Road Warrior

30 Years of Mobile Computing and Wireless Network Evolution

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Update Computer Club, Uppsala

12 February 2022





30 Years, 1992 to 2022





The Samsung Galaxy S9, 2018

The Siemens P1, state of the art in 1992/93



Note: All pictures and drawings in this document without credit line: (c) by Martin Sauter, http://www.wirelessmoves.com

Early 1990s vs. 2008 vs. Today



On the outside, not much has changed in 30 years!



2G, 3G, 4G – Quite A Bit Of Change



Intermediate Steps: Bosch 738 (GSM, ca. 1997), Sony Ericsson V800 (UMTS, 2005), Samsung Galaxy S4 (LTE, 2013)



The GSM Years 1992 - 2004



GSM and GPRS Timeline



* Fox and pin from a Siemens Mobile event in 2001

** Typical and realistic end user speed, NOT cell capacity or theoretical maximum

Mobile Internet On The Road in 2000/2001



Picture of my equipment taken while attending Cebit 2001:

Palm IIIx Siemens S25 used as modem,

Communication over IrDA (infrared), 9.6 kbit/s.



Used for:

- eMail (with SMS notification!)
- Web access via AvantGo Channels

The first time I was not 'disconnected' anymore while traveling!

https://de.wikipedia.org/wiki/Siemens_S25 https://en.wikipedia.org/wiki/Palm_IIIx https://en.wikipedia.org/wiki/AvantGo



2001 – Avantgo – Being Semi-Online



Click the appropriate flag to view channels for that region:

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THE PERFECT TRAVEL COMPANION



Dylan uses AvantGo as his travel companion. Whether he's catching up on the latest industry trade magazines or checking his Northwest WorldPerks miles or picking out a restaurant to take his client to for dinner with Fodors.com AvantGo keeps Dylan informed

STAY IN SYNC WITH THE LATEST HAPPENINGS



amazon.com.

👜 NEWS.COM 🛛 HOLLYWODD.COM

Colleen and Clint use AvantGo in their downtime. AvantGo keeps them up on all the latest technology happenings with CNET, gives them late breaking news from CNN, helps them pick a movie to go to near the café thanks to Hollywood.com and even lets them order new CD



GSM and GPRS Data

- Circuit Switched data mid-1990s: Expensive, paid per minute, 9.6 kbit/s slow compared to 28 – 56 kbit/s fixed line modems.
- Packet Switched, GPRS: Paid by volume, in the early 2000's too expensive for desktop web browsing, got better over time.
- Siemens S45, first Siemens GPRS device, <u>my first</u> <u>mobile device which I needed to upgrade the software</u> <u>over the serial interface with a Windows program</u>. <u>Direly</u> needed as the GPRS protocol stack was quite unstable.



The Siemens S45





Picture taken in 2002 4 Timeslot bundling in downlink direction ('xxxx')

Early GPRS Pricing – January 2001

Always on

19.01.2001 11:38

T-D1-GPRS: Die Preise sind da!

T-D1 bietet zwei Tarife für den neuen Datendienst an Von Marie-Anne Winter

ΑAΑ

Kommentare (9)

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Wie auf teltarif.de <u>bereits</u> zu lesen war, steht der paketvermittelte Datendienst <u>GPRS</u> ab 1. Februar der breiten Öffentlichkeit zur Verfügung. Jetzt hat <u>T-Mobil</u> auch die offiziellen Preise dazu geliefert. Es gibt zwei GPRS-Tarife: T-D1 GPRS eco und T-D1 GPRS pro. Beim T-D1 GPRS eco wird kein monatlicher Grundpreis fällig, dafür bezahlen die Kunden einen Tagesnutzungspreis von 49 Pfennig. Der Volumenpreis je angefangenem <u>10 kByte-Datenblock beträgt 69 Pfennig</u>. Der Tagesnutzungspreis entfällt bis zum 31. März. Dieser Tarif ist günstiger, wenn man nur gelegentlich WAP-Dienste abfragt.

Der monatliche Grundpreis für den T-D1 GPRS pro, der zuzüglich zu den Tarifen <u>Telly, TellyPlus, ProTel</u> oder Protel DataOnly gezahlt werden muss, beträgt <u>19,95 Mark. Hier werden pro angefangem 10kByte-Datenblock nur 19 Pfennig</u> berechnet. Dieser Tarif lohnt sich nur, wenn man täglich auf WAP-Dienste zugreift oder E-Mails empfängt.

