行政院所屬各機關因公出國人員出國報告書
（出國類別：考察）

赴瑞典、芬蘭、德國電信大廠考察 B3G 技術報告

服務機關：中華電信行通分公司
出國人員　職　　稱：處長
　　姓　　名：黃子漢

出國地點：瑞典、芬蘭、德國
出國期間：自 91 年 9 月 1 日至 91 年 9 月 8 日止
報告日期：92 年 3 月 3 日

系統識別號:C09103791

公 務 出 國 報 告 提 要

頁數: 101　含附件: 是

報告名稱:

赴歐洲(瑞典、芬蘭、德國)電信大廠考察B3G技術

主辦機關:

中華電信行動通信分公司

聯絡人／電話:

陳月雪／23442808

出國人員:

黃子漢　中華電信行動通信分公司　行銷處　處長

出國類別: 考察

出國地區: 芬蘭　德國　瑞典

出國期間: 民國 91 年 09 月 01 日 -民國 91 年 09 月 08 日

報告日期: 民國 92 年 03 月 03 日

分類號/目: H6／電信　H6／電信

關鍵詞: B3G,WCDMA,LBS,MNP,IponAir,FleetNet,Telematics

內容摘要: 本公司爲順應世界行動通信技術發展潮流，計畫引進最新通信科技，以提供國內民眾享有與世界並駕齊驅之便捷、新穎的通信服務，並展現全面性經營行動電話業務的雄心與企圖心，將積極參與電信總局主辦的第三代行動通信系統(3G)營業執照競標作業。爲能妥善規劃設計以提供客戶最滿意及最完善的新一代行動寬頻通信服務，了解世界電信大廠有關WCDMA演進及其在B3G之角色、IP核心網路之發展、WLAN和行動電話服務之整合、OSA和行動電話應用平台、Ad hoc網路和其演進、新無線介面(new air interfaces)之研究活動、B3G之服務與應用、行動電話號碼可攜性及下一代網際網路之發展趨勢等，是當前的重要課題。本報告摘述考察內容重點，包括：於瑞典易立信公司研討之3G and Beyond、OSA, OMA and other mobile application platform issues、Number Portability議題；芬蘭Nokia公司研討之3G Strategy and Market Making、Vision for 3G Network Evolution、Beyond 3G Radio Research議題及於德國西門子公司之Siemens' View on Systems beyond 3G、Towards Distributed Network Architectures、FleetNet - Internet on the Road 等議題。

本文電子檔已上傳至出國報告資訊網

摘　要

依據中華電信九十一年度派員出國考察計畫，職奉派自民國九十一年九月一日至八日，共計八天(含行程)，赴瑞典、芬蘭、德國電信大廠考察 B3G 技術，考察主題為 WCDMA 演進及其在 B3G 之角色、IP 核心網路之發展、WLAN 和行動電話服務之整合、OSA 和行動電話應用平台、Ad hoc 網路和其演進、新無線介面(new air interfaces)之研究活動、B3G 之服務與應用、行動電話號碼可攜性及下一代網際網路之發展趨勢等。

本報告摘述考察內容重點，包括：於瑞典易立信公司研討之 3G and Beyond、OSA, OMA and other mobile application platform issues、Number Portability 議題；芬蘭 Nokia 公司研討之 3G Strategy and Market Making、Vision for 3G Network Evolution、Beyond 3G Radio Research 議題及於德國西門子公司之 Siemens' View on Systems beyond 3G、Towards Distributed Network Architectures、FleetNet - Internet on the Road 等議題。

前言

本公司為順應世界行動通信技術發展潮流，計畫引進最新通信科技，以提供國內民眾享有與世界並駕齊驅之便捷、新穎的通信服務，並展現全面性經營行動電話業務的雄心與企圖心，將積極參與電信總局主辦的第三代行動通信系統(3G)營業執照競標作業。為能妥善規劃設計以提供客戶最滿意及最完善的新一代行動寬頻通信服務，了解世界電信大廠有關 WCDMA 演進及其在 B3G 之角色、IP 核心網路之發展、WLAN 和行動電話服務之整合、OSA 和行動電話應用平台、Ad hoc 網路和其演進、新無線介面(new air interfaces)之研究活動、B3G 之服務與應用、行動電話號碼可攜性及下一代網際網路之發展趨勢等，是當前的重要課題。

Ovum 預估 2003 年 6 月前，全球 3G 的用戶數量將達 1140 萬，2005 年前將增加達 6640 萬，至 2007 年 1 月前將超過 2.5 億。Ovum 同時指出，謹慎規劃是 3G 成功的關鍵因素。因此，於瑞典易立信公司主要就 3G and Beyond、OSA, OMA and other mobile application platform issues、Number Portability 議題；於芬蘭 Nokia 公司主要就 3G Strategy and Market Making、Vision for 3G Network Evolution、Beyond 3G Radio Research 議題；於德國西門子公司主要就 Siemens' View on Systems beyond 3G、Towards Distributed Network Architectures、FleetNet - Internet on the Road 等議題進行考察。其行程及主要議題安排如下：

9 月 01 日 - 9 月 02 日	去程
9 月 02 日 - 9 月 02 日	Ericsson 公司考察 B3G & NP 技術
9 月 03 日 - 9 月 04 日	Nokia 公司考察 3G 市場發展策略
9 月 05 日 - 9 月 05 日	Siemens 公司考察 B3G 研究發展
9 月 06 日 - 9 月 06 日	德國 NOC 考察歐洲網路管理計畫
9 月 07 日 - 9 月 08 日	返程

本報告書摘錄考察內容重點彙整成四部分，分別介紹 3G 市場發展趨勢、B3G 研究發展方向、號碼可攜性(NP)技術、及車隊網路發展計畫等，希望對從事行動電話業務與網路規劃之工作同仁有所助益。

目　錄

第一章 3G 市場發展趨勢

一、歐洲地區市場預測

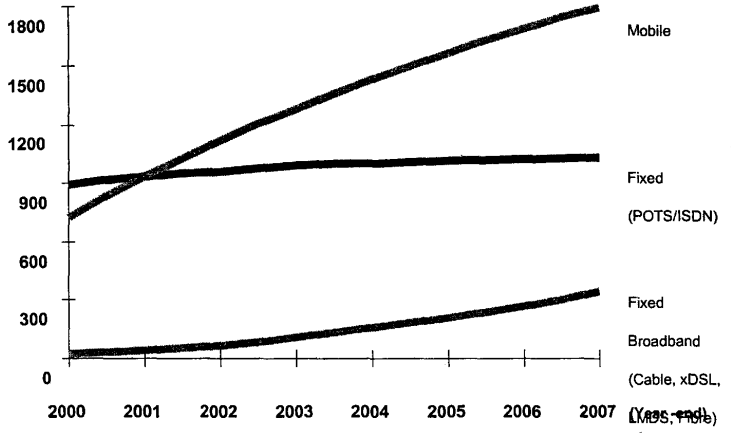
在歐洲，2002 年芬蘭 Sonera 和西班牙 Telefonica 合組的 3G 聯盟，7 月底剛暫停在德國和義大利的 3G 業務，提列 84 億美金的投資損失。二、三年前歐洲發放 3G 執照時，英國、德國都採取拍賣，當時大家都將 3G 想像的很神奇，對市場也有很高的預期，所以競相出高價標購，最後 3G 執照的價格幾乎是 3G 網路建設費的二到三倍，經營成本大幅提升，如果能創造五倍到十倍的話務量，經營就沒有問題，結果卻未如預期理想，使得歐洲電信業者幾乎是奄奄一息。多數歐洲電信業者在斥資逾 1,500 億歐元標購 3G 執照及搭建基礎建設後，終因債務壓力沉重而對發展 3G 出現信心動搖，西班牙電信業者 Telefonica 及芬蘭電信業者 Sonera 日前宣佈，決定暫緩 3G 事業發展，預料此舉將引發帶頭連鎖效應，促使其他歐洲行動通訊業者跟進。近三年來，全球已有 30 個國家發放 3G 執照，然而目前實際已開始提供商業服務者僅日本 NTT DoCoMo KDDI、韓國 SKT 等少數幾個國家，義大利和黃、英國和黃及德國電信預計在 2003 年第一季提供 3G 服務。基於前數市場現況，歐洲電信業者已陸續決定趨緩進入 3G 市場，易利信（Ericsson）、諾基亞（Nokia）、摩托羅拉（Motorola）等設備供應商受害最深；這些業者原期盼搭歐洲 3G 順風車，開發新營收來源，如今卻面臨設備訂單萎縮及手機市場飽和雙重壓力，尤其在 WCDMA 發展不如 cdma2000 理想的情況下，易利信、諾基亞等採 WCDMA 標準的業者所受衝擊更大。歐洲行動產業雖極力尋求 2.5G 及 3G 服務以增加新營收，但只有 20%的歐洲行動使用者表示未來兩年才會採用 2.5G 和 3G 服務。歐洲行動電話市場已趨於飽和，今日年齡在 16 歲以上的歐洲人已擁有及使用手機的比例達 72%，超過 1.9 億人。當行動通話費用下降，SMS 是唯一真正消費者願意付費的非聲音服務。雖然今年 WAP-enabled 手機增加到 23%，但只有 3%的行動使用者使用 WAP。

儘管消費者對功能性增加的電話興趣不高，但電信業者及手機製造商堅定認為，增加更多新功能及應用服務仍是下一代行動手機的必然需求。儘管最近對行動通訊有降溫現象，但 3G 服務很可能將在滿足未來通訊需求上扮演重要的角色。根據 Ovum 預估，2003 年 6 月前，全球 3G 的用戶數量將達 1140 萬，2005 年前將增加達 6640 萬，至 2007 年 1 月前將超過 2.51 億。Ovum 同

時指出，謹慎規劃是 3G 成功的關鍵因素。網路架構在 3G 網路上佔大部分的資金成本，而架構因服務種類而決定，業者將需要謹慎規劃並仰賴規劃工具以發展彈性、具成本效益的架構以符合未來所需。因此，3G 網路有幾項重要議題，包括 3G 規劃不同於 2G，2G 網路主要與聲音的單一服務有關，然而 3G 網路完全不同，強調動態影像服務等。另外，網路設計的行銷角色不同，業者必須確信行銷及技術團隊一開始就緊密合作。因此，一開始就在資源及工具上小幅投資，可同時節省時間及金錢，成功的機會就會大大提昇。

Worldwide subscriptions forecast (millions)

(As of May, 2002)



二、未來市場發展分析

目前歐洲民眾使用手機的人數已超過使用 PC 人數的 1 倍，常發簡訊（SMS）的用戶，數量也已超過常寫電子郵件者。儘管 2002 年行動通訊產業面臨債台高築、前景不明及推出時程拖延等問題，但該產業在歐洲仍然相當成功。第三代行動電話之所以會受人矚目，主要還是在於它革命性的對於個人通訊方式的改變，主要驅力有五個，any where、any time、any content、any one、any medium 等。將所有東西整合在一起，將形成一個多媒體的世界，可預見的也將衍生出許多的 content 與 service，將會刺激新經濟的發展。通訊的建設將改變人類的通訊模式、思考模式甚至整個社

會也發生改變。

儘管 3G 服務上路後，短期內約仍有近 5～10%的應用市場與 2.5G 有所區隔，對新科技追求者或對頻寬需求較高的青少年族群應仍有吸引力存在，然短期內電信業者在力推 2.5G 的應用發展下，如何再找出 3G 的新應用，以吸引消費族群，對電信業者來說將是一大挑戰。

3G 手機受限於專利多掌握在國際大廠如 Nokia 等業者手中，促使其他業者欲投入發展將造成瓶頸，間接也將影響 3G 普及的時程。在 3G 的發展初期，發展 2.5G、3G 雙模共用的手機勢在必行，但由於目前手機業者對雙模的定義仍有爭議，除建議由 2.5G 系統負責語音、3G 系統負責數據傳輸的模式外，直接以傳輸速率區分等均有業者提出，加上 2.5G、3G 的雙模手機在價格、技術等掌握上仍未成熟，也加深 3G 無法突破的困難性。據稱，雙模手機最快應可在 2003 年上半推出，而 3G 專用手機也可望在 2003 年下半問世，但將仍以特定用戶使用為主。

可預期的未來，行動電話的服務市場將可以分為四大類，分別是 C2C（消費者與消費者）、B2C(企業與消費者)、B2B(企業與企業)、B2E(企業與員工)，未來的主要幾個發展應用將包括以消費者為主軸的線上遊戲、在地性服務、以及以企業用戶為主軸的服務。因此，未來網路業者、內容提供者、服務提供者彼此合作情形必定會愈來愈多。唯有透過相互合作，彼此利潤共享，創造新的商業模式，才能達到雙贏局面。

三、未來服務型態

1.從語音傳輸到數據傳輸

有別於 2G 一般手機以傳送「語音」為主，3G 讓手機具備寬頻上網傳送「數據」的功能，傳輸速度可達每秒 386K 到 2M，比固網的 ADSL 專線還快。當語音費率在市場競爭下愈砍愈低，消費者每個月的帳單金額跟著下降，提供數據傳輸以刺激需求，開發新的收入來源，成為行動通訊服務業者一致的目標。目前台灣 2G 的語音市場已經飽和，光靠衝刺用戶數和擴大語音營收，空間有限，業者應該把產業未來寄託在加值服務的提供上。雖然國內外電信產業已經持續緊縮二年，不過似乎尚未出現觸底反轉徵兆，預估歐美電信產業至少還要再等兩年時間，才可能好轉，台灣電信產業則因受傷不重，可望透過

加值服務的提供，刺激景氣復甦。雖然電信服務業並非景氣好壞的領先指標，不過明年台灣電信產業仍需要相當的努力，才可能恢復成長力道。

在行動電話之語音通信模式已呈飽和後，再來該走服務（service）和應用（application）的模式。所謂「服務」和「應用」，指的都是以數據傳輸為基礎。全球的固網傳輸超過 8 成是數據，語音僅佔兩成，但是在無線通訊上，目前語音佔 8 成，數據不到兩成，可預期的過去幾年在固網發生的改變，也將會在無線通訊發生。這個觀點代表了手機不只是拿來講電話，還可以做個人行事曆、玩電動、看新聞、下載鈴聲、傳照片、查地圖、找餐廳和訂機票等。因此，如何開拓語音之後的行動數據加值服務成為業者當今重點，業者也陸續推出許多數據相關服務，故行動數據服務未來三年將會有相當大幅度的成長。

隨著無線通信技術的快速發展，使得行動用戶可使用的頻寬也愈來愈高。由於通信頻寬的增加，許多對於頻寬需求較高的服務都將變得有機會在行動通信系統中實現，使得用戶享用多樣性服務的理想也愈來愈可行，譬如品質較佳的語音服務，無線視訊（Video）服務，無線網際網路(Wireless Internet)等各種無線多媒體服務。特別是近幾年來隨著 Internet 的蓬勃發展，因此結合行動通信和網際網路來提供 Wireless Internet 服務將會成為 3G 的發展重點。

2.主要服務型態

由於第三代行動通信系統具備較高傳輸速率、容量大、多媒體應用、低功率發射、通訊品質高、通訊安全性高、全球無縫隙通訊等特點，有助於提升通信品質，促進相關行業引進高科技產品而提供更先進的服務。

未來 3G 服務的特徵將是：網際網路行動化、多媒體、高速、以及個人化。未來 3G 業者者必須結合系統製造廠商、手機製造廠商及服務內容提供者等合作夥伴，共同開發出各種個人化、創新且吸引人的服務及應用。主要的第三代行動通信服務及應用，包括：

（一）行動上網：網際網路與行動電話是近年來成長最迅速的兩個領域，且有七成以上的行動電話客戶也使用網際網路，所以行動電話與網際網路相結合已是大勢所趨。

（二）行動辦公室(Mobile Office)：3G 將結合行動虛擬專用網路(VPN)，提供企業客戶可以隨時隨地連接企業內部網路，透過 3G 手機或行動通信器，客戶甚至可以進行視訊會議。

（三）行動電子商務(E-Commerce)：提供行動銀行、行動號子、線上購物、訂位、訂票等，行動客戶可以隨時隨地安全地上網交易。

（四）依位置提供之服務(Location Based Service；LBS)：LBS 可提供諸如，緊急追蹤、當地路況報導、餐飲、加油站、電話號簿服務等旅遊相關的服務。

（五）整合訊息(Unified Messaging)：整合行動客戶所有的電子郵件、傳真、簡訊(SMS)、及留言(VMS)等訊息資源，使客戶可以更有效率的接收及處理其多元化的訊息。

（六）遙測(Telemetry)：即如自動販賣機、水錶、電錶、瓦斯錶或攜帶式刷卡機等資料之回報或蒐集。

（七）生活資訊及休閒娛樂服務(Entertainment Services)：透過 3G 手機，客戶隨時隨地可以上網閱讀即時新聞、電子雜誌，查詢火車/飛機時間表、道路路況、最新股市行情及下單，或下載 MP3 音樂檔案、動畫或圖片等，或與朋友連線打橋牌及線上遊戲等，甚至可以上網觀賞最新院線片的預告片及訂位等休閒娛樂。

