History of the Cellular Phone, Running history

November 30, 2006

1855: Maxwell publishes equations [1]

1861: Maxwell revises equations to add displacement current, making 20 equations in 20 variables, predicts radio waves and calculates their speed. that speed is within 1% of the speed of light, as then known. [1]

1865: Frederik Idestam founds a mill for manufacturing pulp p6 [2]

First phones in 1876 all had to be wired to each other in pairs. First switchboard in Boston in 1877. In 1891, automated central office switch patented by Almon Strowger. pg 39 [3]

1876: Lars Magnus Ericsson opens a shop in Stockholm, Sweden to repair telegraph equipment. pg 48 [4]

1879: English inventor David Hughes demonstrates generation of radio waves, but doesn't pursue it further [1]

Finland:From 1880's telephone companies were local cooperatives. Dozens of telephone companies, no sheltering from foreign companies. Extremely competitive p92 [2]

1881: Ericsson's shop starts exporting phones to Norway pg 39[4]

1886-1889: Heinrich Hertz conducts experiments with radio waves, showing they can be reflected, polarized, travel at the speed of light, and others [1]

1890's: paper mill at Nokia got into electrical power generation. p10. [2]

1891-1893: Nikola Tesla gives lectures including demonstrations. If notes from lectures are accurate and iterpreted correctly, Tesla demonstrated the production and reception of radio waves at 20kHz, first with an alternator, and then with tuned LC circuits. [1]

1895: Gugliermo Marconi transmitts short distances in Italy [1]

1897: Tesla files patent for wireless transmitter and reciever, had achieved 25 mile transmission. Issued 1900 [1]

1894: Finnish Rubber Works, Suomen Gummitehdas Osakeyhtio(..) founded 1898. p14 [2]

1901: Marconi transmits across Atlantic, setup is modification of his earlier ones, uses some ideas from Tesla [1]

1920's: forestry made up 90% of Finnish exports, 1/3 of GNP. p13 [2] coalition formed between Nokia, FRW and Finnish Cable Works.

1921: Detroit police dept used mobile radio in 1921, spread to other areas. Used for taxis, ambulances, police, aviation, trucking, others. Can call each

other, but not to the outer phone system. Half-duplex, only one at a time can transmit. p317 [3]

first mobile radio on land was Detroit Police Department in 1921 using 2 MHz. p 286 [5]

1921:Detroit Police Department put mobile recievers in patrol cars, no car-to-dispatcher link. p 16 [6]

By late 1920's, commercial two-way car radios on market. p286 [5]

1929: Ericsson, which places a high value on exporting and international business, begins building the Mexican phone system with ATT p 50 [4]

Paul V. Gavin founded Galvin Manufacturing Corporation in 1928, Chicago, put mobile radios on the market. Radio called Motorola, which became company name in 1947. first portable radiotelephone in 1943, the Handy Walkie, 16 kgs. commercial service began 1946. pg 286. [5]

1940: Motorola introduces "Handie-Talkie" two-way portable device for short-distance communications, like battlefields. For longer range, Motorola came out with "Walkie-Talkie", which had a big heavy backpack with vaccuum tubes, battery, etc. p16-17. [6]

June 21, 1943:US Supreme Court rules that Tesla's patents are valid and Marconi's are not. [1]

First mobile commercial mobile radio in 1946 in St. Louis, MO, 150 MHz. A 450 MHz system added in 1956. By 1964, 1.5 million mobile users. p519 [5]

In post-war era, half of FCW production went to Soviet Union. This was war raparations from Finland to Soviet Union. After the reparation years, Soviet Union continued to import heavily from Finland. Continued to collapse of Soviet Union in 1990's. Finnish Cable Works was largest of coalition. Produced cables for phone and power lines, rubber works made galoshes, tires, etc. p22. [2] Policy decisions in Finland dominated by the Soviet Union, Finlandization p 38

Cooperation between Nordic countries Denmark, Norway, Sweden, Finland, Iceland. Postwar agreements created a common market p91. [2]

1946: first mobile phone system in St Louis, MO. Expensive $2K. Each city had one transmitter, so only 25-30 calls could be made at any one time. Quality not good, with dropped calls and static. p317. [3]

1947: ATT brings out mobile service with new FCC-acquired spectrum, starting in St Louis. push-to-talk, call operator, who then dials number you want.p18 [6]

1947: Bell labs starts with transistor. p19 [6]

1947 Bell system proposes 40-MHz band between 100 and 450 MHz to FCC for mobile, denied becuase no band left over. Considered again in 1949, allocating 470 - 500 MHz, but gave the spectrum to tv instead. Bell tried again in 1958, requesting 764 to 840 MHz, FCC neither confirm or deny.p3-5 [7]

Mobile Telephone Service used VHF, 152 - 159 MHz. Push to talk, went through operator, who connected you with phone company operator, who then dialed the number for you. Replaced by Improved Mobile Telephone Service, could access phone networks directly, so you could dial yourself without going through an operator. UHF channels added in 450-460 MHz range. IMTS phones were 25 pounds, 20 Watts for UHF, 25 Watts for VHF, one 75 Watt transmitting

tower in a market, with about 50 mile radius coverage. VHF had 18 channels, 11 for wireline companies and 7 for wireless; UHF had 26 channels, with 12 for wired and 14 for wireless; 44 total calls could be simultaneously placed in the market. p9-10 [8]

January 14, 1949, DOJ files antitrust suit p121 [7]

Nippon Telegraph and Telephone founded in 1952 by Japanese Ministry of Communications, had monopoly in Japan until 1990's. Began maritime mobile communications in 1952, followed by paging in the 1960's pg 215 [2]

Mobile radio system development began in 1953 by Electrical Communications Laboratories of NTT. Produced 1967 paper by K Araki in NTT's Electrical Communications Laboratories Technical Jounral Vol 16 No5, 1967. Proposed cellular system in 800 MHz band. p520 [5]

1960's: Bell Labs proposes system called Low Attitude Active Communication Satellite, 40 - 70 satellites at 600 to 5000 miles up, was not used. p. 23 [7]

1960 Echo project used balloon satellites, first satellite communications experiment. Crawford Hill Bell Labs and JPL California link. p.9 [7]

Moon used as passive repeater until 1962 between Washington and Hawaii, 25 m antennas at either end. pg. 410 [5]

Telstar I launched from Cape Canaveral with a Delta rocket July 10, 1962. LEO, since Delta rocket couldn't get to GEO. Transatlantic TV began July 23, 1962. [8]

1964 Bell labs creates mobile radio research department. p5 [7]

1964, ATT releases Improved Mobile Telephone System. MJ at 150 MHz and MK at 450 MHz. 25 to 30 kHz channels. FM. Calls established manually by operator. pg 519. [5]

January 24, 1965 final judgement entered on DOJ vs ATT suit p 105 [7]

1966: introduced by ATT in 1966. Survey showed 70% of public wanted it, but when it came out, at $5K, few sold. Would transmitt picture, and then only the parts of the picture that changed. pg 148-149. [7]

1967: three companies,Nokia, Finnish Rubber Works, Finnish Cable Works, merged in 1967, new company Oy Nokia Ab p26 [2]

Japan had public radio paging introduced ini 1968.p 520 [5]

July 26, 1968, FCC proposed 75 MHz for mobile systems, based largely on ATT testimony from 1958. p3-5 [7]

1968:Linkabit was founded by UCSD university professor Irwin Mark Jacobs and UCLA professors Andrew Viterbi and Len Kleinrock to handle consulting. Len Kleinrock soon left. Linkabit hired employees and went from hourly-rate work to bidding for government contracts. Did TDMA for satellite communications. [9]

1969: Nokia first company to use pulse code modulation in phone equipment, an early step into digital p41.[2]

1969: Nordic Mobile Telephone Group founded. Goal to develop system for Nordic countries. p96 [2]

May 20, 1969 FCC set aside 75 MHz from 806 MHz to 881 MHz. pg 3-5. [7]

