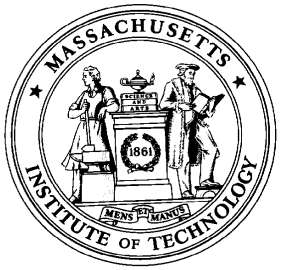
Mapping the Telecom Value Chain: A Roadmap for Communications Networks

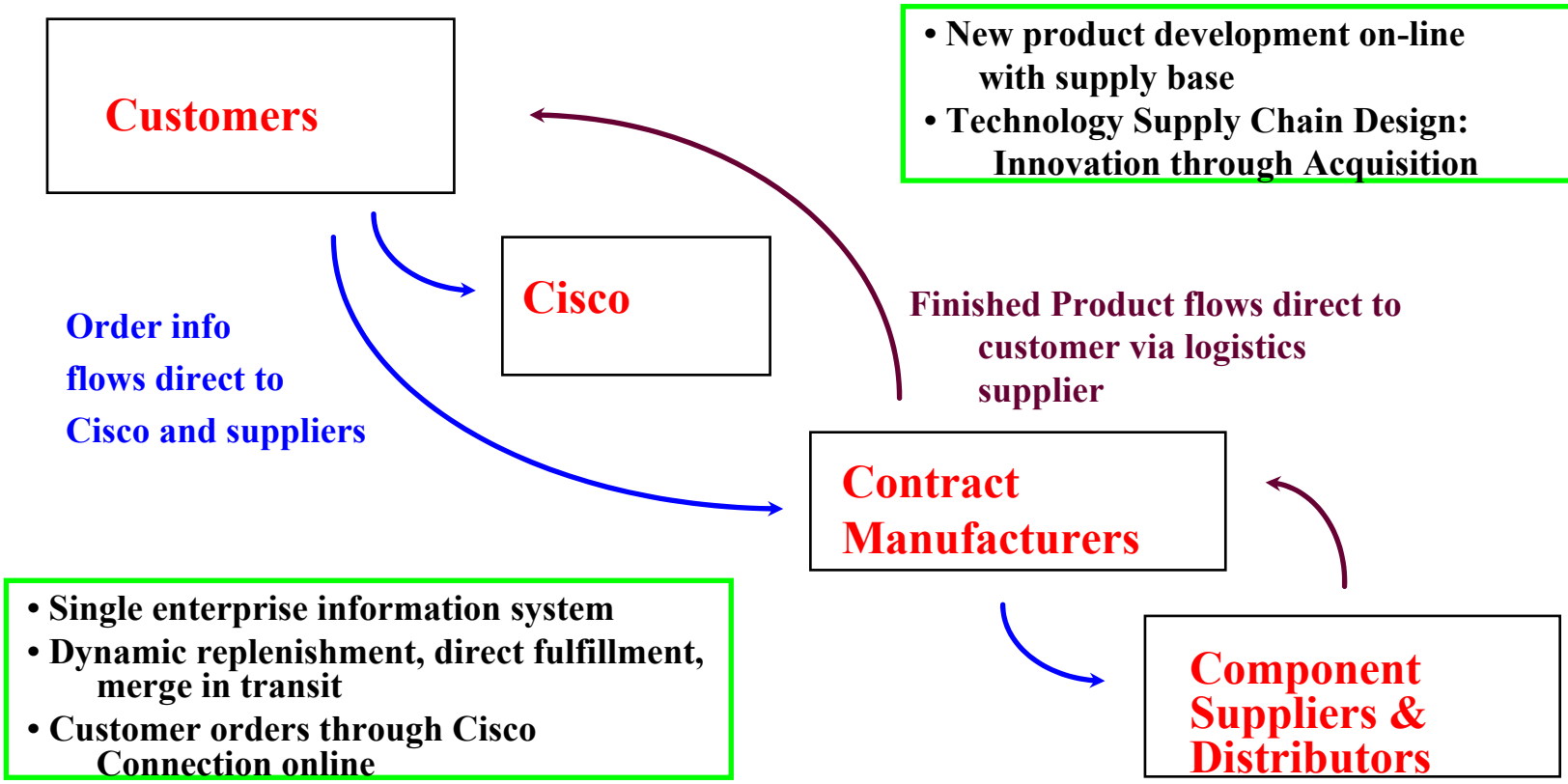


Massachusetts Institute of Technology
Sloan School of Management

Strategic Business System Design And Technology Roadmapping

1. Fruit Flies & Temporary Advantage
2. Supply Chain Design & 3-DCE
3. eBusiness Phenomena:
   Business Model Innovation
4. Technology Roadmapping:
   A telecom example

Cisco's End-to-End Integration for its Fulfillment Supply Chain



Basic Design Principle: Arm's length Relationship with Fulfillment Chain Partners

Value Chain Design in a Fast-Clockspeed World: Study the Industry Fruitflies

Evolution in the natural world:

FRUITFLIES
evolve faster than
MAMMALS
evolve faster than
REPTILES

THE KEY TOOL:

Cross-SPECIES Benchmarking of Dynamic Forces

Evolution in the industrial world:

INFOTAINMENT is faster than
MICROCHIPS is faster than
AUTOS evolve faster than
AIRCRAFT evolve faster than
MINERAL EXTRACTION

THE KEY TOOL:

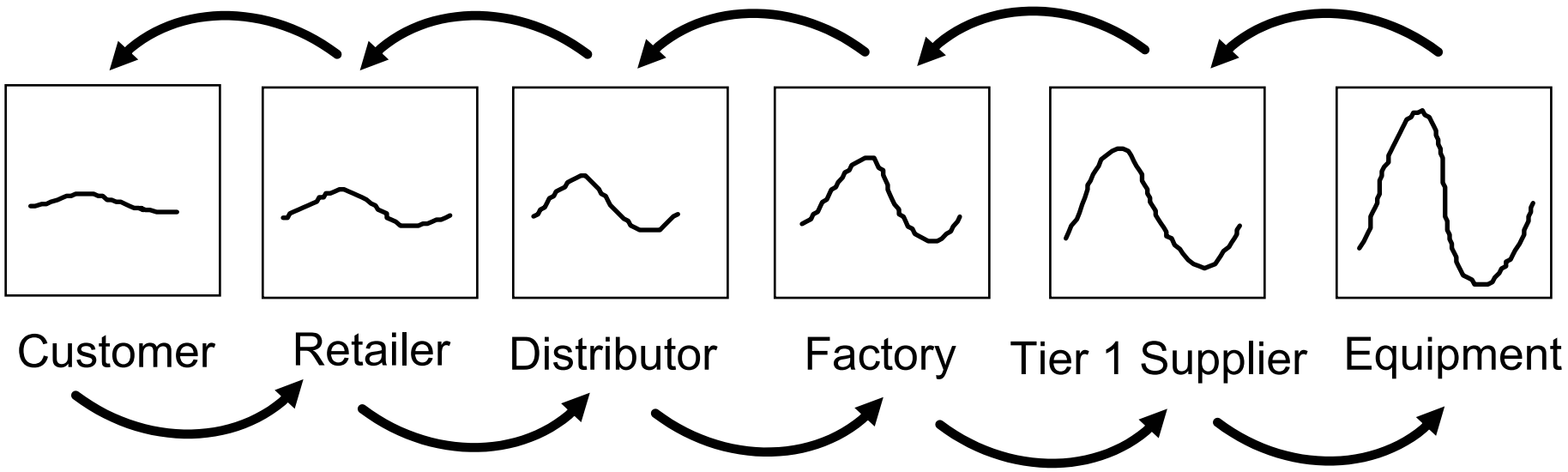
Cross-INDUSTRY Benchmarking of Dynamic Forces

Cisco's Strategy for Technology Supply Chain Design

1. Integrate technology around the router to be a communications network provider.
2. Leverage acquired technology with
   - sales muscle and reach
   - end-to-end IT
   - outsourced manufacturing
   - market growth
3. Leverage venture capital to supply R&D

Basic Design Principle: Acquisition Relationship with Technology Chain Partners

Volatility Amplification in the Supply Chain:
"The Bullwhip Effect"



Information lags
Delivery lags
Over- and underordering
Misperceptions of feedback
Lumpiness in ordering
Chain accumulations

SOLUTIONS:
Countercyclical Markets
Countercyclical Technologies
Collaborative channel mgmt.
(Cincinnati Milacron & Boeing)

Supply Chain Volatility Amplification: Machine Tools at the tip of the Bullwhip

- - -

“We are experiencing a 100-year flood.” J. Chambers, 4/16/01

"Upstream Volatility in the Supply Chain: The Machine Tool Industry as a Case Study," E. Anderson, C. Fine & G. Parker *Production and Operations Management,* Vol. 9, No. 3, Fall 2000, pp. 239-261.

LESSONS FROM A FRUIT FLY:
CISCO SYSTEMS

1. KNOW YOUR LOCATION IN THE VALUE CHAIN
2. UNDERSTAND THE DYNAMICS OF VALUE CHAIN FLUCTUATIONS
3. THINK CAREFULLY ABOUT THE ROLE OF VERTICAL COLLABORATIVE RELATIONSHIPS
4. INFORMATION AND LOGISTICS SPEED DO NOT REPEAL BUSINESS CYCLES OR THE BULLWHIP.

INDUSTRY CLOCKSPEED IS A COMPOSITE:
OF PRODUCT, PROCESS, AND ORGANIZATIONAL CLOCKSPEEDS

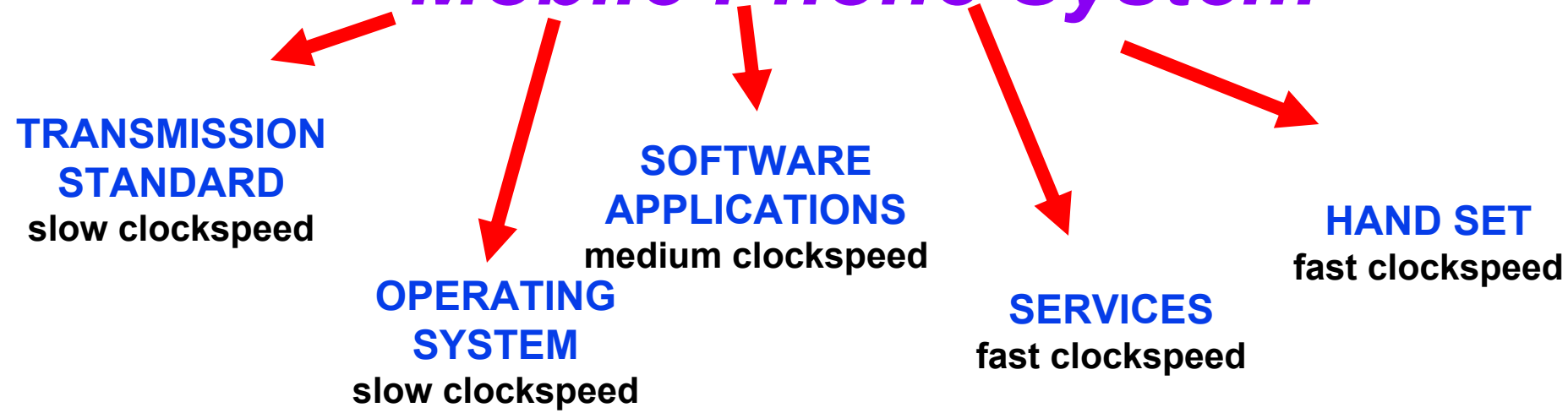
Mobile Phone INDUSTRY CLOCKSPEED

THE *Mobile Phone*
product technology

THE *Mobile Phone* PRODUCTION PROCESS
process technology

THE *Mobile Phone* MANUFACTURING COMPANY
organization

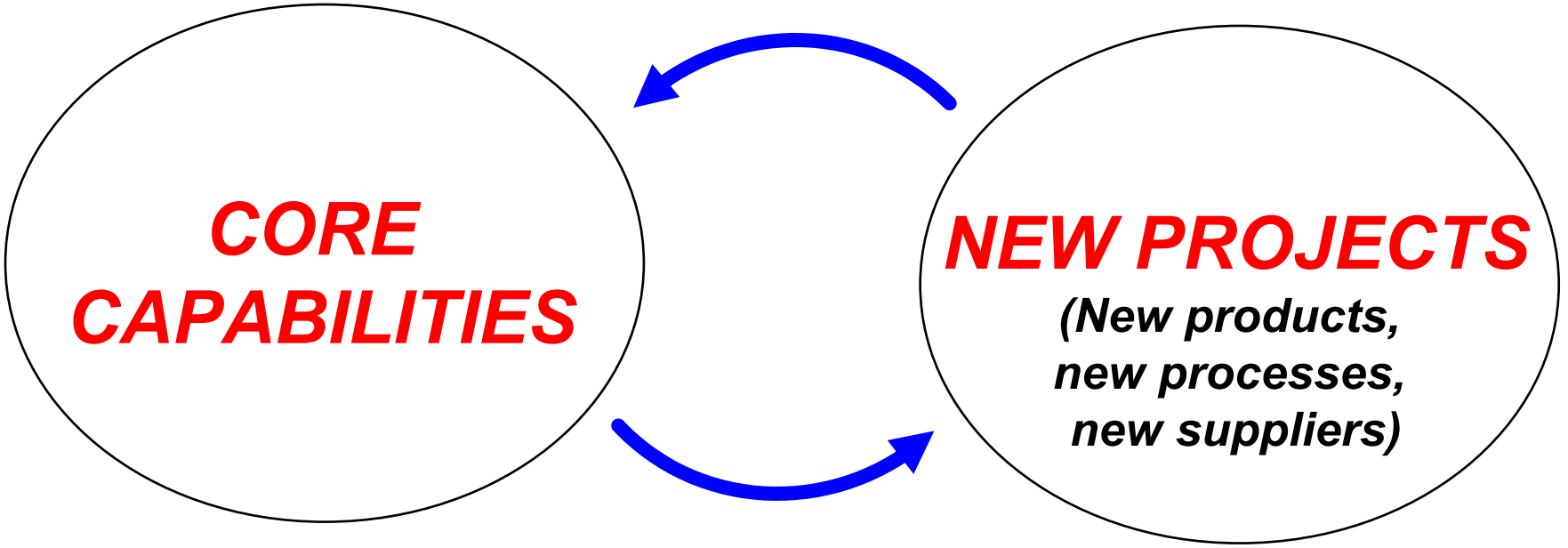
Mobile Phone System CLOCKSPEED is a mix of Transmission Standards, Software and Handsets



ISSUE: THE FIRMS THAT ARE FORCED TO RUN AT THE FASTEST CLOCKSPEED ARE THE MOST LIKELY TO STAY AHEAD OF THE GAME.

