

A minimal signaling channel for SDR download support

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ABSTRACT

A Software Defined Radio (SDR) supports **multiple radio personalities**. Support for multiple radio personalities are due to the fact that the SDR terminal can download and install these different radio or protocol personalities. These necessities the development of a signaling personality that helps in radio personality downloads. A minimal SDR signaling personality or a bootstrap signaling functionality is necessarily an important part of SDR download support. We can call the bootstrapping signaling channel the **Universal Control Channel**. (UCCH). In this submission, we discuss some issues related to UCCH. The motivation for considering the UCCH is covered in section A. Section B considers some of the functional requirements of the UCCH. The network support and its implications on UCCH are highlighted in section C.

SECTION A - THE NEED FOR UCCH

The Software Defined Radios are mobile adaptive radio terminals, which can acquire radio personality through software download. An SDR handset can be modified to perform different functions at different times through software downloads. Software radios give the ability to add or remove software components or allow plug and play of software components. This allows the SDR handset to be specifically tailored to the applications expected to run on the handset resulting in great flexibility. The download software components range from end-user applications to communication physical layer processing algorithms. By downloading appropriate protocol components, switching from one protocol to another is possible. A typical method of downloading software to a mobile terminal is by the use of a wireless link and this is known as Over-The-Air (OTA) reconfiguration. This paper summarizes issues that will have to be considered in developing an SDR bootstrap control channel to support initial network synchronization and OTA software downloads.

Much of the work being pursued by the Software Defined Radio (SDR) downloads forum focuses on the Mobile Execution Environment (MExE). One important issue warranting attention is the development of a bootstrap channel that would allow user terminal synchronization with any supported mode in a given area and support inter system handoff. Much of the need for a UCCH stems from a need for a true over-the-air personality download. Download can be supported through a variety of other technologies (Ex – Bluetooth), much of which have been listed in the SDR download document. The SDR forum is at a risk of becoming redundant in depending too much on

the development of parallel technologies to achieve bootstrap signaling and download. The recommended course of action is that the SDR forum develop the UCCH with download and intersystem handoff support considerations and try and influence other standards to adopt these recommendations.

Figure 1 gives a general setup for the Over-The-Air download scenario. It has three major components, the User Terminal (UT), the service provider (SP) who provides the access network and the Software component store (SCS). An open interface can be defined between the service provider and the software component store as any component vendor can provide the software for download.

