15.965 Technology & Strategy

Iridium and Technologies

Michael A M Davies

Agenda for today

~13:00
~13:45
~14:15

- Iridium
- Technologies
- Logistics
  - Projects session next week
  - First individual paper

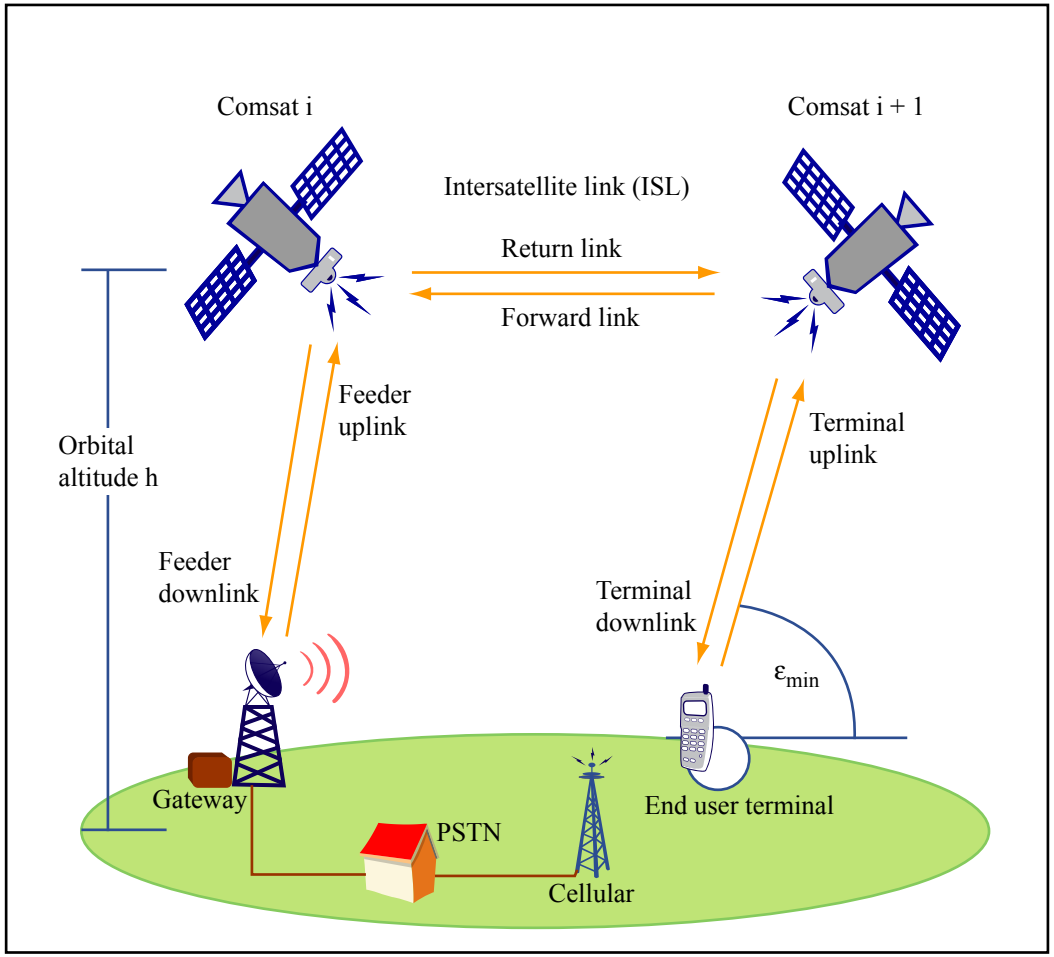
Iridium was technically successful, but a commercial disaster – what can we learn from it?

1. Who is responsible for Iridium's failure?
2. At what point could you have predicted out that there was a significant risk that Iridium would fail?
3. What is your assessment of Iridium's overall system design?
4. What impact did the choices that were made have on the subsequent economics of the venture?
5. What impact did Iridium's organization design have on the outcome, and in particular who were the key stakeholders and what was their motivations?
6. What alternative technical or commercial strategies could or should Iridium have pursued?