Clockspeed drives *Business Strategy Cadence*

Dynamics between New Projects and Core Capability Development: PROJECTS MUST MAKE MONEY AND BUILD CAPABILITIES

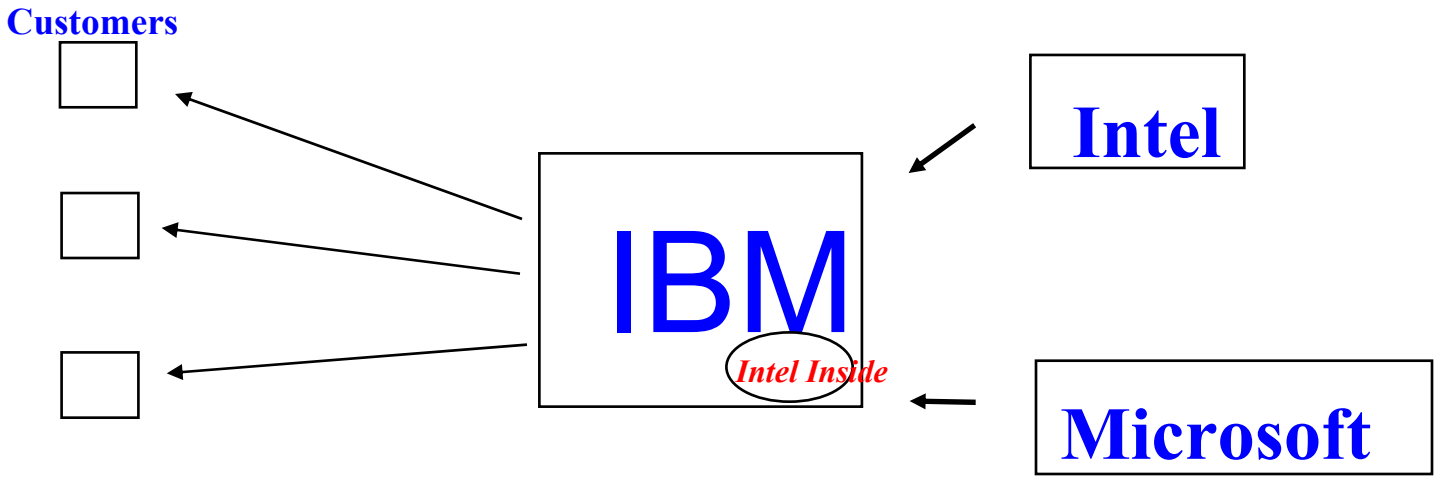


See Leonard-Barton, D. *Wellsprings of Knowledge*

The Strategic Leverage of Value Chain Design:

Who let Intel Inside?

1980: IBM designs a product, a process, & a value chain



The Outcome:

A phenomenonally successful product design

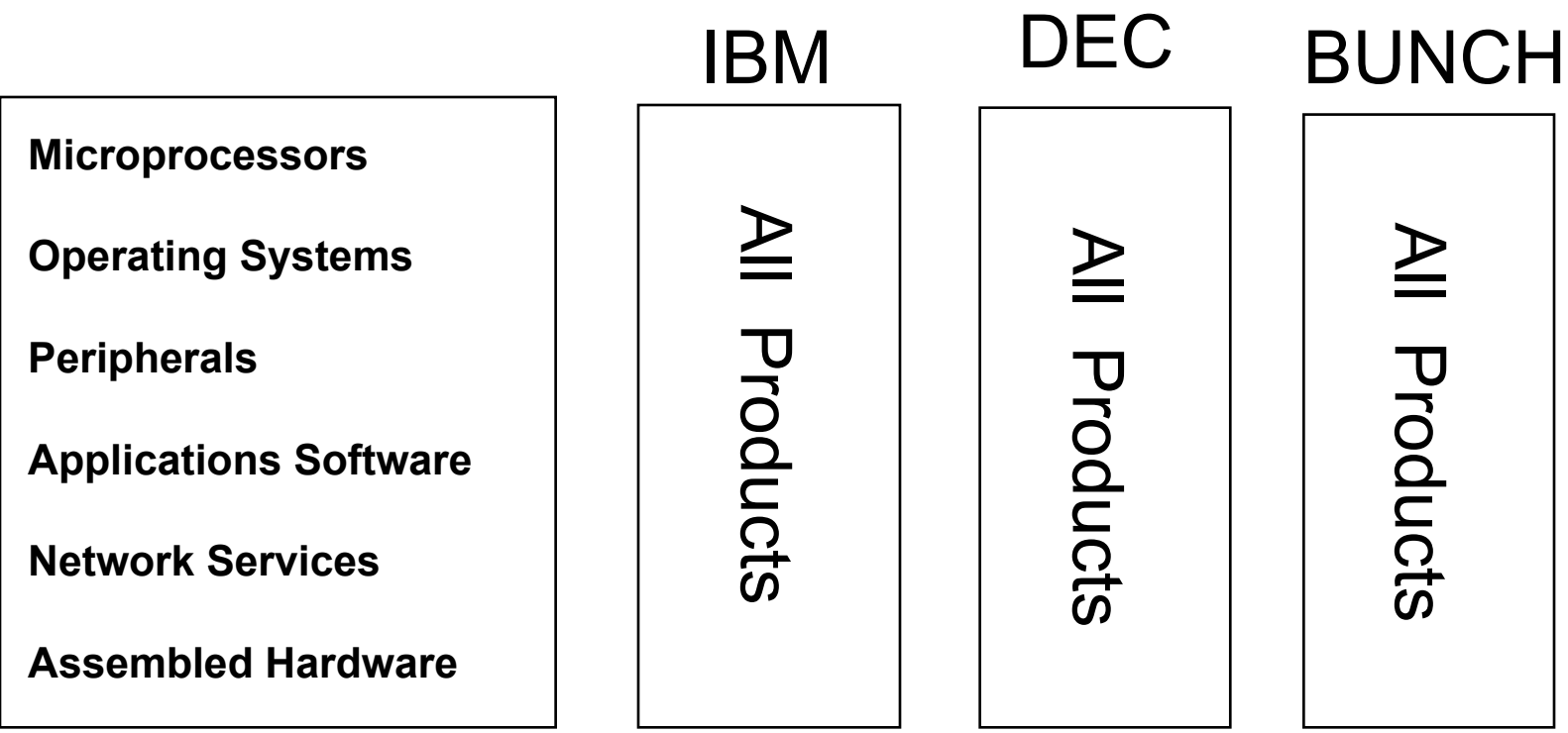
A disastrous value chain design (for IBM)

LESSONS FROM A FRUIT FLY:
THE PERSONAL COMPUTER

1. BEWARE OF *INTEL INSIDE*
   (Regardless of your industry)
2. MAKE/BUY IS **NOT** ABOUT WHETHER IT IS
   TWO CENTS CHEAPER TO OUTSOURCE
3. VALUE CHAIN DESIGN CAN DETERMINE
   THE FATE OF COMPANIES AND INDUSTRIES,
   AND OF PROFIT AND POWER
4. THE LOCUS OF VALUE CHAIN CONTROL
   CAN SHIFT IN UNPREDICTABLE WAYS

Vertical Industry Structure with *Integral* Product Architecture

Computer Industry Structure, 1975-85



(See A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

Horizontal Industry Structure with *Modular* Product Architecture

Computer Industry Structure, 1985-95

Microprocessors	Intel	**Moto**	**AMD**	etc
Operating Systems	Microsoft	Mac	Unix	
Peripherals	HP	Epson	Seagate	etc etc
Applications Software	Microsoft	Lotus	Novell	etc
Network Services	AOL/Netscape	Microsoft	EDS	etc
Assembled Hardware	HP	Compaq	IBM	Dell etc

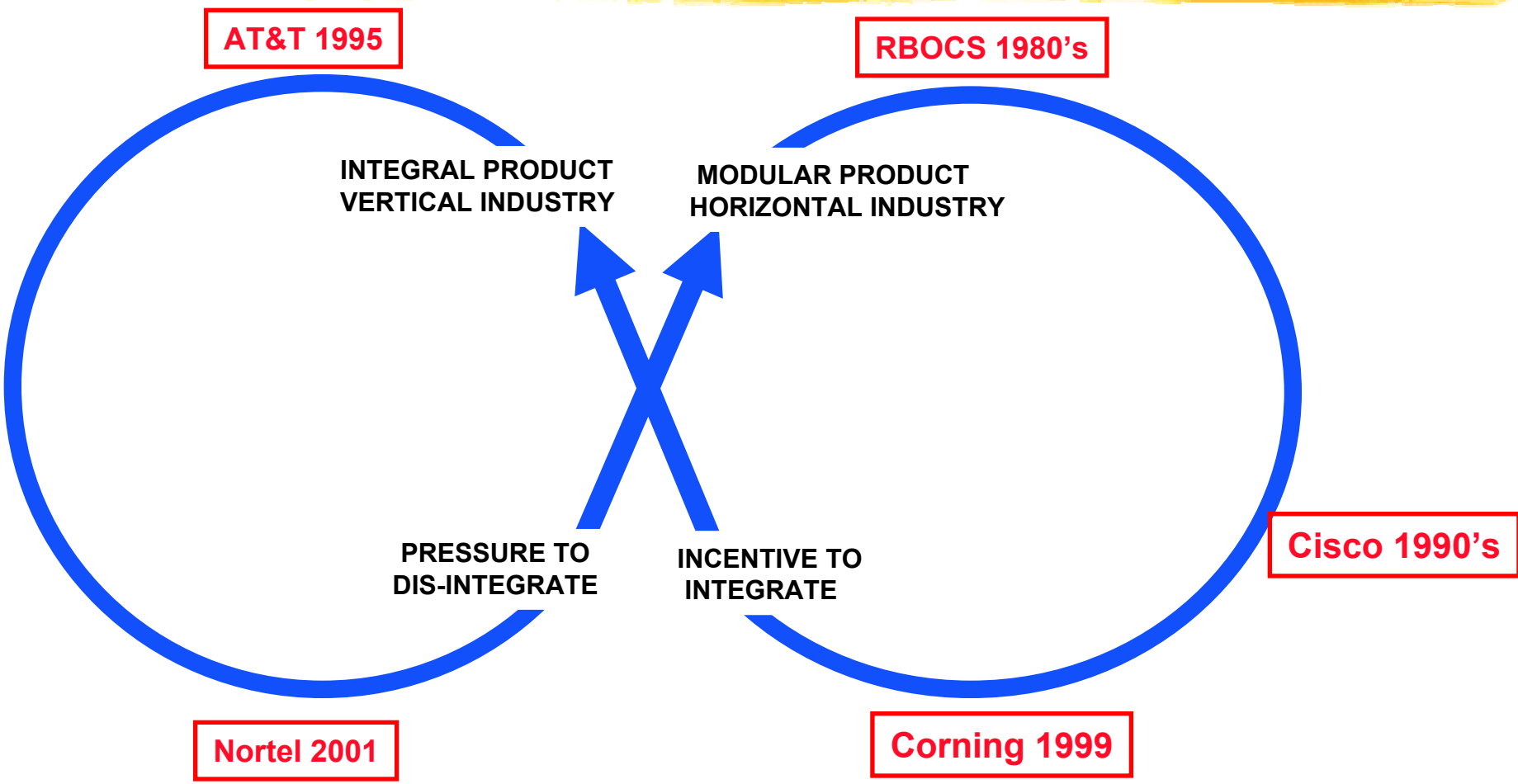
(See A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

THE DYNAMICS OF PRODUCT ARCHITECTURE AND VALUE CHAIN STRUCTURE:

THE DOUBLE HELIX

See Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

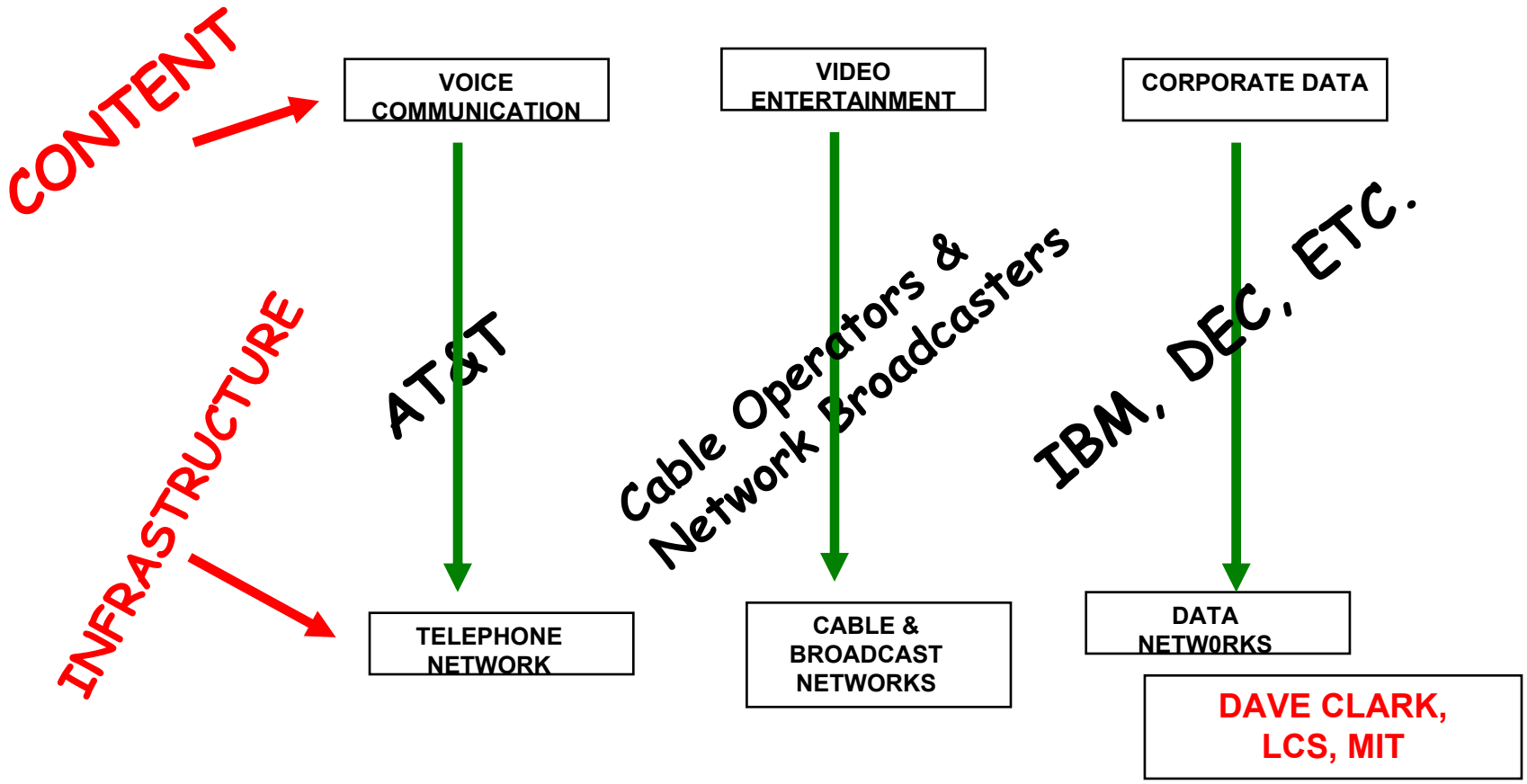
Double Helix Model Applied to the Optical Value Chain



