

Lecture 4

Mobile Communication Services



Mobile Business I (WS 2025/26)

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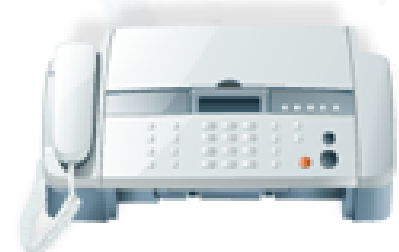
- Classic Mobile Communication Services
 - Introduction with 2G networks (digital networks)
- Mobile Multimedia Services
 - Extension of the classic mobile communication services to enable a richer media experience
- IP-based Mobile Services
 - Internet Protocol (IP) based services influenced by the developments in the Internet

Mobile Communication Services

- Classic Mobile Communication Services
 - Voice / Fax
 - Short Message Service (SMS)
 - Mobile Data Services
- Mobile Multimedia Services
 - Multimedia Messaging Service (MMS)
 - Wireless Application Protocol (WAP)
 - i-mode
 - IP Multimedia Subsystem (IMS)
- IP-based Mobile Services
 - Push Email Services
 - Voice over IP (VoIP)
 - Mobile Messaging
 - Mobile IPTV
- Annex: Wireless Application Protocol (WAP) and Wireless Markup Language (WML) & Mobile Broadcast TV

- **Voice / Fax Service**

- Regular telephone service and emergency call
- Speech signals are digitally coded, using a bidirectional, symmetric, full-duplex point-to-point connection.
- Capable of sending and receiving “Group 3” fax transmissions



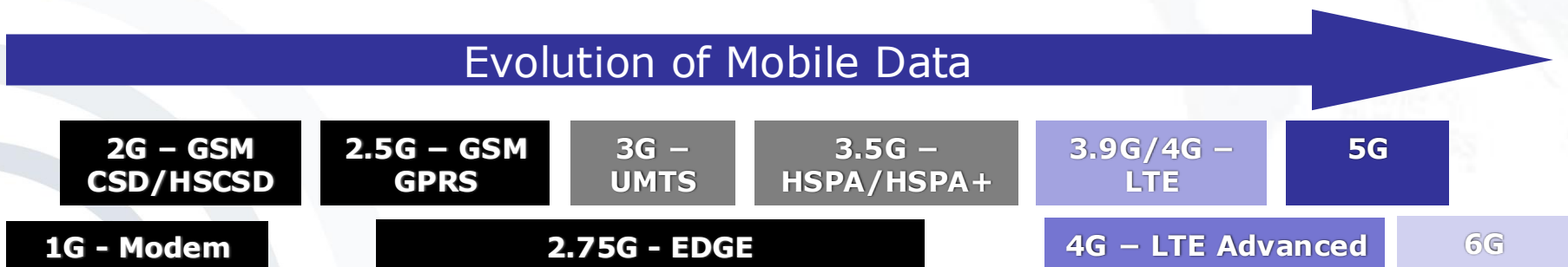
- Short Message Service (SMS)
 - Allows to send and receive short messages of up to 160 characters
 - **7Bit**: 160 characters (plain text)
 - **8Bit**: 140 characters (ASCII)
 - **16Bit**: 70 characters (Unicode)
 - Several SMS types exist:
 - *Point-to-point SMS* (single addressee)
 - *Point-to-multiple SMS* (several addressees)
 - *Cell broadcast SMS* (all users in a cell are addressees)
 - Combination with other value added services (e.g. automated voicebox notification)
 - Messages are sent to an SMS service centre (SMSC) and are processed in a *store-and-forward mode*, meaning that messages that cannot be relayed will be stored and sent again later.

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- **Modem** (modulator-demodulator) in analogue mobile networks (300 - 2400 bit/s)
- **CSD** (Circuit Switched Data) in GSM networks (9.6 Kbit/s)
- **HSCSD** (High-Speed Circuit Switched Data) in GSM networks (57.6 Kbit/s max.)
- **GPRS** (General Packet Radio Service)
- **EDGE** (Enhanced Data Rates for Global Evolution)
- **UMTS** (Universal Mobile Telecommunications System)
- **HSPA** (High Speed Packet Access)
- **LTE** (Long Term Evolution)

Evolution of Mobile Data



Circuit Switched Data (CSD)

- Transmission method originally developed for GSM.
 - Uses a single radio time slot to deliver a constant data stream of 9.6 kbit/s for transferring data.
 - Originally, CSD was designed to support the transmission of fax messages.
 - Not sufficient for “modern” data-services, as WAP over CSD showed

High-Speed Circuit Switched Data (HSCSD)

- Enhancement to Circuit Switched Data
 - Bundling of multiple simultaneous channels, up to 57.6 Kbit/s.

- First packet-based data service
- Employment of time multiplex procedure for data services
- Dynamic allocation of radio channels among the subscribers in a radio cell
- Channels are only blocked when data is actually transferred.
- Packet orientation implies the introduction of new billing methods.

- Advantages of (packet-oriented) GPRS over Circuit Switched Connections (CSD, HSCSD)

Economical network utilization

„Always-online“ allows offering new push services.

New billing methods can be realized (packet-oriented network).

- Disadvantages of (packet-oriented) GPRS compared to Circuit Switched Connections (CSD, HSCSD)

Existing GSM infrastructure must be upgraded implying high investments as well as new terminals

New push services require new security concepts, e.g. because of unintentional data reception (& payments for these data).

Mobile Data Services - Enhanced Data Rates for Global Evolution (EDGE)

- Basic idea of EDGE was the implementation of networks with 3G-like performance without building up a whole new infrastructure.
- By using advanced modulation technologies, data rates of up to 384 kbit/s are reachable.
- However, these data rates are only reachable in close proximity to base-stations. Therefore more base-stations need to be setup.
- First European EDGE system implemented in Hungary (2003).
- Although UMTS (3G) and LTE (3.9/4G) networks are rolled out throughout Europe, more and more GSM networks are still upgraded with EDGE technology. The reason for this is that frequency bands below 1 GHz (GSM often uses 900 MHz) facilitate adequate network coverage especially inside buildings.
- EDGE could also be implemented in mobile networks that did not use the GSM standard, such as TDMA in the Americas.

