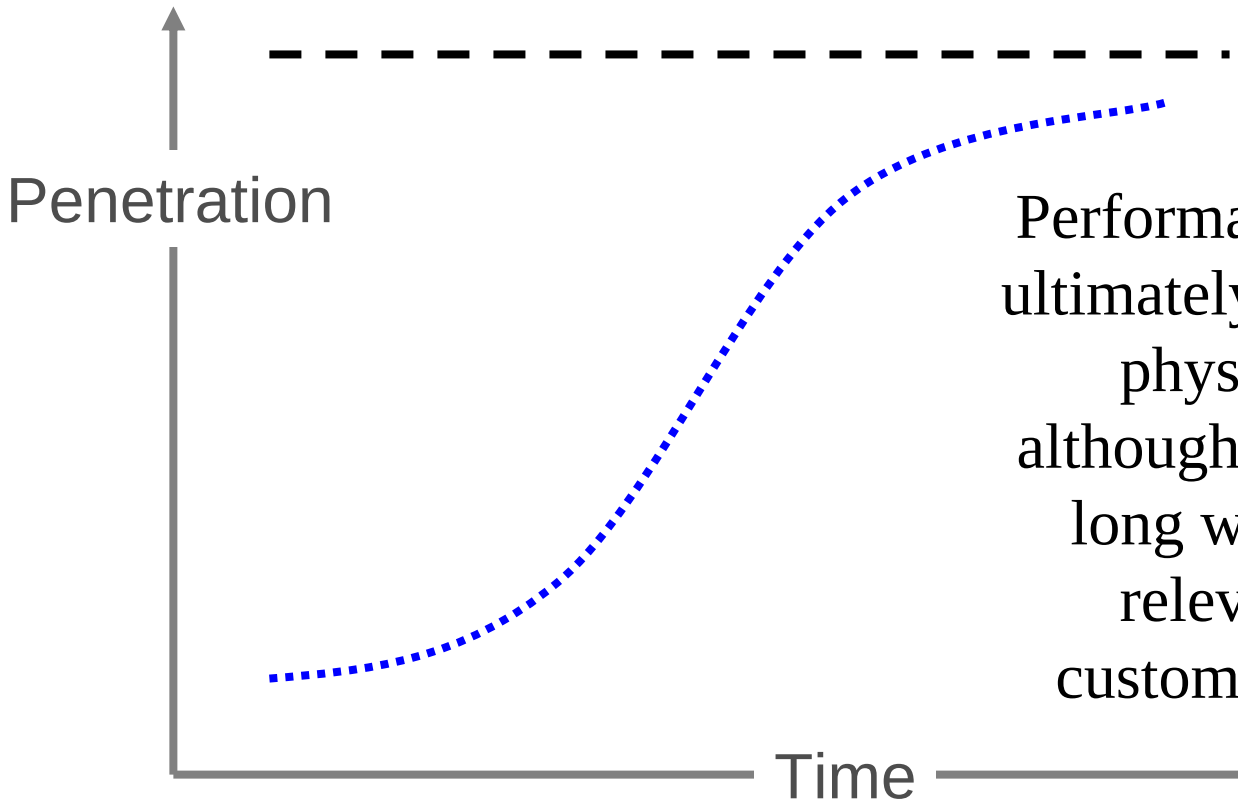
Technologies are characterized by performance envelopes, the limits of what can be done with them, and the trade-offs amongst parameters for them

Different technologies have different envelopes and trade-offs

Technologies compete with each other for potential applications

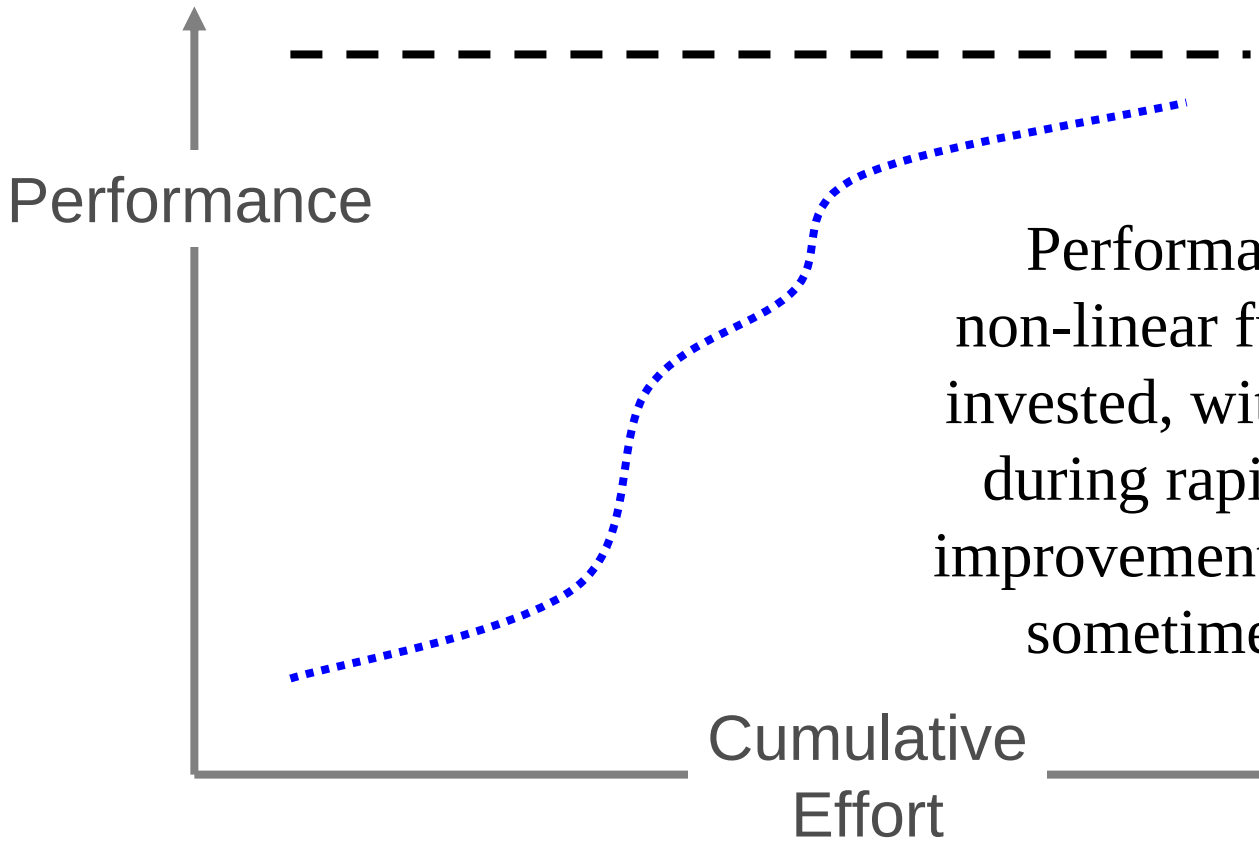
- At any time, there are typically a range of competing technologies that are candidates for each application
- Each of these technologies can be characterized in terms of its key *parameters*
- Each technology typically has a performance *envelope*, which defines the trade-offs inherent in the technology
- Over time, technologies follow an *innovation trajectory*, a vector or function that describes how they have evolved and may evolve, either over time or in response to effort invested in their development
  - rate of change
  - **direction**

Innovation trajectories



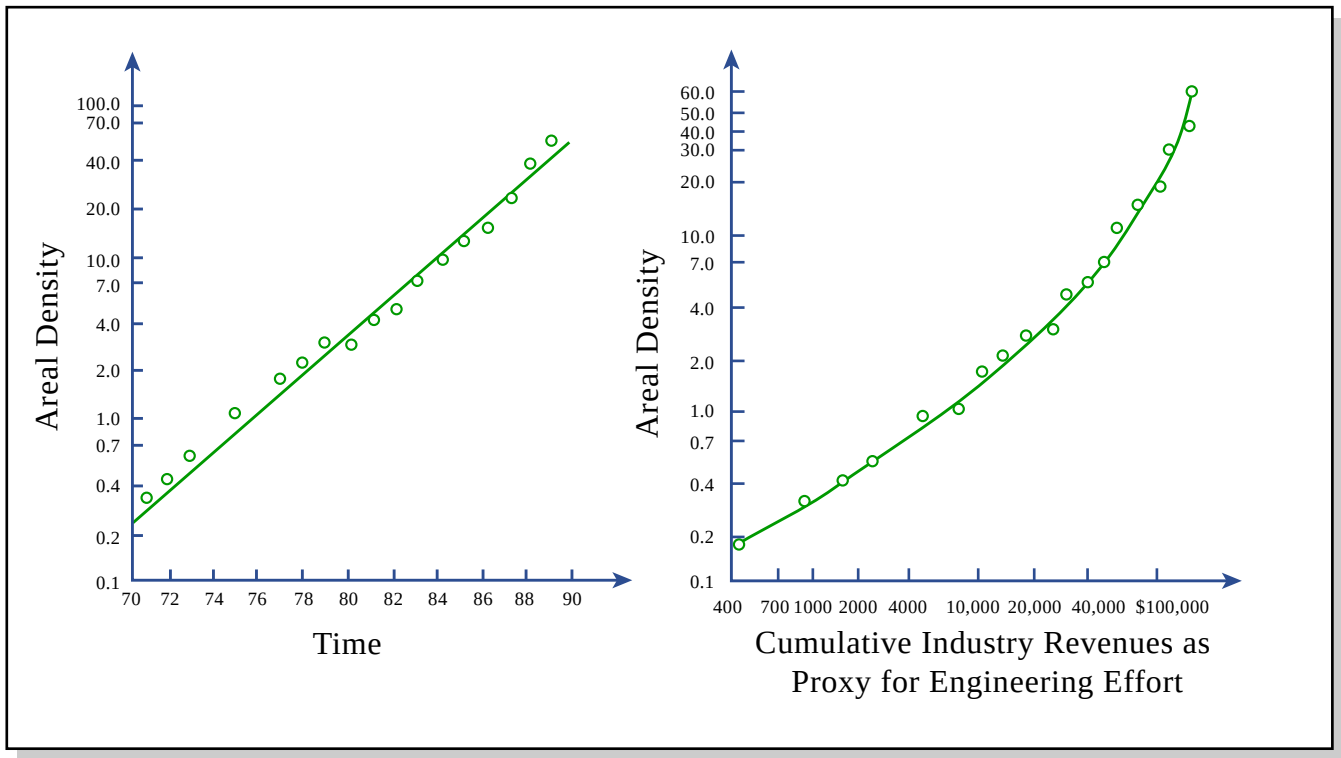
Performance tends to be ultimately constrained by physical limits - although these may be a long way off, or not relevant to what customers want done

Innovation trajectories



Performance is often a non-linear function of effort invested, with rapid progress during rapid growth, slow improvement in maturity, and sometimes slowdowns

S-curves in the rigid disk drive industry



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Within this smooth overall progression, individual businesses went slower or faster

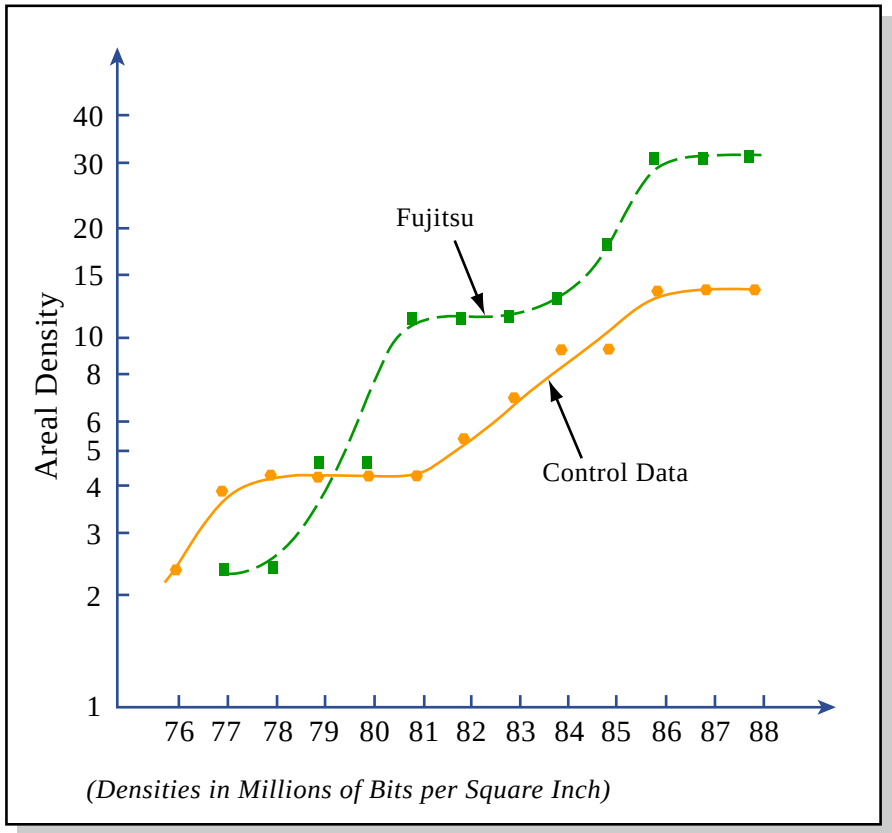


Image by MIT OCW.

The rate at which performance improves can vary dramatically

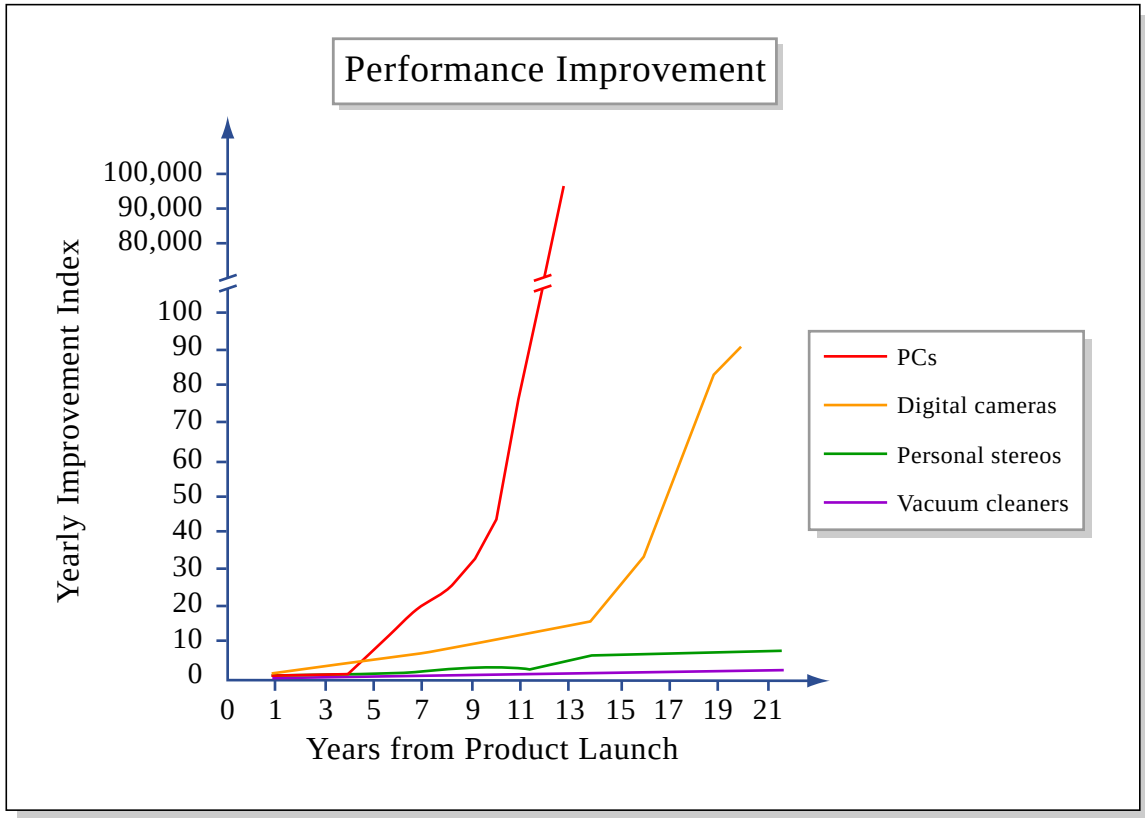


Image by MIT OCW.

Technologies: summary

- Characterized by ***parameters***
  - ***envelope***
  - ***trade-offs***
- Improve in performance
  - over time
  - through learning
  - as a result of investment
  - along an ***innovation trajectory***

Users' needs are diverse, and they change over time, and in response to technological innovation

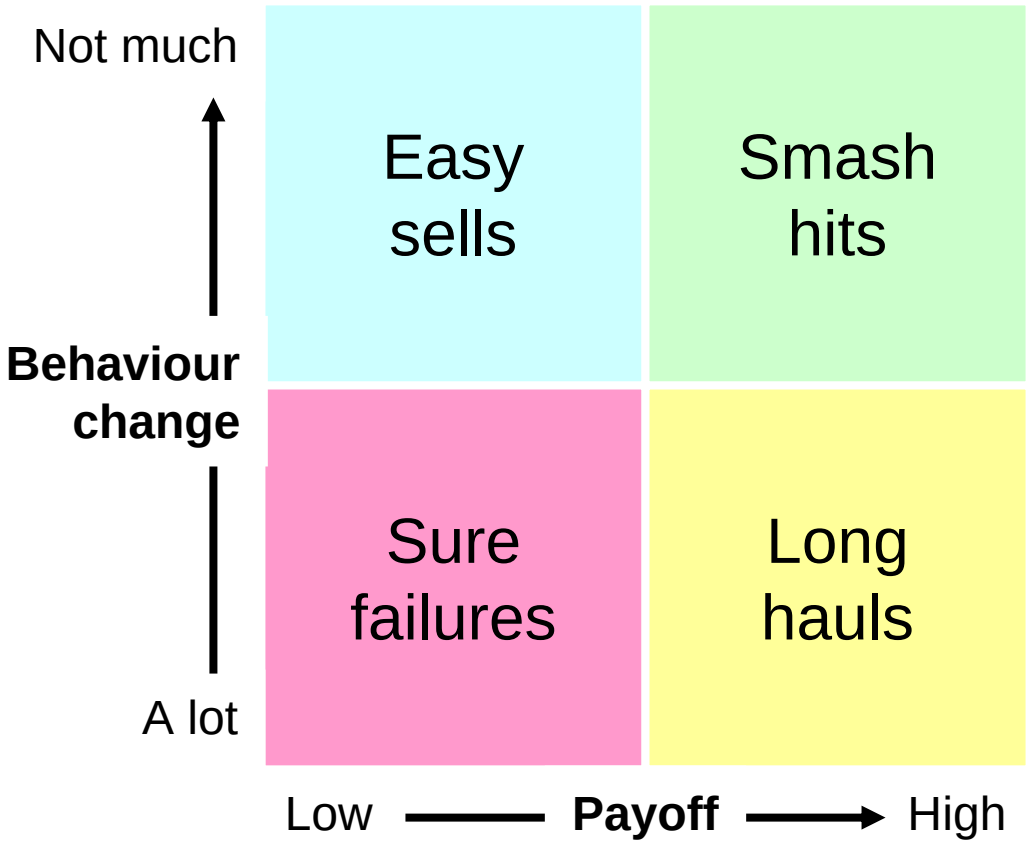
- Heterogeneous - actual or potential users and customers have a range of different needs - jobs they want done - and value they put on getting those jobs done
  - may be related to demographic characteristics
  - but not necessarily, so that in many cases other bases of segmentation may be more useful
- Exogeneous - what users and customers want changes over time in response to, amongst other things, their own changing circumstances and broad societal shifts
- Endogeneous - users and customers' beliefs and behaviour also change in response to technological innovation - new possibilities

But it's not easy to get them to adopt novel products that embody innovative technologies

- Most customers most of the time are loath to change their behaviour
  - requires investment of time and effort
  - involves uncertainty and can induce anxiety
- And are (necessarily) unfamiliar with novel products
- Novel products almost always involve trade-offs
- They evaluate products based on **perceived** value, relative to products they already use to do a job, and are overly sensitive to dis-benefits - "loss aversion"
- At the same time, businesses (full of technologists) tend to underestimate the switching costs, and overestimate the potential benefits

John Gourville, "Eager Sellers and Stony Buyers", Harvard Business Review, June 2006, pages 98-106

