Mobile Search Framework Architecture

Candidate Version 1.0 – 07 Dec 2010

Open Mobile Alliance

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Contents

1. SCOPE (INFORMATIVE) 5
2. REFERENCES 6
2.1 NORMATIVE REFERENCES 6
2.2 INFORMATIVE REFERENCES 6
3. TERMINOLOGY AND CONVENTIONS 7
3.1 CONVENTIONS 7
3.2 DEFINITIONS 7
3.3 ABBREVIATIONS 7
4. INTRODUCTION (INFORMATIVE) 8
4.1 VERSION 1.0 9
5. ARCHITECTURAL MODEL 10
5.1 DEPENDENCIES 10
5.2 ARCHITECTURAL DIAGRAM 10
5.3 FUNCTIONAL COMPONENTS AND INTERFACES DEFINITION 10
5.3.1 Functional Components 10
5.3.2 Interfaces 13
5.4 SECURITY CONSIDERATIONS 14
APPENDIX A. CHANGE HISTORY (INFORMATIVE) 15
A.1 APPROVED VERSION HISTORY 15
A.2 DRAFT/CANDIDATE VERSION 1.0 HISTORY 15
APPENDIX B. FLOWS (INFORMATIVE) 15
B.1 PERSONALISED SEARCH 16
B.2 SE REGISTRATION 18
B.3 END-TO-END SEARCH REQUEST FLOW 19
B.4 INTERWORKING 20
B.5 INTERWORKING 2 21
B.6 SEARCH HISTORY FLOW 21
B.7 RECOMMENDATION FLOW 22
B.8 Q&A FLOW 23
B.9 META-INDEX EXCHANGE/UPDATE FLOW 24
B.10 APPLICATION INITIATED SEARCH 25
B.11 SUBSCRIBE-PUSH 26

Figures

Figure 1: MSF Enabler deployment example 8
Figure 2: Architectural Diagram 10
Figure 3: Personalised Search Flow 16
Figure 4: SE Registration Flow 18
Figure 5: End-to-End Search Request flow 19
Figure 6: Interworking Flow 20
Figure 7: Interworking Flow 2 21
Figure 8: Search History Flow 22
Figure 9: Recommendation Flow 22

Figure 10: Q&A Flow **23**

Figure 11: Meta-Index Exchange/Update Flow **24**

Figure 12: Application Initiated Search flow **25**

1. Scope (Informative)

The Architecture Document (AD) illustrates the Mobile Search Framework Enabler from an architectural perspective. This document contains the architecture diagram as well as functional components and interfaces definitions. To further demonstrate the architecture of the MSF Enabler, several flows are included in Appendix B.

This document does not contain any detailed definition of the components or the parameters of interfaces. These definitions are included in the TS document

2. References

2.1 Normative References

[OSE] "OMA Service Environment", Open Mobile Alliance™, URL:http://www.openmobilealliance.org/

[RFC2119] "Key words for use in RFCs to Indicate Requirement Levels", S. Bradner, March 1997, URL:http://www.ietf.org/rfc/rfc2119.txt

[OMA-MSrchFramework-RD] "Mobile Search Framework Requirements", Open Mobile Alliance™, OMA-RD-MSrchFramework-V1_0, URL:http://www.openmobilealliance.org/

[PUSH-OTA] "Push Over The Air", Open Mobile Alliance™, OMA-TS-PushOTA-V2_3, URL:http://www.openmobilealliance.org/

[PUSH-PAP] "Push Access Protocol", Open Mobile Alliance™, OMA-TS-PAP-V2_3, URL:http://www.openmobilealliance.org/

[OMA-DM] "Enabler Release Definition for OMA Device Management", Open Mobile Alliance™, OMA-ERELD-DM-V1_3, URL: http://www.openmobilealliance.org/

2.2 Informative References

[OMADICT] "Dictionary for OMA Specifications", Version x.y, Open Mobile Alliance™, OMA-ORG-Dictionary-Vx_y, URL:http://www.openmobilealliance.org/

[OMA-PRS-IMPS-AD] "Presence IMPS Architecture v1.3", OMA-AD-IMPS-V1_3, Open Mobile Alliance™, URL:http://www.openmobilealliance.org/

[OMA-PRS-SIMPLE] "Presence SIMPLE Specification", Open Mobile Alliance™, OMA-TS-Presence_SIMPLE-V1_0, URL:http://www.openmobilealliance.org/

[OMA-MLS-AD] "Mobile Location Service Architecture v1.0", OMA-AD-MLS-V1_0, Open Mobile Alliance™, URL:http://www.openmobilealliance.org/

[OMA-MOBAD] "Mobile Advertising", Open Mobile Alliance™, OMA-ERP-MobAd-V1_0,

URL: http://www.openmobilealliance.org/

3. Terminology and Conventions

3.1 Conventions

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [RFC2119].

All sections and appendixes, except “Scope” and “Introduction”, are normative, unless they are explicitly indicated to be informative.

3.2 Definitions

User Interest Model	User Interest Model is created using User related information e.g Search History, user profile. This can be used to know what Search Domain the user is more interested in. Further, it may also help to understand user preference inside that particular Search Domain.
Meta-Index	Meta-index is the information used to describe the content which a MSF-Source can provide. This information may be used for Search Engine selection.
Personalisation Score	Personalisation Score is the similarity between User related information and the result documents. It shows how well the result documents suits user’s preference.
Search History	In the context of MSF Enabler, Search History is the collection of search request, Feedback and Interaction from the user.
Feedback	See definition in [OMA-MSrchFramework-RD]
Interaction	See definition in [OMA-MSrchFramework-RD]
Answer History	Answer History is collection of questions asked and their respective answers provided. This collection can be queried if user wishes to get answers from already provided answers in the past.
Interface Template	The information needed (e.g. format, parameters) to map the search request and result response interface supported by the MSF with that of supported by MSF-Source.

3.3 Abbreviations

OMA	Open Mobile Alliance
MSAS	Mobile Search Application Server
MSS	Mobile Search Server
SE	Search Engine
Q&A	Question and Answer
MSF	Mobile Search Framework

4. Introduction (Informative)

To tackle the limitations of the current mobile search services, the Mobile Search Framework Enabler is expected to enable a kind of mobile search service which can (not limited to):

- Integrate various SE's capabilities to be comprehensive
- Personalise search result according to User related information.
- Provide recommended results.
- Facilitate delivery of targeted advertisements
- Accept multimedia as a search input
- Provide Subscribe-Push Management
- Provide Q&A functionality.

This document defines the architecture of Mobile Search Framework Enabler based on the requirement defined in [OMA-MSrchFramework-RD]. The main components identified for this enabler are Mobile Search Server (MSS), Mobile Search Application Server (MSAS), MSF-Client and MSF-Source.

A following figure shows various interacting entities involved in this enabler. A figure also depicts the possible deployment example for this enabler.

