H.323

• H.323 is a standard of the International Telecommunications Union-Telecommunications Standardization (ITU-T)

• Currently it is a widely adopted signalling suite for VoIP services

• The first release of H.323 dates back to year 1996
H.323

• H.323 is the specification of a complete network architecture
• H.323 is a wide standard which includes a large number of documents
• The basic standard documents referred in this presentation are H.255.0 and H.245
Architecture

• The H.323 architecture includes
  - terminals
  - Multipoint Controller Units
  - gatekeepers
  - gateways

• The basic objective of H.323 is
  - To enable the exchange of media streams among endpoints, in a switched fashion
Architecture

- Usually, the terminal is the user’s equipment
- The terminal must support at least one coded, but in general it supports multiple codecs
- The terminal can also implement a video codec
Architecture

• The gateway translates signalling to external (and also different) signaling domains

• External networks interfaced by a gateway can be GSTNs (Generalized Switched Telephone Networks) including both fixed and mobile networks
Architecture

• On one side, the gateway supports H.323 signaling
• On the side interfacing to an external network, it supports the remote signalling system (for example, SS7 for a PSTN)
Architecture

• On the user plane, the translation service provided by the gateway implements codec translation
• On the control plane, it interworks different signaling systems
• As shown in the picture, through H.323 gateways it is possible to interconnect separate h.323 networks through another type of network
Architecture

- The H.323 gatekeeper is optional, but in most networks a number of gatekeepers is always present.
- The gatekeeper controls a number of devices (terminals, MCUs, gateways).
- The control performed by the gatekeeper includes acceptance of devices into the network and authorization to perform basic tasks such as call setup.
- The gatekeeper allows for a strict control of the H.323 network.
- The gatekeeper can also perform bandwidth control and in this way it can interact with signaling systems for the control of the Quality of Service.
Architecture

- A set of devices controlled by a gatekeeper is called a **zone**
- In the figure, a two-zone network is shown
- The division of a network into zones is a way to achieve scalability, as each gatekeeper must control a limited number of devices
Architecture

• Un MC è il Multipoint Controller
• Gestisce chiamate in conferenza tra molteplici terminali/gateway
• Il MC stabilisce quale formato di media va utilizzato (si deve avere compatibilità mutua tra i partecipanti)
• Cio' avviene trasmettendo ai partecipanti un capability set
• Il capability set può essere cambiato dinamicamente dal MC in seguito a join/leave durante la conferenza
H.323 protocols

• H.323 call signaling and control signaling are derived from the former ITU specifications of the ISDN Q.931 suite
• H.225.0 is the RAS signaling, where RAS means Registration, Admission and Status
• RAS signaling is the communication protocols among devices and the gatekeeper in a zone of the H.323 network
H.323 protocols

- For example, a terminal must use RAS to register itself at its gatekeeper and join the network
- RAS signaling uses UDP as a transport protocol
- Call signaling can be carried by both UDP and TCP
- Old version of H.323 before version 4 use UDP for call signaling
- Starting from version 4, both TCP and UDP can be used
H.323 protocols

- Control signaling H.245 is used for communication between the endpoints of a connection
- H.245 has the purpose of allowing the negotiation of media formats
- H.245 establishes the logical channels through which codec negotiation is to be carried out
- Through codec negotiation, the endpoints of a connection determine which codec is to be used for the connection
H.323 protocols

• In general, in order to establish a connection all the three described forms of signaling are used
• For each signalling category a logical channel is established
• A logical channel is a specific pair of sockets
Audio and video codecs

• H.323 devices must support a basic set of codecs, such as G.711 both in A-law and in $\mu$-law fashion

• Usually multiple codecs are supported, including compressed codecs such as G.729

• For video media streams, H.323 devices must support at least the H.261 Quarter Common Intermediate Format (QCIF)
RAS signaling

• RAS is the signaling exchanges between a gatekeeper and a devices it controls
• RAS signaling is the means by which a gatekeeper controls its zone
• RAS signaling supports a large number of functions, among which:
  - Gatekeeper discovery
    • By which a device discovers its gatekeeper
  - Registration/Unregistration
    • With the gatekeeper
RAS signaling