Variant 1:

0,25€ per day + 0,35€ per 10 kb

→ €35 per MB
→ €35.000 per GB

Variant 2:

10,00€ per month + 0,10€ per 10 kb

→ €10 per MB
 → €10.000 per GB



Source: https://www.teltarif.de/arch/2001/kw03/s4107.html

GPRS Pricing December 2002

Mobiler Datenrausch

22.11.2002 16:39

Drei neue GPRS-Tarifoptionen bei o2

Daten-Turbo gegen zusätzliche Grundgebühr zwischen 9,95 und 39,95 Euro Von Hayo Lücke

★ Kommentare (4)

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Zum 16. Dezmeber führt		
o2 Germany drei neue GPRS-		
Tarifoptionen ein. Zum bisherige	en	
Standardtarif gesellen sich die		
Tarife L, XL und XXL.		
GPRS L ist für eine monatlie	che	
Zusatzgebühr von 9,95 Euro		
erhältlich und beinhaltet ein	•	
Inklusiv-Übertragungsvolumen	von	
1 MB, für jede weiteren 10 kByt	e	
werden 2,5 Cent berechnet.		
GPRS XL kostet bei einem	•	
Inklusivvolumen von 5 MB und		
zuzüglich 2,2 Cent je 10 kByte		
stolze 19,95 Euro, für den Tarif	GPRS XXL werden gar 39,95 Euro zusätzlich	
berechnet. Hier beinhaltet das A	Angebot dann jedoch auch 20 MB Datenübertragu	ng,
für jede weitere 10 kByte fallen	hier 1,9 Cent an.	

€0,025 per 10 kb €2,5 per MB

→ €2.500.- per GB

Still very high but an order of magnitude lower compared to 2 years earlier!



Source: https://www.teltarif.de/arch/2002/kw47/s9331.html

The Story of the GSM Logo



"[The dots symbolize] three [clients] in the home network and one roaming client."

https://blog.wirelessmoves.com/2013/11/the-gsm-logo-the-mystery-of-the-4-dots-solved.html



Meetings: On Paper!



Michael Clayton, 20 Years of GSM presentation, page 10 http://www.3gpp.org/ftp/workshop/2007-03-14_20%20Years%20of%20GSM/Presentation/10_LifeBefore_MichaelClayton_V5.pdf



*CEPT GSM#13 meeting in Madeira: Agreement on the basic parameters of the GSM system. Finalisation in May 87 in Bonn, http://www.gsm-history.org/7.html

Standards: From Paper To Wifi





(2007), Michael Clayton, 20 Years of GSM presentation, page 10 http://www.3gpp.org/ftp/workshop/2007-03-14 20%20Years%20of%20GSM/Presentation/10 LifeBefore MichaelClayton V5.pdf

Evolution of Type Approval

- 1980s: Type approval in EACH country for a mobile!
- The GSMA Network Operators form 'Buyers Club'
- 1991/92: Interim Type Approval (ITA), R&S builds a System Simulator (with a VAX as control computer!)
- Type Approval of mobile devices ('terminals') by National Regulators mandatory before sale!!!
- 1992: Single Regulator Approval for the EU, a radical step! \rightarrow 'Free Circulation'
- 2003: Self Declaration of Conformity in the EU



GSM System Simulator, 1992





Picture from: R&S Brochure for the CRTC02

The UMTS Years 2004-2012



UMTS Timeline



* Typical and realistic end user speed, NOT cell capacity or theoretical maximum ** 1.8 Mbit/s at launch, 42.2 Mbit/s with 2 carriers + advanced mobile hardware



2002 - Siemens 3G Mockups



Cannes, 3GSM Mobile World Congress, 2002



2002 - First Video Call Demo



Cannes, 3GSM Mobile World Congress, 2002



The '3' In The Logo in 2002



Also at the event: I used my HP iPaq PDA, the S45 and a digital camera to take and send a picture back home to people via email. Most recipients were astounded, receiving a picture in real time from an event was a novelty!



Meanwhile in 2004... The world still on 2.5G





Siemens S55 (GPRS) and a HP 4150 PDA, bought in 2003, Bluetooth replaced IrDA for connectivity between devices, (S55 now staid in the pocket), HP had Wifi for local connectivity!

XMAS 2004 – Finally... Unboxing the Sony Ericsson V800





December 2004, after finding UMTS coverage in town!



August 2005 - The V800 In Action



Up date

Sony Ericsson V800 – 3G Phone, 384 kbit/s

2005 – 3G Device Pricing



November 2005 – Nokia 6680 – 3G Phone - €569.-Surcouf electronics store window advertising, Paris



2005 - 3G Data Pricing and Roaming

• One of the cheapest data offers in Germany in 2005: 24 cents per MB, Alditalk, i.e. **240 Euros per GB! ***

(compare to €10.000 – €35.000 per GB just 4 years earlier...)

Data roaming with a German SIM card: Astronomic prices...

• The 'unbelievable' alternative:

Prepaid Internet from Italian Operator 'Wind'. 2005 Mega No Limit offer: **20 Euros for 1 GB** in Italy, **200 MB while roaming (100 Euros per GB)**. *

An international traveler's dream! Actually too good to be true, the roaming offer didn't last long.