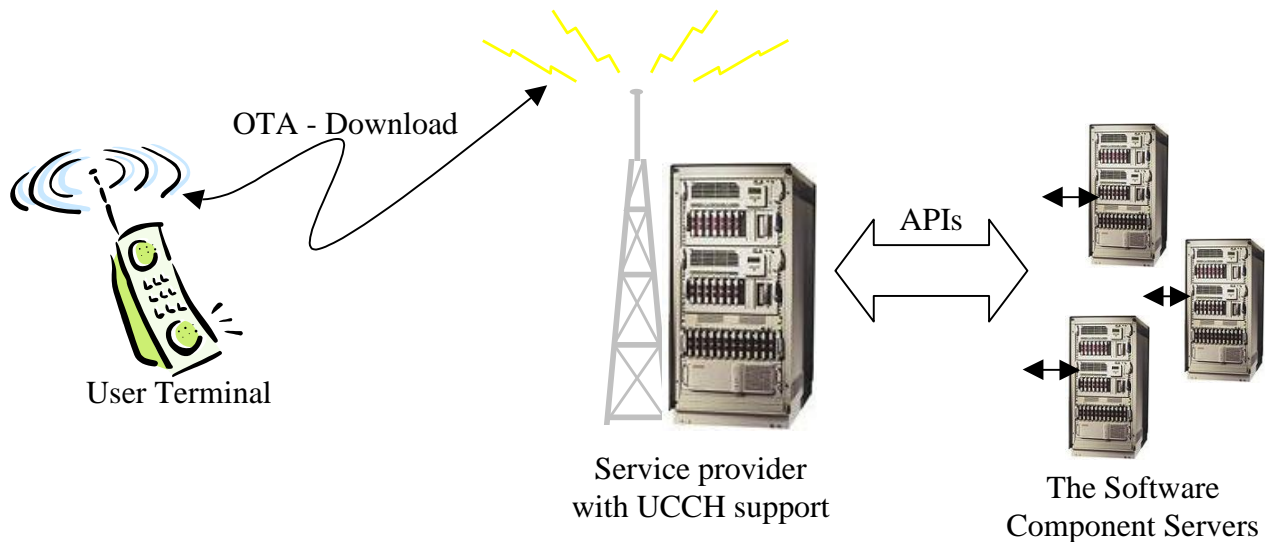


Figure – 1 OTA software download

SECTION B - FUNCTIONAL REQUIREMENTS OF THE UCCH

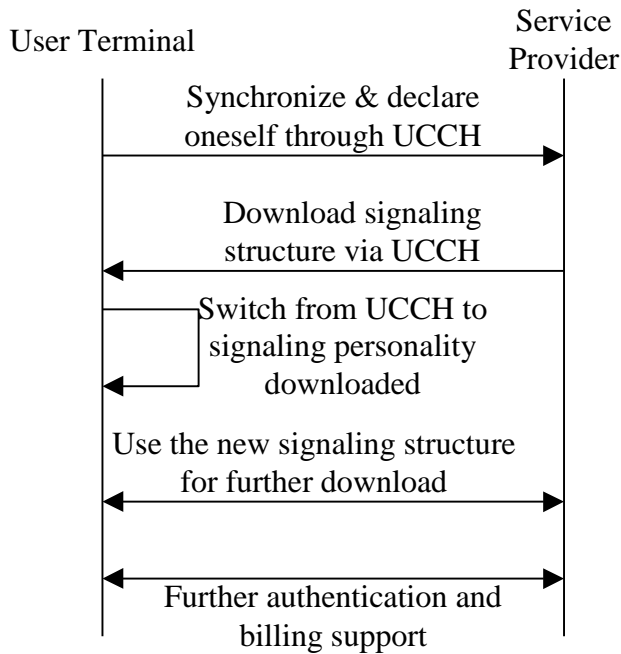
The UCCH primarily will have to achieve two objectives

1. Initial synchronization and download support
2. Intersystem handoff support

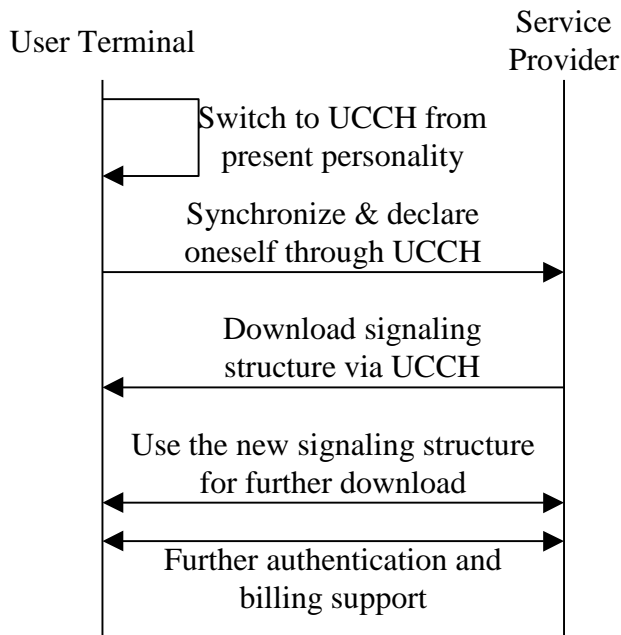
As the UCCH component will be resident in the SDR terminal it is desirable that the UCCH implementation is light, i.e. it supports the bare minimum signaling required by a mobile terminal to sense and approach an access system and request for a download. The UCCH can be a narrow band channel supported by an access method with access guarantees. The UCCH should be in a position to carry out the initial authentication procedures and should be in a position to support the download of at least the signaling personality of the access system available in the location. The UCCH also acts as the base signaling personality of an SDR terminal.

In considering the utility of a signaling channel like the UCCH and development of UCCH with minimal capabilities, a few access scenarios are considered below.

- The Terminal starts from ground zero and wants to acquire a protocol personality – (non-time critical download).

