# IP Telephony – Where are we today?

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# Technology

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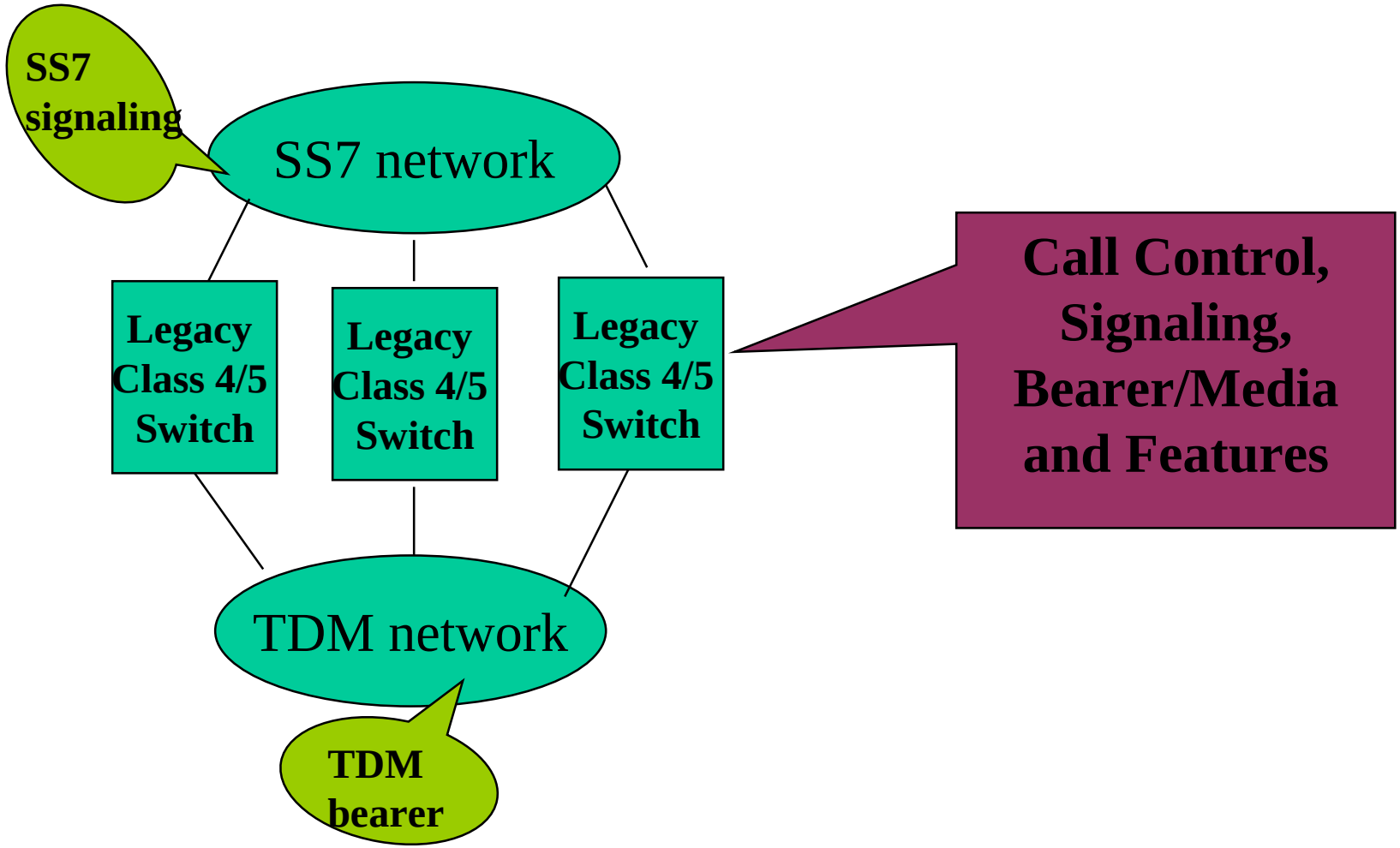
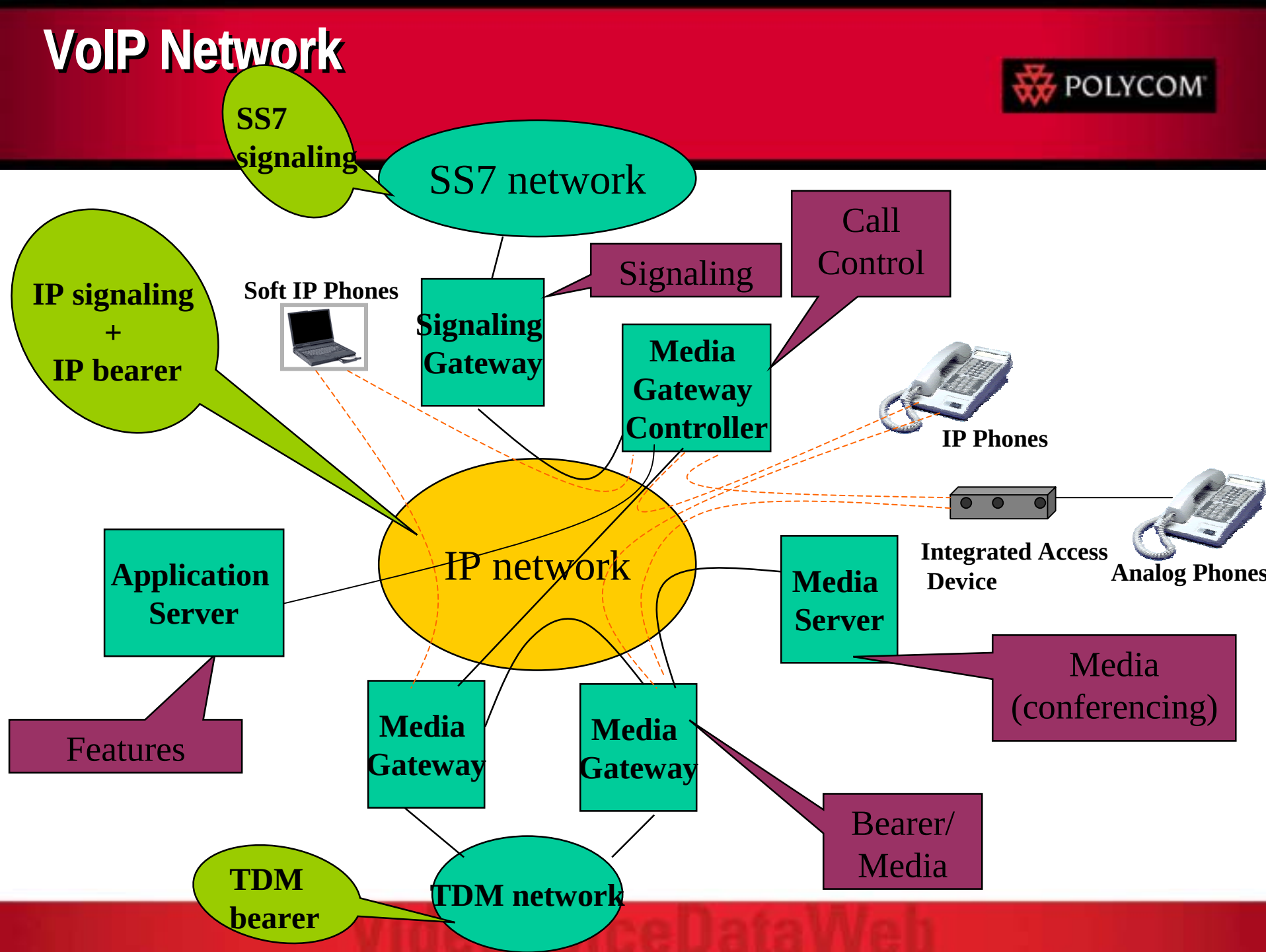
# Brief Introduction …