THE *DOUBLE HELIX* IN OTHER INDUSTRIES

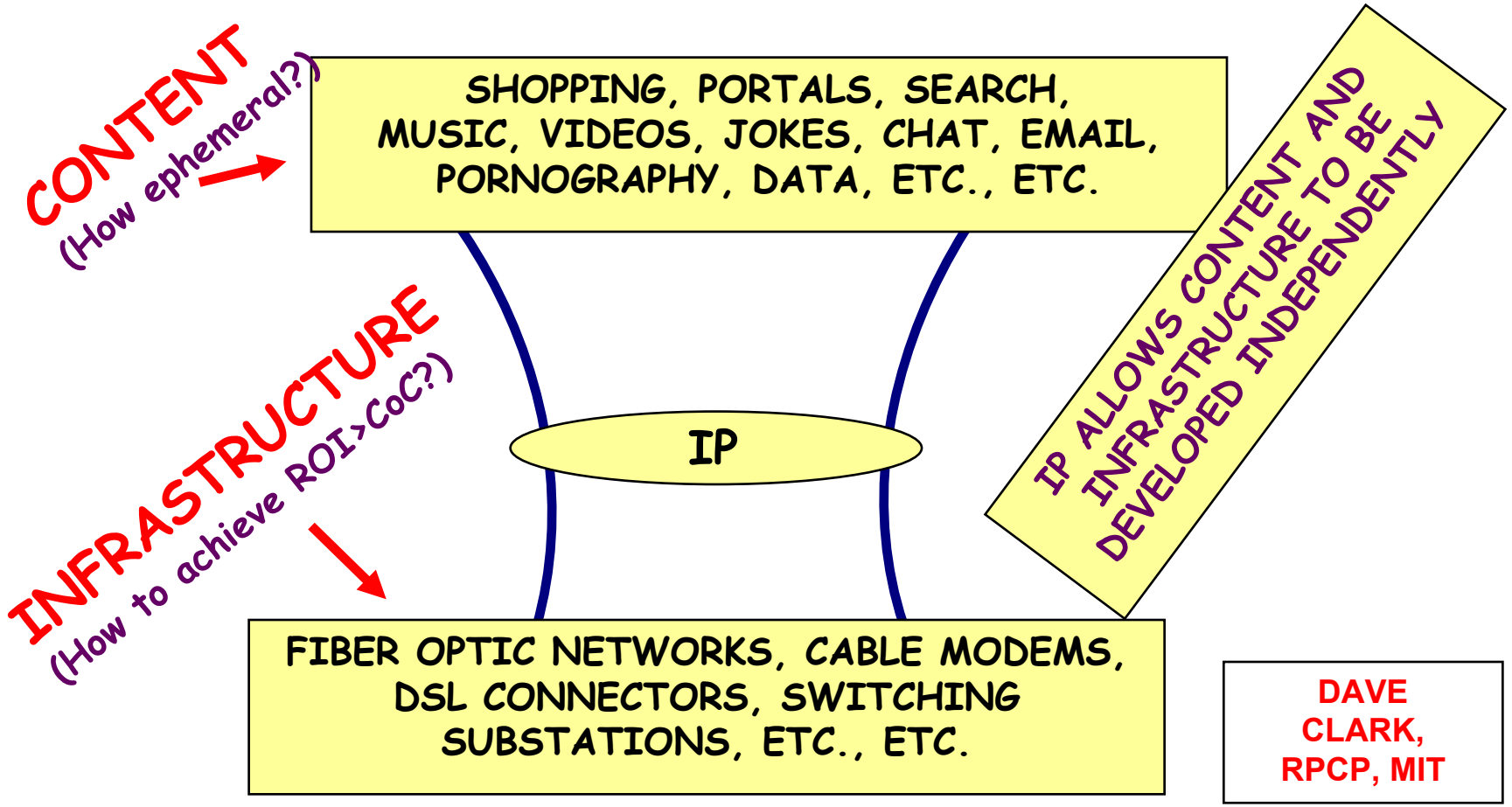
- ***TELECOMMUNICATIONS--***
  - **"MA BELL" was Vertical /Integral**
  - **BABY BELLS & LONG LINES & CELLULAR are Horizontal/Modular**
  - **Today's Verizon is going back to Vertical /Integral**
- ***AUTOMOTIVE--***
  - **Detroit in the 1890's was Horizontal/Modular**
  - **Ford & GM in the mid 1900's were Vertical /Integral**
  - **Today's Auto Industry is going back to Horizontal/Modular**
- ***TELEVISION--***
  - **RCA was Vertical /Integral**
  - **1970'S THROUGH 1990'S were Horizontal/Modular**
  - **Today's media giants are going back to Vertical /Integral**
- ***BICYCLES--***
  - **Safety Bikes to 1890's boom to Schwinn to *Shimano Inside***

TELECOMS: IN THE BEGINNING,
THERE WAS VERTICAL INTEGRATION AND MARKET POWER



IP BEGAT CONVERGENCE & LOSS OF MARKET POWER

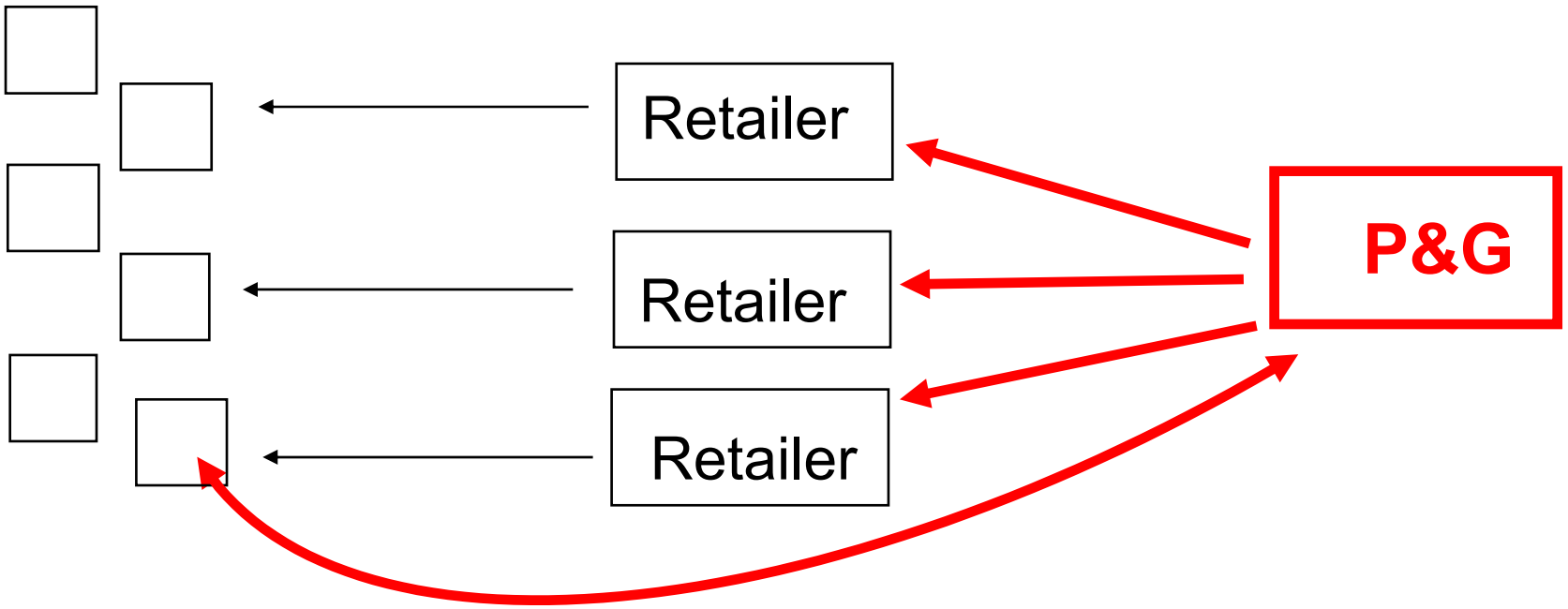
THE HOURGLASS



Controlling the Chain Through Distribution:

The End of *P&G Inside* ?

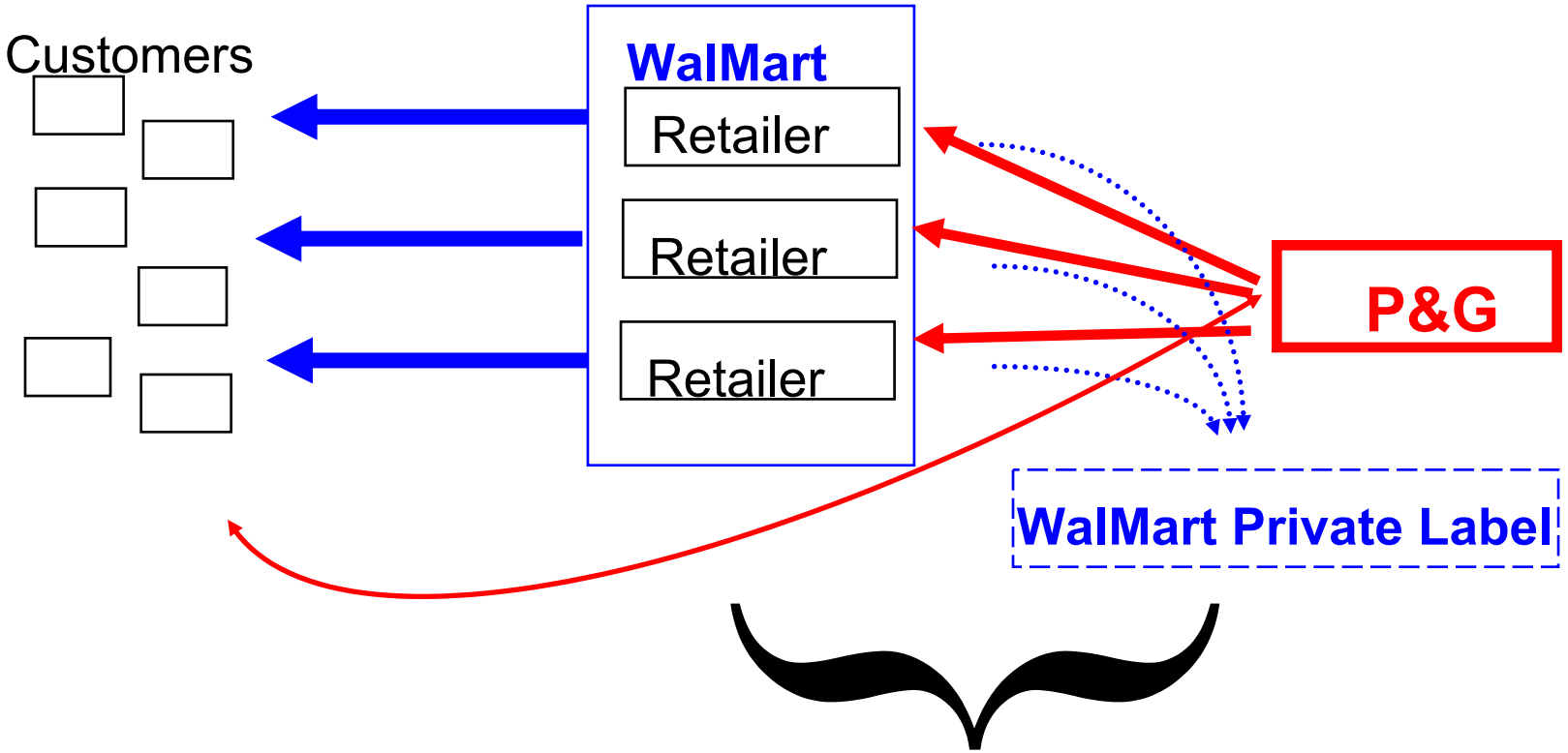
- *Controlling the Channel Through Closeness to Customers:*
- *consumer research, pricing, promotion, product development*



Controlling the Chain Through Distribution:

Beware of *Walmart Outside*

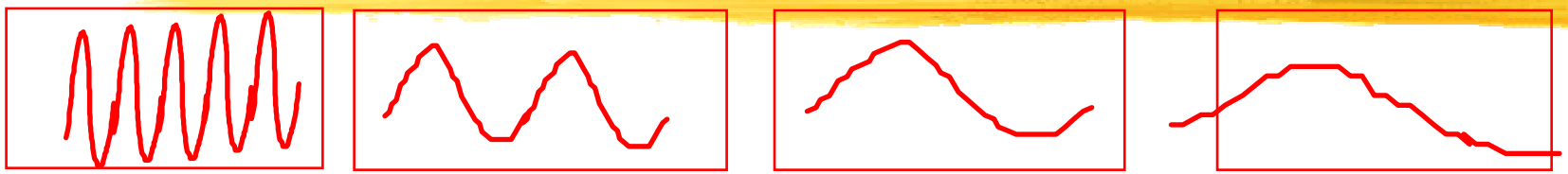
Controlling the Channel Through Closeness to Customers: Chain Proximity



Vertical Growth on the Double Helix

Clockspeed Amplification in *"The Speedup Effect"*

Appendix Value Chain Analysis



Phone & Internet Consumer

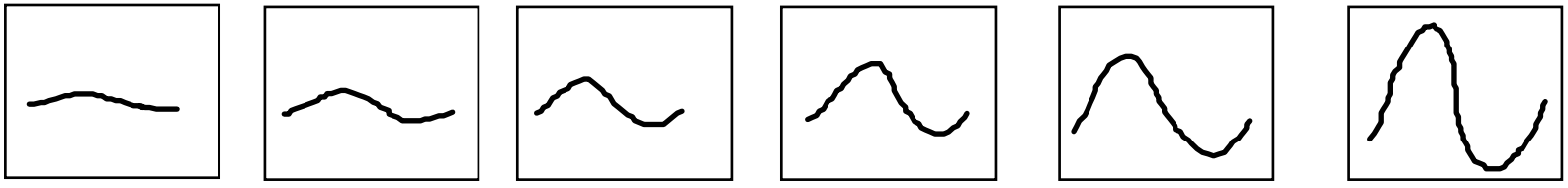
Service Provider (AOL, ATT)

