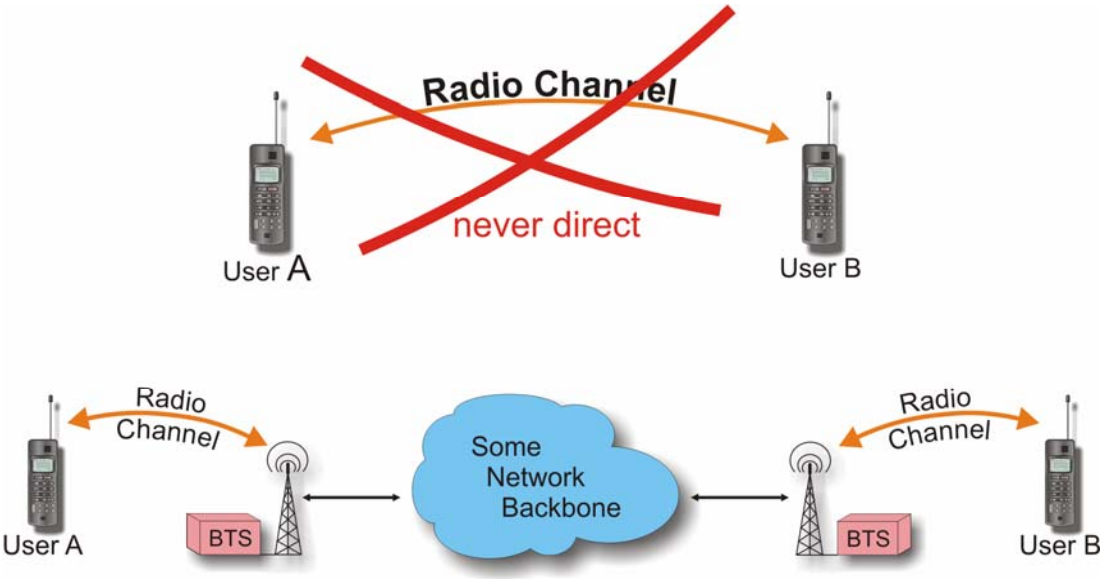
1.1 What is Mobile Radio?



The objective of this section is to illustrate mobile operation in general.

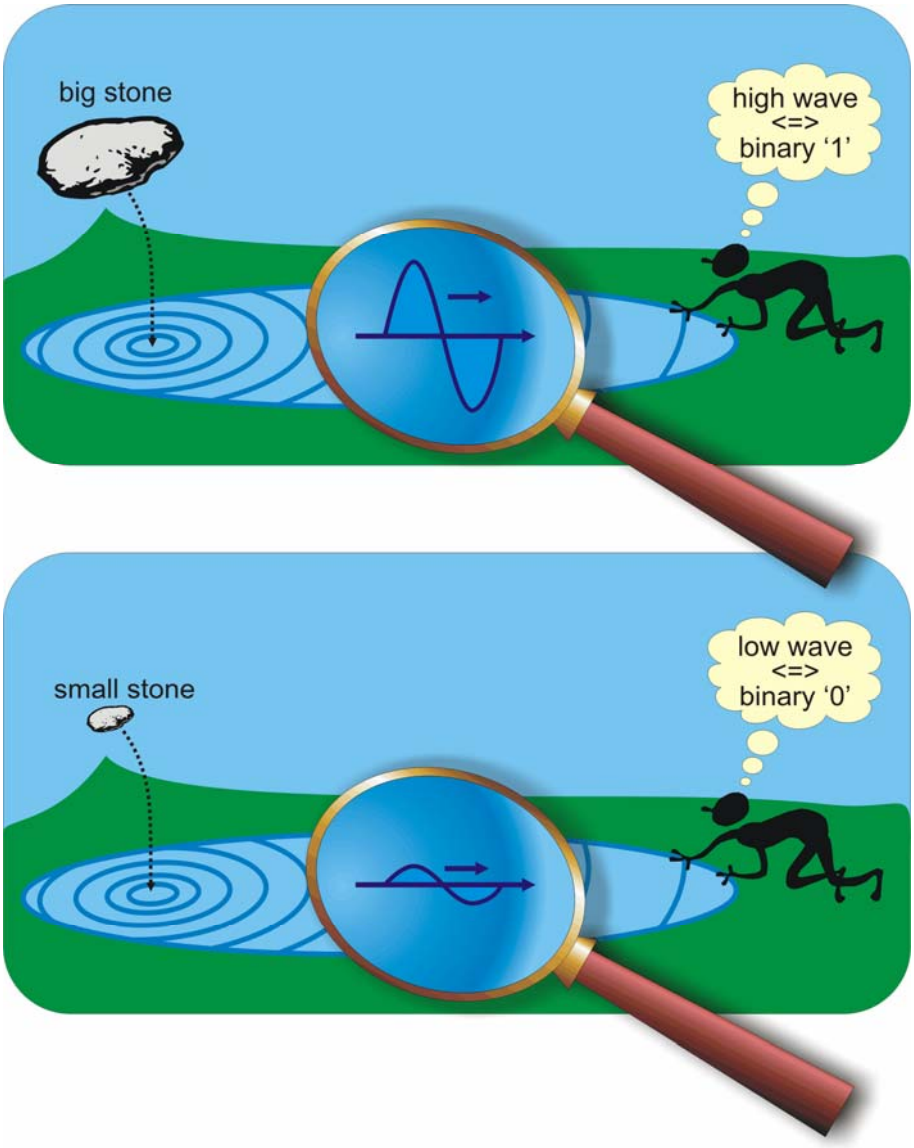
Key point of this section is that mobile operation is never done from peer to peer directly. Mobile operation requires sophisticated network architecture between the two peers to operate properly.