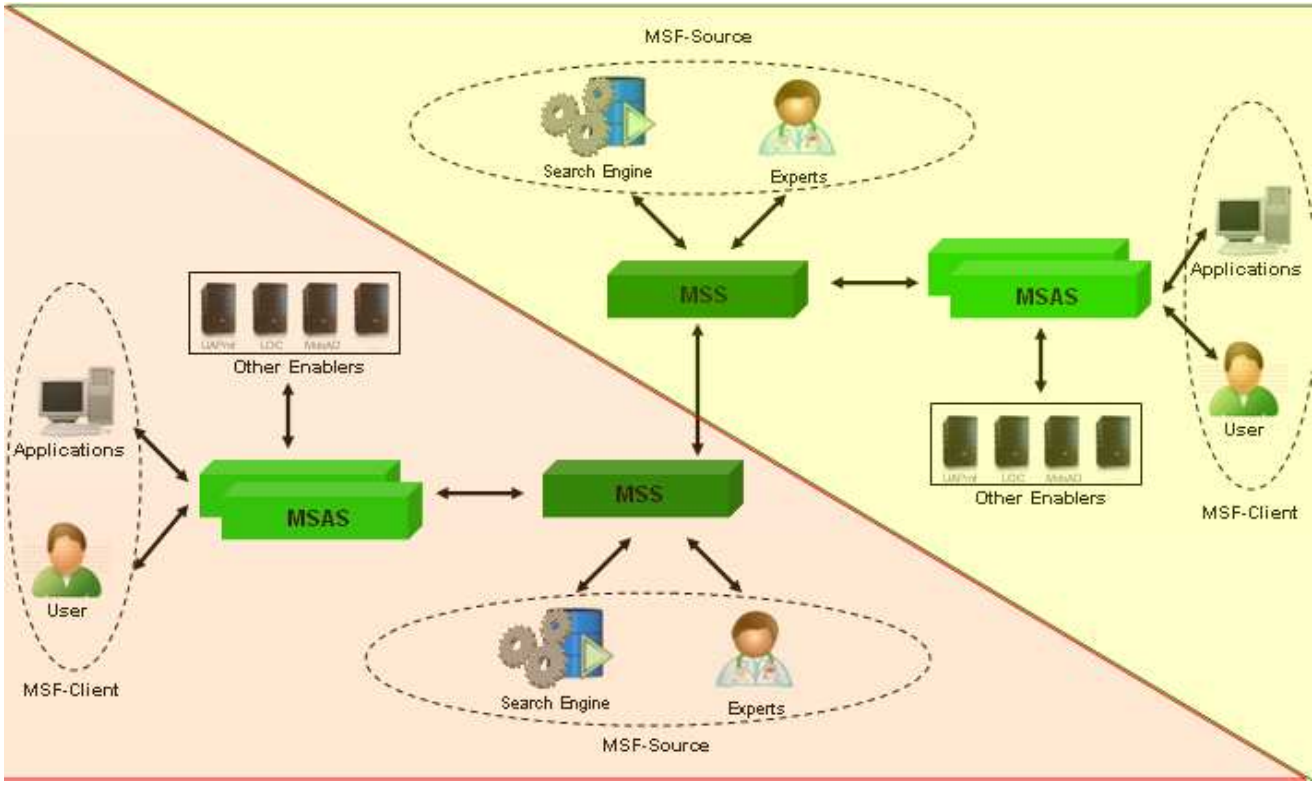


Figure 1: MSF Enabler deployment example

4.1 Version 1.0

Version 1.0 of the MSF enabler architecture addresses all of the functional requirements included in [OMA-MSrchFramework-RD].

5. Architectural Model

5.1 Dependencies

The MSF Enabler has the following dependencies to other OMA Enablers:

- The OMA Push Enabler as described in [PUSH-OTA] and [Push-PAP];
- The OMA Device Management Enabler as described in [OMA-DM].

In addition, deployments of the MSF Enabler can use other OMA Enablers, such as:

- The Presence Enabler as described in [OMA-PRS-IMPS-AD] and [OMA-PRS-SIMPLE-AD].
- The Location Enabler as described in [OMA-MLS-AD].
- The Mobile Advertising Enabler as described in [OMA-MOBAD].

5.2 Architectural Diagram

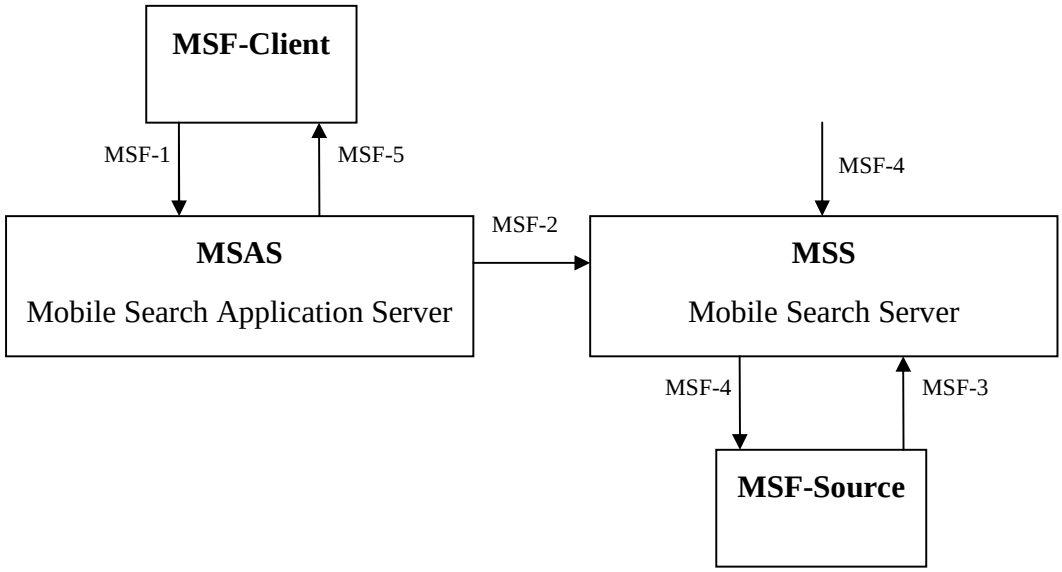


Figure 2: Architectural Diagram

5.3 Functional Components and Interfaces definition

5.3.1 Functional Components

5.3.1.1 MSAS (Mobile Search Application Server)

MSAS is the entry point to the enabler for all the user's requests. The main functionalities identified for MSAS are shown below.

MSAS exposes MSF-1; uses MSF-5 exposed by MSF-Client and MSF-2 exposed by MSS.

When using MSF-5 interface, MSAS acts as Push Initiator when using OMA-PAP and as Push Server when using PUSH-OTA.

5.3.1.1.1 User related information Collection

This function collects User related information including user profile, Search History, user context (e.g location) and User Interest Model, which may be obtained by interacting with other OMA enablers or internally from this enabler. Part of this User related information is sent to the MSS together with the search request, for example, to be used for personalised SE/Experts selection and Personalised Result Consolidation.

5.3.1.1.2 Query Domain Mapping

This function is responsible for identifying a Search Domain(s) for a request for which no Search Domain is specified by the user. This function will use User related information to select the appropriate domain for the request.

5.3.1.1.3 Target Advertising

This function is responsible for inserting advertisement into the search results. Advertisements are selected considering user's preference, location and other context information. This function may interact with OMA MobAd enabler, via MobAd-2 interface, to request for advertisements.

5.3.1.1.4 Search History & Recommendation Management

This function is responsible for store, maintain and manage the Search History.

The Search History consists of Feedback and Interaction of the user on the results received.

In particular it collects Feedback/Interaction from users on the search results provided and uses them in order to provide recommended result. Recommended results are provided by applying (one or more) recommendation algorithm(s) together with User related information on the results.

5.3.1.1.5 Subscribe-Push Management

This function is responsible for managing the Subscribe-Push functionality. It includes the management of:

- The request to subscribe/unsubscribe for specific information/content
- The filtration criteria and triggering conditions, provided or updated by the user. The filtration criteria are used to find the appropriate results/content, whereas the triggering conditions are used to initiate the request from the MSAS and then push the result/content.

The filtration criteria can be (non exhaustive): search keywords, Search Domains, recommended results (in this case the user can choose to get only recommended results), context (e.g. location, …), receiver ID (will be used in case the intended receiver is not same as the one who is requesting or subscribing).

The triggering conditions can be (non exhaustive): push interval (e.g. daily, week days, …), context (location, presence, e.g. the push is triggered when the location is changed, …).

This function is also responsible for the management of policies related to push functionalities e.g considering MSF-Client's abilities to receive pushed content, managing receiver(s) authorizations e.g negotiating for receiving pushed content, for using context information.