Equipment Maker

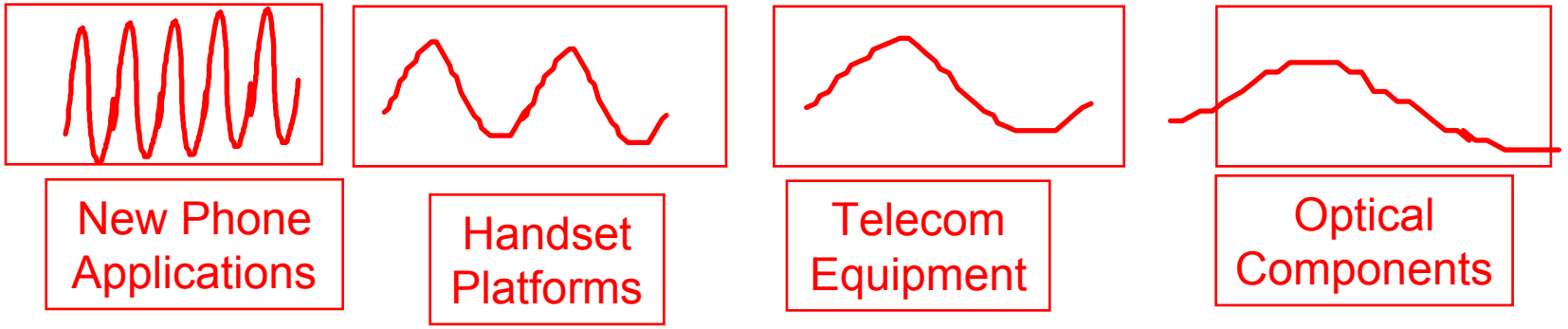
Component Maker

Hypothesis:Clockspeeds accelerate as you head downstream, closer to the final customer

Volatility Amplification in *"The Bullwhip Effect" and* Clockspeed Amplification in *"The Speedup Effect"*

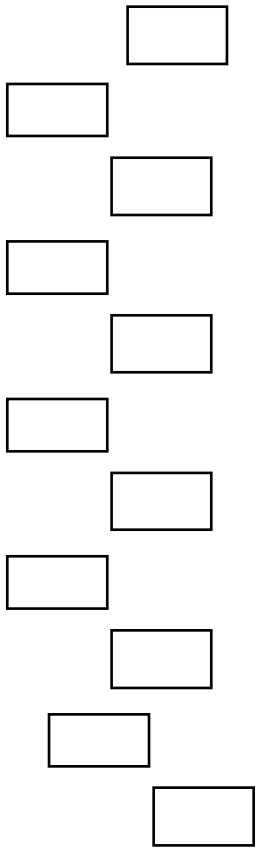


Inventories & Orders fluctuate more as you look upstream, tough on suppliers, but



Clockspeeds accelerate as you head downstream, closer to the final customer

Media Supply Chains: An Industry at *Lightspeed*



Customers

The box

- Wired Phone
- Wireless phone
- PC/laptop
- PDA
- Television
- VCR
- Pager

The Pipe
(Access, Metro, Backbone)

- Land-basedTelco:
  - -copper POTS
  - -fiber
  - -DSL
- Cable Networks
- Wireless:
  - -broadcast TV
  - -CDMA, TDMA, GSM
  - -satellite/microwave
- Retail Outlets
  - -Borders:
  - -Blockbuster
  - -Seven-Eleven
- Delivery (e.g., Fedex)

The Content

- Video/Audio:
  - Movies & Art & News & Sports
- News/articles/books (newspapers & magazines)
- Communication: voice & video & email
- Banking
- Education
- Shopping
- Internet, *et al*

ALL COMPETITIVE ADVANTAGE IS TEMPORARY

Autos:

Ford **in 1920,** ***GM*** **in 1955,** ***Toyota*** **in 1990**

Computing:

IBM **in 1970,** ***DEC*** **in 1980,** ***Wintel*** **in 1990**

World Dominion:

Greece **in 500 BC,** ***Rome*** **in 100AD,** ***G.B.*** **in 1800**

Sports:

Bruins **in 1971,** ***Celtics*** **in 1986,** ***Yankees*** **no end**

The faster the clockspeed, the shorter the reign

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4. Telecom Value Chains:
   A fruit fly example

VALUE CHAIN DESIGN:
Three Components

1. Insourcing/OutSourcing

(The Make/Buy or Vertical Integration Decision)

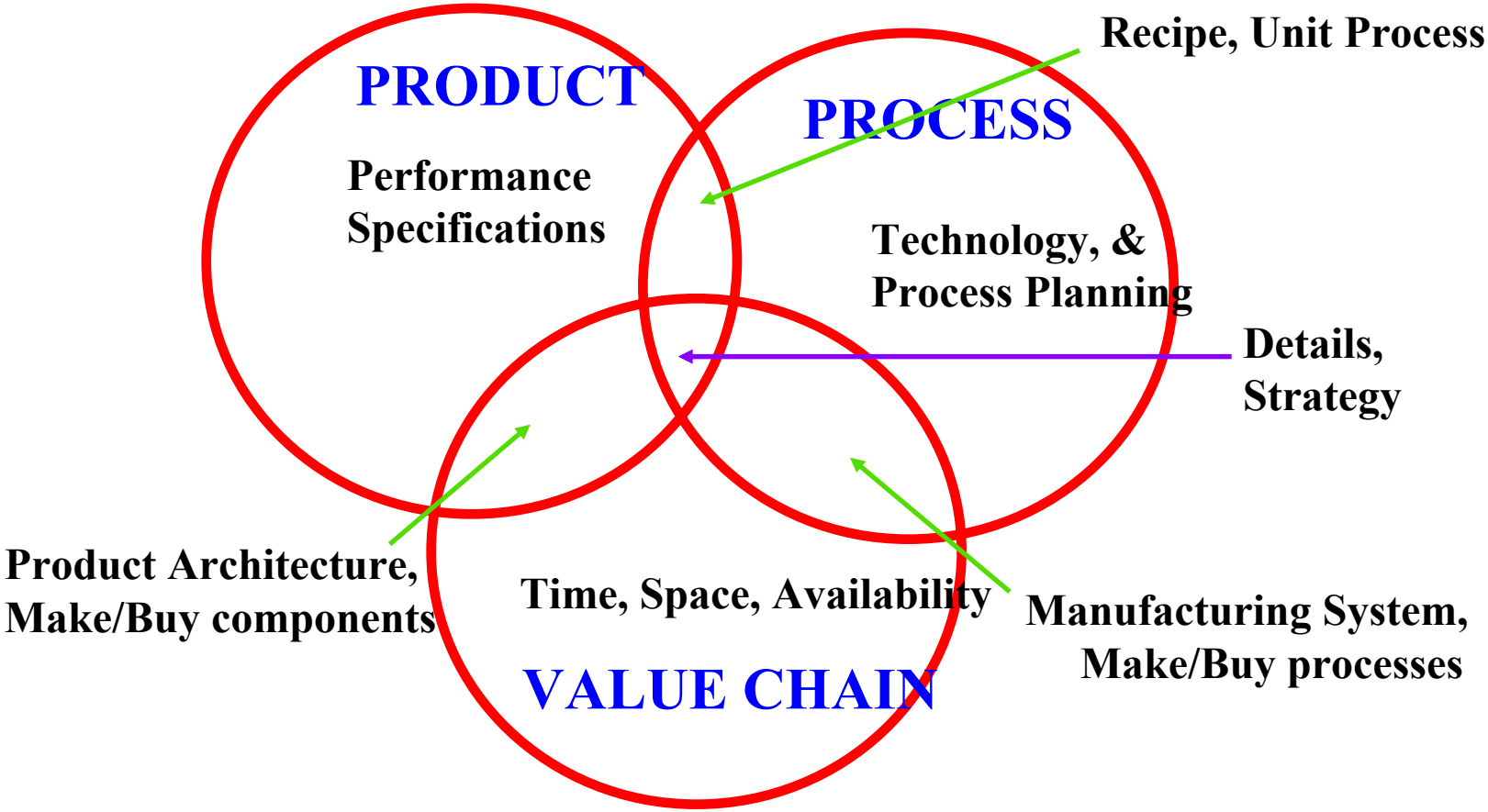
2. Partner Selection

(Choice of suppliers and partners for the chain)

3. The Contractual Relationship

(Arm's length, joint venture, long-term contract, strategic alliance, equity participation, etc.)

IMPLEMENTATION OF VALUE CHAIN DESIGN: EMBED IT IN 3-D CONCURRENT ENGINEERING



ARCHITECTURES IN 3-D
INTEGRALITY VS. *MODULARITY*

Integral product architectures **feature close coupling among the elements**

- **Elements perform many functions**
- **Elements are in close spacial proximity**
- **Elements are tightly synchronized**

- **Ex: jet engine, airplane wing, microprocessor**

Modular product architectures **feature separation among the elements**

- **Elements are interchangeable**
- **Elements are individually upgradeable**
- **Element interfaces are standardized**
- **System failures can be localized**

- **Ex: stereo system, desktop PC, bicycle**

VALUE CHAIN ARCHITECTURE

Integral value-chain architecture
features close proximity among its elements
- Proximity metrics: Geographic, Organizational
Cultural, Electronic
- Example: Toyota city
- Example: Ma Bell (AT&T in New Jersey)
- Example: IBM mainframes & Hudson River Valley

Modular value-chain architecture features multiple,
interchangeable supplier and standard interfaces
- Example: Garment industry
- Example: PC industry
- Example: General Motors' global sourcing
- Example: Telephones and telephone service

DESIGNING ARCHITECTURES FOR PRODUCTS & VALUE CHAINS: THE NEED FOR ALIGNMENT

VALUE CHAIN ARCHITECTURE

(Geog., Organ., Cultural, Elec.)

PRODUCT ARCHITECTURE	INTEGRAL	MODULAR
INTEGRAL	Jet engines Microprocessors Mercedes vehicles	Polaroid Lucent, Nortel
MODULAR	Automotive Supplier Parks	Personal Computers Bicycles Chrysler Vehicles Cisco

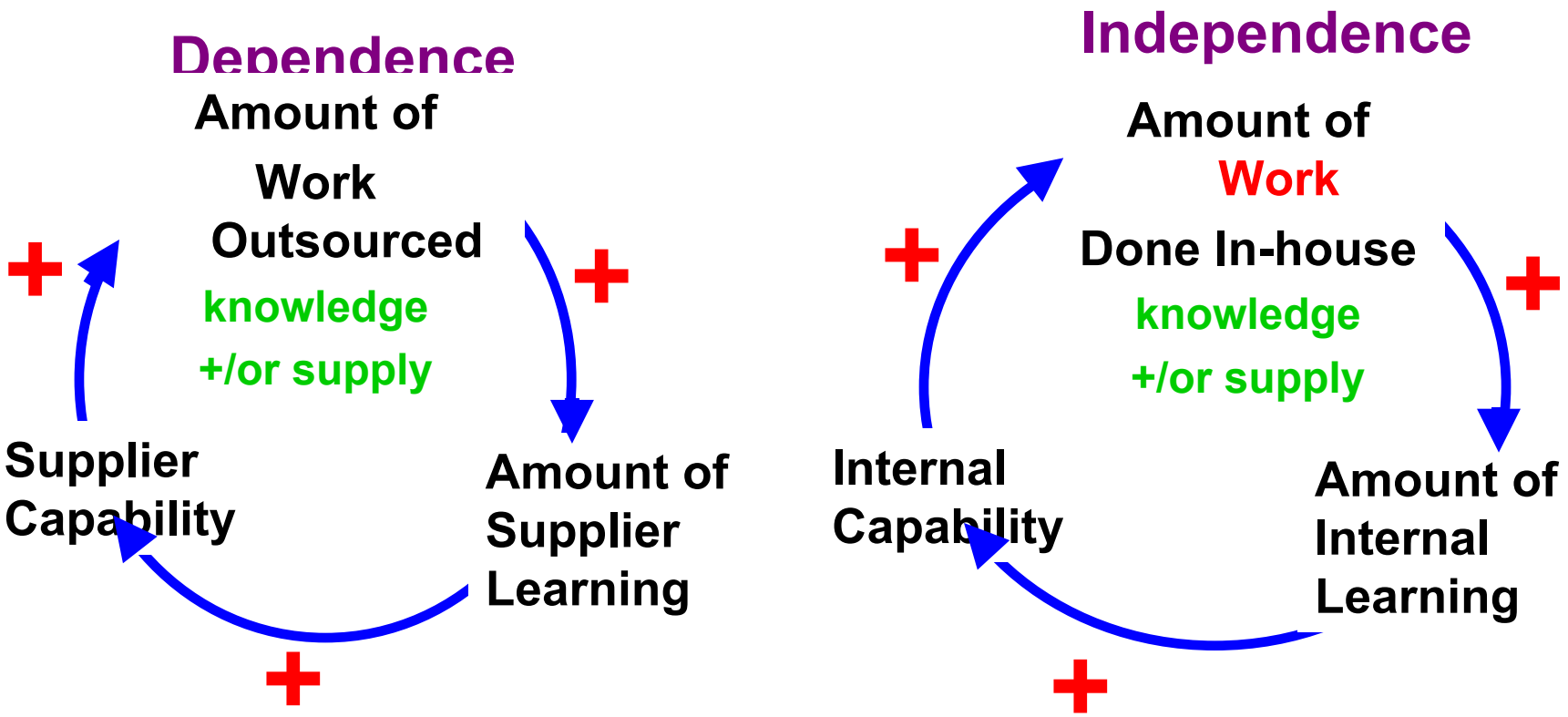
DESIGNING ARCHITECTURES FOR PRODUCTS & VALUE CHAINS: MODULARITY VS. OPENNESS

ARCHITECTURAL STRUCTURE \ ARCHITECTURAL PROPRIETARINESS	CLOSED	OPEN
INTEGRAL	Pentium Chip Mercedes Vehicles SAP ERP	Linux
MODULAR	IBM Mainframes Microsoft *Windows* Chrysler Vehicles	Palm Pilot software & accessories Phones & service Web-based ERP