Importance of decisions and timing

- Early decisions critical – impose constraints, set trajectory
  - influenced by framing: *"A truly global phone system"*
  - often made before project starts, implicit!
- Early decisions are "sticky" – hard to change
  - sunk cost fallacy
  - system architecture: "by-pass" *versus* "bent pipe"
- Initial assumptions often wrong – context can change
  - terrestrial cellular coverage inadequate…
  - international calling to home is lucrative…

Low Earth Orbit (LEO) satellite constellation concept



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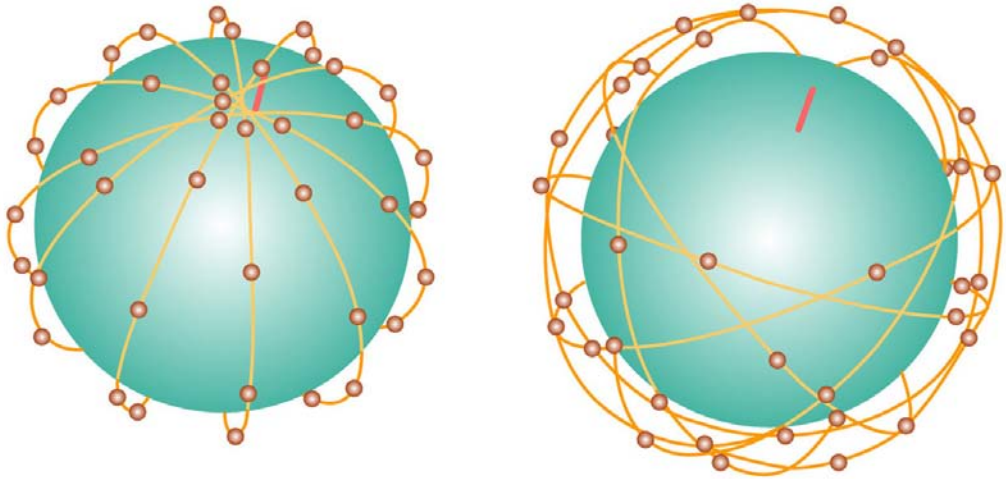
Global coverage and diversity



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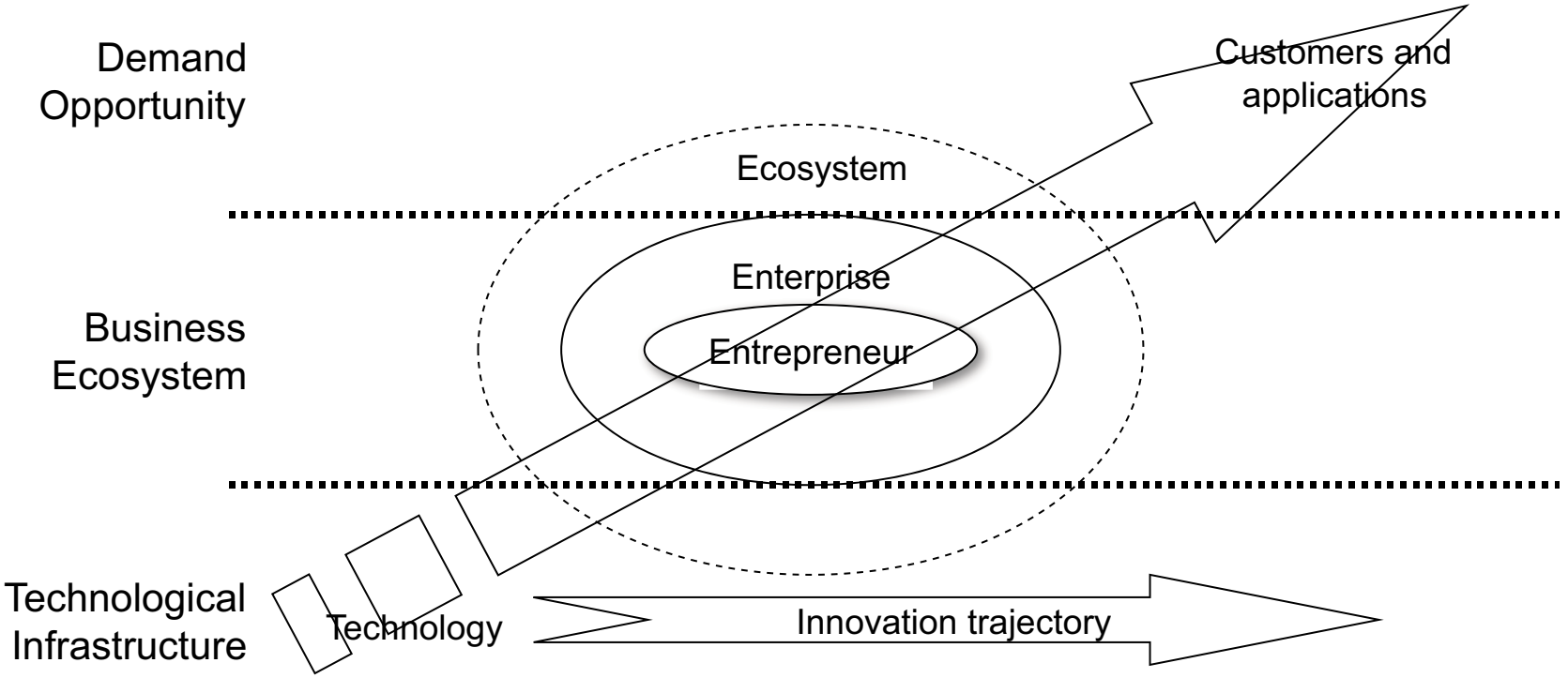
Polar constellation
- global coverage
- less diversity

