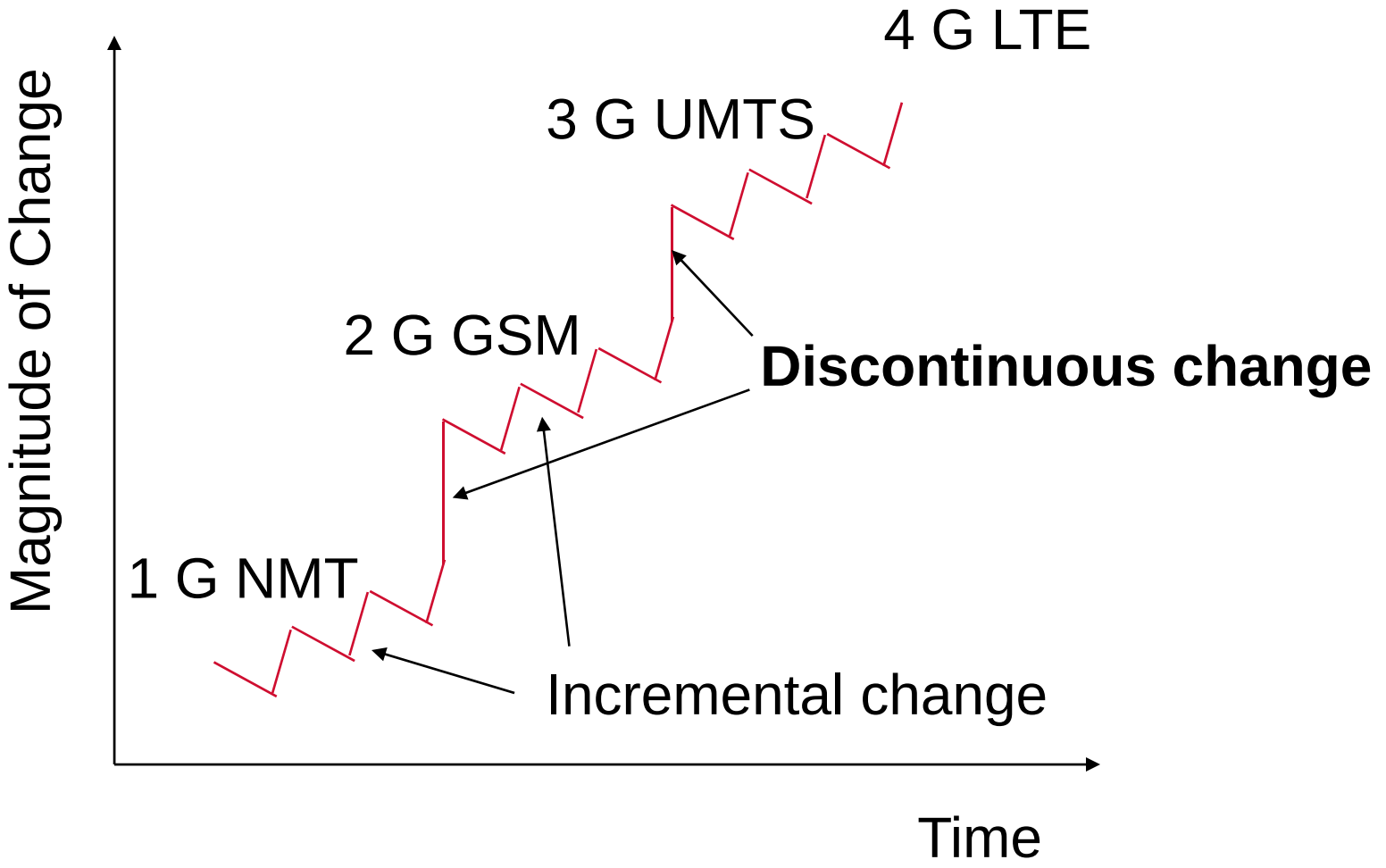
Evolution of mobile networks



Source: adapted from Tushman, 1997

Introduction

- The core concept of the mobile networks was first invented in the early 1940's by the researchers of the Bell Laboratories in the USA
- The cellular systems were, however, not introduced into wide commercial use until the 1980's
- The first public mobile networks were analogy, manually switched and mainly based on the national standards during the 1970's
- The services were mainly targeted at the needs of the traffic, and the terminals were mostly located inside the vehicle