5.3.1.2 MSS (Mobile Search Server)

MSS (Mobile Search Server) is mainly responsible for all the functions needed for Search Engine/Experts integration and result personalisation. The main functionalities identified for MSS are below

MSS exposes MSF-2, MSF-3 and MSF-4; uses MSF-4 exposed by MSF-Source and Other-MSS.

5.3.1.2.1 Personalised SE/Experts Selection

This function is responsible for selecting appropriate SE/Experts for a particular query. To do so, it considers several kind of information e.g SE expertise (Meta-Index - provided by the SE at the time of registration), User related information (e.g Interest Model, location, Search History provided by MSAS), search request (Search Domain, keywords - provided by MSAS).

5.3.1.2.2 Personalised Results Consolidation

This function is actually responsible for results (here results also includes answers) personalisation. This function will achieve personalisation in either of two ways:

- It uses User related information provided by MSAS together with the search request, to personalise search results and provide consolidated list of results. While consolidating it may do optimization on the results e.g remove redundancy, re-ranking/sorting based on e.g rank provided by the SE, SE importance level (may be calculated based on response time, quality of content, cost etc.)
- It can transfer the User related information together with the search request, to the Search Engine (user identity may be secured in this process). Search Engine will personalise search result based on User related information and return the personalised results to MSS. MSS consolidates the result list. While consolidating it may do some optimization on the results e.g remove redundancy, re-ranking/sorting based on Personalisation Score provided by the SE, SE importance level (may be calculated based on response time, quality of content, cost etc.)

5.3.1.2.3 Query Building

This function is responsible for building and forwarding request to the selected MSF-Source(s). This function optimizes user queries in the format which is understandable by the selected MSF-Source(s). This function may also split the user's query for efficiency. This function may also pass User related information, with the search request, to the SE where the personalisation is done.

5.3.1.2.4 MSF-Source Registration

This function is responsible for allowing MSF-Sources to register them with the framework providing some of the information (e.g expertise, Interface Template) about them.

5.3.1.2.5 Q&A History

This function is responsible for maintaining a database of already asked question and their respective answers provided from different Experts. This database can be queried in case user wants questions from Answer History.

5.3.1.3 MSF-Client

MSF- Client is an entity which sends a search request to MSAS using MSF-1 interface and receives responded result from MSF-1 interface. MSF- Client can perform search request by keyword, free text or multimedia input. The MSF-Client can be deployed on a user's device or in an application server.

MSF-Client exposes MSF-5 and uses MSF-1 exposed by MSAS.

5.3.1.3.1 Pushed Content Management

This function is responsible to manage (e.g store, render, queuing) pushed content and the related rules (e.g discar, accept, …).

5.3.1.4 MSF-Source

MSF-Source is the information/content source for MSS. It provides the actual information/content to MSS on request. The MSF-Source can be a Search Engine (providing results against search query) or an Expert (providing answers against question query).

MSF-Source exposes MSF-4 and uses MSF-3 exposed by MSS.

5.3.2 Interfaces

5.3.2.1 MSF-1

This interface is exposed by MSAS and can be used to send/receive search request/response. The supported functions of this interface includes

- Accepting search request from MSF-Client and delivering search response. This request can be also a request for recommended results. In this case the request contains the indication of the algorithm(s) to be applied in order to provide recommendation on the results. The request can be a multimedia search as well where the MSF-Client uses multimedia files e.g. video, audio or image files as search request input, augmented with information that specify the search request purpose (e.g. find similar content, retrieve missing metadata related to the input , etc.). This function includes also the transfer of the response related to the search request from the MSAS to the MSF-Client (including the recommended results).
- Accepting Subscribe-Push search request. In this case, this interface allows the MSF-Client to subscribe/unsubscribe for specific information/content/results by providing/updating one or more filtration criteria (e.g. push interval, Search Domain(s), push context trigger(s), …).
- Providing the Feedback from the MSF-Client to the MSAS about results received and/or modifying an already existing Feedback. Different kind of Feedback can be supported by this interface: vote (a numerical value, e.g. from 0 to 100), comment (a free text where the user can express his evaluation), tag list (a list of keywords that describe the result).
- Providing the Interaction from the MSF-Client to the MSAS on results received. Different kind of Interaction can be supported by this interface: the action to click on particular result or type of result (e.g. results of a particular brand, results with multimedia contents …), the subsequent search done, etc….
- Querying of capabilities and functionalities supported by MSAS such as (not limited to): search functionalities supported (Q&A function, Subscribe-Push, …), recommendation algorithms supported, multimedia support (e.g.: the indication of the media type accepted as input search request), support for the free text search/by keyword, performance parameters (e.g. maximum number of requests accepted per time or in a period of time, minimum interval between two requests, average response time, …), Search Domains supported and geographical coverage, etc…
- Accepting Q&A request from MSF-Client and delivering Q&A responses (synchronous or asynchronous).

5.3.2.2 MSF-2

This interface is exposed by MSS. The supported functions of this interface include:

- Accepting search request from MSAS augmented with a part of user related information and delivering search response. In this response, if the MSF-Source provided its customer Feedback, then the MSS propagates this Feedback to the MSAS.
- Delivering users Feedback from MSAS to MSS.
- Accepting Q&A related request from MSAS and transfer the response (which can be synchronous or asynchronous) back to it.

5.3.2.3 MSF-3

This interfaces is exposed by MSS and can be used to register/de-register and update information related to MSF-Source. The supported functions of this interface include

- Sending asynchronous answer messages to MSS for previously submitted question.
- Accepting question retrieval request, made based on expertise, from Expert.

- Accepting registration, de-registration and update of MSF-Source information request and delivering response. The following is the list (not limited to) of information conveyed or updated to MSS in the registration process
  - Basic Information (access URL, contact)
  - Meta-Index.

This interface is also used for exchanging the Meta-Index between two MSSs.

5.3.2.4 MSF-4

This interface is exposed by MSF-Source and MSS. It is used to accept search request (including Q&A related request and response) from MSS and deliver response to MSS. That is, it is also used for interaction (search request/response) between two MSS.

In the response, if there is an agreement between service provider and MSF-Source to exchange Feedback, then the MSF-Source provides its customer Feedback to the MSS together with the results.

5.3.2.5 MSF-5

This interface is exposed by MSF-Client and can be used to Push subsequent results/content for the subscription request in the context of Subscribe-Push functionality. One or more push notification of results/content can result from a single subscription request.

5.4 Security Considerations

To address the requirements of Authentication and Authorization specified in the RD, the MSF Enabler should provide the following functions:

- Authentication: The MSF Enabler supports mechanism to authenticate the SEs, Experts and other MSSs. The SEs and Experts will be authenticated, when they will be registering/de-registering or updating their information with the MSF Enabler. As MSSs are interworking, when an MSS receives an incoming request from another MSS, its identity is also to be checked. Furthermore the MSF Enabler supports mechanisms to authenticate users when performing requests to MSAS. This user identity will be used to access user information and provide personalised results e.g. recommendation.

- Authorization: The MSF Enabler supports mechanisms to authorize the other MSSs, SE/Expert when they request access to the MSS. Furthermore the MSF Enabler supports mechanisms to authorize MSF-Client when they request access to the MSS. For other MSS and applications, the requests are search requests. For SE and Expert, the requests are changing information requests.

