Scalable push file delivery with MBMS

MBMS push services give operators the ability to deliver multimedia content, simultaneously, to all users in a specific location, without overloading a mobile network.

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Push services are popular on the internet and in mobile environments. Internet push services often use podcast mechanisms, while mobile push services use SMS and WAP-push. Technical realizations today are based on dedicated point-to-point delivery. This article presents MBMS push file services as a scalability extension to unicast services. MBMS is thus used as a "capacity booster" for distributing popular content services.

Push services, which provide content to mobile phones without direct user involvement, have long been of interest to mobile operators. The most common technologies used to realize push services in mobile networks are short message service (SMS) and wireless application protocol push (WAP-push). On the internet, the common technology is podcasting. Existing podcast services employ the really simple syndication (RSS) protocol, and are actually a pseudo-push service — clients periodically poll a server to check for updates and new content, which is then downloaded to user devices. The rationale for periodic polling is that it works in the presence of firewalls and network address translators, which are common obstacles on today's internet.

These point-to-point delivery techniques do not scale well, however. The resources needed to distribute the content increase proportionally with the number of subscribers and the size of the transferred content.

The scalability problem can be solved by using broadcast technologies for pushing content in the form of files. Popular push services can use broadcast distribution technology to complement existing unicast schemes. The resources needed to distribute a file are independent of the number of subscribers, and the time needed to reach all subscribers depends only on file size. By defining separate broadcast channels for different services, it is possible to let users opt-in to the content of their choice. This provides a degree of personalization.

Multimedia broadcast/multicast service (MBMS) is the native broadcast technology of third-generation mobile system (3G) networks.[1] It offers two delivery methods: streaming and download. Streaming is typically used for mobile TV services, while download (here called MBMS push file delivery service) is used for distributing content in files of any size and arbitrary format.

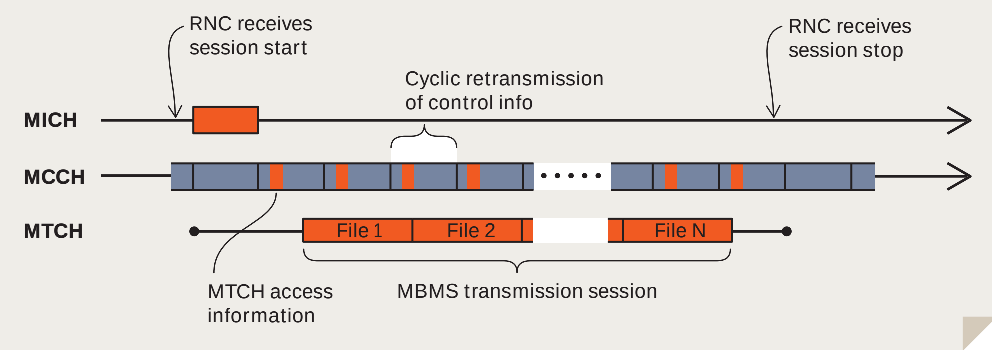
The use of MBMS for mobile TV has been described in a previous article.[2] For the purpose of this article, we note that the MBMS push file delivery service is not orthogonal to mobile TV but rather it is a key enabler for the mass-market distribution of podcast TV as part of a rich mobile TV offering.

What makes MBMS particularly well suited for push services is an effective paging mechanism that can selectively wake up terminals when a transmission is about to start. This allows terminals to remain in standby mode (preserving battery capacity) while waiting for a transmission. As well, MBMS allows precise control of the broadcast area of any transmission, from one cell up to the entire network.

BOX A Terms and abbreviations

3G	Third-generation mobile system
ADP	Associated delivery procedure description
API	Application programming interface
BCAST	Mobile broadcast
BM-SC	Broadcast / multicast service center
C2P	Content-to-person
CBS	Cell broadcast service
ESG	Electronic service guide
FD	File delivery
FDT	File delivery table
FLUTE	File delivery over unidirectional transport
FR	File repair
GPRS	General packet radio service
HSPA	High-speed packet access
HTTP	Hypertext transfer protocol
MBMS	Multimedia broadcast / multicast service
MBSFN	Multimedia broadcast single frequency network
MCCH	MBMS control channel
MICH	MBMS indicator channel
MMS	Multimedia messaging service
MTCH	MBMS traffic channel
OMA	Open Mobile Alliance
PTP	Point-to-point
RNC	Radio network controller
RR	Reception reporting
RSS	Really simple syndication
SDP	Session description protocol
SMS	Short message service
TCP	Transmission control protocol
TMGI	Temporary mobile group identifier
UDP	User datagram protocol
USD	User service description
WAP	Wireless application protocol
XML	Extended markup language

