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
Architectures

- 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 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)
- Ciò’ 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 μ-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 device 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
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)
  - the 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-PROCEEDING 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

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

Connect

• Connect
  – Message sent by the called terminal to inform that the call has been accepted
H.225.0 Call signaling

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)**
Base call with gatekeeper and direct routed call signaling

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N.B. the assumption is that one gatekeeper Routes call signalling and the other doesn’t

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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

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