So we find ourselves with eager sellers and stony buyers



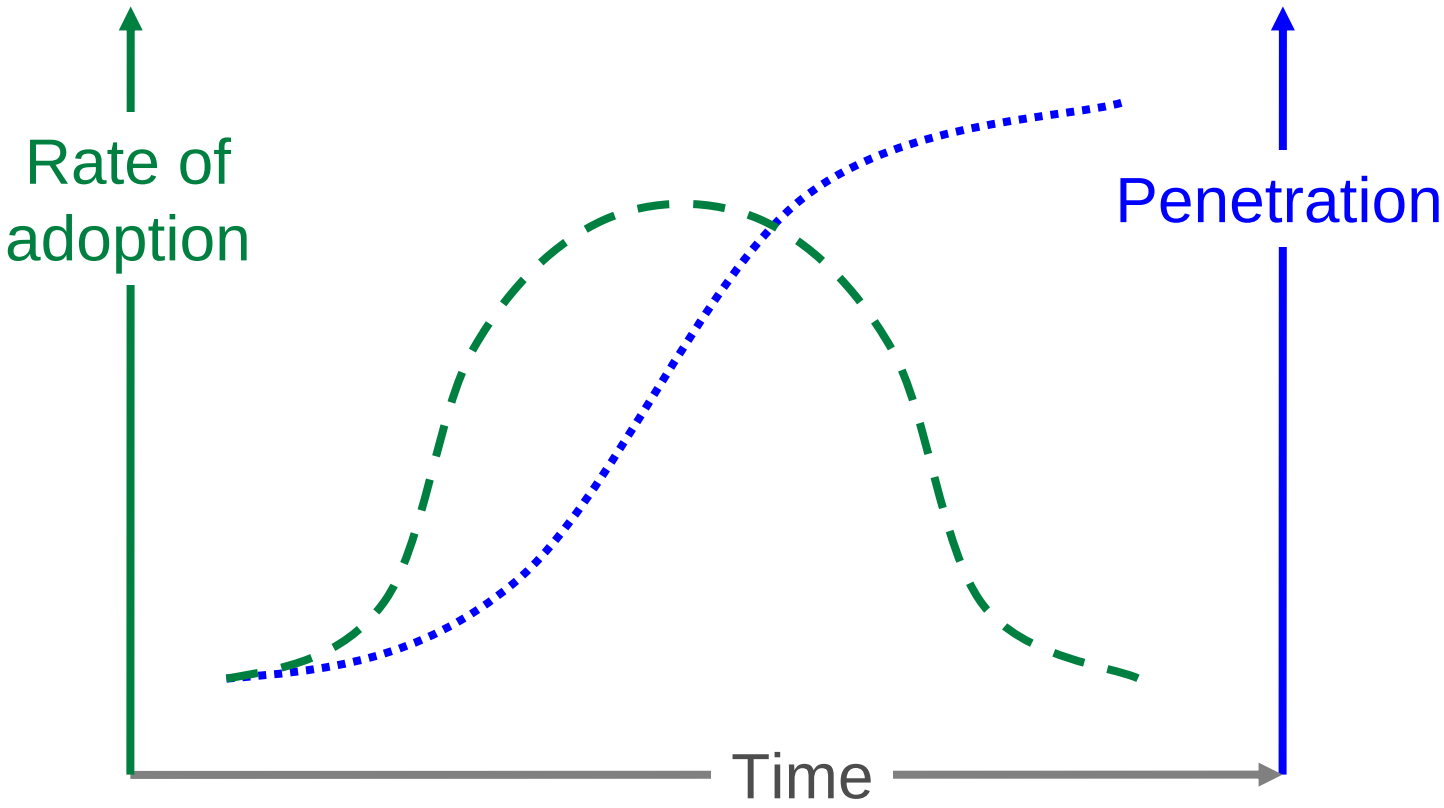
John Gourville, "Eager Sellers and Stony Buyers", Harvard Business Review, June 2006, pages 98-106

Over time, however, successful innovations diffuse amongst users and get widely adopted

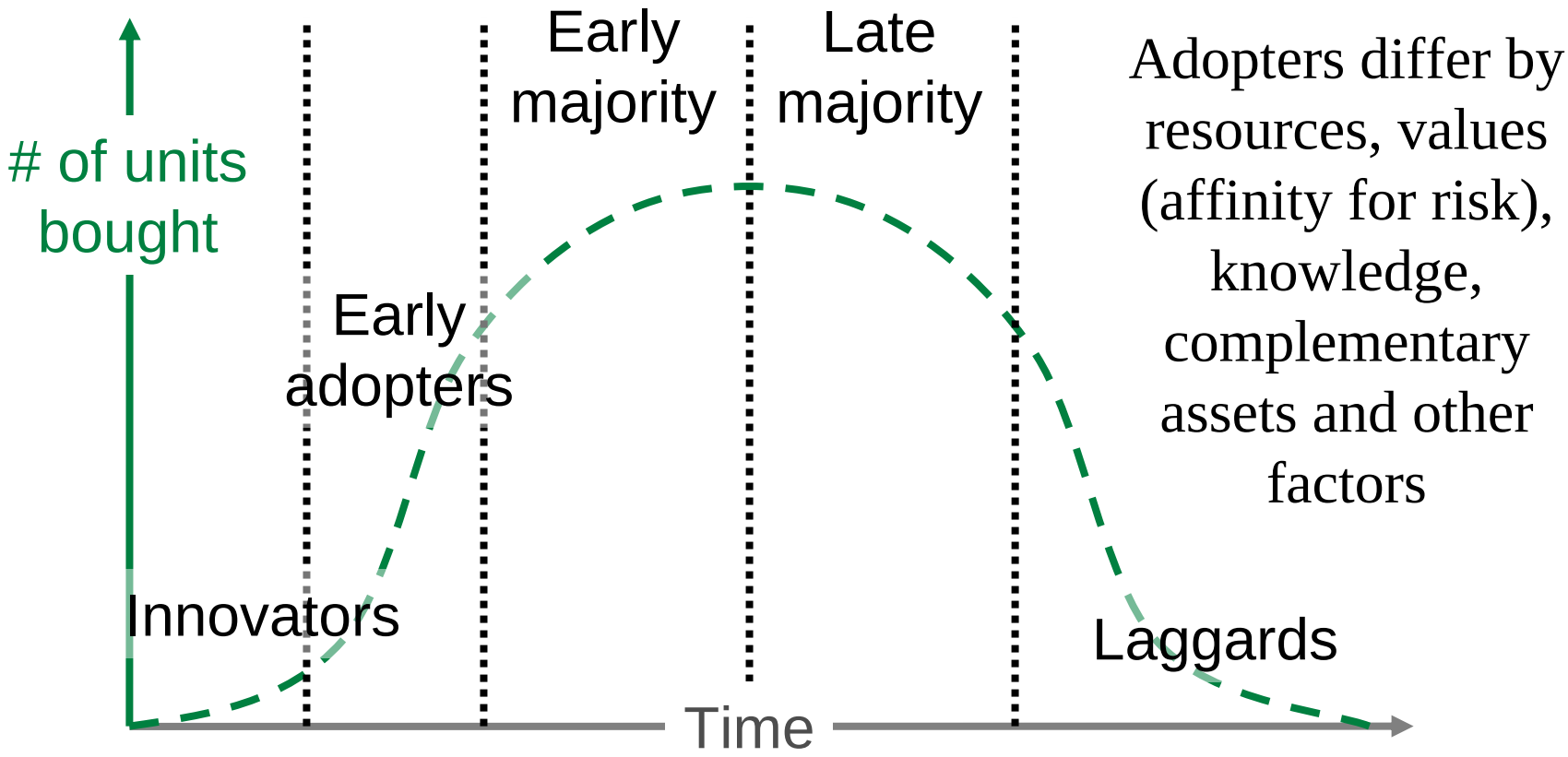
- *Probit* adoption
  - potential users or customers weigh costs and benefits
  - heterogeneity of preferences measn that different users or customers adopt at different times
- *Epidemic* adoption
  - adoption limited by availability of information
  - as potential users and customers become aware of what it does and how to use it, they will adopt
- *Information cascades* and *path dependence*
  - a technology becomes established, it works and is better, and its features well known, legitimizing it
  - once established, network effects take over

Paul Geroski, "Models of technology diffusion", Research Policy, 2000 pages 603-625

Diffusion of innovations



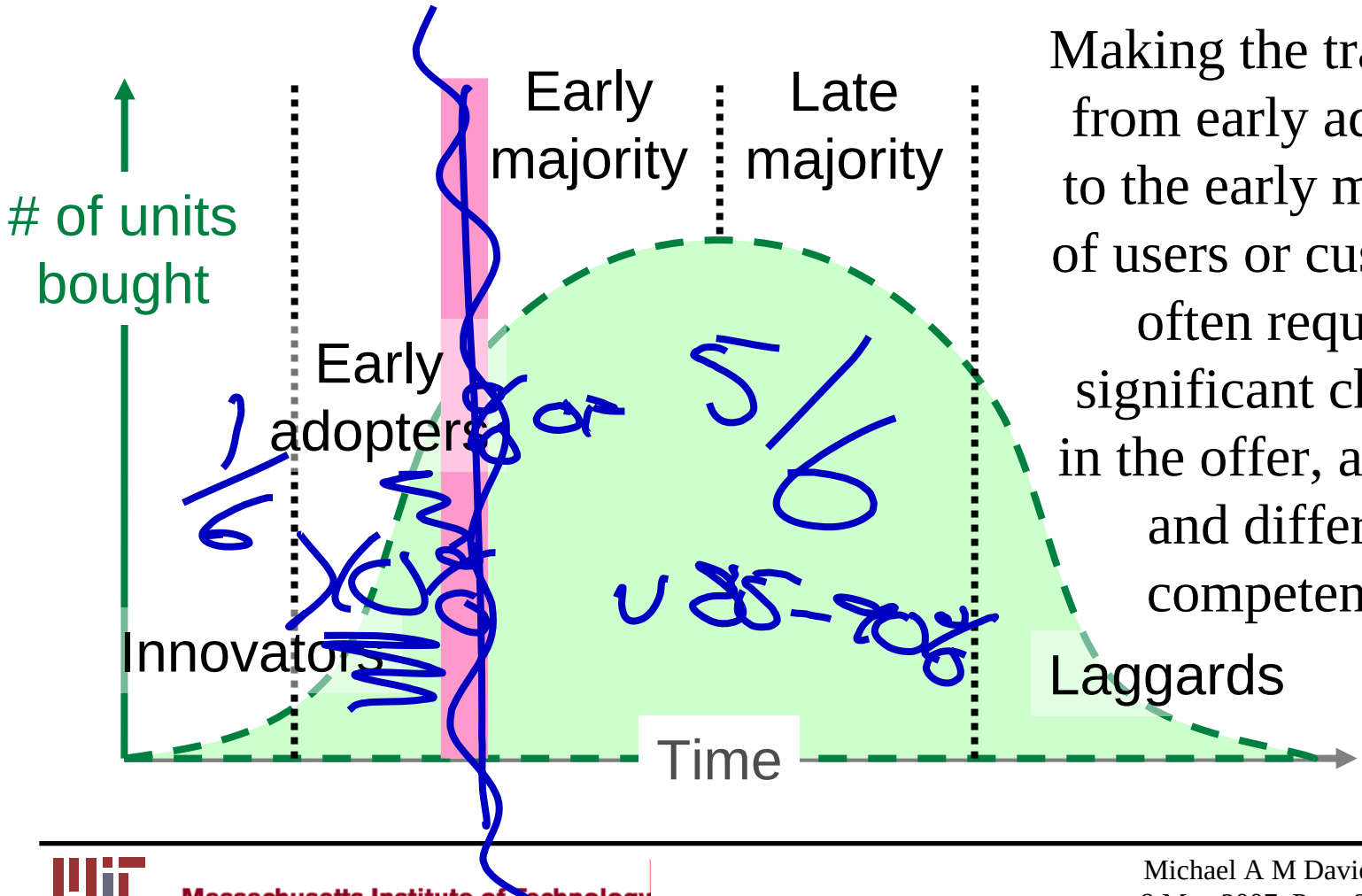
Everett Rogers' segmentation



Everett Rogers identified five product-based factors that governed the rate of diffusion

- Relative advantage - the degree to which a product is better than the product that it replaces
- Compatibility - the degree to which a product is consistent with the users' context, in particular their values and experiences
- Complexity - the degree to which a product is difficult to understand and use
- Trialability - the degree to which a product may be experimented with on a limited basis
- Observability - the degree to which product usage and impact are visible to others

Geoffrey Moore's chasm focuses on *psychographic* characteristics of users or customers



Making the transition from early adopters to the early majority of users or customers often requires significant changes in the offer, and new and different competences

As a result, the rate at which new technologies diffuse can vary widely

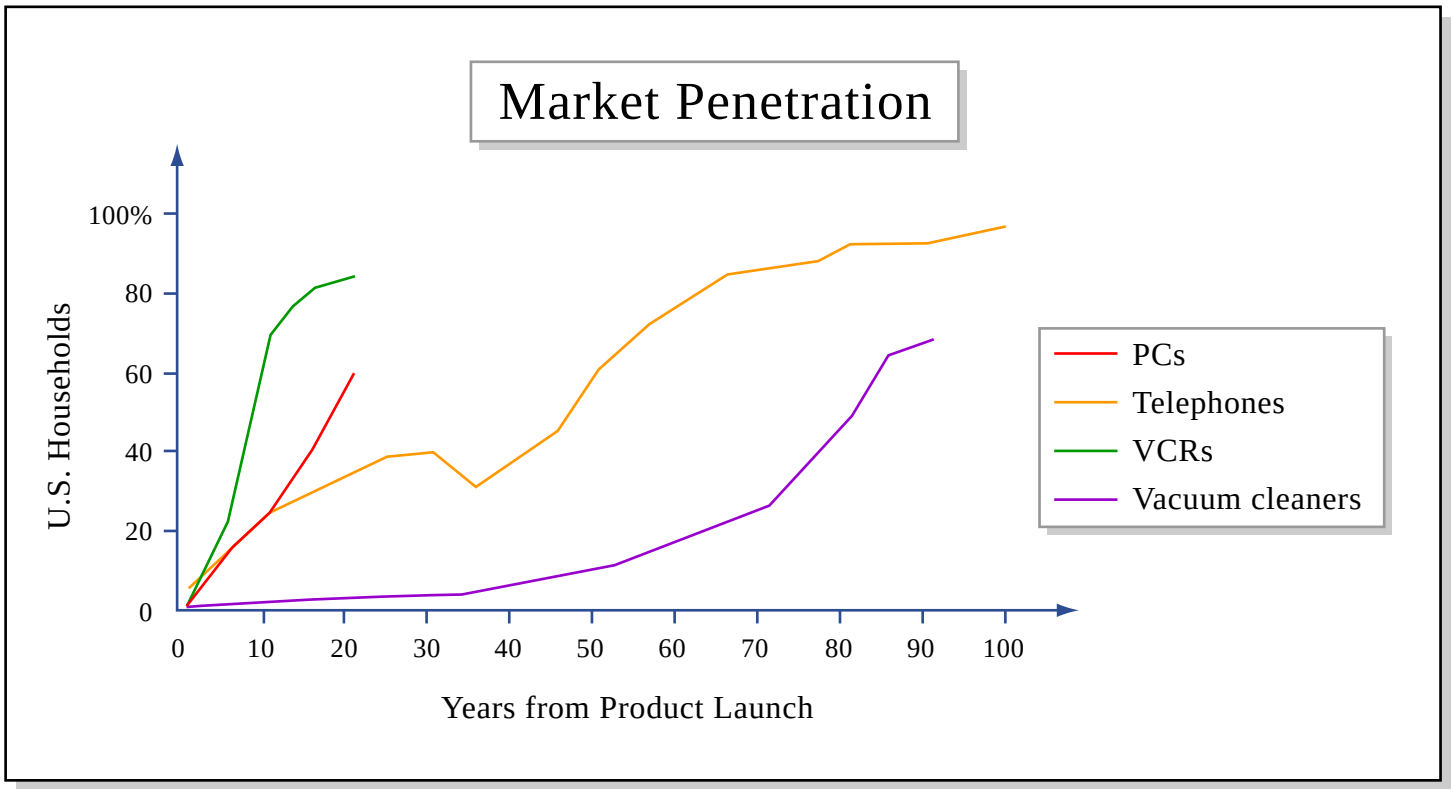


Image by MIT OCW.

Demand opportunity: summary

- Customers are heterogeneous
- Demand opportunity
  - future market, where customers meet products
  - exogeneous change and endogeneous change
- Diffusion of innovations
  - probit - weigh costs and benefits
  - epidemic - driven by information
- Reluctance to change - eager sellers and stony buyers
- Rate of diffusion depends on several factors
  - relative advantage
  - compatibility and complexity
  - trialability and observability
- Crossing the chasm - mainstream is different to early adopters

Co-evolution, life-cycles and transitions

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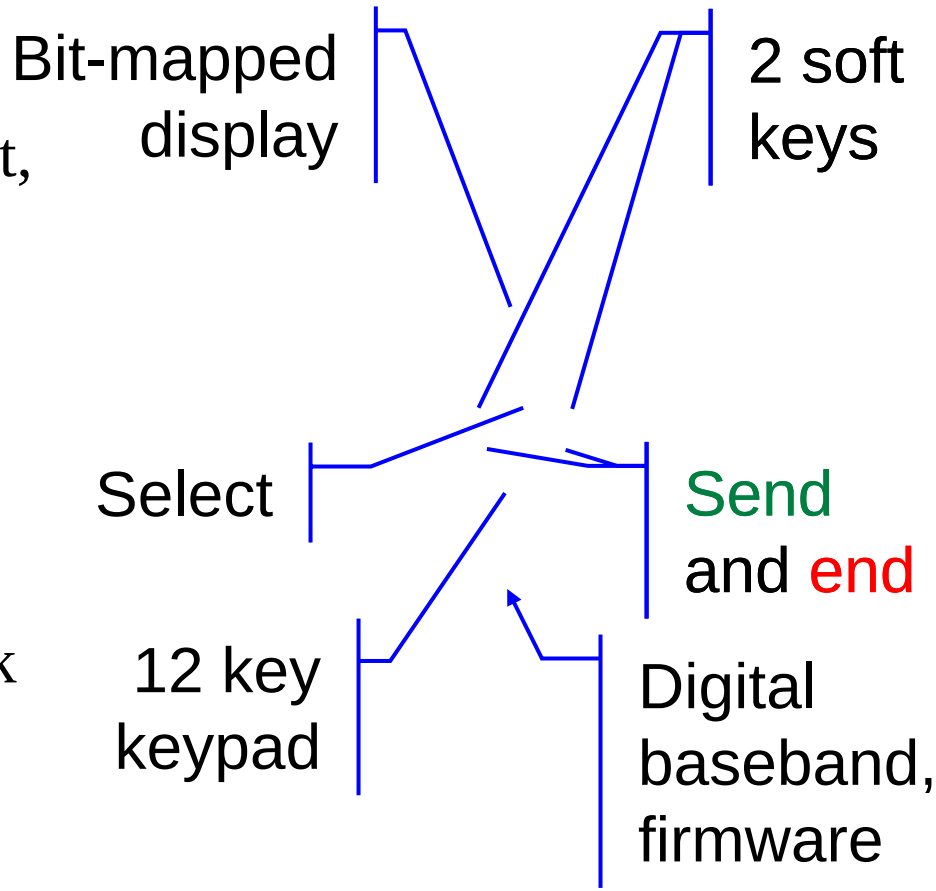
Together, these two phenomena often result in a characteristic industry life-cycle

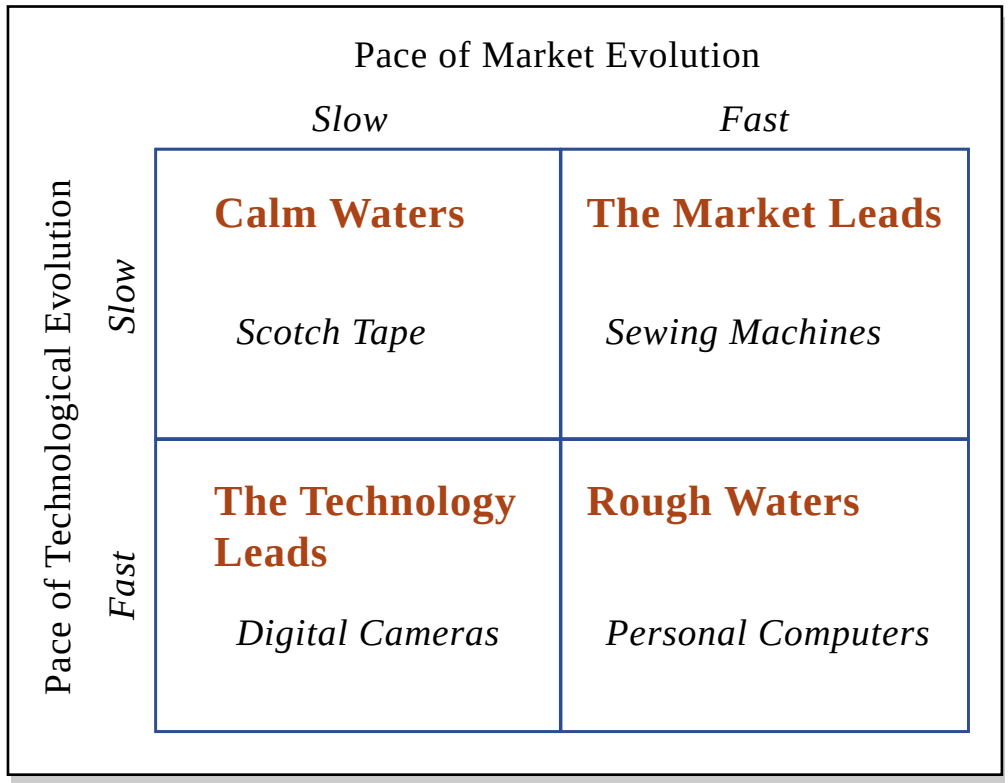
	Early ferment	Dominant design emerges	Incremental innovation	Maturity	Eclipse or renewal
Demand Opportunity	Lead users, early adopters - high payoff, low switching costs	Early mainstream - usability, cost more important	Mainstream customers - soft factors, aesthetics	Saturation, segmentation, customization	
Business Ecosystem	Many entrants - diverse business models	Decisive battles for leadership	Intensifying competition, early consolidation	Fierce competition, consolidation around majors and minors	
Technological Infrastructure	Make it work - innovate on performance, diverse integrative designs	Figure out the optimal architecture, drive down costs, make it easy to use	Broaden the offer, rationalize the portfolio, build up complementary assets	Develop broad portfolio, build platforms, search for new options	