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- Similar to SMS, MMS is a message service especially for the transmission of media such as images, videos, or sounds.
- Multimedia Messages can also be sent to email recipients.
- In addition to the SMS service centre (SMSC), a Multimedia Message Service Centre (MMSC) is necessary to handle the multimedia content of the messages:
 - Different ways of processing MMS due to different types of used mobile devices → Compatibility tests with the recipients' mobile device are necessary to process the data appropriately.
 - For sending out MMS to email recipients, the MMSC uses the standard Internet protocol (SMTP).
 - Furthermore, the MMSC handles the (optional) receipts for receiving MMS.
- Have been used by companies such as Deutsche Bahn and Air Berlin because of reliability (e.g. for ticketing).



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- In 1997, Ericsson, Motorola, Nokia and Unwired Planet founded the WAP-Forum.
- The WAP-Forum is a non-profit organization with the objective to build up an open standard (protocol) for wireless data-communication.
- More than 300 members worldwide (manufacturers, software industry, computer and telecommunication companies & network operators)
- Protocol family, developed by the WAP-Forum to provide internet contents on mobile devices
- Universal use, independent from used network technology (GSM, UMTS, etc.)

- ***Relative advantage:***

- WAP provides an access channel to many special Internet pages
 - using the Wireless Markup Language (WML)
 - bringing information to mobile devices.
- However, only a limited amount of content is available.

- ***Compatibility:***

- High compatibility to previous user experiences, as WAP is based on mobile telephone handsets
- ➡ familiarity
- However, the displayed WAP pages are only of limited quality:
 - user interfaces lack quality,
 - connection-speeds are low

Mobile Communication Services

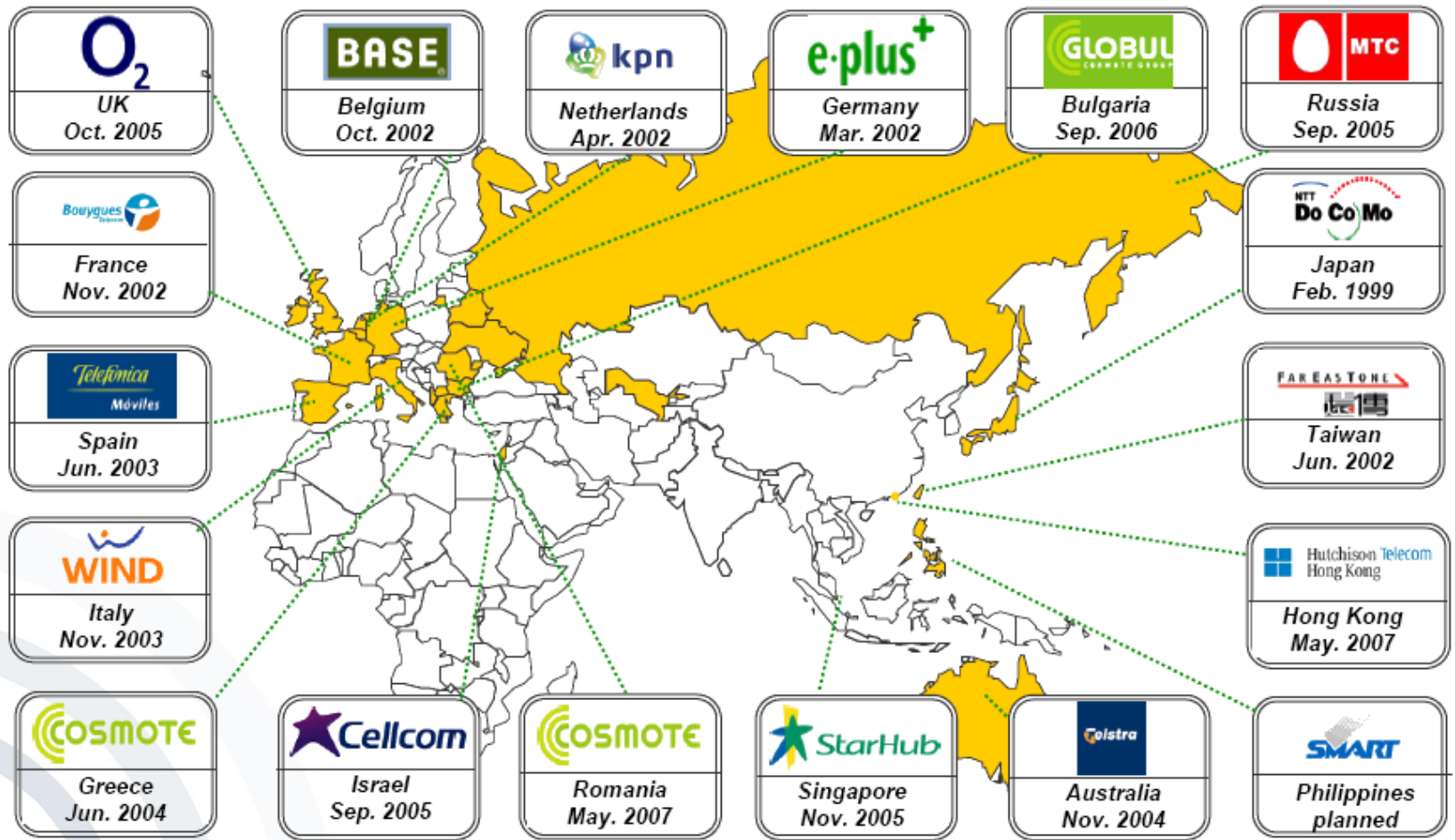
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- Established in February 1999 by NTT DoCoMo in Japan as a service for mobile Internet access.
- Proprietary standard, based on packet-based data transmission.
 - ➔ Requires special i-mode devices
 - ➔ Advantages
 - “Always-online“-functionality
 - Charging based on data volume since 1999