Appendix A. Change History (Informative)

A.1 Approved Version History

Reference	Date	Description
n/a	n/a	No prior version –or- No previous version within OMA

A.2 Draft/Candidate Version 1.0 History

Document Identifier	Date	Sections	Description
Draft Versions OMA-AD-MSrchFramework-V1_0	10 Apr 2009	All	Establish the initial empty Architeccture Document
	22 Apr 2009	1	Incorporate 0003R01
	11 Jun 2009	3.2, 3.3, 5.2, 5.3	Incorporate 0005R06, 0006R01
	2 Jul 2009	3.2, 4, 5.3, Appendix B	Incorporate 0015R01, 0016R02, 0017R01, 0018R01.
	10 Jul 2009	2.1, 3.2, 3.3, 5.1, 5.3, Appendix B	Incorporate 0020R02, 0021R01, 0022R02, 0025R01, 0027R02
	31 Jul 2009	3.2, 5.3, Appendix B	Incorporate 0028R05, 0034R01. Replace “User Information” with “user related information”
	13 Aug 2009	Appendix B	Incorporate 0033R03, 0036R01, 0039. Replace “User Information” with “user related information”.
	1 Sep 2009	3.2, 5.3, Appendix B	Incorporate 0041R02, 0043, 0044R01, 0047R01, 0049R03, 0052R01, 0053R01, 0054R01, 0056R01, 0057R01, 0059R01, 0060. The Contents is updated.
	17 Sep 2009	5.3, Appendix B	Incorporate 0046R03, 0048R03, 0065R01. The Contents is updated.
	20 Oct 2009	1, 2.1, 3.2, 4.1, 5.2, 5.3, Appendix B	Incorporate 0068, 0072, 0075. Most COMMENT boxes are removed. And the Contents is updated.
	5 Nov 2009	5.2, 5.3	Change the MSF-Client box in AD from dotted line to bold line. Incorporate 0055R02.
	10 Nov 2009	5.2, 5.3	Incorporate 0092, 0093, 0096R01.
	14 Jan 2010	2.1, 2.2, 3.2, 4, 5.1, 5.2, 5.3.1.1.3, 5.3.1.1, 5.3.2.1, B.11	Incorporated 104R01, 105, 108, 109R01, 110, 114R01, 118, 119R01, 120.
	15 Jan 2010	5.3.1, 5.3.2	Incorporated 111R04, 112R02, 113R03. Chnages MSF-Clinet into bold lines.
	25 Jan 2010	All	Incorporated 0005R01, 0006, 0008R01, 0010, 0011R01. All ADRR editorial comment were incorporated
	3 Feb 2010	All	Incorportated 007R01, 0026R01
Candidate Versions OMA-AD-MSrchFramework-V1_0	23 Feb 2010	All	Status changed to Candidate by TP ref #OMA-TP-2010-0072-INP_MSrch_1_0_AD_for_Candidate_approval
Draft Versions OMA-AD-MSrchFramework-V1_0	15 Sep 2010	All	Incorporated 97
	19 Sep 2010	All	Editorial update: change “personalized” to “personalised”
	12 Oct 2010	All	Incorporated agreed CRs: OMA-CD-MSrchFramework-2010-0120-CR_DM_Dependency_to_AD; OMA-CD-MSrchFramework-2010-0123-CR_Interface_Adaptation_AD_changes.
	11 Nov 2010	All	Incorporated agreed CRs: OMA-CD-MSrchFramework-2010-0134-CR_AD_Improvements.doc
Candidate Version: OMA-AD-MSrchFramework-V1_0	07 Dec 2010	All	Status changed to Candidate by TP ref # OMA-TP-2010-0499-INP_MSrchFramework_V1_0_ERP_for_Candidate_Approval

Appendix B. Flows (informative)

This section describes some high-level logical flows between the architectural entities of the Mobile Search Framework Enabler. These flows just serve for a better understanding of the architecture. For normative details see the Technical Specification

B.1 Personalised Search

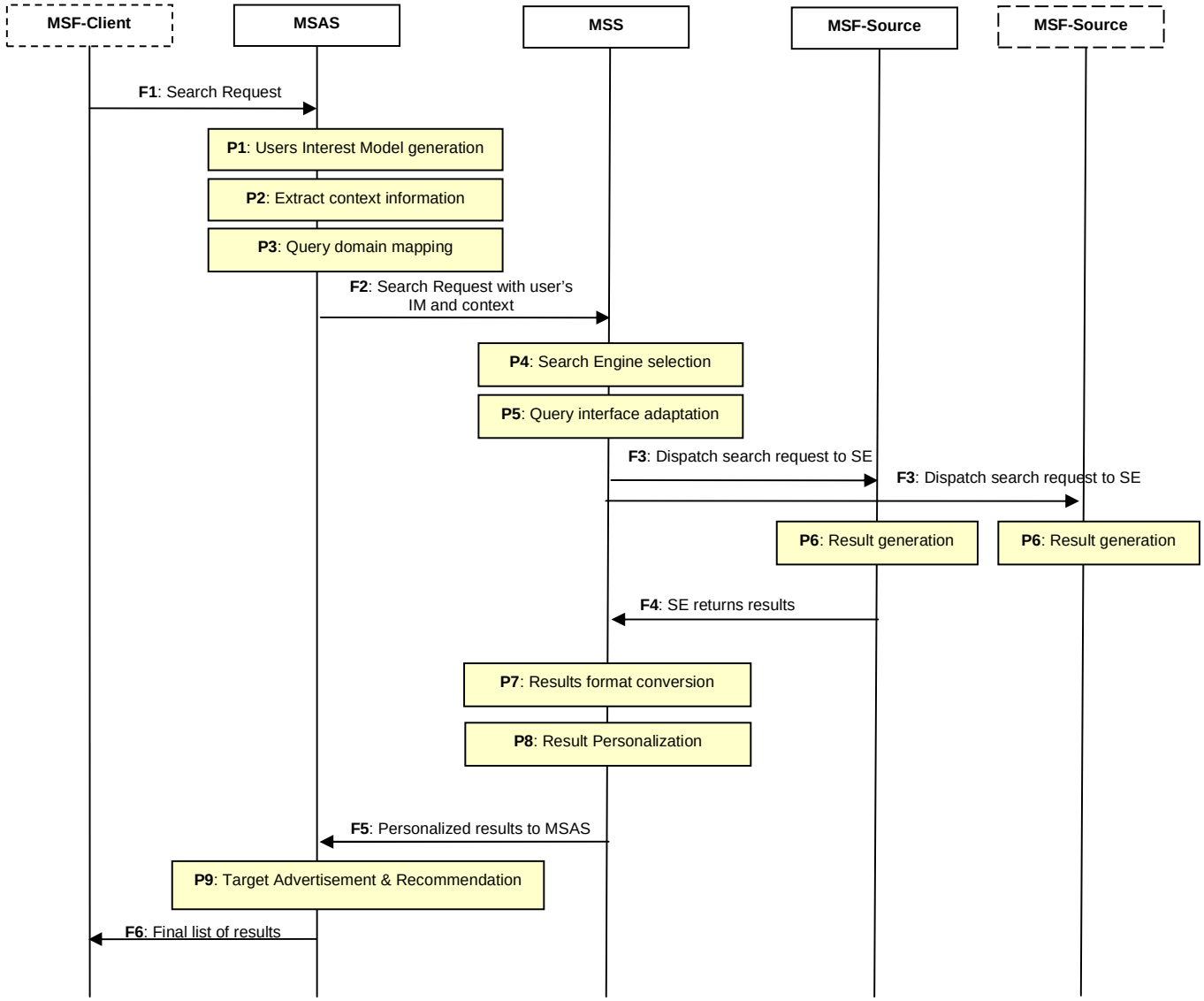


Figure 3: Personalised Search Flow

- **F1**: MSF-Client send a search request to MSAS.
- **P1**: MSAS may generate users Interest Model (IM) considering user profile and Search History. User IM will be retrieved every time the request is received from MSF-Client.
- **P2**: MSAS interacts with other enablers to get the required user context information.