Dominant design

- After a technological innovation and a subsequent era of ferment, a basic architecture that becomes the accepted market standard
- Dominant designs may not be better than alternatives nor innovative
- They have the benchmark features to which subsequent designs are compared



The relative speed with which technology and demand co-evolve results in different scenarios



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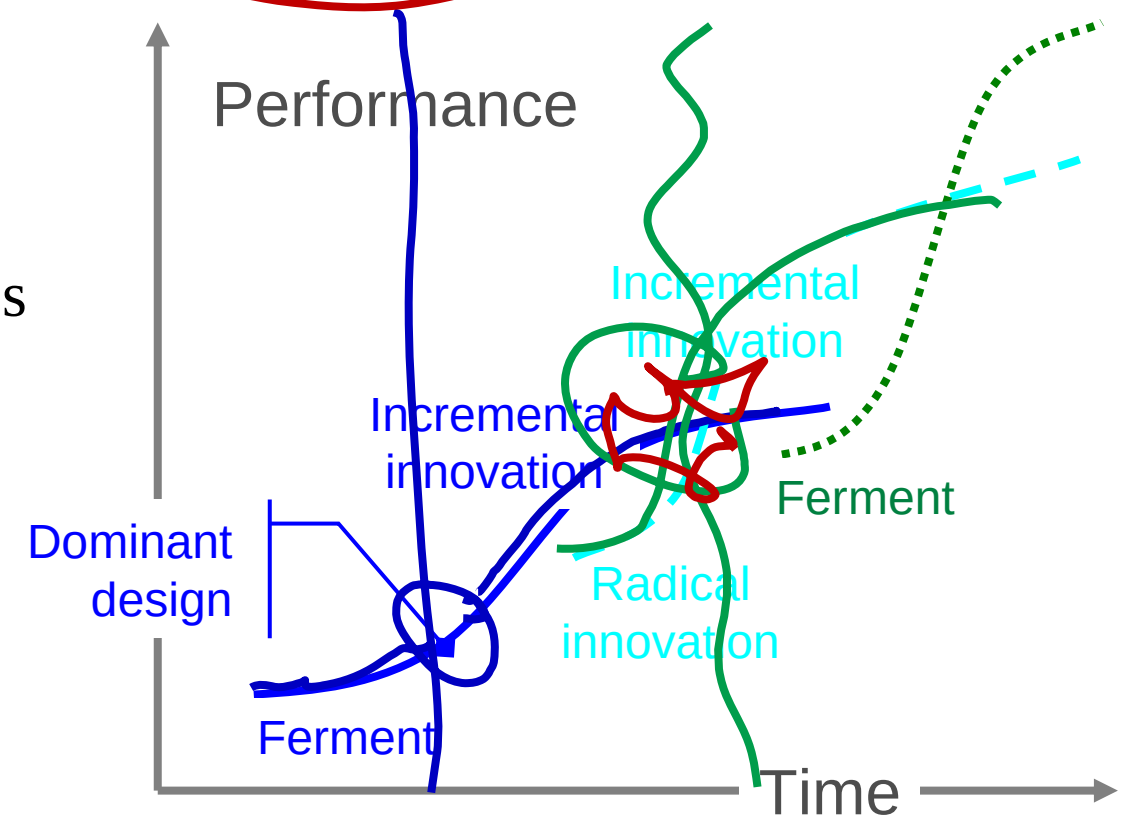
…and determines how likely a business is to be able to achieve first-mover advantage

The Situation Your Company Faces	First-Mover Advantage		Key Resources Required
	Short-Lived	Durable	
Calm Waters	***Unlikely*** Even if attainable, advantage is not large.	***Very likely*** Moving first will almost certainly pay off.	Brand awareness helpful, but resources less crucial here
The Market Leads	***Very likely*** Even if you can't dominate the category, you should be able to hold onto your customer base.	***Likely*** Make sure you have the resources to address all market segments as they emerge.	Large-scale marketing, distribution, and prod-ction capacity
The Technology Leads	***Very unlikely*** A fast-changing technol-ogy in a slow-growing market is the enemy of short-term gains.	***Unlikely*** Fast technological change will give later entrants lots of weapons for attacking you.	Strong R&D and new product development, deep pockets
Rough Waters	***Likely*** A quick-in, quick-out strategy may make good sense here, unless your resources are awesome.	***Very unlikely*** There's little chance of long-term success, even if you are good swim-mer. These conditions are the worst.	Large-scale marketing, distribution, product-ion, and strong R&D (all at once)

Figure by MIT OCW.

Technological innovation and the diffusion of innovations cause transitions

- *Incremental* innovation involves relatively minor changes
- *Radical* innovation is based on different engineering and scientific principles



Incremental and radical innovations have very different competitive consequences

Incremental innovation

- Introduces relatively minor changes
- Happens once dominant design has been established
- Typically drives rapid performance improvement
- Exploits the potential of the established design
- Typically reinforces position of incumbents

Radical innovation

- Based on a different set of engineering principles
- May open up whole new markets and potential applications
- Often creates great difficulties for incumbent firms
- Can be basis for successful entry by insurgents

But sometimes, "…apparently modest changes…" have dramatic consequences

Xerox and Canon in small copiers

- Pioneers plain paper copiers
- In 1970's competitors win share with much smaller, more reliable copiers
- Little new scientific or engineering knowledge
- But Xerox takes ~8 years to launch competitive product
- …and it loses 50% of its market share

Sony and RCA in portable radios

- Mid-1950's RCA develops prototype portable radio
- Sony- small new insurgent - uses transistorized radio to enter US market
- Sony's radios produced with technology licensed from RCA
- But RCA doomed as a follower, can't match Sony

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

Two different sorts of knowledge: component or modular; architectural or integrative

Component

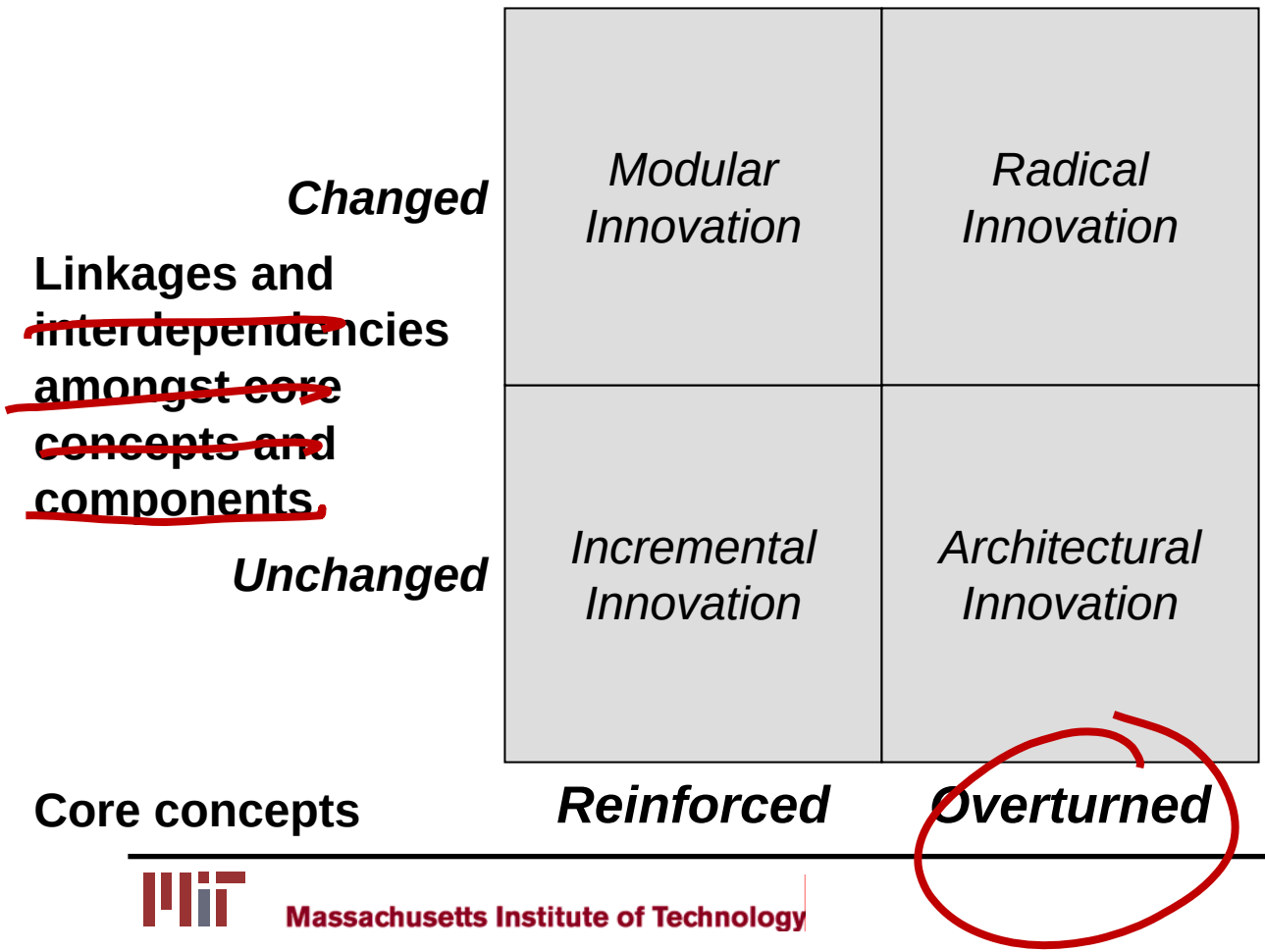
- Knowledge about each of the core design concepts
- How they are implemented in a particular component within a product
- Specialized and focused, can be mastered by an individual or a small team
- Constant focus once dominant design established
- Radical change obvious

Architectural

- Knowledge about ways in which components link together into coherent whole and are interdependent
- Tends to become embedded as tacit knowledge
- Communication channels, information filters and problem-solving strategies
- Shift may not be apparent

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

A framework for thinking about different types of innovation and the resulting transitions



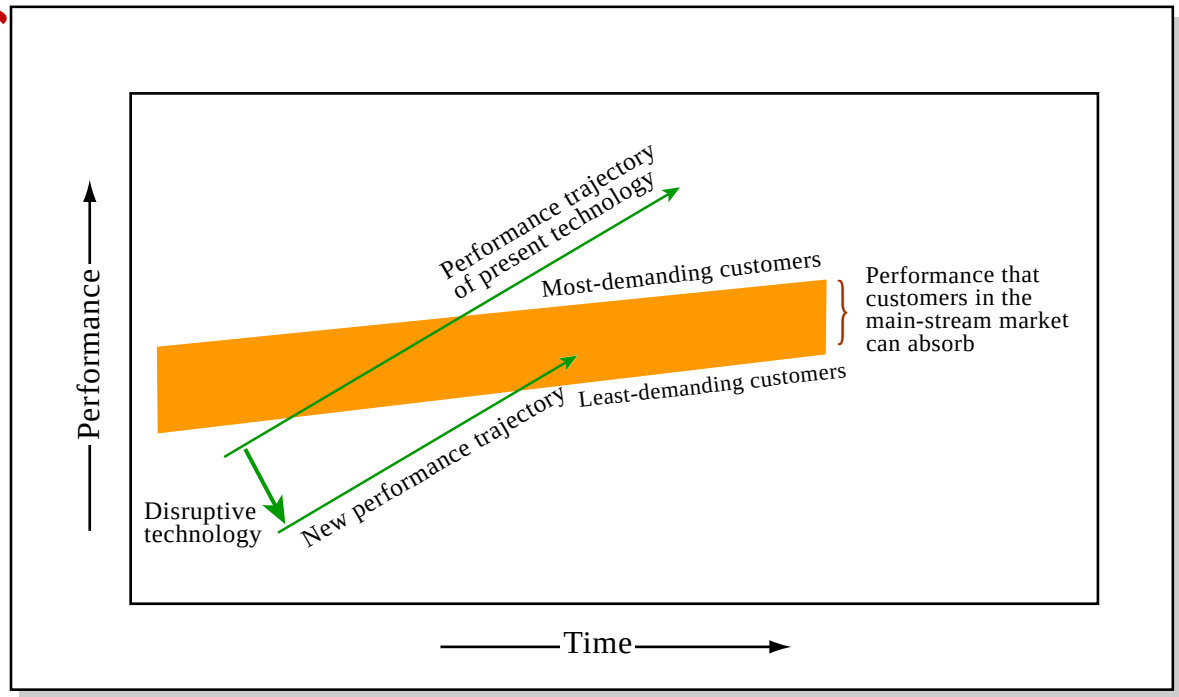
Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

Architectural innovation and the consequences of transitions in semiconductor capital equipment

	Generation				
	1	2	3	4	5
Firm	Contact	Proximity	Scanner	Step and Repeat (1)	Step and Repeat (2)
Nikon					**70**
GCA				**55**	12
Perkin-Elmer			**78**	10	<1
Canon		**67**	21	9	
Kasper	17	8			
Cobilt	**44**				

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

Difficult transitions also happen when technological innovation outstrips the demand opportunity



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Disruptive technologies have two key characteristics

- Products and services that embody these technologies in their early stages have **attributes that make them unattractive to incumbents' current mainstream customers**, and typically appeal only to small and emerging markets or segments, and offer inferior returns

BUT

- These technologies have the **potential for rapid innovation** along trajectories that will in future enable products and services that are attractive to incumbents' mainstream customers, allowing insurgents to later invade established markets and displace the incumbent

Three things are needed for these technologies to empower insurgents and threaten incumbents

Investment

- Even though products and services that embody these technologies are unattractive to incumbents' current mainstream customers at the outset, insurgents perceive sufficient demand opportunity to fuel investment and innovation

Innovation trajectory

- The innovation trajectory for these technologies evolves in the right direction and fast enough to meet the evolving requirements of the incumbents' current mainstream customers

Indifference

- The demand opportunity represented by incumbents' mainstream customers is evolving along a different trajectory than can best continue to be met using incumbents' sustaining technologies

Disruptive innovations in disk drives

- An alternative explanation
  - could have mastered the architectural transition
  - but novel technologies did not meet needs of current customers
- Response to transition depends on technical knowledge **and** on the perceived demand opportunity, business model and capabilities

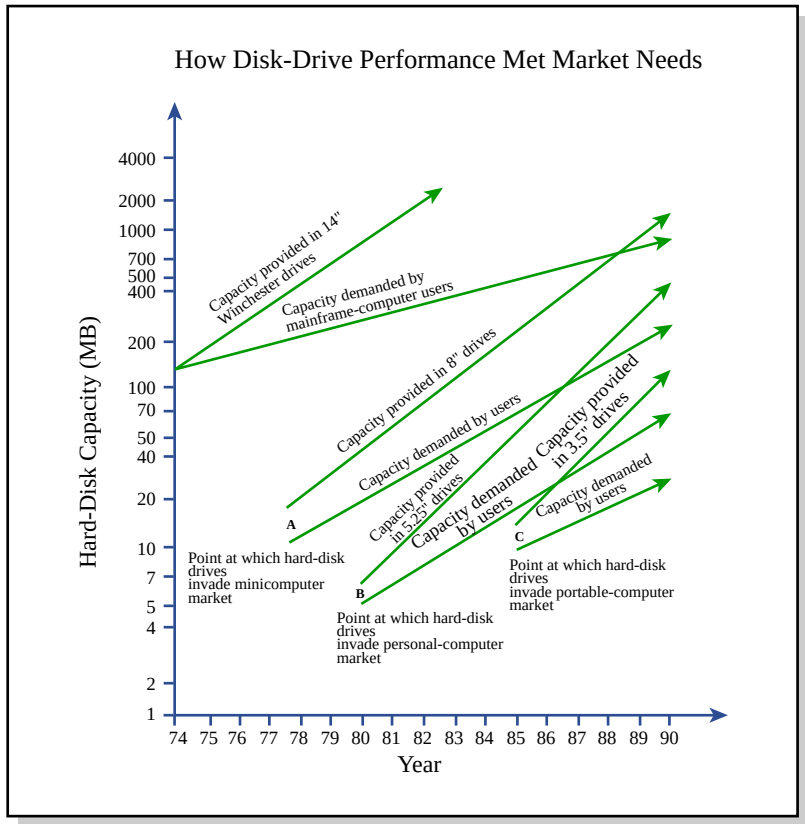


Image by MIT OCW.

Each of these generations involved innovation along a new and different trajectory

	Generation				
	1	**2**	**3**	**4**	**5**
	14”	**8”**	**5.25”**	**3.5”**	**2.5”**
Demand opportunity	Mainframe	Mini-computers	Desktop computers	Portable computers	iPods
Leader(s)	CDC	Shugart	Seagate	Conner Quantum	
New attributes		Internal power supplies Smaller	Higher density Lower unit cost	Rugged Lightweight Low-power	Tiny

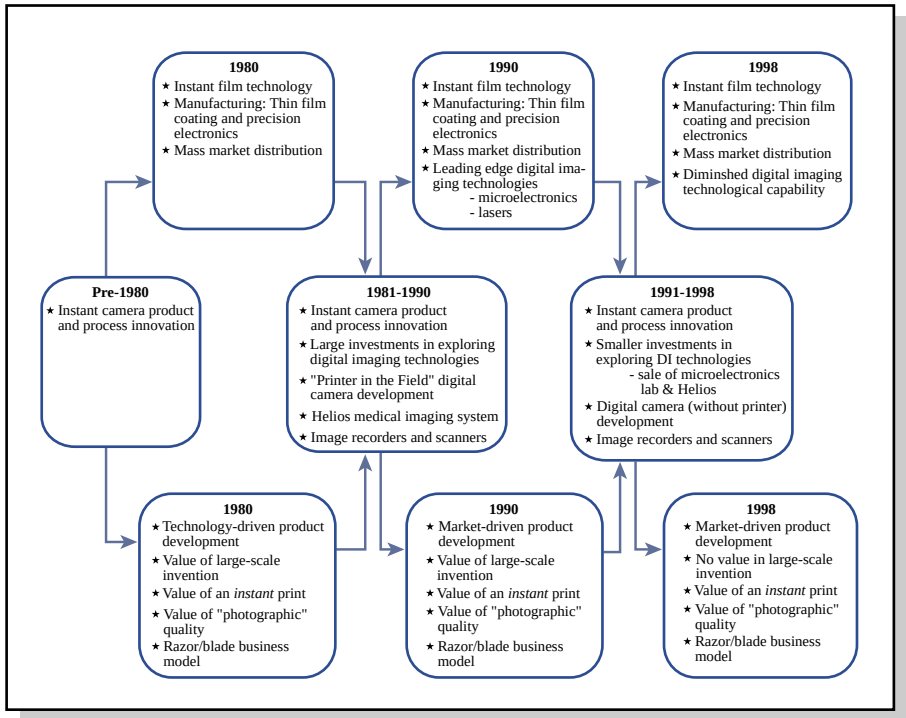
Clayton Christensen, “Exploring the Limits of the Technology S-Curve - Part I: Architectural Technologies”, Production and Operations Management, Fall 1992, pages 358-366

Even where incumbents pursue radical innovations, cognitive limitations may doom them

- Polaroid was the leader in instant photography
- Technology-driven company
  - long-term, large-scale research
- Believed in consumables
  - *"What's the business model? It's the razor/blade … so we make money with the film"*
- Commits to digital imaging
  - '86 Microelectronics Lab
  - by '89, 42% of budget
  - superior imaging technology
- Did not invest in other areas
  - low cost electronics manufacturing
  - rapid product development
  - new marketing and sales
- Takes long time, capabilities erode, people leave

Mary Tripsas and Giovannit Gavetti "Capabilities, Cognition and Inertia: Evidence from Digital Imaging", Strategic Management Journal, 2000, pages 1147-1161

The evolution of capabilities and beliefs at Polaroid



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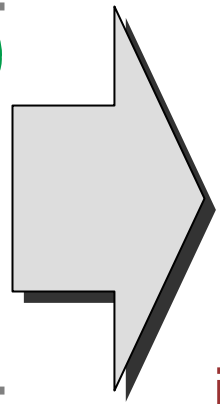
Organization response to transition ultimately depends on four key factors

Demand opportunity - who your customers are and what they want

Business ecosystem - your chosen niche, its business model and hence how you make money

Technological infrastructure - explicit and tacit component and architectural knowledge



Your mental models - beliefs about the future, about how to make money, communication channels, information filters and problem-solving strategies