- Admission
  - An endpoint asks to the gatekeeper the authorization to participate to a call; bandwidth may be specified
- Bandwidth change
  - Function by which, for example, the gatekeeper can force an endpoint to reduce the consumed bandwidth
- Disengage
  - Used by the endpoint to communicate to the gatekeeper that it is leaving a connection
- Status
  - Messages exchanged to communicate information about the status of a device
- Resource availability
  - A device can communicate to a gatekeeper the amount of free resources available
Gatekeeper Discovery

• In order to register, an endpoint must first discover its gatekeeper

• The endpoint may have been configured statically with the address of a gatekeeper: no discovery is needed in this case; however, this solution is not flexible

• In order to perform discovery, the endpoint sends a Gateway-ReQuest message (GRQ) to
  - A set of preconfigured IP addresses or
  - To the IP multicast group 224.0.1.41:1718
Gatekeeper discovery

• A gatekeeper can answer with a Gatekeeper ConFirmation message (GCF) or Gatekeeper ReJect message (GRJ)
• A gatekeeper can also respond with a GCF message including an alternative list of gatekeepers to be checked by the terminal
• If the endpoint received multiple positive answers, it chooses one
Endpoint registration and cancellation

- The endpoint sends to the gatekeeper the Registration ReQuest (RRQ) message, on the RAS port (1719)
- The gatekeeper can accept the request by replying with a Registration ConFirmation, RCF, message or reject the request with a Registration ReJect, RRJ, message
- Registration have a limited duration, explicitly stated in seconds, up to a maximum of 136 years (usually they are shorter than the maximum)
- If a registration is going to expire soon, the endpoint can renew it with another RRQ message, with the Keepalive option activated
- Endpoint unregistration is implemented through Unregistration ReQuest (URQ) messages and the associated positive response is Unregistration ConFirmation (UCF)
- If the unregistration request is placed while a connection involving the requesting terminal is active, the request is rejected with a Unregistration ReJect (URJ) message
- The gatekeeper can autonomously unregister a terminal
Endpoint registration and cancellation

**Diagram:**

- **Host**
  - registration
  - unregistration
- **Gatekeeper**
  - RRQ
  - RCF
  - oppure
  - URQ
  - UCF


Admission

- The endpoint requests the permission to participate to a call with the Admission ReQuest (AQR) message
- The endpoint specifies
  - Type of call (point-to-point or multiparty)
  - the partner (or the list of partners)
  - il call identifier (una stringa univoca)
  - The call reference
  - The required bandwidth (in 100 bit/s units)
  - ... Other parameters
Admission

• The gatekeeper’s positive answer is communicated to the endpoint with the Admission ConFirmation (ACF) message

• In general the parameters in the ACF message are the same used in the ARQ message (parameter’s values may be different)
Admission

- An important parameter in admission-related messages is the call model.
- The endpoint can require:
  - *direct call signaling*: exchanging call signaling directly with the remote partner.
  - *gatekeeper-routed signaling*: exchanging call signaling with the gatekeeper.
- The gatekeeper may confirm the terminal’s request or force hits decision on the call model to be used.
- The gatekeeper rejects the request with the Admission Reject (ARJ) message.
Direct call signaling

- The figure shows a simple example of direct call signaling
- RAS signaling and call signaling are represented with a different thickness of lines
- In the figure, we assume that both endpoints are in the same zone
Gatekeeper-routed call signaling

- In the figure, we assume that both endpoints are in the same zone.
- The gatekeeper routes call signaling.
Disengage

• A Disengage ReQuest (DRQ) message is sent by the terminal to the gatekeeper to inform that the terminal is leaving a connection.