- Legacy Telephony
  - TDM/SS7 based infrastructure
  - Traditional Class 5/Class 4 switches
- Voice over IP
  - IP-based packet infrastructure for PSTN voice transport
  - Analog voice encapsulated in IP packets
  - New elements that collectively perform traditional telephony functions and more
- And what is IP Telephony?
  - Voice + Messaging + Video + Data over IP networks = IP Telephony
  - Public Internet : Best Effort Service
  - Managed IP Network : SLA based Service

# Traditional PSTN Network



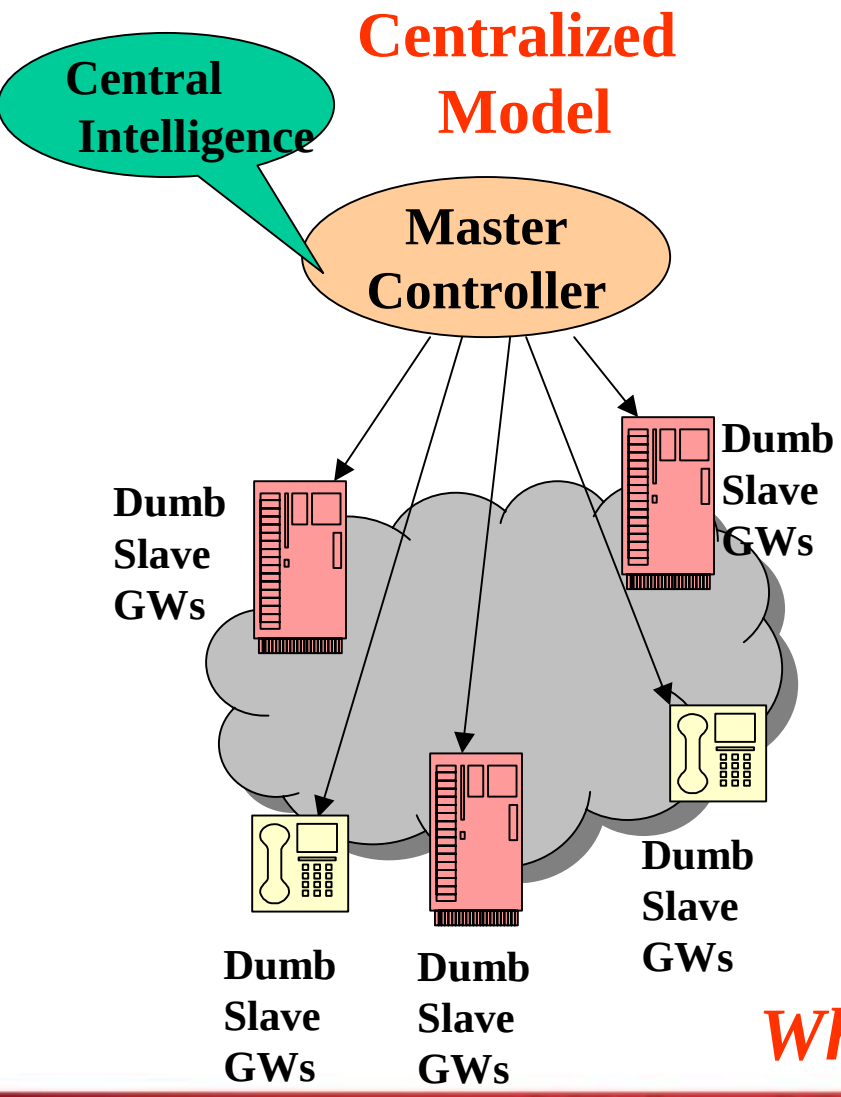
# VoIP Network

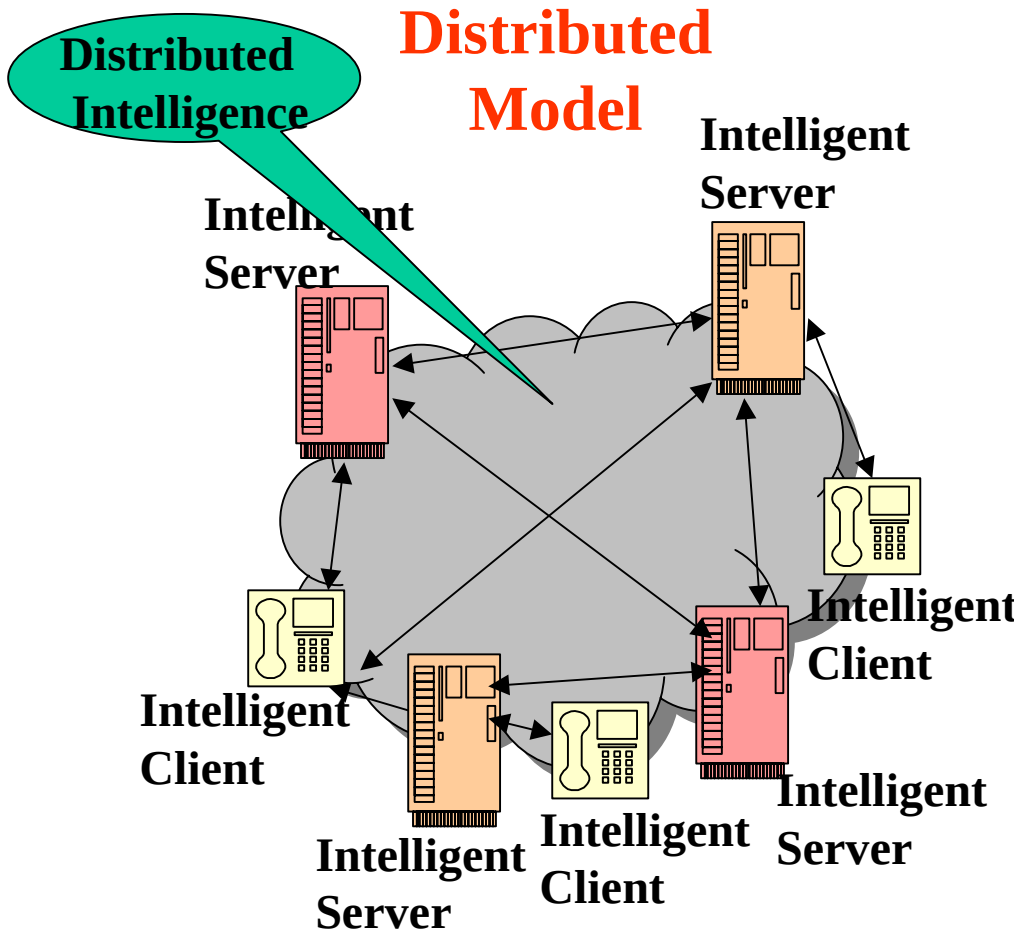


# The Elements ..

- Terminals or Endpoints
  - IP Phones
  - Soft Phones/PC Phones
- Media converter
  - Media Gateway/PSTN Gateway
- Call Processor
  - Media Gateway Controller or Gatekeeper or Proxy Server or Softswitch
- Signaling Gateway
- Application Server
- Media Server

