4TC-Architectures de Réseaux Mobiles
Mobile Network Architectures

Part 1 – Logical Channels

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Outline

- User and control planes
- Downlink/uplink
- Shared and dedicated information
- Physical channels
- Logical channels
- Transport channels
- Call establishment scenario

User plane

- Also known as *data plane*
- The goal of any (mobile) network:
    - Get data from source to destination
    - As quickly and efficiently as possible
- User data:
    - Voice calls (GSM)
    - Voice calls and IP applications (UMTS)
    - IP applications (LTE)

Control plane

ı Any information exchange the network needs in order to take the user data from source to destination

ı Classical examples in the IP world: building routing tables

ı In mobile networks:

   ı Keep track of the mobile nodes
   ı Call establishment
   ı Resource allocation

Downlink

ι Transmission path from a cell site (more generally from the operator network) towards the User Equipment (UE)
ι Involves both control and user data
ι Should not be confused with incoming calls (calls received by an UE)

Uplink

l Transmission path from an UE towards a cell site (more generally towards the operator network)
l Involves both control and user data
l Should not be confused with outgoing calls (calls initiated by an UE)

Common information

- Information useful to multiple UEs
- Generally control data
- But also user data: multicast or broadcast groups

Dedicated information

l Information destined to or coming from a single UE
l Some control data (channel estimation, resource allocation, handover information, etc.)
l Secure transmission of most of the user data

Channels

- Physical channels
  - Define **where** data is transmitted over the air (which slot/carrier frequency in GSM, which OFDM symbols in LTE)
- Transport channels
  - Define **how** data is transmitted over the air (encoding, interleaving options, etc.)
- Logical channels
  - Define **what** type of information is transmitted over the air (dedicated/shared, user/control)

Channels

- Common channels
  - Carry common information
- Shared channels
  - Carry dedicated information, using shared resources
- Dedicated channels
  - Carry dedicated information on dedicated resources

Transport channels

- Define the way information is treated at the physical layer
- Can be considered as a service provided by the physical layer to the MAC layer
- Data is multiplexed into transport channels depending on how it is transmitted over the air
- Do not exist in the GSM architecture

Transport channels

- Broadcast Channel
    - BCH (UMTS and LTE)
    - Downlink
    - Control
    - Common
    - Used to transmit system and cell related information to the UE

Transport channels

- Multicast Channel
  - MCH (LTE only)
  - Downlink
  - User and Control
  - Common
  - Used to establish and manage a multicast group and multicast traffic exchange

Transport channels

- Paging Channel
    - PCH (UMTS and LTE)
    - Downlink
    - Control
    - Common
    - Used to broadcast paging messages in one or several cells
    - Supports discontinuous reception (DRX) from the UE, enabling the power save mode

Transport channels

- Random Access Channel
  - RACH (UMTS and LTE)
  - CPCH = Common Packet Channel (UMTS)
  - Uplink
  - Control and User
  - Common
  - Used for initial access to the network by the UE and transport of non-real-time user data

Transport channels

- Uplink Shared Channel
  - USCH (UMTS) and UL-SCH (LTE)
  - Uplink
  - Control and User
  - Shared
  - Used for transmission of dedicated control and user application by the UEs

Transport channels

- Downlink Shared Channel
  - DSCH (UMTS) and DL-SCH (LTE)
  - FACH = Forward Access Channel (UMTS)
  - Downlink
  - Control and User
  - Shared
  - Used for transmission of dedicated control and user application to the UEs

Transport channels

- Dedicated Channel
  - DCH (UMTS)
  - Downlink and Uplink
  - User
  - Dedicated
  - Used for transmission of dedicated control and user application to the UEs
  - Removed in LTE, the corresponding traffic goes through DL-SCH

Logical channels

l Define the data transfer services offered by the MAC layer
l Unlike transport channels, they do not mix control and data traffic
l Also exist in the GSM architecture

Logical channels

- Broadcast Control Channel
  - BCCH (GSM, UMTS and LTE)
  - Downlink
  - Control
  - Common
  - Contains the System Information Block (SIB): cell access information, scheduling of other system information transmission, radio resource configuration, cell reselection parameters, etc
  - In GSM, some extra broadcast channels are defined: Frequency Correction Channel (FCCH), Synchronization Channel (SCH) and Cell Broadcast Control Channel (CBCH)

Logical channels

- Paging Control Channel
    - PCH (GSM), PCCH (UMTS and LTE)
    - Downlink
    - Control
    - Common
    - Broadcast channel used to notify an UE of an incoming call
    - Each UE periodically listens to the information

Logical channels

- Common Control Channel
    - CCCH (GSM, UMTS and LTE)
    - Downlink and Uplink
    - Control
    - Common
    - Used to deliver control information when there is no confirmed association between the UE and the network (i.e. in the connection establishment phase)
    - In GSM, consists of the Random Access Channel (RACH) and the Access Grant Channel (AGCH)