FIGURE 1 **Push file delivery on MBMS traffic channels (MTCH).**



Business incentives for push services

Today's consumers expect to access content at will, wherever they are. Market research consistently shows that the adoption of new services is ruled by consumer convenience and value. Consumers want to stay informed and updated within their areas of interest, and they want immediate access to information of their choosing. Market studies show consumer willingness to pay a moderate fee for fast and easy access. Alternately, indirect payment, through the acceptance of advertisements, is already established in internet usage behaviors. Users accept advertisements if they are not intrusive or if users have an option to control how they are rendered.

The value of push services to users lies in their ability to receive any type of multimedia content, through a simple interface with a single subscription. Ultimately, users will not care about how content reaches them as long as it is available when they want it, whether they are online or not.

Pushing content in the background according to user preference and storing it in the terminal for later consumption significantly reduces service startup and content access times. In most cases the content is already available in the terminal when the user decides to consume it. Any missing content may still be fetched on demand.

Existing push services are rarely timely or simultaneous, since they rely on point-to-point transmissions that can only be parallelized to a limited extent and otherwise require sequential transmission of the same content. In addition, mobile operators are looking for ways to distribute more of their own content to subscribers without risking network overload. One solution is to broadcast popular services.

From a business perspective, the key questions that arise are *what kind of content is interesting to deliver, what costs are involved to deliver it,* and *how will revenues be generated?*

The types of content and services operators deliver will range from immediate real-time services, such as emergency alert messages, to less time-critical background delivery for later consumption, such as news and weather updates, active wallpapers, sport highlights, selected clips or tunes, and so forth. The content can also be for machine-to-machine communications, such as software updates, maps, or other kinds of system application data.

Business cases developed by Ericsson show that revenues as low as EUR 1 per user per month can motivate a complete investment in MBMS infrastructure at relatively small service penetration levels. Past that breakeven point, any additional subscriber brings pure profit. Moreover, operators can obtain this revenue either through subscription fees or from advertising. Typical advertising models to mobile users include static or dynamic banners, (preload) content-related advertisement, or opt-in models. MBMS file delivery can be used with all common advertisement models, and it can be closely tied to the service and type of content.

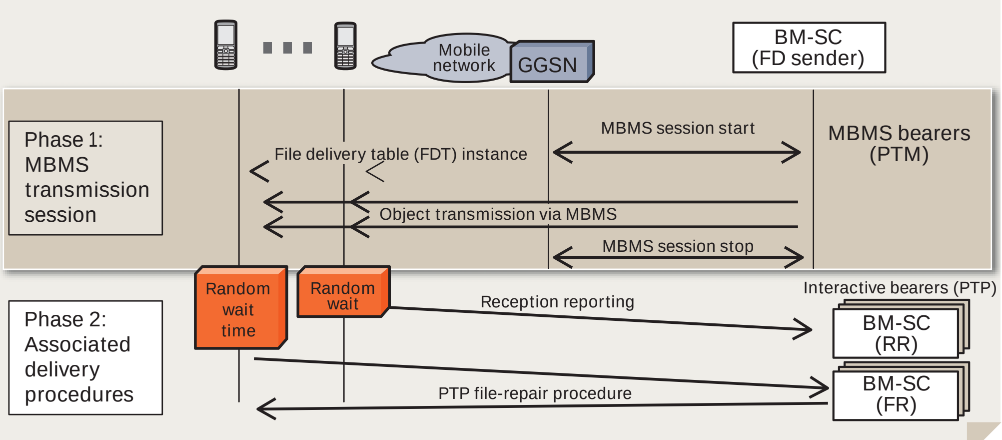
MBMS push file delivery enabler

MBMS system and notification mechanism

Essentially, MBMS offers a scalable mechanism for delivering multimedia content over 3G networks. The MBMS architecture is the same for the two supported delivery methods: streaming (used for mobile TV) and download (used for file delivery services). The general characteristics of MBMS have been described in an earlier article and still apply.[3] Recent enhancements introduced in the MBMS standards, such as the support of single-frequency networks (MBSFN), also apply to both delivery methods.