INFORMATION ARCHITECTURE MUST REFLECT BUSINESS MODEL

In/Outsourcing: Sowing the Seeds of Competence Development to develop

dependence for knowledge or dependence for capacity



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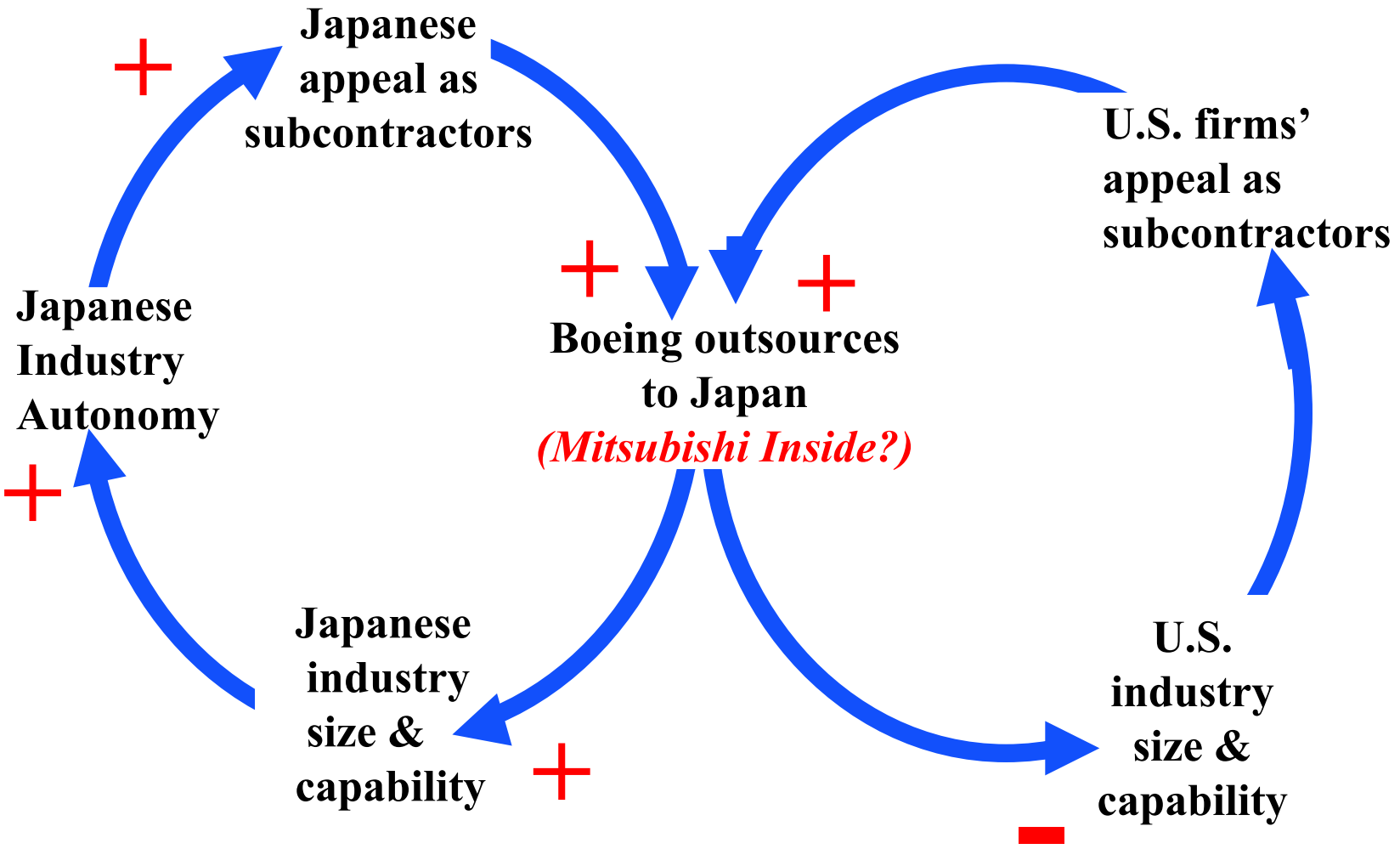
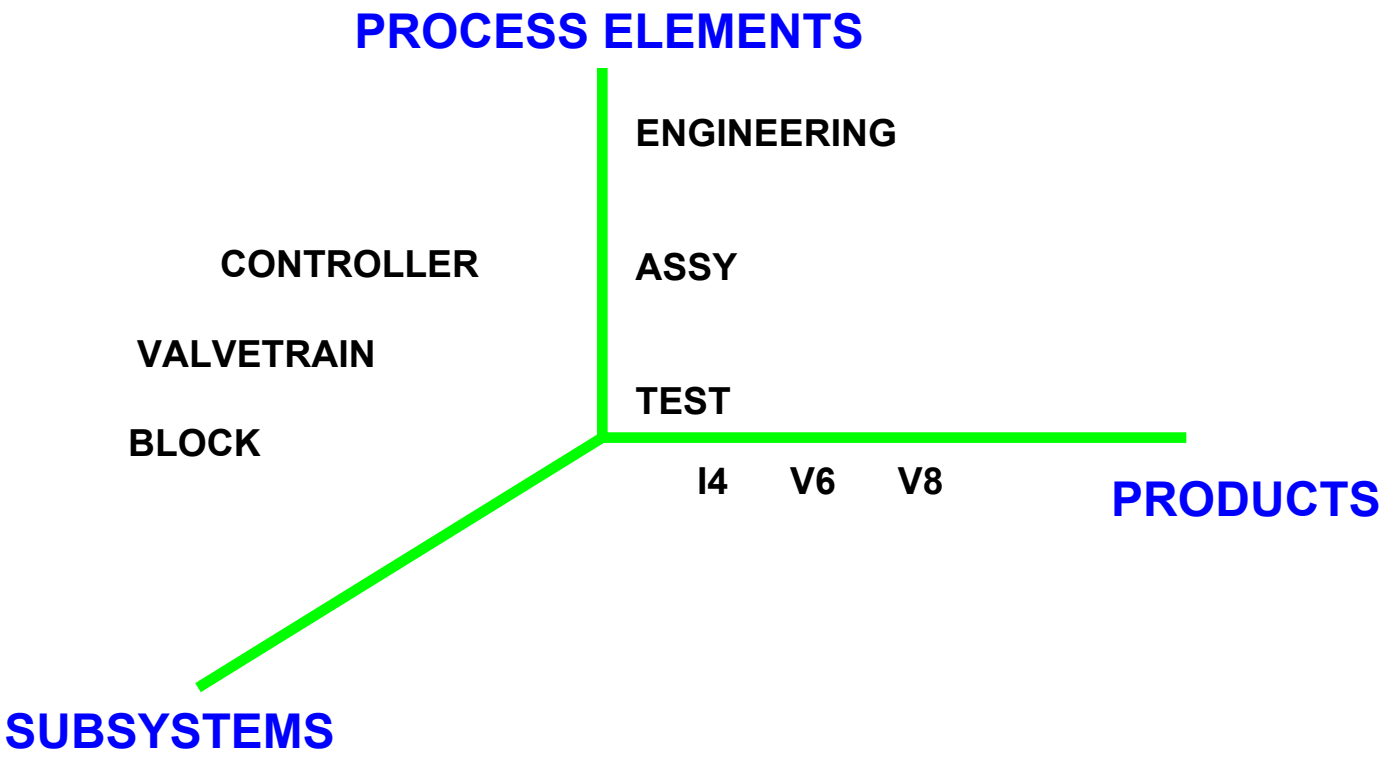
Technology Dynamics in the Aircraft Industry:

LEARNING FROM THE DINOSAURS



SOURCEABLE ELEMENTS

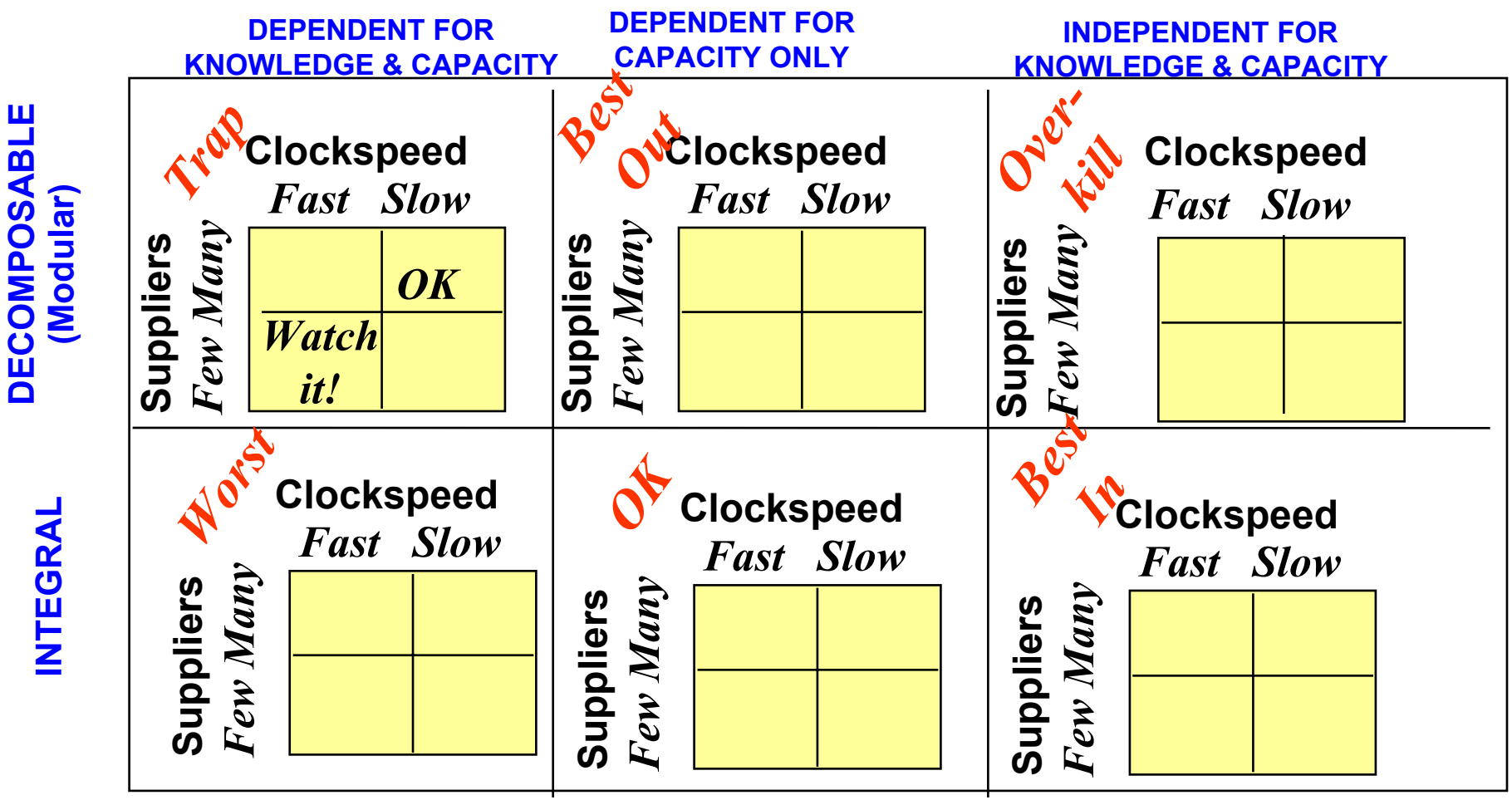


Strategic Make/Buy Decisions: Assess Critical Knowledge & Product Architecture

ITEM IS INTEGRAL ITEM IS MODULAR	DEPENDENT FOR KNOWLEDGE & CAPACITY	INDEPENDENT FOR KNOWLEDGE & DEPENDENT FOR CAPACITY	INDEPENDENT FOR KNOWLEDGE & CAPACITY
	A POTENTIAL OUTSOURCING TRAP	BEST OUTSOURCING OPPORTUNITY	OVERKILL IN VERTICAL INTEGRATION
	WORST OUTSOURCING SITUATION	CAN LIVE WITH OUTSOURCING	BEST INSOURCING SITUATION

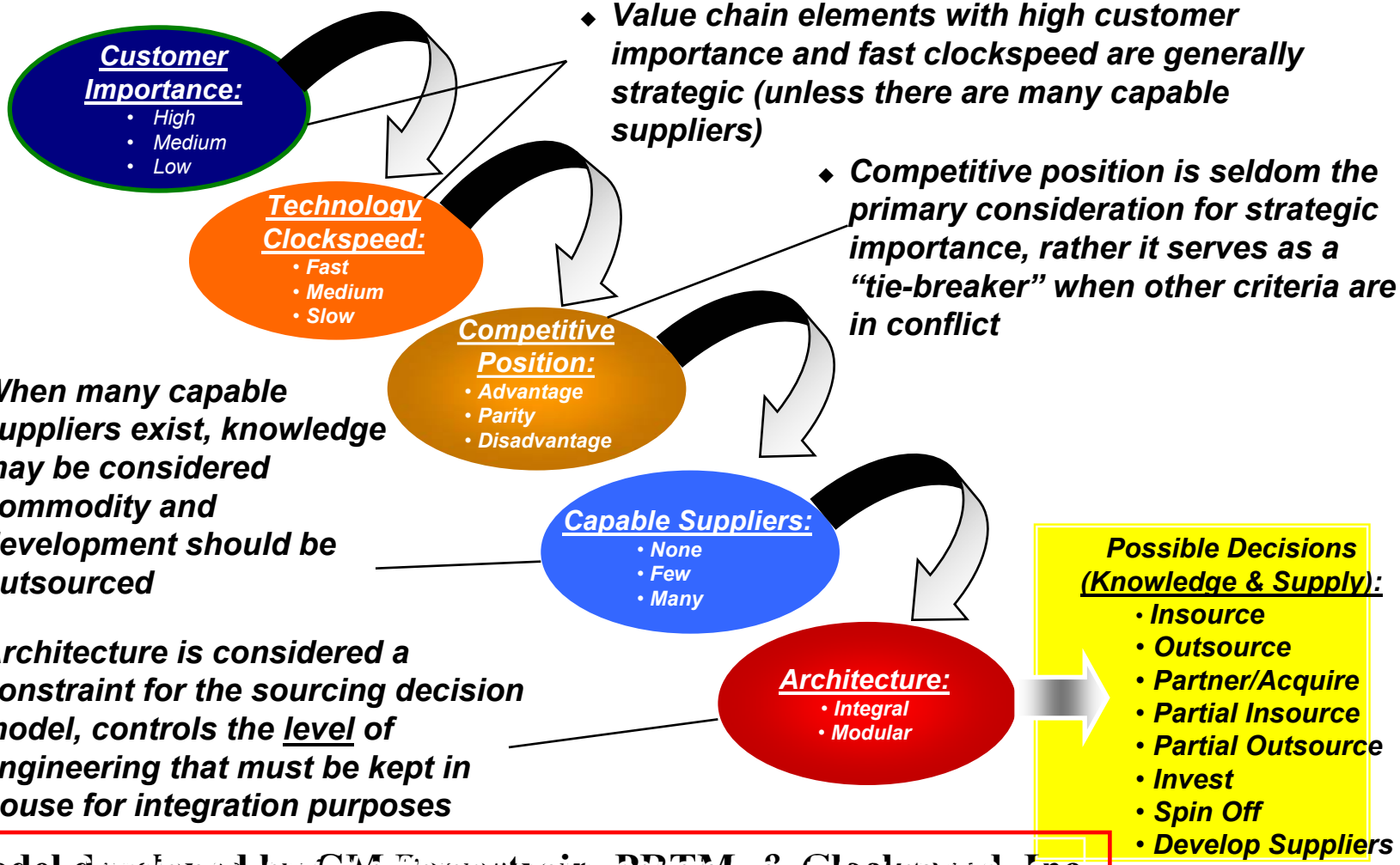
Adapted from Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