ATT began Phase I study May 20, 1970 to find feasibility. 18 month study ended Nov. 1971. pg.5 [7]

early 1970's: ATT telling FCC, press that technology for cellular system is ready.p20 [6]

1970's: FCC originally intended to give whole spectrum to ATT, which had spent $200 million inventing the technology. Department of Justice wanted spectrum of each city divided into many segments (5 or 6) per city.p22 [6]

1970 prototype unit aluminum casing 12 x 12 x 25 in. p.14. [7]

1970's: Citizen Band radio, AM, using IC's. p23. [6]

Trials began in Tokyo in 1971. Pilot system in 1975. p520 [5]

1971, Jacobs retired from teaching to run company full time. [9]

1973 oil supply crisis began Nokia's executives looking into becoming electronics company. p39 [2]

1973: Motorola introduces Dynatac ("The Brick"), on cover of July Popular Science, expected service to start in 1976. p22. [6]

1974: Channels 73 to 83 given to cellular by FCC in 1974. FCC allocates 40 MHz and reserves another 30 MHz for future use if cellular grows. pg 6-7. [7]

1974: DOJ banned ATT from manufacturing cellular phones in 1974, Japanese company Oki makes first 200 phones, months later 600 units each made by Oki, Motorola, E.F.Johnson. p10 [7]

1974: trial conducted in Chicago 1974-1977 with these units, eventually reaching 5000 test units, after trial, AMPS specifications written, all the units became obsolete. Expensive way to design a system, but was effective, p. 36. 16 base stations pg 97 [7]

1976: Radio Common Carrier, association of dispatch and paging, lobbies FCC not to allow ATT into cellular. delay lasts until 1980. FCC decides to split allocated 40 MHz into Band A and Band B. Band A is for non- wireline companies (paging and dispatch) and Band B is for phone companies. p. 10 [7]

late 1970's: Scandinavian countries join to make the first international cellular system, backed by order for a system from deep-pocketed Saudi Arabia p 49 [4]

1977 equipment manufacturers join Nordic Mobile Telephone Group, Mobira made first NMT base station in 1979 p 97. [2]

1977: FCC authorizes two experimental cellular systems, first in Chicago, and then in Washington/Baltimore. ATT would test AMPS in Chicago, Motorola and American Radio Telephone Services Inc(ARTS) would do Wash/B.p24. [6]

1978: FCC called for improved modile telephone system, ATT proposed AMPS, demonstrated in Chicago in 1978, but delayed introduction to 1983 by interference with military and TV frequencies. [5]

1979: cellular introduced in Japan [10]p79

NTT modified AMPS specs, reduced BW to 25 KHz from 30 kHz for a channel. Introduced system in 1979, but didn't use diversity in base stations, poor quality. [7]

Service began Dec. 3, 1979 in Japan, called MCS, mobile control station.p520 [5]

Analog in Japan: MCS L1 first system, 600 channels with separation of 25 kHz. Units were 6600 cm$\hat{3}$, 7kg. in 1985 2300 cm$\hat{3}$, 3 kg, 5 W output. p523 [5]

1979: Mobira Oy (mobile radio) joint venture between Nokia and Solara (Finnish electronics company) p89 [2]

late 70's: Defense Map Agency topographical data used by Bell Labs to predict wireless coverage p.18, first cells in 1983 were 8 miles radius p. 47. [7]

Trunking began in late 1970's to share channels. Used by drivers, emergency services, government. pg 519 [5]

Electronics division of Nokia took a lot of investment and did not make a profit until the 1980's. In 1980 FIM 180 million invested in division, 12% of all Finnish RD investment that year, and would increase to FIM 400 million by mid 80's p46. [2]

Kari H. Kairamo 1932-1988, senior vp for international affairs 1970, managing director 1977, chief executive 1986. Management by perkele (Satan). p34 Encouraged internationalization, overseas employees and markets p34, believed in following example of Japan and Asian Tigers by growth through overextension. p34 Encouraged speed in bringing new technology to market p36. Kairamo recieves a lot of the credit for Nokia's reshaping in the 1980's. Hanged self Dec 11 , 1988.p69 [2]

In 1980's (70's?) Linkabit worked on digital and encrypted satellite communications. Did encryption for HBO. [9]

1980: sold Linkabit to M/A-COM. Linkabit did systems and M/A-COM did components. Relations soured, M/A-COM management wouldn't back long-term projects. [9]

1980's: deregulation in UK and ATT breakup provided new oportunities to get into markets p125 [2]

In 1980's, Nokia acted as an OEM, supplying IBM, Control Data, Tandy, Northern Telecom, HItachi, Olivetti, Ericsson, British Telecom, others. Most American sales through Radio Shack, Tandy owned 50% stake in Nokia's Korean factory. p262. [2]

Early to mid 1980'2: Ericsson tries to get into computer business, like other communications companies, sees convergence, but doesn't work out (too early). dumps computer division. p48 [4]

in 1981, only 24 people in New York could simultaneously use a mobile phone. Only 700 customers, thousands on waiting list. p19 [6]

May 4, 1981: Fcc announces division of 40 MHz spectrum among 2 systems in each market, total of 666 channels, big jump over 44 channels. Also, with reuse, those 666 channels would serve multiple users in the market. One block would go to wireline cmpany, one to nonwireline. FCC would accept applications for each city, if more than one application for a block, an administrative law judge would decide. Criteria: engineering plan for capacity, geographic coverage, business plan including predicted number of users and pricing; also public service attributes and ability to serve local community (deliberately vague).p25. [6]

October 1981, first commercial NMT 450 introduced in Sweden. Finland in 1982. [2]

Nokia: Acquisition spree in early 1980's, Salora Oy, TV maker, Luxor AB, electronics and computer in Sweden, Oceanic, French television, others. Bought Mobira, Finnish mobile phone company. 1982-1987 Nokia market value tripled from FIM 2.275 to 8.029 billion; largest in Finland, had become electronics giant. Sprawling company, in paper pulp, rubber, electrical power, consumer electronics, 27,600 employees in 1987 pg 50 [2]

1982: European Converence of Postal and Telecommunications Administration (CEPT) forms standards body Groupe Special Mobile, largely promoted by Nordic countries and Netherlands. p110 [2]

Analog in Scandinavia: O(..)sten Ma(..)kitalo a Swedish engineer, holds 20 patents, pioneer of GSM, created NMT while working for Televerket. in 450MHz band, 180 channels spacing of 25 kHz, or 225 channels with spacing 12.5 kHz. NMT-900 introduced in 1986 with 1000 channels, 25 kHz or 1999 channels 12.5 kHz. used in Denmark, Finland, Norway, Sweden in 1981,1982, expanded to Netherlands, Saudi Arabia, Spain ini 1982, Malaysia, Oman, Tunisia, Turkey in 1985, olthers p523. [5]

Jan. 8, 1982: US District Court Judge Harold Greene announces ATT breakup consent degree. ATT split up by Jan, 1984 into seven Regional Bell Operating Companies. ATT would keep long-distance, Bell Labs and equipment manufacturing division, Western Electric, later Lucent Technologies. Cellular not seen as significant in reorganization and breakup. Study by ATT in 1980 predicts 900,000 cellular subscribers by 2000. Actual number in 2000 was about 100 million. p26-27 [6]

January 11, 1982: MacNeil/Lehrer Report, ATT Chairman Charles Brown is discussing the breakup with Rep Tim Worth of Colorado. Sez ATT would leave cellular to local companies. Gave away cellular business. p27 [6]

March 1982: FCC announces details of cellular spectrum allocation. The hundreds of markets would be distributed in rounds, starting with large cities where there was the most interest. Round I was 30 largest cities, which were the only markets many believed would be profitable. Deadline for applications June 7, 1982. Round II was 31 to 60. Round III 61 to 90th largest. Continue until all 305 Metroplitan Statistical Areas given away. p27-28. [6] PLAYERS: - MCI Communications Corp began as Microwave Communications, Inc., tried since late 60's to be alternative long distance operator. CEO William McGowan called it "Money Coming In" at a shareholders meeting. By 80's had long-distance service in 60 cities and revenues of about 1 billion a year. Applied in round I for, LA, Cleveland, Dallas/Fort Worth, Denver, Houston, Kansas City, Miami, Minneapolis, Philadelphia, Pittsburgh, Portland, Tampa. Wasn't elegible for wireline block. p30 [6]