（八）其他應用：利用 3G 的寬頻特性，亦可以提供客戶隨時隨地進行視訊會議、遠程教學、或遠距醫療等服務。

由於第三代系統具備高速寬頻特性又能連接網際網路，故可以開拓的服務及應用潛力無窮，只要不斷的發揮想像力，經營者即可開發出包括食衣住行育樂、新聞時事資訊、金融理財投資、消費休閒娛樂等豐富且多元化的服務及應用，尤其是時間敏感度及位置敏感度高的個人化資訊服務，更能創造商機。一般認為，未來行動電話將會壓縮到個人電腦的空間，甚至將可望取代個人電腦，成為最普遍的上網工具。更可預見人類的生活型態，亦將隨著行動通信日新月異的發展而改變。

第二章　B3G 研究發展方向

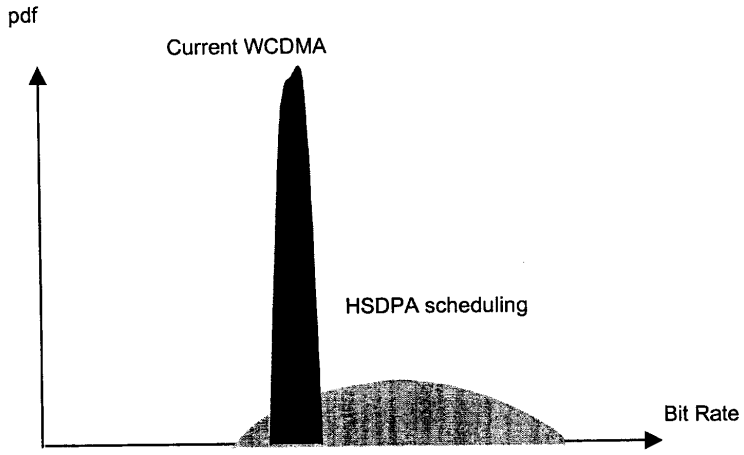
一、3G and Beyond

B3G 之發展目的是要找出方法以增加 GSM 容量

- SAIR from Ericsson
  - Advanced signal processing technique
  - Interference rejection with only one antenna!
- Adaptive Antennas
  - Up to 200% more capacity
  - Step by step migration
    - 20% penetration => up to 100% capacity gain
- Cannel Allocation Tiering (CHAT)
  - Interference diversity
  - Interference suppression
  - Interference avoidance

二、High Speed Downlink Packet Access (HSDPA)

- Enhanced support for downlink packet data for WCDMA
  - Higher peak data rates (~10 Mbps)
  - Higher capacity
  - Lower air-interface delay
- New transport channel HS-DSCH
  - High Speed Downlink Shared Channel
  - Higher-order modulation
  - Fast link adaptation and fast channel-dependent scheduling
  - Hybrid ARQ with soft combining
- 3GPP Release 5 (March 2002)



三、HSDPA 特性

- Best-effort packet data service
- Co-exists with speech-service on same carrier
- Support High Peak-Rates
- 2-3 times higher system throughput
- Low delay ---> interacts well with TCP/IP

四、Wireless World Research Forum – WWRF 目標

Secure momentum, strategic orientation, and impact for the research on wireless communications beyond 3G ; Evolutionary steps of 3G as well as new concepts.

五、Research topics of importance

1.Data rates for 4G

- Extreme peak data rates
  - Target > 100 Mbps (downlink)
- Good coverage for very high data rates
  - Also for high speeds and substantial time dispersion

2.Continuing challenges

- Multiple Access and Modulation
- Channel Modeling
- Spectrum Flexibility for 4G Radio Access
- Efficient use of the spatial dimension
- Fast Resource Management

3.Multiple Access and Modulation

- The bandwidth of 4G might be 10 times larger than WCDMA

- Candidate MA schemes:
  - Single carrier DS-CDMA
  - Multi-carrier DS-CDMA
  - OFDM with spreading in the frequency domain (OFCDM)

4.Efficient use of the spatial dimension

- Interference management with multiple Tx and Rx antennas integrated with radio network functionality
  - Adaptive antennas, space time coding, MIMO transmission
  - Combined with rich feedback and fast scheduling
- Different antenna concepts complements each other.
  - When to use which scheme for what?
- Advanced antenna solutions is a core component in the design but optional to implement.

5.Fast Resource Management

- Resource management interacts closely with physical layer
  - fast and characterizing measurements
  - fast control and reconfiguration
- Adapt to instantaneous and not average radio conditions
  - exploit multi user diversity
  - exploit the frequency dimension
  - exploit the spatial dimension

六、B3G 無線電研究(Radio Research)

1. Mobile Radio Systems Generations

1980 年代	1990 年代	2000 年代	2010 年代
1G：類比語音技術			
	2G：數位語音及行動數據		
		2.5G ： 封 包 數 據 及 Always connected	
		3G：多媒體及多種服務	
		3G Evolution：IP 網路及 higher data rates	

2. Nokia 之 3G Evolution

- Nokia 3G is clearly ahead of competition, Nokia WCDMA R4 is some 0.5 year earlier
- Nokia 3G product range is clearly the widest in the industry
- Nokia 3G solution has the most comprehensive functionality and feature set
- Nokia is one of the most active companies in 3GPP standardization

3. Nokias' view of 4G Trends and Drivers

- 3G evolution is based on the combination of existing technologies like cellular as main interface and WLAN for hot-spot usage
- 4G (a.k.a. Systems B3G or Systems beyond IMT-2000) is a research topic for new air interfaces and systems to be considered after 2010
- Streaming and fast download of medium size entertainment material(MP3, good resolution video clips, 3D)
- Transport and last hop transmission for very high throughput are also issues but need to be developed for 3G evolution already

4. 4G radio Research Positioning

- Up to 100Mbps/1Gbps carrier bit rates in wide/local area deployments
- Bandwidth up to 100Mhz

- Multicellular efficiency of e.g. WCDMA+HSDPA up to 0.5-1.0 bits/s/Hz
- Adaptability to different radio environments
- Efficient support of services with wide variety of QoS requirements(RT, non-RT, etc.)

七、IPonAir/Wireless Routing and Mobility

1.Main target: cellular ad hoc interworking, i.e.

Incorporating multihop communication into cellular networks to realize the following benefits

- Load reduction in cellular networks (hot spot areas may be congested; high data rate required)
- Coverage extension of cellular networks (no cellular infrastructure exists)
- Efficient handoff and policy based routing

2.Technical Issues

- **Description of IPonAir system architecture**
- **Multihop routing in cellular networks (Siemens)**

  Investigation of routing algorithms

  Distributed routing, e.g. DSR, AODV and DSDV

  Centralized routing, e.g. BS as a central controller
- Management of multihop communications

  Network partition by using transmission power control
- **Multihop routing for coverage extension (TU München)**

  Investigation of routing algorithms

  Broadcast and anycast based routing algorithms
- **Efficient handoff for coverage extension and policy based routing (Uni. Bremen)**

  Efficient MIP handoff and hierarchical Mobile IP (HMIP)

  Extensions of MIP for multihop routing algorithms support (AODV)

  Policy based MIP routing (multiple interfaces)

八、Beyond 3G Project Air Interface

1.Beyond 3G Research Projects in China

- Joint Research Beyond 3G (JRB3G) –

  Start: August 2001

  Funded by Siemens

  Partners:

Three Chinese Universities
Three German Universities

- National 863 High-Tech project FuTURE (Future Technology for Universal Radio Environment).
  Start: May 2002
  Funded by Chinese government & Siemens
  Partner: Southeast University, Nanjing

2.Joint Research Beyond 3G (JRB3G) - Goals

The Joint Research B3G (JRB3G) initiative research between Chinese and German Universities started in 08/01

Goals :

Identification of key requirements
Identification of and research in key areas
Contribute to world-wide standardisation bodies
Exchange of researchers

Key Requirements Envisaged :

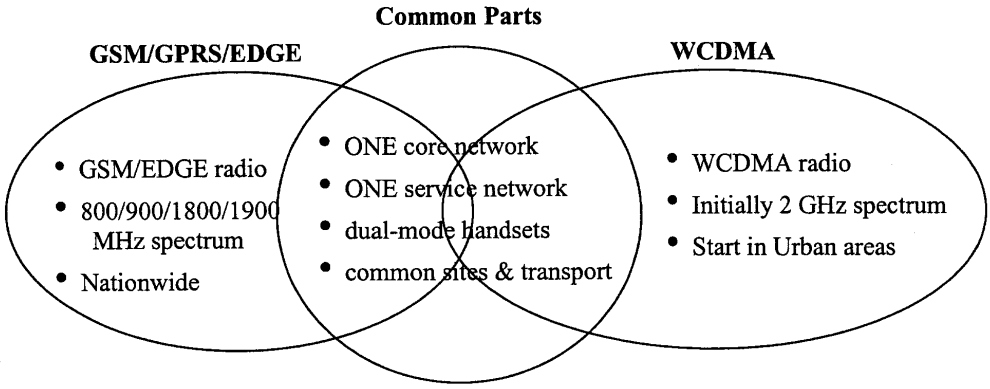
Data rates up to 100 Mbps
Channel bandwidth: 20 - 100MHz
High spectral efficiency (GE 1bit/s/Hz/cell)
Support of mobility up to 250 km/h
IP optimised
Ad-hoc capability (self- organising networks)
Support of asymmetric services
Support of different Quality of Service (QoS) requirements
Large area coverage
Compatibility to 2G and 3G systems
Moderate receiver complexity (Moore's Law)
Minimising risks for human health

3. FuTURE - Goals

- Development of an Air-interface for a B3G system
  Key Design criteria:
  System capacity 3 – 5 times higher than in 3G
  Support of high speed mobility (250 km/h)
  Support of backward compatibility to 3G
- Development of an Experimental system: GMC-TDD-xDMA
  Initial set-up:
  2 Mobile Stations
  1 Base station

Multiple antennas at the receiver side?

GSM & WCDMA - the seamless network
- investment in 2G can be reused in 3G



第三章 行動電話號碼可攜性(MNP)技術

行動電話號碼可攜性(MNP-Mobile Number Portability)可定義為：(1) Keep the same number within one country between operators MSISDN，(2) services not included

一、行動電話號碼可攜性 MNP(Mobile Number Portability)標準

- Standards tailored for a mobile network
- 3G TS 22.066
  - Support of MNP ; Service Description - Stage 1
- 3G TS 23.066
  - Support of MNP; Technical Realization - Stage 2
- Developed as TS technical Specification by 3GPP
  - Accepted as standards within ITU, ETSI, ANSI and many national standards

二、行動電話號碼可攜性服務提供程度

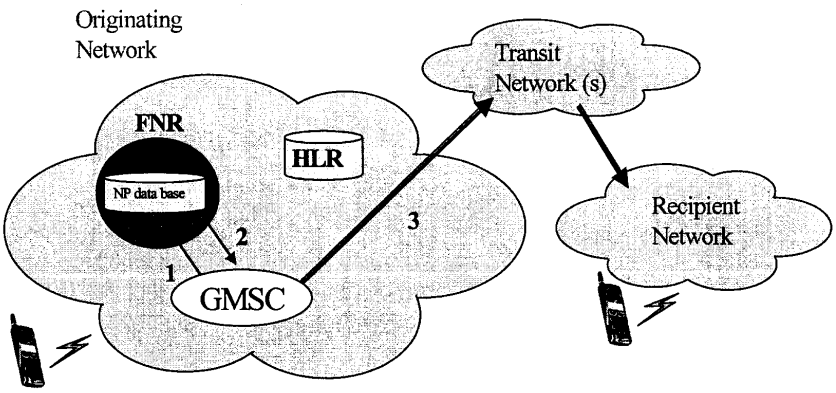
- The ported subscriber can use exactly the same service as non ported one
- The services offered by donor network have no influence on services provided by the subscription network
- Handling of supplementary services is not affected
- The IMSI shall not be ported
  - a new IMSI is issued to a ported subscriber

三、行動電話號碼可攜性型態 I

- SRF Signalling Relay Functions (supported by FNR)
  - Call related
    - Direct Routing
    - Indirect Routing
    - Indirect Routing with referance to the Subscription Network
  - Non-Call related
    - Direct Routing
    - Indirect Routing

MNP Call Related SCENARIO

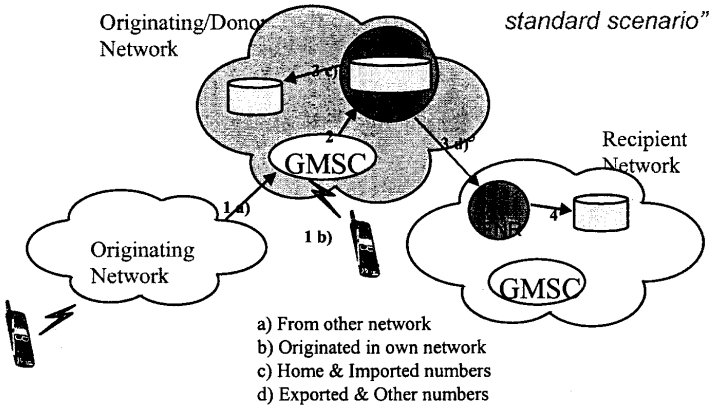
"Direct Routing" - Call related message
Exported/Other subscriber



2.- SRIack with MSRN=PREFIX + MSISDN

MNP NON-CALL SCENARIO

"Non Call related message
standard scenario"



四、行動電話號碼可攜性型態 II

- IN Call Related (not supported by FNR, supported by another product)
  - Terminating Call Query on Digit Analysis
  - Query on HLR Release
  - Originating Call Query on Digit Analysis

五、行動電話號碼可攜性 Benchmarking：SRF Direct Routing

- SRF 優點
  - Support of non-call related features like SMS
  - Shorter execution time
  - Higher call handling capacity
  - Higher number of transactions per second
  - Complete solution implemented in one node
  - Large customers base
  - Follows 3GPP, ETSI, ITU standards
  - Strategic tool for 2G to 3G migration
  - Offers flexible usage of network resources
- IN 優點
  - Higher data Base Capacity
    - 50 millions individual for IN
    - 16-32 millions individual entries depending on processor for SRF

六、行動電話號碼可攜性服務解決方式

- Standardized solution uses Concatenated Addressing (I.e. a prefix in ISUP addressing parameters), independently of the approach
- The prefix is agreed in length and meaning among the WCDMA/UMTS/GSM operators in the country, together with the National Telecom Regulatory body
- Operators exchange information about ported subscribers, either directly among them, or by means also of a centralized national database for ported numbers.
- Some actions to wrongly updated info, or fees for usage of other operators' network resources to be agreed.

七、推動行動電話號碼可攜性服務好處

- MNP may lead to an increased competition and quality and may help increasing a total subscriber base
  - MNP may accelerate service innovation
- Efficient use of numbering plan

第四章 車隊網路發展(FleetNet - Internet on the Road)

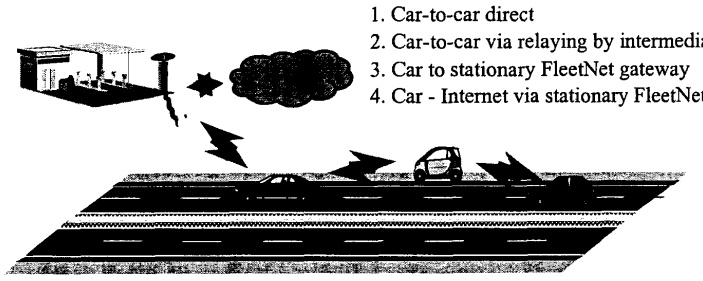
Development of technologies for communication between vehicles as active mobile Internet nodes free of charge。合作夥伴包括：DaimlerChrysler AG, FhI Fokus, NEC Europe Ltd., Robert Bosch GmbH, Siemens AG, TEMIC TELEFUNKEN microelectronic GmbH, TU Hamburg-Harburg, University of Hannover, University of Mannheim, TU Braunschweig。研究計畫期間 Sept. 1, 2000 - Dec. 31, 2003。

Telematics Services Today	Inter-vehicle Communications
Mobile cellular networks	Decentralized by mobile ad hoc networks
Charged for usage	Buy and use for free
Access network	Local network
Server oriented services	Floating applications Data is transmitted and consumed, where it is generated and needed

一、Inter-Vehicle Communications Platform

1. Car-to-car direct
2. Car-to-car via relaying by intermediate cars
3. Car to stationary FleetNet gateway
4. Car - Internet via stationary FleetNet gateway

Inter-Vehicle Communications Platform



1. Car-to-car direct
2. Car-to-car via relaying by intermediate cars
3. Car to stationary FleetNet gateway
4. Car - Internet via stationary FleetNet gateway

Applications

- **Cooperative Driver Assistance**
  - emergency notifications
  - platooning
- **Decentralized Floating Car Data**
  - dynamic navigation
  - route weather forecast
- **User Communication & Information Services**
  - Internet access
  - mobile office