Strategic Make/Buy Decisions: Also consider Clockspeed & Supply Base Capability



Adapted from C. Fine, *Clockspeed*, Chap. 9

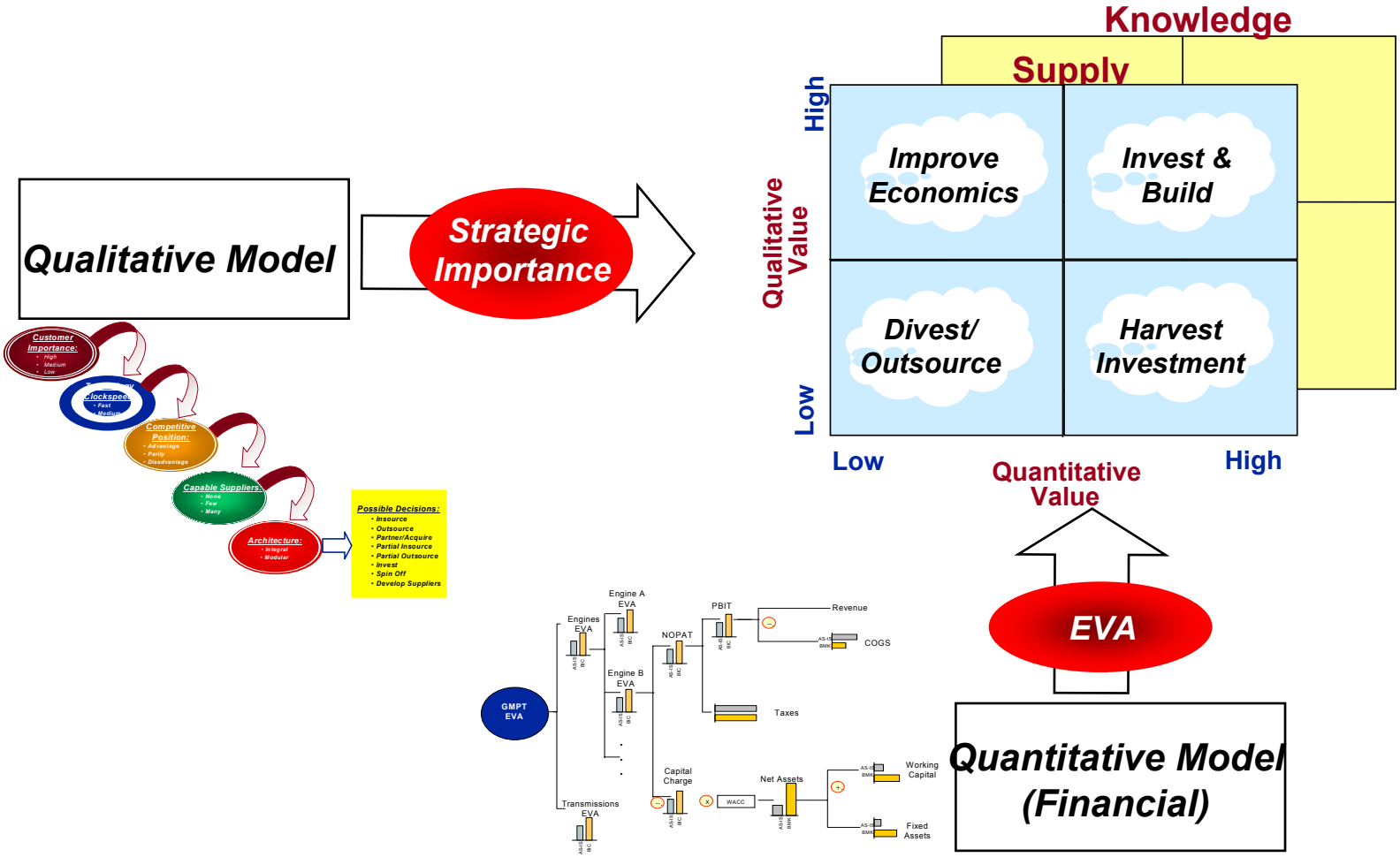
Qualitative analysis of strategic importance uses five key criteria



- *Value chain elements with high customer importance and fast clockspeed are generally strategic (unless there are many capable suppliers)*
- *Competitive position is seldom the primary consideration for strategic importance, rather it serves as a "tie-breaker" when other criteria are in conflict*
- *When many capable suppliers exist, knowledge may be considered commodity and development should be outsourced*
- *Architecture is considered a constraint for the sourcing decision model, controls the level of engineering that must be kept in house for integration purposes*

Model developed by GM Powertrain, PRTM, & Clockspeed, Inc.

Every decision requires qualitative and quantitative analysis to reach a conclusion



Model developed by GM Powertrain, PRTM, & Clockspeed, Inc.

Value Chain Mapping

Organizational Supply Chain

Chrysler	Eaton	casting supplier	clay supplier

Technology Supply Chain

engines	valve lifters	casting manufacturing process	clay chemistry

Capability Chain

Supply Chain Management	Quality assurance	NVH engineering	R&D

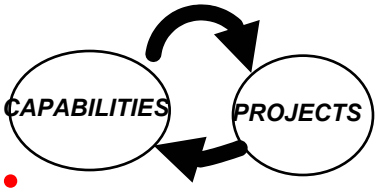
Underlying Assumption: You have to draw the maps before you can assess their dynamics.

VALUE CHAIN DESIGN IS *THE ULTIMATE* CORE COMPETENCY

Since all advantages are temporary,
the only lasting competency is to continuously build and assemble capabilities chains.

KEY SUB-COMPETENCIES:

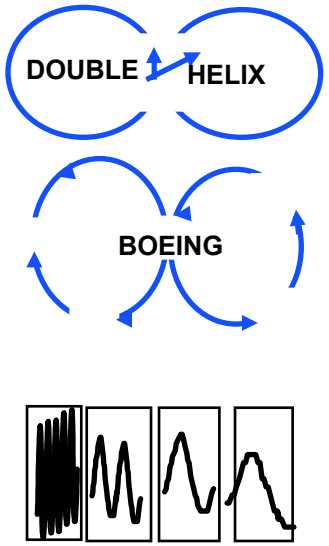
1. **Forecasting the dynamic evolution of market power and market opportunities**
2. **Anticipating Windows of Opportunity**
3. **3-D Concurrent Engineering: Product, Process, Value Chain**

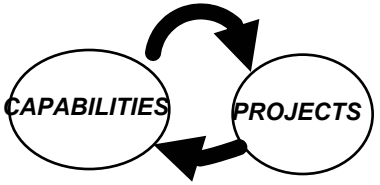


Fortune Favors the Prepared Firm

PROCESS FOR VALUE CHAIN DESIGN

1. Benchmark the Fruit Flies
2. Map your Supply Chain
   - -Organizational Value Chain
   - -Technology Value Chain
   - -Competence Chain
3. Dynamic Chain Analysis
   at each node of each chain map
4. Identify Windows of Opportunity
5. Exploit Competency Development Dynamics
   with 3-D Concurrent Engineering





STRATEGY IN 3-D: CASE EXAMPLES

Boeing: Static 3-D in airplane Projects
Dynamic, Strategic Value Chain, unintegrated w/ Product & Process

Intel: Modular Product vs. Process
Integral Process and Value Chain

Chrysler: Modular Product & Value Chain
(weak on process?)

Toyota: Integral 3-D in Nagoya
(weak on global 3-D?)

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Internet Era Phenomena:

eCompetition in Business Model Innovation

Benchmarking the eFlies

E-tailing:

Attack:

Amazon, Webvan Market disruption in hopes of making a place

Defend:

Walmart.com, Ford.com Defense can require costly SC revamping

B2B:

E2E integration:

Cisco, Dell Integration pays off with modular products

Marketplace Creation:

Freemarkets Reverse auctions reduce short term costs

Covisint Common standards reduced supplier investment cost

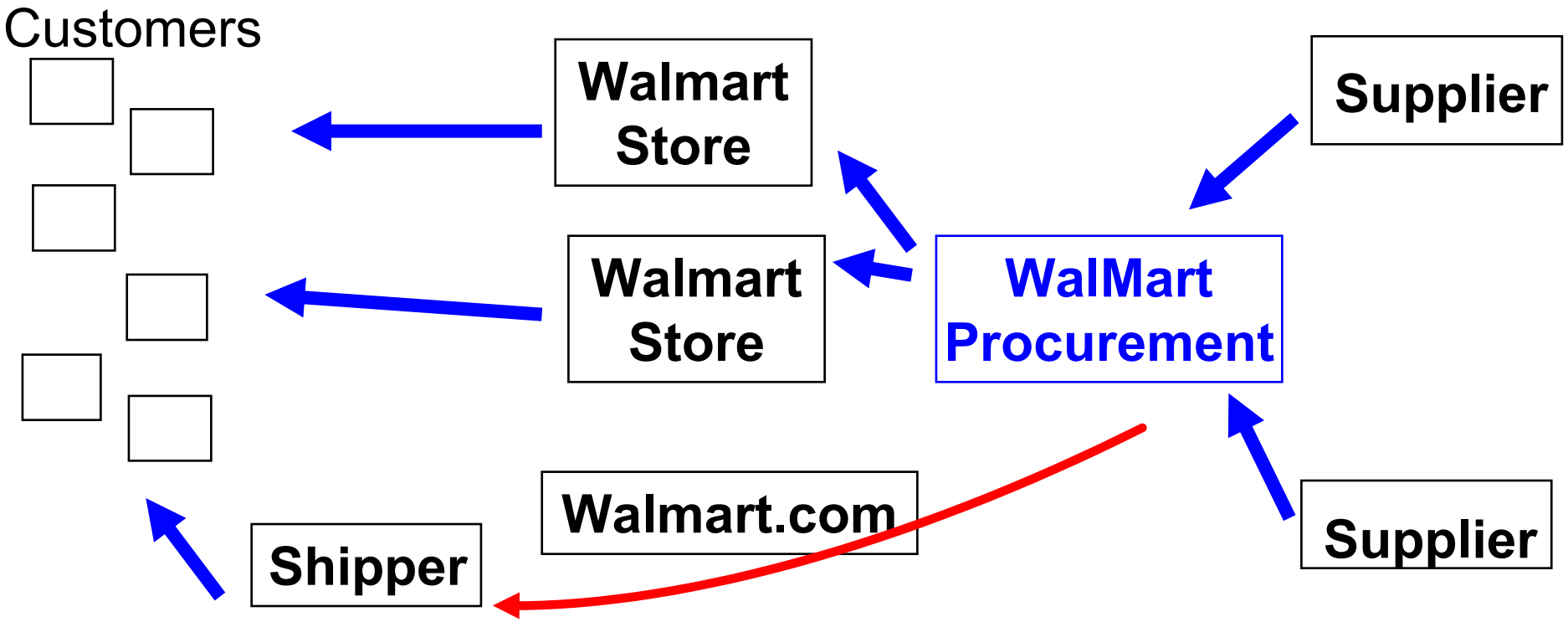
Free & Open Digital Content:

Peer-toPeer Sharing/Theft:

Napster Industry-shaking disruptions require value chain SWAT team

DOT.COM COMPETITION: FOCUS ON THE SUPPLY CHAIN

CASE#1: WALMART.COM GOT NO TRACTION

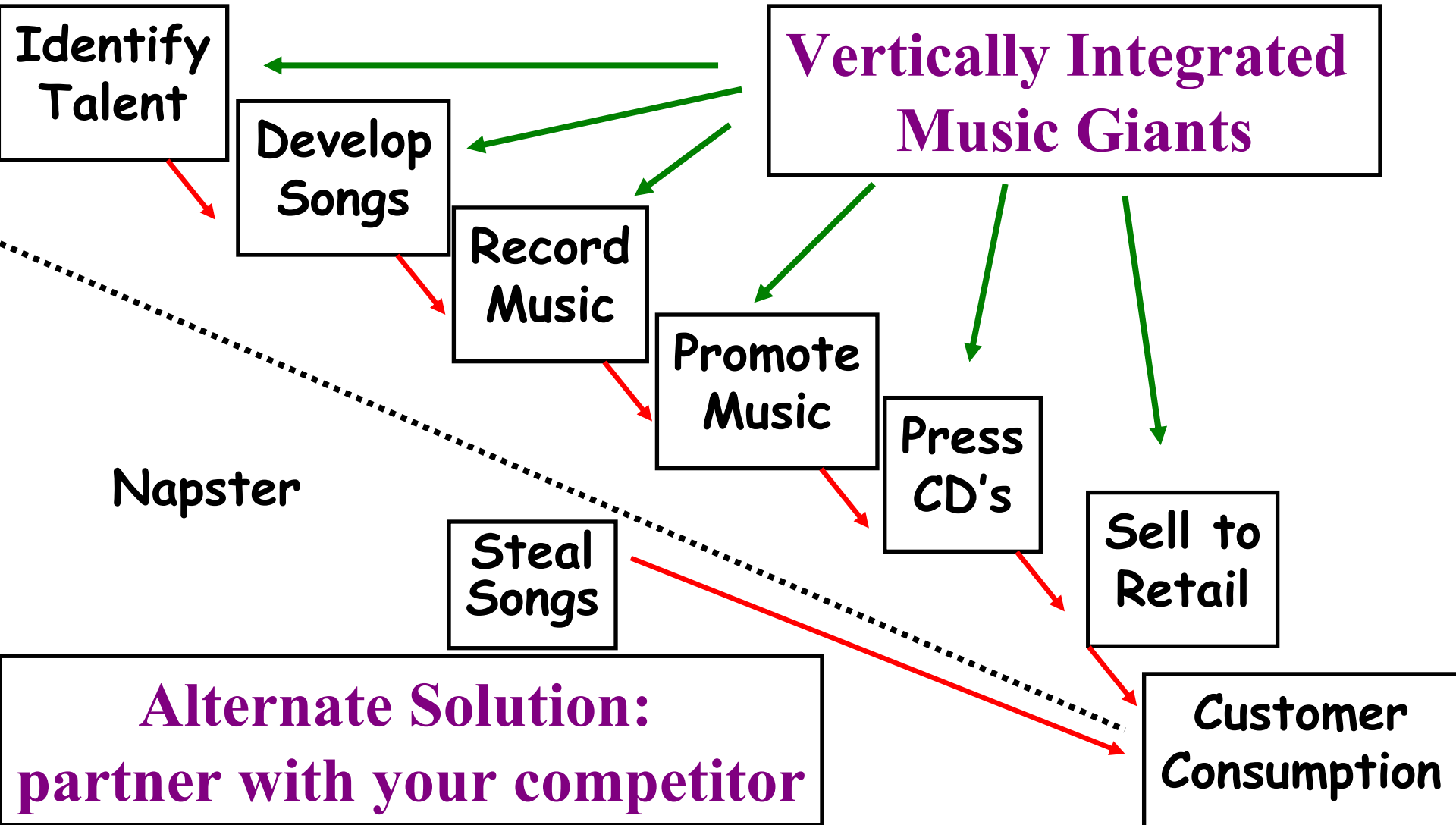


Alternate Solution: Partner with UPS or Fedex

DOT.COM COMPETITION: FOCUS ON THE SUPPLY CHAIN

Napster's New Supply Chain Strategy

(go to the end and steal everything!)