Introduction

- ARP mobile networks in Nordic countries were in the beginning of 1980´s the largest in the Europe
- NMT 450 and 900 networks continued this forerunner role competing in **fragmented** market with english TACS, US AMPS, German Netz-C, Italy RTS, no **economies of scale** in equipment, no roaming, limited spectral efficiency, services and security
- WARC conference in 1979 reserved frequencies in 900 MHz, the **standardisation** process of GSM can be interpreted as an extension of NMT
- In the early days of GSM the PTT´s were part of the public sector, French PTT made first initiative for pan-European mobile network
- 1982 CEPT established Group Speciale Mobile working group after Nordic and Dutch PTT´s initiatives

Case GSM

- EU started to play major role in mid 1980´s and ETSI was set up to continue the standardization work now **open for all players** from public to private
- ETSI and EU played major role also in facilitating the share of **IPR** based on **basket model**
- Main manafacturers involved were Nokia, Ericsson, Motorola, Siemens, Alcatel, AEG, Bosch, Orbitel, Matra, Philips
- **Co-operation** between operators has been facilitated by MoU, e.g. **roaming** agreements, rollout timetable to 1991, tariffing
- Independent research organizations and universities have also significantly influenced in GSM development in EU **research** programs
- In USA (D-AMPS, CDMA) and Japan (PDC, CDMA) there where several competing standards (**high switching costs**), which could not evolve to global mass markets at similar extent like GSM

Case GSM

- The decision that GSM is digital required range of new technology compared to NMT, however the way GSM developed gave significant **advantages to Nordic firms** allthough 82% of patents came outside Nordic countries (Motorola 50%)
- Most **discontinuos** R&D consequences concerned BSS and MS, while NSS and OSS could be upgraded from NMT and ISDN
- The **advantages** of digital radio transmissions related to improved spectrum efficiency, security and new services, it also facilitated the use of highly integrated CMOS circuits in mobile terminals, which influenced to reduced size and price
- **Centralized** GSM network **architecture** and standardized services worked because services are evolutionary without high **market uncertainty** compared to Internet where experimenting through separated network and service layers was required

Case GSM

- **Interfaces** between BSS and NSS were tightly specified, while internal interfaces and component technologies were loosely specified, which left room for company innovations and R&D alliances
- Adoption of TDMA radio interface made possible considerable cost reduction for operators in BSS (1/3 of NMT) and also favoured Nordic manufacturers
- The downside of the basket model was that complexity increased significantly
- The risks were mainly related to VLSI, increased amount of software, inconsistency in system definition and new features
- e.g. the lines of sw code in MS grow from 20 000 in NMT to 500 000 in GSM
- Hence ETSI decided to freeze **phase** 1 in 1989 and further development was divided in phase 2 and 2+

Case GSM

- **Standard war** between GSM and CDMA rival revolution type, Qualcomm executing **performance play**, Motorola in D-AMPS **controlled migration**
- **Alliances** were also used, GSM has **open interfaces** between major network elements, which enabled for operators to build multivendor networks
- EU´s **liberalization** of telecom market (deregulation) opened the competition for GSM
- Added value compared to NMT: Mobile voice incremental, pricing, roaming, SMS discontinuous and unexpected success, mobile data, SIM **reduced the switching cost** of terminal and operator, fast coverage expansion
- All European countries awarded licenses to 2-3 operators
- This enabled also internationalization by acquisitions e.g. Vodafone and **consolidation** process
- Competition was further promoted by the launch of PCS1800 (dual mode terminals), **substitute** technologies like DECT and ERMES failed