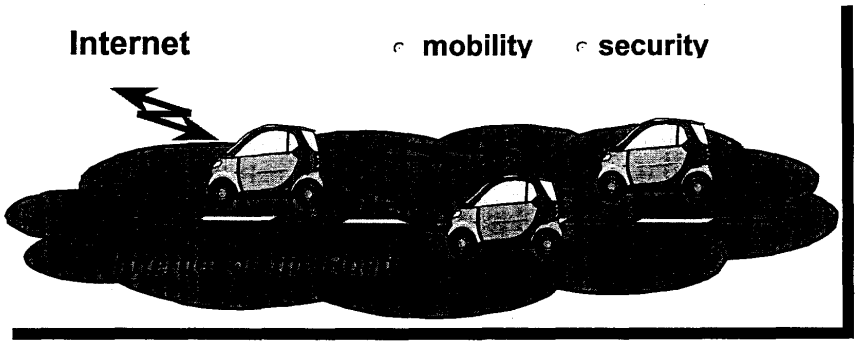
二、Applications

- **Cooperative Driver Assistance**
  - Emergency notifications
  - Relaying of sensor data
  - High demands on transmission delay and security
  - High priority when related to passengers' safety
  - Position dependent addressing
- **Decentralized Floating Car Data**
  - Example: Provision of a traffic flow profile on the anticipated route
  - Data from different routes may be evaluated and provided to a onboard navigation system
  - Transmissions occur periodically
  - Communications based on broadcasts
  - Route weather forecast
- **User Communication & Information Services**
  - Common Internet applications (Mail, Chat, WWW, ...)
  - IP-addressing and position dependent addressing
  - High bandwidth demands
  - Marketing along the road scenarios

三、Challenges

- **Internet Integration**
  - mobility
  - security
- **Position Based Routing**

  For inter-vehicle communications, addressing w.r.t. IDs and/or geographic positions is required.
- **Radio Hardware and Frequency Bands**
  1. Funkwarn-System Robert Bosch GmbH 868 MHz
  2. Radar systems 24,00 - 24,25 GHz
  3. IEEE 802.11 Radio LANs ISM-Band: 2,4 - 2,483 GHz
  4. ETSI/BRAN Hiperlan Hiperlan bands at 5 GHz
  5. UTRA TDD Unlicensed UMTS-Band: 2,010 -2,020 GHz
- **Medium Access Control and Radio Resource Management**
- **Internet Integration**



觀感與建議

一、 WCDMA 發展不如 cdma2000 理想的情況下，易利信、諾基亞等採 WCDMA 標準的業者所受衝擊更大。歐洲行動產業雖極力尋求 2.5G 及 3G 服務以增加新營收，但只有 20%的歐洲行動使用者表示未來兩年才會採用 2.5G 和 3G 服務。

二、 Ovum 預估 2003 年 6 月前，全球 3G 的用戶數量將達 1140 萬，2005 年前將增加達 6640 萬，至 2007 年 1 月前將超過 2.5 億。Ovum 同時指出，謹慎規劃是 3G 成功的關鍵因素。

三、 3G 網路有幾項重要議題，包括 3G 規劃不同於 2G，2G 網路主要與聲音的單一服務有關，然而 3G 網路完全不同，強調動態影像服務等。另外，網路設計的行銷角色不同，業者必須確信行銷及技術團隊一開始就緊密合作。因此，一開始就在資源及工具上小幅投資，可同時節省時間及金錢，成功的機會就會大大提昇。

四、 3G 手機受限於專利多掌握在國際大廠如 Nokia 等業者手中，促使其他業者欲投入發展將造成瓶頸，間接也將影響 3G 普及的時程。在 3G 的發展初期，發展 2.5G、3G 雙模共用的手機勢在必行，但由於目前手機業者對雙模的定義仍有爭議，除建議由 2.5G 系統負責語音、3G 系統負責數據傳輸的模式外，直接以傳輸速率區分等均有業者提出，加上 2.5G、3G 的雙模手機在價格、技術等掌握上仍未成熟，也加深 3G 無法突破的困難性。據稱，雙模手機最快應可在 2003 年上半推出，而 3G 專用手機也可望在 2003 年下半問世，但將仍以特定用戶使用為主。

五、 可預期的未來，行動電話的服務市場將可以分為四大類，分別是 C2C（消費者與消費者）、B2C(企業與消費者)、B2B(企業與企業)、B2E(企業與員工)，未來的主要幾個發展應用將包括以消費者為主軸的線上遊戲、在地性服務、以及以企業用戶為主軸的服務。因此，未來網路業者、內容提供者、服務提供者彼此合作情形必定會愈來愈多。唯有透過相互合作，彼此利潤共享，創造新的商業模式，才能達到雙贏局面。

六、 歐洲電信大廠皆已著手進行 B3G 之研發展，目的是要找出方法以增加 GSM 容量。WWRF 目標: Secure momentum, strategic orientation, and impact for the research on wireless communications beyond 3G；Evolutionary steps of 3G as well as new concepts。

七、 B3G 面臨之挑戰與困難有：Multiple Access and Modulation、Channel Modeling、Spectrum Flexibility for 4G Radio Access、Efficient use of the spatial dimension、Fast Resource Management 等。

八、 號碼可攜服務是促進電信市場公平競爭所不可或缺的機制之一，電信總局表示 3G 開台營運後，將提供行動電話號碼可攜性服務。行動電話號碼可攜性服務可提供程度，依歐洲電信大廠之界定為

- The ported subscriber can use exactly the same service as non ported one
- The services offered by donor network have no influence on services provided by the subscription network
- Handling of supplementary services is not affected
- The IMSI shall not be ported
- a new IMSI is issued to a ported subscriber

九、 行動電話除了提供 Human 使用之市場外，歐洲電信大廠亦積極投入車輛應用之 Non-Human 市場之研發。現正繼 Telematics 服務朝 Inter-vehicle Communications 服務開發，以提供更有效能及便宜之車輛管理服務。

1.Cooperative Driver Assistance

- 緊急事件通知
- 偵策資料傳送
- 高標準之傳輸延遲及傳輸安全
- 高優先傳送有關乘客安全訊息
- 位置相關定位

2.Decentralized Floating Car Data

- Provision of a traffic flow profile on the anticipated route
- Data from different routes may be evaluated and provided to a onboard navigation system
- Transmissions occur periodically
- Communications based on broadcasts

- Route weather forecast

3.User Communication & Information Services

- 一般網際網路應用 (Mail, Chat, WWW, ...)
- IP-定位及位置相關定位
- 高頻寬需求
- Marketing along the road scenarios

附　錄

ERICSSON

3G and Beyond

Jan Färjh
Director
Access Technologies and Signal Processing
Ericsson Research

ERICSSON

Outline

- Capacity evolution
  - GSM/EDGE
  - WCDMA
- Wireless evolution beyond 3G
  - WWRF/WWI
  - Research topics of importance

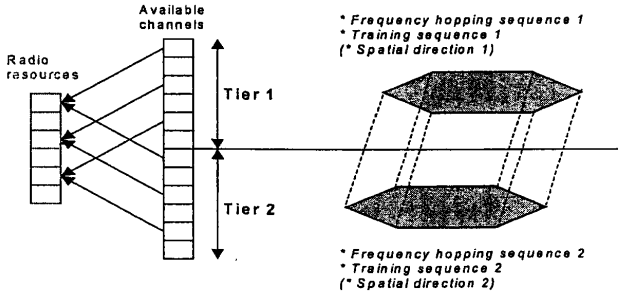
ERICSSON

Means to increase capacity in GSM

- SAIR from Ericsson
  - Advanced signal processing technique
  - Interference rejection with only one antenna!
- Adaptive Antennas
  - Up to 200% more capacity
  - Step by step migration
    - 20% p enetration => up to 100% capacity gain
- Cannel Allocation Tiering (CHAT)
  - Interference diversity
  - Interference suppression
  - Interference avoidance

ERICSSON

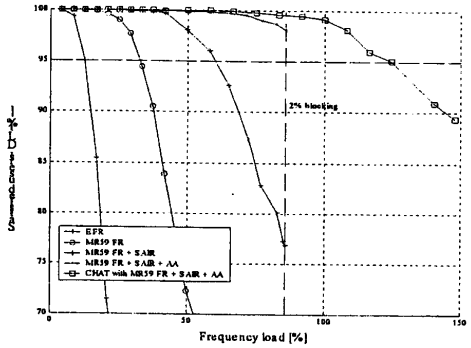
Channel Allocation Tiering (CHAT)



ERICSSON

CHAT Fractional Reuse

DL performance



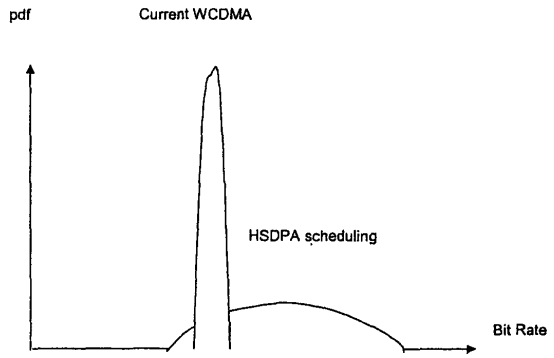
ERICSSON

High Speed Downlink Packet Access (HSDPA)

- Enhanced support for downlink packet data for WCDMA
  - Higher peak data rates (~10 Mbps)
  - Higher capacity
  - Lower air-interface delay
- New transport channel HS-DSCH
  - High Speed Downlink Shared Channel
  - Higher-order modulation
  - Fast link adaptation and fast channel-dependent scheduling
  - Hybrid ARQ with soft combining
- 3GPP Release 5 (March 2002)

ERICSSON

Principal behavior



ERICSSON

High Speed Downlink Packet Access (HSDPA)

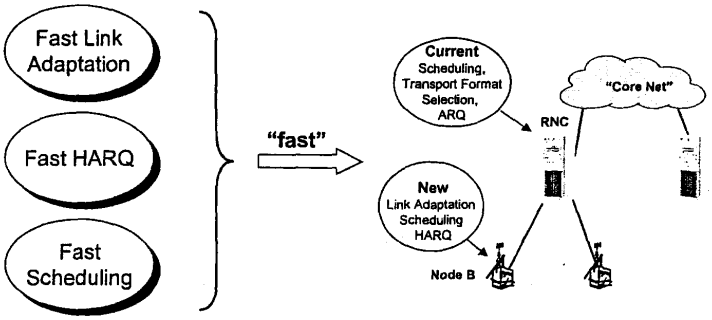
Characteristics !

- Best-effort packet data service
- Co-exists with speech-service on same carrier
- Support High Peak-Rates
- 2-3 times higher system throughput
- Low delay ---> interacts well with TCP/IP

ERICSSON

Basic Technologies and Architectural Aspects

Basic Technologies **Architectural Aspects**



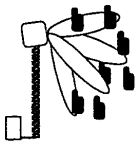
ERICSSON

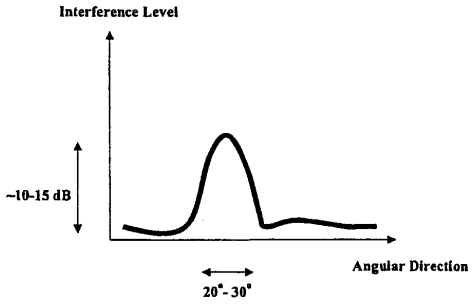
HSDPA/R5

HS-DSCH Performance Enhancement Possibilities by Employing Advanced Antenna System Concepts

ERICSSON

Fixed Beams

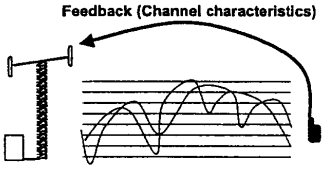


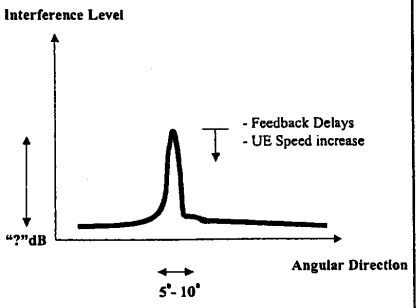


"Helps All - appr. 5 dB"
Lower system level interference:
- add users *AND/OR*
- increase average throughput

ERICSSON

Rich Feedback

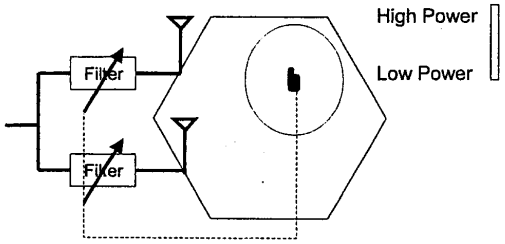




"Helps All - But How Much?"
Lower system level interference:
- add users *AND/OR*
- increase average throughput

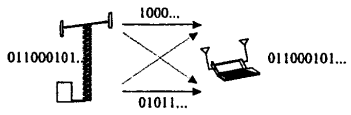
ERICSSON

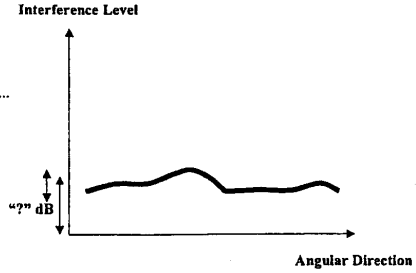
Transmit Diversity with Rich Feedback



ERICSSON

MIMO



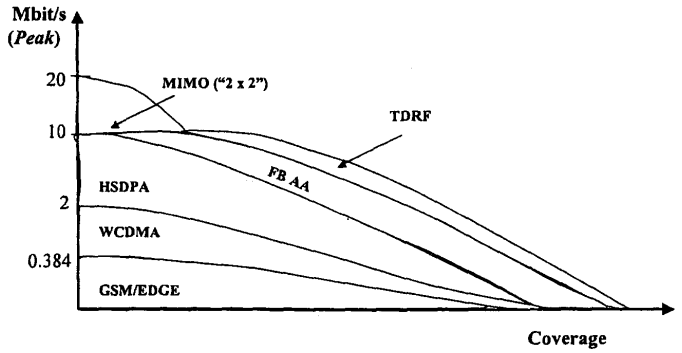


"Helps Some - But How Often?"

Higher Peak Bit Rates possible

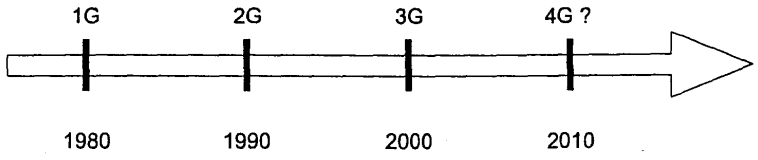
ERICSSON

Positioning of the Concepts



ERICSSON

Wireless access evolution beyond 3G



ERICSSON

From
Frame work Programs 1989 – 2002...

Wireless Strategic Initiative – WSI

Wireless World Research Forum – WWRF

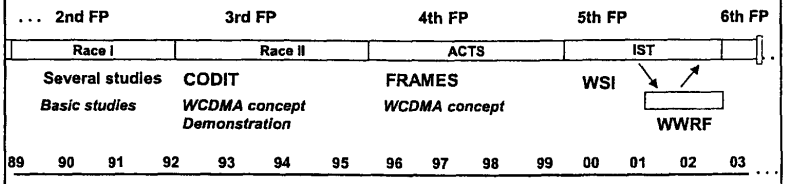
To

...The EU FP6 2002 – 2006

"Wireless World Integrated Project"

ERICSSON

A Chain of Research programs – From basic studies to New System Concepts



ERICSSON

Wireless World Research Forum - WWRF

Goal: - Secure momentum, strategic orientation, and impact for the research on wireless communications beyond 3G

- Evolutionary steps of 3G as well as new concepts.

ALCATEL – Build on the results of the WSI Think Tank 2000

ERICSSON – More detailed investigation of the identified issues

NOKIA Connecting People – Develop proposals to support international and national research programs

SIEMENS

Motorola – Discuss the implications of research results on spectrum and regulatory issues

.....

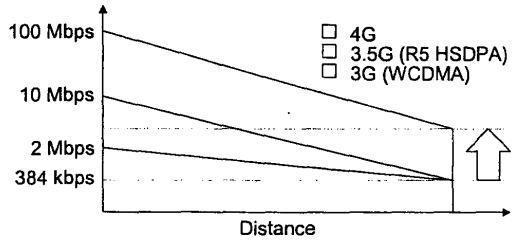
ERICSSON

Research topics of importance

ERICSSON

Data rates for 4G

- Extreme peak data rates
  - Target > 100 Mbps (downlink)
- Good coverage for very high data rates
  - Also for high speeds and substantial time dispersion



ERICSSON

Continuing challenges

- Multiple Access and Modulation
- Channel Modeling
- Spectrum Flexibility for 4G Radio Access
- Efficient use of the spatial dimension
- Fast Resource Management

ERICSSON

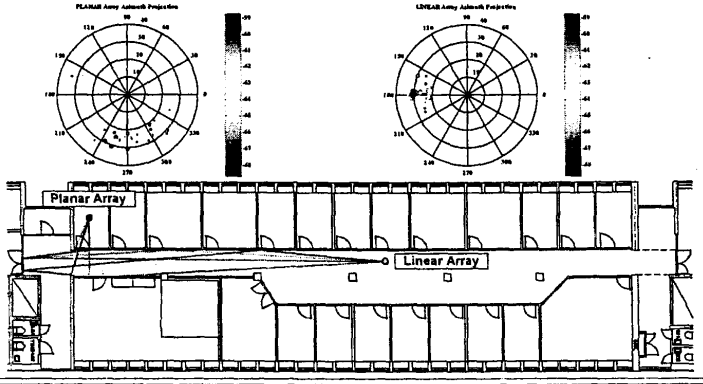
Multiple Access and Modulation

- The bandwidth of 4G might be 10 times larger than WCDMA
- Candidate MA schemes:
  - Single carrier DS-CDMA
  - Multi-carrier DS-CDMA
  - OFDM with spreading in the frequency domain (OFCDM)

ERICSSON

Channel Modeling

- Accurate channel models essential for design and evaluations:
  - Wideband, MIMO, Indoor and outdoor measurements



ERICSSON

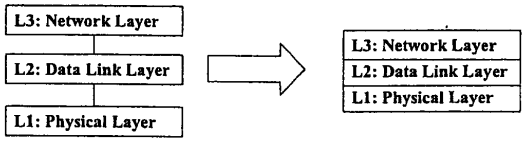
Efficient use of the spatial dimension

- Interference management with multiple Tx and Rx antennas integrated with radio network functionality
  - Adaptive antennas, space time coding, MIMO transmission
  - Combined with rich feedback and fast scheduling
- Different antenna concepts complements each other.
  - When to use which scheme for what?
- Advanced antenna solutions is a core component in the design but optional to implement.