Walker constellation
- population coverage
- less diversity

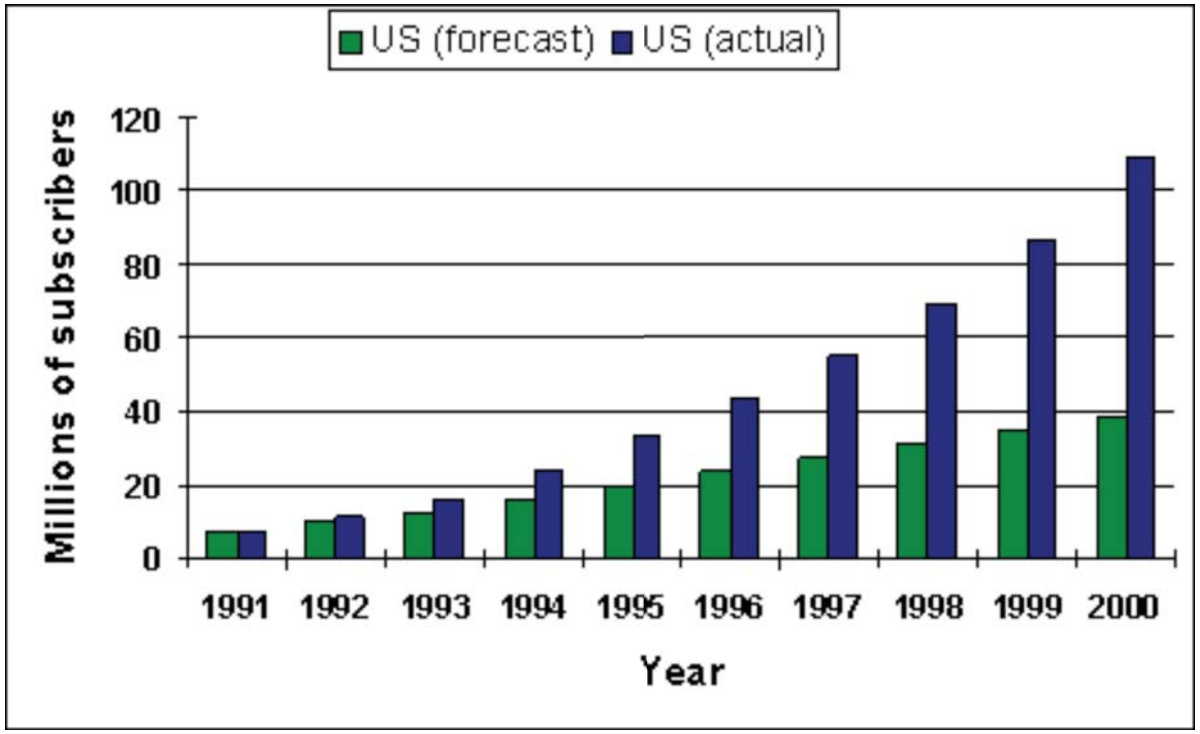
Who was doing the design? What was the context?

- Customers
  - cellular works well enough
- Local PTTs
  - nationalized, large source of revenues
  - licenses required to operate telecom service
- Motorola Space Systems Group
  - transition from military
  - bootleg project
  - limited (at best) contextual knowledge

Alignment: design must fit context



By 1995 (pre-launch) US cellular subscribers were way ahead of 1991 projections (announced)



Adaptation: things change

- Now have local gateways – so why "bypass" architecture?
- When could you have known that Iridium would fail?
  - capital spend ramps in 1996
  - 1st satellite launched in 1997
  - prospects for cellular growth were right by 1995
- BUT who was going to pull the plug?
  - Motorola: prime contractor, but only 20% of the equity
  - other equity participants: limited skills, money in game
  - financiers: strongest incentives, weakest ability…

What would flexibility look like?