Mobile Multimedia Services i-mode Services around the world

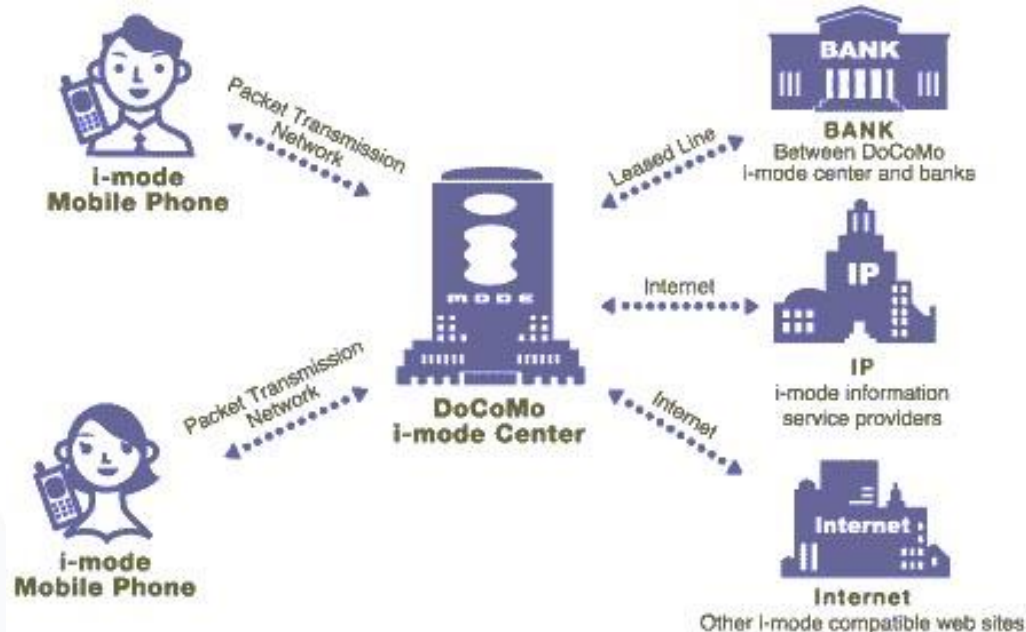
◆ i-mode subscribers (ex-Japan): over 7.3 mil
 ◆ Service area: 18 countries/regions (ex-Japan)

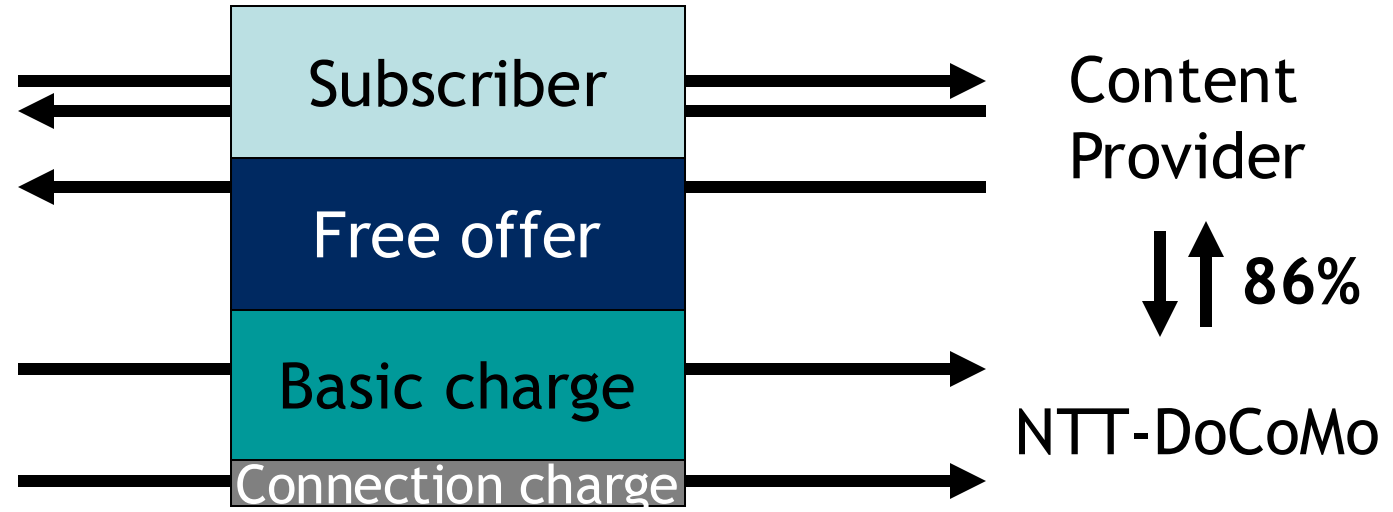


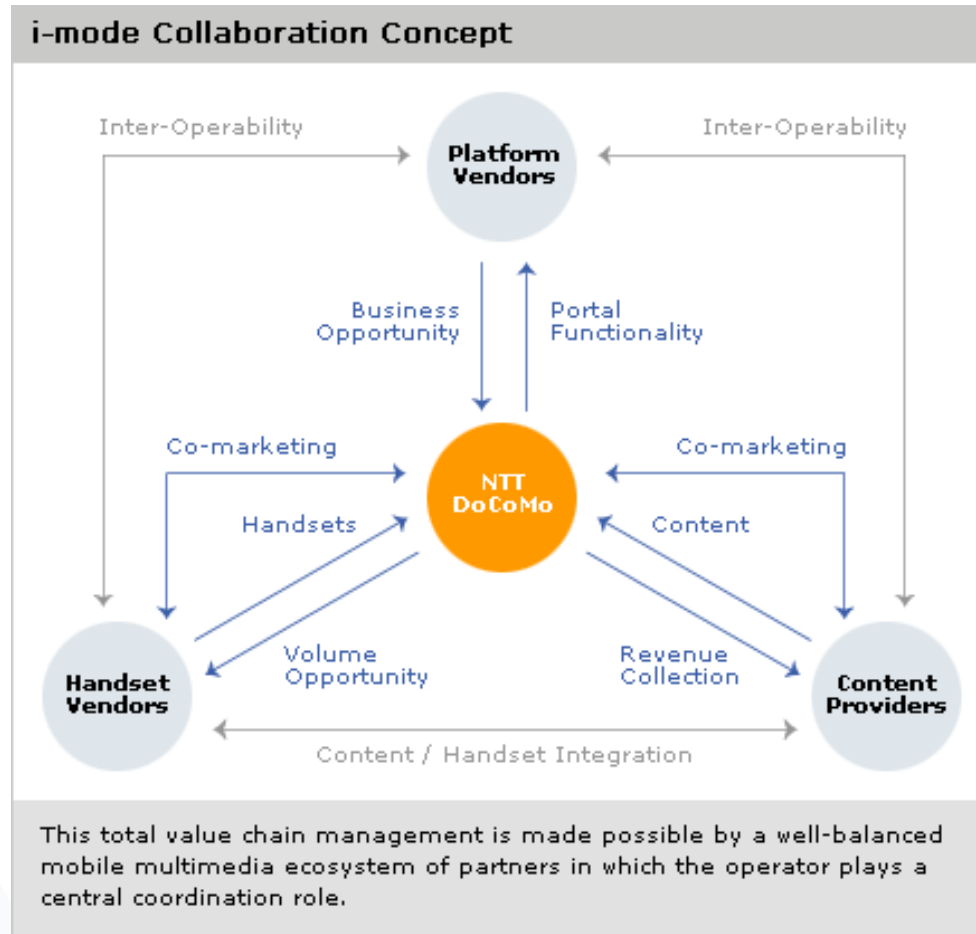
Dates indicate service launch

[NTTDoCoMo 2007]