ERICSSON

Fast Resource Management

- Resource management interacts closely with physical layer
  - fast and characterizing measurements
  - fast control and reconfiguration



- Adapt to instantaneous and not average radio conditions
  - exploit multi user diversity
  - exploit the frequency dimension
  - exploit the spatial dimension

ERICSSON

Summary

- Evolution of GSM/EDGE and WCDMA ongoing
  - Advanced antenna Systems
  - High Speed Downlink Packet Access
- Continuing challenges exists, e.g.
  - Multiple Access and Modulation
  - Channel Modeling
  - Spectrum Flexibility for 4G Radio Access
  - Efficient use of the spatial dimension
  - Fast Resource Management
- WWRF and WWIP initiatives to cover issues for 4G

NOKIA

The Roots of Nokia

Fredrik Idestam (1838-1916)
Founder of Nokia
President of Nokia Company 1871-1894

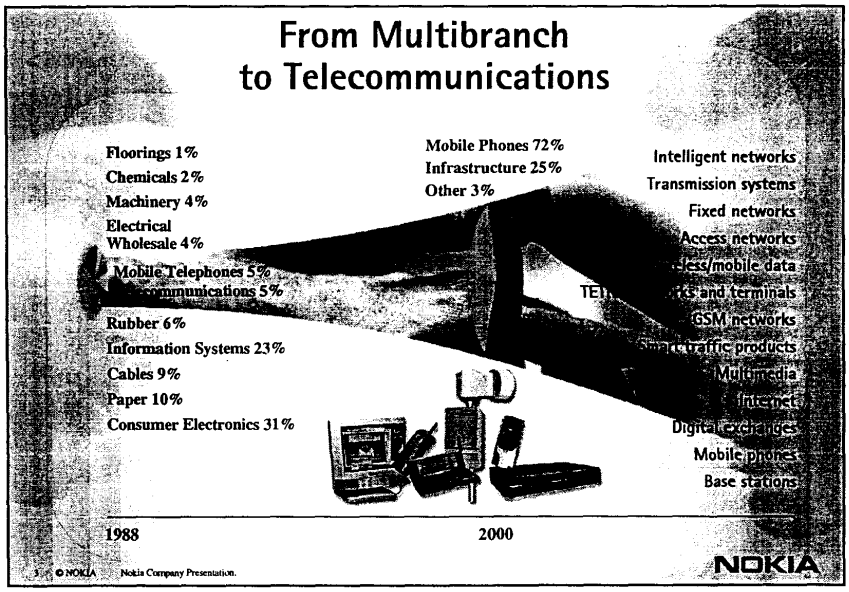
Founded in Tampere in 1865. Soon moved to neighboring town of Nokia. First product was groundwood.

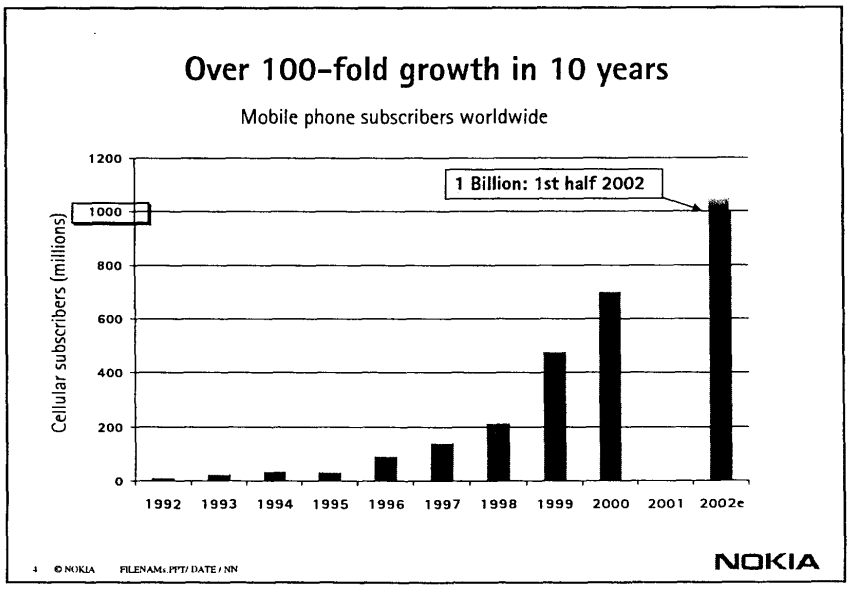
Finnish Rubber Works Ltd. Founded in Helsinki in 1898. Soon moved to Nokia. First product was rubber galoshes

Finnish Cable Works Ltd. founded in Helsinki in 1912. First product was imported copper wire coated with rubber-impregnated textile layer.

Nokia Corporation formed in 1966 through the merger of Nokia Company, Finnish Rubber Works and Finnish Cable Works.

NOKIA


From Multibranch
to Telecommunications
Floorings 1%
Chemicals 2%
Machinery 4%
Electrical
Wholesale 4%
Mobile Telephones 5%
Rubber 6%
Information Systems 23%
Cables 9%
Paper 10%
Consumer Electronics 31%
Mobile Phones 72%
Infrastructure 25%
Other 3%
Intelligent networks
Transmission systems
Fixed networks
Access networks
Mobile phones
Base stations
1988
2000
NOKIA


Over 100-fold growth in 10 years
Mobile phone subscribers worldwide
1 Billion: 1st half 2002
Cellular subscribers (millions)
1200
1000
800
600
400
200
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002e
NOKIA

Nokia - Key Figures 2001 (pro forma)

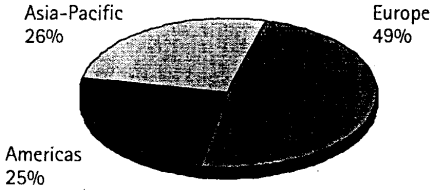
	2001 EUR	2000 EUR	Change %
Net sales (million)	31 191	30 376	+3
Operating profit (million)	5 237	5 861	-11
Operating margin (%)	16.8	19.3	
Earnings per share, diluted, (split adjusted)	0.79	0.84	-6
Net debt to equity, gearing (%)	-41	-26	
Research and development (million)	2 985	2 584	+16
Personnel (year-end)	53 849	60 289	-11
Proposed dividend	0.27	0.28	-4

1 EUR = 0.9026 USD (December 31, 2001)

NOKIA

Balanced Global Market Presence

Net sales 2001
EUR 31.2 billion



- Biggest markets US, China and UK

1 EUR = 0.9026 USD (December 31, 2001)

NOKIA

Nokia Networks

The Partner for the Mobile World

- Net sales EUR 7.5 billion, personnel 19 392 in 2001
- Leader in 2G networks. Leading 3G supplier.
- Leader in cost-efficient all-IP networks for future high capacity needs, including fixed broadband access
- Over 100 GSM customers around the world. Targets at 35% market share in mobile networks.
- Leader in TETRA networks for public safety and security
- World-class services for network deliveries, integration and support; end-to-end solutions for optimised network performance and increasing network usage

1 EUR = 0.9026 USD (December 31, 2001)

NOKIA

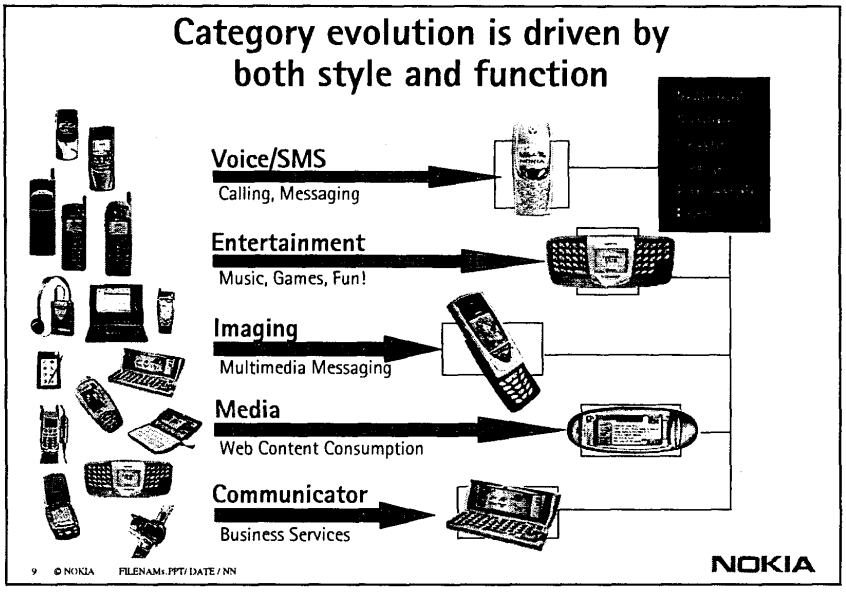
Nokia Mobile Phones

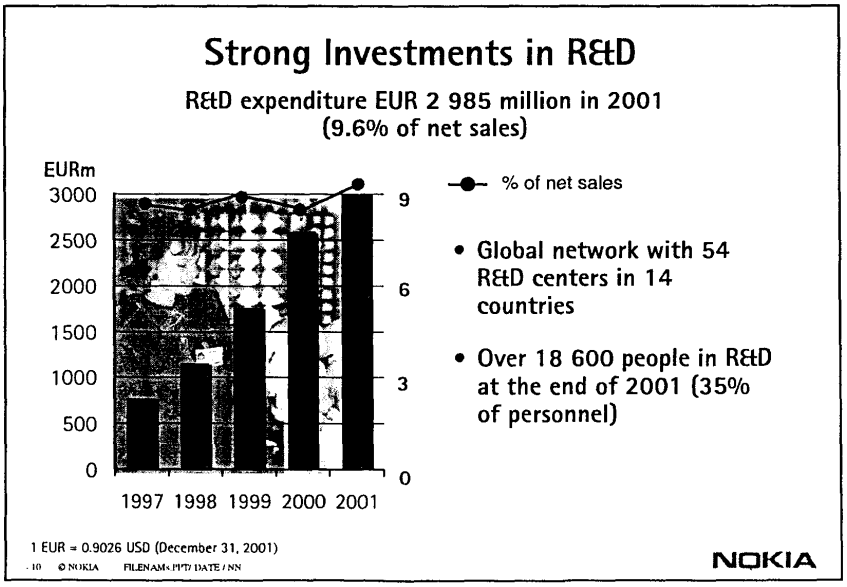
The World Leader in Mobile Handsets

- Net sales EUR 23.2 billion, sales volume of approx. 140 million units; personnel 26,453 in 2001
- The world's leading mobile phone company since 1998 with about 37% market share in 2001
- One of the world's most recognized and valued consumer brands
- Constantly evolving product portfolio covering all consumer segments and standards worldwide
- A world leader in development of mobile terminal software and server solutions

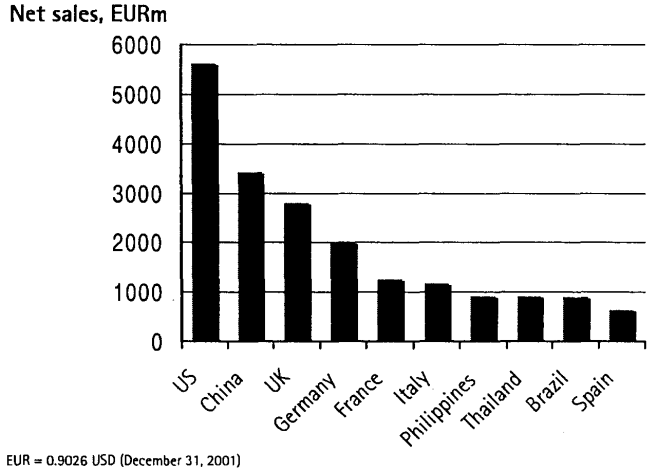
1 EUR = 0.9026 USD (December 31, 2001)

NOKIA


Category evolution is driven by both style and function
Voice/SMS
Calling, Messaging
Entertainment
Music, Games, Fun!
Imaging
Multimedia Messaging
Media
Web Content Consumption
Communicator
Business Services
9 © NOKIA FILENAME.PPT/ DATE / NN
NOKIA


Strong Investments in R&D
R&D expenditure EUR 2 985 million in 2001
(9.6% of net sales)
EURm
3000
2500
2000
1500
1000
500
0
9
6
3
0
1997 1998 1999 2000 2001
% of net sales
• Global network with 54 R&D centers in 14 countries
• Over 18 600 people in R&D at the end of 2001 (35% of personnel)
1 EUR = 0.9026 USD (December 31, 2001)
10 © NOKIA FILENAME.PPT/ DATE / NN
NOKIA

Nokia's Largest Markets 2001



1 EUR = 0.9026 USD (December 31, 2001)

NOKIA

Life Goes Mobile – Now!

In the future, a major part
of personal communication
– be it voice, data, images, or video –
will be wireless

The personal wireless terminal
will be the main application
platform and media!

NOKIA

MMS for sharing personal moments

NOKIA

MMS for sharing personal moments

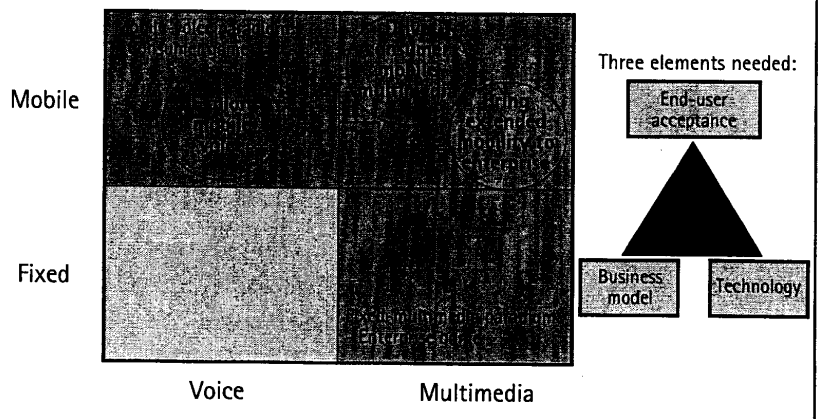
NOKIA

Nokia 3G Strategy and Market Making

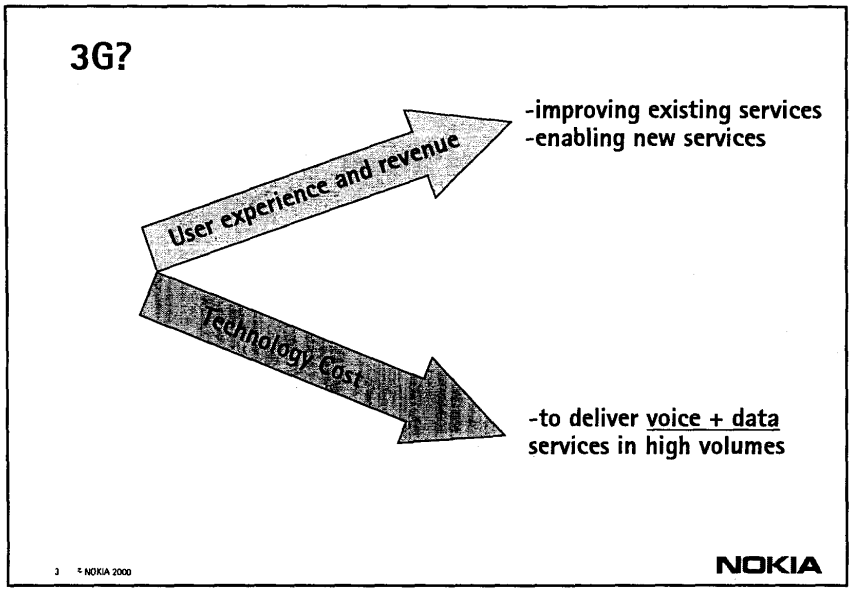
Hannu Pikkarainen
Nokia Networks

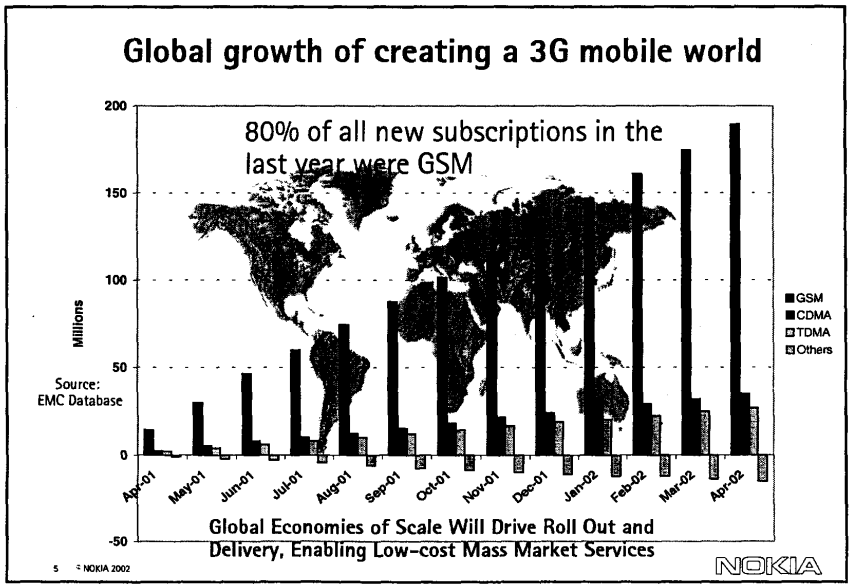
NOKIA

Nokia Strategy



NOKIA

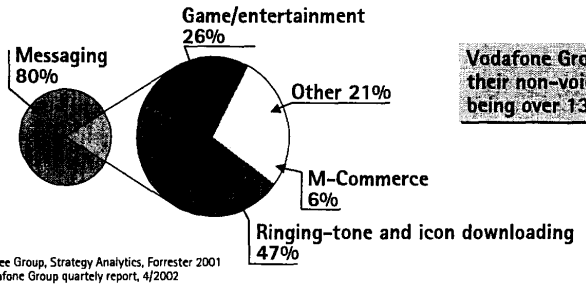

3G?
User experience and revenue
Technology cost
-improving existing services
-enabling new services
-to deliver voice + data services in high volumes
NOKIA


