Design Issues for Service Delivery Platforms

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Incorporate User Experience: A Grounded Theory Study of Individual User Needs

With a Preface by Prof. Dr. Reinhold Behringer

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Preface

Service delivery platforms (SDPs) play an important role in the evolving ubiquitous online mobile connectivity. Data rates and available bandwidth have increased dramatically with the introduction of new generation mobile networks (4G) and are set to increase further with new developments of 5G networks. This enables new mobile services such as video on demand and cloud-based services such as Software as a Service (SaaS). However, mobile bandwidth will always been limited at any single network node, due to physical limitations of wireless connectivity of simultaneous connections. Therefore, measures need to be taken to ensure efficient use of the available bandwidth.

The SPICE project (Service Platform for Innovative Communication Environment), funded by the European Commission in the Framework Programme 6 during 2006-2008, has addressed several of the issues of such SDPs and has contributed to technological improvements of service platform functionality and security. But this has been done mainly from a technology and engineering perspective. What has not been sufficiently investigated were issues related to users and stakeholders of such SDPs.

This book addresses this gap by investigating the user needs related to SDPs. The author has investigated the user requirements of those stakeholders from developers to end users and has developed guidelines for the development of future SDPs. These guidelines have been validated through scientific methods in real-world scenarios, where significant improvements in usability could be observed. Therefore, this book is a MUST-READ for system architects and software developers who are designing and implementing new SDPs. The content of this book will help improving the usability of future SDPs.

Leeds, Reinhold Behringer
Professor of Creative Technology
Leeds Beckett University

Dedication

I would like to dedicate this dissertation to my family and friends, in gratitude to their collective efforts in providing me with invaluable advice, encouragement and wisdom, whilst allowing me space for my own explorations.

I particularly dedicate this thesis to my parents, who have given me all their love, support and understanding. Without them I could not have accomplished the following. Their knowledge of the value of education is truly beyond my comprehension and I am a lucky beneficiary.

Moreover, I dedicate this work to my deceased best friends Johannes Beiglböck and Harald Hörl, who inspired me with their energy and friendship, and who helped me to learn about life and the knowledge how to live a good one. In memory of the comfort and advice they gave me in the past, whenever I needed them.

Vienna, Martin Bergaus

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Vienna, Martin Bergaus

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Abbreviation	Explanation
1G	First generation of wireless telephone technology; an analogue telecommunication standard using analogue radio signals.
2G	Second generation of wireless telephone technology; a digital telecommunication standard using digital radio signals; Global System for Mobile Communications (GSM) standard, with introduced data services.
2.5G	Second generation of enhanced wireless telephone technology; enables high speed data transfer over upgraded existing 2G networks; High-Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS) or Code Division Multiple Access (CDMA) technology.
3G	Third generation of wireless telephone technology; IMT-2000 family – a generation of standards for mobile telecommunications services, that must allow the simultaneous use of speech and data services; provide peak data rates of at least 200 kbit/s according to IMT-2000 specification; for example mobile internet access, video calls and mobile TV; W-CDMA technology.
3GPP	3rd Generation Partnership Project, worldwide cooperation of standard setting bodies, for the standardising of UMTS (Universal Mobile Telecommunication System) and GSM (Global System for Mobile Communications) technology.
4G	Fourth generation of wireless telephone technology; includes all-IP packet-switched networks, mobile broadband access, and multi-carrier transmission; mobile Worldwide Interoperability for Microwave Access (WiMAX) and Long-Term Evolution (LTE).
AAA	Authentication, Authorisation, Accounting, network service for recognising users, awarding access rights and charging features.
AD-HOC ROUTING	Term for the radio networks, which connect several terminals to an interconnected network, which can be configured by a mobile ad-hoc network. Special routing procedures provide for the fact, that the existing ad-hoc network continuously adapts itself if nodes (end devices) move, appear or fall out.