- Focus on entertainment-services (e.g. in order to bridge waiting time)
- Convenient accounting via phone bill
- Integrated push e-mail-service



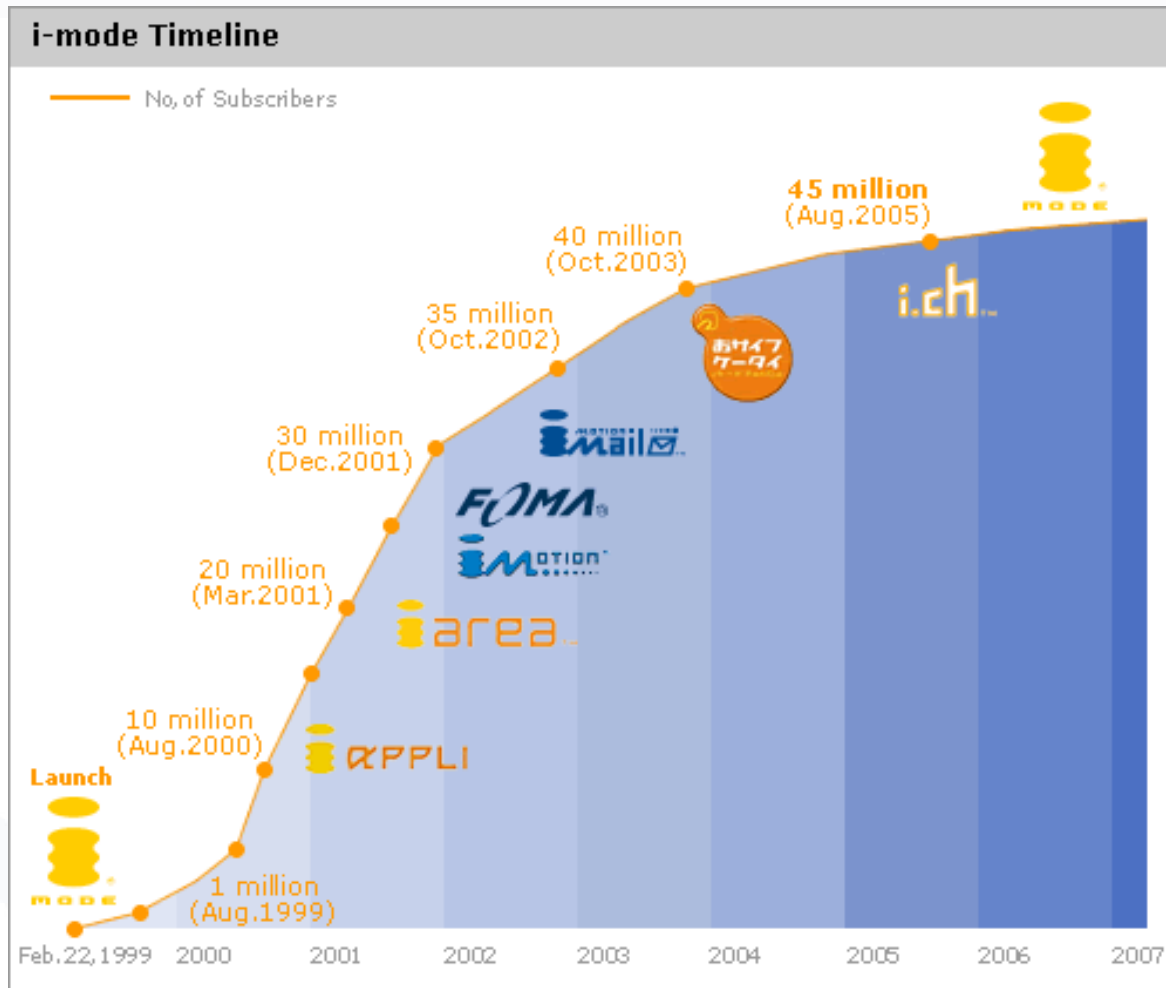




[NTTDoCoMo 2007]