Global growth of creating a 3G mobile world
80% of all new subscriptions in the last year were GSM
Millions
200
150
100
50
0
-50
Source: EMC Database
Apr-01
May-01
Jun-01
Jul-01
Aug-01
Sep-01
Oct-01
Nov-01
Dec-01
Jan-02
Feb-02
Mar-02
Apr-02
GSM
CDMA
TDMA
Others
Global Economies of Scale Will Drive Roll Out and Delivery, Enabling Low-cost Mass Market Services
NOKIA

Non-voice services make increasing ARPU impact

- Non-voice services 11.7% of total ARPU in Western Europe 2001
- Up from 7% in 2000, estimate 15% for 2002

Non-voice service usage in Western Europe (2001)



Vodafone Group reported their non-voice services ARPU being over 13% in 3/02

Sources: Yankee Group, Strategy Analytics, Forrester 2001
Vodafone Group quartely report, 4/2002

NOKIA

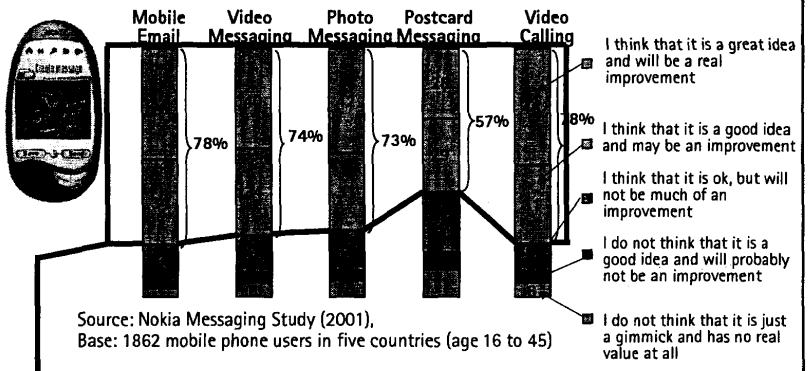
Nokia end-to-end Service Enablers

	2001	2002	2003	2004
TERMINAL	• GPRS terminal • Smart messaging • WAP Push • Personal Java • SyncML • Bluetooth • DRM (MP3/AAC)	• WCDMA/GSM terminal • Colour display • MIDP Java • XHTML browser (WEB/WAP)[1] • Multimedia messaging [1]	• EDGE terminal • Rich call, Instant messaging, Presence • IPv6 • Nonreal time SIP	• WCDMA/EDGE terminal • QoS streaming & conversational • OTDOA, A-GPS
NETWORK	• 3GPP R99 netw • Wideband b • QoS differen • Network techn • Operator V • xDSL syste • Positioning • Cell-based • Bearers • WCDMA: 38			• 3GPP Rel.6 • IMS/PSTN interworking Network technologies • VoIP PMR-solution Bearers • WCDMA: 10M
APPLICATION PLATFORMS & SERVICES	• Multimedia Messag • Java Midlet provisioning • Enhanced location service • WAP push • Remote terminal management • Mobile payments and advertising • Downloadable JAVA games	• Presence server • Content protection • 3G Streaming Server	• Messaging support • Voice Browsing Server • Context sensitive content • GPS positioning	• Advanced SIP service capabilities • Seamless access • Persistent sessions • Application driven QoS • Application distribution between terminal and server • Multicast Service

Imaging & Messaging
Mobile Games
Mobile Music
Mobile Shopping
Mobile Office

NOKIA

End-users are keen on new messaging services ...



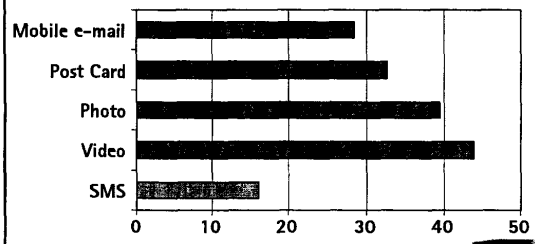
Source: Nokia Messaging Study (2001),
Base: 1862 mobile phone users in five countries (age 16 to 45)

2/3 of core target segment of mobile messaging thinks multimedia messaging as improvement

NOKIA

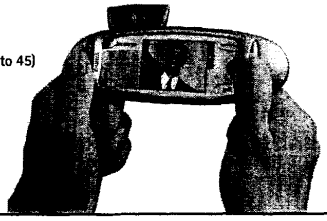
... and they are ready to pay more ...

Tariff-level that end-users would pay for messaging (eurocents)



End-users see different multimedia messaging applications 2-3 times more valuable than what is currently charged for SMS

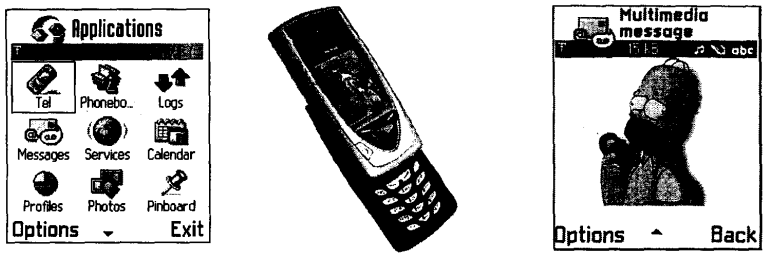
Source: Nokia Messaging Study (2001),
Base: 1862 mobile phone users in five countries (age 16 to 45)



NOKIA

Looking into 2002

[redacted] [redacted] [redacted]



[redacted]

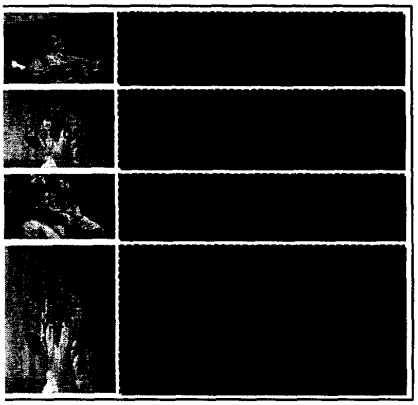
NOKIA

End-to-End With Nokia

NOKIA

Nokia end-to-end capabilities

Example: MMS



- MMS capable terminals in two UI classes for 1H/02
- e2e MMS solution including:
  - Legacy phone support
  - Email support
  - Voice clip support
- Optimised GPRS networks for MMS services
- e2e prepaid support for Nokia MMS solution
- Flexible tariffing models supported
- Open interfaces for 3rd party content development

NOKIA

The first WCDMA 3G networks are opening this year

Mobile middleware and services

- Mobile middleware platforms built for GPRS will convert to 3G
- Multimedia Messaging Service infrastructure is up-and-running for WCDMA 3G openings in 2H02

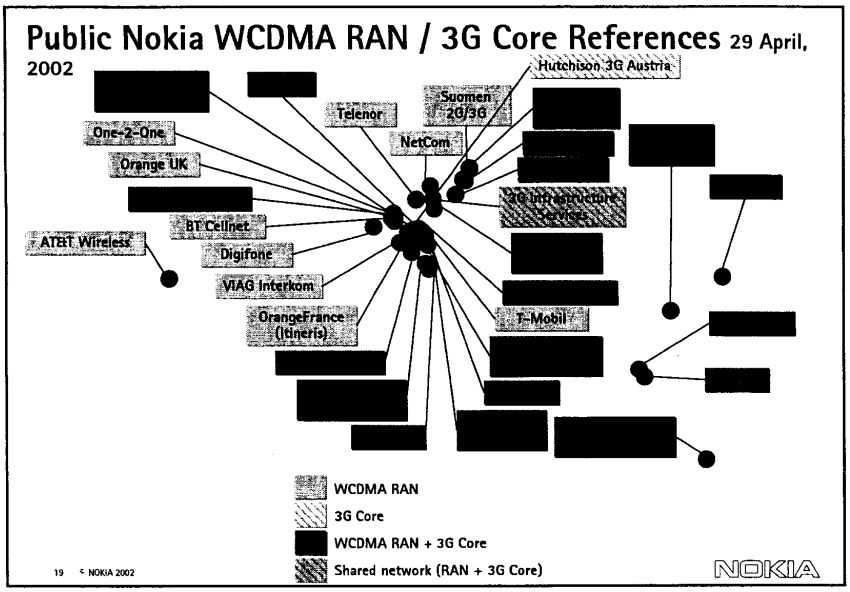
Mobile terminals

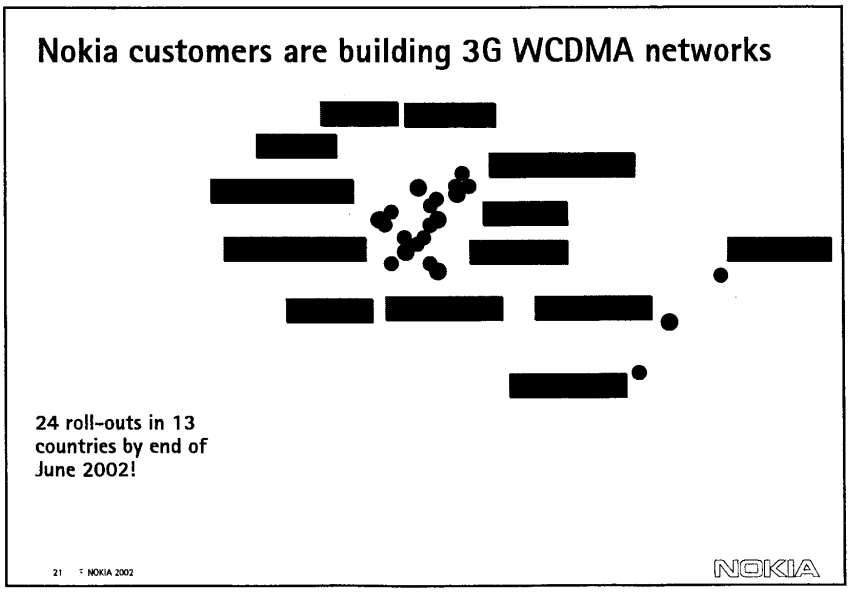
- Nokia will launch **dual-mode** GSM/WCDMA terminals in 2H02

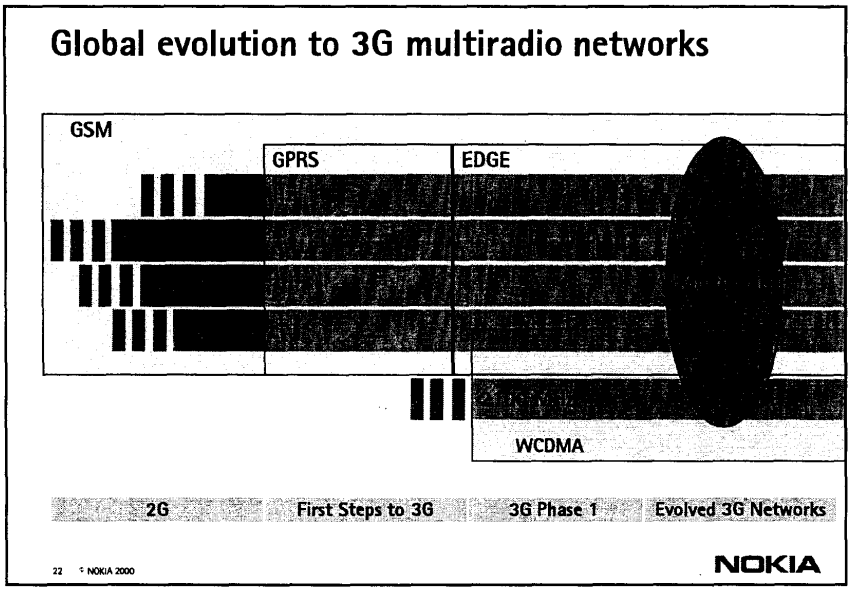
Mobile networks

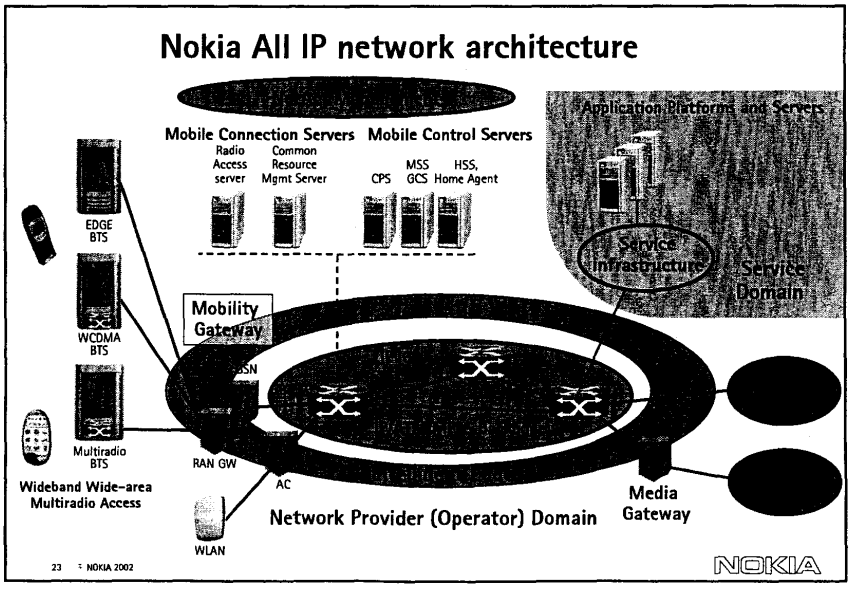
- Volume deliveries of network equipment started in September 01
- First 3GPP R99 commercial standard version voice call in December 01 and packet data call in February 02
- Many operators are building networks now

NOKIA


Public Nokia WCDMA RAN / 3G Core References 29 April, 2002
Hutchison 3G Austria
Suomen 2G/3G
Telenor
NetCom
One-2-One
Orange UK
BT Cellnet
AT&T Wireless
Digifone
VIAG Interkom
OrangeFrance (Itineris)
T-Mobil
WCDMA RAN
3G Core
WCDMA RAN + 3G Core
Shared network (RAN + 3G Core)
19 © NOKIA 2002
NOKIA


Nokia customers are building 3G WCDMA networks
24 roll-outs in 13 countries by end of June 2002!
21 © NOKIA 2002
NOKIA


Global evolution to 3G multiradio networks
GSM
GPRS
EDGE
WCDMA
2G
First Steps to 3G
3G Phase 1
Evolved 3G Networks
22 © NOKIA 2000
NOKIA


Nokia All IP network architecture
Mobile Connection Servers
Radio Access server
Common Resource Mgmt Server
Mobile Control Servers
MSS CPS
GCS
HSS, Home Agent
Application Platforms and Servers
Service Infrastructure
Service Domain
EDGE BTS
WCDMA BTS
Multiradio BTS
Mobility Gateway
RAN GW
AC
Wideband Wide-area Multiradio Access
WLAN
Network Provider (Operator) Domain
Media Gateway
23 © NOKIA 2002
NOKIA