API	Application Programme Interface is a specification, intended to be used as an interface, by software components to communicate with each other. An API includes different specifications for routines, data structures, object classes and variables.
AMBIENT INTELLIGENCE	Highly specified sensors for radio networks and mini computers in used applications and services. These objects around communication ability serve to enhance people's everyday lives. A sensor in the office ascertains when the temperature is too high (air-conditioning is switched on), or too low (heating is switched on).
AUC	Authentication Centre is a function to authenticate each Subscriber Identity Module (SIM) that attempts to connect to the GSM core network when the mobile phone is switched on.
B3G	Beyond 3rd Generation, is the fourth generation (4G) of cell phone mobile communications standards; provides mobile ultra-broadband internet access; conceivable applications include amended mobile web access, IT telephony, gaming services, high-definition mobile TV, video conferencing and 3D television.
BLUETOOTH	An open wireless technology standard, which facilitates the exchange of data over short distances, from wired and mobile devices, creating personal area networks with high levels of security.
BSC	Base Station Controller is part of a traditional cellular telephone network that is responsible for handling traffic and signalling between a mobile phone and the network switching subsystem.
BSS	Business Support Systems; support business processes within a company; used to manage contract relations with customers easier, suppliers and partners as well as the management of products and resources.
BTS	Base Transceiver Station is a piece of equipment that facilitates wireless communication between user end devices and a network.
CAMEL	Customised Applications for Mobile Network Enhanced Logic, a standard for mobile communication networks, initiated by the European Institute for Telecommunication norms, expanded service offers in UMTS.
CDM	Code Division Multiplexing is a channel access method used by various radio communication technologies (see also CDMA2000).

CDMA2000	Mobile technology standard developed in the mid 1990s; is the competitor of UMTS. This is not represented in Europe, but in America (the USA, South America), parts of Asia (Japan, Korea) and also parts of Africa. CDMA2000 standard also based on the CDMA procedure (Code Division Multiple Access), but not compatible with it.
CELLULAR IP	This is a network protocol standard, makes routing functionality available for mobile participants in IP networks.
CIT	Critical Incident Technique is a procedure that was developed originally as an observation method to uncover critical incidents concerning situative conditions and involved or following reactions. Besides this, there are data from observations to uncover relevant or critical incidents.
CLOUD COMPUTING	Cloud Computing allows suppliers to provide computer performance, storage space and software licences for abstracted, highly scalable and administered IT infrastructure. This will enable users in the future, whether private or commercial, to operate anywhere from low-performance, low-storage-capacity machines, providing they have a reliable internet connection.
CONTEXT AWARENESS	Software technology concept; can change its structure, functionality and behaviour to adapt itself to different situations according to the end device being used. Context-Awareness uses information to tune the behaviour to it. Nowadays context adaptation has to be discussed, as a key requirement for future mobile and ubiquitous systems.
DCSM	Distributed Communication Sphere: communication working field in SPICE.
DIAMETER	Diameter is an authentication, authorisation and accounting protocol, for the authentication of communication partners on a network. The diameter protocol is defined in the RFC 3588, and fulfils the requirements of the AAA transport profile "Authentication, Authorisation, Accounting", from RFC 3539. Diameter is used in the IP Multimedia Subsystem.
DHCP	Dynamic Host Configuration Protocol is a network protocol that is used, to configure network devices for communicating within IP networks: A DHCP client acquires an IP address, a default route and one or more DNS server addresses from a DHCP server. This information is used for configuring its host. The host is able to communicate on the internet.

DNS	Domain Name Server is a hierarchical distributed naming system for computers, services, or any resource connected to the Internet, or a private network.
DSP	Digital Signal Processing is the manipulation of an information signal in order to modify it mathematically in a certain way; it is characterised by the representation of discrete time and discrete frequency.
EDGE	Enhanced Data Rates for GSM Evolution; further development of GPRS or HSCSD, developed to increase data transfer rates by means of new modulation procedures; in comparison to GSM (GMSK), EDGE uses 8-phase Shift Keying (8-PSK) modulation; data rate of 59.2 kBit/s possible, maximum theoretical transfer rate 473 kBit/s, in practice maximum 220 kBit/s download and 110 kBit/s upload.
EIR	Equipment Identifier Register maintains a list of mobile phones that are identified by their International Mobile Equipment Identity (IMEI) which are to be banned from the network or monitored. It is often integrated in the Home Location Register (HLR).
EPC	Evolved Packet Core is the main component of the System Architecture Evolution (SAE). EPC serves as equivalent of GPRS networks via the Mobility Management Entity, Serving Gateway and PDN Gateway subcomponents.
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network, a mobile radio standard, which was defined as UMTS's UTRAN successor, within the scope of 3GPP.
FDD	Frequency Division Duplexing means that the transmitter and receiver operate at different carrier frequencies. The station must be able to send and receive a transmission at the same time, and does so by slightly altering the frequency at which it sends and receives.
FDM	Frequency Division Multiplexing is a technique in which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, each of which is used to carry a separate signal.
GALILEO	European, open, global, and independent positioning system, which is intended to be compatible with other navigation systems such as GPS.
GERAN	GSM EDGE Radio Access Network, Radio Access Network for GSM/EDGE Standard.