Mobile Multimedia Services

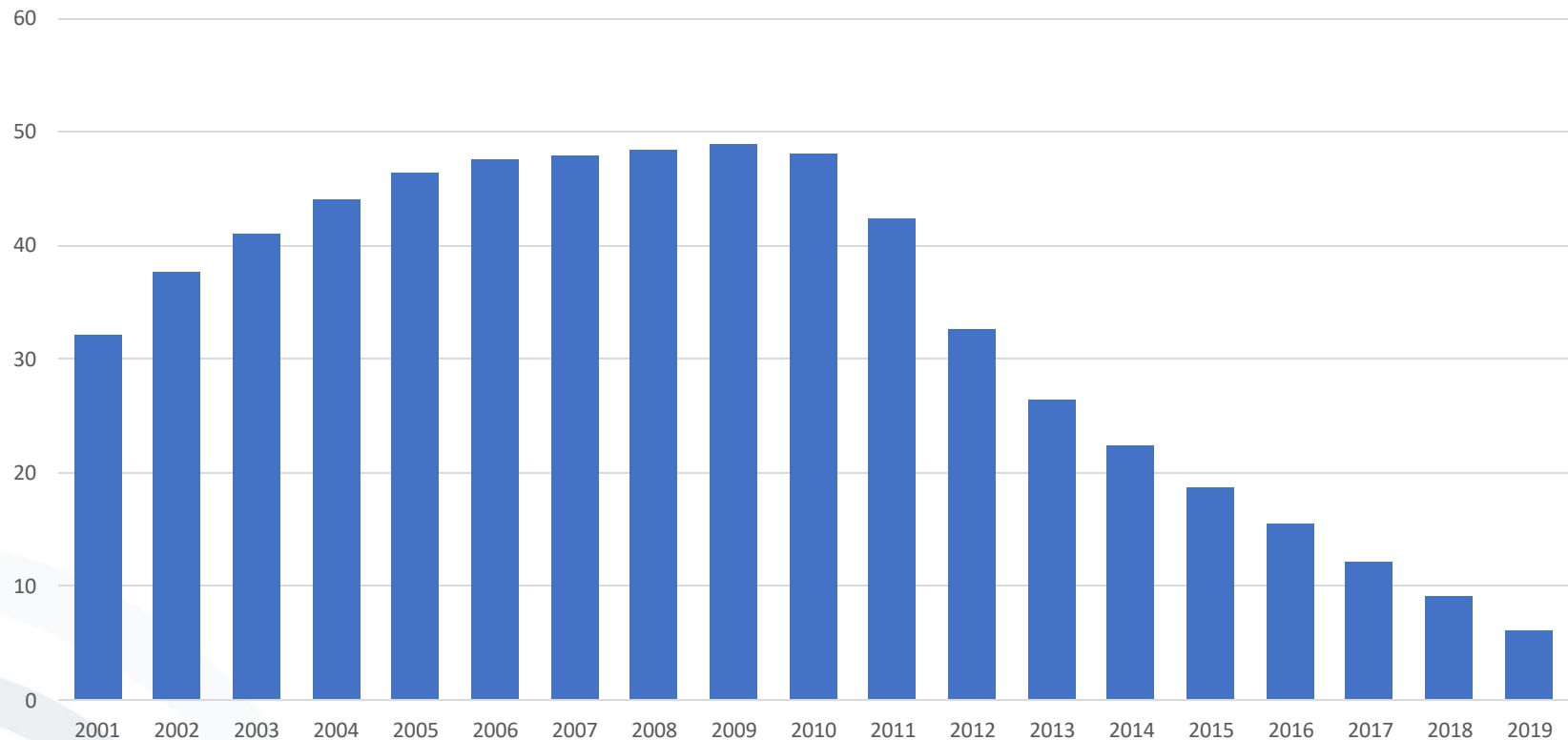
i-mode Users Base Development (global)



- 2015: i-mode is an important part of the market for DoCoMo's traditional flip-phones

Mobile Multimedia Services i-mode Users Base Development (Japan)

i-mode subscriptions by NTT customers on March 31 each year



- 2016: Docomo stopped shipping mobile phones compatible with its i-mode
- 2020: DoCoMo announces that it will end the i-mode service on March 31, 2026.

[NTTDoCoMo 2019]

- Number of users in Germany at the beginning of 2003, according to e-plus:
 - Planned: 750.000
 - Achieved: 125.000

- Mobile Internet Services Penetration in Germany - Number of users:

- 500.000



- 4.500.000



- 5.500.000



- 2008-04-01 i-mode service ended by E-Plus

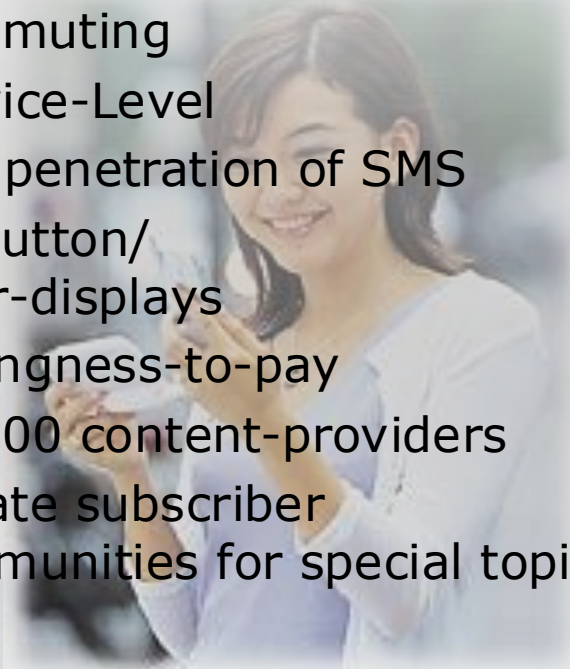


[Samsung SGH-Z320i,
Source: Samsung, E-Plus]

Transferability from Japan to Germany?

Japan:

- Low penetration of stationary internet connections
- Commuting
- Service-Level
- Low penetration of SMS
- "i"-button/
color-displays
- Willingness-to-pay
- 77,000 content-providers
- Private subscriber communities for special topics



Germany:

- Primarily voice + SMS
- About 160 content providers
- Skepticism
- SMS



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Mobile Multimedia Services IP Multimedia Subsystem (IMS)

- Architectural framework for delivering Internet Protocol (IP) multimedia services
- **In a nutshell: Internet Protocol (IP) realized as a service based on 2.5G/3G Mobile Networks**
- Originally designed by wireless standards body 3rd Generation Partnership Project (3GPP) as a part of the vision for evolving mobile networks beyond GSM
 - Original formulation (3GPP R5) an approach to delivering “Internet services” over GPRS
 - Later updated by requiring support of networks other than GPRS, such as Wireless LAN and fixed line
- Since it is becoming increasingly easier to access content and contacts using mechanisms outside the control of traditional wireless/fixed operators, the interest of IMS is being challenged.

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- Internet Protocol (IP) based services:
 - Push Email Services
 - Voice over IP (VoIP), e.g. Skype
 - Rich Communication Suite - enhanced (RCS-e/joyn)
 - Mobile IPTV

- Other IP-based mobile services:
 - Instant Messaging
 - Online Games
 - Automotive Communication

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- “*Always-on*” technology for transmitting new emails by “*pushing*” them to a mobile device, once they arrive, providing seamless over-the-air synchronization
- Needs a special server software to get emails from a standard email server (using POP3, IMAP, etc.) and push them to the recipients device
- The most popular implementations were proprietary (e.g. RIM Blackberry, Microsoft Exchange ActiveSync, Apple iCloud).
- However, **more open standards** also exist:
 - Push-IMAP (with IMAP-IDLE command)
 - Synchronization Markup Language (SyncML)




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- Voice over IP (VoIP) describes a telephony technology, using Internet protocols for transmitting the speech data.
- The data is transferred in a continuous stream of packets (packet-oriented), instead of a dedicated line.
- There are two general application scenarios:
 - ***Internet-based telephony***: Communication between Internet users or communication from the Internet into another communication network (e.g. phone network)
 - ***Intranet-based telephony***: Communication with users in the same network (e.g. company phone system)

- In order to compensate transmission problems (lost packets, speech disruption, etc.) buffers are used.
- In VoIP systems, users can be identified by their:
 - Nicknames (e.g. Skype, Freeworlddialup)
 - Phone number (Sipgate)
 - Phone number (using ENUM - “*telephone number mapping*” for mapping telephone numbers to Internet-addresses - RFC 3761)

- Currently, there are 2 different approaches available for signalling an incoming call:
 - The ITU (International Telecommunication Union) has released the **H.323** standard for packet-oriented networks. **H.323 Plus**: an open-source project for H.323. 
 - The IETF (Internet Engineering Task Force) on the other hand follows an Internet-based approach by using **SIP** (Session Initiation Protocol). **Opal**: an open-source project for SIP.