Room for your Notes

- **Abbreviations of this Section:**

BTS	Base Transceiver Station

1.1.1.3 Analogy: Using Water Waves to convey Information

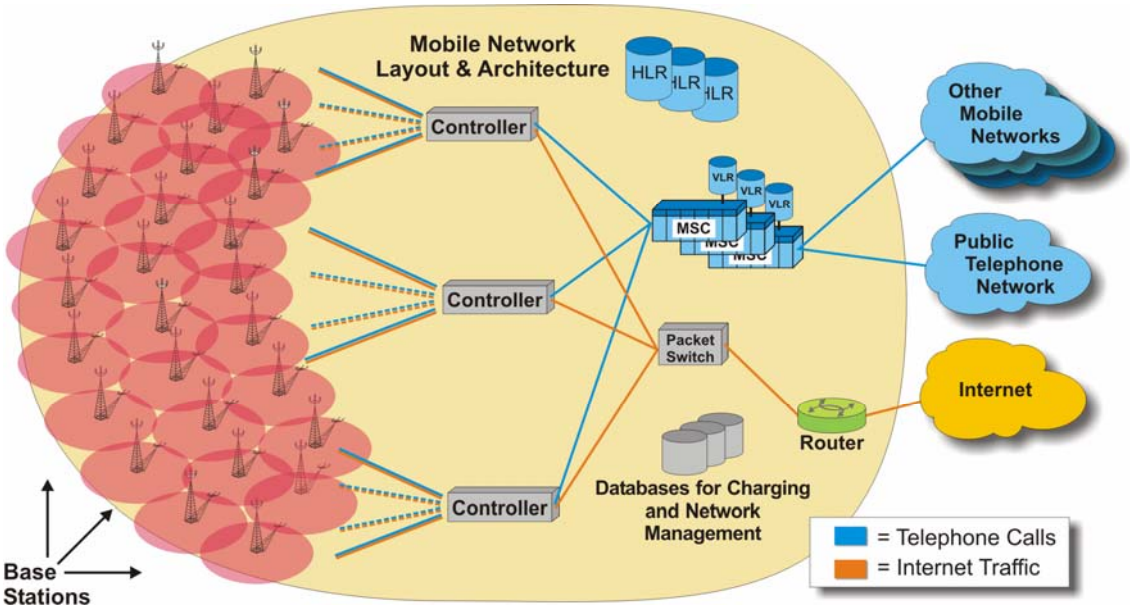


The objective of this section is to translate the aforementioned abstract technical statement into everybody's daily experience.

Key point of this section is that it is obvious how difficult and error-prone the data transfer through the medium water is. You may well translate this into the wireless world.

Room for your Notes

2.2 Cellular Networking and the related Architecture



The objective of this section is to make the student aware about the basic architectural elements and layout of a given mobile network.

Key points of this section are:
1. Nowadays, mobile networks support both types of traffic: Standard voice calls and internet traffic.
2. The “controller” network elements represent traffic concentrators which take care of all radio related network control functions like power control, radio resource management and handover between two cells.
3. The Mobile Service Switching Centers are standard switches, inherited from the fixed telephone environment.
4. In addition to the already introduced database, called VLR, there are HLR’s which memorize the data and information about a single user *permanently*, among others the currently serving VLR.

Why are there HLR’s in addition to VLR’s?

Coverage Area Considerations
Frequently, there is the question which area is covered by a single base station, a single controller, MSC or HLR. Please find some answers underneath:

- One **base station** usually consists of two to three sectorized cells to double or triple the capacity. The range of a base station may be in the range of tens of kilometres or it may be as small as 100 meters or even less. The actual range is controlled by the output power of such a base station.
- The indicated **controllers** control a certain number of base stations whereas the actual number of controlled base stations depends on the vendor. The typical coverage area of a controller is e.g. one small city.
- The **MSC/VLR's** and **packet switches** cover larger areas or entire cities and their vicinity. Example: The area of Cary requires at least one MSC and one packet switch but for all RTP incl. Raleigh and Durham multiple MSC/VLR's and packet switches are required.
- An **HLR** cannot be tied to a certain area. HLR's are rather defined by the maximum number of subscribers that they are able to store subscriber information for. Subscriber information relates to subscription details, current registration status and VLR and other information.

