

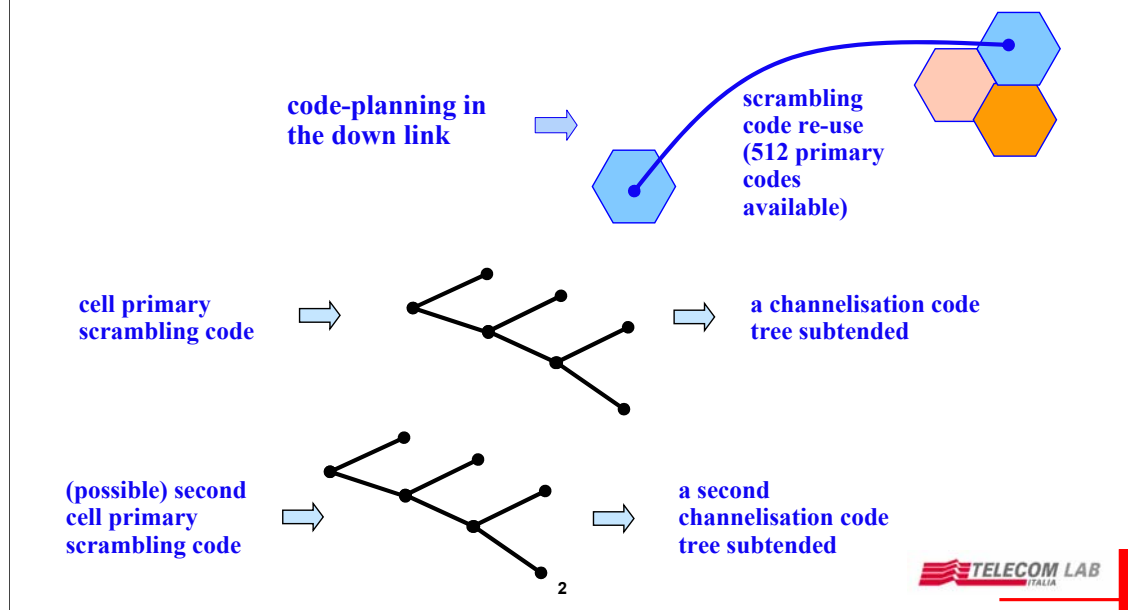
e4.1

System acquisition

Politecnico di Torino
2006



Scrambling and code planning in the down link



As for the *down link* segment, 512 primary *scrambling* codes are available. They are assigned to the cells (sectors) in the network planning phase. Even if belonging to a long-code family, each code is used just for the first 38.400 chips of the sequence. The scrambling code covers then an entire frame of 10ms (3.84 Mchip/s is the transmission rate).

The efficient use of the *scrambling* codes in the *down link* requires to plan the codes. This planning however does not reveal particularly complex.

There are in addition, secondary *scrambling* codes that are associated to the single dedicated channel (not to common channels).

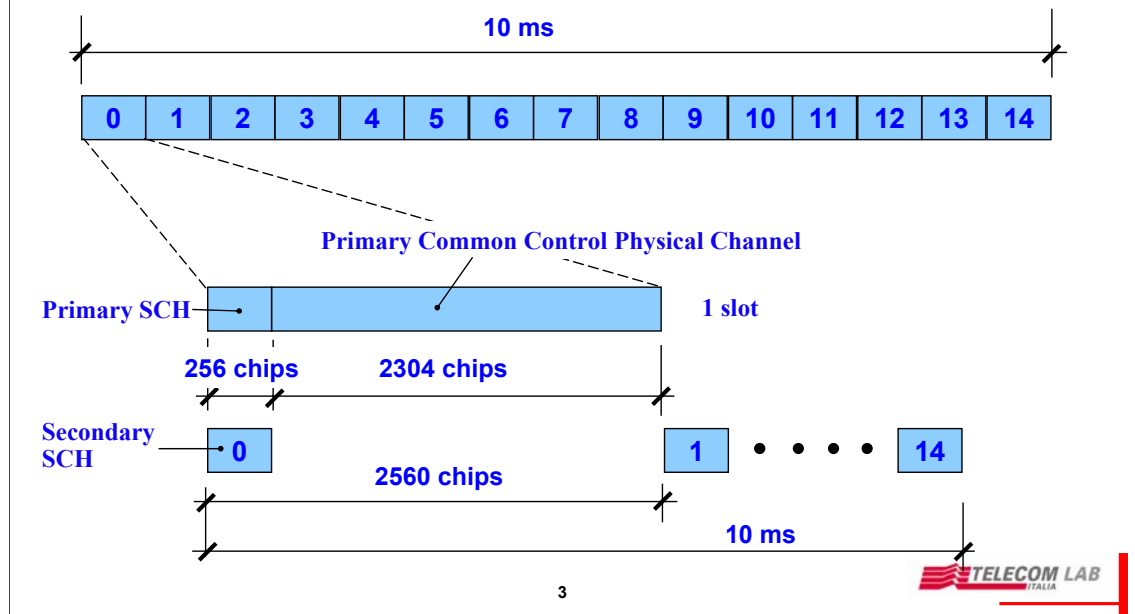
To preserve the *down link* orthogonal behaviour a single code per base station shall be used. Whenever another one has to be added, it has to be used just for those connections that cannot be hosted on the down link orthogonal codes tree. This limit preserves the channel from a great degradation (due to the non-orthogonal attitude of the scrambling codes).