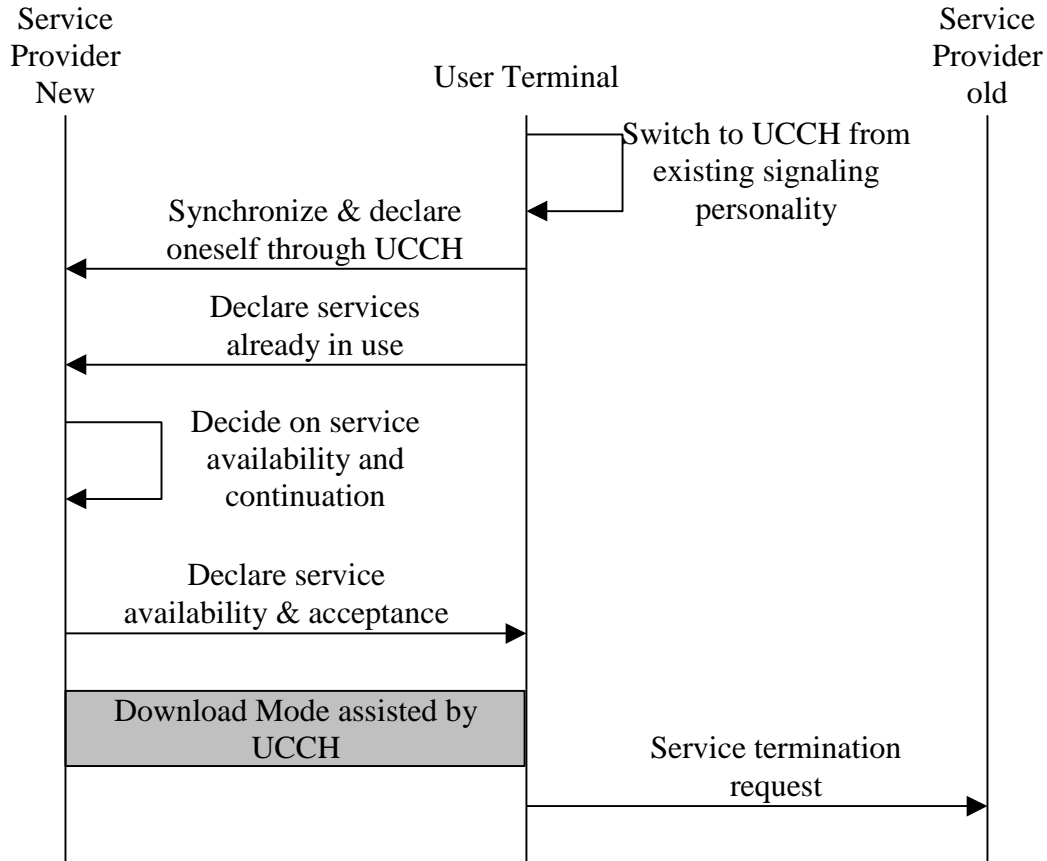


- A terminal already has a protocol personality that is supported and the terminal wants to change to another personality also supported in the area for want of better data rates etc.



- A terminal has a personality supported in the area, but wants to change (without service disruption) as it is moving towards another area. Also known as inter system

handoff (Time Critical download). UCCH should support simultaneous negotiations between different access networks for services. The sensing of the target band-mode and signaling to the target mode access system can be achieved when the active mode is in an idle state or in a non-critical use state.



- A terminal already has a protocol personality that is supported and the terminal wants enhancements (non-time critical download). In such a case the UCCH acts as an enhancement to the already existing signaling channel.

The development of a UCCH will also have to consider the following types of personality download to a user terminal, which are –