- **P3**: MSAS maps a Search Domain(s) for the request using users IM and other related context information, in case user doesn't specify any Search Domain.
- **F2**: MSAS sends search request with required user related including (not limited to) User Interest Model, location, profile to MSS.
- **P4**: MSS selects an appropriate search engine based on (not limited to) SE expertise, User related information (received in F2), search request (Search Domain, keywords) etc.
- **P5**: MSS translates request format into the format supported by each MSF-Source.
- **F3**: MSS dispatches the request to the selected SE. User related information including (not limited to) User Interest Model should also be sent with the search request to the SEs.
- **P6**: SE search for the results. SE may use User related information (received in F3) to personalise (mainly ranking and sorting) the result list produces.
- **F4**: SE returns the results. If personalisation has been performed by SE in P6 then this request will also include Personalisation Score (calculated in P6) associated with each result.
- **P7:** MSS converts the results format into a global uniform format. This is to help consolidating result (with different format) from different SE. MSS also removes redundancy among the results.
- **P8:** MSS aggregate the results provided by different search engine. In case personalisation has been performed by SE, MSS re-rank and sort the results according to Personalisation Score (returned by SE in F4) and SE importance level (e.g calculated based on response time, quality of content, selection ranking score, cost etc.) If Personalisation Score from different SEs are incomparable then MSS may calculate Personalisation Score itself (based on user related information received in F2) to use it for result consolidation and sorting. In case personalisation has not been performed by SE, MSS will do personalisation (in terms of personalised ranking and sorting) based on User related information (received in F2).
- **F5**: MSS send the personalised results to MSAS
- **P9**: MSAS complement search results with target advertisement and recommendations based on users Feedback.
- **F6**: Final search result are provided to the user

B.2 SE Registration

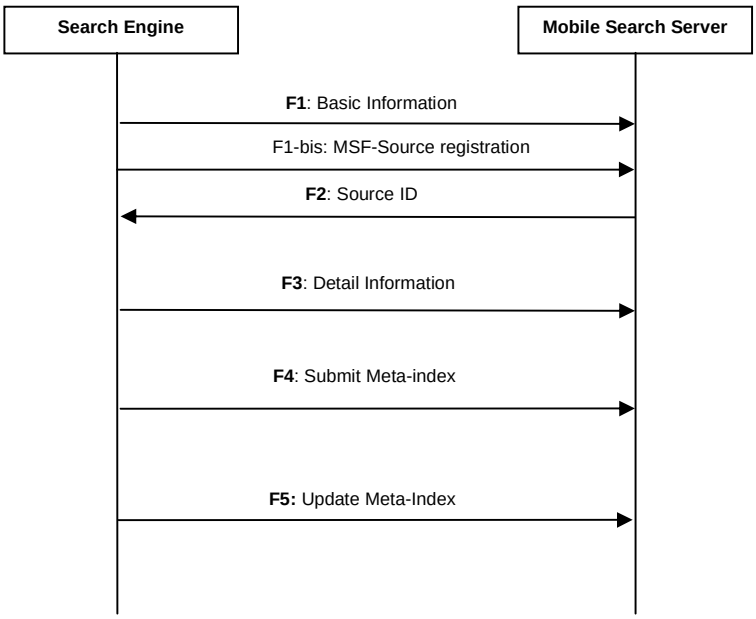


Figure 4: SE Registration Flow

- **F1**: SE registers basic information like name, location, Search Domain, contact etc.
- F1-bis: The MSF-Source submits to the MSS the Registration Information.
- **F2**: MSS acknowledge the request and assign a Source ID to the SE.
- **F3**: SE further registers detailed information like supported request/response interface, required User related information, Target user group etc.
- F4: SE then submits Meta-Index (defined in section 3.2).
- F5: SE may further update their Meta-Index as required sometime in future.

B.3 End-to-End Search Request Flow

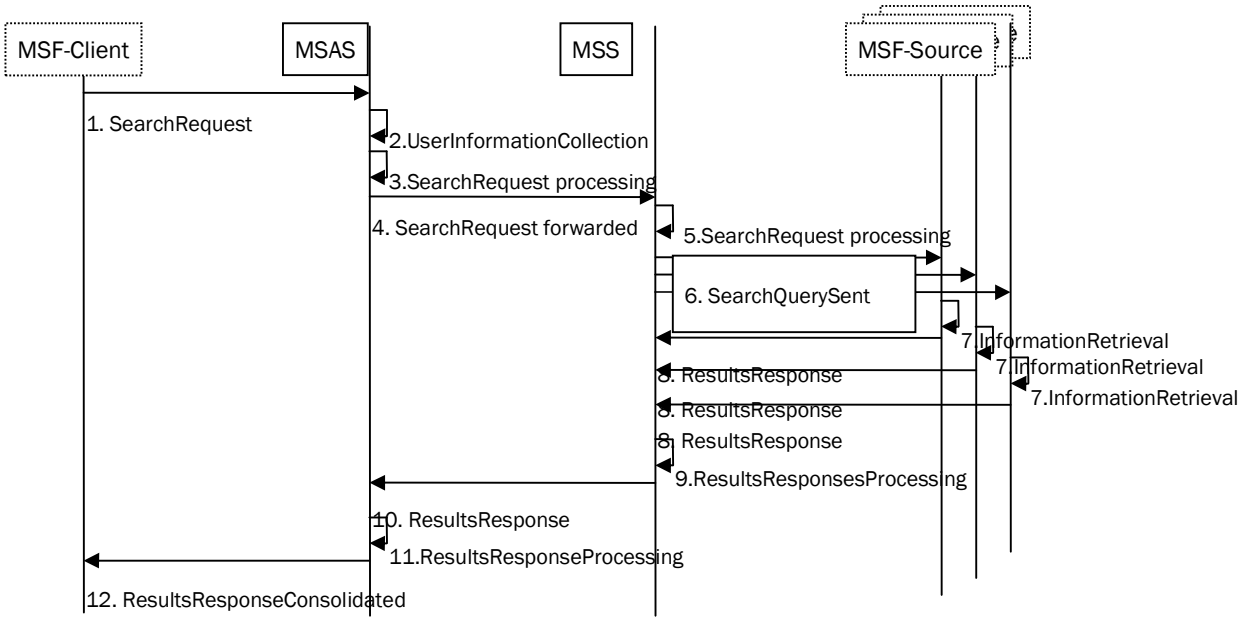


Figure 5: End-to-End Search Request flow

1. SearchRequest: The MSF-Client sends a search request to the MSAS.
2. UserInformationCollection: The MSAS collects the user related information (e.g. profile, location, …) by interacting with other OMA enablers or internally from this enabler. As part of this step, the MSAS recovers internally the Search History information related to the search request (from all users).
3. SearchRequestProcessing: The MSAS processes the search request before forwarding it to the MSS. The type of processing which can be performed are, for example, Query Domain Mapping
4. SearchRequestForwarded: The MSAS forwards the search request enriched with some of the user related information collected and with the result of the processing applied to the MSS.
5. SearchRequestProcessing: The MSS processes the search request and other information received. The types of processing which can be performed are, for example, Query Building, MSF-Source(s) selection.
6. SearchQuerySent: The MSS sends the query for the search to the selected MSF-Source(s).
7. InformationRetrieval: The selected MSF-Source(s) retrieves the correct information that MSS has requested.
8. ResultsResponse: The selected MSF-Source(s) sends the response to the MSS containing the results.
9. ResultsResponsesProcessing: The MSS processes the results responses received before sending them to the MSAS. The types of processing which can be performed are, for example, results optimization by removing redundancy or by sorting the results.
10. ResultsResponse: The MSS sends the response to the MSAS containing the optimized results.
11. ResultsResponseProcessing: The MSAS processes the response before sending it to the user. The type of processing which can be performed are, for example, applying one or more recommendation algorithms to provide recommended results and re-rank the result according to that (i.e putting recommended result at the beginning of the list).
12. ResultsResponseConsolidated: The MSAS sends the consolidated results to the user.