-Barry Yampol founded Graphic Scanning at age 29, doing communications. Sold a data comm. network to NYSE and large firms, took business from Western Union. By 1983 was largest paging company in US with 160,000 customers. Created Graphnet in 1975, first packet-switched network, linked computer networks, like early internet. Wanted to get into telephone business, went for cellular. Planned to file in every cellular market. 32-33 [6]

Graphic Scanning's problem: 1981, created four companies to apply for pag-

ing spectrum with Graphic Scanning taking the profits, against FCC rules. FCC began ASD investigation, if all licenses and applications were disqualified, Graphic Scanning could lose half of their revenue and collapse. Seen as unwise by GS since a set of major properties, cellular, had been put in jeapordy by much smaller paging licenses. p53-54. [6] Graphic Scanning: trouble with FCC over paging licenses, threatened to disqualify all licenses. Also facing high construction costs for systems. FCC allowed GS to sell its spectrum, sold for $287 million. p 120 [6]

-Western Union got into the application process, making deals with other companies that were filing, and file it's own applications for Buffalo, Kansas City and New Orleans. Had positions in 15 of the 30 first markets. p 36 [6]

Western Union goes down: Oct 4, 1982, buys E.F. Johnson Company, equipment manufacturer. Their equipment was not so good, W U employees would rather have gone with Motorola. CEO had made the decision without consulting cellular department. Spent $1 billion on Easylink for electronic mail. feb 1983, Westar VI satellite lost. Wu had 3.28 million POPs. Didn't show up for market trading in New York, left it to others, would up with 13/16 of Mobile, Alabama. Sold everything. EF Johnson sold for $38 mill (had bought for $132 million) in April 1985. Oct 1, 1985, sold cellular. e.g., sold 1 million POPs in LA for $10 a POP ($9.6 million). The people they sold to would sell four months later for $30 a POP. Sold miles of tubing beneath big cities that would be used for fiber-optic comms. Sept 1994: bankruptcy. p108-111 [6]

-Metro Mobile, NYC startup founded by George Lindemann, who made his money with Vision Cable Communications, he sold for $220 million in 1981. files for Cincinnati, Denver, Houston, Kansas City, Miami, Tampa, San Diego, Minneapolis, Pheonix. . p 37 [6]

-LIN Broadcasting goes for top markets, New York, LA, Houston, Philly, Dallas-Ft Worth. Ceo Donald Pels. LIN estimates that by 1990, cellular would have 2.5% of market. Ave user would take 15 minutes a day, bring in $30 a month. p37 [6]

-McCaw: Elroy McCaw had many assets, three sons grew up in wealth, died of stroke in August 1969 at 57, empire collapsed in debt and taxes, almost everything sold off except for a small cable tv company, Twin Cities, with 4,000 subscribers and 1970 monthly gross income of $8000. Craig ran company while still at Stanford. Business style was to buy other companies on borrowed money through the 1970's. Filed applications for Denver, Kansas City, San Fransisco, San Jose, Portland and Seattle.p37-40. [6]

-Metromedia's John Kluge wanted into cellular, paid top dollar for paging companies. Kluge came from Germany in 1922 at age 8, grew up in Detroit, went to Columbia U, then a salesman for a paper company. Doubled companies sales and got 1/3 of company. Served in army in war, after started WGAY in Silver Spring for $15,000, AM station. Was involved in many businesses, including many independent tv stations throughout the country that had been overlooked. Made money with them through low cost reruns. Renamed company Metromedia in 1961. Richest man in US in 1989. Went after top cellular markets NYC, LA, Chicago, Boston, DC. p41-43. [6]

-ATT applied in 29 markets, put in 57,600 pages, Graphic Scanning submitted 1.5 million pages. p47 [6]

On Jun7 1982, FCC headquarters at 19th nd M streets flooded with boxes. 190 applications for 30 markets. Applicataion requirements were vague, so large detailed applications, each application typically hundreds of pages, although filled with guesses since no one knew what the demand would actually be. applicants had spent over $100K an application. 55 applications for wireline markets and 135 for nonwireline. Wireline not too competitive, with many markets with only one applicant like ATT and GTE. Most competitive were medium-sized markets. Boston and Chicago had only 2 applicants, Tampa had 11. Applicants were trying to avoid competition, wound up in most competition. p 45-46 [6]

On June 8 press release: wireline 30 markets all settled by companies, ATT would run 23 and GTE would have 7. ATT and GTE had intimidated the smaller phone companies to join the settlement. Settlement would allow wireline companies to start building systems while nonwireline companies fight it out.p47 [6]

After submissions, FCC then took petitions to deny competitors a license, another flood of paper. p52 [6]

Nonwirelines began settling, Western Union, Graphic Scanning and Associated Communications settled Indianapolis, and Buffalo, then other markets settled, one by one. p57 [6]

Round 2: November 8, 1982, 353 applications, most from nonwireline applicants, ave of 12 per market. FCC surprised since they expected most competition for large markets. p61.[6]

November 20, 1982 Modification of final judgment p 121 [7]

1983: AMPS service starts in Chicago, Typical phone cost $3,000, ATT predicted one million users by 2000. [9]

Round 3 applications due March 8, 1983, 567 applications p 62.[6]

Judges for applications were federal staff attourneys, chose mostly by coverage area, word got out so applicants made big areas. Graphic Scanning had applied in all 90, MCI in 51, Western Union in 72, McCaw in 26 p 63-64. [6]

March 16, 1983: Barry Yampol resigns as CEO of Graphic Scanning to appease FCC p 67. [6]

October 1983: FCC announces lottery for cellular spectrum licenses. p 68. [6]

Data modems were tried in AMPS in 1984, 300 bps. Worked like phone modem with handoff, some retransmission needed after handoff. While landlines have random error, cellular modems had burst error. Apply interleaving to turn burst errors into random errors. FM uses pre and post emphasis to fix voice, but distorts data. p 137-138. [7]

In 1984 new system added to NMT at 900 MHz since 450 MHz band full, commercially available 1986. NMT first international system. Originally refered to as juppinalle (yuppie toys), became ka(..)nnykka(..), ka(..)nny, term introduced by Nokia, meaning extension of the hand p97 [2]

Jorma Ollila was an account manager for Citibank Oy, Citibank's Finnish company. One of accounts managed was Nokia. Did an analysis of Nokia's activities and structure, was hired in 1984 or 1985 as vice president of international operations. Became CFO in 1986.p122 [2]

1984: Mobira Talkman launched, can be taken out of car. 5 kg. p 99 [2]

Nationwide roaming introduced in 1984, in Japan. Nippon Indou Tsushin (IDO) used MCS L2, Daini Denden Inc. (DDI) used J-TACS, based on U.K. system. p 523 [5]

1984: Joint venture launched with Tandy to manufacture phones in South Korea and sell them through RadioShack. p101 [2]

January 1, 1984 RBOC's split off p121 ATT had to spin off 26 regional operating companies, which were grouped into 7 companies: Pacific Telesis, Nynex, Bell Atlantic, Ameritech, US West, Bell South, South Western Bell. Regional Bells could not manufacture products, can't tell vendors how to manufacture products. Any products they influence can only be produced and sold outside of North America pg 121 - 122[7]

Metromedia and Graphic Scanning announce settlement of Boston in March 14, 1983 (fourth nonwireline after Indianapolis, Milwaukee, Buffalo). p 65. [6]

Oct 1983: first commercial cellular call in Chicago to Alexander G Bell's grandson in Germany. GM would offer as option in some 1984 cars for about $3K, a monthly fee of $45 and per minute charges. p 69-70. [6]

Fall 1983: nonwireline settlement in Balt/Wash with several companies. Pick Cellular One for the name to give the consumers. Licensed Cellular One name to other nonwireline consortiums, became a recognizable name although there was no Cellular One national company. p71. [6]