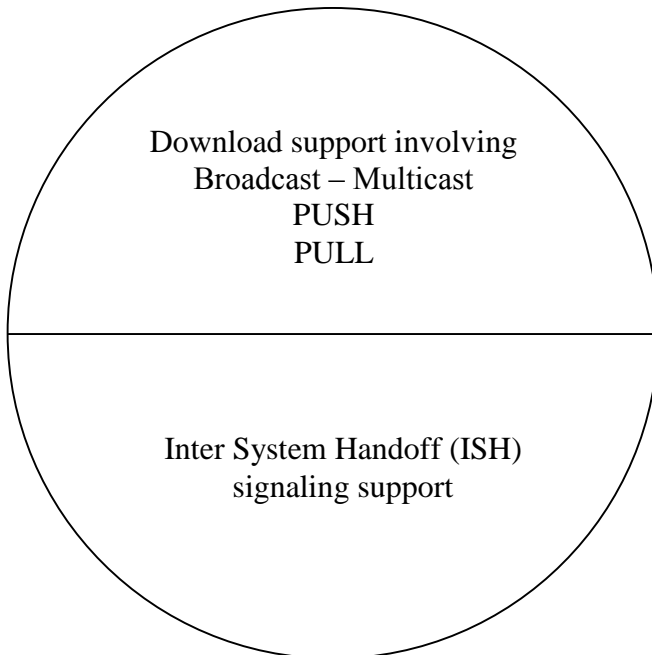
1. Complete personality download
 - Full personality download
2. Incremental personality download
 - Involves just in time download of needed components
3. Partial personality download
 - Involves the user terminal to specify the exact components required (typically the case during inter system handoff).

Software component download as in the SDR scenario generally involves moderate to low download volumes (in comparison with typical internet data downloads). The download times can be moderate to large for a complete download and can be short for

incremental and partial downloads. Additionally download software falls into three distinct categories, communication and computing applications, protocol entities for modification or changing of the air interface or the bearer service, low-level signal processing algorithms for modification or changing of the physical layer processing. Download software content may include hardware-specific binary image, code that needs to be interpreted or compiled, software objects and software agents.

Software download can be achieved through one or a combination of the following operations.

1. **Pure-Push.** In this method of component download, all the download bandwidth is dedicated to the periodic push and no requests is made by the user terminal except for the periodic capability updating via the UCCH. If the UT wants a software component, the client simply waits for the desired component to appear in the UT download cache.
2. **Pure-Pull.** In this method all bandwidth is dedicated to pulled pages so there is no periodic push. UCCH is used extensively in the initial communication with the service provider network. On missing software components in the UT cache the UT immediately, send a pull request for the component to the server.
3. **Hybrid Push and Pull.** This method mixes both push and pull by allowing clients to send pull requests for misses on a signaling channel while the server supports a push plus interleaved responses to the pulls on the download channel.
4. **Broadcast – Multicast.** A mode used to download enhancements to existing UT capabilities or advertise access network capabilities and synchronization information used by a UT for initial signaling personality download.

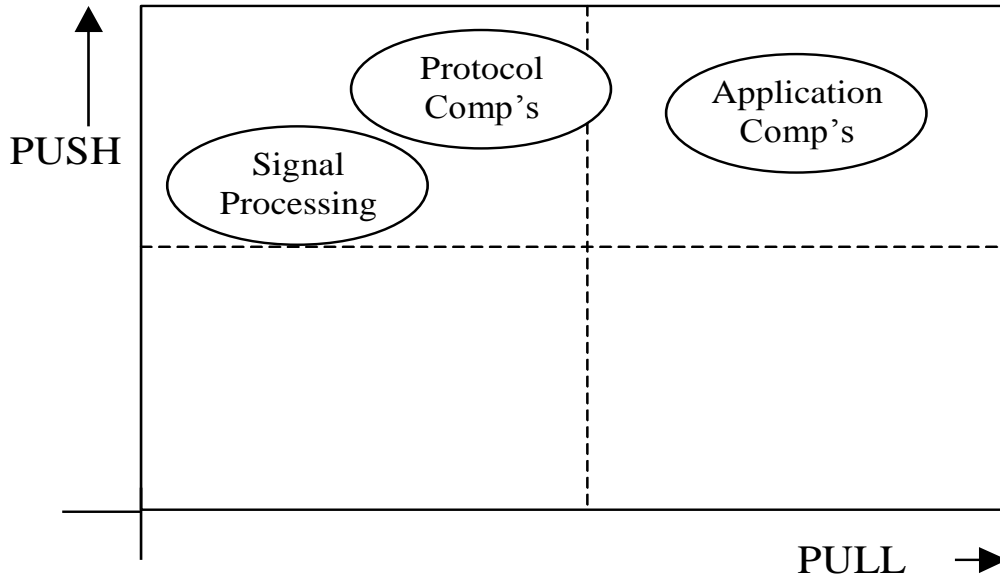


UCCH support space for SDRs

Three download scenarios involving degrees of download and signaling volumes are summarized below -