GGSN	Gateway GPRS Support Node, Crossing of the GPRS net in a public Data Network (PDN) or Packing Data Network.
GMSC	Gateway Mobile Switching Centre, Interfaces with other telephone networks.
GPS	Global Positioning System (NAVSTAR GPS); is a space-based worldwide navigation satellite system, which provides reliable location and time information, regardless of weather conditions, at all times and anywhere on or near the earth; developed in the 1980s; initially launched by the United States Department of Defense. It orbits the Earth and makes it possible to pinpoint geographic location - location accuracy ranges from 10m to 100m - nowadays it is both a military and commercial programme.
GPRS	General Packet Radio Service is a packet-oriented mobile data service, developed around higher data rates. It is packet-oriented and uses the same channels as GSM, with theoretical data rate of maximum 171.2 kBit/s - all 8 channels are bundled up. Maximum practical speed 115 kBit/s; available to users of 2G cellular communication systems, GSM as well as 3G systems; a 2.5G mobile standard, typically adopted by GSM operators as a migration step towards 3G.
GSM	Global System for Mobile Communications is, a European-developed digital mobile cellular standard which allows for international roaming arrangements between mobile operators, whilst providing subscribers with the possibility of using their phones in many parts of the world. It is used primarily for telephony, for management-provided and package-provided data transfer, as well as short communication, and was developed at the beginning of the 1980s. It is used in more than 200 countries and has approximately 3.4 billion users. It is compatible with ISDN or other analogue telephone networks and uses frequency carriers of 900 MHz to 1800 MHz; low speed rate of 9.6 kBit/s to 14.4 kBit/s.
GTM	Grounded Theory Methodology: research methodology focusing on an inductive research approach.

HANDOVER	The process of transferring an ongoing call or data session from one channel, connected to the core network, to another channel. It is a process with which the Mobile Switching Centre (MSC) passes a mobile phone conversation from a radio frequency in one cell to another radio frequency in another, as a subscriber crosses the boundary of a cell. For example - the mobile station changes its radio cell from GSM to UMTS base stations during a conversation, or a data connection, without interruption to the connection.
HCI	Human Computer Interaction involves the study, planning, and design of the interaction between people and computers.
HDTV	High-definition Television provides a resolution that is substantially higher than that of standard-definition television.
HFC	Hybrid Fibre Coax is a telecommunication industry term, for a broadband network, that combines optical fibre and coaxial cable.
HLR	Home Location Register is a central database that contains details of each mobile phone subscriber that is authorised to use the GSM core network.
HSCSD	High-Speed Circuit Switched Data is an enlargement of the GSM standard, used to speed up data transfer by the grouping together of several data channels. Besides this, data transfer rates, up to about 115.2 kbit/s (8×14.4 kbit/s), can be theoretically reached; through changes in the existing GSM infrastructure it is possible for the data rate to be increased by transference.
HSPA	High-Speed Packet Access, further development of (3.5G) UMTS, which is separated in HSDPA (High-Speed Downlink Packet Access) and HSUPA (High-Speed Upload Packet Access). Purpose: higher download speeds (2 MBit/s).
HSDPA	High-Speed Downlink Packing Access, data transfer procedures of the mobile radio standard UMTS, protocol allows for the increase of the data rates in a UMTS network.
HSUPA	High Speed Uplink Packing Access, data transfer procedures of the mobile radio standard UMTS. Protocol allows for an increase of the data rates in a UMTS network.
HTTP	Hypertext Transfer Protocol: a standard transport protocol for transferring 'web pages' from one machine to another.

ICT	Information and Communications Technology: ICT consists of IT, as well as telecommunication, broadcast media (all types of audio and video processing and transmission) and network based control and monitoring functions; often used as extended synonym for IT, but also to stress the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers, middleware and software, storage, and audio-visual systems, which enables users to create, access, store, transmit, and manipulate information.
IP	Internet Protocol Address. A numeric value that serves to identify an interface that is connected to the Internet, in a unique way.
IMEI	International Mobile Equipment Identity. Unique serial number used for mobile phones, typically those connected to the GSM network.
IMS	IP (Internet Protocol) Multimedia Subsystem, collection of specifications of 3rd generation Partnership Project (3GPP), the aim of IMS is to enable access to the services of different networks.
IMSI	International Mobile Subscriber Identity, a unique number that is associated with all GSM and Universal Mobile Telecommunications System network mobile phone users. The number is stored in the Subscriber Identity Module (SIM).
ISC	International Switching Centre is a 3G core network element such as a Mobile Switching Centre (MSC) that controls the network switching subsystem elements on an international level.
ISDN	Integrated Services Digital Network. A digital switched network, which supports the transmission of voice, data and images, over conventional telephone lines.
IST FP6	Information Society Technologies aims to increase innovation and competitiveness in European businesses and industry; Framework Programme six.
ITU	International Telecommunication Union; the United Nations specialised agency for telecommunications. http://www.itu.int/
LBS	Location-based Services are mobile services that can provide information to the end user, by aid of data, dependent on position (e.g., data from the GPS-position regulation), and produce services of other kinds, for example, advertising services.