12 February 2022, Martin Sauter, https://blog.wirelessmoves.com



* Sources: Screenshots taken at the time

ca. 2007 - 3G Data Roaming Prices

- After Wind offer ceased, 3G data roaming became nonaffordable, local pre-paid SIMs for data were the only alternative.
- Ca. 2007 Vodafone Germany introduces WebSessions for Roaming in Europe
- 15 Euros for 50 MB in 24h, several passes per day possible. (i.e. €300.- per GB)
- At the time I used it a lot while traveling. 1 or 2 passes were usually enough for business use (mostly email) during daytime and private Internet use the rest of the day.



2005 – Still External Wifi





2006 - First 3G Routers



Barcelona, 3GSM World Congress, February 2006



The Mobile World in 2006 and 2007



Blogging Equipment for 3GSM World Congress, Barcelona, 2006 (left), 2007 (right) (Nokia 6680 and Nokia N93, both 3G, 384 kbit/s max.)



https://blog.wirelessmoves.com/2006/02/how_to_moblog_f.html https://blog.wirelessmoves.com/2007/02/3gsm_congress_b.html

2006 - 3G For The Masses



3G Video Call Phone

Announcement at 3GSM World congress, February 2005 (left) On the High Street March 2006 (right)



2007 - HSDPA Enters The Realm



2007, Early HSDPA cat. 12 card, 1.8 Mbit/s top speed (Sierra Wireless AirCard 850)



USB Tethering





2008 Motorola V3xx - HSDPA 3.6 Mbit/s

2008 HSDPA Dongle + Router



Huawei HSDPA Dongle, 3.6 Mbit/s, 2008



And then... The Nokia N95



The Nokia N95, HSPA 3.6 Mbit/s, 'What Computers Have Become', 2007 (same year as the first iPhone)



2008/09 – The First Android Phone



Late 2008, The 'HTC Dream' aka T-Mobile G-1, Picture Taken in Paris, January 2009



3G Dongles Get Smaller and Faster



2010, Huawei E176, 7.2 Mbit/s down, 5.6 Mbit/s up (HSDPA + HSUPA, HSPA)



To Wifi Tether... or Not To Tether?

- In 2006, the Nokia N80 was one of the first 3G devices to include Wi-Fi. https://blog.wirelessmoves.com/2006/05/how_the_nokia_n.html
- Immediately in 2006 there were ideas to use it as a Wi-Fi Access Point to act as a Gateway to other devices to the Internet via 3.5G HSDPA.
- But it still took until 2010 and Android 2.2 before Wi-Fi tethering actually became available.
- Were Nokia and others afraid of network operators?



The LTE Years 2011-



LTE Timeline





* LTE USB Dongles and first network deployments already in December 2009 (Telia, Oslo, Norway) but limited customer reach

** Typical and realistic end user speed, NOT cell capacity or theoretical maximum

2008 - First LTE Chipset Prototype



February 2008 - LG LTE Chipset Prototype, FPGA, 3GSM Barcelona



2009 - LTE in a Box





February 2009, 3GSM World Congress Barcelona, LTE Prototypes

2010 - The First LTE Device on Sale in Some Countries



Samsung, 1800 MHz only, not sold in Germany as it had no 2G/3G capabilities, but used in other commercial networks (e.g. Norway)



Testing LTE 800 in the Countryside



May 2011: LTE on 800 MHz Testing, Huawei LTE dongle, 75 Mbit/s in a 10 MHz Channel, 100 Mbit/s in a 20 MHz Channel



2011 - LTE Comes To The City





June 2011, LTE Launch in Cologne





2012 - Let's Do Some LTE Testing!

Massive video streaming test, Samsung Galaxy S II LTE devices May 2012, Bonn





2022 - Fast Forward - 10 Years Later

- Devices still around the same size as in 2012.
- Prices now at a couple of euro cents per GB or full flat rate for €50-80 per month depending on the country.

- Users typically buy 5 to 50 GB/month data bundels for 5 to 30 euros, including unlimited voice and SMS.
- EU roaming for data now typically included in monthly contract / prepaid subscription without additional charge.
- 5G in first countries on 3.5 GHz with 100 MHz bandwidth used as a massive capacity booster. End user speeds of > 1 Gbit/s possible in practice.
- Picture above shows 5G Active Antenna System (AAS) with beamforming capability.



Annex...



Further Reading - Books

- Riveting business journalism: Susanne Päch Die D2 Story, 1994 (German)
- Friedhelm Hillebrand GSM and UMTS The Creation of Global Communication, 2002
- Hillebrand, Trosby, Holley, Harris Short Message Service – The Creation of Personal Global Text Messaging, 2010
- Michel Mouly, Marie Bernadette Poutet The GSM System for Mobile Communication, 1992









Further Reading - Online

- History of GSM, Friedhelm Hillebrand, from a German and technical point of view: http://www.gsm-history.org/
- History of GSM, Stephen Temple, from a UK and commercial point of view: http://www.stephentemple.co.uk/history-of-gsm/
- History of GSM, Ericsson, view from inside a major player of the industry: https://www.ericsson.com/en/about-us/history/changing-the-world/big-bang
- My personal blog, my thoughts on wireless since 2005: https://blog.wirelessmoves.com