There are, however, differences in how the MBMS features are used by ▸▸

FIGURE 2 **MBMS file-delivery principle with point-to-point file repair.**



the different types of services. For instance, live TV services produce a continuous packet stream for typically a long period (several hours). File delivery services produce bursts of data, the size of a burst being determined by the file size and the selected bit rate. The radio resources are only reserved for the duration of the burst and are then released and can be used by other services.

MBMS defines three MBMS-specific radio bearers:

- **MICH (MBMS indicator channel), used to notify terminals about the imminent start of an MBMS transmission session;**
- **MCCH (MBMS control channel), which carries control information about all ongoing MBMS transmission sessions; and**
- **MTCH (MBMS traffic channel), which carries the actual data of an MBMS transmission session.**

Figure 1 illustrates the relationship between these channels. While in standby mode, the terminal monitors MICH during its regular paging occasions. MICH indicates upcoming changes in the MCCH for a particular service identified by its temporary mobile group identifier (TMGI). Triggered by MICH, the terminal fully powers on its receiver and reads MCCH to find detailed information about the session. The terminal then tunes to MTCH and starts receiving data.

The MICH and MCCH channels are always active in a cell, whereas MTCH is set up only for the duration of an MBMS transmission session. Upon reception of the session-start message from the broadcast/multicast service center (BM-SC), the radio network controller (RNC) triggers the notification on MICH, establishes the corresponding MTCH, and updates MCCH with MTCH access information. The RNC releases the MTCH resources on reception of an MBMS session-stop message. MTCH is thus only active for the duration of the file transfer.

Pushing files over MBMS

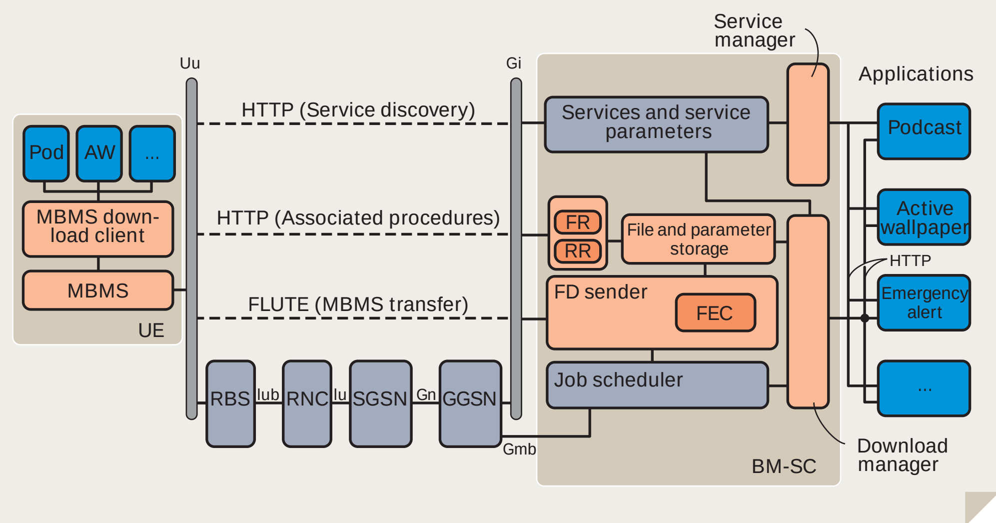
Figure 2 depicts the general principle of an MBMS file-delivery session. It is assumed that the terminal has discovered the service and already activated reception. Because TCP and HTTP do not support multicast/broadcast addressing and are bidirectional by nature, the 3GPP has selected the IETF FLUTE (file delivery over unidirectional transport) protocol for transferring files over MBMS, which is unidirectional. Files are fragmented and sent in UDP packets. Transmission robustness may be increased using the DF Raptor™ forward error correction (FEC) code from Digital Fountain. For MBMS download, terminals must support Raptor FEC. The BM-SC decides on the usage and the coding rate.