Co-evolution, life-cycles and transitions: summary

- ***Co-evolution*** of technological innovation and diffusion creates ***life-cycles***
- Key transition is emergence of ***dominant design***
- Different types of ***transitions***
  - incremental vs radical
  - modular vs architectural
- Disruptive technologies
  - initially unattractive to incumbents' mainstream customers
  - rapid innovation along trajecotry that makes them attractive so insurgents can invade

Business ecosystems

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High-tech businesses are built on *systems*, which co-evolve with business ecosystems

- *"…new products are rarely stand-alone items. Rather, they are components of broader systems or architectures"*[1]
- *"…co-evolution [is] a process in which interdependent species evolve in an endless reciprocal cycle, in which 'changes in species A set the stage for natural selection of changes in species B'- and vice versa"*[2]

- *"The organization of firms and industries and the architecture of products are interrelated."*[1]
- *"Indeed, harnessing the full potential of the technology necessarily involves cooperation amongst industry participants, many of whom might also be competitors."*[1]

David Teece, "Capturing Value from knowledge Assets", California Management Review, Spring 1998, pages 55-79
James Moore, "Predators and Prey", Harvard Business Review, May-June 1993, pages

High-tech businesses are built on systems, which involves *business ecosystems*

- Products part of larger and more complex systems
- Products are comprised of multiple (sub-)systems

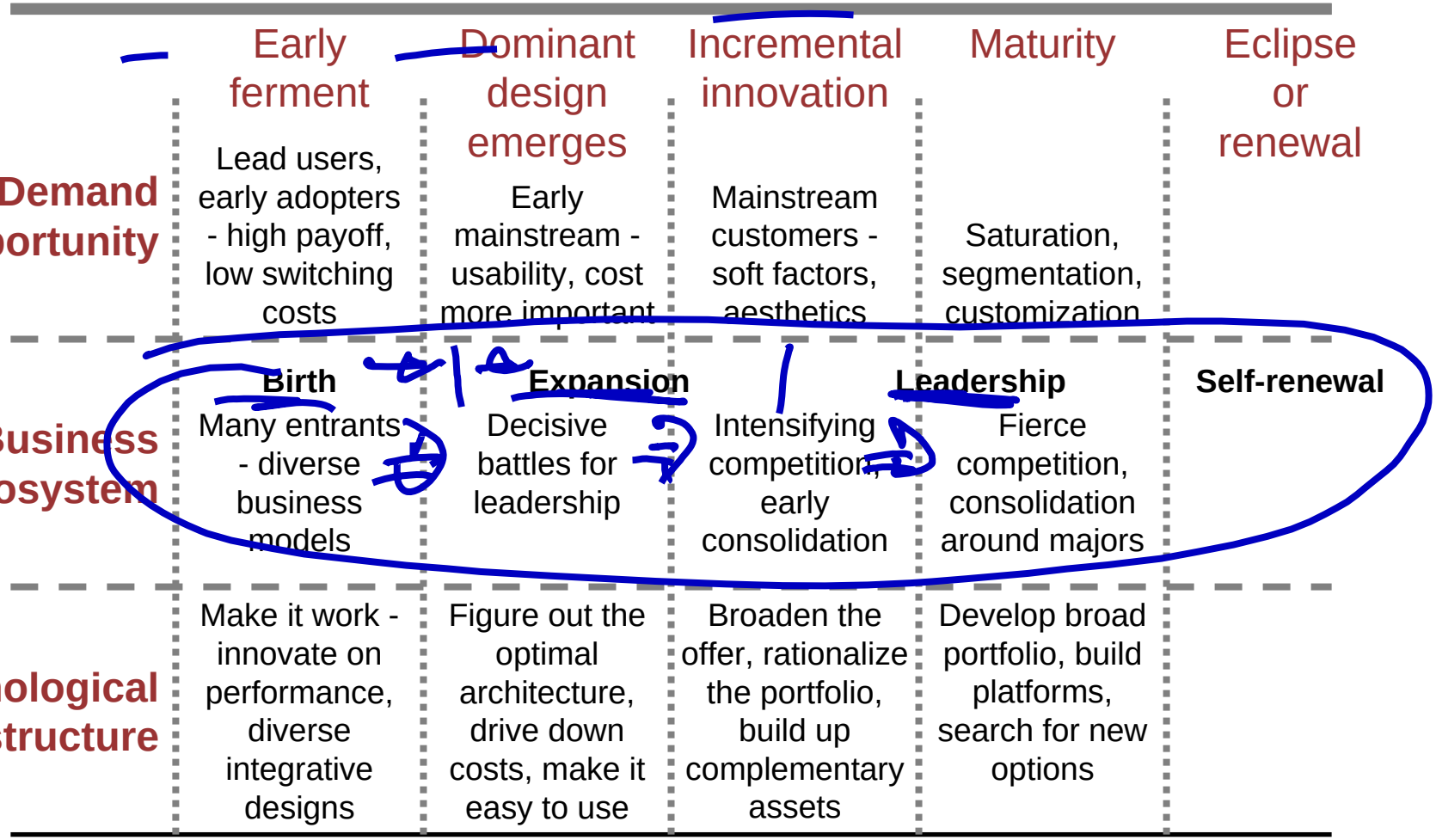
- Performers
- Media companies
- *Personal computing*
- *Browsers, ISPs*
- Apple
- *Cases, headphones, docks, cars*
- Software vendors
- Component vendors

The wireless sensor networking business ecosystem in about 2003

Industries vs business ecosystems, business ecosystems vs biological ecosystems

Industry	Business ecosystem	Biological ecosystems
• Stable structure and boundaries – SIC codes – mature • Same customers • Same suppliers • Similar scope of activities • Same business models • Horizontal competition amongst like competitors	• Innovation • Dynamic and evolving • Unclear and fuzzy boundaries • Very different scope of activities • High degrees of specialization • Participants depend on one another for their effectiveness and survival	• *Stable inputs(?)* • Dynamic and evolving • Unclear and fuzzy boundaries • Very different scope of activities • High degrees of specialization • Participants depend on one another for their effectiveness and survival

Ecosystems go through stages, co-evolving with technological innovation and demand opportunities



Ecosystem maps: Architectural; Business; and Chronological

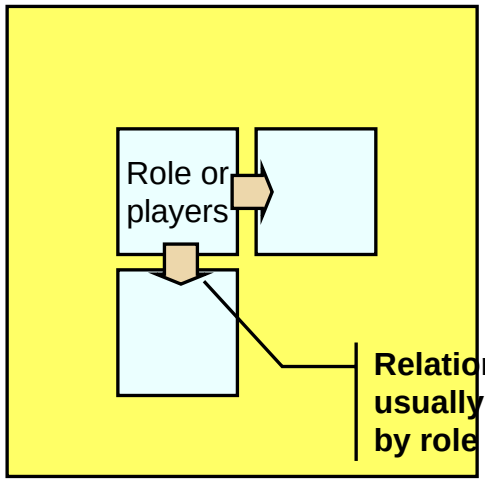
		Content	Application
Architectural map	A	How things work, roles Contributions of individual participants or business elements "You are here and there are your neighbors"	Basic education about the STRUCTURE of the business, roles and niches, and who its competitors and complementors are
Business map	B	Participants with relative share, at a point in time Optionally, adjacent ecosystems too "Who's doing well"	Illustrate relative SCALE or strength of a business, its competitors and complementors Can demonstrate ecosystem invasion
Chrono-logical map	C	Detailed ecosystem changes (or events) over time Activity compared with competitors Evolution trajectory "What's going on"	Show historical or potential DYNAMICS in the ecosystem Benchmark against competitors; show strategic intent Help plan for strategic goals

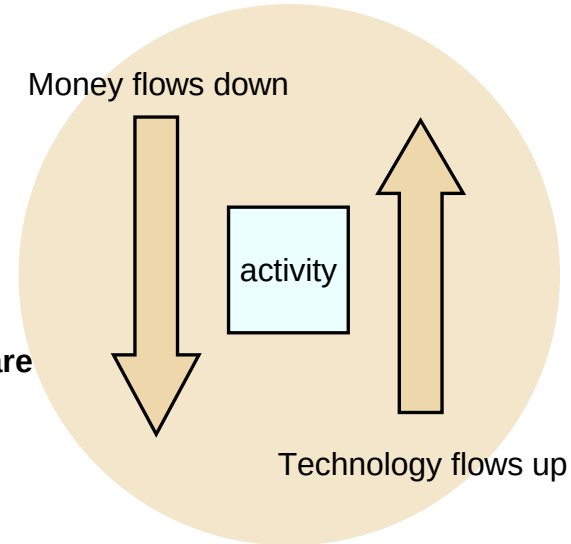
A: players or roles on a plane with dimensions that illustrate contributions, locations and relationships

(A)

Architectural map

Logical hierarchy
or Scope
or Adjacent ecosystems





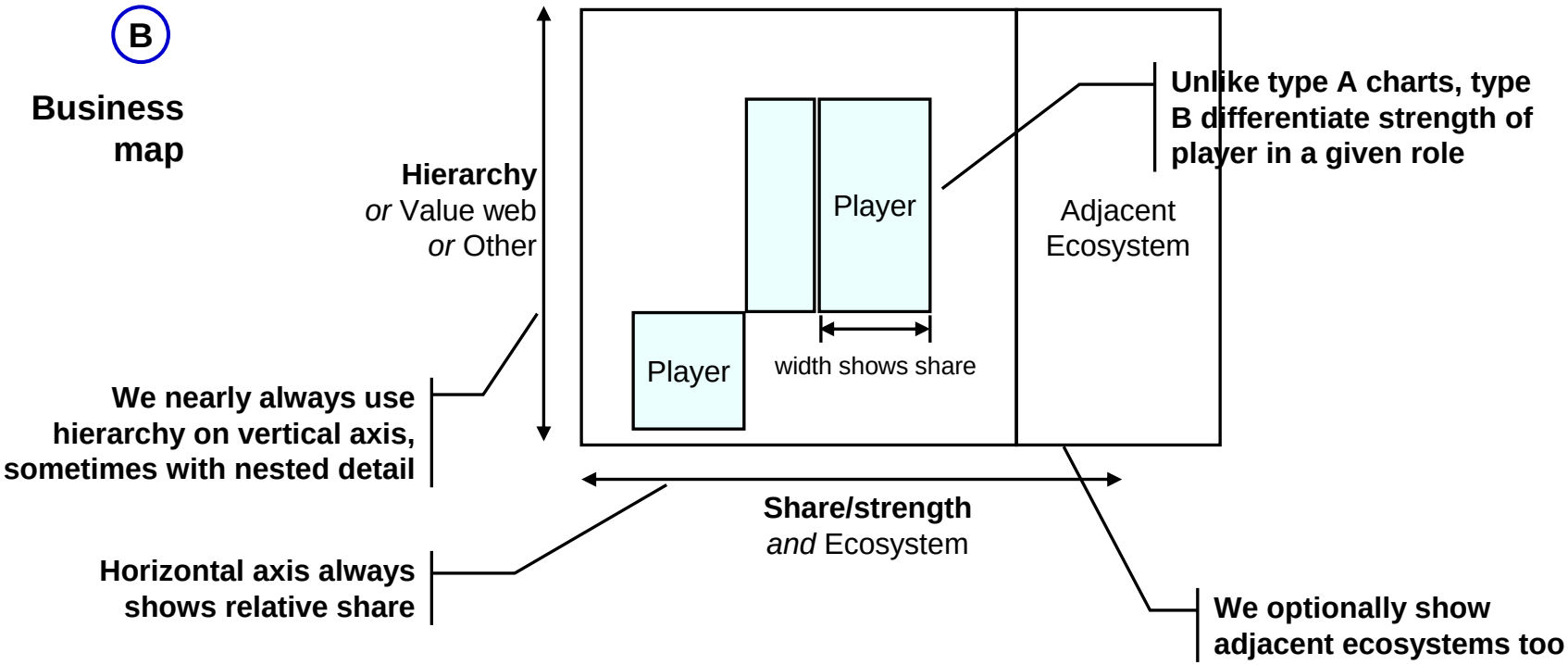
We nearly always use hierarchy on vertical axis

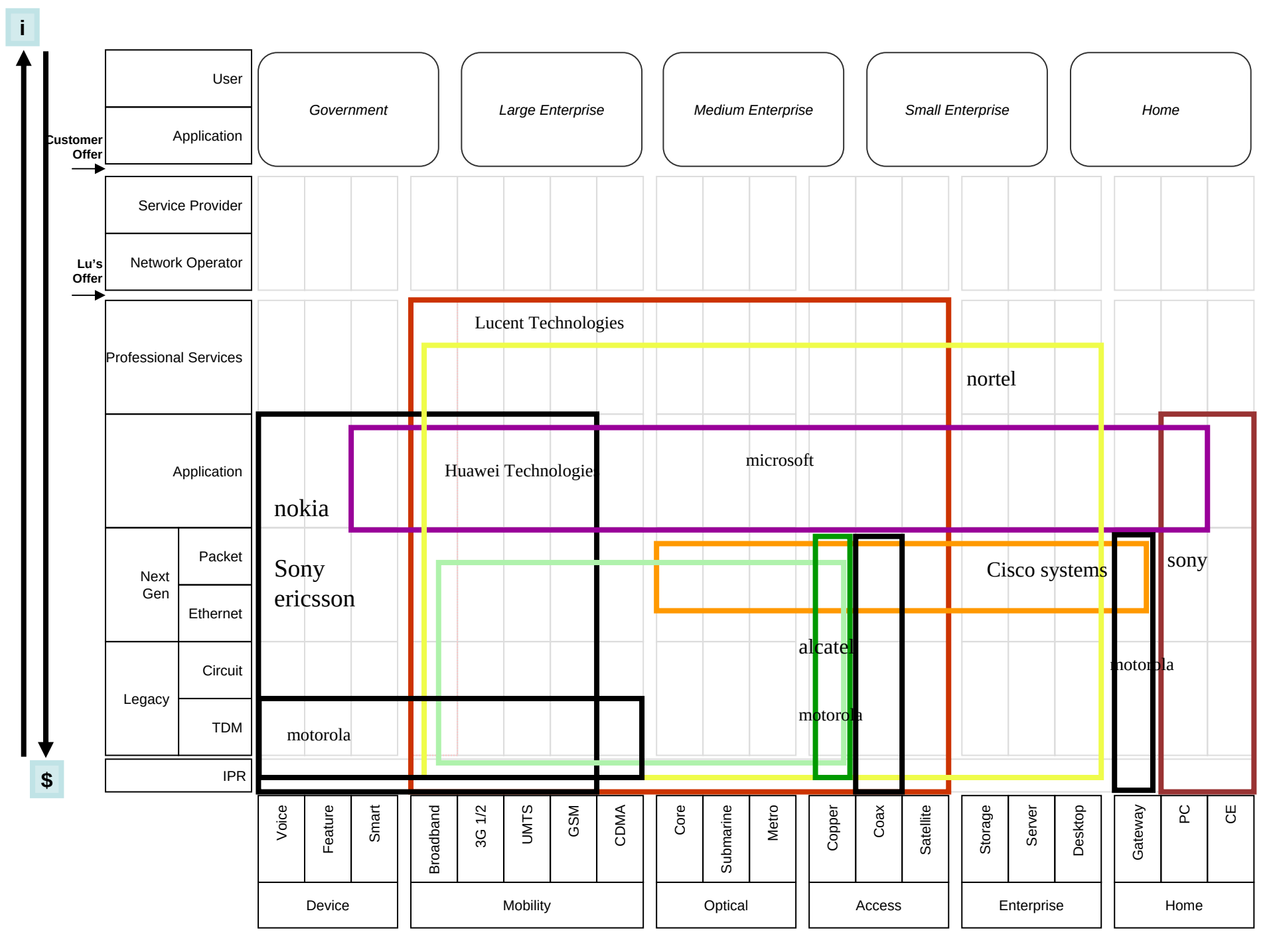
Horizontal axis – physical topology, showing what is next to what, is most common

Physical topology
or "Wiring diagram"
or Geography
or Value chain

This model <u>sometimes</u> helps the choice of dimension and direction for axes

B: relative strength of players on horizontal axis, value capture on the vertical axis




i
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Medium Enterprise
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Circuit
TDM
IPR
$
Lucent Technologies
nortel
microsoft
Huawei Technologie
nokia
Sony ericsson
Cisco systems
sony
alcatel
motorola
motorola
motorola
Voice
Feature
Smart
Broadband
3G 1/2
UMTS
GSM
CDMA
Core
Submarine
Metro
Copper
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Satellite
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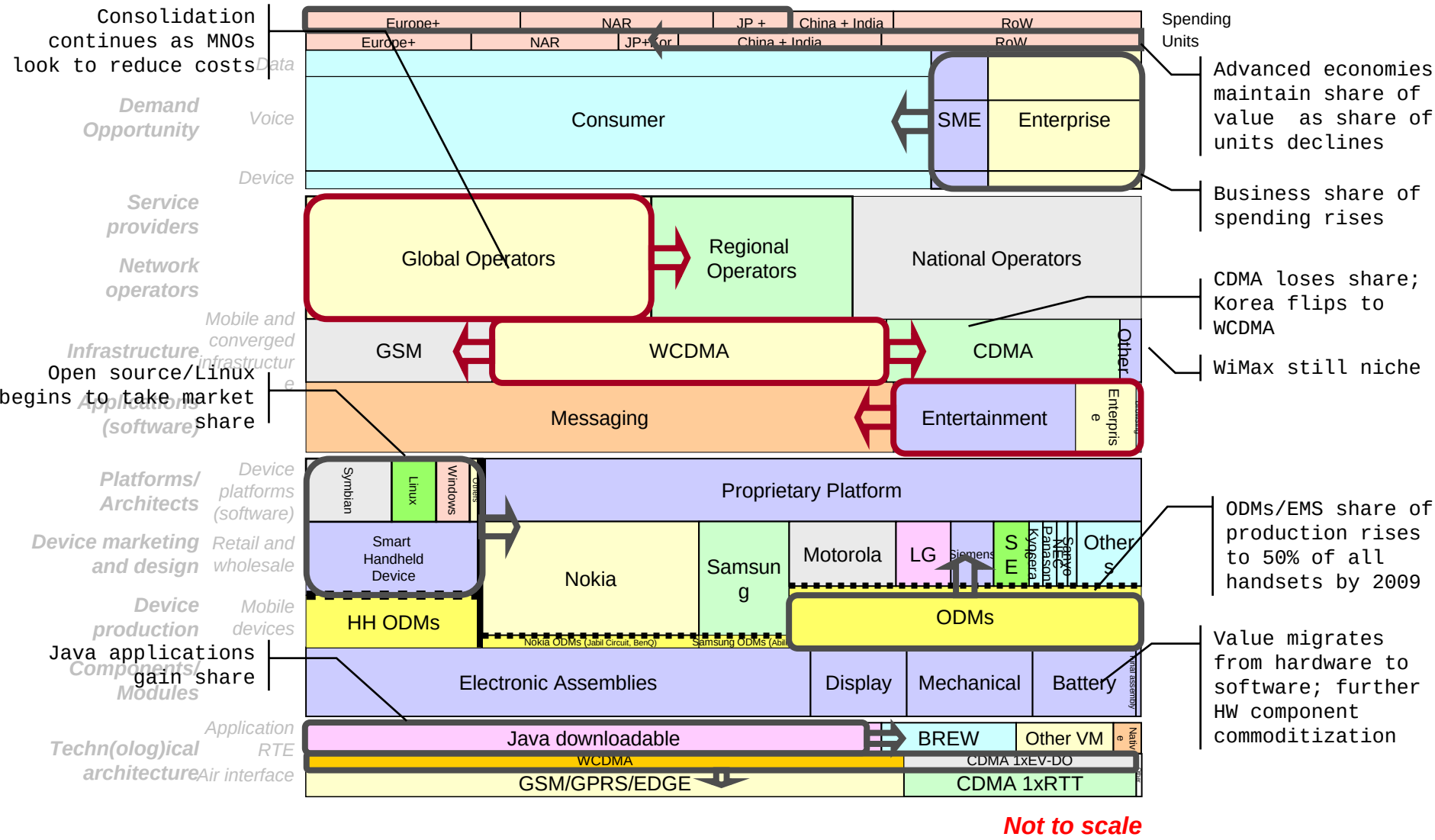
Device
Mobility
Optical
Access
Enterprise
Home