Case GSM

- Regulation of **interconnection** charges, separation of numbering space enabled calling party pays
- First commercial service launch 1991 in Finland in time
- **Critical mass** easily created, global market selected GSM as **dominant design**, huge **network externalities** and **positive feedback** effects enabled **tipping** market
- 1992 commercial GSM services were initiated in 15 and 1996 in 103 countries by 167 operators
- 1997 number of subscribers started to increase from 50 million exponentially, now more than one billion subscribers, service revenue 277 billion USD (2004, GSM Association)
- 2001 also main US operators transferred to GSM in 1900 MHz, GSM technology accounted about 60 % of global mobile communications market

Case UMTS

- the first actions in 3G evolution were the spectrum allocation in 2 GHz band by the World Radio Conference in 1992

- the original success of GSM created **excessive expectations** of the market demand for the third generation mobile technologies

- originally 3G was planned to be a **revolutionary** concept especially in the research domain, which would renew the whole 2G network infrastructure

- EU's research projects investigated the suitability of different radio access technologies for the 3G systems

- their work became the basis of the standardization work of ETSI, which decided to select WCDMA (Wideband Code Division Multiple Access)

Case UMTS

• the name of the European 3G version became UMTS (Universal Mobile Telecommunications System), and it was also decided that it is an **evolutionary** approach of GSM

• the decision of the European Union at the same time suggested that the member states should introduce the UMTS services in 2002 and the networks should cover 80 % of the population by the year 2005

• after this, companies in the USA started to promote their own CDMA2000 system, which is an evolution from 2G CDMA, while Japan operator NTT DoCoMo decided to join the European effort

• China also introduced its own 3G radio interface called TD SCDMA

Case UMTS

• ETSI delegated the UMTS specification work to a co-operative organization called 3GPP, while the 3GPP2 project was established to develop the rival CDMA2000 standard

• however, 3GPP started to produce specifications for UMTS efficiently and the first 3GPP R99 specification was ready in 2000

• it was also decided that UMTS would use the existing core network of GSM with GPRS

• the main new aspect was the radio network UTRAN, which contained a new controller called RNC and base stations that increased transmission speeds up to 2 Mbit/s per mobile user and even more by the incremental development of modulations like HSDPA or HSUPA

Case UMTS

• NTT DoCoMo was also the first operator who offered commercial 3G services, which began in Japan in 2001 by the name FOMA (Freedom of Mobile Multimedia Access)

• when the mobile hype was in the hottest phase, several European countries decided to award UMTS licences for the operators on the basis of an auction procedure

• the fear of getting out of the market raised the price of the licences to incredibly high levels especially in Germany and England

• this got the operators into financial trouble and the whole **industry stagnated**

Case UMTS

• the introduction of video into the mobile environment did not create enough value added
• because of these experiences many operators in Europe delayed their commercial 3G launches until 2004
• the operators that made an earlier start suffered from a shortage of terminals
• thus the original timetables set by the European Union could not be reached
• in 2005 there were globally 41 million 3G subscribers and 82 networks in 37 countries, which was 3 years behind what was originally forecasted

Case UMTS

• because GSM networks will still be able to serve all the demand for the basic voice call service cost efficiently for a long time, the only way for 3G to differentiate are the mobile data services – **competition with substitutes**, flat rate pricing like in ADSL

• lower frequencies increase the range of the base stations and thus decrease the network investment

• if operators start to move their existing customer base mainly using the voice services from GSM to UMTS and take the 900 MHz band **incrementally** in UMTS rural usage, the 3G network investments could be profitable in the long run

• by analogy with this, there will then be a transition similar to the one in NMT to 900 and in GSM to 1800 MHz, and then there would be an **evolution in the services**.