- H.323
 - Based on H.320, known from ISDN videoconferencing systems.
 - Without video encoding, H.323 is used for VoIP.
 - Complex, monolithic defined multimedia-concept.
 - Limited to telephony- and videoconferencing systems.
 - High maturity level (long development history)

- SIP
 - Based on Internet technologies.
 - Seamless integration into the Internet protocol architecture is possible.
 - Is limited to signalling an incoming call
 - Can be used with other protocols for different purposes. Besides VoIP, SIP can also be used for instant messaging applications.

- The market has made its decision:
 - Manufacturers and providers that have used H.323 in the past have switched to SIP.
 - The UMTS sector also decided to use SIP, although VoIP was not one of the driving factors.
 - Proprietary protocols are also used widely (e.g. Skype). However, in enterprise applications they play a minor role at the moment.
- Switching from one standard (H.323 ↔ SIP) to the other is easy, since both use the RTP protocol (Real Time Protocol) for transferring and encoding speech data.

- VoIP has to face the same threats (malware, etc.) as all other Internet services.
- The 3 major problems in the mobile environment are
 - The billing
 - For the communication, VoIP “outsources” some of the communication network’s intelligence into the mobile device
➔ VoIP terminals become a target for potential attacks.
 - Since VoIP is using the Internet (a shared medium) it is possible to eavesdrop the communication. However, by using encryption or secured lines, this problem can be solved (e.g. VPN or SSL).

IP-based Telephony

- LTE networks are **IP-based systems** (all-IP networks)
 - Voice calls in GSM and 3G (UMTS) are **circuit-switched**.
 - Only **packet-switched** communication is supported in LTE networks - no circuit-switched connections/calls/telephony!
- Six different approaches to provide telephony services in Long Term Evolution networks:
 - **CSFB (Circuit Switched Fallback)**
 - **VoLGA (Voice over LTE via GAN - Generic Access Network)**
 - **VoLTE (Voice Over LTE)** based on the IP Multimedia Subsystem (IMS) network.
 - **SVLTE (Simultaneous Voice and LTE, handset-based approach)**
 - Usage of Over The Top contents (OTT) (e.g. Skype, WhatsApp, Signal) - not actively marketed by mobile operators
 - **VoNR (Voice over New Radio)** for newer smartphones, gradually introduced since 2021, using 5G.



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WhatsApp

- Introduced for iOS in 2009 originally enabling users to share their status
- Rapidly expanded its user base when it included a **messaging component** a few months after launch
- Introduction of **encryption** features in 2012, but no information on what kind of encryption was deployed
- Acquisition by **Facebook** for \$19bn in 2014
- **Voice Calls** introduced in 2015
- Full **end-to-end encryption** introduced 2016 in cooperation with Open Whisper Systems, employing the open source Signal protocol
- Some new features were introduced in 2022 to improve the privacy (e.g., online status control and screenshot blocking)

Signal

- The non-profit Signal Foundation was announced by WhatsApp co-founder Brian Acton and Open Whisper Systems co-founder Moxie Marlinspike.
- Offers full **end-to-end encrypted** instant messaging, voice calling and video calling powered by the open source Signal Protocol for both security and privacy

- Launched in 2011 by Tencent, originally as a messaging app for the Chinese market.
- Rapidly evolved into a multi-purpose “super app” integrating messaging, social networking, payments, gaming, and more.
- Introduced voice messaging and multimedia sharing early on, which drove massive adoption.
- WeChat Pay, launched in 2013, transformed the platform into a dominant mobile payment ecosystem in China.
- WeChat does not offer default end-to-end encryption for all chats; data handling and state oversight remain major privacy concerns in global discussions.
- By 2023, reported over 1.3 billion monthly active users worldwide, but primarily concentrated in China.

Mobile Messaging WeChat



- Founded in 2013 by Pavel and Nikolai Durov, creators of the Russian social network VKontakte.
- Distinguished itself early with a focus on privacy and speed, offering cloud-based instant messaging across devices.
- Introduced optional end-to-end encrypted “Secret Chats” in 2013, using its custom MTPProto2.0 protocol.
- Rapid global growth during periods of WhatsApp outages and increased concerns over Facebook’s data handling.
- As of 2023, Telegram reported over 700 million monthly active users worldwide.
- Features include channels for broadcasting to large audiences, groups supporting up to 200,000 members, bots, stickers, and file sharing up to 2GB.



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- IPTV is originally targeted to set-top boxes. How to make IPTV *mobile*, i.e. available on smartphones and tablets?
- Unicast or Multicast?
 - Linear TV programme or streaming of individual content (web streaming)?
 - Both suffer from bandwidth limitations of the mobile network and a wireless link being sensitive to interferences
- Standardization organizations worked on this:
 - ITU-T IPTV Focus Group (FG IPTV) (continued under the IPTV Global Standards Initiative until 2016)
 - Collecting requirements regarding mobility and wireless characteristics
 - Open IPTV Forum (transferred its activities to the initiative HbbTV in 2014)
 - Mobility service based on IP Multimedia Subsystem (IMS)
 - HbbTV (Hybrid broadcast broadband TV)
 - Publishes IPTV publications



- Identification of users by using the IP-address of the device:
 - Usage of the Internet Protocol version 6 (IPv6) → includes Mobile IP, once it can be used in a production environment
 - Billing of services and access is possible due to large address space.
- Different communication technologies can be used to transfer data on the back-channel:
 - 3G and younger communication networks
 - Wireless LAN infrastructure (WLAN)
 - WiMax
- “Enabler” for new (data) services

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Wireless Application Protocol (WAP)