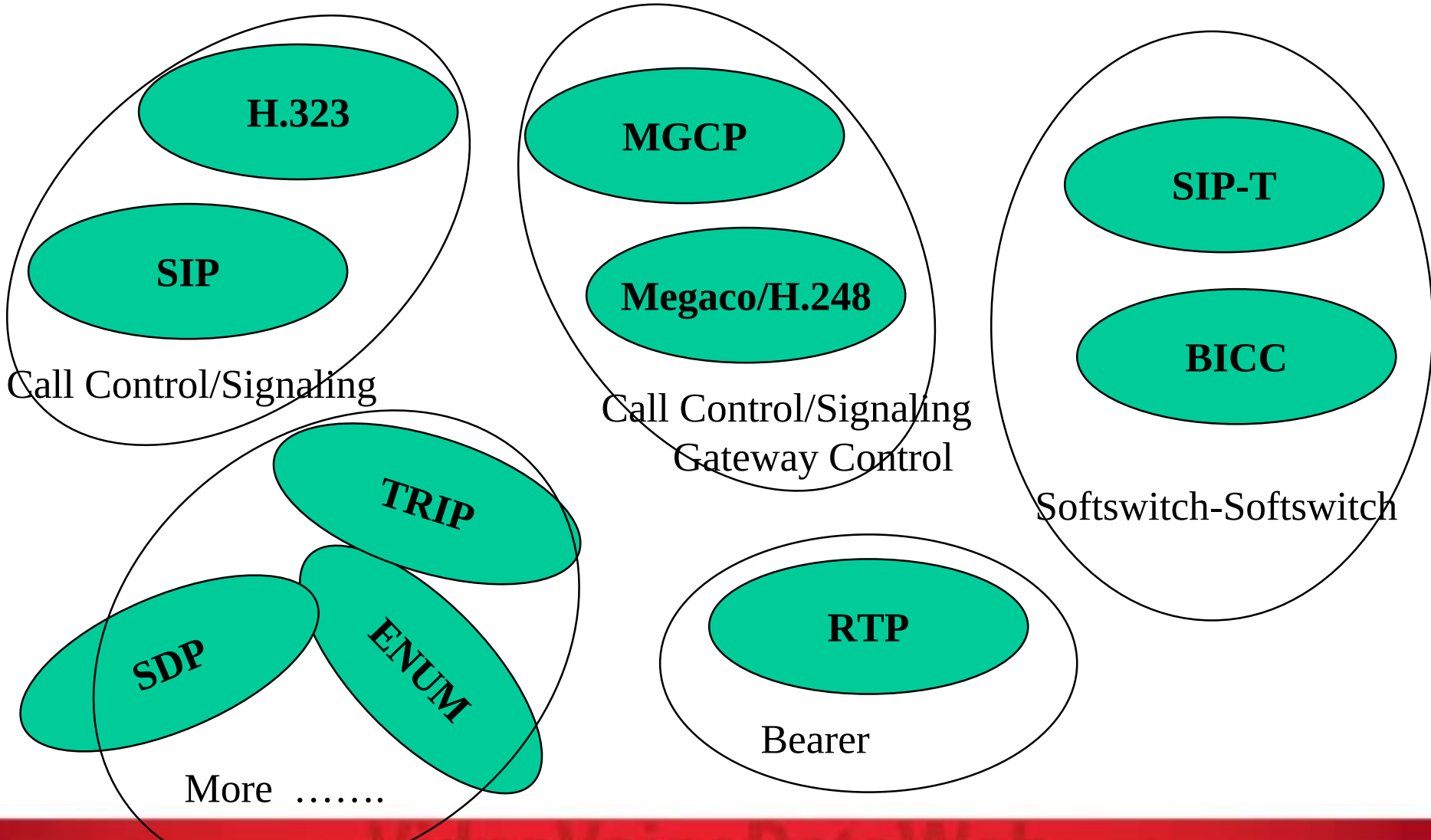
# Network Paradigms




*Which paradigm suits your network?*

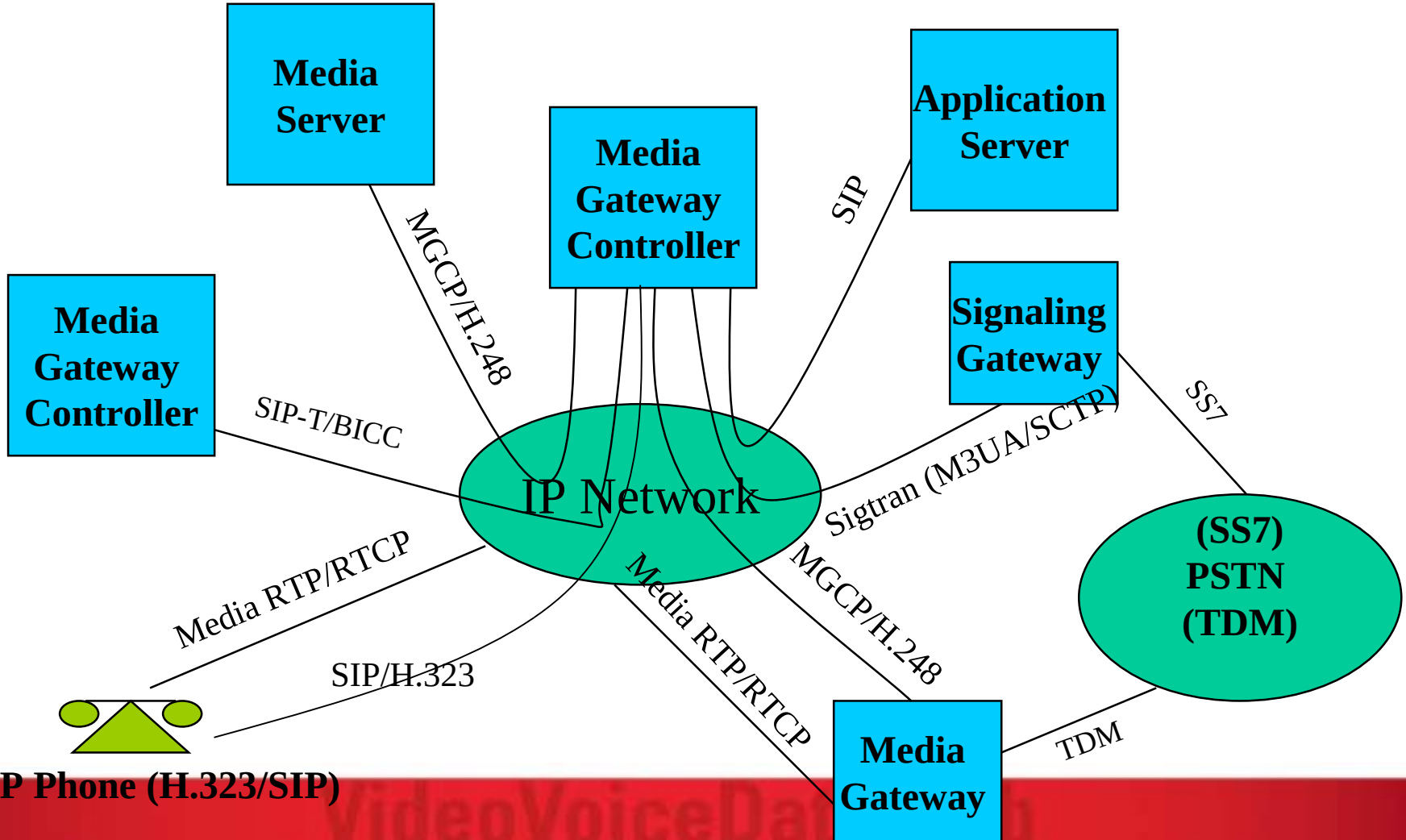
# IP Telephony Protocol Soup



# Putting All Ingredients of the Soup together !

*Protocol selection is a strategic decision. Depends on existing network and future services planned*

*Ultimately, one winner will make it easy for all !*



# Performance Challenges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# IP Telephony Performance Challenges

- Need to engineer network appropriately for good quality IP Telephony services (voice, video)
  - Adequately provisioned core with proper traffic and congestion management methods
  - Sufficent bandwidth in the access
    - Video is a bandwidth hog. Require about 384 kbps for a good quality video connection
  - Reliability/Availability
    - ~ 99.999% availability through implementation methods yielding Redundancy, Resilience, Survivability, Robustness

# IP Telephony Performance Challenges

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- Network requirements for high performance
  - Coding Algorithms: what codec, what bit rate?
    - Greater the compression, more the encoding delay
    - Determine appropriate packetization times and packet length
  - VAD and CNG (for voice)
    - At the transmitter: Detection of voice activity, silence suppression
    - At the receiver: Comfort Noise generation, Voice playback
  - Latency/Delay
    - Components: Packetization, Propagation, Network Processing, Jitter buffer delay and speech playback delay
    - PLCs add about 5ms-10ms delay in multimedia transmission
    - Impact on perceived audio/video quality
