

Wireless Revolution

The forces and strategies that shaped a revolution

What will we learn?



14:332:301

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Wireless Revolution: How did it happen in 50+ years?

- ❑ 1940s- The first “conventional” radio telephones and the first cellular proposals
 - ❑ But few channels and limited technology
- ❑ Four decades later-
 - ❑ Only 50 thousand “conventional” subscribers (US)- Cellular begins
- ❑ A decade later-
 - ❑ ~50 Million cellular subscribers
- ❑ Today-
 - ❑ ~9 Billion (smart) cellphones worldwide!
- ❑ “Tomorrow”-
 - ❑ ~45 Billion Internet of Things (IoT) devices (2030)

An Innovation in Multidisciplinary Education

- ❑ Course introduced in Fall 2008
- ❑ Open to all sophomores, juniors and seniors at Rutgers (some freshmen/women too)
 - Humanities/Social Sciences elective for students in School of Engineering
 - Technical elective for students in School of Arts & Sciences, School of Communication & Information, etc.
 - Taught in “Flipped” Mode since 2021
- ❑ Created and co-taught with Richard Frenkiel
 - Inventor of the Cellular System, National Medal of Technology Winner
 - Member of the National Academy of Engineering, Winner of the Draper Prize)
 - Former Mayor of Manalapan, NJ
 - Retired in 2021

Course Objective

- ❑ To broaden the student's understanding of strategic thinking with its multidisciplinary problems, and to develop strategic skills
- ❑ Why just wireless? MBA programs use Harvard Business Cases to explore many situations (from lobster fishing to pile driving and executive search)
 - Because wireless is important and complex and exciting
 - Because our experience is in wireless
 - By limiting our focus to one industry we can develop a more complete understanding, as we would in a real job
- ❑ But the approach used here “works” in any strategic situation
 - From Boeing to McDonalds

What is Strategic Thinking?

Intentional and rational thought process that focuses on the analysis of critical factors and variables that will influence long-term success of a business/team/individual

- ❑ Includes careful and deliberate anticipation of threats and vulnerabilities to guard against and opportunities to pursue
- ❑ Leads to a clear set of goals, plans, and new ideas required to survive and thrive in a competitive, changing environment
- ❑ Must account for economic realities, market forces, and available resources

Source: Center for Management and Organization Effectiveness (CMOE)