B.4 Interworking

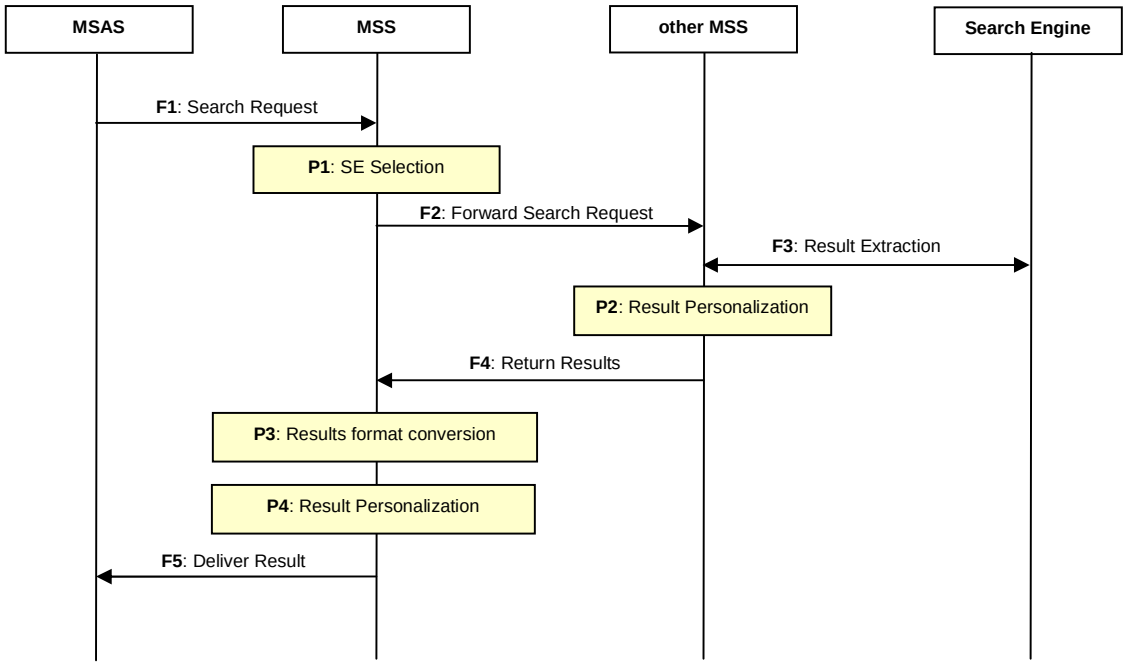


Figure 6: Interworking Flow

- **F1**: MSAS sends search request with required user related information (e.g User IM, location, profile) to MSS.
- **P1**: MSS selects an appropriate search engine based on (not limited to) SE expertise (Meta-Index), user related information (user Interest Model, location, profile), search request (Search Domain, keywords) etc.
- **F2**: MSS forwards request to other MSS. MSS will also send targeted SE's ID and user related information, including (not limited to) user Interest Model, to other MSS. Before sending the request to other MSS, if required, MSS converts the request into a format suitable for other MSS.
- **F3**: other MSS gets the result form the targeted SE(s) according to the specified SE's ID in F2
- **P2**: other MSS can personalise result based on information received in F2.
- **F4**: other MSS returned personalised search results to MSS.
- **P3:** MSS converts the results format into a global uniform format. This is to help consolidating result (with different format) from different SE. MSS also removes redundancy among the results.
- **P4**: MSS further do personalisation on the result based on any other user related information which was not made available to other MSS.
- **F5**: Final results/contents are returned to MSAS.

B.5 Interworking 2

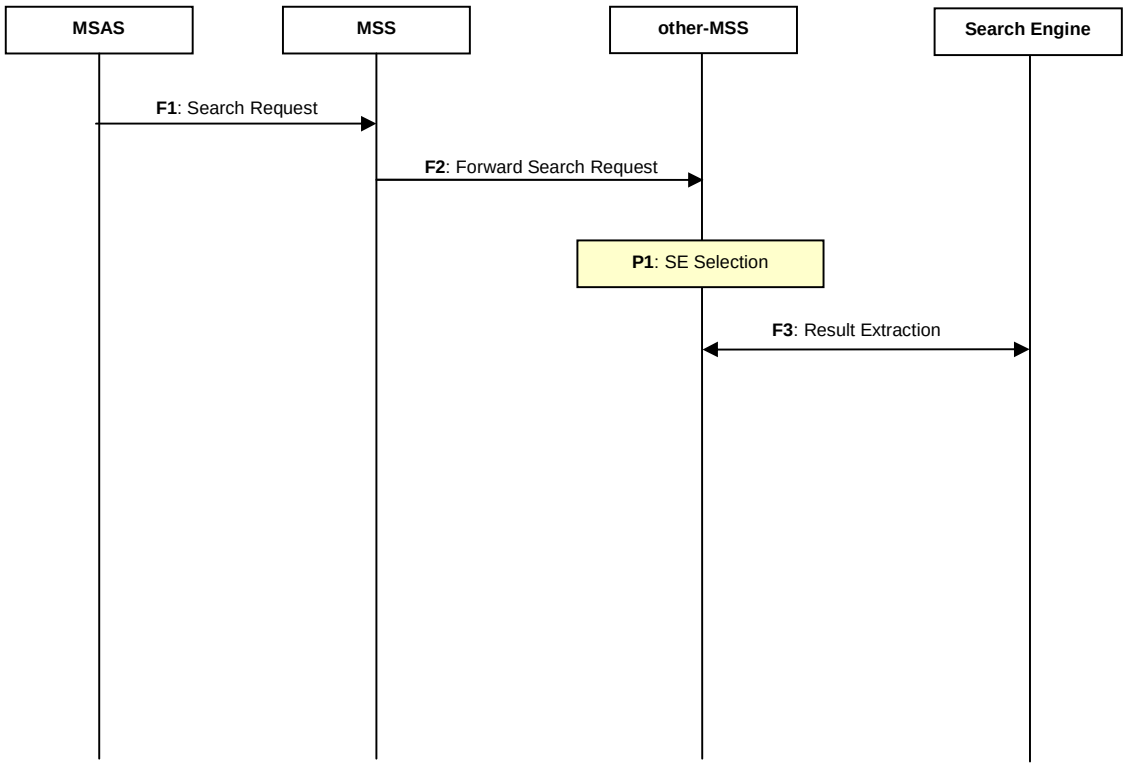


Figure 7: Interworking Flow 2

- **F1**: MSAS sends search request with required user information (e.g. User IM, location, profile) to MSS.
- **F2**: MSS selects other-MSS (e.g based on the capabilities of SEs registered to other-MSS) and forwards the request to it. MSS will also send user related information, including (not limited to) user Interest Model, to other MSS. Before sending the request to other MSS, if required, MSS converts the request into a format suitable for other MSS.
- **P1**: other MSS selects an appropriate search engine based on (not limited to) SE expertise (Meta-Index), user related information (user Interest Model, location, profile), search request (Search Domain, keywords) etc.
- **F3**: other MSS gets the result form the targeted SE(s).

For further steps refer to B.4 from P2 to F5.