Beyond 3G Radio Research

September 5th, 2002

Lauri Oksanen

Nokia Networks
Research, Standardization, and Technology

Contents

- Radio development trends
- Beyond 3G/4G radio research
- Spectrum issues

Contents

- **Radio development trends**
- Beyond 3G/4G radio research
- Spectrum issues

NOKIA

Mobile Radio Systems Generations

Radio performance seems to be the main driver for new generation

4G

Cost efficient IP based network, higher data rates

3G Evolution

Multimedia Messaging, Multiple services

3G

Packet data, always connected

2G Evolution

Digital voice, mobile data

2G

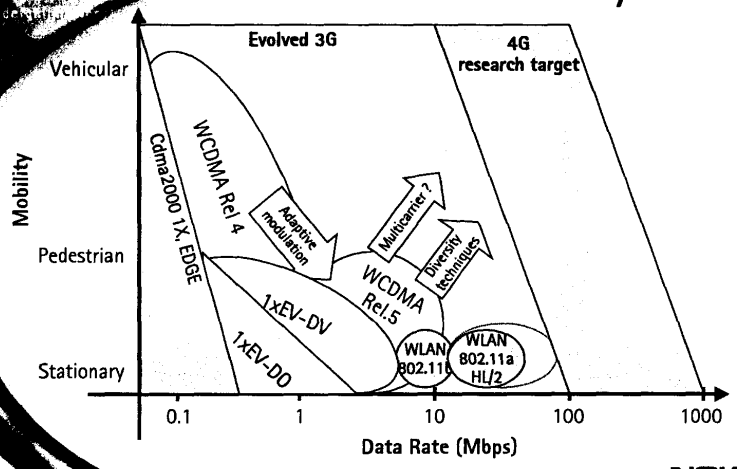
Analog voice telephony

1G

80's | 90's | 00's | 10's

NOKIA

Constant Evolution of Radio Towards Higher Data Rates and Better Mobility



NOKIA

3G Radio Evolution Continues

5 MHz

WCDMA today

- **Current 5-MHz WCDMA**
  - WCDMA Rel'99
  - WCDMA R5 with HSDPA
  - Potential performance enhancements with beamforming and base station multiuser detection

Enhanced 5-MHz WCDMA

- **Enhanced 5-MHz WCDMA**
  - New frequency bands 1.7/2.1 GHz and 2.5 GHz
  - Uplink improvements for lower latency
  - Downlink HSDPA improvements for higher bit rates

10-MHz WCDMA

- **Higher bandwidth 10..20 MHz WCDMA**
  - For boosting user bit rates
  - Higher chip rate or multicarrier

NOKIA

Nokia in 3G Evolution

- Nokia is committed to 3G and its evolution
  - Nokia 3G is clearly ahead of competition, Nokia WCDMA R4 is some 0.5 year earlier
  - Nokia 3G product range is clearly the widest in the industry
  - Nokia 3G solution has the most comprehensive functionality and feature set
  - Nokia is one of the most active companies in 3GPP standardization

WLAN is a Hot Spot Technology

- Currently WLAN (802.11) is a cost efficient hot spot coverage and capacity solution for best effort data
- Improvements can and will be made in
  - Bit rate (100 Mb/s study ongoing)
  - QoS support
  - Security
- But to maintain low cost, ease of deployment, and backwards compatibility
  - WLAN should not be developed towards a wide area, high mobility system

Contents

- Radio development trends
- **Beyond 3G/4G radio research**
- Spectrum issues

4G Trends and Drivers

- Many definitions for the term 4G exist. Nokia's view:
  - 3G evolution is based on the combination of existing technologies like cellular as main interface and Wireless LAN for hot-spot usage
  - 4G (a.k.a. "Systems Beyond 3G" or "Systems beyond IMT-2000") is a research topic for new air interfaces and systems to be considered after 2010
- Radio performance and higher throughput/lower delays identified as major drivers for 4G
  - Streaming and fast download (instant gratification) of medium size entertainment material (MP3, good resolution video clips, 3D)
    - System needs to serve at least up to 2020 and user interfaces will develop radically
  - Large size down-loads (e.g. mail-box synch.)
- Transport and last hop transmission for very high throughput are also issues but need to be developed for 3G evolution already

4G Radio Research Positioning

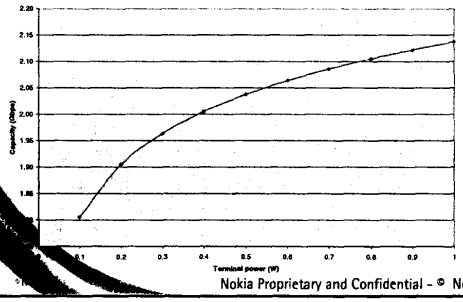
- 3G will go towards 10/100 Mbps (wide/local area) (with WLAN providing the 100 Mb/s hot spot capability) – 4G should be clearly better
  - Up to 100 Mbps/1 Gbps carrier bit rates in wide/local area deployments
  - Bandwidth up to 100 MHz
- Clear cellular capacity improvements over 3G (best effort packet)
  - Multicellular efficiency of e.g. WCDMA+HSDPA up to 0.5-1.0 bits/s/Hz
  - 4G
    - Single cell efficiency up to 5-10 bits/s/Hz
    - Multicell efficiency >> 1 bits/s/Hz
- Adaptability to different radio environments
  - Parametrized solution yielding optimal or close to optimal performance in different radio conditions (wide area, local area)
- Efficient support of services with wide variety of QoS requirements (RT, non-RT, etc.)

Why 100 Mbps/1 Gbps ?

- Absolute numbers are not that important but target setting is !
- 3G will go towards 10/100 Mbps (wide/local area) – 4G should be clearly better
- No application may need that high bit rates but the system may need it in order to
  - Serve many high bit rate users simultaneously
  - Maximize throughput/capacity
  - Minimize latencies
- There may be an optimum bandwidth which will maximize the spectral efficiency of a wireless system
  - Research target must be set high to "capture" that optimum
- Short distance radio bit rates will go towards 1 Gbps and users expect wide area coverage service level to be fairly close

Where are the Capacity Limits ?

- ple analysis of cellular capacity limit based on "Nilsson, O. undamental limits and possibilities for future telecommunications. IEEE Communications Magazine, vol. 39 no. 5, May 2001, 164-167 pp".
  - Bandwidth = 100 MHz
  - Carrier frequency = 2 GHz
  - Density of mobile terminals = 1000 per km^2

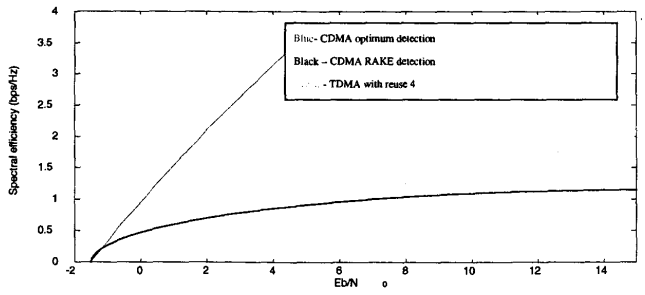


- Although analysis is idealistic very high capacities per cell seem to be possible
- Additional (possible) capacity increase by MIMO solutions not included !

NOKIA

DS-CDMA vs. TDMA capacity

- A was a good choice for re-use 1 system operating at low SNR
- Does a cross over point exist where DS-CDMA is no longer the right choice?
- Verdu* shows the spectrum efficiency for CDMA with increasing Eb/N_0:

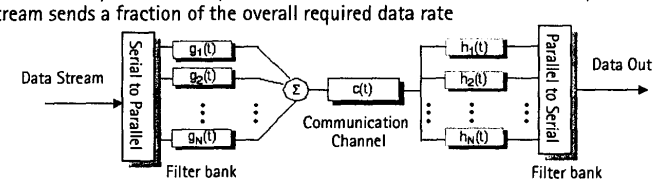


*Verdu', S. and S. Shamai, "Spectral Efficiency of CDMA with Random Spreading," IEEE Transactions on Information Theory, Vol 45, March 1999.

NOKIA

Role of Multicarrier

- Hypothetical single carrier TDMA system
  - R=1/2 channel code
  - Symbol rate of 50 Million per second
  - 4 bits per modulated symbol
- Typical cellular channel has 2 us of memory
  - 2 us channel memory = 100 symbols of memory
  - Optimal (ML) equalization requires 16^{100} operations per decoded symbol
  - **Single carrier (GSM style) TDMA is computationally intractable**
- Multicarrier systems create parallel streams of data such that each independent data stream sends a fraction of the overall required data rate



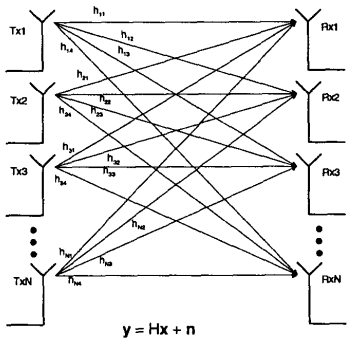
Conclusion: A parallel bank of single channel equalizers spanning small number of symbols is less complex than one equalizer over many symbols

NOKIA

MIMO

What is MIMO?

- Multiple transmit and receive antennas
- Spatial multiplexing is a type of MIMO that creates multiple simultaneous radio channels between the base station and mobile station
- Placing multiple antennas on a "terminal" becomes easier with higher carrier frequency



NOKIA

4G Targets and Multiantennas

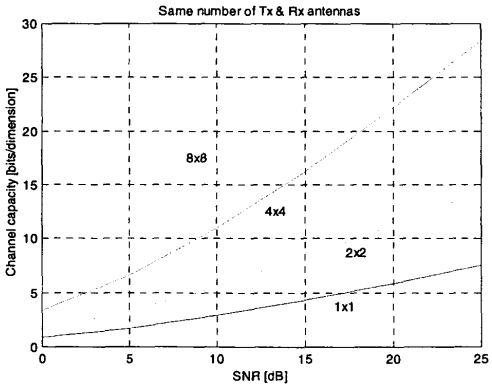
The ultimate bound for achievable spectral efficiency and data rate

- N_{Tx} and N_{Rx} are the number of transmit and receive antennas
- $SNR(N_{Tx}, N_{Rx})$ is the signal-to-noise-ratio with given number of antennas
- Capacity in bps/Hz

$$C \sim \mathrm{Min}(N_{Tx}, N_{Rx}) \cdot \log_2(1 + SNR(N_{Tx}, N_{Rx}))$$

- If either N_{Tx} or N_{Rx} equals 1 ⇒ capacity increases logarithmically (=slowly) when SNR increases
- If N_{Tx} and N_{Rx} both are larger than 1, capacity increases much faster

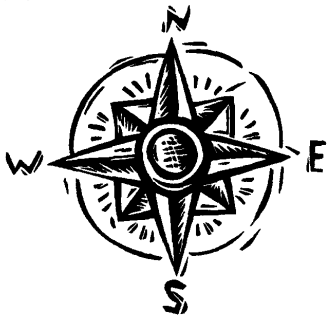
4G Targets and Multiantennas



Conclusion: 1 to 10 bps/Hz at reasonable SNR can only be achieved with MIMO

Current Likely Direction for 4G Radio Research

- Technology conclusions
  - Spread spectrum (and CDMA) may not be optimum for achieving upto 10 bps/Hz
  - Multicarrier is needed to contain receiver complexity and allow flexibility in use of available spectrum
  - Spatial multiplexing (MIMO) will play an important role in 4G



NOKIA

Contents

- Radio development trends
- Beyond 3G/4G radio research
- **Spectrum issues**

NOKIA

4G and Spectrum

- Spectrum is a scarce resource and need long term planning
- Topics requiring careful consideration
  - Frequency range
    - Preferably under 5-6 GHz
  - Paired/unpaired band
    - Unpaired bands are easier to find
  - Dedicated/shared bands
    - Capability of spectrum sharing would be beneficial
  - Minimum width of a frequency block
    - Spectrum efficiency important
  - Number of bands
    - Should be minimized
  - Global harmonization
    - Globally common bands should be sought after as much as possible

4G Spectrum: Next Steps

WRC-2003 agenda item 1.22: "to consider progress of the ITU studies concerning future development of IMT-2000 and systems beyond IMT-2000, ..."

Draft WRC-2006 agenda item 2.16: "to review the requirements for future development of IMT-2000 and systems beyond IMT-2000, ..."

- At WRC-2003 we should get a proper agenda item agreed to the WRC-2006.
- In the meantime international view needs to be shaped positive towards identifying new spectrum for systems beyond IMT-2000 in WRC-2006
- Need must be justified
  - E.g. traffic requirements

Conclusions

- 3G will continue to evolve after initial deployment
- Evolution towards IP-based core networks with multi-radio access, integrated 3G and WLAN will offer data rates from 10 to 100 Mbps
- In parallel, a revolution may happen within 10-15 years
- One key driver for 4G systems: high data rates everywhere -> hyperavailability of all media
- Unused spectrum does not exist - long term planning necessary to make spectrum available
  - WRC-2006 expected to consider requirements and identification of spectrum for 4G systems
- Possible 4G solutions and system will compete with evolved 3G => research targets must be set high
  - Peak data rates of 100 Mbps/1 Gbps in wide/local area access
- Early research points to multicarrier and MIMO techniques in 4G radio
- Target is for initial standards to be ready around 2010, subject to the outcome of WRC-2006

NOKIA

CONNECTING PEOPLE

ERICSSON

FNR Number Portability

Visit to Ericsson
By National Telecommunication Program Office, Taiwan
Stockholm September 2-3, 2002

Antun Samukic
Strategic Product Manager FNR
Flexible Numbering Register Server

ERICSSON

AGENDA

- General Overview
- Key elements of MNP
  - SRF method
    - Call related feature
    - Non-call related feature
  - IN Method
- Some Comparision
- Conclusions
- Additional Commercial Functionalities
- Contacts

ERICSSON

Base for FNR MNP Mobile Number Portability Standards

- Standards tailored for a mobile network
- 3G TS 22.066
  - Support of MNP ; Service Description - Stage 1
- 3G TS 23.066
  - Support of MNP; Technical Realization - Stage 2
- Developed as TS technical Specification by 3GPP
  - Accepted as standards within ITU, ETSI, ANSI and many national standards

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

MNP Mobile Number Portability

- Ability for a UMTS or GSM mobile subscriber to change a subscription network
  - within a portability domain
  - whilst retaining original MSISDN
- Accompanied with certain administrative actions as a part of porting process

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

MNP Mobile Number Portability
Service Aspects

- The ported subscriber can use exactly the same service as non ported one
- The services offered by donor network have no influence on services provided by the subscription network
- Handling of supplementary services is not affected
- The IMSI shall not be ported
  - a new IMSI is issued to a ported subscriber

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

WHAT IS A MOBILE NUMBER PORTABILITY?

KEEP THE SAME NUMBER
MSISDN

WITHIN
ONE COUNTRY
BETWEEN OPERATORS

6[illegible]9502

MANDATED BY REGULATION

SERVICES NOT INCLUDED

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

MOBILE NUMBER PORTABILITY DEFINITIONS

- Network types
  - Donor network
  - Recipient network
  - Other network
- Subscriber types
  - Home subscriber
  - Exported subscriber
  - Imported subscriber
  - Subscriber in other network

ERICSSON

MOBILE NUMBER PORTABILITY Types (1)

- SRF Signalling Relay Functions (supported by FNR)
  - Call related
    - Direct Routing
    - Indirect Routing
    - Indirect Routing with referance to the Subscription Network
  - Non-Call related
    - Direct Routing
    - Indirect Routing

ERICSSON

MOBILE NUMBER PORTABILITY
Types (2)

- IN Call Related (not supported by FNR, supported by another product)
  - Terminating Call Query on Digit Analysis
  - Query on HLR Release
  - Originating Call Query on Digit Analysis

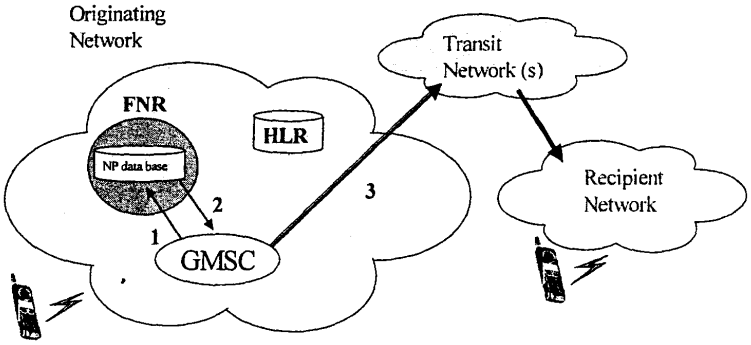
Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