Please take a pencil and separate the access network from the core network

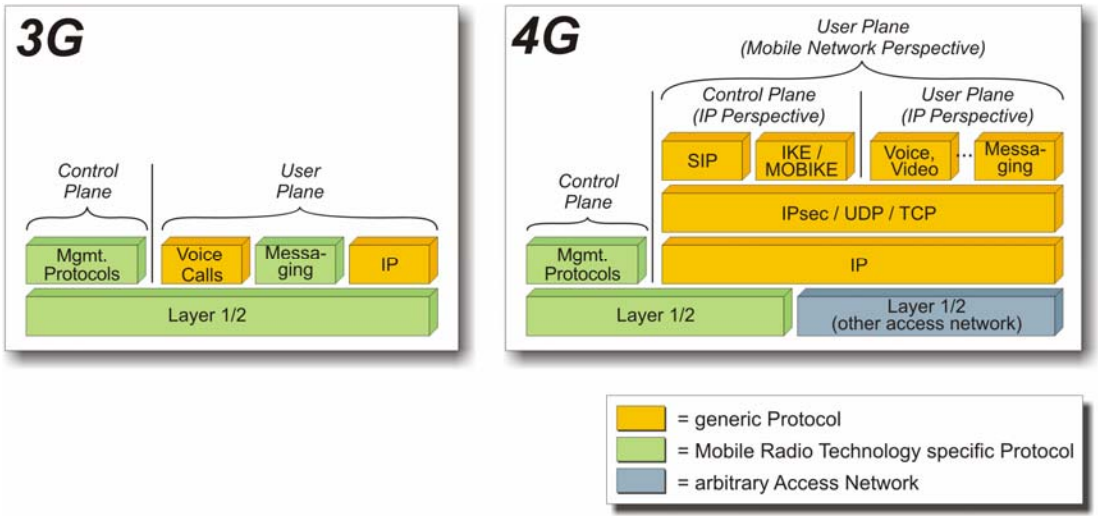
Room for your Notes

- **Abbreviations of this Section:**

HLR	Home Location Register	**RTP**	Research Triangle Park
MSC	Mobile Services Switching Center	**VLR**	Visitor Location Register

4.3 Technical Details of the Evolution

4.3.1 Protocol Stack Comparison between 3G and 4G



The objective of this section is to illustrate the protocol stack related differences between 3G and 4G mobile radio systems.

Key points of this section are:
1. In the previous mobile radio generations 2G and 3G the management protocols were self-contained to control all service delivery functions of the mobile network. In 4G, the management protocols are restricted to functions like establishment of IP-connectivity and “micro-mobility”.
2. With 4G, the protocol focus is beyond IP: All service control related protocols are residing on top of the IP-layer. Even the plain voice and other service delivery protocols are placed on top of IP.

The most important consequences of the aforementioned protocol stack architecture are:

- **Fixed Mobile Convergence**
  The protocol stack figure makes it transparent: the underlying access technology is less important and it may be mobile radio (orange part) or anything else like DSL or WLAN (blue part).

- **Triple and Quadruple Play Services**
  Triple Play is nothing else but the provision of audio/video broadcast/multicast services, conversational and internet access services by a single source, e.g. the mobile operator. The illustrated protocol stack paves the way towards Triple Play, because the IP-based control plane, namely the SIP-protocol can control every session type, may it be conversational or audio/video broadcast or multicast related.
  And Triple Play migrates towards Quadruple Play once that mobility is added.

- **Seamless Mobility Function among different Access Network Types**
  Seamless mobility is another consequence of the IP-centric protocol stack. IP-based protocols like IKEv2 or MOBIKE have been tailored to allow for "macro mobility" which is nothing else than the possibility to switch among different access networks and access network types and remain connected to a central core network.

Of course, there are many more consequences like the possibility to select specific voice or video codecs for a data transfer etc..

- **Abbreviations of this Section:**

3G ...	3rd Generation ...	**IPsec**	Internet Protocol / secure (RFC 2401)
4G	4th Generation ...	**MOBIKE**	IKEv2 Mobility and Multihoming Protocol (RFC 4555)
DSL	Digital Subscriber Line	**SIP**	Session Initiation Protocol (RFC 3261)
IKE	Internet Key Exchange (RFC 2409)	**TCP**	Transmission Control Protocol
IKEv2	Internet Key Exchange protocol / version 2 (RFC 4306)	**UDP**	User Datagram Protocol (RFC 768)
IP	Internet Protocol (RFC 791)	**WLAN**	Wireless Local Area Network (IEEE 802.11)