Dec. 6 1983, Kluge and some executives announced offer to buy Metromedia for $2.2 billion. took the company private and sold off TV stations to Rupert Murdoch for $2 billion to pay for deal. Murdoch would use the stations to found Fox network. Kluge nmed richest man in US in 1989. Had 36 million POPs. p118-119 [6]

Chicago: Graphic Scanning vs Metromedia, Judge Thomas B. Fitzpatrick rules for Metromedia, saying GS system too expensive, even though GS was significantly larger. GS had proposed 4 times more cell sites than Metromedia, anticipating hand-held phones (i.e., they lost for being correct). p 66. [6]

1984, competition, Phone price fell from $3K to $2K, in Chicago Ameritech charges $50 monthly and 40c per minute daytime and 24c off peak, Cellular One $35 a month , 40c daytime, 20c offpeak. p 83-84 [6]

Feb 21, 1984: big settlement affecting all 60 round II and III markets between more than 10 big applicants. p77. [6]

Smaller applicants not in the big settlement formed a settlement group, assembled by McCaw.p 79 [6]

FCC allows cumulative chances after lobbying from settlement groups, then allows companies to buy the applications of other companies. p 86. [6]

Companies not allowed to buy and sell spectrum, by FCC law, so licenses were sold with overpriced assets, legal fiction that FCC pushed McCaw bought

Knight-Ridder's applications in eight markets for $1 million, presumably the cost of the application process. p 87-88 About $3 per POP p96 [6]

MRTS in Rockville had 3.3 million POPs, and sold application services for $150K each. Switch to lotteries took cash flow. Couldn't come up with money for system construction, sold POPs. p 111-112 [6]

MCI: Round I battle: group of MCI, Metromedia and Graphic Scanning against another group called Los Angeles Cellular Telephone Company. Both present the same engineering plan with 23 BTS. LACTC drew in a 24th cite on Catalina Island, made no commercial sense, but was larger. Judge Walter C. Miller ruled in feb 1984 that MCI's was better. On appeal, LACTC won since their system was larger. Also: MCI antitrust lawsuit filed in 1974 against ATT, seeking $5.8 billion, in 1980 a jury gave MCI $600 million, tripled by law. Jan 1983, appeals court upheld verdict but ruled award size should change. May 28, 1985 came new jury award $37.8 million, tripled to $113.3 million. Decided to sell paging and cellular to McCaw in summer 1985 p 114-116. [6]

April 11,1984: FCC officially announces lottery for all cell licenses, including Round II and III. p 80 One commentator FCC acknowledge was Henry Geller, former FCC official then director of Washington Center for public Policy research at Duke University. Said FCC should auction licenses, since spectrum was a publicly owned commodity. p 80 Expensive, complicated applications for nothing, there was a random element. But FCC touted faster, more efficient distribution. Financial qualification rules relaxed, so almost anyone could apply. Also, FCC would pick 2 through 10th place finishers for each market. p 81-82. FCC relaxed engineering and market research requirements for applications, allowing applicants to submit copies of standard reports. Applications sold by consulting companies for $1.5K each. p 88 [6]

July 16, 1984, Round 4: 5,180 applications; about 1,000 rejected by FCC for mistakes like wrong page numbers p89 [6]

Round II lottery to be held October 3, then round 3, McCaw tries to put together settlements before. Almost all of the markets settled before lottery. p 92 [6]

September 1984: applicants meet in New York to trade rights in markets. Used POP, based on 1980 census, as basis for trading. Eg, 1/8 of market X for 1/5 of market Y. p95 [6]

1985: 200,000 subscribers in U.S. for cellular [9]

start of 1985: 32 cell phone systems in US with 91,000 customers p104. [6]

Kairamo's successor Simo Vuorilehto, an engineer from pulp and paper industry, restructured, sold off industrial units. Debt of $2.6 billion, debt-to-equity ratio of 65 %, not uncommon.p68 Common stock average annual growth only 1% 1984 to 1989. p76 [2]

TACS introduced 1985. UK government invited potential operators, excluding British Telecom and Mercury, to apply for 25 year license. Vodafone and Cellnet won. Used TACS, developed by Motorola based on AMPS. 1000 channels, 25 kHz, 900 MHz band. E-TACS(extented) introduced 1987 with 1640 channels, 25 kHz. TACS spreads to Ireland, HK, Austria, China, Italy, Kuwait, Pakistan, Spain, others. p524 [5]

early to mid 80's: radio scanners could listen to cell phone conversations. p125 [6]

1985: Jacobs quit in 1985, founded Qualcomm in July 1985 with six other former Linkabit employees. Had no product in mind. M/A-COM did not both pursueing anti-competitive litigation.[9]

1985: C 450 introduced in 1985. system in UK p 524 [5]

Jan 8 1985, RBOC Pacific Telesis announced plans to buy CellNet's 23.5% stake in San Fransisco license, would sell off its small wireline license. McCaw sued to stop sale, keep cash-rich wirelines out of nonwireline area, lost in 1986, but by then McCaw had significant spectrum assets, and the introduction of wealth wireline companies drove up price p 123-124. [6]

The Cellular Corporation: Nicholas R. Wilson came from England in 1966, success as stock broker, then decade of scam-ish investments. Partnered with lawyer Albert Schneider, consultant Peter Lewis of MRTS, salesmen from California in August 1984. Lewis would prepare Round V applications, then they'd sell them at $15K each. Modified: charge $45K, $15K up front and $30K owed. Deduct $45K from taxes, and the $30K would only be collected if application won the lottery. Became American National Group, then American National Cellular. Partnership split, California salesmen went off and Wilson and Schneider founded the Cellular Corporation in Cleveland. p130 -133 [6]

winter 1984-1985: General Cellular Corporation sold thousands of applications.Wladimir Naleszkiewicz collected fees, spent money, filed a few applications, dumped more than a thousand applications in the trash. Pleaded guilty to two counts of mail fraud. p132-133. [6]

FCC's no pooling rule, one chance per applicant per market. But an applicant could own less than 1market. Intended for people who owned stock in corporations that may have stakes in cellular. TCC scheme: winner would own 50.01% of market, the remaining 49.99% would be owned by the pool of other applicants, with none having more than 1% of any market. Scheme copied by other companies. American National Cellular used infomercial with Mike Douglas. Douglas paid $25K for half-hour. Infomercial played up Barron's article stating $20 per POP possible. Federal Trade Commission investigated in 1985. Noverber 1985, FTC shuts down ANC. Didn't know it but if they had allowed the applications to go through, the customers would have made a lot of money p 134-137 [6]

CSP: Group that entered Rounds 2 and 3 with some success, made money from settlements, became Vanguard Cellular. winter of 83-84 sold applications for Round 4 for $175K. FCC switch to lottery: have to refund? No, came up with new scheme: each group that had bought an application would submit an application for each member. Would agree in advance to share benefits, in violation of FCC rules. Vanguard won 7 of 30 markets, became CSP.Runners-up challenged CSP. p 153-155 [6]

MCI exit: spring 1985, had 7 million POPs, McCaw offered $156,623,000. MCI instead sold to Mobile Communications Corporation of America for that price. that deal fell through because MCI didn't want to sell to RBOC BEll South, which owned part of MCCA, deal went back to McCaw. p 196. [6]

end of 1985: 102 systems in 85 markets, 340,000 customers., 0.2% of population p 126. [6]

1986: Craig McCaw decides to divest from cable and focus on cellular. Sold to Jack Kent Cooke for $755 million; 433,000 subscribers. p199 [6]

CT-2 System: 1986, Shaye Company develops CT-2. Digital phone, 40 channels over 4MHz, each channel gets 100 kHz. UK gov gave four licenses, so each one only had 10 channels. Poor capacity. Also it was TDD and suffered from interference between licensees. p149-150 [7]