- Could Iridium have had earlier feedback?
  - what kind of project "milestones" could they have used?
- Technical experiments
  - single satellite to test coverage in buildings, cities
  - two satellites to test communication links between them
- Market experiments (??)
  - skew orbits to serve target test market first
  - even if only one area – what info would they get?

The $5 billion question: Why did they not think like this

- Cognitive biases that influence perceptions of risk
  - over-optimistic (means are biased upwards)
  - over-confident (under-estimate variance in outcomes)
- Ex-post managerial reactions to experiments that fail!
- The cost (and time) required to conduct early experiments are salient, but the information generated is hard to value
  - costs: tangible, occur NOW, impact specific budget
  - benefits: subtle, intangible (info), in future, different part of the organization

Closing thoughts

- Big Bang projects usually blow up
- For most opportunities from technology-driven settings: not enough customers who care enough
- *"Most complex projects in an uncertain environment can be broken down into a series of smaller experiments, the value of which will exceed their cost."*

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

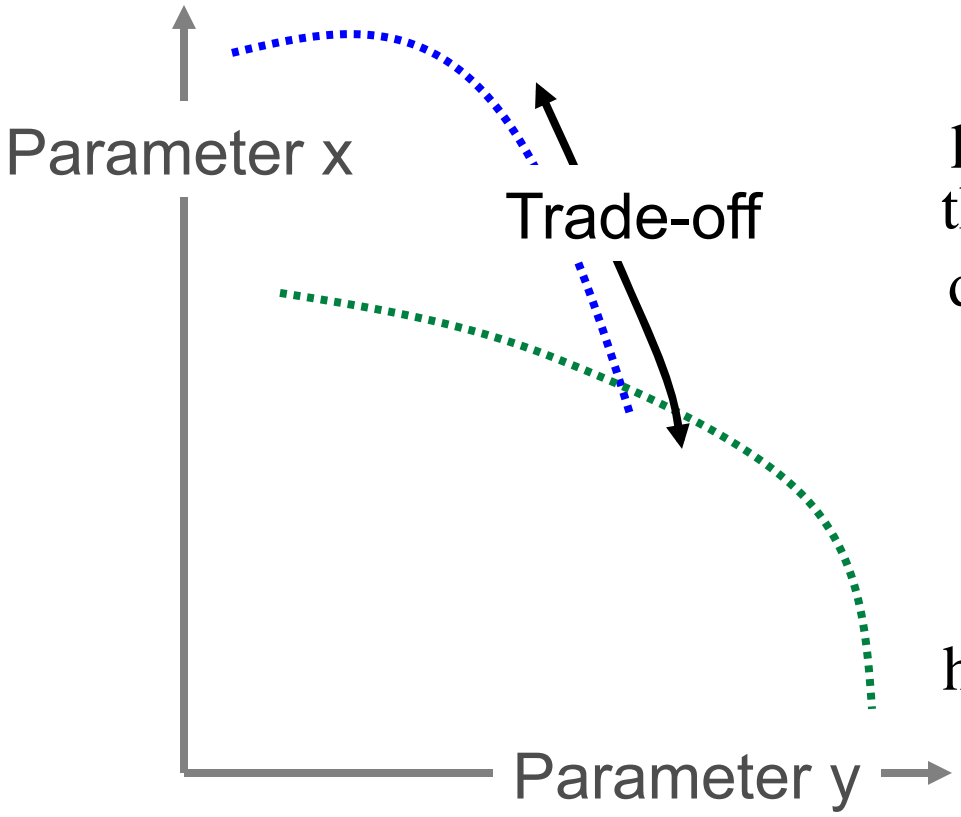
Parameter

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

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

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

Envelope

noun

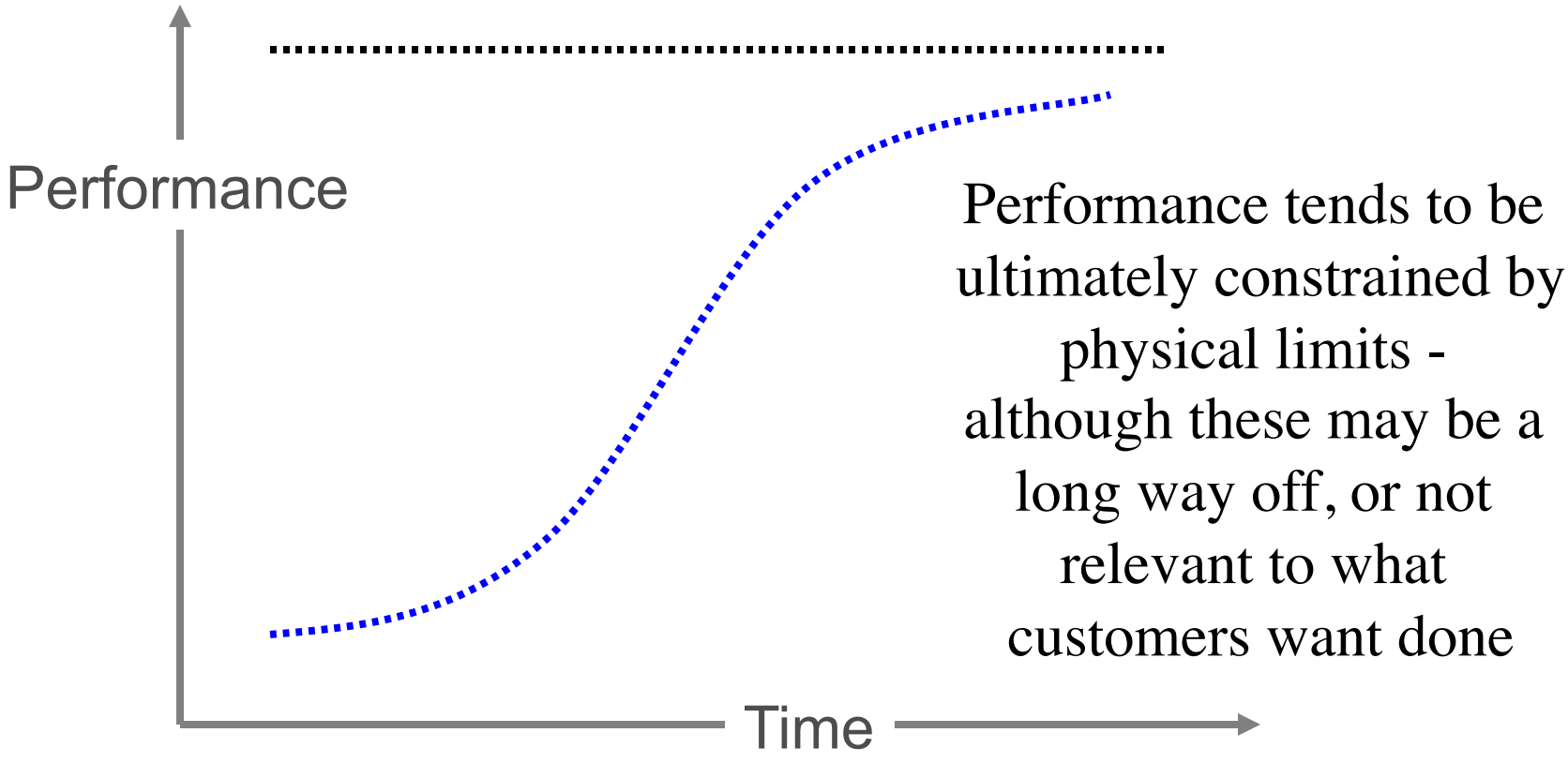
1. the technical limits within which an aircraft or electronic system may be safely operated[1]
2. the maximum operating capability of a system (especially an aircraft)[2]