Alternate Solution: partner with your competitor

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Sample Optical Network Value Chain: Layers & Players

Access Provider	AT&T	Sprint	etc.
Network Mgmt/Maintenance	AT&T	Williams	etc.
Network Owner	Level 3	Verizon	etc.
Network Construction/install	Nortel	Fluor	etc.
Network Design	Nortel	Alcatel	etc.
Network Elements	Nortel	Lucent	etc.
Control Software	Nortel	Cisco	etc.
Box Assembly	Nortel	Flextronics	etc.
Modules	Nortel	JDSU	etc.
Actives	Nortel	JDSU	etc.
Passives Fiber	Corning	Lucent	etc.
Silicon	Intel	Broadcom	etc.
GaAs	Vitesse	Hittite	etc.
InP	RF MD	TRW	etc.

OPTICAL VALUE CHAIN:
MINI CASE EXAMPLE

NORTEL NETWORKS plays at at least three levels of the Optical Network Telecom value chain:

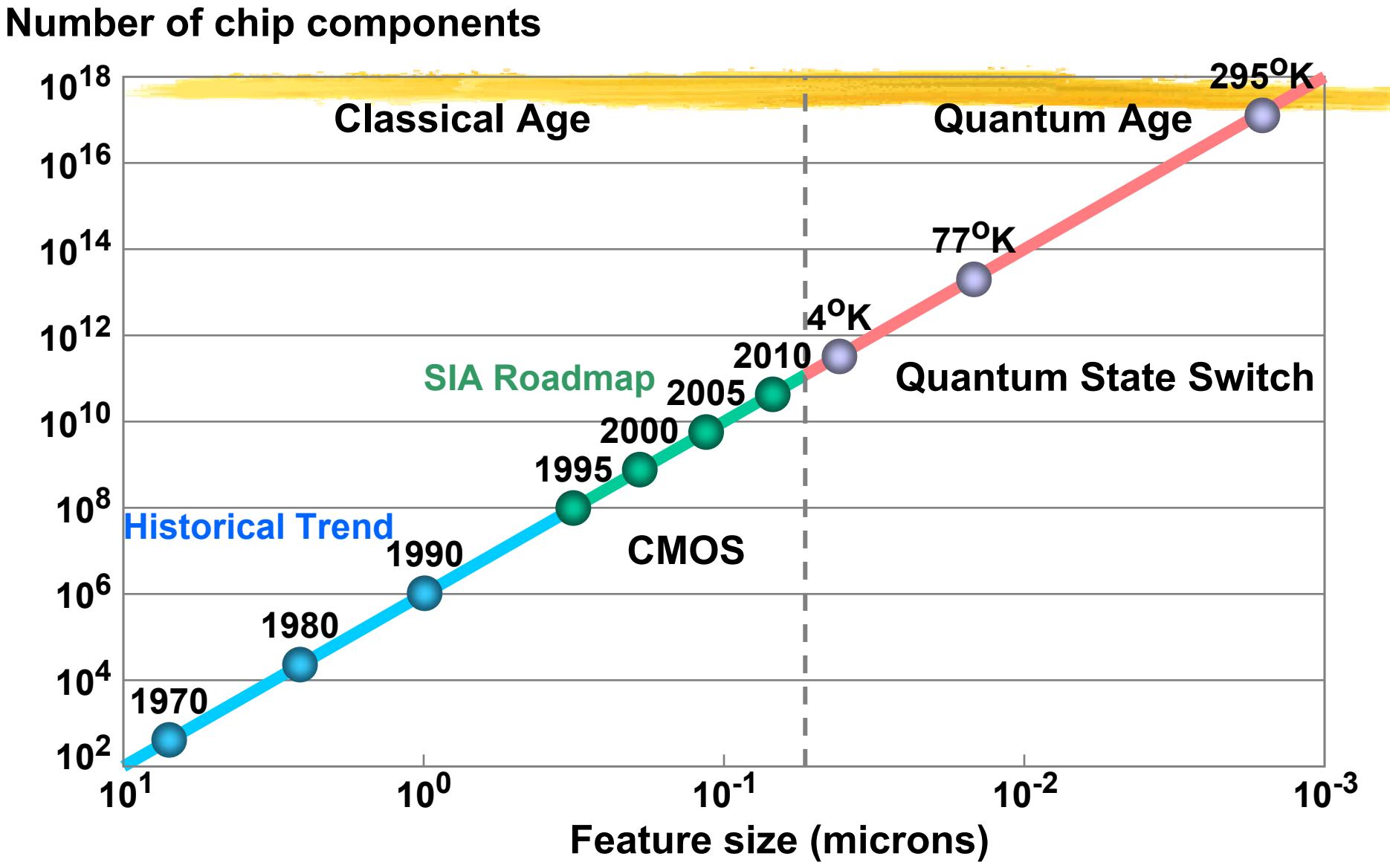
1. Network design & installation
2. Modules (OC-192 network elements)
3. Components (lasers, amplifiers)

QUIZ: Should Nortel sell their components business?

Hint: How likely are the scenarios of:

- An *Intel Inside* effect in components?
- Networks become sufficiently modular as to be assembled by the customer?

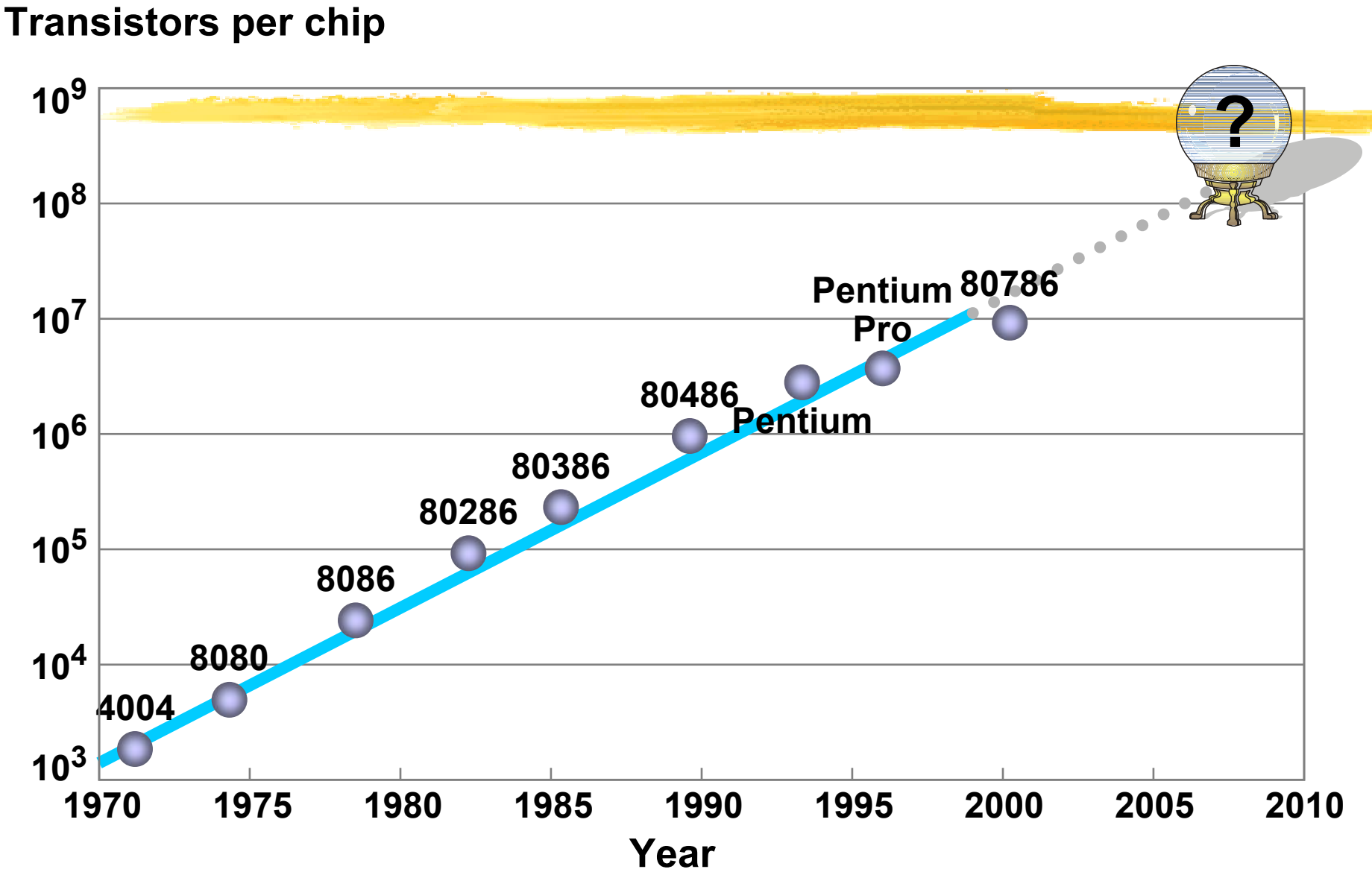
Roadmap for Electronic Devices



International Technology Roadmap for Semiconductors '99

Year	2005	2008	2011	2014
Technology (nm)	100	70	50	35
DRAM chip area (mm^2)	526	603	691	792
DRAM capacity (Gb)	8		64	
MPU chip area (mm^2)	622	713	817	937
MPU transistors ($x10^9$)	0.9	2.5	7.0	20.0
MPU Clock Rate (GHz)	3.5	6.0	10.0	13.5

Moore's Law



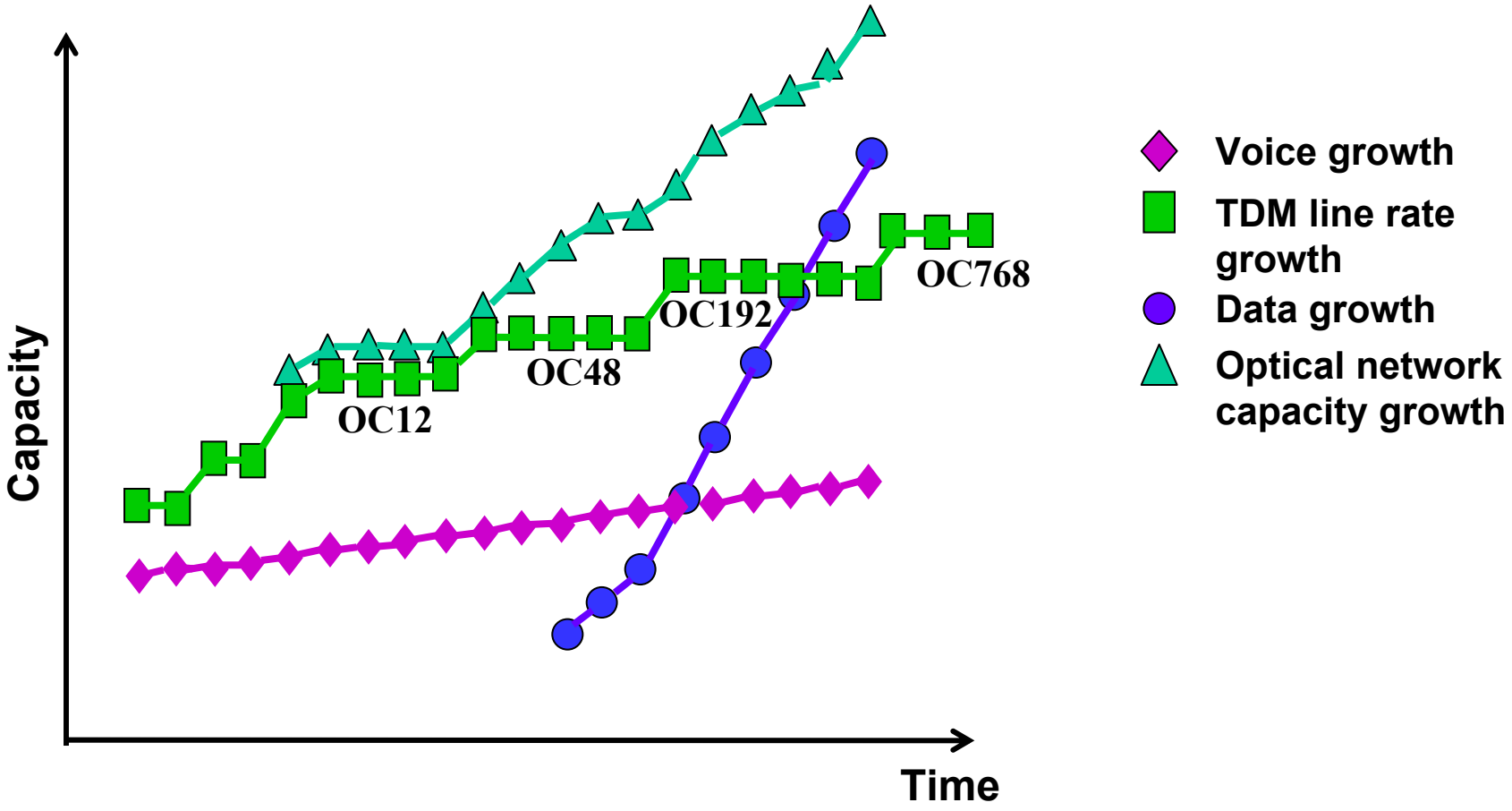
Source: Joel Birnbaum, HP, Lecture at APS Centennial, Atlanta, 1999

Disk Drive Development 1978-1991

Disk Drive Generation	Dominant Producer	Dominant Usage	Approx cost per Megabyte
14”	IBM	mainframe	$750
8”	Quantum	Mini-computer	$100
5.25”	Seagate	Desktop PC	$30
3.5”	Conner	Portable PC	$7
2.5”	Conner	Notebook PC	$2

From 1991-98, Disk Drive storage density increased by 60%/year while semiconductor density grew ~50%/year. Disk Drive cost per megabyte in 1997 was ~ $ .10

Optical Networking is Keeping Up!