On the *down link* a *Common Pilot Channel* (CPICH) is defined. It uses a non-modulated orthogonal code (SF=256) together with the primary *scrambling* code of the cell. The orthogonal code used is used all over the cell and identifies the cell itself. The *Common Pilot Channel* is used for the estimate of the dedicated channels performed by the MS receiver. It is also used to estimate of the common channels not associated to dedicated channels.

MS uses the measured power level of the received *Common Pilot Channel* to drive the handover and cell selection-re-selection procedures. The *Common Pilot Channel* level can be varied to regulate the cell load: the number of cell-camped mobile terminals varies accordingly.

A secondary pilot channel (using any of the available orthogonal codes with a 256 SF) is available in the cell. It can use secondary scrambling codes. It is used for the control of the adaptive antenna.

Physical channels for synchronisation



The *Synchronisation Channel* (SCH) is just used at the physical level. Through the SCH the synchronization is acquired by the mobile terminals. It uses in the *down link* a particular orthogonal code and it does not use any scrambling code. In fact, it has to be read by all the mobile terminals before they acquire the *scrambling* code of the cell they are visiting. SCH is composed by two channels:

- The primary SCH carries a code word 256 bits which allows the terminal to extract a non-modulated waveform. The code word is the same for all the system cells. Identifying the un-modulated waveform leads the terminal to become synchronous in time. This code is transmitted in all the slots and revealed through the correlation peaks. The terminal is then slot-synchronous.
- The secondary SCH uses different combinations of code words. These are 64 combinations and each one identifies the group of scrambling codes assigned to a base station. The identification of a specific combination of code words requires that all the frame slots (15) are read. The identification of the combination of code words allows the mobile to identify the group of *scrambling* codes (among the 64 possible groups) to which the base station belongs to.

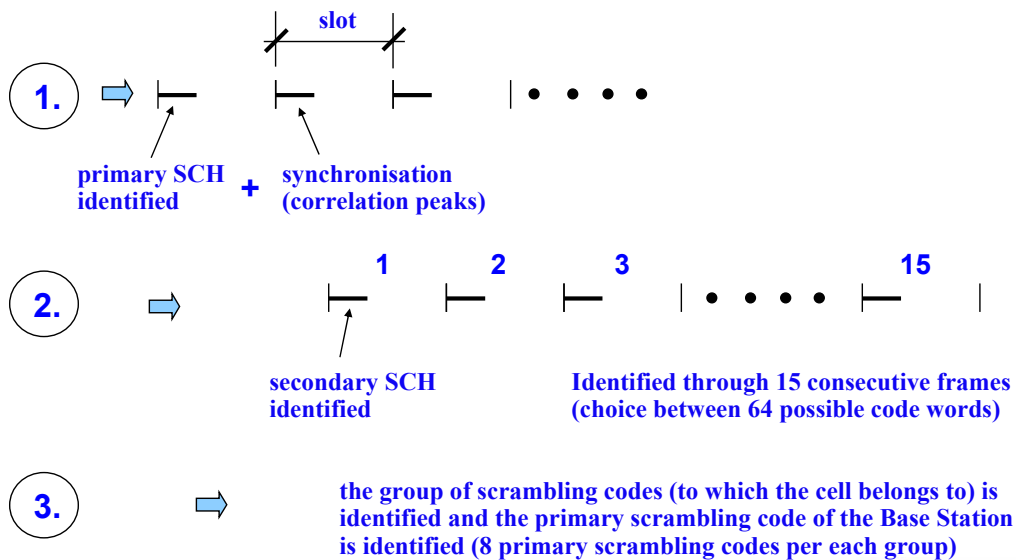
Once the secondary SCH has been identified, the mobile terminal knows the scrambling code of the base station and, in addition, it is slot and frame synchronous.