• The DRQ message must specify the call reference, to identify the disengaged connection, and the disengage reason (for example, normalDrop, to signal a normal release of the connection without errors).
Disengage

• Normally, the gatekeeper responds with a Disengage ConFirm (DCF) message

• Only in case of error or inconsistency the gatekeeper responds with a Disengage ReJect (DRJ) message
  – An inconsistency case is that of a terminal erroneously sending to the wrong gatekeeper the DRQ message
Resource availability

• Two RAS messages concern resource availability: Resource Availability Indicate (RAI) and Resource Availability Confirm (RAC)

• RAI is sent by a gateway to a gatekeeper to communicate the amount of available resources

• The gatekeeper needing to forward a call through a gatekeeper can choose among multiple gateways taking into account available resources
H.255.0 call signaling messages (I)

- Alerting
- Call-proceeding
- Connect
- Progress
- Setup
- Setup Acknowledge
- Release Complete
H.255.0 call signaling messages (II)

- Information
- Notify
- Status
- Status Inquiry
- Facility
H.225.0 Call signaling

Setup

• Setup
  - The SETUP message is used to start the call signalling transaction to setup a call
  - The SETUP message specifies, among other parameters
    • Identification of calling and called partners
    • Information on the logical channels to be used by H.245 control signalling to negotiate the format of media
H.225.0 Call signaling

Call-Proceeding

- Call-proceeding
  - The CALL-PROCEDING message is a provisional response (optional) used to inform the receiver of the message that the issued request is being processed
H.225.0 Call signaling

• Alerting
  - This message is used to inform the calling terminal that the called terminal has been reached and it is ringing
H.225.0 Call signaling

Progress

- This is a provisional response issued by gateways (the function is similar to that of CALL-PROCEEDING)
H.225.0 Call signaling

Connect

- Message sent by the called terminal to inform that the call has been accepted
H.225.0 Call signaling
Release complete

- Release complete
  - It is used to release a call
H.225.0 Call signaling Facility

• Facility
  – Used for the redirection of a call
H.245 control signaling

- H.245 is used for the negotiation of the format of media
- The H.245 signalling session can start after the reception of the SETUP message
- Various options are available
  - The called terminal can start the H.245 session after the reception of the SETUP message
  - The calling terminal can start the H.245 session after the reception of CALL PROCEEDING or PROGRESS or ALERTING
  - Otherwise, the H.245 session must start after the CONNECT message
Base call without gatekeeper

- SETUP
- CALL PROCEEDING
- ALERTING
- CONNECT
- Open session H.245
- Close session H.245
- RELEASE COMPLETE

RAS signaling (H.255.0)

Call signaling (H.255.0)

Control signaling (H.245)
Base call with gatekeeper and direct endpoint call signaling

- **RAS signaling (H.255.0)**
- **Call signaling (H.255.0)**
- **Control signaling (H.245)**

- **ARQ**
- **ACF**
- **SETUP**
- **CALL PROCEEDING**
- **ALERTING**
- **CONNECT**
- **Open session H.245**
- **Close session H.245**
- **RELEASE COMPLETE**
- **DRQ**
- **DCF**
- **ARQ**
- **ACF**
N.B. the assumption is that one gatekeeper routes call signalling and the other doesn’t.

Base call with gatekeeper and direct routed call signaling

RAS signaling (H.255.0)
Call signaling (H.255.0)
Control signaling (H.245)
GK2 rejects ARQ from EP2 because it wants to route call signaling. EP2 sends a FACILITY mess. to GK1. GK1

**Base call gatekeeper routed call signaling**

- **ARQ**
- **ACF**
- **SETUP**
- **CALL PROCEEDING**

**RAS signaling (H.255.0)**
**Call signaling (H.255.0)**
**Control signaling (H.245)**

GK2 rejects ARQ from EP2 because it wants to route call signaling. EP2 sends a FACILITY mess. to GK1.
H.245: logical channels

- The H.245 control signaling establishes dedicated logical channels to transport media-related information.
- To establish a logical channel two messages are required: **Open Logical Channel Message** and **Open Logical Channel Ack**.
- Then, a **Capabilities Exchange** procedure is started, by which the two terminals exchange information about supported codecs and reach a decision about which codec/codecs is/are to be used.
Connection (RAS, Call, Control)

RAS signaling (H.255.0)
Call signaling (H.255.0)
Control signaling (H.245)

ARQ
ACF
SETUP
CALL PROCEEDING
ALERTING
CONNECT
OLC
OLC ACK
OLC CONFIRM
Media
CLC
CLC ACK
END SESSION
END SESSION
RELEASE COMPLETE
DRQ
DCF
ARQ
ACF