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

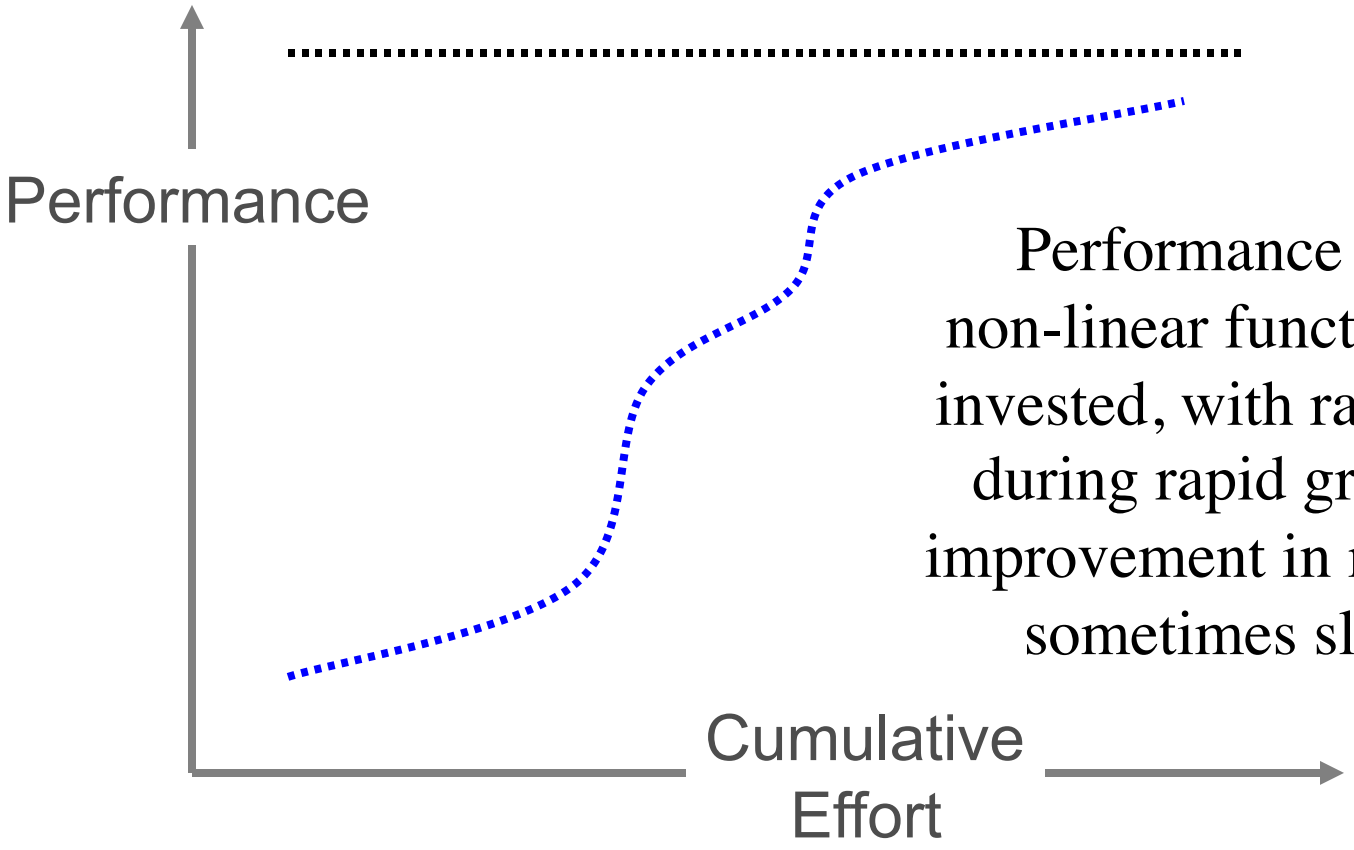
Technologies compete with each other for potential applications

- 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



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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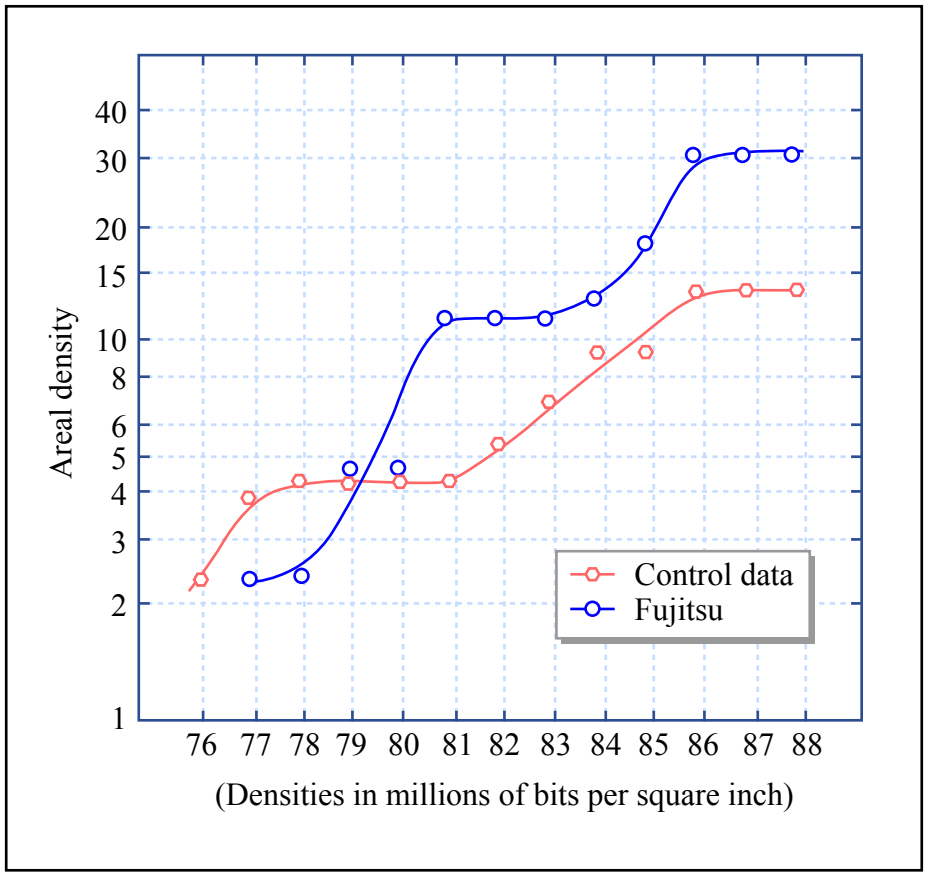
Clayton Christensen, "Exploring the Limits of the Technology S-Curve - Part I: Component Technologies", Production and Operations Management, Fall 1992, pages 334-357