Primary and secondary SCHs are transmitted in parallel.

In the cell, a *Primary Common Control Channel* (Primary CCPCH) transporting the *Broadcast Channel* (BCH) is then defined. The primary CCPCH must be read by all the cell-camping mobiles. For this reason, it adopts a fixed channel encoding and a specific orthogonal code (SF=256). It adopts a convolutional code with *rate*=1/2 and *interleaving* depth extended over two frames (20 ms).

The SCH and the *Primary Common Control Physical Channel* are time multiplexed, as shown in the figure. 256 chips are left free in each slot for the primary SCH channel.

Physical channels for synchronisation



4

TELECOM LAB
ITALIA

The *Synchronisation Channel* (SCH) is then used to supply the cell synchronisation (slot and frame). As said, it is composed by a primary and a secondary channels. The identification of the secondary channel completes the synchronisation process. Moreover, it supplies the mobile terminal with the group of scrambling code the visited cell belongs to (among the 64). Now the MS limits the scrambling code search to the 8 primary codes belonging to the identified group of codes.

The searching process does not have to solve any synchronisation issues (the acquired time alignments give the MS the starting points of the *scrambling* codes).

The synchronisation steps are sketched in the figure.

The procedure has been adopted to simplify the scrambling acquisition process on the side of the mobile station: by using the SCH channels, the latter can restrict the scrambling code search to the set of 8 codes belonging to the identified group (step 2 of the figure).

The described procedure holds just for the initial acquisition phase. In the scrambling code planning a particular code configuration can be chosen for the contiguous cells (those involved in the handover procedure). In this way, the search of the primary scrambling code is simplified.

The Random Access Channel

power increase
(1dB granularity)

BCH

RACH

RACH

AICH

RACH

preamble

preamble

preamble

preamble

- channelisat. code
- scrambling code
- signature set

message
(10-20 ms)

5

TELECOM LAB
ITALIA

The PRACH uses a set of preambles that are coded by adopting one out of the 16 available signature sequences. The signature sequences are sent to the mobile stations through the BCH. The PRACH adopts a *spreading* factor of 256.

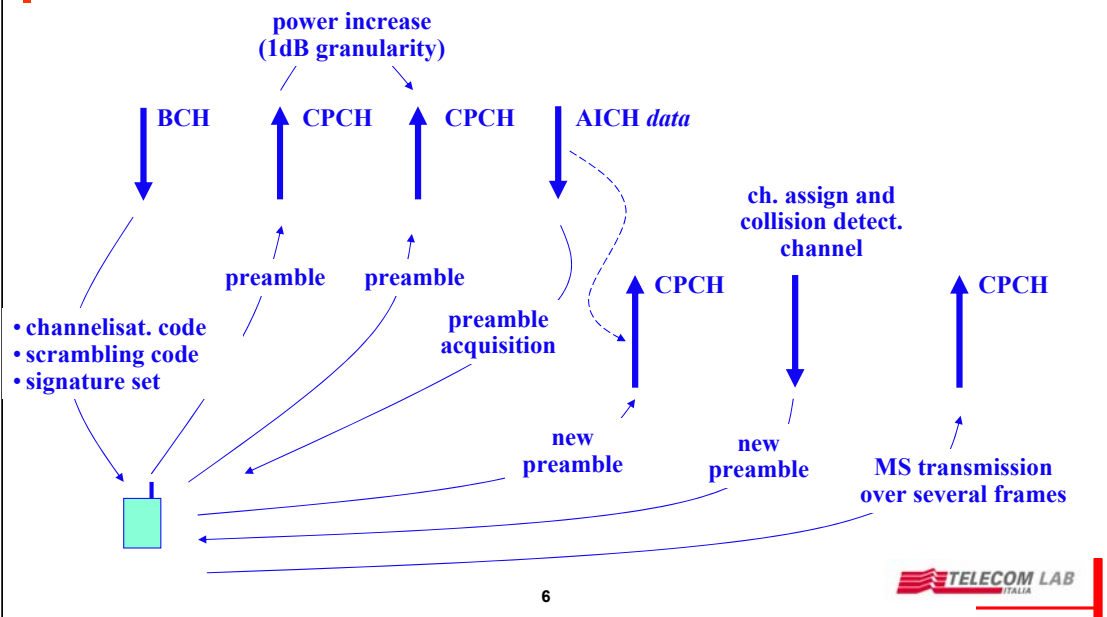
MS monitors on the *down link* the *Acquisition Indication Channel* (AICH) which is used to confirm the reception of the random accesses.