More on Strategic Thinking

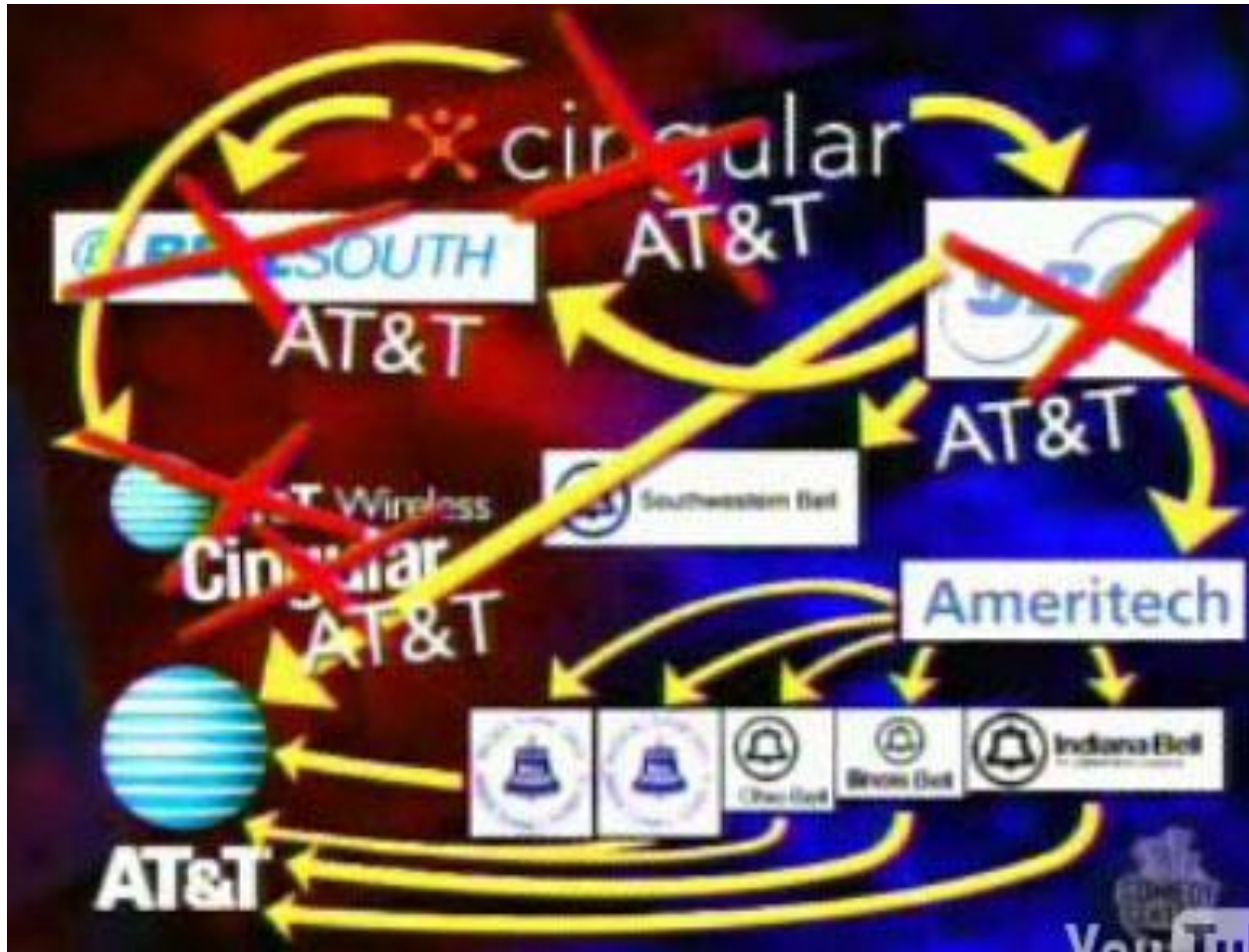
- ❑ Requires research, analytical thinking, innovation, problem-solving skills, communication and leadership skills, and decisiveness
- ❑ Important issues might often be non-technical
- ❑ Need to understand a wide variety of subjects like cost, finance, profit, politics and competition and see what really matters
 - ❑ At least a “High Level” or “Approximate” understanding is necessary of a diverse set of areas
 - ❑ Putting an economic value on an engineering detail
 - ❑ “*Back of the envelope*” calculations
 - ❑ Apples and Oranges

Examples of Things we will learn- 1

- ❑ Historical Perspectives and Progression
 - ❑ “Alexander Bell (1876)” to “Guglielmo Marconi (1895)” to “Early Cellular (1980)”
- ❑ Early Cellular to Today
 - ❑ E.g. Major cellular providers today: AT&T, Verizon and T-Mobile
 - ❑ Was it always like this? What was the Bell System? How did it happen?
 - ❑ What were the economic and political factors?
 - ❑ What are the barriers to entry?
- ❑ Cellular technology was invented in the USA but other countries had commercial service deployed and running before the USA
 - ❑ How did this happen?

The journey from AT&T to AT&T

As summarized by Stephen Colbert



<https://imgur.com/a/VI78TXq>

Examples of Things we will learn- 2

- ❑ The Gs of wireless: 2G, 3G, 4G, 5G (and now 6G?)
 - ❑ What are they?
 - ❑ How are they different?
 - ❑ Why do we need a new one every few years?
- ❑ How is spectrum managed in the US?
 - ❑ How are spectrum licenses awarded?
 - ❑ What are the economic implications of the cost of spectrum?
 - ❑ Is the value of spectrum specific to location/geography?
- ❑ What is unlicensed spectrum?
 - ❑ How is that managed?
 - ❑ How did Cordless, WiFi and Bluetooth come about?

Examples of Things we will learn- 3

- ❑ What is the difference between spectrum, bandwidth (channel) and frequency?
- ❑ Why are some frequencies used for certain systems and not others?
 - ❑ E.g. WiFi uses 5 GHz, Cellular uses 900 MHz and Bluetooth uses 2.4 GHz.
 - ❑ What technical reasons govern this choice?
 - ❑ What political (regulatory) reasons govern this?
- ❑ How do radio signals propagate in the real world?
 - ❑ What impact does that have on system design choices?