80's:Analog cellular in Europe: Scandinavian Nordic Mobile Telephone (NMT), U.K. Total Access Communication System (TACS), Germany C 450, France RadioCom 2000, Italy Telephone Mobile System (RTMS), all incompatible p521. [5]

1986 Mobira Oy became Nokia-Mobira Oy. Cityman first handset introduced for TACS in UK p103 [2]

1986: Before 1985, FCC rule that nontelephone companies had to be in Band A and telephone companies had to be in Band B. 1985 Pactel bought Communication Industry, which owned Band A markets San Diego, San Fransisco, others, and a paging manufacturing company and a radio manufacturing company. 1986 Pactel got FCC waiver to operate in Band A markets. Other Bell companies then also bought Band A markets. Restriction from department of Justice: can't own two licenses in the same market. pg 131-132. [7]

Feb 4, 1986: Round V: filing place moved from Washington to warehouse in Gettysburg, PA. Trucks rolled up with more than 8,000 applications for the 15 markets, . p138 [6]

Monday Feb 24, 1986: round IV lottery for 91-120 largest markets at FCC headquarters p 144 [6]

Mark R. Warner, lawyer, convinced some winners to let him act as broker, help auction selling several markets for about $9 a POP. p150. [6]

March 1986: ruling that PacTel could buy half of San Fransisco nonwireline license, other RBOc's strated buying into cellular. BellSouth bought MCCA nd Graphic Scanning; PacTel bought CCI; Bell Atlantic buys Metro Mobile. Bell Atlantic and Nynex merge in 1996. Southwestern Bell renamed SBC and buys PacTel in 1997 and Comcast in 1999. Bell Atlantic merges with GTE. p 290-291. [6]

Round V lottery on April 21, 1986 p 154 [6]

Lewis of MRTS: solicited for applicants with fliers on windshields in Washington area. sixty dollars to get in, 3 per applications for 20 markets. If someone didn't want to pay, he would loan the money. p180 [6]

Many winning applicants were part of conglomerates that were not allowed by FCC rules, many markets were held up for years in legal wrangling. p 185. [6]

McCaw financing: got financing from ATT, eager to get back into cellular. p192. [6]

McCaw goes with Michael Milken to raise money for MCI deal, had to raise $250 billion in three months. McCaw had to come up with the money by July 3, 1986, 1 year after deal signed. Planned to sell MCI paging to MCCA to

pay for deal with Maxwell and Charisma to buy 9 million POPs in the south. Complications: July 1 was Metromedia/Southwestern Bell deal set POP at $45, much more than MCI or Maxcell/Charisma deal. Also, MCI found out about sale to MCCA, executives not happy. Deal went through 3:25 pm on July 3. p200-204 [6]

July 1986, Southwestern Bell announces buying Metromedia cellular for $1.65 billion, about $45 a POP. Southwestern stock fell since percieved as having paid too much. p193. [6]

1987, 200 cellular systems operating in 127 cities.p319 [3]

1987: over a dozen European contries sign memorandum agreeing to development and adoption of GSM. [9]

1987: Got contract from Omninet $250,000 to design a satellite messaging system for trucking. Two-way satellite mobile communications had not been done outside of military. Project bacame big, buyers wanted entire package of service, so Qualcomm merged with Omninet in 1988. OmniTRACS contracts started coming in in late 1988. [9]

1987: ATT demonstrated FDMA in Chicago in June. Used 10 kHz channels, 8.3 kbps vocoder. ARTS used results to require 10kHz channels and C/I =18 dB. Later, Motorola demonstrated FDMA in Santa Ana, Ca. Wanted to build on ATT's successful test, so reduced channel bandwidth to 7.5 kHz and vocoder to 6.2 kbps. voice quality not good. Ericsson demonstrated TDMA in Los Angeles.Used 30 kHz channels, which should allow 3 slots, but said couldn't do it in time, used 2 slots, equivalent to 15 KHz each. With added room used 13kbps vocoder (can't be used for 10 kHz channels), good voice quality. TDMA chosen as standard by CTIA. pg 67-68. [7]

Japan: Cellular phone service began in 1987. DoCoMo spun off to handle wireless. Nokia was a phone providor for Docomo. p215. [2]

Conference held in Denver, August 1987. ATT, Motorola, NEC for FDMA; Ericsson and Northern Telecom for TDMA. Every company had one vote, whether giant or tiny, and even if had no experience or knowledge in the topic. FDMA got 16 votes, TMDA got 37 votes. pg 103 [7]

1987: Picking vocoder: ATT and Motorola had Code Excited Linear Prediction, Ericsson used Regular Pulse Excited Linear Prediction Code, similar to GSM. 10 candidates. Survey done by Bell Northern Research and MPT, Canadian companies. had listeners rate sound quality in different environments and at different speeds on a 1 (bad) to 5 (good) scale. Typical phone is 4 or 5. ATT and Motorola vocoders scored about 3.3 average. Motorola's was a little higher, so it was chosen. Afterwards, ATT claimed they had sent the wrong vocoder version, but too late. pg 104. [7]

April 1987 500 $cm\hat{3}$, 750 g, 1W output. Japan p523 [5]

McCaw IPO August 21,1987 to raise capital, sold 10.5 million shares at $21.75. Then made another deal with Drexel to sell $600 million in bonds. Six weeks later was Monday, October 19 stock crash, stoped some competitors' IPO's. p205-206. [6]

1988: MCS L2, channel spacings of 12.5 kHz and 6.25 kHz, 2400 channels. p 523 [5]

1988, Nokia: electronics 59%, cable 18%, forestry 14%, rubber 8%. 44,600 employees, revenues of FIM 21.8 billion p65 [2]

Cable companies: Feb 1988 Comcast buys AmCell for $230 million, April 1988, Century Cable buys Providence Journal Cellular. p 289[6]

1988: GSM trial conducted in Paris. used 10 time slots and 300kHz a channel. Trial didn't work, so slots reduced to 8 and BW to 200 kHz. System worked. pg 150-151 [7]

1988: 1.5 million cellular subscribers in US [9]

AMPS: FDMA developed by Bell Labs, originally 666 channels, upped in 1988 to 832 channels. FCC rule states one company could not hold more than 5% of both A and B blocks in any market. (CFR 47CFR22.942). E.g, Southwestern Bell (SBC, later Cingular Wireless) merged with Ameritech; conflict in Chicago, where SBC operated A and Ameritech B; B sold to Verizon Wireless. Bell Atlantic Mobility, GTE, Airtouch merged to create Verizon Wireless. Conflict in Cleveland, where AirTouch was A and GTE was B. Sold B to Alltel. 416 channels in a block, 21 control channels, 2 channels required for a call, 196 simultaneous calls per carrier. Capacity increased by adding more cell sites and lowering power p14-15 [8]

January 1988: new high price, McCaw pays $81 a POP to buy Miami from Washington Post Co. p 206 [6]

September 1988: CTIA publishes user performance requirements asking for 10X improvement in capacity. Qualcomm recommended CDMA based on past digital communications experience. Seemed military-type expensive solution, not applicable for commercial use. [9]

November 1988: John Stanton, who had sold McCaw on the idea of cellular and had led the cellular expansion fought with Craig McCaw, perhaps Craig was jealous, left company p 207. [6]

RSA licenses: large tracts of land with meager populations, not cost efficient to build systems. But the highways had a lot of people and to show a big footprint to compete with wirelines. p218 [6]

RSA's: 288,258 applications for 428 RSA's, lotteries in 1988 and 1989. FCC had tried to tighten financial requirements, but application mill companies were able to set up a letter of credit from foreign banks for every applicant. p221.[6]

FCC had tightened 1% rule, now no sharing of chances at all. The Cellular Corporation came up with "Mutual Contingent Risk Sharing Agreement", split profits but not ownership. Caused runners up to challenge, years of litigation held up building systems. p 227-228. [6]

1989: Donaldson, Lufkin and Jenrette estimate average value of publicly traded cellular companies is $108 a POP, and average private market value of $229 a POP.p229 [6]