Mobile business ecosystem and dynamics

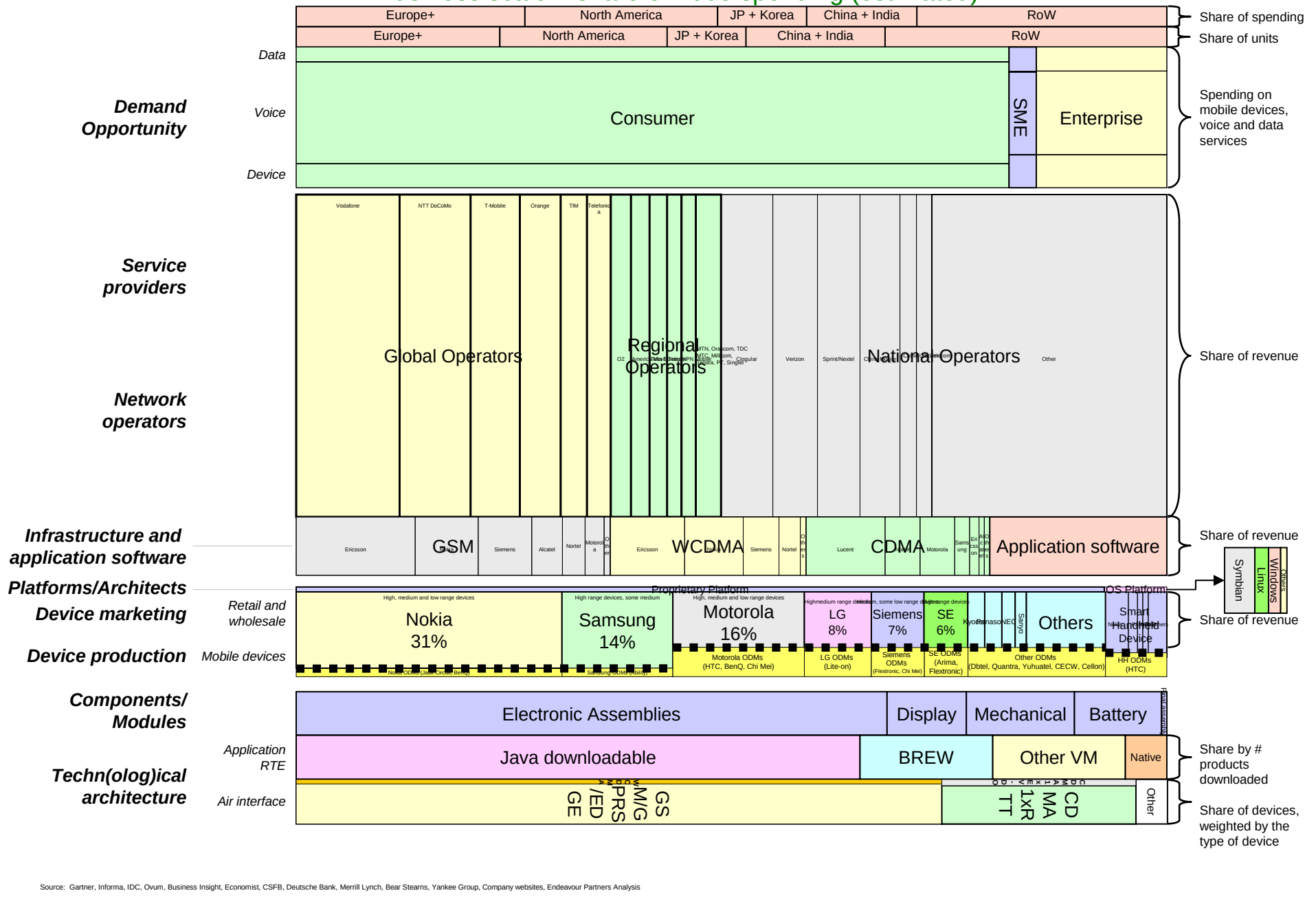


Not to scale

Mobile Business Ecosystem

B

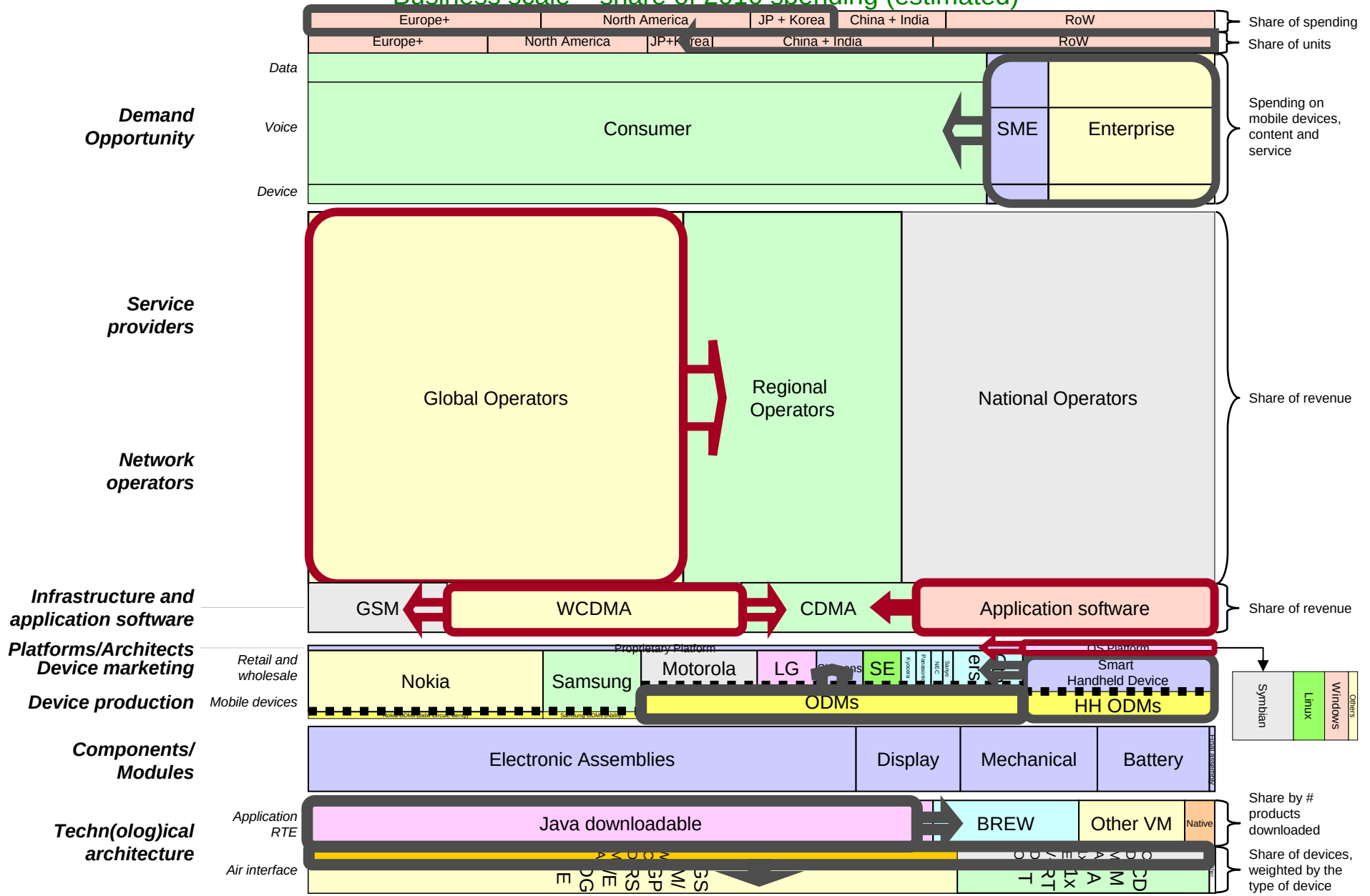
Business scale – share of 2005 spending (estimated)



Source: Gartner, Informa, IDC, Ovum, Business Insight, Economist, CSFB, Deutsche Bank, Merrill Lynch, Bear Stearns, Yankee Group, Company websites, Endeavour Partners Analysis

Mobile Business Ecosystem

Business scale – share of 2010 spending (estimated)



Source: Gartner, Informa, IDC, Ovum, Business Insight, Economist, CSFB, Deutsche Bank, Merrill Lynch, Bear Stearns, Yankee Group, Company websites, Endeavour Partners Analysis

So, business ecosystems involve related choices about niche and strategy

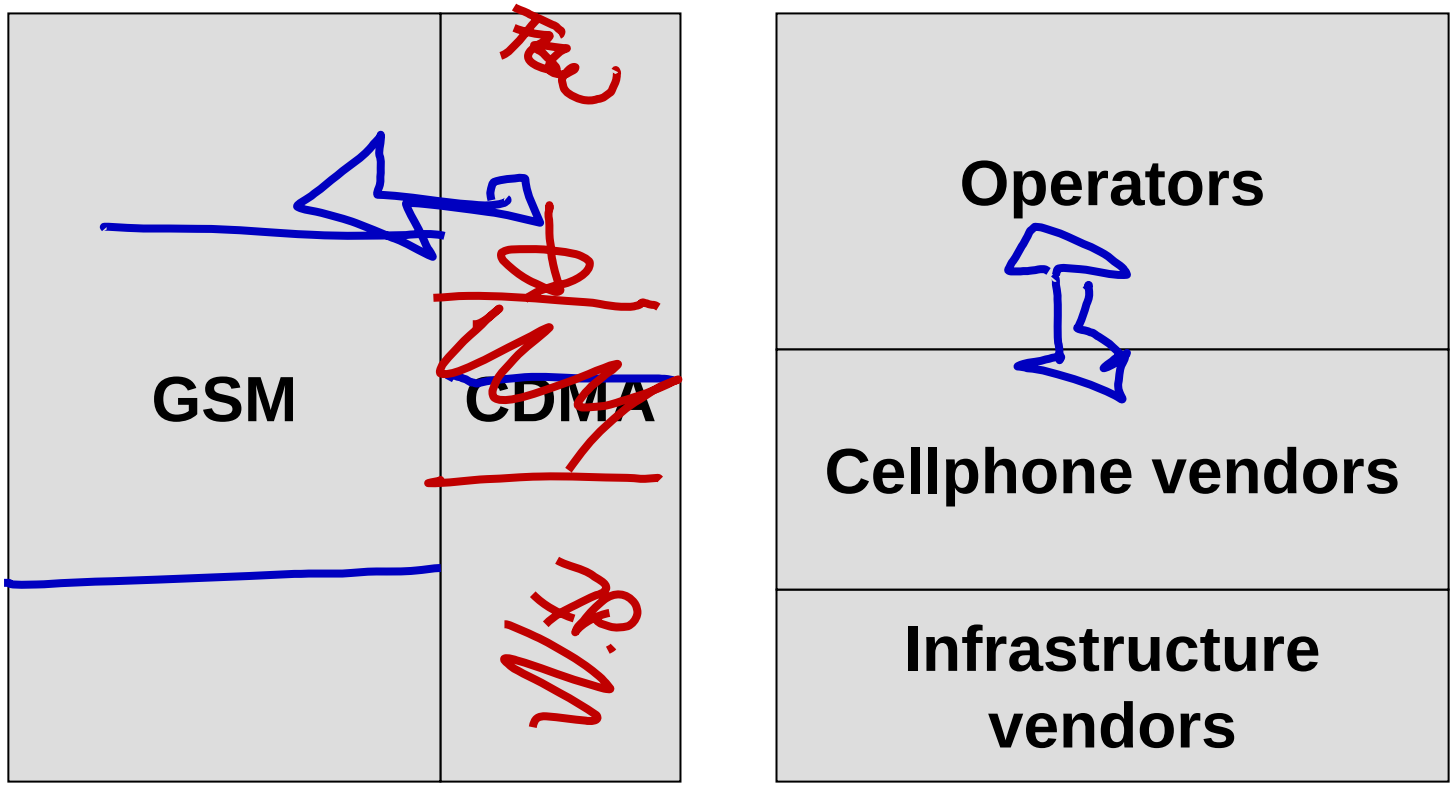
- Leader or keystone/dominator role or niche versus secondary or follower role or niche (so-called niche)
  - leaders shape architecture - how components, and hence companies, fit together
  - leaders invest in platforms to improve overall system performance or economics of others
  - secondary or followers occupy niches defined by leaders or keystones
- As a leader, key trade-off between creation and capture
  - how much to share, to grow overall ecosystem
  - how much to do oneself - scope of activities
  - bigger pie, smaller slice **vs** smaller pie, bigger slice

Business ecosystems: summary

- High-tech products rarely stand-alone
  - made up of (sub-)systems
  - part of systems
- Duality of mapping between systems architecture and structure of business ecosystems
- Involve business ecosystems
  - inter-related businesses
  - co-operation and competition = co-opetition
- Evolve through stages
- Offer niches
  - leader - shape evolution, broad scope, integrators, invest in platforms
  - follower - occupy niche, specialist

Value capture

Performance depends on competition both between ecosystems and within ecosystems



Technology businesses, in ecosystems, must *capture* value, just as much as *create* value

Challenge

- Need complements, and hence complementors, to construct a complete offer
- Most players have broad range of possible activities
- In high-tech, many activities draw on similar underlying skills
- Innovation is typically rapid, eroding leadership

Capture

- Complementary assets
  - unique manufacturing capacity
  - brand
  - channels
- Knowledge assets
  - patents, copyright
  - trade secrets
  - tacit knowledge

The *resource-based view* explains how a company's *resources* drive its performance

- *"Companies are very different collections of physical and **intangible** assets and capabilities. No two companies are alike because no two companies have had the same set of experiences, acquired the same assets and **skills**, or built the same organizational cultures."*

- Substitutability
  - not trumped by something different
- Superiority
  - **distinctive competence**
  - better than competitors from customers' perspective
- Inimitability
  - hard to copy
- Durability
  - does not depreciate quickly
- Appropriability
  - bound to the business
- Dynamic capabilities

David Collis and Cynthia Montgomery, "Competing on Resources", Harvard Business Review,July-August 1995, pages 118-128

OK, so where does *inimitability* come from?

- Physical uniqueness
  - real estate location, mineral rights
  - **unique** manufacturing assets(?)
  - *location, location, location*
- Path dependency
  - because of what has happened in their accumulation
  - must be built up over *time*
  - **brand name**
- Causal ambiguity
  - cannot disentangle what it is or how to re-create it
  - **organizational capabilities**

For technology businesses, *knowledge assets* (intellectual property) are critical to value capture

- Patents
  - disclosed information about **novel** and **useful** invention
  - legal monopoly for a fixed period of time
- Copyright
  - exclusive rights to the **execution** of a design, such as an innovation
- Trade secrets
  - protect covered secrets in perpetuity
  - **misappropriation is theft**
- Trademarks
  - right to use a distinctive sign to identify offer

- Tacit knowledge
  - can be basis for **distinctive competence**
  - difficult to articulate in a way that is meaningful and complete
  - slow and costly to transmit
  - ambiguous, needs face-to-face communication, prone to errors of interpretation
  - often contextually dependent
  - may be causally ambiguous: *"so complex that the firm itself, let alone its competitors, does not understand them"*

Key to value capture is *focus* on *locus* of value

- *"… the virtuous virtuals have carefully nurtured and guarded the internal capabilities that provide the essential underpinnings of competitive advantage… they invest considerable resources to maintain and extend their core competences [because without them] their strategic position in the network would be short-lived"*

Henry Chesbrough and David Teece, "Organizing for Innovation: When is Virtual Virtuous?", Harvard Business Review, August 2002, pages

- *"Attractive profitability seems to flow … to the point at which unsatisfied demand for functionality, and therefore technological interdependency exists."*

Clayton Christensen and others, "Disruption, disintegration and the dissipation of differentiability", Industrial and Corporate Change, 2002, pages 955-993

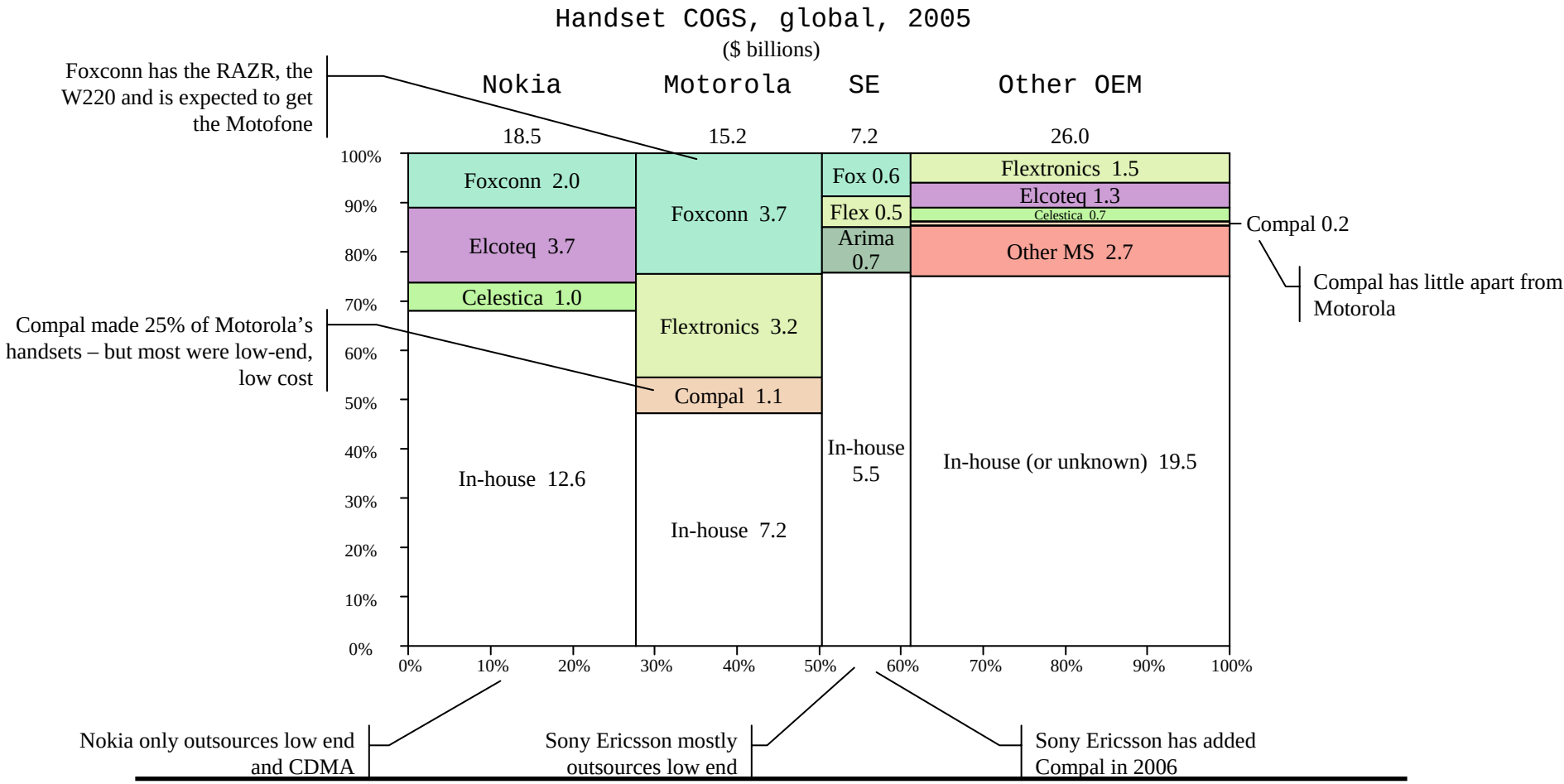
Amdahl's Law: "…make the common case fast…"

- Amdahl's Law is concerned with the speedup achievable
  - from an improvement to a computation
  - affects a proportion P of that computation
  - where the improvement has a speedup of S

"God grant me the serenity to accept the things I cannot change (much); courage to change the things I can (a lot); and wisdom to know the difference."