Logical channels

- Dedicated Control Channel
    - DCCH (GSM, UMTS and LTE)
    - Downlink and Uplink
    - Control
    - Dedicated
    - Used to deliver control information when a connection was already established between the UE and the network
    - In GSM, it is further divided on the Standalone Dedicated Control Channel (SDCCH), the Fast Associated Control Channel (FACCH), and the Slow Associated Control Channel (SACCH)

Logical channels

- Multicast Control Channel
  - MCCH (LTE only)
  - Downlink and Uplink
  - Control
  - Common
  - Used for establishing Multicast/Broadcast Multimedia Services (MBMS) groups

Logical channels

- Dedicated Traffic Channel
  - TCH (GSM) and DTCH (UMTS, LTE)
  - Downlink and Uplink
  - User
  - Dedicated
  - Used to transmit user data after the establishment of a connection
  - In GSM, two types of TCH exist: Full Rate Traffic Channels (TCHF) and Half Rate Traffic Channels (TCHH)
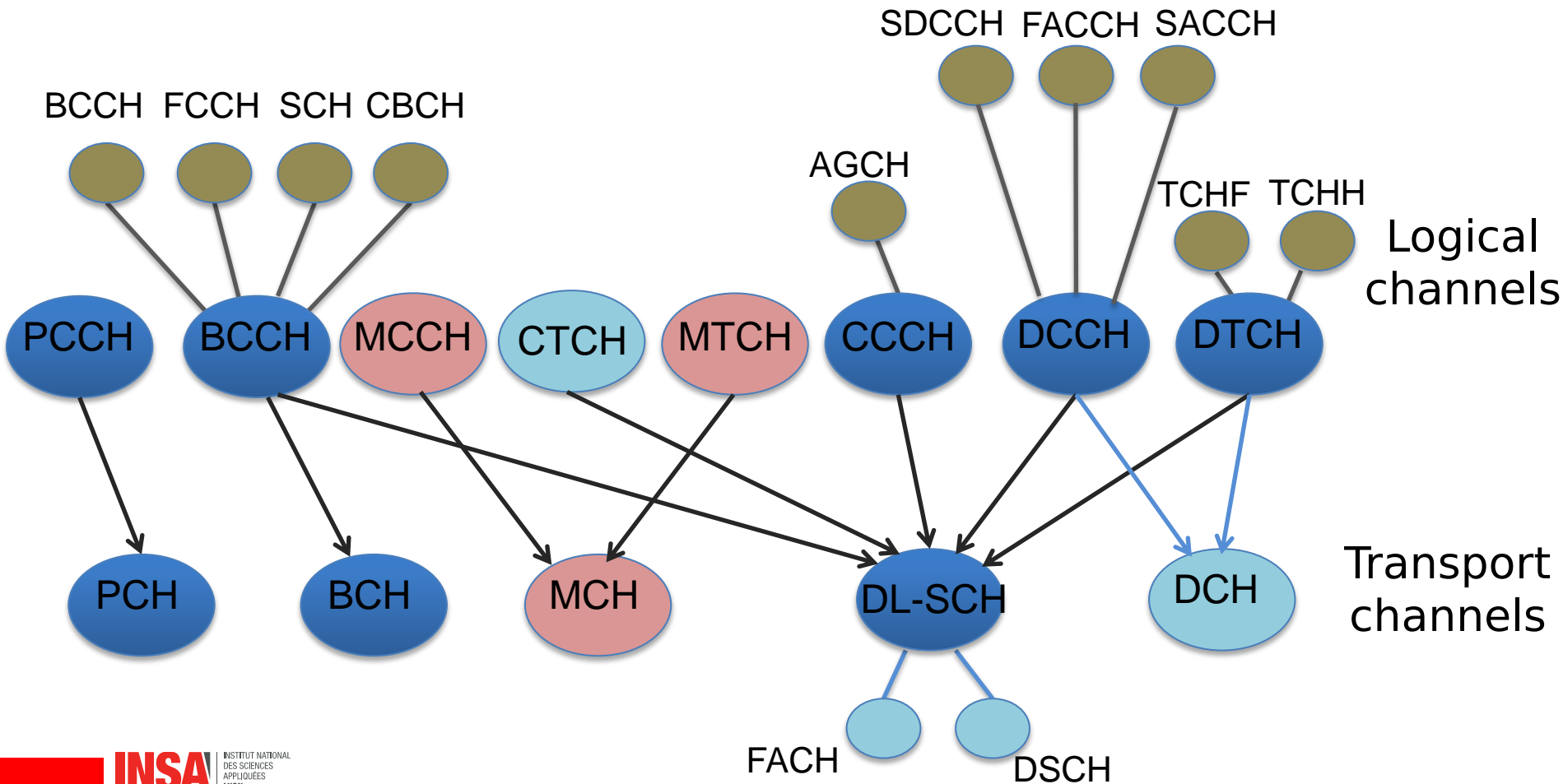
Logical channels