1989: Nextel bought 805-821 and 851-867 MHz, Motorola developed system. TDMA with 25 kHz channels and six time slots. Mobile integrated radio system (MIRS). 25/6=4.1 kHz per slot. 16QAM, so 16.4 kbs per slot. QAM uses AM along with PM, so distortion. Performance not good, reduced to three time slots, changed name to Integrated Digital Enhanced Network (iDEN). pg. 153-154. [7]

NextTel: Morgan O'brien, FCC lawyer thought of using other spectrum. Spent only 11 months at FCC, worked on Docket 18262, which increased the spectrum for Specialized Mobile Services. Plan: use SMR radios, which looked like phones and could access the phone networks, as a third cellular system. But SMR licenses were thinly sliced and scattered among dozens of licenses in each city. While employed at law firm Jones, Day, Reavis and Pogue full time, founded Fleet Call and started buying licenses in 1987-1989 with venture financing. Planned to buy SMR licenses in 6 largest cities and combine them into one block, and use new technology to put the dispatch into small channels. Would be cheaper than cellular. System would also be digital while cellular was still in analog. By 1990, Fleet Call had spent $250 million to buy 1,600 SMR systems in the 6 cities. Got FCC permission to build digital mobile sytem in Feb 1991. Sept 1991: Motorola introduces first dispatch radio and cell phone, called Enhanced SMR. Fleet Call had 61 million POPs, had paid about $5 a POP. First service in August 1993 in Los Angeles. March 24, 1993, changed name to Nextel. When system went up, got bad reviews for quality. Novermber 1993: Motorola sold SMR licenses to Nextel in return for about $1.8 billion in Nextel stock, 20% of the company. Feb 1994, MCI purchase 17% of Nextel stock for $1.3 billion. Buying back into market it had sold out of a few years earlier. ESMR phones worked well in the lab but not so great in the field, was only supplier, producing dillemma for Nextel and MCI. ESMR put six conversations per channel, while digital cellular used 3 or 4. Motorola wanted to reduce the calls per channel to 3. But this would reduce the number of customers and revenue. MCI had offered $21 a share, but estimated that decreased capacity would value Nextel at bout $14 a share, so lowered offer, deal fell through. March 1995: Nextel needed to raise $700 million to build system throughout US, parts of Canada, Mexico; phones constantly getting bad reviews in press. Out of the blue O'brien got a call from Craig McGraw wanting to invest. Put $1.1 billion into Nextel over 7 years for 23.5% of company. Had sold out at $275 a POP, and was buying back into cellular for $20 a POP. p 251-266 [6]

1989, NTT's system used diversity at base stations and handsets. NTT used 300 bps for the control channel, overlapped with random FM noise at around 200 Hz for a moving vehicle, also low quality. pg 46-47. [7]

1989: CTIA committee wrote IS-54 standard with TDMA in 4 months, estimations made from GSM. Didn't work, revised as IS-136. pg. 99 [7]

1989: DDI introduces Handy-Phone based on Motorola's TAC handset, 221 cm$\hat{3}$ 303g. p 523 [5]

January 1989: Telecommunicaion Industry Association votes for TDMA digital system; Europe already decided on GSM (also TDMA). This is IS-54, second generation cellular. Qualcomm decided to go right to network operators to try to sell CDMA, got okay from FCC (the operators could use whatever system they wanted). Big push to sell to Pacific Telesis, PacTel. L.A. system at capacity. [9]

Jan, 1989: British Telecom would put $1.5 billion into McCaw, get 22% stake, equaling $140 POP. McCaw then offers $5.8 billion to buy LIN, $285 a POP. McCaw had only $1.3 billion ready. LIN lost a lawsuit for New York

and Philadelphia markets, offer changed to $261.25 a POP. Instead, on Sept 11, 1989, BellSouth merges with LIN. p.235-238. [6]

April 1989: Qualcomm asks Pactel for $200,000 to do a study of CDMA, Pactel instead offers $1 million for a demonstration system in 6 months. pg 174. Demonstration on Nov 3 1989 in Sorrento Valley. pg 175. Amps took 20 years to develop, GSM took 10 years, TDMA took 7 years and CDMA took 5 years pg 180. [7]

Oct. 1989, McCaw sells 1.3 million POP in south to Contel for $1.2 billion, using that to help pay for $1.9 billion purchase of New York license from Metromedia (half, LIN owned other half) p 240.[6]

November 3,1989: CDMA test in San Diego put together with PacTel help. Put in CDMA equipement into BTS's. GPS not fully operational then, demo times to coincide with most overhead satellites. Demo successful, drove van around making calls. Excellent voice quality, demonstrated 10x capacity improvement over AMPS. [9]

Dec. 1989: McCaw offers $320 per POP for LIN, BellSouth couldn't match so McCaw won. McCaw became a major cellular company with this deal, with gave them major markets and a national footprint. p243 [6]

late 1980's: Japan under pressure to open telecommunications market. American and European companies wanted in for communications and for equipment. U.S. pushed for ATT like breakup of NTT. Spun off some divisions. p 79 [10]

Late 1980's: Motorola took Nokia and Tandy to court over patent infringement for hand phones, went to US International Trade Commission in 1989. Lawsuit dropped when Nokia agreed to pay licensing to Motorola. p189 [2]

In late 1980's, Nokia filed only 10 patent applications a year. Not a high priority. After lawsuit instituted patent training and rewards. Nokia filed 800 patent applications in 1998 and 1,000 in 1999. Ericsoon filed 1,000 in 1997, Motorola filed 2,000 a year by 1999 p189 [2]

early 1990's: Cellular Data Inc. system proposed using 2.5KHz to transmit data with each 30kHz voice channel. Never made it, was overshadowed by CDPD p151-152 [7]

early 90's: First international 1G system, NMT used 450 MHz, then 900 MHz band, by end of 1990's used by 4.5 million people in 40 countries. p95 [2]

December 1989 Wall Street Journal article "Nokia's Bold Strategy May Be Unraveling" p78 [2]

Residents of Nokia region didn't like company using their name, suggested in 1990 that company would have to pay royalties p76. [2]

Early 1990's Nextel Communications purchased Specialized Mobile Radio licenses around country to create one national network. Offers cell phone and two-way radio.p22-23 [8]

Iridium concieved in 1987, formed as consortium by Motorola in 1990. Initially with 77 satellites, reduced to 66 in 1992. $5 billion cost, organizations from 14 countries involved. [5]

February 1990: repeat test in New York City, with NYNEX Mobile as host, successful. Commitments from ATT, NYNEX Mobile, Ameritech Mobile Communications, Motorola, OKI Electric, PacTel Cellular to develop CDMA in a

two-year plan to create a full system. [9]

July 1990, Qualcomm and network operators publish CDMA comman air interface. Common protocol created since CTIA and TIA already commited to TDMA. Called Green Book, later revisions Blue, Red and Gold. Lobby CTIA to accept these standards. [9]

Digital: by 1990 10 million subscribers, rather than the predicted 500,000. Chicago, Los Angeles, New York over 500,000, London over 750,000. p524 [5]

1990: Iridium announceed, LEO system with Motorola, Lockheed Martin, Raytheon and others. [9]

August 1990: Korean Electronics and Telecommunications Research Institute presented with CDMA. Had been looking for an opening in the cellular communications field, since everything in the 1980's was dominated by foreign companies. Joint development agreement in MAY 1991. Qualcomm would recieve royalties, but donate 20% back to ETRI. [9]

1990 there were still less than 1 million user in Japan [10],p79

Finnish mobile operator Radiolinja introduces GSM network in 1991. [2] p110

NAMPS: 1991, Motorola, uses 10 kHz channels,rather than AMPS' 30 kHz. Also has digital messaging.AirTouch was block B in Los Angeles, in 1993 redid system with NAMPS and reuse, and had 6,000 channels rather than 416.p16-17 [8]

1991: DDI and IDO introduce N-TACS with 1200 channels with 12.5 kHz BW. pg 523 [5]

1991: Loral signs with Qualcomm to to produce Globalstar. 48 LEO satellites. Phones would use regular cellular systems when in range. [9]

