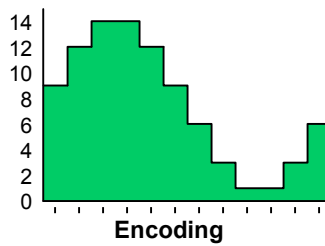
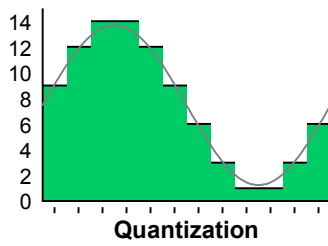
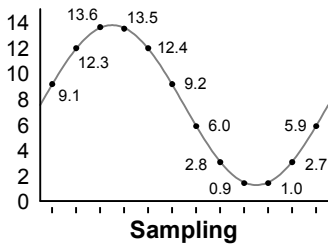


Pulse Code Modulation (PCM)



Sampling

8000 discrete signal measurements are taken at equal intervals every second

Quantization

The level of each sample is rounded to the nearest expressible value

Encoding

Digital values are encoded as binary numbers for encapsulation

Compression (Optional)

The digital signal is compressed in real time to consume less bandwidth

Power Over Ethernet (PoE)

Cisco Inline Power (ILP)

Pre-standard; employs a 340 kHz tone to detect devices; power needs communicated via CDP

IEEE 802.3af

Detects power requirements of PoE device by the line resistance present

IEEE 802.3at

Uses LLDP to negotiate delivery of up to 25 watts in .10 W intervals

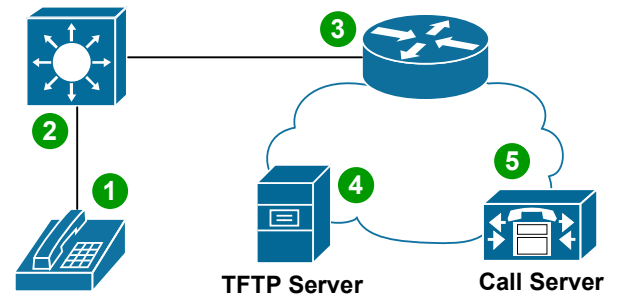
IEEE 802.3af Classes

0	15.4 W	3	15.4 W
1	4 W	4	Reserved
2	7 W		

Voice Codecs

	MOS	Bandwidth	Complexity	Free
G.722 SB-ADPCM	4.13	48-64 kbps	Medium	Yes
G.711 PCM	4.1	64 kbps	Low	Yes
iLBC	4.1	15.2 kbps	High	Yes
G.729 CS-ACELP	3.92	8 kbps	High	No
G.726 ADPCM	3.85	32 kbps	Medium	Yes
G.729a CS-ACELP	3.7	8 kbps	Medium	No
G.728 LD-CELP	3.61	16 kbps	High	No

IP Phone Boot Process



1. Power Over Ethernet (Optional)

Power is supplied via IEEE 802.3af/at or Cisco ILP

2. VLANs Learned via CDP or LLDP

Voice and data VLANs communicated via CDP/LLDP

3. IP Assignment via DHCP

The phone sends a DHCP request in the voice VLAN; the response includes an IP and DHCP option 150

4. Configuration Retrieved via TFTP

The phone retrieves its configuration from one of the TFTP servers specified in the DHCP option

5. Registration

The phone registers with the call server(s) specified in its configuration

Signaling Protocols

ITU-T H.323

Originally designed for multimedia transmission over ISDN; mature and widely supported; peer-to-peer call control

Session Initiation Protocol (SIP)

Text-based, similar in nature to HTTP; defined in RFC 3261; peer-to-peer call control

Media Gateway Control Protocol (MGCP)

Employs centralized call control; defined in RFC 3661

Skinny Client Control Protocol (SCCP)

Cisco-proprietary; limited support on gateways; centralized control

Calculating Required Bandwidth

G.711/Ethernet Example

Codec Payload (Bitrate × Sample Size)	64 Kbps × 20 msec	160 B
L2 Overhead	Ethernet (18) + 802.1Q (4)	+ 22 B
L3 Overhead	IP (20)	+ 20 B
L4 Overhead	UDP (8) + RTP (12)	+ 20 B
Packets per Second	1000 msec / 20 msec	× 50 pps
Total Bandwidth		88.8 Kbps

Access Switch Port Configuration

```
interface FastEthernet0/1

! Configure data and voice access VLANs
switchport access vlan <VLAN>
switchport voice vlan <VLAN>

! Trust ingress QoS markings
mls qos trust cos

! Optionally pre-allocate power for the port
power inline static [max <wattage>]
```