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



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Clayton Christensen,
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The rate at which performance improves can vary dramatically

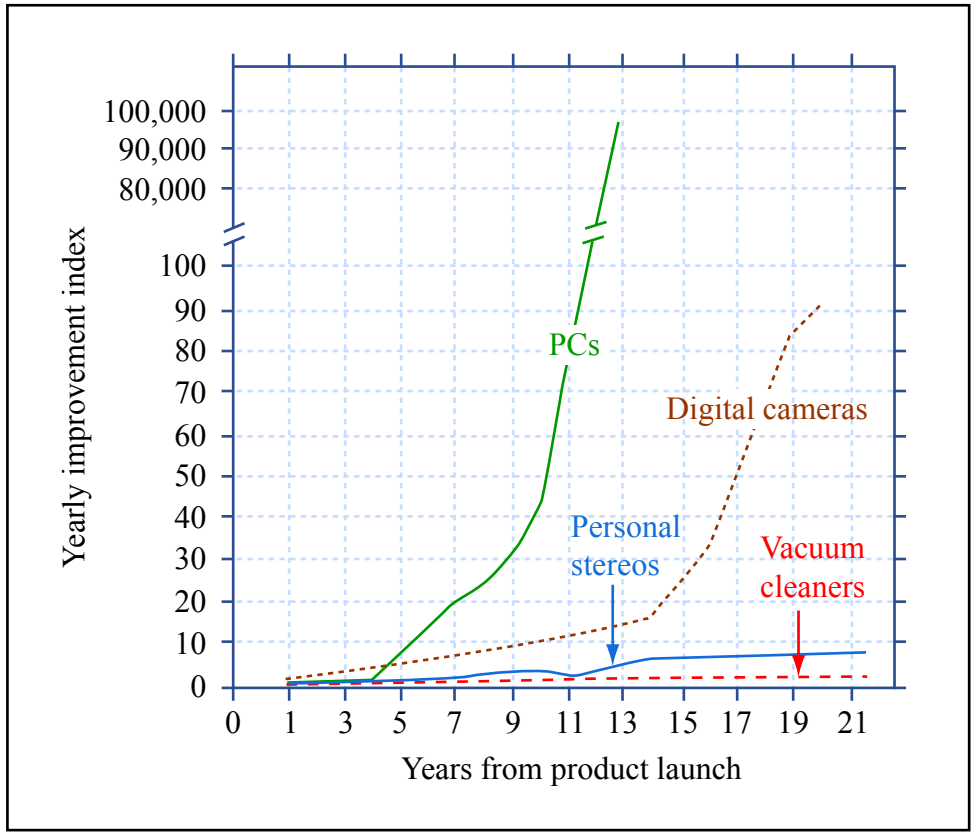
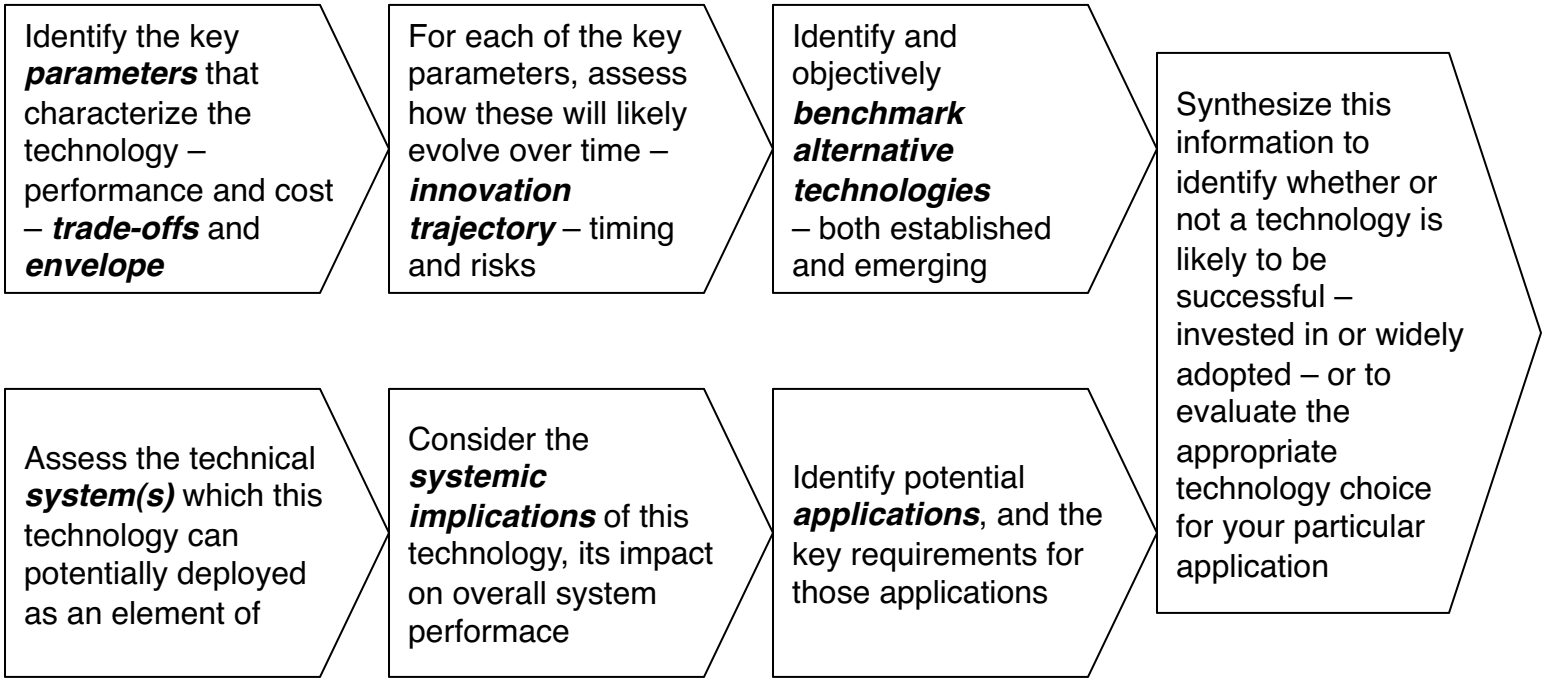