      - Echo (RT delay > 50ms), Talker overlap (RT delay > 250ms)
      - Loss of audio-video synchronization, checker-celled picture, hazy motion

*Latency Benchmark: Toll quality PSTN-like voice: 150ms RTT (ITU G.114)*

*Occasional packet loss is tolerable ; Delay > 300ms completely unacceptable*

# IP Telephony Performance Challenges

- **Jitter**
  - **Jitter = Delay Variation ( *MUST AVOID in multimedia networks!* )**
  - **Jitter Buffer compensates for jitter on the receiver side: Choose optimal size!!**

***Rule of thumb: Jitter Buffer size = atleast 2 x speech frame size***

- **Packet loss**
  - **Packet loss should be < 1% for acceptable quality**
  - **Use Codecs with packet loss concealment algorithms (E.g G.729, G.723.1, H.263/H.264 – built-in PLC; G.711, G.726 - add-on PLCs)**
  - **Packet loss is mostly bursty in nature. Hence, packet loss performance is directly related to packet size, the shorter the better**
  - **Impact on perceived audio/video quality : Clipped speech and distorted image**

# IP Telephony Performance Challenges

- **Transcoding/Tandeming: Parameters to transcode**
  - **Audio codecs (G.729A. G.711 )**
    - **Audio Transcoding: Two or more encodings of a signal through different types of non-G.711 codecs separated by G.711 e.g G.726 to G.711 to G.729A**
    - **Audio Tandeming: Two or more encodings of a signal through same types of non-G.711 codecs separated by G.711 e.g G.729A to G.711 to G.729A**
  - **Video Codecs (H.261, H.263, H.264)**
  - **Bandwidths (128 kbps, 384 kbps, 512 kbps etc.)**
  - **Video formats (CIF, QCIF etc.)**
  - **Video frame rates (30 fps, 14 fps etc.)**
  - ***Every participant must get his optimal capability!!***