"Direct Routing" - Call related message

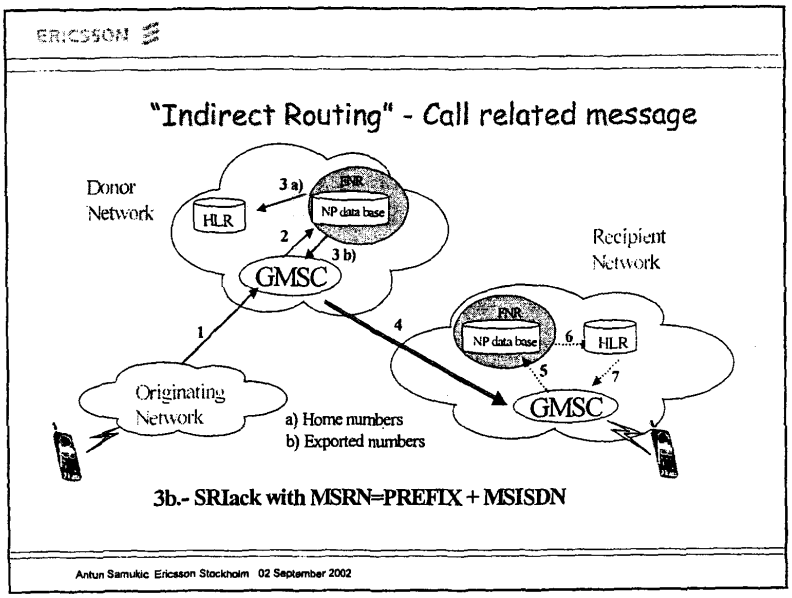
MNP SCENARIO 1

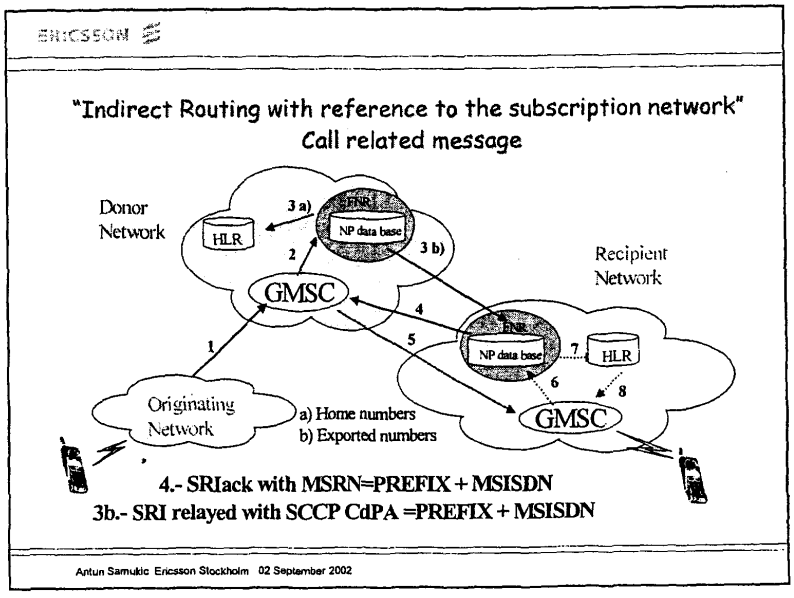
Exported/Other subscriber



2.- SRIack with MSRN=PREFIX + MSISDN

Antun Samukic Ericsson Stockholm 02 September 2002

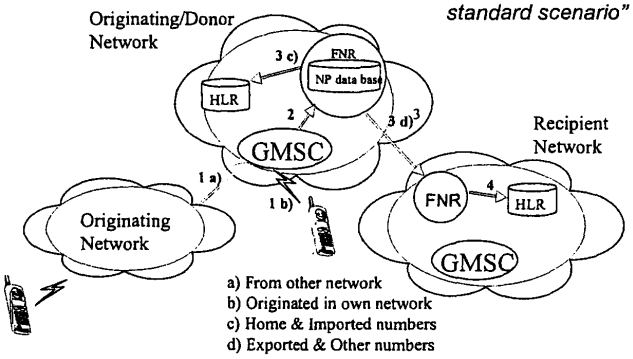

ERICSSON
"Indirect Routing" - Call related message
Donor Network
HLR
3 a)
INR
NP data base
2
3 b)
GMSC
Recipient Network
1
4
INR
NP data base
6
HLR
5
7
GMSC
Originating Network
a) Home numbers
b) Exported numbers
3b.- SRIack with MSRN=PREFIX + MSISDN
Antun Samukic Ericsson Stockholm 02 September 2002


ERICSSON
"Indirect Routing with reference to the subscription network"
Call related message
Donor Network
HLR
3 a)
INR
NP data base
2
3 b)
GMSC
Recipient Network
4
1
5
INR
NP data base
7
HLR
6
8
GMSC
Originating Network
a) Home numbers
b) Exported numbers
4.- SRIack with MSRN=PREFIX + MSISDN
3b.- SRI relayed with SCCP CdPA =PREFIX + MSISDN
Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

MNP NON-CALL SCENARIO

"Non Call related message standard scenario"



ERICSSON

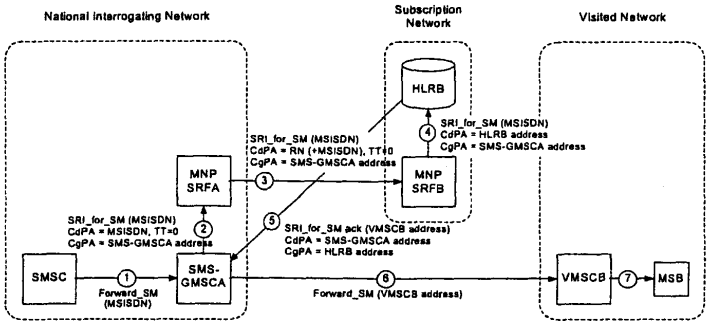
Non-Call Related Signalling

MSISDN is used to route message: (exemples 23.066)

- Delivery of SMS
- International SOR
  - Support of Optimal Routing
- Any Time Interogation
- CCBS Call Completion on Busy Subscribe
  - Busy Subscriber is a Ported Subscriber
- ...

ERICSSON

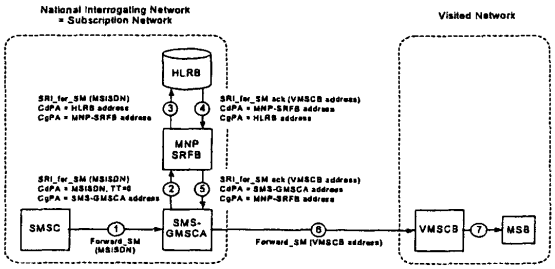
Delivery of SMS to a Ported Number
Direct Routing, Illustration 23.066



Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

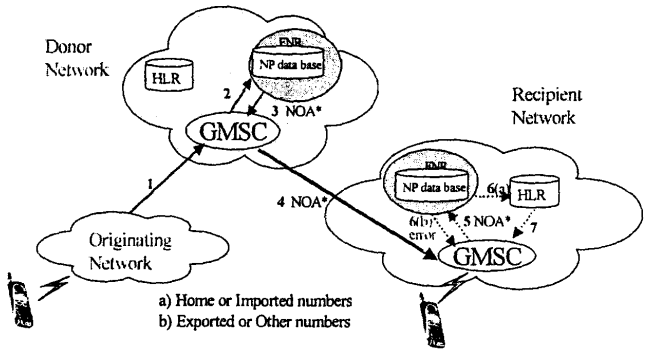
Delivery of SMS to Non-Ported Number
Direct Routing, Illustration 23.066



Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

DATABASE MISMATCH DETECTION



Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

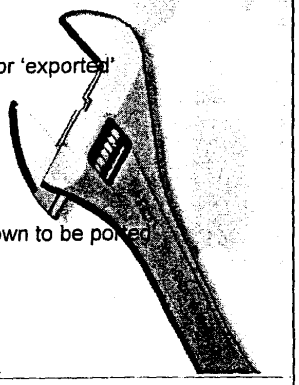
MNP Database Structure

Individually:

own_range_dn - other_nw_prefix -> 'ported-out' or 'exported'
other_range_dn - own_nw_prefix -> 'imported'
other_range_dn - other_nw_prefix ->'ported

Using DN Series:

own_range_series - own_nw_prefix -> 'home'
other_range_series - other_nw_prefix -> 'not-known to be ported'



Antun Samukic Ericsson Stockholm 02 September 2002

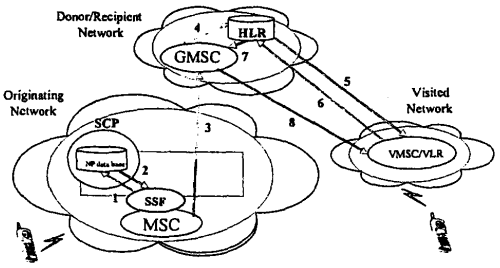
ERICSSON

IN Call Related Scenarios Not Realised by FNR

- Two following two scenarios are used for illustration
  - not part of FNR product
  - part of IN product

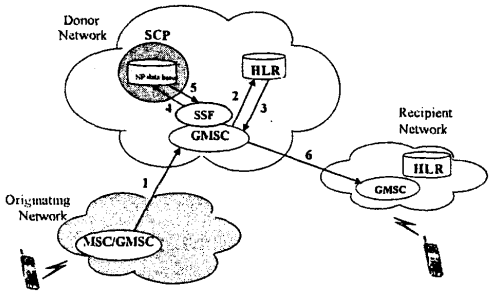
ERICSSON

"All Call Query" - Direct Routing
Call related message



ERICSSON

"Query on HLR Release" -Indirect Routing Call related message



Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

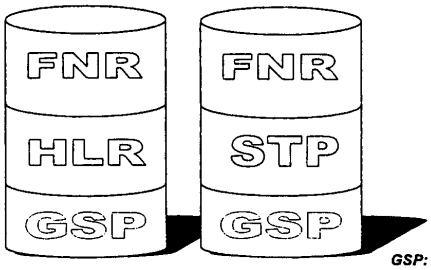
MNP Benchmarking
SRF Direct Routing - Most Used Methods

- SRF Advantages
  - Support of non-call related features like SMS
  - Shorter execution time
  - Higher call handling capacity
  - Higher number of transactions per second
- IN Advantages
  - Higher data Base Capacity
    - 50 millions individual for IN
    - 16-32 millions individual entries depending on processor for SRF

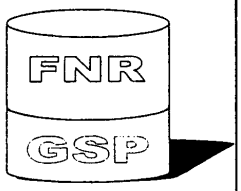
Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

FNR CONFIGURATIONS



Co-Located configuration



Stand alone configuration

GSP: General Signaling Platform
STP: Signaling Transfer Point
FNR: Flexible Numbering Register
HLR: Home Location Register

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

MNP SOLUTION

- Standardized solution uses Concatenated Addressing (I.e. a prefix in ISUP addressing parameters), independently of the approach
- The prefix is agreed in length and meaning among the WCDMA/UMTS/GSM operators in the country, together with the National Telecom Regulatory body
- Operators exchange information about ported subscribers, either directly among them, or by means also of a centralized national database for ported numbers.
- Some actions to wrongly updated info, or fees for usage of other operators' network resources to be agreed. ,

Antun Samukic Ericsson Stockholm 02 September 2002

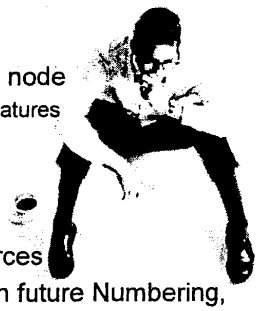
ERICSSON

MNP OPORTUNITIES

- MNP may lead to an increased competition and quality and may help increasing a total subscriber base
  - MNP may accelerate service innovation
- Efficient use of numbering plan

ERICSSON

Advantages SRF (FNR)



- Complete solution implemented in one node
  - Call related features and non-cal related features
- Large customers base
- Follows 3GPP, ETSI, ITU standards
- Strategic tool for 2G to 3G migration
- Offers flexible usage of network resources
- Offers full co-operation capabilities with future Numbering, Naming and Addressing technologies
  - depending on regulation and standardisation

ERICSSON

Other Commercial Features and Configurations

ERICSSON

WHAT IS FLEXIBLE ALLOCATION OF MSISDN?

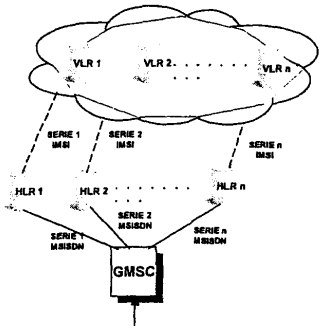
Break the MSISDN-IMSI relationship in the HLR

Within one GSM network operator

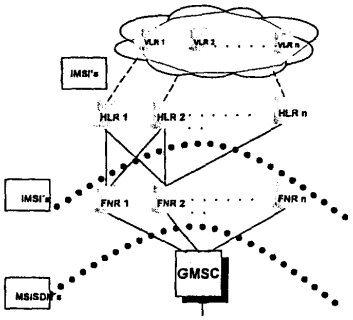
HLR nodes balancing

ERICSSON

NETWORK WITHOUT FLEXIBLE ALLOCATION OF MSISDN NUMBERS



NETWORK WITH FLEXIBLE ALLOCATION OF MSISDN NUMBERS



Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

APLICATIONS

- SIM CARDS/NUMBER MANAGEMENT
  - SIM replacement no matter which is the concerned subscriber number:
    - •theft / lost card
    - •malf unction / destruction
  - Possibility to choose any subscriber number from the WHOLE network:
    - •VIP / go lden numbers
    - •addit ional numbers belonging to Series not used to be tied to a given HLR
- NETWORK CONFIGURATION
  - HLRs' balance (memory and signaling) based on IMSI Series independently of MSISDN Series

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

WHAT IS A MOBILE NUMBER MIGRATION?

KEEP THE SAME NUMBER MSISDN

TDMA/CDMA to GSM/UMTS
2G - 2G, 2G-3G

Access to new services with the same number

PDC to UMTS
2G - 3G

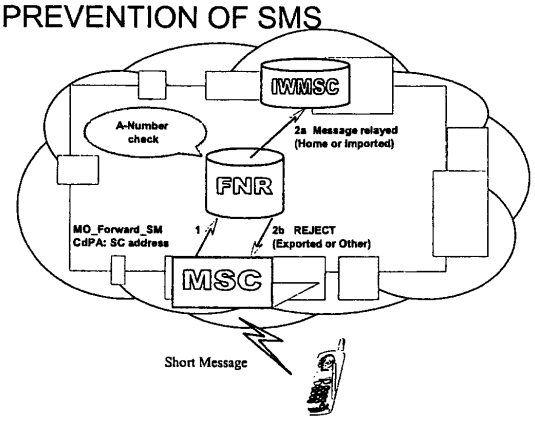
SERVICES NOT INCLUDED

CHANGING NETWORKS AT SINGLE OPERATOR

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

FRAUD PREVENTION OF SMS



Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

FNR File Input / FNR File Output

- File Output reads all or a subset of the data stored in the FNR database and stores them in a file on an external device
- File Input reads the data stored in the file generated by FNR File Output or by an external tool and administrate them (initiate or end) in the FNR database
- FNR File Input & FNR File Output can be used to keep the consistency among all the FNR databases in a network operator or belonging to different operators inside a country

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

Areas of FNR Development

Mobile Number Portability

FNR & Network migrations
Migration TDMA to GSM/UMTS/WCDMA
Migration PDC to GSM UMTS/WCDMA
SMS TDMA/GSM Interoperability, FNR + MG, ...

Service level, Pre - paid, VPN, MMS,...

Numbering - Naming Interactions, ...