LDAP	Lightweight Directory Access Protocol is an application protocol for the access and the maintenance of distributed directory information services over an IP network.
LTE	Long Term Evolution, is a standard for wireless communication of high-speed data for mobile phones and end devices developed by 3GPP; based on GSM/EDGE and UMTS/HSPA network technologies with increased capacity and speed, using new modulation techniques.
M-COMMERCE	Mobile Commerce is similar to e-commerce, however the term is usually applied to the emerging transaction activity in mobile networks.
MGW	Media Gateway, Benefit data-transferring Authority on a UMTS network.
MMS	Multimedia Messaging Service provides more sophisticated mobile messaging than SMS. A global standard for messaging, MMS enables users to send and receive messages with formatted text, graphics, audio and video clips. Unlike SMS, it is not limited to 160 characters per message.
MOBILE IP	A network protocol standard that allows the change of a computer network to another network, whereby users of mobile terminals keep a firm IP address alongside, at the same time.
MS	Mobile Station or mobile telephone.
MSC	Mobile Switching Centre, mobile full-digital agency on the mobile radio network, component of GSM, UMTS or Long-Term Evolution (LTE) of mobile radio networks.
NFC	Near Field Communication: a set of standards for Smartphones and end devices for establishing radio communication with each other by linking them together, usually no more than a few centimetres; present and anticipated applications include contactless transactions, data exchange, and simplified setup of more complex communications such as Wi-Fi.
NGN	Next Generation Networks: one telecommunication network that transports all information and services (voice, data, media and video) by encapsulating these into IP packets.
NUDIST	Non Numerical Unstructured Data Indexing Searching and Theorizing: software product from QSR international which helps with the undertaking of qualitative research and is especially useful when a researcher is working with large amounts of data. It helps to structure the researchers' data in order to interpret it.

NVIVO	Is a data analysis software product from QSR international, designed for qualitative research by working on very rich text-based and/or multimedia information where deep levels of analysis of small, or large, volumes of data is required.
OMC	Operation and Maintenance Centre; company and servicing headquarters for telecommunication networks.
OMSS	Operation and Maintenance Sub-System, part of the Mobile Switching Centre.
OSI	Open Systems Interconnection, is an effort to standardize networking; started in 1977.
OSS	Operations Support System, Company Support System, Network Management System that supports automated service processes.
PAM	Pluggable Authentication of Module, is a mechanism for integrating multiple low-level authentication schemes into a high-level application-programming interface (API). It allows programs that rely on authentication to be written independently of the underlying authentication scheme.
PAN	Personal Area Network is a computer network implemented for the communication among computers and mobile end devices.
PDA	Personal Digital Assistant is a generic term for handheld devices that combine computing and communication functions.
PSTN	Public Switched Telephone Network, totality of all public management-engaged telephone networks.
QoS	Quality of Services refers to network traffic resource reservations and control mechanisms in computer environments.
RFID	Radio-frequency Identification is used for wireless non-contact systems, that use electromagnetic fields to transfer data from a tag, attached to an object, for the purpose of automatic identification and tracking.
RTP	Real-Time Transport Protocol, a protocol for the continuous transference of audio-visual data streams in IP based networks.
SAE	System Architecture Evolution is the core network architecture of 3GGG's Long Term Evolution (LTE) wireless communication standard.
SCE	Service Creation Environment in SPICE - Service Creation Environment on a Service-Delivery-Platform (SPICE).

SCTP	Stream Control Transmission Protocol, Session Initial Protocol (SIP) Transport Protocol is a reliable, connection-oriented transport protocol, which touches on a potentially unreliable package service without connection.
SDM	Space Division Multiplex, Space multiplex procedures, transference canals are bundled up in order to enable parallel, but exclusive use, by several transmitters and receivers.
SDL	Service Description Language: is a platform, programme and protocol independent description language for network services, for the exchange of messages, on the basis of XML.
SDP	Service-Delivery-Platform, Official development and execution platform, makes available services as a uniform program interface and shows a sub range of NGNs.
SGSN	Serving GPRS Support Node, SGSN has a similar function to a Mobile Switching Centre (MSC) for linguistic communication for GPRS data communication.
SIM	Subscriber Identity Module is a small printed circuit board that is inserted into a GSM-based mobile phone. It includes subscriber details, security information and memory for the personal directory of numbers. This information can be maintained by subscribers when changing handsets.
SIP	Session Initial Protocol, special net protocol from the Internet-protocol family for the construction, control, and dismantling of a communication meeting between two or more participants.
SLA	Service Level Agreement, agreement about the quality and price of a service contract.
SMS	Short Message Service; is a service available on digital networks, typically enabling messages with up to 160 characters, to be sent from, or received on, a subscriber's mobile phone via the message centre of a network operator.
SMSS	Switching and Management Sub-System: Mediation subsystem in a telecommunication system.
SOA	Service Oriented Architecture, architecture oriented structuring of services of IT systems; is a set of principles for designing and developing software in terms of interoperable services.
SON	Self-Organising Networks, self-curative/-optimising networks.