Historical development of Nokia towards mobile business

- Nokia Electronics and Televa were early movers in digital technology
- Early development of Nokia´s PCM techniques in transmission networks, which had their origin in diversifying from cable business to electronics
- Converging R&D projects led 1978 to the joint venture Telefenno, which focused on emerging ISDN standard in switching system for fixed networks
- Nokia acquired remaining shares of Televa and Telenokia was established 1981
- The first generation digital switching system DX200 for fixed networks was delivered 1982

- Salora developed televisions and radiotelephones to ARP and NMT networks
- Nokia Electronics and Salora made co-operation in production and marketing, which led to founding of Mobira in 1979, which started to develop also BTS for NMT
- Parallel Motorola started to grow after introduction of AMPS networks in USA
- In the early 1980´s Nokia entered to data modem business through acquisition, which technical knowledge was later transferred to GSM development of Mobira
- Mobira was market leader in NMT terminals and entering to GSM was logical step

- Nokia Mobile Phones 1988, where all Mobira´s MS business was transferred
- Nokia Cellular Systems 1987 for BTS and BSC development
- Telenokia focused first the business opportunities to fixed networks (mainly PCM transmission and DX200, export to Soviet market) rather than in NMT
- The upgrading of DX200 to MSC required however complementary rather that substitute technologies, R&D co-operation with Finnish PTT
- The move towards cellular switching applications was highly initiated by Mobira, because turnkey system deliveries had became necessary for NMT infra market

- Also local PTT had strong incentive to promote **competition** in the switching equipment market dominated by Ericsson
- 1984 Telenokia made the decision to enter mobile switching after finalisation of DX200 to fixed networks, first delivery to Turkey in 1986, **platform strategy**
- The decision to enter GSM switching was made in late 1980´s several years after Mobira´s first GSM R&D project, interoperability problems already solved mainly in Finnish multivendor market environment
- The decline of fixed soviet market starting from 1989 made also possible to shift resources to GSM
- Also VTT and Finnish Universities contributed to Nokia´s R&D, **Tekes R&D funding**

- Nokia joined 1987 to ECR900 **alliance** with Alcatel and AEG to ensure interoperability
- Alliance provided also access to **protectionistic** European market
- This phase suffered also from crisis of consumer electronics, which consisted 50 % of Nokia´s sales in electronics, risk taking in GSM projects
- Also MS development suffered from **IPR problems** and **delay in standardization**
- Significant milestone was the launch of Radiolinja GSM in 1991, which was based Nokia´s NSS, OSS and MS, BSS was delivered jointly with ECR900 alliance
- Ericsson co-operated closely with Televerket

- Nokia´s BTS and BSC components were finalized and delivered in 1992 and then Nokia was able to provide turnkey deliveries of GSM networks, decision to **focus on telecommunications**
- The european export market opened to Nokia through liberalisation and new operators that had no legacy systems and were **not locked in** to national equipment providers
- **Migration** no competitive advantage in GSM but was in later in UMTS / UTRAN
- Nokia and Ericsson rapidly became the surest way for operators to achieve trouble-free and fast roll-out to GSM

- Eastern Europe and free 900 MHz band, Asia and Middle East later
- Market share in mobile networks 25-30 %
- After duopolic period of network dominated business, mobile terminal business became main growth factor reaching almost 40% global market share (**product platforms**, wide scope of models -> **economies of scale** in components, strong buyer, logistics)
- many complementary products to MS, user interface -> **switch. costs**

Conclusions

- Market and committee based mechanisms – strong standardization **culture differences** between USA and Europe
- The **role of governments** in the creation of global standards
- **Public** sector forced strongly single **standard** but let details to be defined by **private** players
- **Network externalities** and **positive feedback** favoured **centralized** over market oriented **selection of technology**
- GSM is also a success story of **regulation** policy

Conclusions

- **Market aspects** for new services have to be considered early in the standardization process: enduser real needs, threat of substitutes, service / terminal pricing and availability, system life cycle, network roll-out strategy
- GSM provided clear **incremental benefits** to operators and endusers while **technology competence** requirement for Nokia were in many way **discontinuous**
- Success requires economies of scale and network externalities – leveraging domestic markets parallel with **early** setting of **global** objectives
- Domestic **cluster** of companies and institutions and their dynamics based on Porter´s theories explain well Nordic vendor´s **competitiveness**