Image by MIT OpenCourseWare.

Fernando Suarez and Gianvito Lanzolla, "The Half-Truth of First-Mover Advantage", Harvard Business Review, April 2005, pages 121-127

Technology assessment



First individual assignment

- Why is this technology and domain interesting and important, what makes it significant and worthy of focus?
- What are the key ***parameters*** that characterize it, what are the key ***trade-offs*** and the performance ***envelope***?
- How have the key parameters evolved over time, what has been the ***innovation trajectory*** for this technology?
- What are the key ***alternative technologies*** with which it competes for potential ***applications***, and what are their advantages and disadvantages?
- How do you anticipate the key technologies in this domain are likely to evolve, and are they likely to be subject to "natural technological limits"?

The first individual assignment is due on Lecture #5

- Must **not** be longer than a maximum of 2,000 words
  - about four (4) pages long
  - excluding tables or figures (which are encouraged)
  - 1.5 line spacing, 10 to 12 point (10-12pt) font
  - 1 inch or greater (≥1") margins all round
- Filename **must** have the following format: '15.965-firstname-lastname-paper 1'
- If you don't know how, figure it out now

If you submit a paper late, your mark for that paper will be reduced by a simple sliding scale

- As of **09:00:00** an 8% discount, scaling the mark for that paper by 92%
- Thereafter an additional 4% per hour that the paper is late, so that a paper that is just over an hour late will be subject to a 12% discount, scaling the mark for that paper by 88%
- As a result, a paper that is one day, twenty-four hours, late will earn a zero mark

15.965 Technology Strategy for System Design and Management

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