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- More than 300 members worldwide (Manufacturers, software industry, computer and telecommunication companies & network-operators)

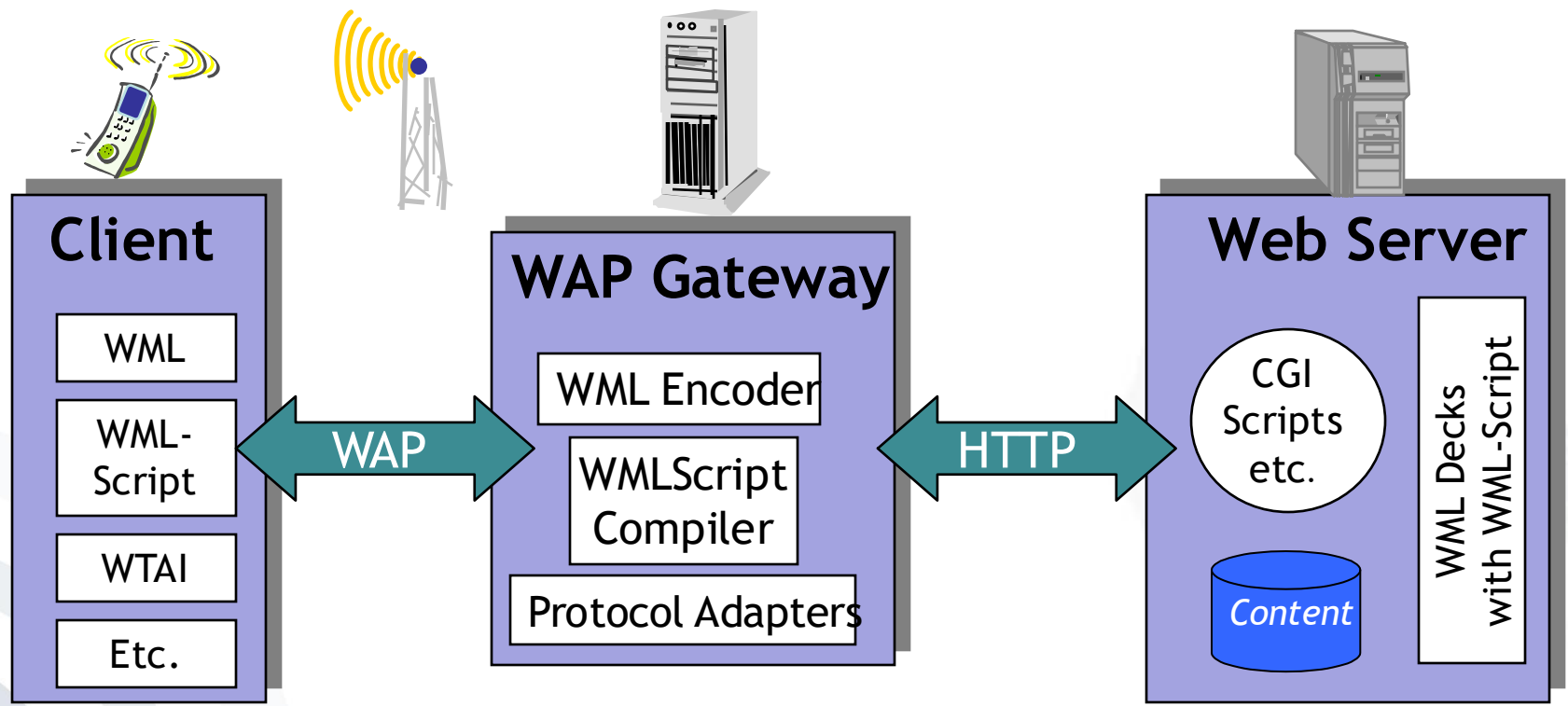
- Protocol-family, developed by the WAP forum to provide internet contents on mobile devices
- Universal use, independent from used network technology (GSM, UMTS, etc.)

- **Objectives**

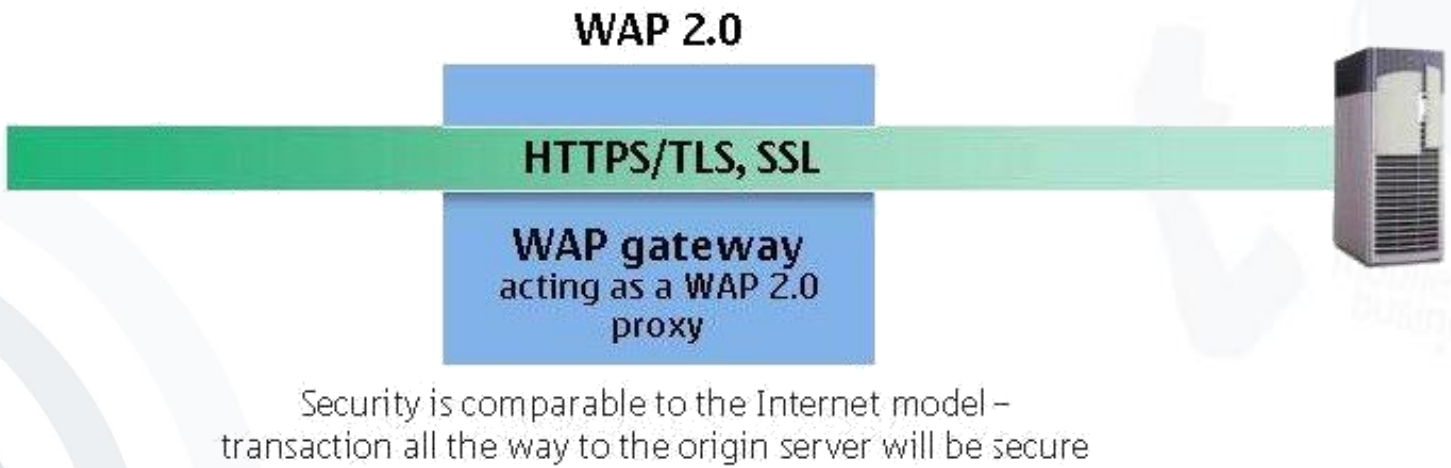
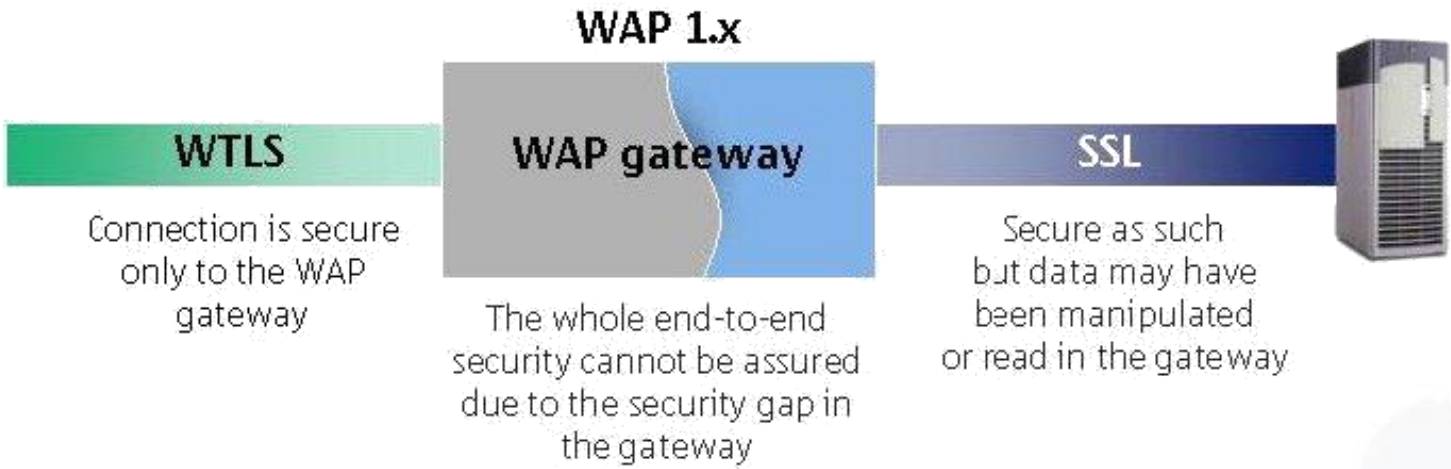
- Interoperability (support of devices from different manufacturers)
- Scalability (services have to be extendable on demand)
- Efficiency (quality of services should be as good as possible in wireless networks)
- Reliability (consistent & predictable platform)
- Security (Protection of integrity & confidentiality)