The Raptor FEC code is a low-complexity code that allows entire files of up to several megabytes to be used as a single FEC source block. Raptor's special property is the generation of a high number of independent FEC symbols from a single source block.

In addition to using FLUTE for MBMS transmission sessions, 3GPP has defined complementary procedures for service discovery, security, and associated delivery procedures, all of which may use an interactive bearer.

Figure 2 schematically shows MBMS file delivery. It is assumed that the BM-SC hosts the content and communicates to the mobile network through the gateway GPRS support node (GGSN). MBMS bearers are established, used, and released during phase 1 of the procedure, while phase 2 shows the point-to-point (PTP) file repair and reception-reporting functions. Point-to-point file repair allows terminals to request missing data (lost packets) using interactive bearers, for example, HSPA. The "random wait time" between phase 1 and phase 2 is introduced to avoid uplink congestion. The reception reporting function allows operators to monitor how many terminals have received the content.

FIGURE 3 Architecture for MBMS push file delivery.



BOX B Overall architecture

Figure 3 schematically depicts a possible MBMS push file delivery architecture. The BM-SC hides the transmission complexity by providing a web service API to application servers. The service and download managers handle the abstraction of internal mobile-network procedures to web service methods.

The service manager registers new applications and generates the corresponding service attributes and description files: user service description (USD), session description (SDP), and associated delivery procedure description (ADP).

The download manager handles transmission requests issued by the applications. Files and transmission parameters are locally stored for subsequent file repair (FR) actions. The file delivery (FD) sender partitions the files to fit into UDP packets. FEC redundancy is optionally added to increase transmission reliability. The "job" scheduler controls the transmission and uses the Gmb interface to establish and release the necessary MBMS bearers. The reception reporting (RR) function collects reception acknowledgements.

A FLUTE file delivery table (FDT) instance is delivered to the terminals, in-band with the actual content. This describes the files and associated transport parameters, which are provided during the MBMS transmission sessions.

Service discovery and service activation

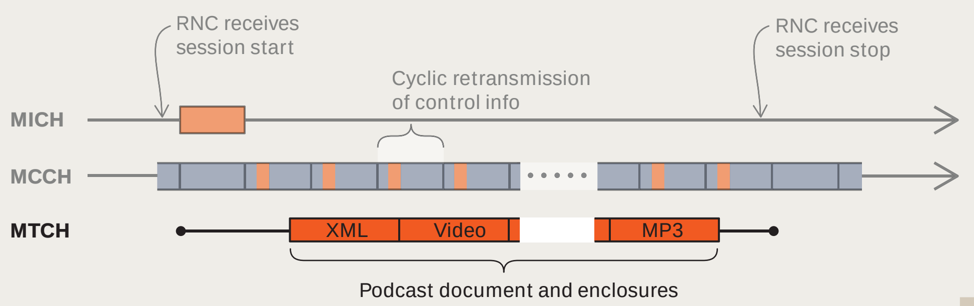
Service discovery refers to methods that terminals use to obtain a list of available services along with information on those services.[4] For example, a terminal may use the Open Mobile Alliance Mobile Broadcast (OMA BCAST) Electronic Service Guide (ESG), although not all parts are necessary for "unscheduled" push services.[5]

The advantage of BCAST-ESG is that it allows seamless integration of unicast and broadcast offerings by relating several access methods to the same service. Service identifiers communicated to the terminal during service discovery are independent of the actual access system.

Users can register to available services once they have discovered them via the ESG. Registration has two objectives: it triggers activation of service reception in the terminal, and it measures the size of a service's audience. Popular services should use MBMS; the rest should use OMA-push (unicast).

In the case of MBMS, service activation means a terminal starts to monitor MICH/MCCH in anticipation of MBMS transmission sessions. In the context of OMA-push delivery, the terminal sends the service identifiers to the BM-SC, which uses SMS technology (that is, OMA-push) to inform the terminal about new content.[6] The terminal then uses HTTP to retrieve the content.

FIGURE 4 Podcast on MBMS.



Push file delivery systems

In the following example, we use a "Football Breaking News" video service to illustrate the pros and cons of technical realizations of a push service. When a team scores, the service pushes a short video clip of the goal to interested fans. A 30-second video clip of reasonable quality can easily reach 500KB in size.