The AICH is received by all the mobiles, then it is transmitted at a constant power.

The power used for the preamble transmission is the one dictated by the open loop power control mechanism. If the mobile terminal does not receive any answer from the network, it re-transmits the same preamble with an increased power (1 dB granularity).

Pag. 5

The Common Packet Channel



The RACH structure may be used on the *up link* to transmit user data as well. The *Common Packet Channel* (CPCH) adopts the same orthogonal and scrambling criterion adopted for the RACH.

The transmission is subject to the power control mechanism, which is resolved by associating to the CPCH a DPCCCH channel: the latter guarantees through the *Transmit Power Control* range, the fast power control of the MS emitted signal.

The access is performed as for the RACH with the only difference that here a distinct preamble (CPCH specific) is used. After the access is detected, (through the AICH-data) the MS carries out a further access with the same power level but adopting another signature sequence, randomly chose among the 16 available. The same signature is sent by the network as down link acknowledgement (the *Channel Assignment/Detection CPCH Channel* is transporting this ACK).

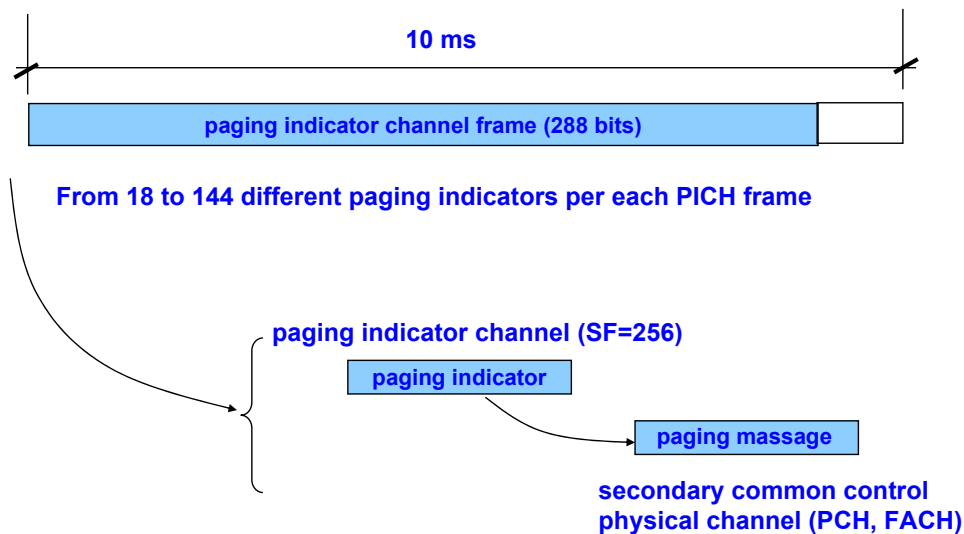
Once received this confirmation, MS starts the data transmission, which can be extended to several frames (there are limits to the transmission time due to the fact that CPCH cannot use the *soft handover* mechanisms and the measurements of the surrounding cells. The CPCH is anyway applied the fast power control scheme.

The AICH data can adopt the same orthogonal code used by the AICH associated to the RACH.

As said, the AICH has access to 16 signature sequences. Each sequence is formed by 4096 *chips* (16 symbols per sequence SF=256). To transport 16 signature sequences two frame periods are then needed (20ms).

The chips left free are used to notify MS what are the CPCH left free, on which MS can perform the access according to the above scheme. The channel-assignment messages and the collision detection messages are sent in parallel. Each can use 16 different symbol sequences to identify the transmitting mobiles.

The Paging procedure



7

TELECOM LAB
ITALIA

The *Secondary Common Control Physical Channel* (CCPCH) carries two control channels: the *Paging Channel* and the *Forward Access Channel* (FACH). The *spreading factor* used is fixed and set at the maximum spreading factor the mobile terminals can accept.

The distinction between the paging control channel and the *forward access* channel is guaranteed by the fact that the *paging* information is anyway indicated over a different physical channel, namely the *Paging Indicator Channel*. This channel uses orthogonal codes with the maximum value of SF (256).

The *secondary* CCPCH is transmitted at the maximum power.