November 1991: capacity trials, CAP I. Demonstration in San Diego of commercial-style system, with multiple mobile units. RF noise broadcast to simulate more users. [9]

December 4,5 1991: CTIA technology forum to present CDMA system, ASICS. [9]

December 16, 1991: IPO to raise money, which had all been used up for CAP I trial. 20 % of company offere, 4 million shares at $16 a share. Closed at $17.625 first day, raised $68 million for Qualcomm. [9]

1992: Cellular Digital Packet Data system supported by some cellular operators. Used idle cellular channels for data transmission. Data moves among channels as they are taken up by voice. Conflicted with cellular system. A detector at the base station would determine which channels are free. Cellular systems detect interference in a channel to avoid that channel, so a cellular system would not take back a channel. Determination made that in a heavy urban environment, a dedicated data channel would be better than moving data channels. pg 152.[7]

1992: NTT Mobile Communications Network spun off. Division moribund, only 80,000 new subscribers a year, 1% of population subscribed. In first year sold half as many phones as in the previous year. Japanese economy slowing down.p81 [10] Changed name to Docomo, like everywhere. Sounds corny in Japanese, too. Some employees complained pg 84. [10]

January 6, 1992: CTIA board meeting unanimously endorsed TDMA again for digital cellular in U.S. Thought CDMA would not be ready until 1994, with TDMA having a two-year advantage. Not all bad, also recommended development of wideband spread spectrum alongside TDMA, but work on the other standard should not slow or hinder TDMA development. [9]

Finland in recession in 91 92, Ollila became CEO in Feb 1992, goal to focus company on mobile phones. Four guiding principles: Focus, Global, Telecom-oriented, High Value-added. p124. [2]

April 1992: at meeting in Niagara Falls, suggestion made that CDMA CAI was sensitive military information. Released obtained to distribute. [9]

May 1992: CDMA test with Deutsche Bundespost Telekom in Germany. Then trial in Switzerland. Bell Atlantic Mobile Systems testing CDMA around D.C. Good performance in all trials. [9]

Sept 1992: McCaw needed cash and access to long-distance networks to tie in cells. ATT wanted to get back to the consumer without going through the RBOC's. ATT would buy 1/3 of McCaw for $3.73 billion, British Telecom would sell it's 22% stake to ATT, McCaw would use ATT brand. August 13, 1993, deal changed to ATT bought McCaw completely for $12.6 billion + $4.9 billion of McCaw's debt. p248-249 [6]

September 1992: US West New Vector announced CDMA would be used in upgrade. First U.S. implimentation to be in Seattle by end of 1993. [9]

1992: David Reynard files suit against several cellular companies, claiming cell phones gave his wife a brain tumor, appeared on Larry King Live on CNN in 1993. Suit dismissed, but debate and publicity raged. p282 [6]

1992: Qualcomm tests CDMA for PCS in San Diego with PacTel and in Baltimore-Washington with American Personal Communications [9]

1992 to 1999, cellular subscribers worldwide went from 23 million to 436 million p113. [2]

May 1993: Qualcomm agrees to supply US West with 36,000 cellular phones [9] 1993: Interdigital files suit, claiming IS-95 infringes on patent #5,179,571, Settled in 1994 with Qualcomm paying Interdigital $5.5 million [9]

July 1993: CDMA CAI published by TIA as IS-95. Lawsuits already starting over IP. Interdigital claimed part of IP. [9]

July 22, 1993: on South Lawn of White House at press conference Wayne Schelle announced PCS as system that would allow complete communication, news, data, etc into wireless phones. PCS would be all digital, allowing more data compression, better sound quality. Also PCS would have smaller, lower power cells closer together, boosting reception and using less cell-phone power. Clinton highlights that auction is expected to bring $7 billion into treasury. p268 [6]

August 1993: Clinton signs Omnibus Budget Reconciliation Act, permits FCC to auction PCS spectrum [9]

August 1993: Congress gives FCC power to hold an auction. p 267. [6]

FCC split PCS spectrum into 6 blocks, A to F. A and B are 30 MHz each, sold for 51 Major Trading Areas. C to F are for the 492 smaller Basic Trading

Areas, with C and F set aside for small businesses, minorities, etc. p269-270. [6]

December 1993: CDMA Development Group founded to lobby for CDMA around the world. [9]

1994: Nokia first manufacturer to introduce handphones for all major digital standards (GSM, TDMA, personal communications networks, Japan Digital), Nokia 2100 series of phones; supplying GSM systtems to 59 operators in 31 countries by August 1997. p111. [2]

TRW Space and Electronics grounp and Teleglobe (Canada) formed venture in 1994 to develop Odyssey. 12 satellites in MEO, project given up in 1999 with financil problems. [5]

1994: China selecting system. Gao-Feng Zhu vice minister of MPT was not assured that CDMA was mature, went with GSM in late 1995. pg 185. [7]

February 1994: Qualcomm Personal Electronics founded with Sony having 49% ownership, Qualcomm 51% [9]

Nov. 1994: Motorola introduces CDMA in Hong Kong, and then in Jan. 1995 in Los Angeles. pg 185 [7]

December 1994: Qualcomm and Northern Telecom join to make CDMA infrastructure [9]

Decmeber 4, 1994: A and B auctions begin, all on computer. 3 major bidders: ATT; PCS Primeco, a conglomerate formed by 4 RBOC's Bell Atlantic, Nynex, US West and AirTouch; Sprint Telecommunications Venture, joint between Sprint, Cox Comcast and Tele-Communications Inc. (TCI) p 270. [6]

PCS A and B auction: After a couple of months $7.7 billion raised, about $15 a POP. p271. [6]

Prepaid service was a Christmas gimmick in 1995 Germany by DI. 1996 Telecom Italia Mobile offered rechargeable prepaid cards. By end of 2000, 60% of European cellular and 30% worldwide was prepaid cards p 525 [5]

1995: PCS auctions from FCC. A and B blocks go to established companies, C blocks reserved for small businesses, etc. A and B blocks concluded in March. C auction held up in litigation over who could bid, started in December. C block auction surpassed A and B prices. A and B price average was $15 per potential user, C price average was $40 per user. [9]

Dec 18, 1995: C-block auction begins.rather than a few bidders, 400 applied for participation, claimed small business. E.G., NextWave, founded by executives from Qualcomm, aplied as small business, had a lot of capital. Go! Communications was also a small business, but had $100 million in capital and $700 million in loan commitments from investors. p 271. FCC rule only 10% down, rest paid over 10 years p 272. A and B block auctions had taken months to reach $15 a POP, C block auction reached that in one hour.p272[6]

PCS: 1200 channels: A,B,C 30 MHz each, 300 channels each, D,E,F, 10 Mhz, 100 channels each. A and B split into 51 Major Trading Areas, licensed to wireless companies. C,D,E,F split into 493 Basic Trading Areas. C and F reserved for entrepreneurial companies. A,B,C had two phase requirement, 5 years to provide service to 1/3 of pop in service area, 2/3 in ten years. D,E,F had to cover 1/4 in five years. If not met, company loses license. A and B had

18 winners, 99 licenses, $7,019,403,797. About $70.9 million per license. Tower transmitts and 100 Watts, phone maximum of 250 mW p21-22. [8]

Nokia introduced snap-on covers in mid1990's p262. [2]

Cloning: recieve transmitted ESN and mobile phone number, reprogram into phone. Make calls in other markets since system can find simultaneous usage in one system. Phones after 1995 can't be reprogrammed. p139 Digital uses authentication, dependent on 26 character long A-key p140 [8]

1995: NTT, Astel, DDI started PHS system in Japan. Low quality and low cost. NTT used existing phone lines, Astel used electrical power lines and DDI built microwave link system. by 1998 7 million subscribers, but none had made a profit, since cellular costs were decreasing, had more features and mobility. pg 156. [7]

Nokia market share in Japan was 12 % in mid-1990's, but fell to 5 % by 2000. Attributed to relatively large phones. Nokia models weighed 92 grams, in line with 100 gram phone in Europe, but Japan had phones selling from Panasonic for 70 grams and less. p213. [2]