SPATEL	SPICE advanced service description language for telecommunication services, Enlarged, official description language for telecommunication services, a platform which simply allows the definitions of official parameters according to a standardised action.
SPICE	Service Platform for an Innovative Communication Environment, Collection of specifications with particular adjustment for user-centred, IP based services.
SSL	Secure Sockets Layer, is a cryptographic protocol that provides communication security over the internet and that encrypts the segments of network connections at the applications layer.
TCP	Transmission Control Protocol, Protocol for arranging which way data should be exchanged between computers, a reliable, connection-oriented, package-intermediatory transport protocol in computer networks.
TDD	Time Division Duplexing is the application of Time Division Multiplexing (TDM) to separate outward and return signals.
TDM	Time Division Multiplexing is a type of multiplexing in which two or more bit streams or signals are transferred apparently simultaneously as sub-channels in one communication channel, but are physically taking turns on the channel.
UBIQUITOUS COMPUTING	The English term "Ubiquitous" means "everywhere". It refers to the development that computers are to be seen everywhere in our lives (from the modern pocket calculator to the Smartphone). Computers have played a role of increasing responsibility since the 1990s, with a trend towards Ubiquitous Computing. This means "completely piercingly“; it is difficult to separate either concept from another, therefore, they are summarised under "Ubiquitous Computing".
UBS	Ubiquitous Services are services that support human computer interaction in which information processing has been thoroughly integrated into everyday objects and activities.
UDP	User Datagram Protocol is a network protocol without connection.
UMTS	Universal Mobile Telecommunication System is the European term for third generation mobile cellular systems or IMT-2000 based on the W-CDMA standard. It is a third generation mobile radio standard; with clearly higher data transfer rates (up to 7.2 MBit/s with HSDPA; without maximum 384 kbit/s).

URL	Unique/Uniform Resource Locator. A naming system for web resources.
USIM	Universal Subscriber Identity Module (card). A printed circuit board (similar to a SIM) that is inserted into a mobile phone. Adopted by W-CDMA operators for 3G mobile. Capable of storing information, with sophisticated security functions, in comparison to SIMs. Also referred to as User Identity Module, or USIM.
UTRAN	UMTS Terrestrial Radio Access Network is a hierarchically built up radio access network in a mobile radio network according to the UMTS standard.
VLAN	Virtual Local Area Network is the concept of partitioning a physical network, so that distinct broadcast domains (is a logical division of a computer network, in which all nodes can reach each other by broadcast at the data link layer) are created.
VLR	Visited Location Register is a database of the subscribers who have roamed into the jurisdiction of the MSC (Mobile Switching Centre) that it serves.
VoIP	Voice over IP: phoning in computer networks that are built up according to internet standards.
VHE	Virtual Home Environments is a system to support GSM roaming.
WAP	Wireless Application Protocol - A licence-free protocol for wireless communication, which enables the creation of mobile telephone services, and the representation of internet pages on a mobile phone, and is therefore the mobile equivalent of HTTP (Hypertext Transfer Protocol).
WEARABLE COMPUTING	Computer or electronic components one carries directly on the body.
WIDGET	Component of a graphic window system: Widgets are always integrated into a certain window system and use this for interaction with the user, or other windows system Widgets.
WLAN	Wireless Local Area Network: local radio network according to the standard of the IEEE-802.11 family.

Wi-Fi	Wireless Fidelity: wireless systems that provide internet connectivity, this refers to Wireless Fidelity, the 802.11b specification for Wireless LANs, laid out by the Institute of Electrical and Electronics Engineers (IEEE). It is part of a series of wireless specifications that also includes 802.11a, and 802.11g. Sources: International Telecommunication Union (2003) and Home Office (2003b).
WPAN	Wireless Personal Area Network is a personal area network for interconnecting devices centred around an individual person's workspace, in which the connections are wireless.
XML	Extensible Mark-up Language of structured records, in the form of text data.