B.6 Search History Flow

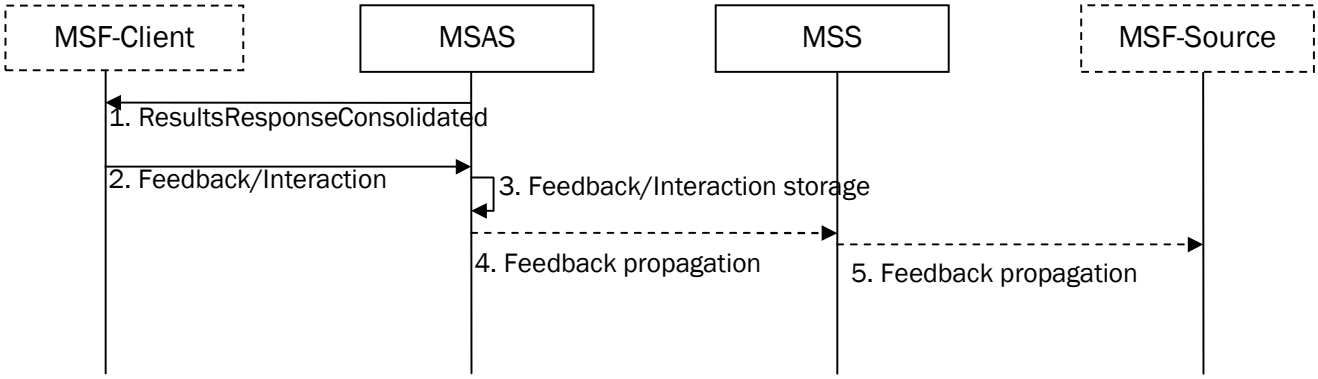


Figure 8: Search History Flow

1. ResultsResponseConsolidated: the MSAS sends the consolidated results to the user.
2. Feedback/Interaction: The user expresses (explicitly or implicitly) his Feedback/Interaction about the results.
3. Feedback/Interaction storage: The MSAS stores the received Feedback/Interaction from the user.
4. Feedback propagation: Optionally (depending on the agreement between service provider and MSF-Source) the MSAS can report Feedback received from its users about the results to the MSS.
5. Feedback propagation: The MSS propagates the Feedback, if provided by the MSAS in step 4, to the MSF-Source (that provided the results).

B.7 Recommendation Flow

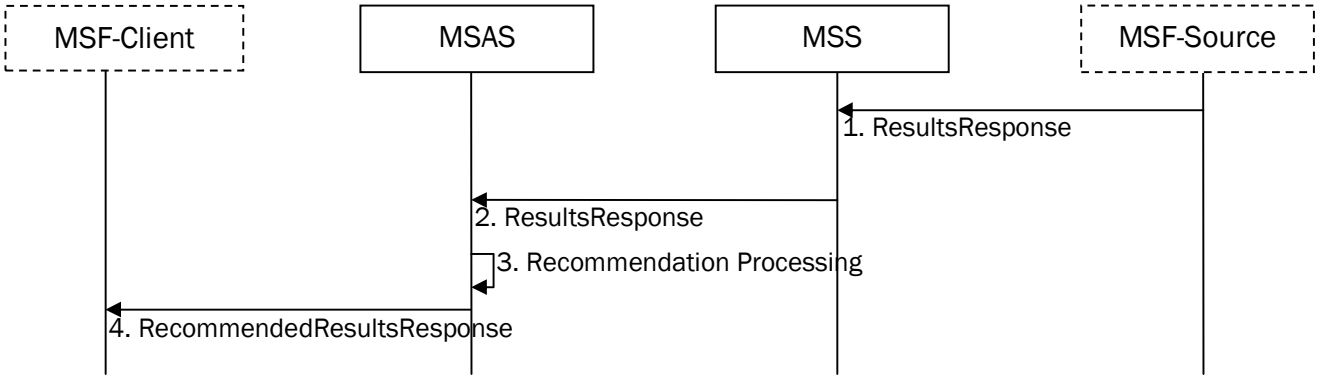


Figure 9: Recommendation Flow

1. ResultsResponse: The selected MSF-Source(s) sends the response to the MSS containing the results. Optionally, depending on the agreement between service provider and the MSF-Source, the MSF-Source can send the Feedback (from its customers) about the results provided.

2. ResultsResponse: The MSS sends the response to the MSAS containing the optimized results. The MSS propagates the results with associated Feedback, if provided by the MSF-Source in step 1.

3. RecommendationsProcessing: The MSAS processes the response before sending it to the user by applying one or more recommendation algorithms in order to provide recommended results and re-rank the results according to that (i.e putting recommended result at the beginning of the list). The processing related to the recommendations uses the Search History information retrieved by the MSAS and, optionally the Feedback provided by the MSF-Source in step 1.

4. RecommendedResultsResponse: The MSAS sends the consolidated results, including the recommended results, to the user.

B.8 Q&A Flow

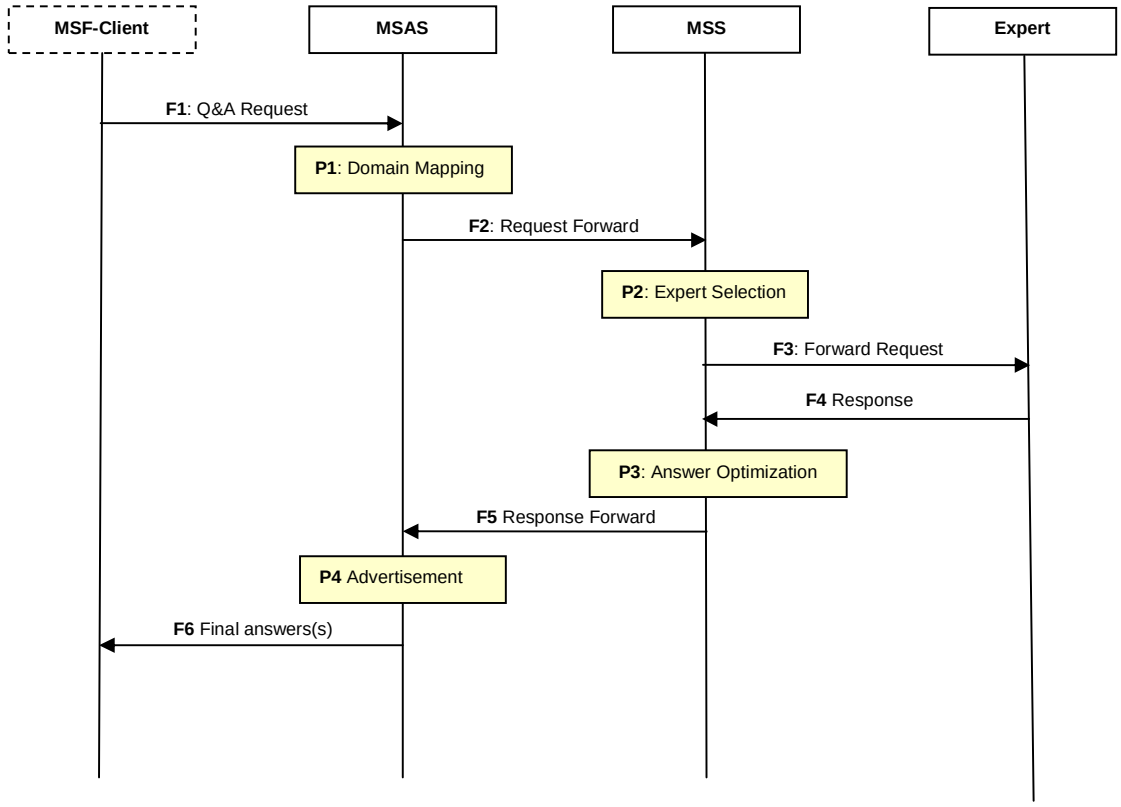


Figure 10: Q&A Flow

- **F1**: User sends a question to MSAS. User will specify whether the answer is required from Answer History or from Experts.
- **P1**: MSAS will perform domain mapping for the question.
- **F2**: MSAS will forward request to MSS.
- **P2**: MSS select appropriate experts. If the answer is required from Answer History, no Expert selection will be done. MSS will retrieve answer(s) from Answer History and then continue from P3 by passing F3 and F4.
- **F3**: MSS dispatch the request to selected Expert(s).
- **F4:** Experts answers the question and send as a response to MSS.