Multicast Traffic Channel
- MTCH (LTE only)
- CTCH = Common Traffic Channel (UMTS) is an equivalent point-to-multipoint channel, but only downlink
- Downlink and Uplink
- User
- Common
- Used to transmit user data in a multicast group

Channel mapping

Channel mapping

Uplink channels

Logical channels

Transport channels

GSM only
UMTS only
LTE only
GSM, UMTS, LTE

SDCCH FACCH SACCH

TCHF TCHH

CCCH DCCH DTCH

RACH UL-SCH DCH CPCH
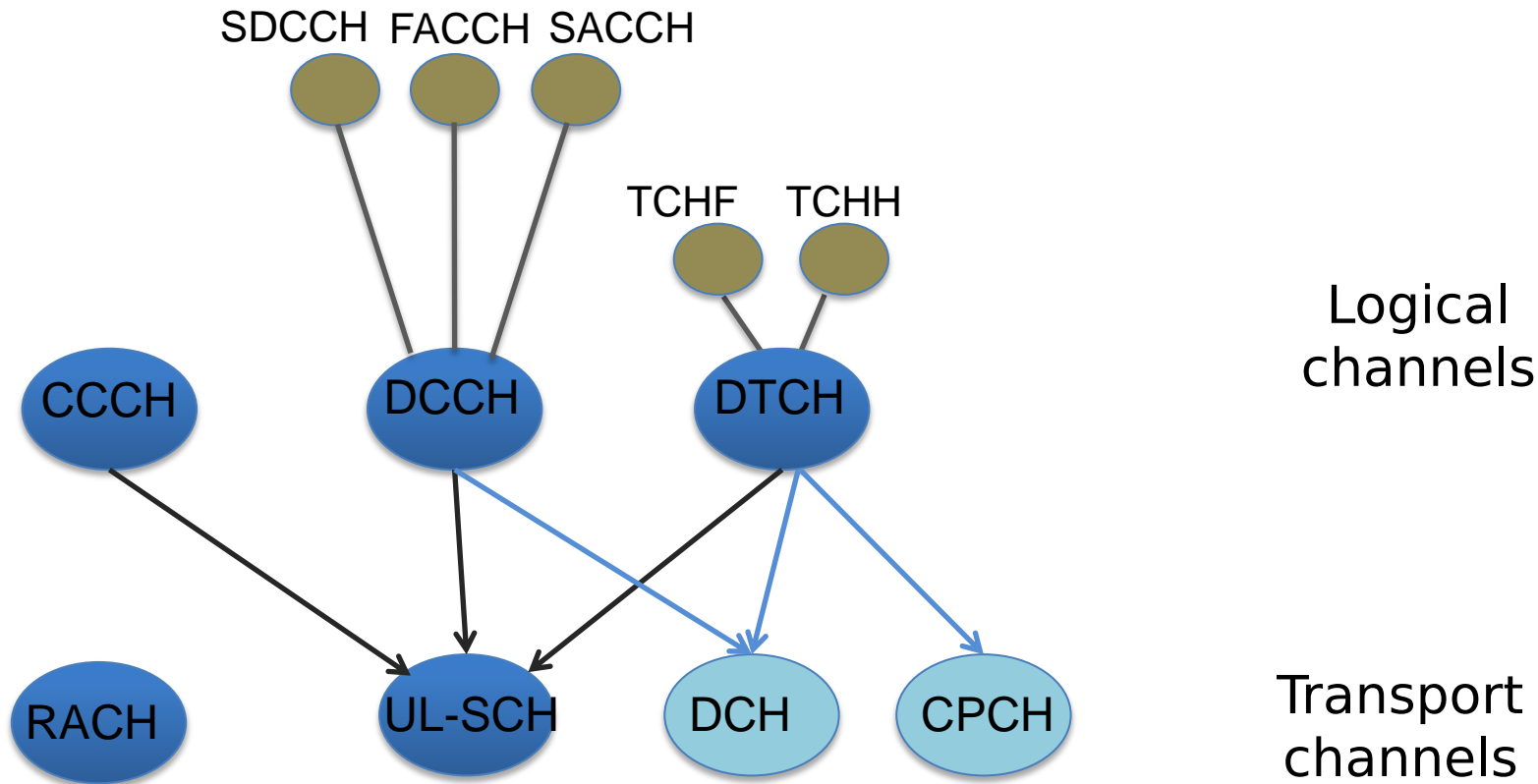
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  - Resource grant and control information (for upper layer connection establishment) on the CCCH

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  l Establishment of a DCCH and a DTCH

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- ı Resource grant and control information (for upper layer connection establishment) on the CCCH
- ı Establishment of a DCCH and a DTCH
- ı User data is transmitted on the DTCH, while control data (buffer information, channel quality indicators, handover related information) is exchanged on the DCCH