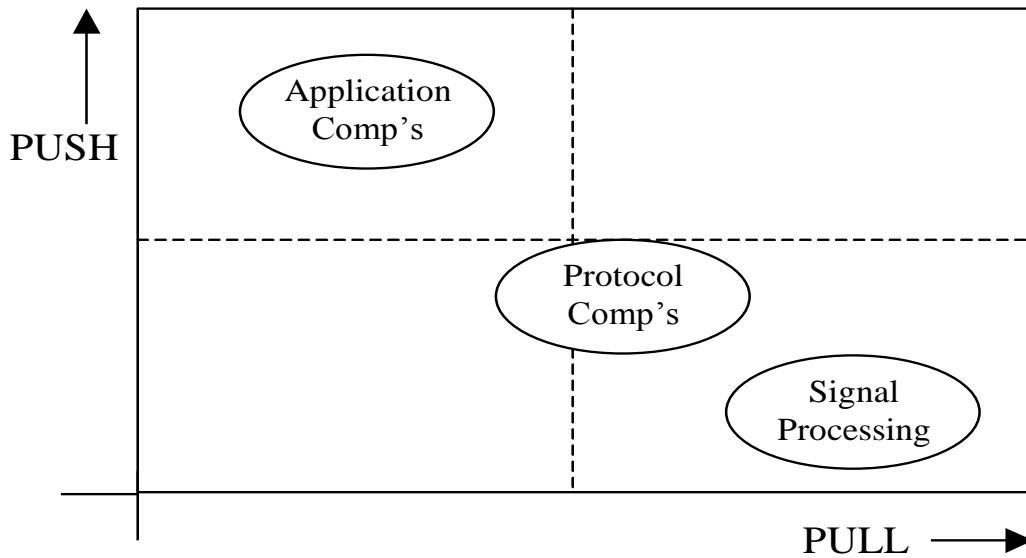
- Complete download scenario
The download and signaling volumes are high. The download
- Download during inter system handoff
High levels of signaling and moderate download volumes.
- Download for functional enhancements
Involving low signaling and moderate to low download volumes.

A more or less empty user terminal cache characterizes the initial download phase. Large signaling and large to moderate download volumes characterize the complete download scenario. The complete protocol personality download might involve a hybrid download approach involving PUSH, PULL, Broadcast-Multicast to varying degrees. The client might not be aware of the complete component set requirements. A few scenarios showing typical download methods versus download component types are shown in the following figures.



Push vs Pull for complete download scenario

Clients in steady state (a state where most of the download is incremental) request for certain class of components falls considerably. In steady state it is beneficial to obtain downloads through PULL.



A Push vs Pull possibility for the incremental download

SECTION C - THE SYSTEM OR NETWORK SUPPORT FOR THE UCCH

The UCCH facilitates protocol download and the considerations of a UCCH will also influence the handheld architecture. The consideration of the amount of processing and synchronization burden borne between the access network and the user terminal can further influence the development of the UCCH. A strong network support would reduce the measurement times faced by a user terminal for initial synchronization. The UCCH logical structure can be based on the access network taking the initiative and broadcasting its services to new terminals entering the network area. A strong network support can help achieve minimal signaling in the UCCH.

In the lack of much network support, the user terminal synchronizes with the access network over UCCH and queries for the services available. For inter system handoff support the UCCH will have to be supported by the target access systems.

CONCLUSIONS

An appropriate component download strategy in SDRs is very important, as a good download support protocol along with support for inter system handoff is critical for the success of the SDR efforts. A Universal Control Channel (UCCH) has to be developed and efforts should be made for the adaptation of such a protocol into other standards. This paper has listed a few considerations that the UCCH should cater to if it has to act as a good download support or intersystem handoff support signaling protocol. It is also advisable to consider the entire gamut of download scenarios when developing the UCCH signaling protocol. Further, in an SDR environment the download components can be classified into categories that would facilitate decision of class of components most suited for particular type of download like through a PUSH, PULL or through a Broadcast download. Provision should be provided in the UCCH to facilitate information exchange so that the above methods of download are supported.

One of the important questions that will have to be answered in trying to define the UCCH would be –

“Will UCCH have to be defined on a separate physical band altogether or should the UCCH be defined as a logical channel which can be integrated and supported by existing standards”.