***Transcoding increases distortion and delay.***

***Beyond one transcode, network performance drops to unacceptable levels for most codec combinations.***

# Performance: The Key Parameters

- **Quality of Service**
  - **Real time voice/video packets must receive higher priority than non-real time data packets**
  - **Significant delay/jitter events can be avoided only by implementing a proper QoS Strategy**
    - **Best Effort: no guarantees provided**
    - **Overprovisioned Network: Throw Bandwidth**
      - Need to constantly keep upgrading as more and more real-time services are offered. Easy but not the best thing!
    - **Prioritized Queuing**
      - Differentiation in the queuing of traffic for various classes of traffic
      - Assigns a priority or classification to every IP packet
      - packets sent in order of priority
    - **Traffic Engineered Tunnels**
      - Constraint-based (traffic sensitive) connection-oriented paths through a routed network (MPLS Label Path, ATM VC)

***Prioritized queuing with Traffic Engineered tunnels in the core are a must for offering SLA-based IP Telephony Service !***

# Policies

Security

Regulatory


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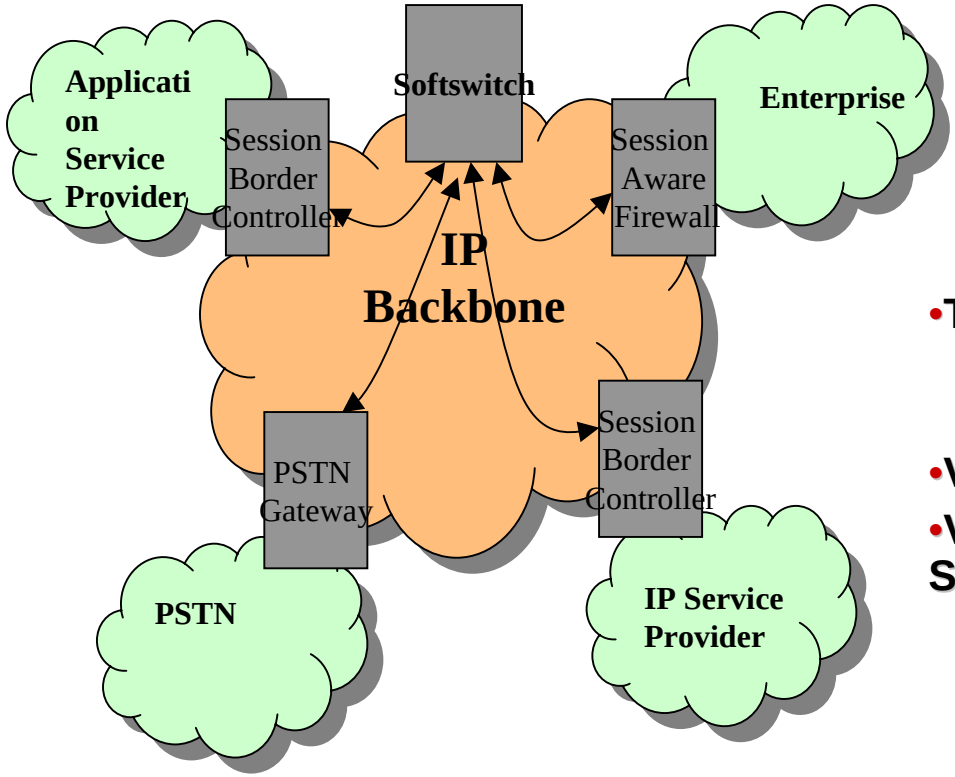
# Security: Issues to Ponder....