- Reinhold Niebuhr

In mobile devices, all of majors outsource much of their work, limiting basis for differentiation



Sources: SinoPac; Nomura; ABN Amro; KGI; Yuanta; Ericsson company reports

Despite importance of collaboration, still large differences: Nokia keeps clear leadership

Feature set and cost comparison:

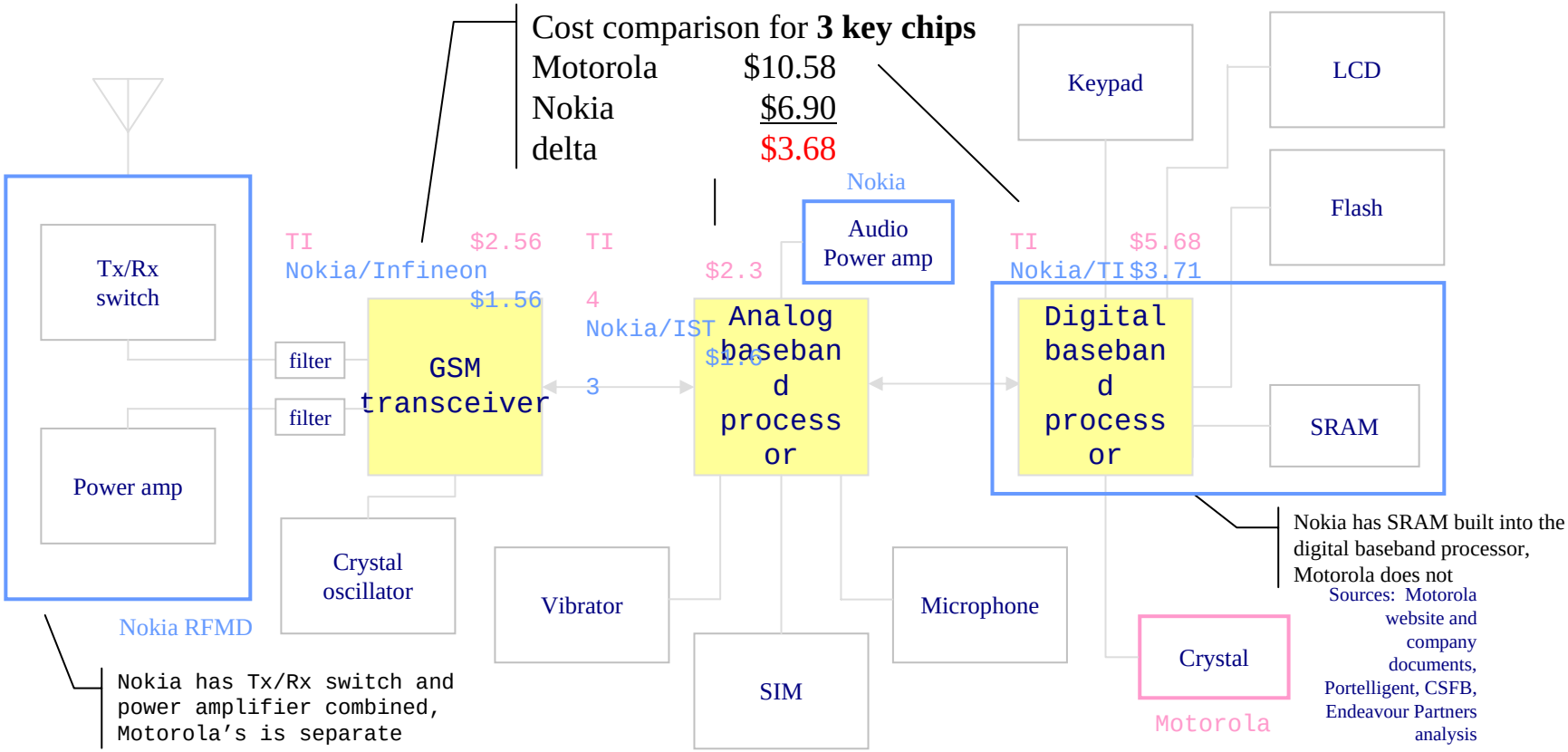
	Nokia 1110	Motorola C138
Standby time	Up to 380 hours	Up to 300 hours
Talk time	Up to 5 hours	Up to 7.5 hours
Technology	GSM dual band (900/1800 and 850/1900 versions)	GSM dual band (900/1800)
Weight	80g	81g
Volume	78cc	94cc
Dimension	104 x 44 x 17 mm	100 x 45 x 21 mm
Display	96 x 68 mono	96 x 65 mono
Other features	Removable covers, MP3 grade, multiple language, speaker & jack	Headset jack
Messaging	SMS, EMS (picture messaging)	SMS, EMS
Personalization	Games, polyphonic ring, speaking alarm, stop watch, icon menu	Games, ringtones, alarm clock, calculator, stop watch
Call management	200 entry phonebook	SIM only
Manufacturing cost	$29.45	$34.91
Retail price	$60 to $75	Around $50

- Nokia 1110 phone beats the Motorola C138 on most key measures that matter to customers:
  - ✓ 27% more standby time
  - ✓ removable covers
  - ✓ speakerphone
  - ✓ polyphonic ringtones
  - ✓ 200 entry phonebook
  - ✓ 17% smaller and 20% thinner
  - ✗ 33% less talk time

Sources: Nokia and Motorola website and company documents, Portelligent, CSFB

Nokia has 15% cost advantage from investing in research to lower the costs of three key chips

Architecture teardown and cost comparison: Nokia 1110 and Motorola C138



Value capture: summary

- Co-opetition: cooperation and competition
  - vertical competition amongst complementors
  - diverse strategies, niches and scope of activities
- Complementary assets
  - reputation
- Knowledge assets
  - patents, copyright
  - trade secrets, tacit knowledge
- Inimitability
  - physical uniqueness
  - path dependency
  - causal ambiguity
- Focus on locus of value

Standards

High-tech businesses are built on systems, with *interfaces*, which may be *standards*

- Products part of larger and more complex systems
- Products are comprised of multiple (sub-)systems

- Systems are comprised of sub-systems and components
- Sub-systems and components are integrated, made compatible, through ***interfaces***
- Interfaces can be customized or standardized, as **compatibility standards**

ZigBee

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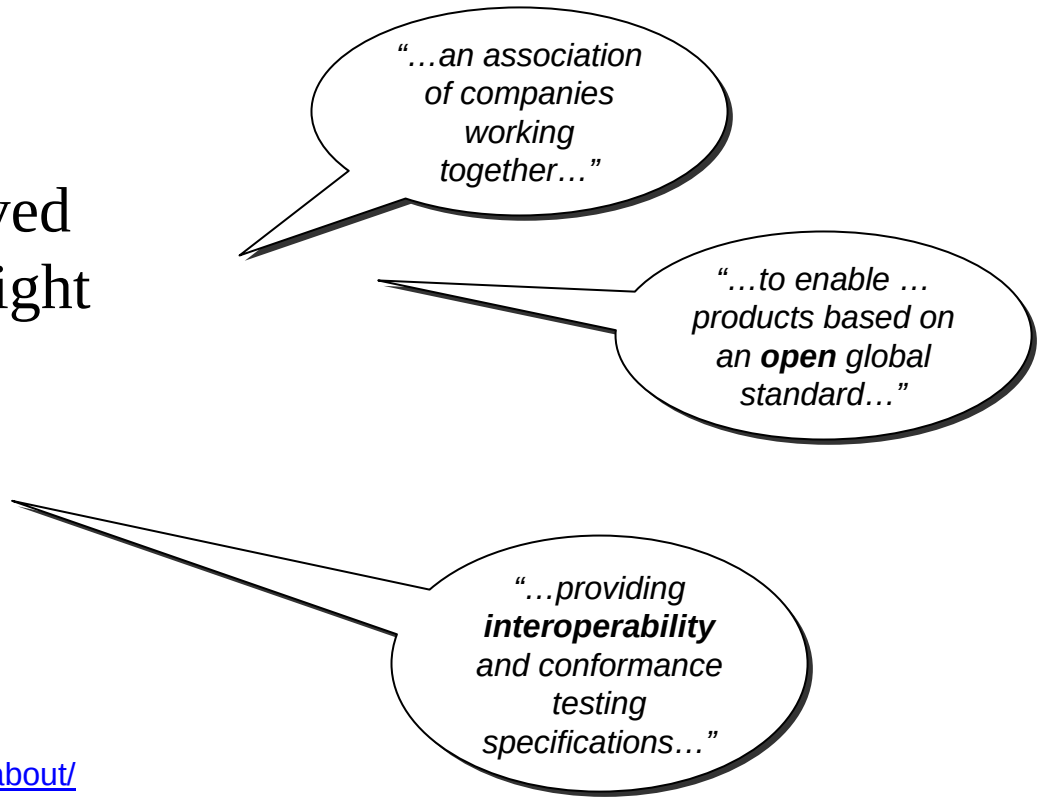


http://www.zigbee.org/en/about/

Z-Wave Alliance

Image removed due to copyright restrictions.

*"…an open **consortium** of manufacturers…"*

"…who build products based on Z-Wave…"

*"…allow all products from all members to **interoperate** seamlessly…"*

*"…stringent conformance test to assure … complete **interoperability** with all other devies and controls…"*

http://www.z-wavealliance.org/modules/AboutUs/

ZigBee and Z-Wave are battling each other, albeit with different strategies…

ZigBee Alliance

- *"The ZigBee Alliance is a global **ecosystem** of companies **creating wireless solutions** for use in **residential, commercial and industrial** applications"*
- *"[It] comprises **technology providers and original equipment manufacturers worldwide**. Membership is **open to all**."*
- *"…the only wireless standards-based technology:*
  - *that addresses the unique needs of **remote monitoring & control**, and **sensory network applications***
  - *enables **broad-based deployment** of wireless networks with low cost, low power solutions*
  - *provides the ability to run for years on inexpensive primary batteries for a typical monitoring application"*
- *"Initial markets*
  - *Home Automation*
  - *Building Automation*
  - *Industrial Automation"*

Z-Wave Alliance

- *"The Z-Wave Alliance members lead the **home controls** market…"*
- *" …more than 125 companies are developing products that incorporate the Z-Wave technology."*
- *"…Zensys' Z-Wave technology is **the only technology** in the market with a **true ecosystem of interoperable products** that focuses on the home automation segment."*
- *"Unlike competing technologies, Z-Wave-enabled products are **readily available** from leading consumer brands, giving Z-Wave a significant **time-to-market** advantage*
- *"Recent findings…have confirmed existing doubts about the viability of wireless control products based on IEEE 802.1.5.4, such as those from the ZigBee community… [and] clearly demonstrated that… products using 15.4 technology are seriously compromised and often inoperable even within the most basic residential"*

[Compatibility] standards have been around a long while: railroad gauges in the 19th century

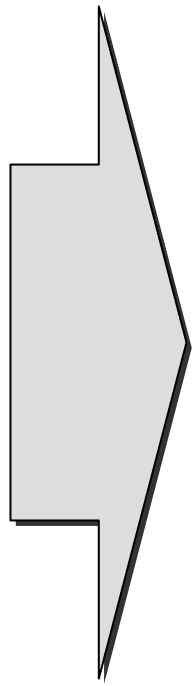
- Standard gauge 4’ 8½”
  - George Stephenson
  - built the Stockton & Darlington Railway
  - the Rocket
- broad gauge 5’0”
  - American South
  - Finland
- broader gauge 7’0¼”
  - Great Western Railway

Standards battles have been going on for a long while

• Electric Power	• DC (Edison) vs AC (Westinghouse)
• Roads	• *Width, side of the road, signage*
• Color Television	• Mechanical (CBS) vs electronic (RCA)
• Air travel	• *Door on front left, jetways/airbridges, taxi ways*
• Video cassettes	• Betamax (Sony) vs VHS (Matsushita+)
• Cellphones (1)	• *Several co-existing standards*
• Personal computers	• Windows vs MacOS
• 56k modems	• K56flex (Rockwell/Lucent) vs x2 (US Robotics/3Com) vs v.90
• Cellphones (2)	• TDMA (Ericsson/AT&T) vs CDMA (Qualcomm) vs GSM (EU+) vs PHS
• Documents	• PDF (Adobe) vs Reader/ (Microsoft)

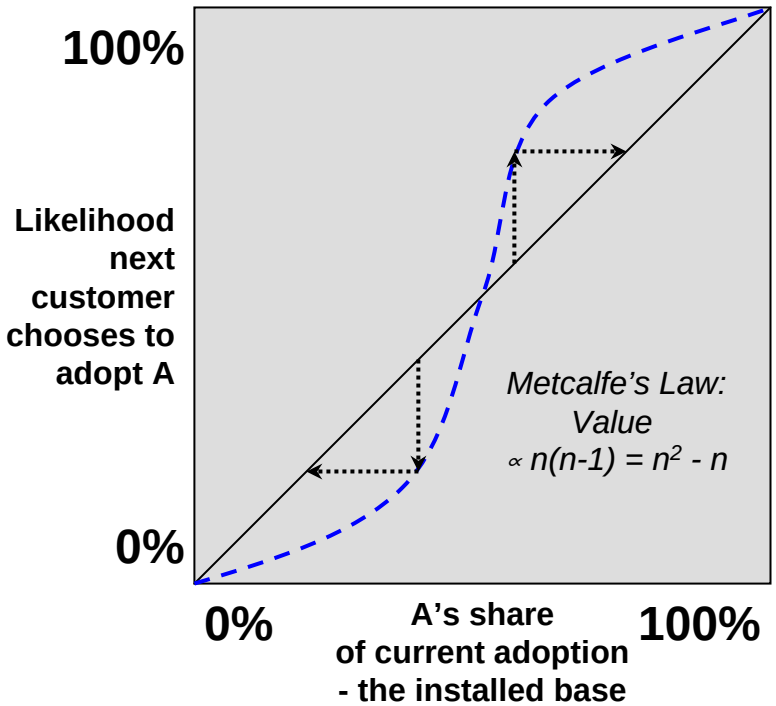
What triggers standards battles, and what are the outcomes?

- How important are *network effects*, how much consumers value broad compatibility
- Two (or more) businesses or business ecosystems vying for dominance



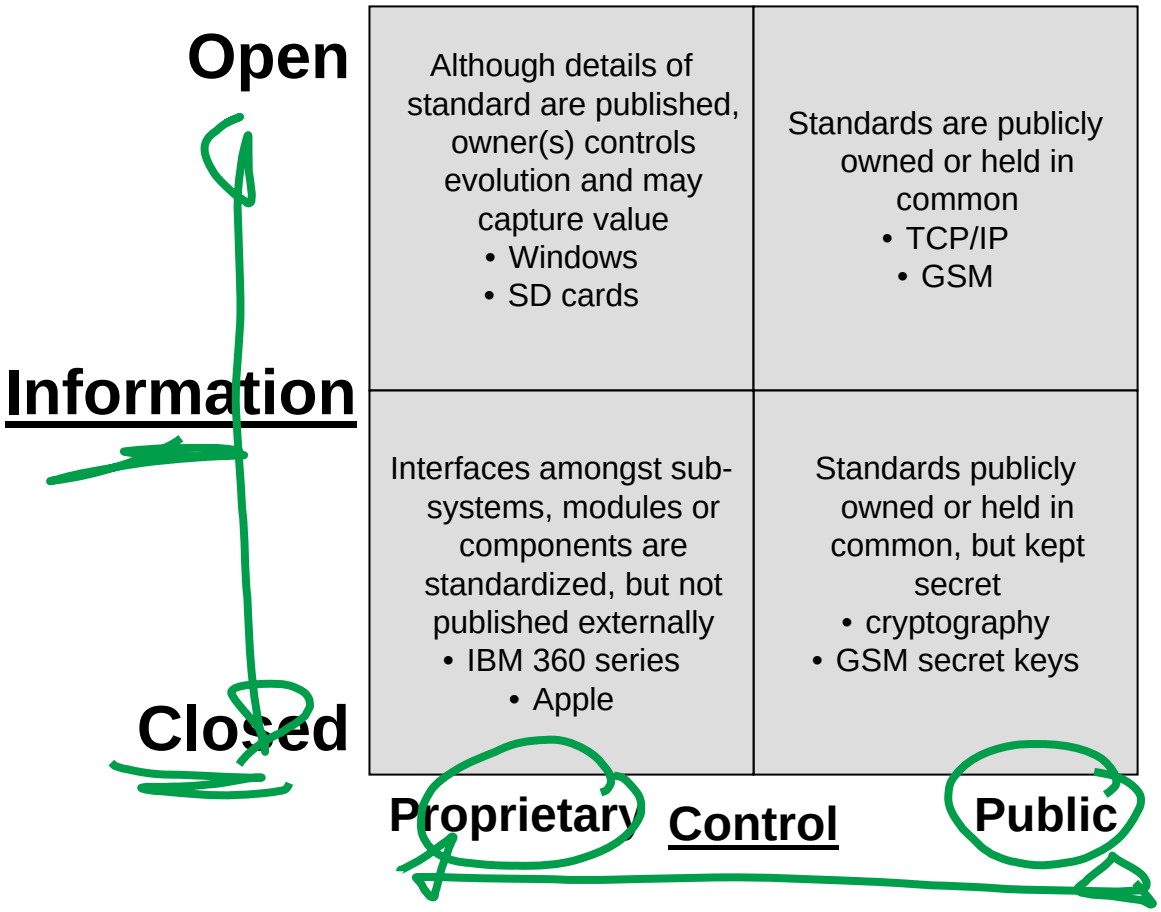
- Tipping
  - "fight to the death"
- Truce
  - convergence
  - comprise
- Two (or more)
  - no tipping
  - duopoly or oligopoly

If network effects, so-called network externalities, are important, adoption may tip

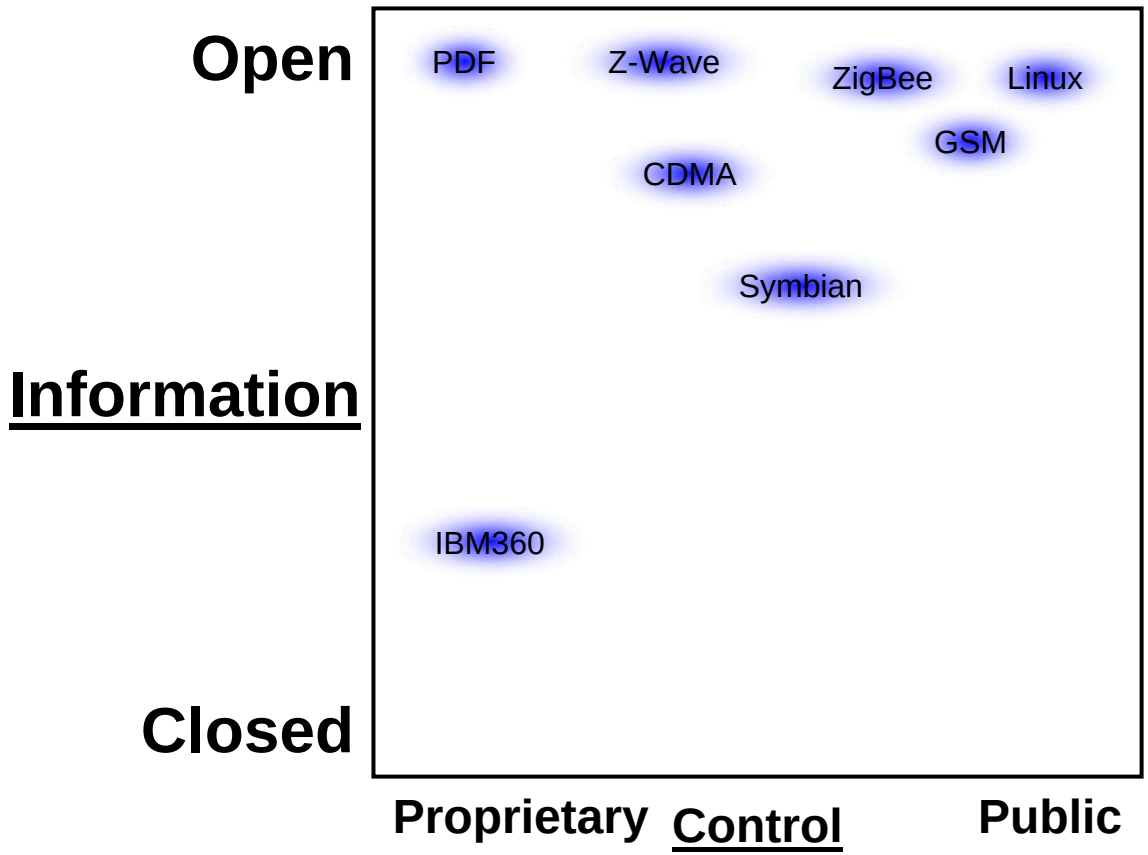


- Direct or real networks
  - people I can talk to
  - content I can use
  - places I can go
- Indirect or virtual networks
  - software and hardware
  - development communities
  - complements