Examples of Things we will learn- 4

- ❑ Creating “rudimentary” Balance Sheets and Profit and Loss (P&L) statements?
 - ❑ How to use them in making economic and financial arguments in cellular system design?
 - ❑ How to use them in making marketing decisions?
- ❑ High level understanding of:
 - ❑ Growth and Depreciation
 - ❑ How are stock prices determined?
 - ❑ What is a P/E ratio?
 - ❑ How do companies deal with slow growth?
 - ❑ When things don't go well: Role of bonds, bankruptcy and cash flow
- ❑ Case Studies in Wireless Business (satellite communications)

Examples of Things we will learn- 5

- ❑ How did WiFi disrupt the wireless ecosystem beginning in the late 1990s?
- ❑ How did Steve Jobs disrupt the cellular business in the early 21st century?
- ❑ How is Elon Musk disrupting the cellular business today?

Course Outline / Lecture Schedule

- ❑ Lecture 1: Introduction
- ❑ Lecture 2-9: The road to cellular and the decades that followed: a world of technology, politics, economics and competition that has changed the world
- ❑ Lecture 10: Movie and Discussion
- ❑ Lecture 11: Midterm Exam 1 (February 26)
- ❑ Lecture 12-15: The basics of Radio Communications- frequency, spectrum, capacity and coverage; Digital Radio
- ❑ Lecture 16-17: The Technology of the Gs (2G, 3G, 4G, 5G)
- ❑ Lecture 18-19: Unlicensed spectrum world of cordless, WiFi & Bluetooth
- ❑ Lecture 20: Midterm Exam 2 (April 6)
- ❑ Lectures 21-24: Stocks, bonds, and company growth
- ❑ Lecture 25-26 Case Studies- One2One and Iridium
- ❑ Lecture 27, 28: Personal Finance, Wrap-up & Survey

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Flipping Things Around



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Flipped Course Format and Requirements-1

Grading, Attendance and Mode of Instruction

- ❑ “Classwork”: 60% of grade
- ❑ 2 Midterm Exams: 40% of grade
 - Scheduled for Thursday, February 26 and Monday, April 6
- ❑ **Mode of Instruction:** In-Person Lectures in RWH-206
- ❑ Attendance and Student Participation are very important to achieving the goals of this course (**and also a good grade 😊**)

Flipped Course Format and Requirements -2

Prelecture Reading

- ❑ Consistent with the “Flipped” format, “Pre-Lecture Reading” is required reading before each lecture.
 - Reading for the following week will be Posted on Canvas on Thursdays. Pre-Lecture Reading for Lectures 2 and 3 are now posted.
- ❑ Your task before class is
 - Read ahead, prepare a written 3-4 sentence summary of the reading
 - Identify any questions you may have and also identify points you’d like to bring up for class discussion

Flipped Course Format and Requirements -3

"Classwork"

- ❑ At the beginning of each lecture, an "Assignment" will open on Canvas that you can write answers into.
- ❑ Typically, there will ~5 questions and the Assignment will close at the end of the lecture period.
- ❑ Question 1 on the assignment will always be:
 - ❑ Write a 3-4 sentence summary of the "Pre-Lecture Reading"
- ❑ At the beginning of each lecture, you will be given ~2-3 minutes to write in your answer
- ❑ An in-class discussion of the summary will follow
- ❑ Every student in the class should be prepared to be called upon to read out their summary (~4 students will be called upon each lecture)

Flipped Course Format and Requirements -4

"Classwork" Continued

- ❑ A review of the "Pre-Lecture Reading" with slides will then take up as much of the rest of the class as necessary
 - ❑ Focus will be on topics related to the remaining questions on the assignment as well as suggested by student questions
 - ❑ There will be appropriate pauses to allow students to answer the remaining questions that are part of the assignment
- ❑ Remarks on preparing the "Pre-Lecture Reading" summary
 - ❑ Clear concise summary that addresses all the salient points
 - ❑ OK to use AI tools for the summary but make sure you read the entire document before **"generating"** a summary and **IMPROVE** it
 - ❑ Please avoid writing lengthy paragraphs/essays
 - ❑ No more than 3-4 sentences

"I wrote you a long letter because I did not have the time"

Source: Blaise Pascal, Mark Twain, George Bernard Shaw and many others according to the Internet 😊

Flipped Course Format and Requirements -5

"Classwork"

- ❑ Meant **for only those who attend the lecture/class**
- ❑ If you are absent from the lecture, DO NOT SUBMIT THE CLASSWORK remotely
- ❑ If you are found submitting answers remotely, you will get docked negative points

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