- **P3:** MSS will perform optimization on different answer received form different Experts (or form Answer History) e.g redundancy check, ranking based on expert level etc. MSS also save the question and their corresponding answers into Answer History in case answers are from experts.
- **F5:** MSS forwards the final answer list to the MSAS
- **P4**: MSAS insert advertisement with the response and performs recommendations.
- **F6**: Final answer(s) are provided to the user.

B.9 Meta-Index Exchange/Update Flow

This flow is divided into three parts; (1) MSSs share information about each other (2) MSSs exchange Meta-Index for the first time (3) MSSs, periodically, updates submitted Meta-Index.

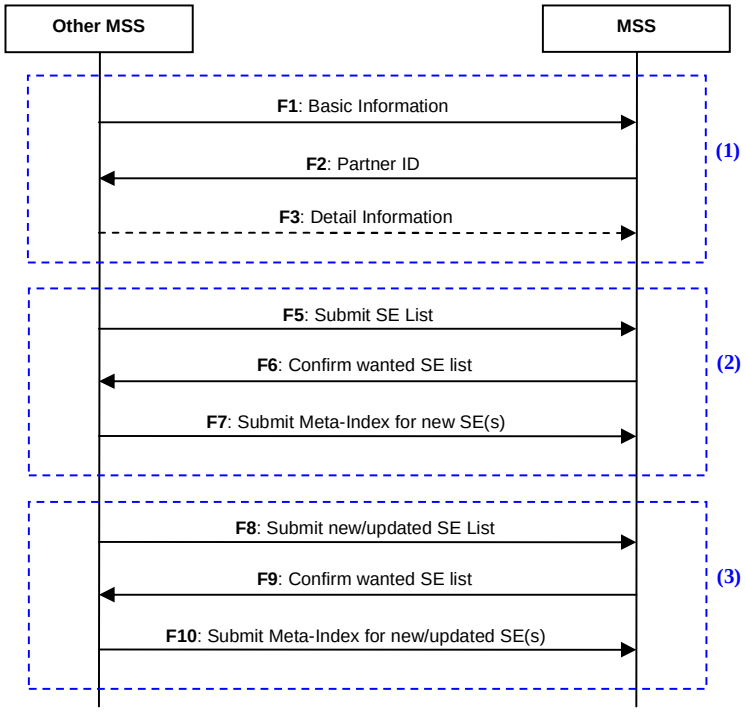


Figure 11: Meta-Index Exchange/Update Flow

- **F1**: Other MSS registers basic information about itself like name, location, Search Domain, contact etc.
- **F2**: MSS acknowledge the request and assign a partner ID to the other MSS
- **F3**: Other MSS further registers detailed information about itself like supported request/response interface, required user related information, target user group etc.
- **F5**: Other MSS submits the list (with some text description) of some or all (depending on there polices) the SEs registered with it.
- **F6**: MSS confirms the list of those search engines for which it require Meta-Index (MSS may only require Meta-Index for those SE which are useful for it. The criterion of selection is implementation specific).
- **F7**: Other MSS sends the Meta-Index only for those SE returned (selected) by MSS.
- **F8:** Other MSS will trigger update of Meta-Index based on some trigger condition. The example of identified trigger condition for this enabler are periodically (e.g weekly), threshold of SE added/updated, manually at any time. Other

MSS will send the list (with some text information) of newly added SE and those which have updated their Meta-Index to MSS.

- **F9:** MSS will confirm the list of those SE for which it requires Meta-Index.
- **F10:** Other MSS sends the Meta-Index or updated Meta-Index only for those SE returned (selected) by MSS.

B.10 Application Initiated Search

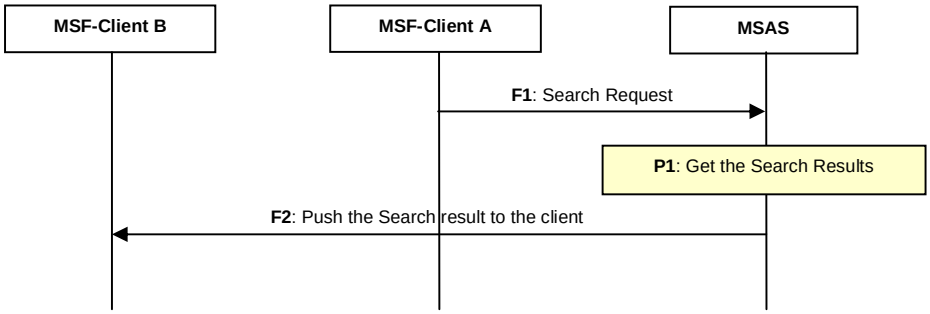
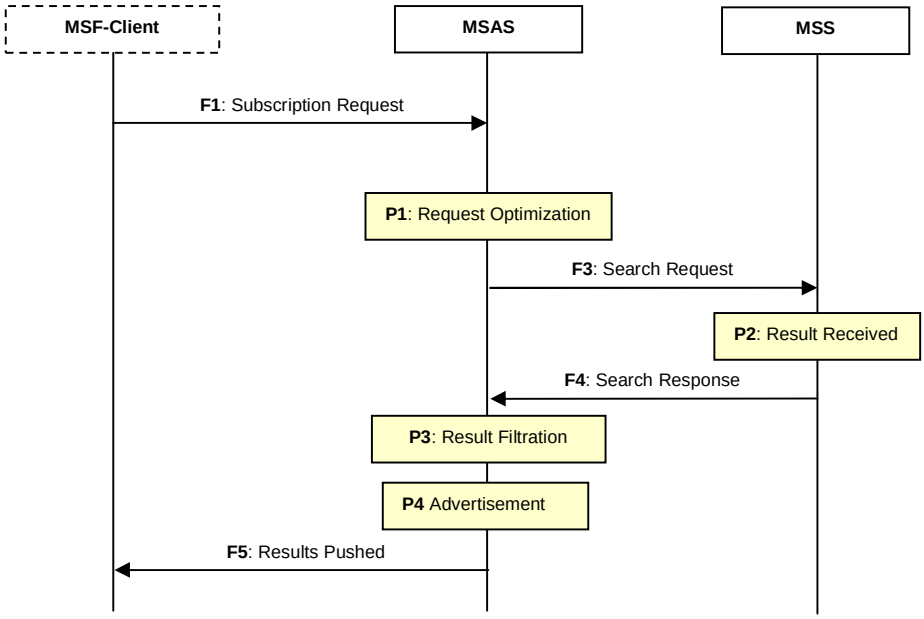


Figure 12: Application Initiated Search flow

- **F1**: An application as MSF-Client-A sends a search request(s) to MSAS, the search request(s) carries one or more client IDs (different than MSF-Client-A) as MSF Requestor-B for the search result.
- **P1**: MSAS gets the final result
- **F2**: MSAS pushes the search results for each search request, to one or more target client (MSF-Client-B) according to the specified ID(s) in F1. Before this step there is a need of required management functionality related with push.

B.11 Subscribe-Push



- **F1**: MSF-Client sends subscription request to MSAS with several filtration criteria and triggering condition. MSF-Client may specify a different receiver's ID for pushed content.
- **P1**: MSAS will consider context information while generating search request. E.g if user location is "Boston" and keywords provided are "Nike stores" then MSAS may generate final request with keywords "Nike stores Boston". MSAS will generate subsequent search request consider the time interval (if provided by the user as triggering condition).
- **F3**: MSAS will send search request to MSS periodically (according to the time interval provided by the user as triggering condition).
- **P2**: MSS receive the result.
- **F4**: MSS send the result to MSAS.
- **P3:** MSAS may further filter the results received based on (not limited to) presence, recommended results
- **P4**: MSAS insert advertisement to the search result.
- **F5**: Final results/contents are provided to the intended user. Before this step there is a need of required management functionality related with push.