"Killer Technologies" of the Information Age: Semiconductors, Magnetic Memory, Optoelectronics

"We define a ***'killer technology'*** as one that delivers enhanced systems performance of a factor of at least a hundred-fold per decade."

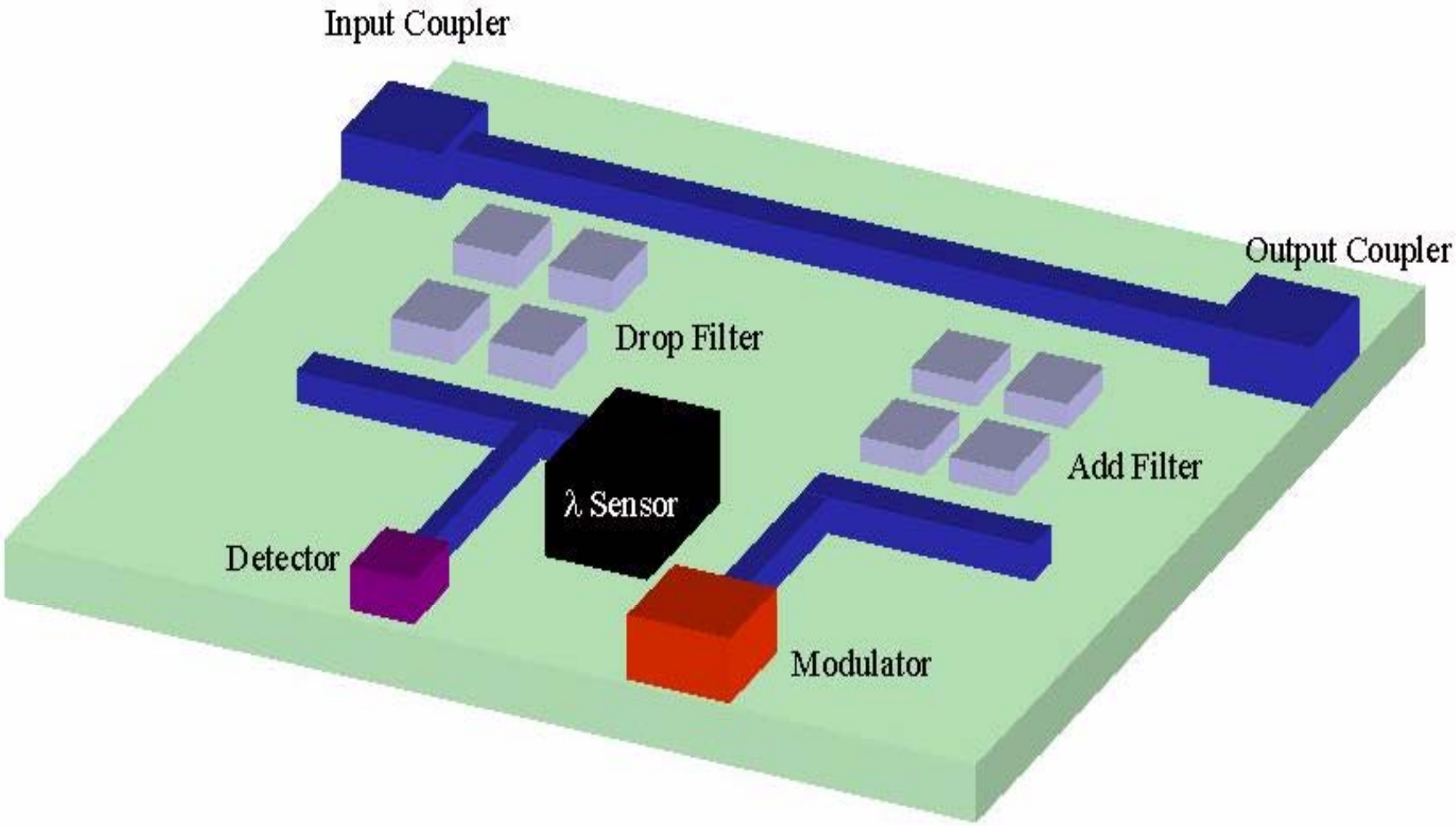
C.H.Fine & L.K. Kimerling, "Biography of a Killer Technology: Optoelectronics Drives Industrial Growth with the Speed of Light," published in 1997 by the Optoelectronics Industry Develoment Association, 2010 Mass Ave, NW, Suite 200, Wash. DC 20036-1023.

Killer Question:

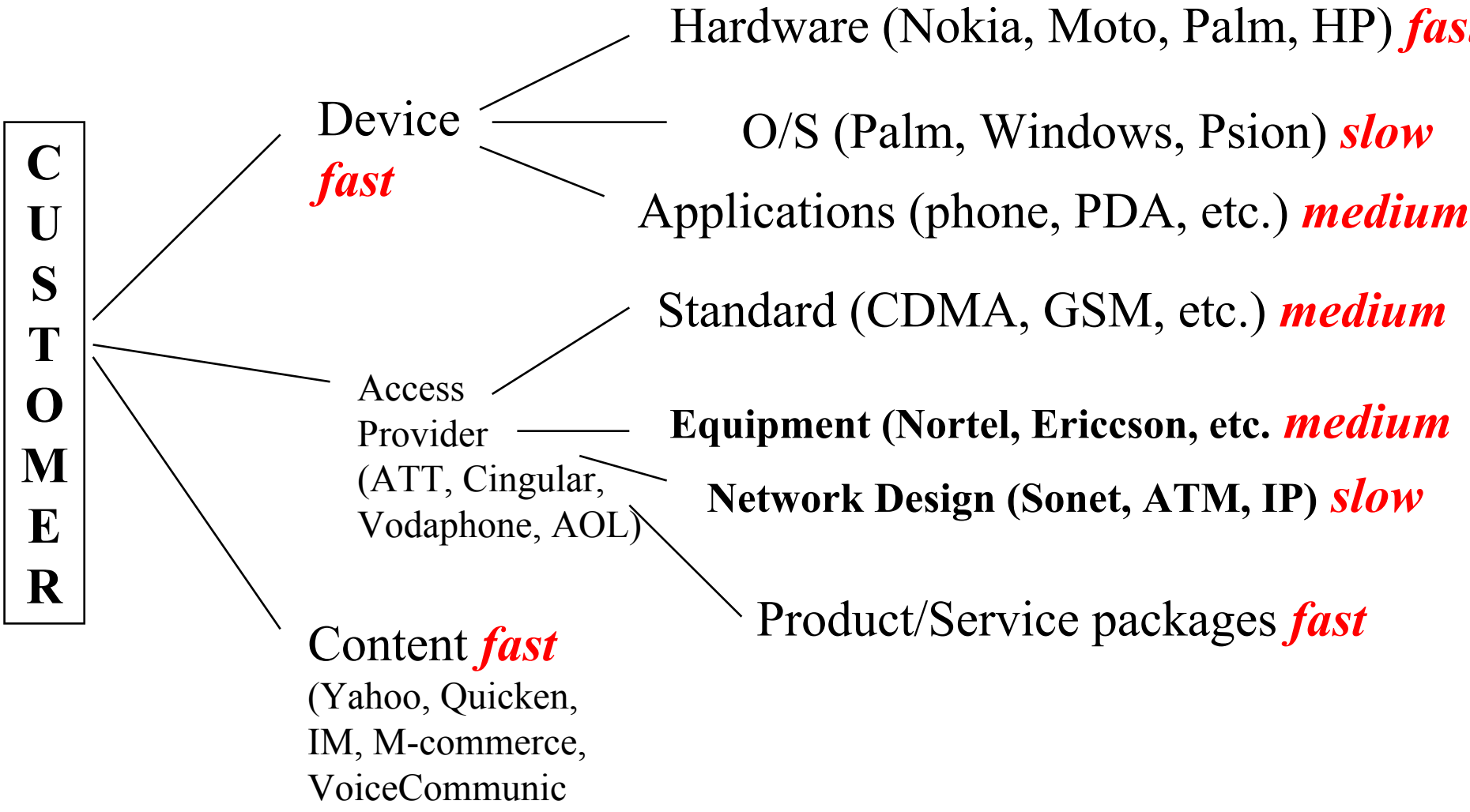
Will *Integrated Optics* evolve linearly like Semiconductors with Moore's Law or like Disk Drives with repeated industry disruptions?

Example Concept for Integrated Photonics Chip

Dr. Gale Petrich, MIT Microphotonics Center

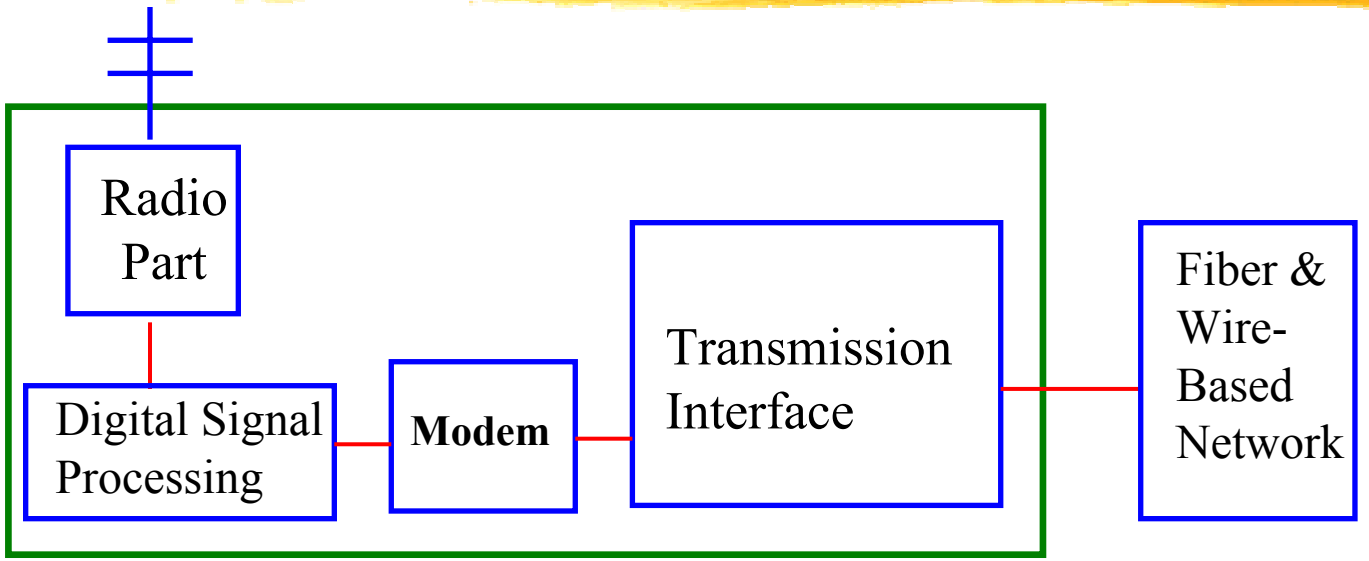


Wireless Value Chain
& clockspeeds



WIRELESS VALUE CHAIN: MINI CASE EXAMPLE

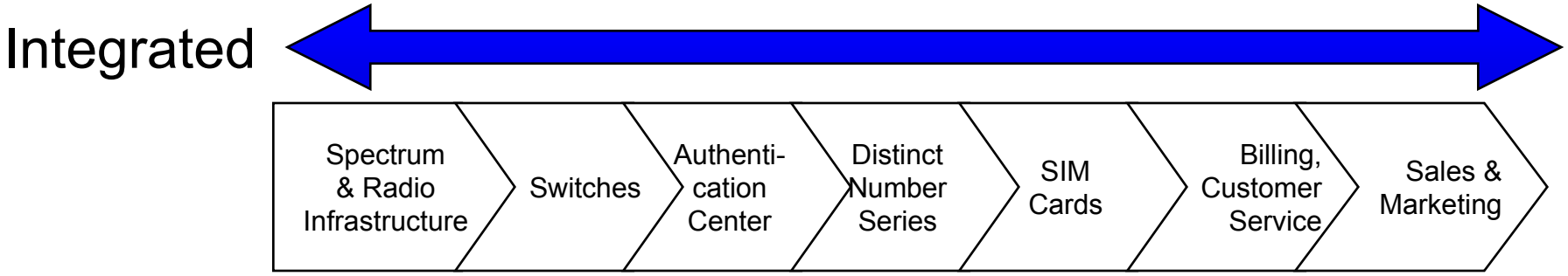
Wireless Base Stations (WSB'S) comprise 4 key subsystems:



WSB architectures are
-integral & proprietary
Suppliers include: Nortel, Moto, Ericsson, Siemens, Nokia
Disruptive Modem advances (e.g., MUD) can double Base Station Capacity

Modular WSB's might
(1) Stimulate new WSB entrants (ala Dell)
(2) Stimulate standard subsystem suppliers
(3) lower prices to the network operators
(4) Speed base station performance imp.
(5) Increase demand for basestations due to improved price-performance ratios.

Value Chain of Mobile Virtual Network Operator (MVNO)



MVNO:

- Does not have Spectrum & Radio Infrastructure
- Needs a host network
- Has at least Billing, Customer Service, Sales and Marketing

Eelco de Jong, MIT

All Conclusions are *Temporary*

Clockspeeds are increasing almost everywhere

Telecoms exhibits fast clockspeed & high volatility

Telecom Technology is a clockspeed driver

Value chain design is a key competency

Study of Fruit Flies can help with crafting strategy