Multimedia messaging service (MMS) is often used for content-to-person (C2P) services. MMS uses SMS (OMA-push) to notify interested terminals about new content. A modern MMS installation with a capacity of 200 messages per second can deliver a message to 100,000 terminals in less than 10 minutes. However, being unicast, the delivery duration is directly related to the size of the target group. Increasing the target group size to 200,000 terminals doubles the delivery duration.

Cell broadcast service (CBS) uses broadcast radio bearers, but it does not implement any notification or paging mechanism. This typically means that battery drain is high. In addition, CBS only defines the delivery of short (text) messages (up to a size of 1230 octets or 1.2KB). A typical ringtone, by comparison, is about 150KB. In summary, CBS is not suitable for multimedia services.

Modern terminals are often shipped with podcast clients (unicast only). Podcast allows the distribution of multimedia clips. Since podcast push is realized by a periodic poll of the service status, the delivery delay depends on the polling interval. For example, to ensure that video events are delivered within ten minutes, the polling interval must be set to ten minutes or less. The high polling frequency affects the capacity of terminals, the radio network, and the service layer. In the terminal, the frequent establishment of a dedicated radio bearer for the short polling message drains the battery; and in the radio access network, resources must be allocated to terminals that are otherwise idle and can be released only after a predefined period of inactivity. In the service layer, servers must be able to handle a constant flow of polling messages from a large number of terminals.

MBMS is ideally suited to realize a mass-market video goal service. Interested terminals monitor MICH for the temporary mobile group identifier (TMGI) of the video goal service. This approach does not consume dedicated radio resources nor does it increase battery consumption during idle mode. The duration of time needed to deliver the video clip when a team scores depends only on the size of the clip and the bit rate of the bearer. Given a 64Kbps MBMS bearer, it typically takes about 1.5 minutes (including notification and bearer setup) to deliver a 500KB video clip regardless of the size of the target group.

BOX C Podcast on MBMS

Podcast is a popular enabler used by internet applications. A podcast is an unscheduled push service — the internet itself does not offer any real push mechanisms. The push perception is realized by a continuous, periodic retrieval (polling) of an extended markup language (XML) document from a server. RSS-formatted XML documents describe in a general section the nature of the podcast feed, followed by the description of one or more content items. Content items may describe video clips, MP3 files, or news headlines. The actual content is not embedded in the XML document. Instead, an HTTP link is provided to, say, a video clip (or general enclosure).

In contrast, MBMS provides a real push mechanism. Terminals continuously monitor the paging channel for incoming transmissions. MBMS file delivery allows for the transmission of one or more files in a single transmission session. The transmission session may contain the descriptive XML document as well as content enclosures, such as video clips (Figure 4).

Summary

This article presents the general concept of push file services and discusses the scalability issues of today's realizations. All realizations on the internet and in mobile environments use dedicated point-to-point (unicast) resources. This works fine, but resources must be provided for each user. If the popularity of such services increases, the resources must increase proportionally.

Pushing content to terminals in the form of files has several advantages:

- **The content is stored in the terminal's memory giving end-users the perception that service response time is fast.**
- **Operators may either decide to preload the terminals during non-busy hours and employ unused network resources or to use external events to trigger content push. Football highlights or stock market updates are examples of event-based services that have real-time delivery requirements.**

Operators can use MBMS push services to complement existing unicast services. MBMS can be regarded as a capacity booster for popular services, while unicast serves the remainder. Service personalization can be provided by mapping each push service to a separate broadcast channel. Terminals monitor a set of broadcast channels to receive the wanted information. This way, each terminal receives its own, personal mix of content.

Because MBMS is based on broadcast transmissions in the network and over the air, transmission duration becomes independent of the size of the target group. This is particularly important in fulfilling real-time delivery requirements.

Push services generally enable operators to control when the content is distributed. In this way, they can push non-time-critical content whenever resource usage is low (for example, at night), optimizing their use of the network.

MBMS features an effective paging mechanism that can selectively wake up terminals when a transmission is about to start. This makes it possible to have the MBMS push file delivery service continuously active in terminals without draining their batteries.

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