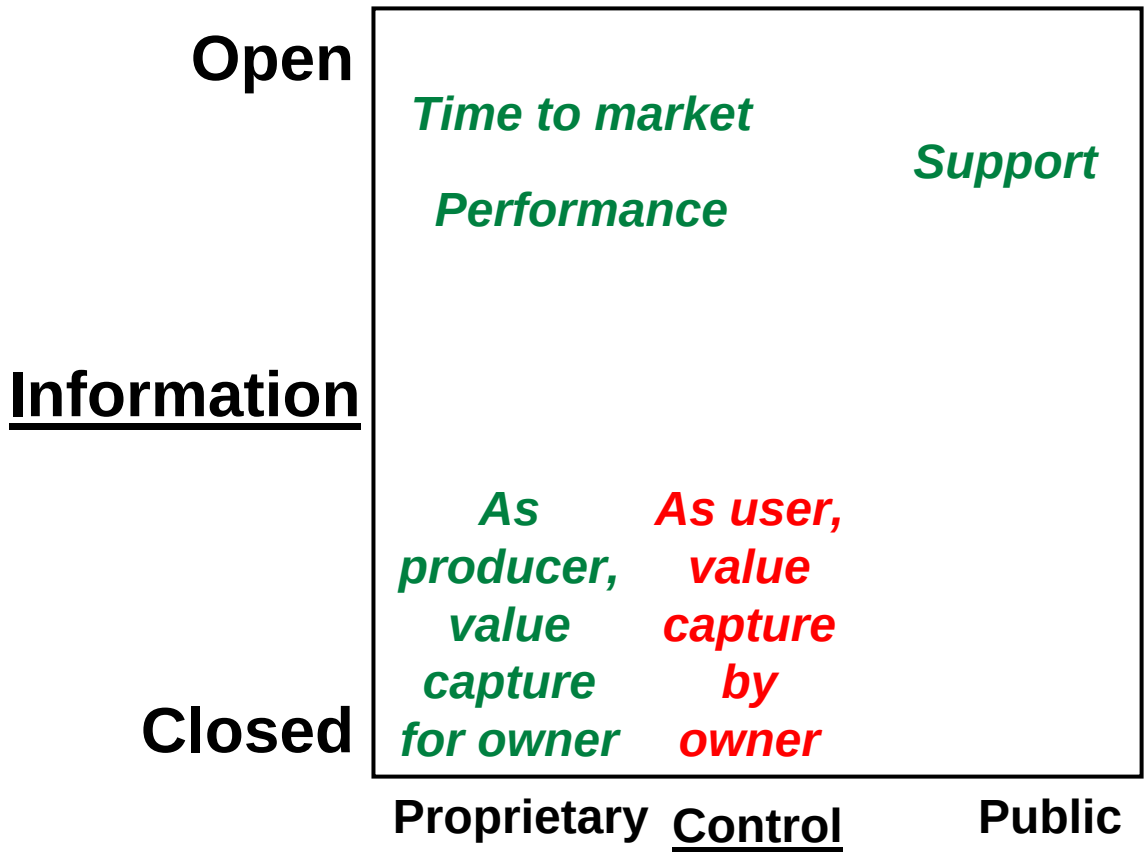
Types of compatibility standards



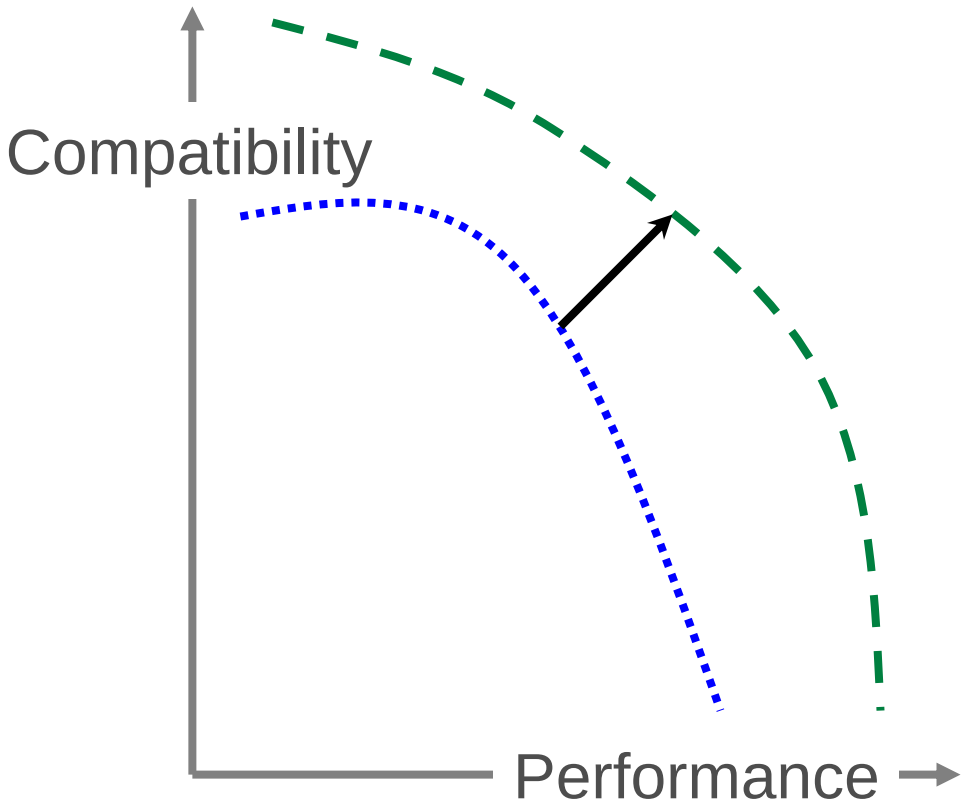
In practice, the extent of control and the availability of information are both a continuum



And each type of standard has distinct advantages and disadvantages

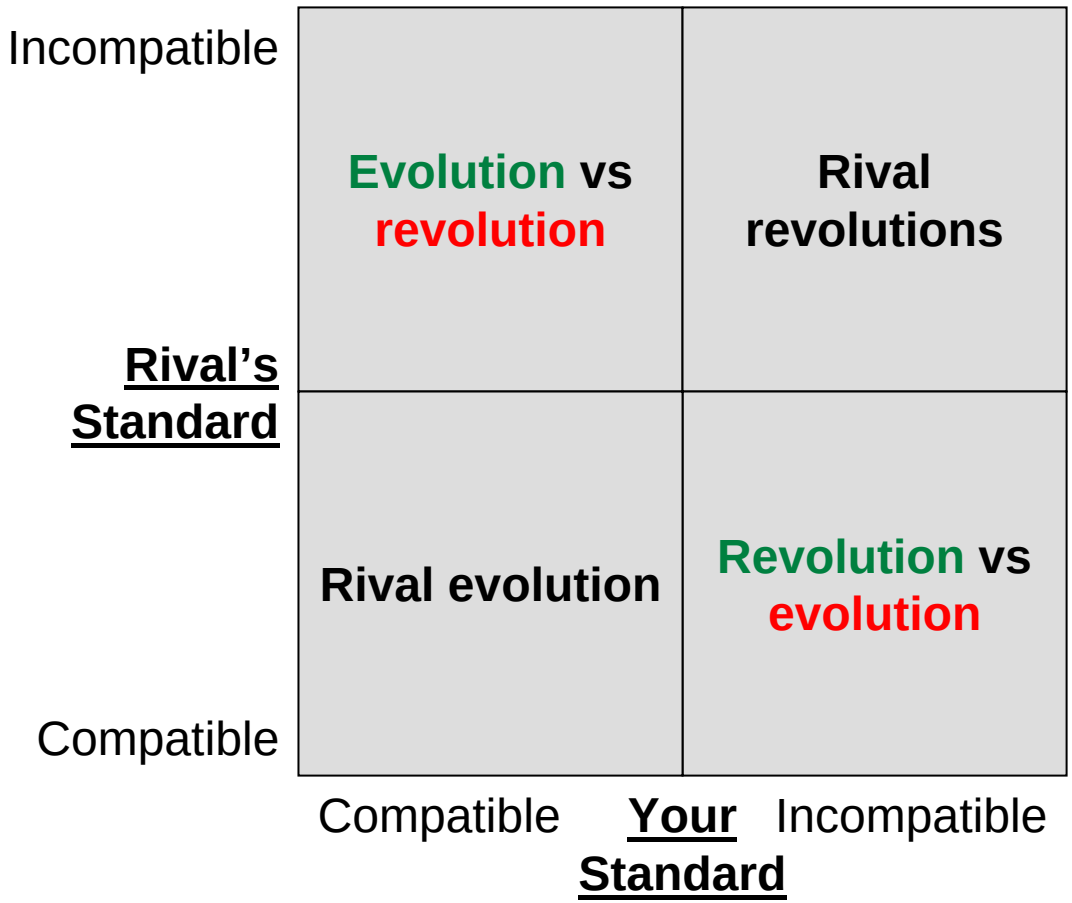


Technology envelopes and trade-offs



- Adopters face a trade-off between better performance and the payoff from network effects

Types of standards battles



Key assets in standards battles

- Prior adoption
  - installed based from previous era
  - helpful with evolution strategy
- Technological innovation
  - deliver superior performance
  - helpful with revolution strategy
- Timing, being first-to-market
  - get there early, establish momentum, learn
- Intellectual property rights
  - Qualcomm's patents for CDMA
- Strength in complements
  - influence overall system level performance
- Reputation
  - credibility, players expectations are that you will win… so you are more likely to

Two key strategems for standards battles

- Pioneering - pre-emption
  - just do it
  - pioneer an early lead so that positive feedback works for you
  - early entry - with associated trade-offs and risks
  - penetration pricing - which needs to be re-couped
- Prosletizing - expectations management
  - convince players that you will win
  - vaporware
  - “predatory product pre-announcements”
  - assembling alliances, announcing adoption
  - fear, uncertainty and doubt - FUD

Standards forums - let's go shopping!

- What are the costs involved in participation?
- Who are the participants?
  - incumbents or insurgents
  - customers or producers
- What is the intellectual property regime?
  - disclosure and licensing - what is "reasonable"
  - **rights held by non-participants**
- What is the process by which decisions are made?
  - consensus
  - voting
- How is compliance enforced?

Interesting standards battles going on today

• Low-power wireless	• ZigBee vs Z-Wave (Zensys) vs ISA-SP100
• Mobile OSs	• Symbian (Nokia and others) vs Windows Mobile (Microsoft) vs Linux
• Mobile TV	• MediaFlo (Qualcomm) vs DVB-H vs DMB
• Web content	• Flash (Adobe) vs Silverlight (Microsoft)
• High definition content	• Blu-Ray (Sony) vs HD-DVD (Microsoft)
• Documents	• OpenDocument vs OpenOffice XML (Microsoft)
• Mobile broadband	• WiMAX vs IEEE 802.20(?) vs LTE

It can get ugly… and expensive (particularly once the lawyers or the government get into it)

- **Qualcomm**'s tactics in mobile broadband
  - August 2005 pays $818 million for Flarion
  - September 2005 revives 802.20, proposes OFDM-based technologies
  - June 2006, IEEE suspends 802.20 at Intel and Motorola's instigation
  - Chairman had not disclosed that he is a consultant for Qualcomm
  - ~20 paid consultants voting as a bloc
- **Qualcomm** in deathmatch over 3G
  - royalties of ~5% on its CDMA, with >80% of the patents, generating ~$2.5 billion per year
  - wants ~5% on W-CDMA (vs ~3% incumbents pay), <20% of patents
  - in litigation with Broadcom and Nokia
- **Rambus** found by FTC to have deceived JEDEC about its patents
  - amended its patent applications to extend their scope
  - tried to charge a royalty rate of 3.5%
- **Microsoft** in a stand off with EU
  - unreasonably high prices for Windows Server Protocol Program
  - threatened with "structural separation", fines of €3 million **per day**

802.20 typically <10 people, then Qualcomm buys Flarion and commits aggressively

Image removed due to copyright restrictions.

http://techon.nikkeibp.co.jp/article/HONSHI/20070328/129634

(Compatibility) standards: summary

- Importance depends on power of ***network effects***
- Types of standards
  - open vs closed access to information
  - proprietary vs public control
- Adopters trade-off
  - performance
  - compatibility
- Standards battles
  - compatible vs incompatible
  - revolutionary vs evolutionary
- Strategems for standards battles
  - pioneering
  - prosletizing

Modularity

Modularity is becoming more prevalent, increasing value creation, challenging value capture

- Falling costs of co-ordination make modularity easier
- Modularity, where it can be employed effectively, can accelerate value creation
  - once dominant design established, hence stable architecture and modular interfaces
  - and ultimate performance is not critical
  - autonomous or modular innovations, in this context
- Very challenging for value capture
  - loss of control for leaders
  - rapid, diverse innovation
  - revenues and value widely dispersed

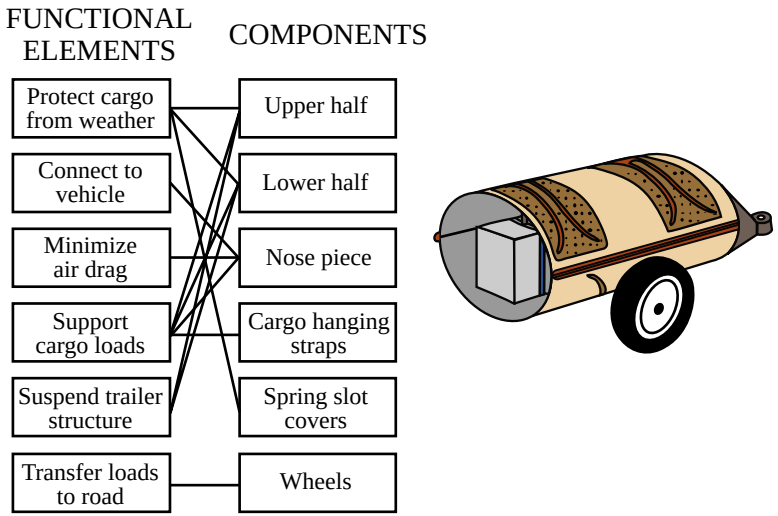
Modularity → decoupling

- *"When a product or process is 'modularized,' the elements of its design are split up and assigned to modules according to a formal architecture or plan."*
- *"From an engineering perspective, a modularization generally has three purposes:*
  - *to make complexity manageable*
  - *to enable parallel work*
  - *to accommodate future uncertainty"*

Modularity in the Design of Complex Engineering Systems,
Carliss Y. Baldwin and Kim B. Clark, HBS Working Paper, January 2004

Product Architecture

Integral



Modular

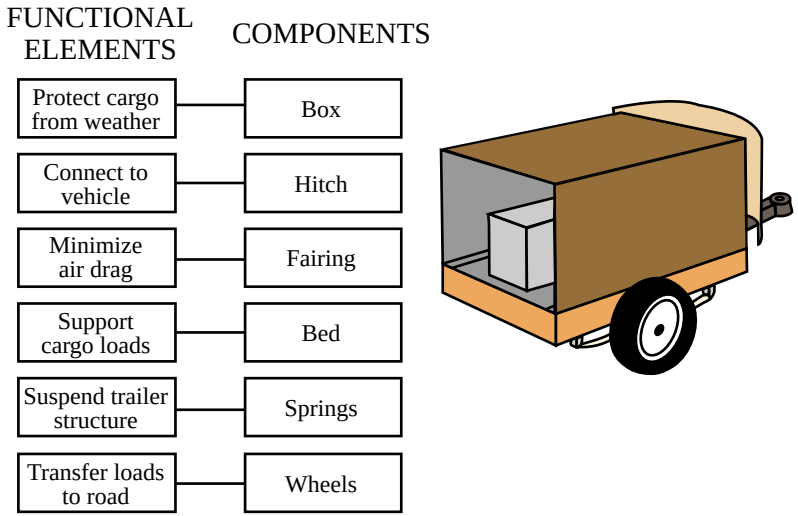


Image by MIT OCW.

Interfaces

Modular

- Customer understands and can specify key parameters
- Can be measured and tested reliably and unambiguously
- Understand how variation affects system performance
- Market can function effectively
- Codified knowledge
- Difficult to protect

Interdependent/ Systemic/Integral

- Associated with optimizing design for ultimate performance
- Unstructured technical dialogue
- Necessary information for market does not exist
- Management and integration most efficient coordinating mechanisms

IBM System/360

- First modular computer, conceived as a family of computers
  - different sizes suitable for different applications
  - same instruction set
  - standard interfaces for peripherals
- Design rules and decentralized development
  - Central Processor Control Office defines rules
  - each team full control over hidden elements
- Wildly successful, drove other players out of the market
- BUT undermined IBM's dominance in the long run - through emergence of plug-compatible modules

Nippon Denso can make 288 products from just 8 modules

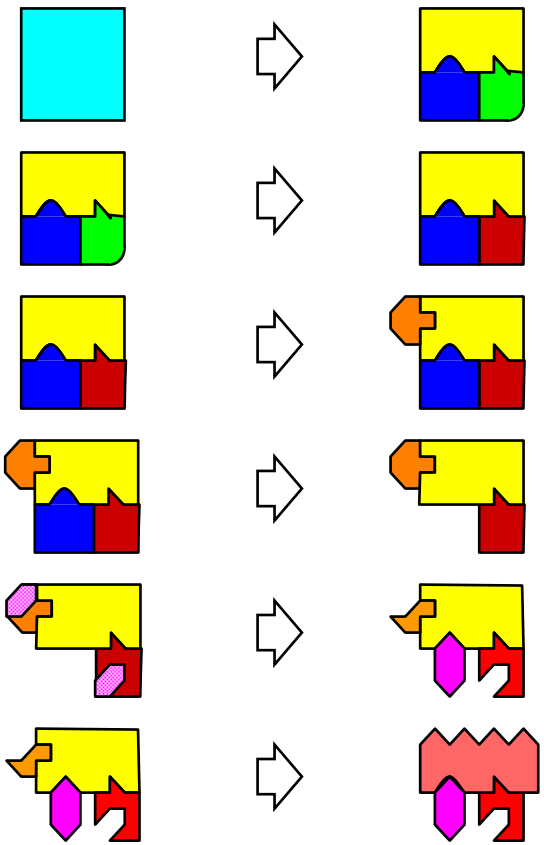
Image removed due to copyright restrictions.

Braun family of coffee makers

Image removed due to copyright restrictions.

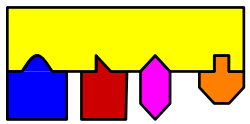
There are six modular operators that together enable a very wide range of system designs

Splitting	Separating systems into modules that interact across well defined interfaces
Substituting	Switching between components that perform the same function
Augmenting	Adding a module to increase the functions of the system
Excluding	Removing a module to reduce the functions the system can perform
Inverting	Making an embedded function into a stand-alone module
Porting	Moving a module from one system to another

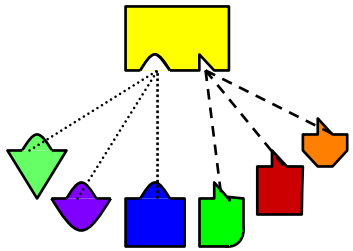


The resulting systems can exhibit several different types of modularity

Slot

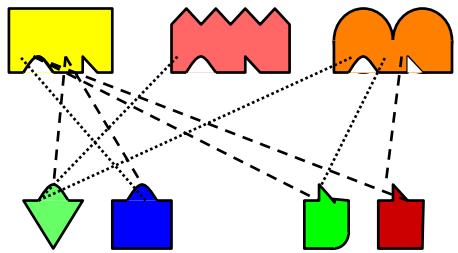


Component Swapping

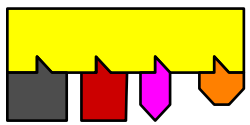


Direct

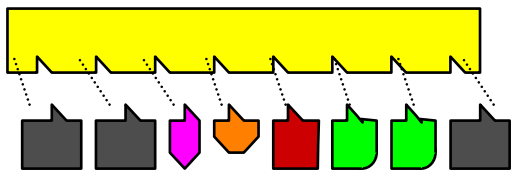
Component Sharing



Bus



Bus



Modular platforms can be a very effective vehicle for diverse offers

Image removed due to copyright restrictions.

Strategic options

Architect

- For system innovations, may require broad scope of activities at the outset
- Create design rules, define visible information
- Convince people this architecture will prevail
- As modularity established, lead the evolution of the business ecosystem

Module player

- Conform to the architecture, interfaces and test protocols established by others
- Master the hidden information involved
- Rely on superior execution

Modularity: summary

- Modularity when and if:
  - performance not critical
  - dominant design established
- Accelerates value creation, makes value capture tough
- *Focus on locus* of value
  - bottleneck, constrains overall system performance
  - build inimitable capabilities and core competences

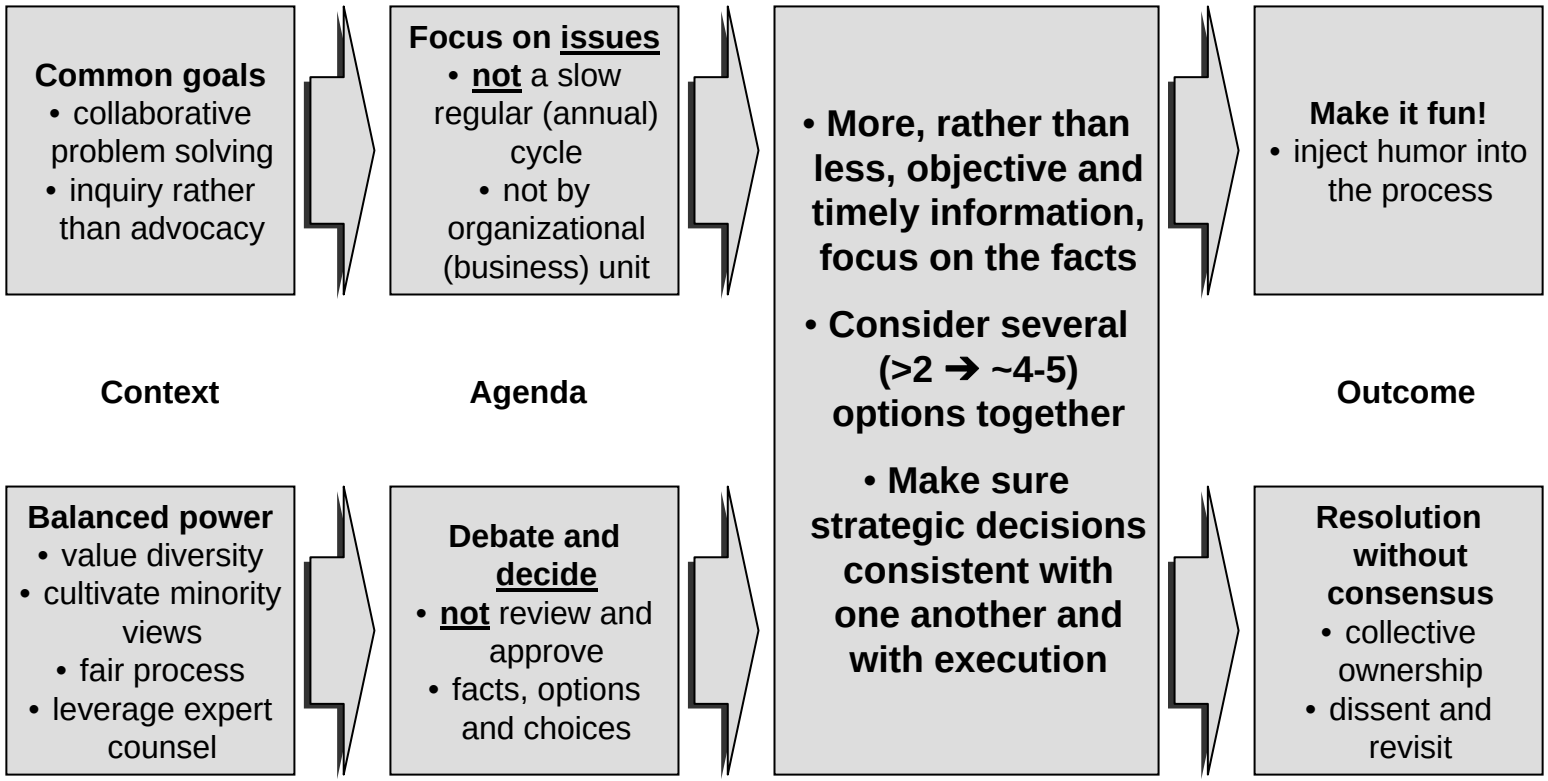
Decision-making

Effective decision-making involves conflict - challenging leads to better decisions