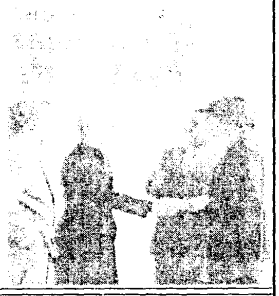
FAM Flexible Allocation of MSISDN

Antun Samukic Ericsson Stockholm 02 September 2002

ERICSSON

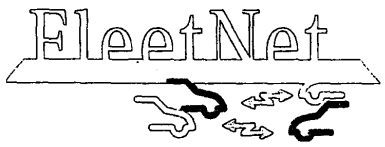
Thank You

Strategic Product Manager:
Antun Samukic
antun.samukic@ece.ericsson.se



FleetNet

FleetNet - Internet on the Road



FleetNet

Contents

FleetNet

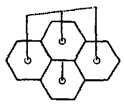
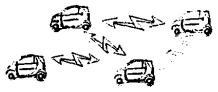
Vision ***Development of technologies for communication between vehicles as active mobile Internet nodes free of charge***

Partners

DaimlerChrysler AG
Fhl Fokus
NEC Europe Ltd.
Robert Bosch GmbH
Siemens AG
TEMIC TELEFUNKEN microelectronic GmbH
TU Hamburg-Harburg
University of Hannover
University of Mannheim
TU Braunschweig

BOSCH
TEMIC
FOKUS
DAIMLERCHRYSLER
NEC
SIEMENS
Universität Hannover

FleetNet

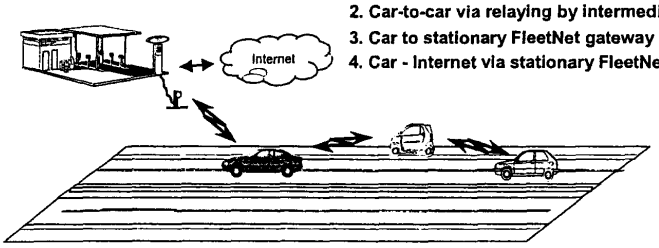
Telematics Services Today		***Inter-vehicle Communications***
Mobile cellular networks	⇨	**Decentralized by mobile ad hoc networks**
		
Charged for usage	⇨	**Buy and use for free**
Access network	⇨	**Local network**
Server oriented services	⇨	**Floating applications**
	⇨	**Data is transmitted and consumed, where it is generated and needed**

Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

Inter-Vehicle Communications Platform

1. Car-to-car direct
2. Car-to-car via relaying by intermediate cars
3. Car to stationary FleetNet gateway
4. Car - Internet via stationary FleetNet gateway



Applications

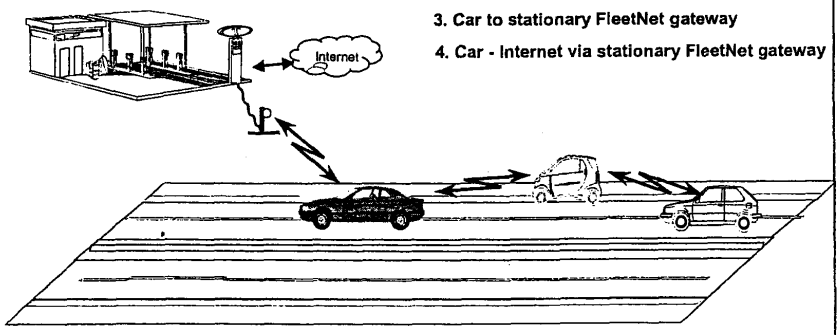
- **Cooperative Driver Assistance**
  - emergency notifications
  - platooning
- **Decentralized Floating Car Data**
  - dynamic navigation
  - route weather forecast
- **User Communication & Information Services**
  - Internet access
  - mobile office

Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

Inter-Vehicle Communications Platform

1. Car-to-car direct
2. Car-to-car via relaying by intermediate cars
3. Car to stationary FleetNet gateway
4. Car - Internet via stationary FleetNet gateway



Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

Contents List

FleetNet

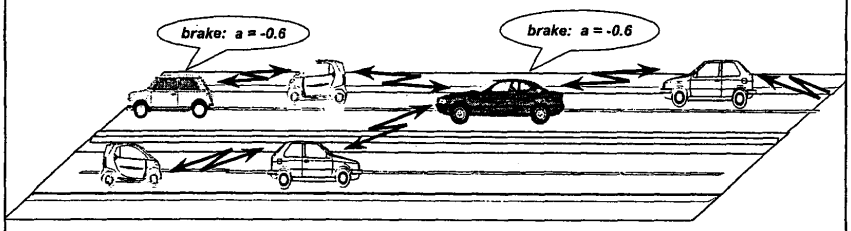
Application Classes

- Cooperative Driver Assistance
- Decentralized Floating Car Data
- User Communication and Information Applications

FleetNet

Cooperative Driver Assistance Applications

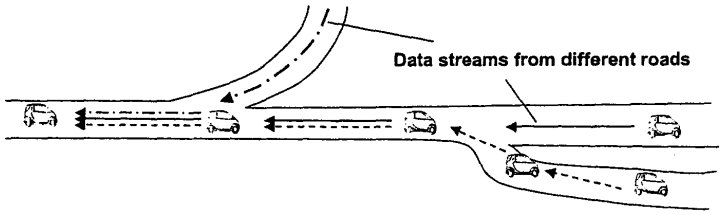
- Relaying of sensor data
- High demands on transmission delay and security
- High priority when related to passengers' safety
- Position dependent addressing



Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

Decentralized Floating Car Data Services



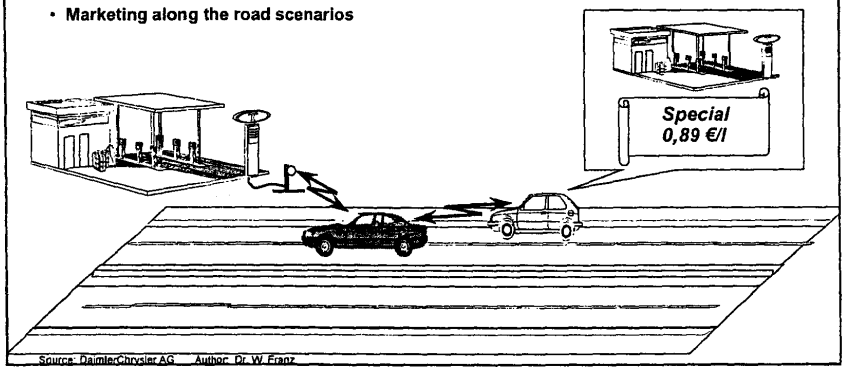
- Example: Provision of a traffic flow profile on the anticipated route
- Data from different routes may be evaluated and provided to a onboard navigation system
- Transmissions occur periodically
- Communications based on broadcasts

Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

User Communication and Information Applications

- Common Internet applications (Mail, Chat, WWW, ...)
- IP-addressing and position dependent addressing
- High bandwidth demands
- Marketing along the road scenarios



Source: DaimlerChrysler AG Author: Dr. W. Franz

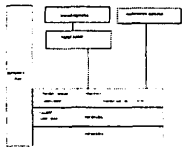
FleetNet

Contents List

FleetNet

Objectives

Communication Platform
-> Standards on ad hoc radio protocols
-> Standards on basic applications



Demonstrator
-> Implementation of communication protocols
-> Implementation of selected applications

Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

Project Partners

Sept. 1, 2000 - Dec. 31, 2003

BOSCH
TEMIC
SIEMENS
NEC
FOKUS
Universität Hannover

Partly funded by the German Federal Ministry of Education and Research

Bundesministerium für Bildung und Forschung

FleetNet

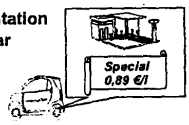
Contents

FleetNet

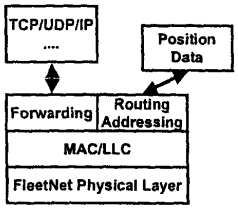
Technical Challenges

Demonstrator and Applications

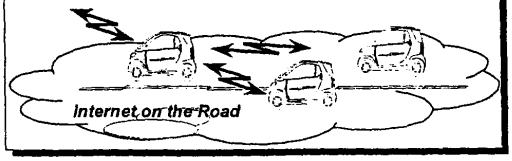
- Design and Implementation
- Integration into the car
- HM interfaces
- User Acceptance



FleetNet Radio Subsystem



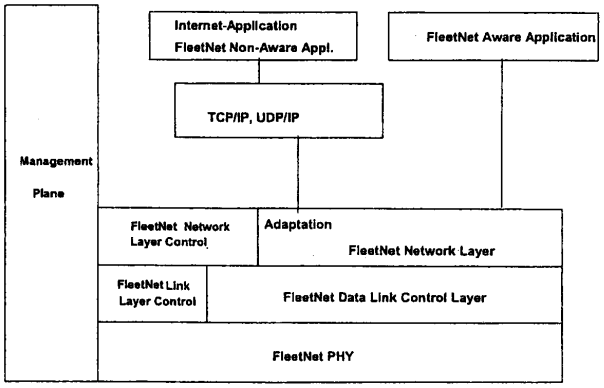
Internet Integration • mobility • security



Source: DaimlerChrysler AG Author: Dr. W. Franz

FleetNet

Protocol Architecture



FleetNet

FleetNet Protocol Functionalities

FleetNet Management	**FleetNet Network Layer Control** • Beacon generation • Position update table (routing,address mapping) • Power control	**FleetNet Network Layer** • Forwarding • DLC service selection
	FleetNet Link Layer Control • Radio ressource mgmt • Dynamic channel allocation	**FleetNet DLC** •LLC: Buffering, ARQ, segm. •MAC: Frame synchronization, random access, priorities, reservation
	FleetNet Phy	

FleetNet

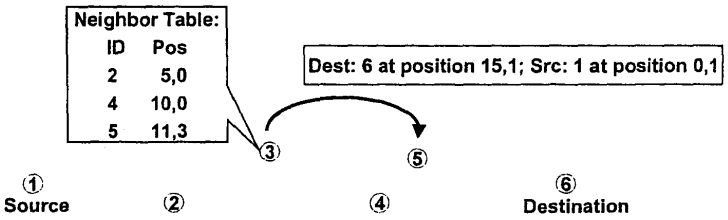
Position Based Routing

For inter-vehicle communications, addressing w.r.t. IDs **and/or** geographic positions is required.

Unique ID	Geographic Position

L3 address of a Fleetnet node

Forwarding according to positions:



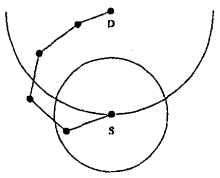
FleetNet

Position Based Routing: Requirements & Advantages

Requirements:
- **Each node has to be aware of its position & position of its 1-hop neighbors**
- **Location Service maps node IDs to their current geographic position**
- **Strategies to handle positional errors**
- **Greedy forwarding strategy plus recovery strategy**

Advantages of Position Based Routing

- **no route setup/maintenance needed**
- **forwarding hops determined 'on the fly'**
- **thus, works in highly dynamic networks**
- **Geocast addressing easily supported**



Greedy Routing Failure

FleetNet

Radio Hardware and Frequency Bands

1.	Funkwarn-System Robert Bosch GmbH	868 MHz
2.	Radar systems	24,00 - 24,25 GHz
3.	IEEE 802.11 Radio LANs	ISM-Band: 2,4 - 2,483 GHz
4.	ETSI/BRAN Hiperlan	Hiperlan bands at 5 GHz
5.	UTRA TDD	Unlicensed UMTS-Band: 2,010 -2,020 GHz

Most promising candidate: UTRA TDD

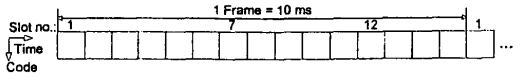
1. UMTS Standard
2. Supports high speeds and sufficient user bitrates
3. Unlicensed frequency band of 10 MHz (2010 - 2020 MHz)
4. Technical problems can be solved
5. UMTS - mass market anticipated

FleetNet

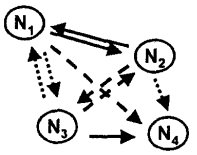
Medium Access Control and Radio Resource Management

FleetNet Ad Hoc Mode - UTRA TDD Ad Hoc

Transmitter-concept: One transmitting node per time slot and multiple codes



Example with 3 codes:
Code 1: →
Code 2: - →
Code 3: ····→



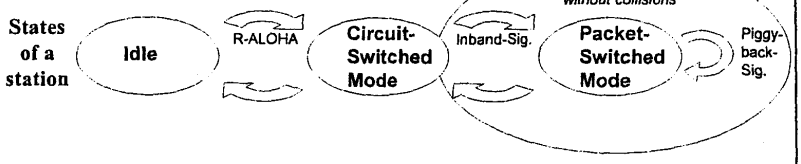
Time slot 1
Time slot 7
Time slot 12

- Equal power for all codes
- PC mechanism like in pure TDMA systems can be used

Source: Siemens AG Author: M. Lott

FleetNet

Reservation of Capacity



- Reservation of Circuit-switched Broadcast Channel (CSBC)
- CSBC is a permanently reserved resource
- Capacity reservation by means of inband-signaling on CSBC
- Periodically usage of reserved slots as long as needed

→ Performance similar to R-ALOHA without collisions

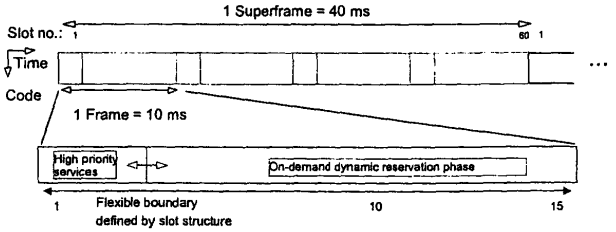
Resource Management

- Broadcast of slot status (reserved / free) on CSBC
- Hidden stations can be combated

FleetNet

MAC und RRM

- Frame and slot structure like UTRA TDD (TDMA/CDMA/TDD)



- Reservation of Circuit-switched Broadcast Channel (CSBC)
- CSBC is a permanently reserved resource
- Capacity reservation by means of inband-signaling on CSBC
- Periodically usage of reserved slots as long as needed

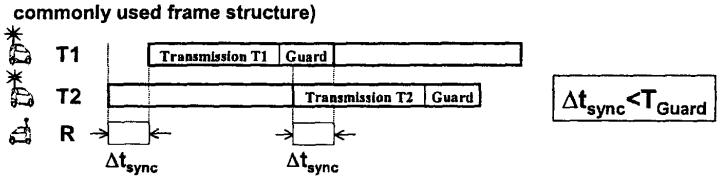
→ Performance similar to R-ALOHA without collisions

- Broadcast of slot status (reserved / free)

FleetNet – Synchronization (1)

Coarse Time Synchronization

- To ensure a reception of bursts without overlap (allign nodes to commonly used frame structure)



- Realization: Using external time reference coming from *GPS:*
  - accuracy: < 1 µs (Sufficient for coarse time synchronization)
  - one clock reference for all FleetNet nodes

Fine Time + Frequency Synchronization (One-Shot Sync.)

- Realization: Correlation with reference midamble

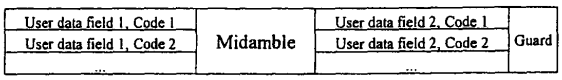
Additional schemes without GPS are under investigation

Source: Siemens AG / TUHH Author: A. Ebner

FleetNet – Synchronization (2)

One-shot Synchronization

- Each received burst has to be demodulated and decoded without any prior knowledge of the respective transmitting FleetNet node
- Task is to estimate
  1. time offset, caused by different propagation delays and imperfect coarse time synchronization
  2. Carrier frequency offsets, caused by doppler shifts and frequency offsets of the local oscillator



- Realization: Using the received midamble field for
  1. Fine Time Synchronization (search max. correlation with reference midamble)
  2. Frequency Synchronization (search max correlation with modulated version of reference midamble)

Source: Siemens AG / TUHH Author: A. Ebner

FleetNet

Internet Integration

Goal

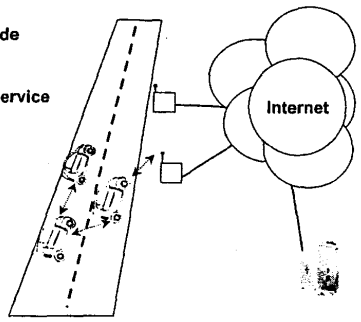
- Vehicles should be able to access the Internet using FleetNet

Achieved by a gateway architecture

- Gateway functionality provided by FleetNet node
- E.g., road-side station („FleetNet Gateway")
- FleetNet Gateways offer Internet access as a service

Challenges for efficient communication

- Temporary (short-living) Internet connectivity
- Mobility of vehicles
- Discovering FleetNet Gateways
- Support of legacy applications



FleetNet

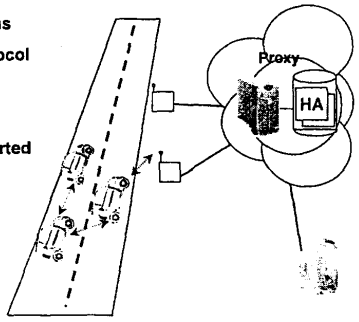
Internet Integration – Communication Architecture

Approach: Combination of Mobile IP and Proxy

- Mobile IP supports mobility of vehicles
  - Transparent to upper communication layers!
- Proxy within the Internet separates connections
  - Allows deployment of new transport protocol
  - Enables Caching
  - Allows a transparent Internet access
  - Legacy applications within vehicle supported

Service Discovery

- Vehicles can find FleetNet Gateways
- Applications can choose „best" gateway
- Enable marketing along the road



FleetNet

Contents

FleetNet

Summary

Ad hoc radio networks will provide new applications

- Which will complement todays telematic services based on cellular networks

Application Fields

- Cooperative Driver Assistance Applications
- Decentralized Floating Car Data Services
- User Communication and Information Services

FleetNet - Internet on the Road

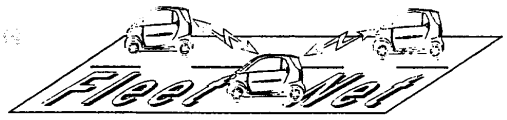
- Communication platform based on mobile ad hoc radio networks
- Objectives: Standardization and Demonstration
- Results will be open
- Further Information: *www.fleetnet.de*

FleetNet

Thank you for your attention!

Universität Hannover

NEC



BOSCH

Cars on the Internet was yesterday

Cars as Internet is tomorrow

FOKUS

DAIMLERCHRYSLER TEMIC SIEMENS

Further Information:
www.fleetnet.de

This project is partially funded by the German Ministry of Education and Research (BMB+F)

Bundesministerium für Bildung und Forschung

FleetNet

Contacts

DaimlerChrysler AG	Dr. W. Franz	Walter.franz@daimlerchrysler.com
Fhl Fokus	B. Bochow	Bochow@fokus.gmd.de
NEC Europe Ltd.	Dr. H. Hartenstein	Hannes.hartenstein@ccrle.nec.de
Robert Bosch GmbH	Dr. W. Detlefsen	Wolfgang.detlefsen@de.bosch.com
Siemens AG	M. Lott	Matthias.lott@icn.siemens.de
TEMIC TELEFUNKEN m. GmbH	M. Schedl	Manfred.schedl@temic.com
TU Hamburg-Harburg	Prof. Dr. Dr. Rohling	Rohling@tu-harburg.de
University of Hannover		
TU Braunschweig	Prof. Dr. L. Wolf	Lars.Wolf@ibr.cs.tu-bs.de
University of Mannheim	Dr. M. Mauve	Mauve@informatik.uni-mannheim.de