ANNEX

- Application environment: WAP Gateway



ANNEX



ANNEX



wap.bahn.de



pda.bahn.de

- **Wireless Markup Language (WML)**
 - Markup language used to define contents which are transmitted via WAP
 - Specified in 1998 by W3C as XML-document type
 - **Challenges:**
 - Attributes of mobile devices
 - Bandwidth of mobile networks

- Small language (in comparison with HTML) to manipulate the display.
- Segmentation of WML documents in cards & decks (n:1)
- Navigation between Cards inside a WML document
- Navigation between Decks by opening a new WML document

■ Demo



```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD
WML 1.2//EN" "http://www.wapforum.org/DTD/
wml_1.2.xml">
<wml>
<head>
  <meta name="Author" content="Jan Muntermann"/>
  <meta name="Description" content="IWI Home"/>
</head>
<card id="startPage">
  <p align="center">
    <img src='images/iwi.wbmp' alt='Body' />
  </p>
  <p align="center">
    Institut für Wirtschaftsinformatik<br/>
    <small>WAP-Demopage</small><br/>
    &#187;<a href="navigate.asp">weiter</a>&#171;<br/>
  </p>
</card>
</wml>
```

ANNEX

- Digital Video Broadcast (**DVB-H** for handheld devices) and Digital Multimedia Broadcasting (**DMB**) were tested and launched in some markets (Italy, Austria), but failed economically and were hence switched off.
- Multimedia Broadcast Multicast Service (**MBMS**), a technology to broadcast Mobile TV through UMTS/3G networks, was published in Release 6 from 3GPP, but not deployed by any network operator.
- **Evolved** Multimedia Broadcast Multicast Service (**eMBMS**) - or short “LTE Broadcast” - was published in Release 9 from 3GPP and might see commercial launches in the future. Tests by MNOs in 2014, e.g. by
 - Vodafone in Düsseldorf football stadium in May 2014 [Voda2014] and at Kieler Woche [Connect2014];
 - KPN at the Amsterdam Arena stadium in 2014 [KPN2014].
 - KT of South Korea launched the commercial eMBMS in January 2014 (as reported in [Telecoms 2016]).
 - In the UK, EE trialed LTE-B at the 2015 FA Cup Final at Wembley.




Rich Communication Services - enhanced (RCS-e)

- Founded in 2007 as the Rich Communication Suite Industry Initiative
- Adopted by the **GSMA** 2008 as a cross-carrier ecosystem
- Originally marketed using the **brand name joyn** (Message+) to application developers and end users
- **Universal Profile** protocol published in November 2016, enabling guaranteed connections to other supporting carriers globally
- Google started deploying RCS via their **Messages** app in June 2019
- In October 2019, the four major US carriers announced the development of an app implementing RCS, which will be compatible with the Universal Profile.



Rich Communication Services - enhanced (RCS-e)

- Formerly Rich Communication Suite
 - Cross-carrier ecosystem developed in a **global initiative by the GSMA**
 - Originally marketed using the **brand name joyn (Message+)** to application developers and end users.
- 
- “Enhanced Phonebook”: Automatic update of contacts (network converged address book), social presence information (status, available services)
 - “Enhanced Messaging”: 1-to-1 and group chat, file transfer, sending location data
 - “Enriched Calls”: Voice connections can be enhanced by IP-based communication (e.g. video calls). In LTE networks: Voice over IP/LTE, Video over IP/LTE.

ANNEX

- **Wide range of IP-based services** are implemented into the network infrastructure.
- Built upon the capabilities of the **IP Multimedia Subsystem (IMS)** - like Voice over Long Term Evolution (VoLTE)
- Provides “*Mobile Network Operators (MNOs) with a means of transitioning voice and messaging services into an all-IP and LTE world*”. [Wiki 2013]
- **Global interoperability** (interworking between networks) and development and distribution of user-friendly und secure **RCS-e client software** for smartphones users using various **mobile OS** platforms among biggest challenges

ANNEX

- A GSMA specification for advanced communications
- Supported by 55 operators and 11 OEMs as well as 2 OS providers: Google and Microsoft
 - Group chat, social presence information, IP voice calls, file transfer are additions to the specification.

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