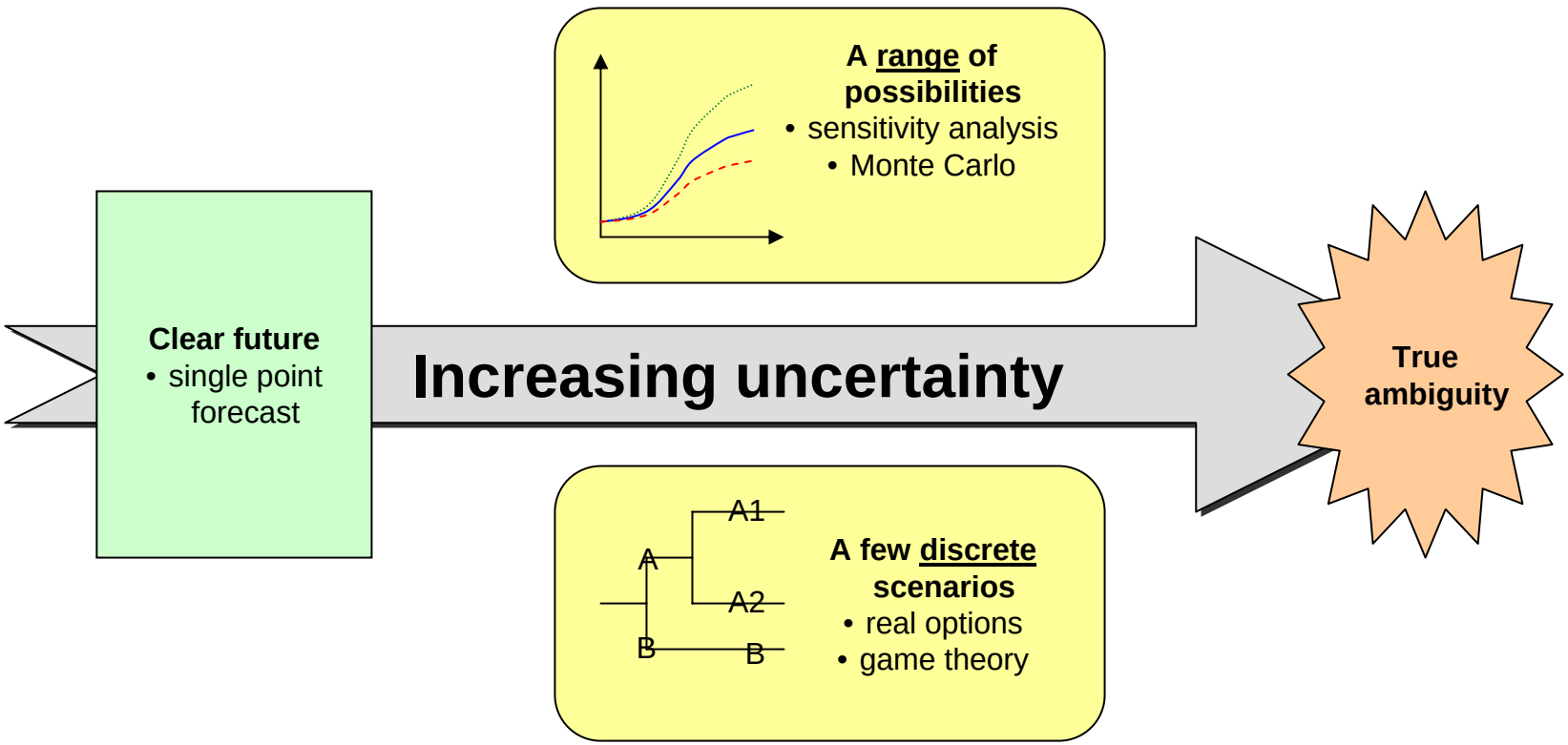
- Incomplete and ambiguous information
- Uncertainty
  - how customers will respond
  - innovation trajectories
  - how co-opetition will play out
- Limited time
- Wide range of options

- *"Management teams whose members challenge one another's thinking develop a more complete understanding of the choices, create a richer range of options, and ultimately make the kinds of effective decisions necessary in today's competitive environments"*

How can you make good decisions, when conflict is likely?



As a key part of focusing on the facts, recognize and embrace uncertainty



Types of uncertainty

Discrete scenarios

- Does it work?
- Does anyone buy it?
- Competitor entry
- Collaborator partnership
- Patent litigation
- Standards battles

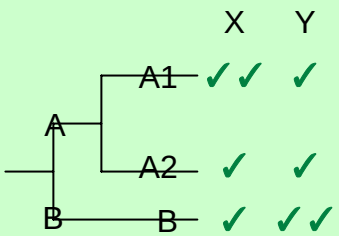
A range of possibilities

- Innovation trajectories
  - performance
  - cost
  - timing
- Pricing
- Adoption rates and ultimate penetration

Three basic types of decision, with increasing risks and levels of commitment

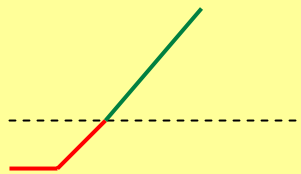
No-regrets moves

- worth doing anyway
- positive payoffs in most scenarios



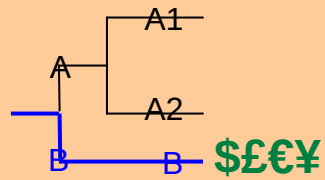
(Real) options

- positive payoff in some outcomes
- otherwise, small cost to play
- parallel or sequential



Big bets

- work in some scenarios
- high cost, negative effects in other cases



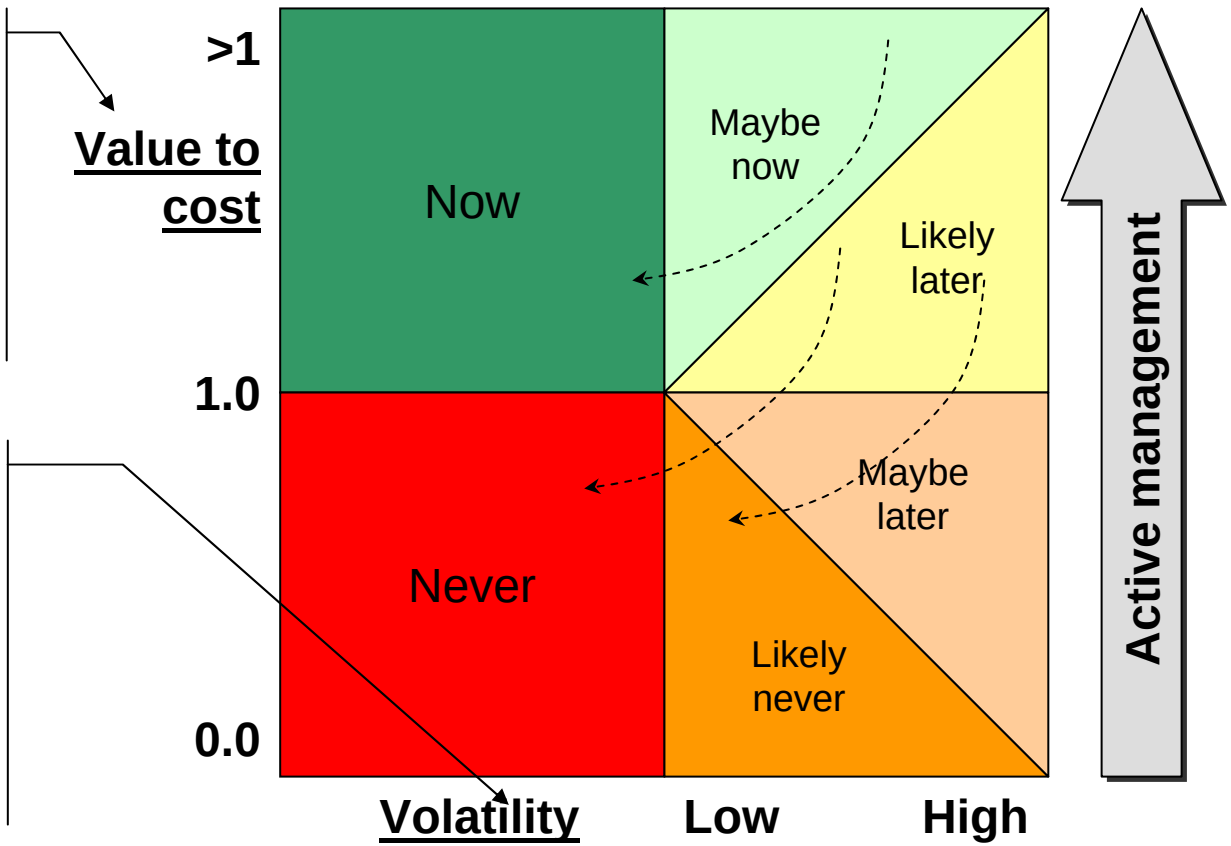
Increasing risk

Increasing investment and commitment

What you do about real options, and when depends on *value to cost*, and on *volatility*

Net present value, taking into account time value of being able to postpone the decision

How much things can change
- variance
- time horizon



For high-tech businesses, timing - and hence (active) waiting - is critical to success

- High-tech involves volatility
  - innovation
  - diffusion
  - co-evolution
- Steady stream of small and medium-size opportunities
- A few *golden opportunities* or *life-and-death threats*

- Anticipate
  - analyze
  - reconnoiter
- Prepare
  - build resources
  - create options
- Commit
  - make the big bet

Decision-making: summary

- Conflict inevitable, challenge valuable
- Common goals and balanced power
- Focus on facts, debate and decide
- More objective and timely information
- Consider several options together
- Strategic decisions consistent with each other and with execution
- Embrace uncertainty
  - range of possibilities
  - discrete scenarios
- Real options
  - value to cost
  - volatility
- Active waiting

Strategy and technology

Demand opportunity
- segments
- behaviour change
- diffusion and adoption
- chasm

Technological infrastructure
- architecture
- parameters
- envelope and trade-offs
- innovation trajectory

Co-evolution & transitions
- episode, era
- dominant design
- radical vs incremental
- architectural vs modular
- disruptive

Business ecosystems, value creation and value capture
- niche
- lead/follow
- co-opetition
- inimitability
- focus on locus of value
- standards
- modularity

Decision making
- common goals, balanced power
- focus on timely, objective facts
- embrace uncertainty
- several options

Framework

Demand Opportunity

Customers

Applications or Outcomes

Markets

Underlying drivers of time behaviour (dynamics)
- customers and applications (*vs products*)
- activities and processes (*vs* organization)

Connections or linkages, feedback loops (+ and -)

Business Ecosystem

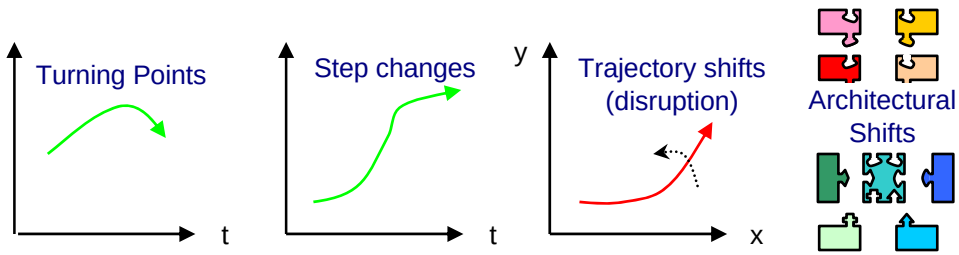
Offer Partners

Technology Partners

Operations
Marketing
Innovation
Management

Value Creation
versus
Value Capture

Technological Infrastructure



Time

Questions and quotations

- OK, it's cool technology, but will it really be any better in customers perception, when we finally get it to work?
- Why on earth should I bother with the hassle and anxiety of trying to figure this &*!% out?
- *"Show me the money!"*
- *"Any sufficiently advanced technology is indistinguishable from magic"*
- How do I get to be Switzerland, rather than Belgium?
- Where's the bottleneck - and what can we do that customers care about, better than the other guys, that they can't copy?

1: Jerry Maguire (Tom Cruise) to Rod Tidwell (Cuba Gooding, Jr.) in "Jerry Maguire", directed by Cameron Crowe, 1996
2: Arthur C Clarke in "Profiles of the Future", 2nd Edition, 1973

Definitions

Theory

noun

1. a belief or principle that guides action or assists comprehension or judgment[1]
2. a set of statements or principles devised to explain a group of facts or phenomena, especially one that has been repeatedly tested or is widely accepted and can be used to make predictions about natural phenomena[1]
3. a well-substantiated explanation of some aspect of the natural world; an organized system of accepted knowledge that applies in a variety of circumstances to explain a specific set of phenomena

1: American Heritage® Dictionary, © 2000 Houghton Mifflin
2: WordNet®, © 2005 Princeton University

Technology

noun

1. electronic or digital products and systems considered as a group[1]
2. a technological process, invention, method or the like[2]
3. the practical application of science to commerce or industry[3]
4. the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society and the environment[2]
5. the sum of the ways in which social groups provide themselves with the material objects of their civilization

1: American Heritage® Dictionary, © 2000 Houghton Mifflin
2: Random House Unabridged Dictionary, © Random House Inc. 2006
3: WordNet®, © 2005 Princeton University

Strategy

noun

1. a plan, method or series of maneuvers or strategems for obtaining a specific goal or result[1]
2. the science and art of military command as applied to the overall planning and conduct of large-scale combat operations[2]
3. the art or skill of using strategems in endeavors such as politics and business[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Domain

noun

1. a knowledge domain that you are interested in or communicating about[1]
2. a field of action, thought or influence[2]
3. a realm or range of personal knowledge, responsibility and so on[2]
4. a sphere of activity, concern or function; a field[3]

1: WordNet®, © 2005 Princeton University
2: Random House Unabridged Dictionary, © Random House Inc. 2006
3: American Heritage® Dictionary, © 2000 Houghton Mifflin

Parameter

noun

1. one of a set of measurable factors…that define a system and determine its behaviour…[1]
2. a factor that restricts what is possible or what results[1]
3. a distinguishing characteristic or feature[1]

1: American Heritage® Dictionary, © 2000 Houghton Mifflin

Envelope

noun

1. the technical limits within which an aircraft or electronic system may be safely operated[1]
2. the maximum operating capability of a system (especially an aircraft)[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: WordNet®, © 2005 Princeton University

Trade-off

noun

1. the exchange of one thing for another of more or less equal value, especially to effect a compromise[1]
2. an exchange of one thing in return for another, especially relinquishment of one benefit or advantage for another regarded as more desirable[1]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Era

noun

1. a period of time marked by distinctive character, events and so on[1]
2. the period of time to which anything belongs or is to be assigned[1]
3. a period of time as reckoned from a specific date serving as the basis of its chronological system[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Epoch

noun

1. a period of time marked by distinctive character, events and so on[1]
2. the **beginning** of a distinctive period in the history of anything[1]
3. a **point of time** distinguished by a particular event or state of affairs[1]
4. a notable event that marks the **beginning** of a period of history, especially one considered remarkable or noteworthy[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Episode

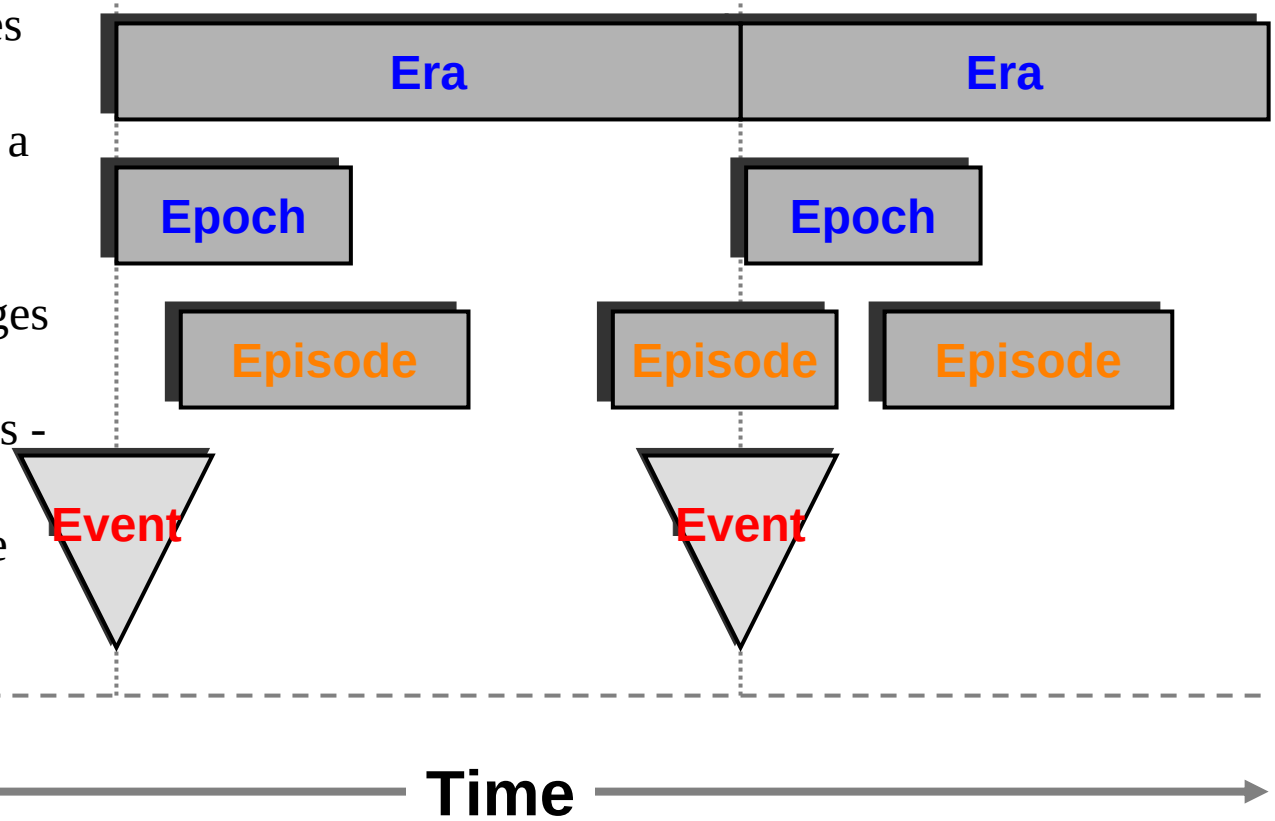
noun

1. a portion of a narrative that relates an event or a series of connected events and forms a coherent story in anf of itself[1]
2. an incident in the course of a series of events[2]

1: American Heritage® Dictionary, © 2000 Houghton Mifflin
2: Random House Unabridged Dictionary, © Random House Inc. 2006

Some terminology for timelines and transitions

Epoch applies to the beginning of a new period marked by radical changes and new developments - while *era* applies to the entire period



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(Business) Ecosystem

noun

1. a a system formed by the interaction of a community of organisms with their environment[1]
2. *"[a system in which] companies co-evolve capabilities around a new innovation, they work co-operatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations"*[2]
3. *"[a] loose network…of suppliers, distributors, …makers of related products or services, technology providers [that] affect, and are affected by, the creation and delivery of a company's own offerings"*[3]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: James Moore, "Predators and Prey", Harvard Business Review, May-June 1993, pages
3: Marco Iansiti and Roy Levien, "Strategy as Ecology", Harvard Business Review, March 2004, pages

(Business) Niche

noun

1. a situation or activity specially suited to a person's interests, abilities, or nature[1]
2. the position or function of an organism in a community of plants and animals[2]
3. the status of an organism within its environment and community (affecting its survival as a species)[3]

1: American Heritage® Dictionary, © 2000 Houghton Mifflin
2: Random House Unabridged Dictionary, © Random House Inc. 2006
3: WordNet®, © 2005 Princeton University

Modularity

noun

1. the use of individually distinct functional units, as in assembling an electronic or mechanical system[1]
2. designed with standardized units or dimensions, as for easy assembly and repair or flexible arrangement and use[2]

1: Random House Unabridged Dictionary, © Random House, Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Locus

noun

1. a center or focus of great activity or intense concentration[1]
2. a center or source, as of activities or power[2]

1: American Heritage® Dictionary, © 2000 Houghton Mifflin
2: Random House Unabridged Dictionary, © Random House, Inc. 2006