June 1995: PCS PrimeCo and Airtouch Communications announce they will deploy CDMA [9]

July 1995: Sprint Technology Ventures goes with CDMA. Tide has turned, other companies sign up. War for CDMA essentially won. [9]

October 1995: first commercial CDMA system launched in Hong Kong by Hutchison Telephone. [9]

October 1995: Nokia agrees to supply equipement to Jianxi Posts and Telecommunications Administration, network operating in 1996. p151. [2]

Jan 1996, CDMA system set up in two Korean markets, poor voice quality. By April the performance was better and was introduced commercially, by November 1996, over 1 million Korean subscribers pg 189. [7]

Jan 23 1996, Anthony Easton of PCS 2000, had formerly been with GCC application mill, bid $180 million on Norfolk, Va license, had meant to bid $18 million. Would lead to years of investigation and lawsuits. p 273. [6]

1996 PCS auction, PCS A & B bands brought in $7 billion for 60 MHz, one time payment. C band could be paid off over 3 to 5 years. Spectrum of 30 MHz brought in $10 billion. Gateway and Nextwave went bankrupt. pg. 100 [7]

1996: Nokia 9000 Communicator comes onto US market. Like a little PC, with a full keyboard and flip-up screen. Meant to lead to wireless office p226. [2]

1996: south Korea comes on line with hundreds of thousands of users. [9]

May 1996: Strong growth in company in 1995, US digital hansdset market not growing as fast as expected, analog phone manufacturers cutting prices. May 1996 Nokia announced first-quarter pretax profit of FIM399 million ($84 million), 70% drop from previous quarter. Investors had been expecting FIM 800 million. Shares fell 18% on Helsinki stock exchange. p127 [2]

PCS C band auction ended May 6, 1996, raised more than $10 billion, $40 a POP. Bidders had trouble coming up with 10$ down. 8 winning biders, including NextWave defaulted. FCC tried to get back spectrum, but couldn't under bankruptcy protection. There had been no lien in the applications. $7 billion

of $10 billion gone in defaults. Future auctions required full payment at once. Four years of lawsuits for FCC to get back spectrum. Decmeber 2000, reauction. Allowed telecom providers to own up to 85% of these small businesses, due to lobbying pressure. Auction ended January 26, 2001, raising $16.9 billion, 90% of licenses going to affilliates of giant carriers. p 274-275 [6]

E911: July 1996 by FCC: phase 1: by April 1, 1998 automatic number identification and cell site must be transmitted to the plublic safety agency if an emergency call is made, so they can call you back if you get disconnected. Phase 2 by Oct 1, 2001, must transmit automatic location identification; locate phone within 125 meters 2/3 of the time. For network-based system: locate within 100 meters 2/3 of the time, 300 meters 95% of times. For handset-based systems: locate within 50 meters 2/3 of time, and 150 meters 95% of times p 204-205. [8]

1997, cell makers in Nokia chose W-CDMA for 3G, but network people wanted to stick with GSM, where they had experience. Compromise reached, CDMA for cell to base station, and GSM for base station and switching office. Ericsson had similar strategy, teamed up. NTT didn't want GSM, though. Still, they all teamed up to present a 3G front. p215-216. [2]

German Siemens, French Alcatel and Canadian Nortel announced they had their own 3G proposal a month after Nokia, Ericsson, NTT block announced.Motorola joined new alliance (Siemens) p217. [2]

By 1997 year end: AMPS 69,612,00;TACS 16,107,000; NMT-450 1,854,000;NMT-900 2,627,000; Other 696,000; Total 91,408,000 pg 523. [5]

1997: Qualcomm buys 50% of Chilesat PCS for $42 million. iin 1998 puts $110 million into Pegaso Telectommunications (Mexico), OzPhone Pty. Ltd. (Australia), Metrosvyaz Limited (Russia), Orrengrove Investments Limited (Russia), and other small start-ups. [9]

Until 1997, QPE was only one producing CDMA phones, but then Nokia, Samsung, Motorola got in. [9]

First Iridium satellites launched May 5,1997 at Vandenbergh Air Force Base. More launched for 72 (six spares). [5]

June 1997: ITU set up team for 3G in June 1997. p104 [7]

1998: Symbian founded by Nokia, Motorola, Ericsson, Matsushita and Psion (palmtop computer maker). purpose was to provide software and applications. pg 241 [2]

1998 Bluetooth launched by Nokia, Ericsson, 3Com, IBM, Intel, Lucent, Microsoft, Motorola, Toshiba to handle short-range communications between devices. p244. [2]

1998: ATT launches Digital One Rate, flat rate for minutes, $60 per month for 300 minutes, $150 per month for 1,400 minues, ATT owned long-distance, so no long-distance fee, and ATT had nationwide coverage, so no roaming. p277 [6]

Globalstar: Loral and Qualcomm in 1991. 48 sats in LEO altitude of 1410 km. Sats first launched in Feb 14 1998 from Cape Canaveral. Service began October 1999.100,000 subscribers expected, had 30,583 subscribers in 102 countries by 2000. [5]

January 1998 ETSI vote, Nokia and Ericsson recieved 61% OF VOTES, but 71standard based on both W-CDMA and CDMA-TDMA reached, Siemens joins. European strife over p219. [2]

Jan 1998 European Telecommunication Standard Institute picked CDMA for 3G in January 1998. 13 proposals submitted to ITU, 8 were CDMA. p104 [7]

Japan's IDO and DDI sided with Qualcomm on 3G to try to break Docomo's dominant position in Japan. p224. [2]

1998: Qualcomm and Microsoft form Wireless Knowledge for internet access to portable PCs.p219. [2]

September 1998: Leap Wireless spun off [9]

Operator Harmonization Group formed October 1998, made up of operators. Reduced 13 to 3 standards pg 104-107. CMDA-direct spread, CDMA-multicarrier, TDMA [7]

1998: European Union required all EU member states to use ETSI 3G, protrayed by US and Qualcomm as protectionism that would keep out US companies.Dec 1998 EU Commisioner Bangemann recieved letter from Sec State Madeleine Albright, US trade representative Charlene Barshefsky, Secretary of Commerce William Daley and FCC Chairman William Kennard threatening trade war. Banemann replied with Jan 1999 letter making clarification. EU only required each member state to have one ETSI provider in each market. US govt appeased. p220. [2]

Service began Nov. 1, 1998. $3,000 handsets. 400,000 subscribers forecasted, only 55,000 subscribers by Aug 13, 1999, when filed for bankruptcy. Ceased service on March 17, 2000. the system was sold for $25 million. [5]

1999: Metricom started in San Fransisco, later added Seattle and New York. Uses 2.4 Ghz, unlicensed industrial Science, Medical band. 28.8 kbps. Uses Ricochet units. Uses packets like the internet. 160 kHz for downlink and 160 kHz for uplink. put 5000 "poletops" nodes at $2K each. pg 154-155. [7]

Jan 1999 Vodafone from Britain buys Airtouch, then merges with Bell Atlantic, which was then merging withGTE. New company called Verizon in April 2000, largest wireless phone company. Had 26.3 million subscribers, to 12 million US subscribers for ATT , 6.5 mill for Sprint PCS and 5 million for Nextel. p 291. [6]

Feb. 1999: QCOM Axes 700 permanent employees. [9]

March 1999: QCOM Sells infrastructure division to Ericsson, including 1,200 employees [9]

July 1999: Sony announces it's leaving North American CDMA handsets, turns over manufacturing lines to Qualcomm. [9]

Nokia showed off Media Screen in September 1999, Smartphone looking like a flat-panel TV screen. Runs on Linux. Nokia 9000 Communicator example of Communicator class. p241-243 [2]

December 1999: Kyocera would buy handset division. [9]

2000 about 50% of Americans using internet, 15% of Japanese.pg 123 [10]

April 2000, SBC merges with BellSouth to create Cingular. p291 [6]

June 2004: 160 million cellular subscribers in US [9]

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