- New IP Requirements
  - Viewing voice packets as part of sessions
  - Policies are required for Sessions
  - New IP Services are enabled to handle
    - Routing sessions between different networks, carriers and domains
    - Session packet flow anchoring
    - Detect failures and reroute
    - Usage based Billing/reporting at session flow level
    - Session aware borders for security

# Security: What change is required…

*Need for Session Aware Firewalls!!*
*"Session Border Controllers"*




- VoIP Firewall Traversal Solution for Carrier to Carrier Peering
  - Integrated SIP Application Layer Gateway (ALG)
  - Overcome NAT/NAPT problem
    - Signaling messages exchanged on fixed port; Modify signaling message to permit bearer traffic flow
    - Dynamic 'pinhole' opening/closing
- Topology Hiding
  - Provide an address normalization boundary
- VoIP Media Anchoring Solution
- VoIP Session QoS / Service Level Agreement Solution
  - Per session based policing
  - Guaranteed service in congested environments
- VoIP Session Admission Control Solution

# Regulation

- Numbering Services
  - Rate Centre Association of Numbers
  - Impact on Number Conservation
  - Number Portability Compliance for VoIP providers?
- Information service versus Telecommunications service
  - Access charges at Origination and Termination points?
  - Non compliance of today's "Computer" and "Telephone" to traditional definitions (e.g. PDAs)
  - ENUM – dial an E.164 number to reach any type of endpoint
- CALEA
  - Requires North American telecommunications carriers to modify their equipment, facilities, and services to ensure that they are able to comply with authorized electronic surveillance.
- Availability
  - Available at all times
  - Telephone service available even if power cut - Separate power?

# Regulation

- Countries prohibiting IP Telephony
  - Albania, Botswana, Burundi, Cuba, Cyprus, Kenya, Mauritius, Mexico, Nepal, Pakistan, Panama, Slovakia, South Africa, Thailand, Vietnam, and Yemen
- Countries restricting IP Telephony
  - Hungary (quality restrictions – delay > 250ms and packet loss > 1%, Colombia (too many permits), Paraguay (fax or )
  - India (elaborated in the next slide)
- Countries permitting IP Telephony
  - Australia, European Union, Singapore, Switzerland, USA

# Regulation: India

- Milestone – Deregulation of Telecommunications in April 2002
  - ISPs permitted to offer IP Telephony services
  - PC to PC (anywhere), PC to PSTN phone located outside India, IP phone to IP phone (anywhere)
  - IP Addressing scheme, no E.164 addresses
  - ISP IP Telephony services viewed as non-real time application services to differentiate from offerings of Facility based carriers
    - ISP VoIP based services are not “telecommunication” services and so will not be tariffed
  - Incumbents can also offer IP Telephony services
    - VoIP based toll quality service offered by Facility based carrier, will be tariffed

# Deployment Scenarios

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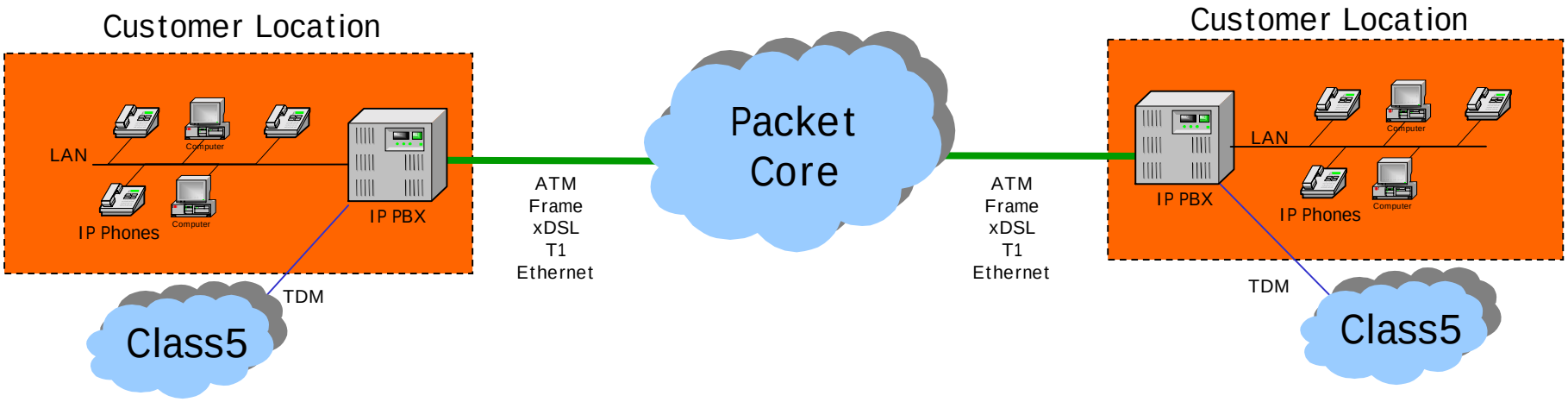
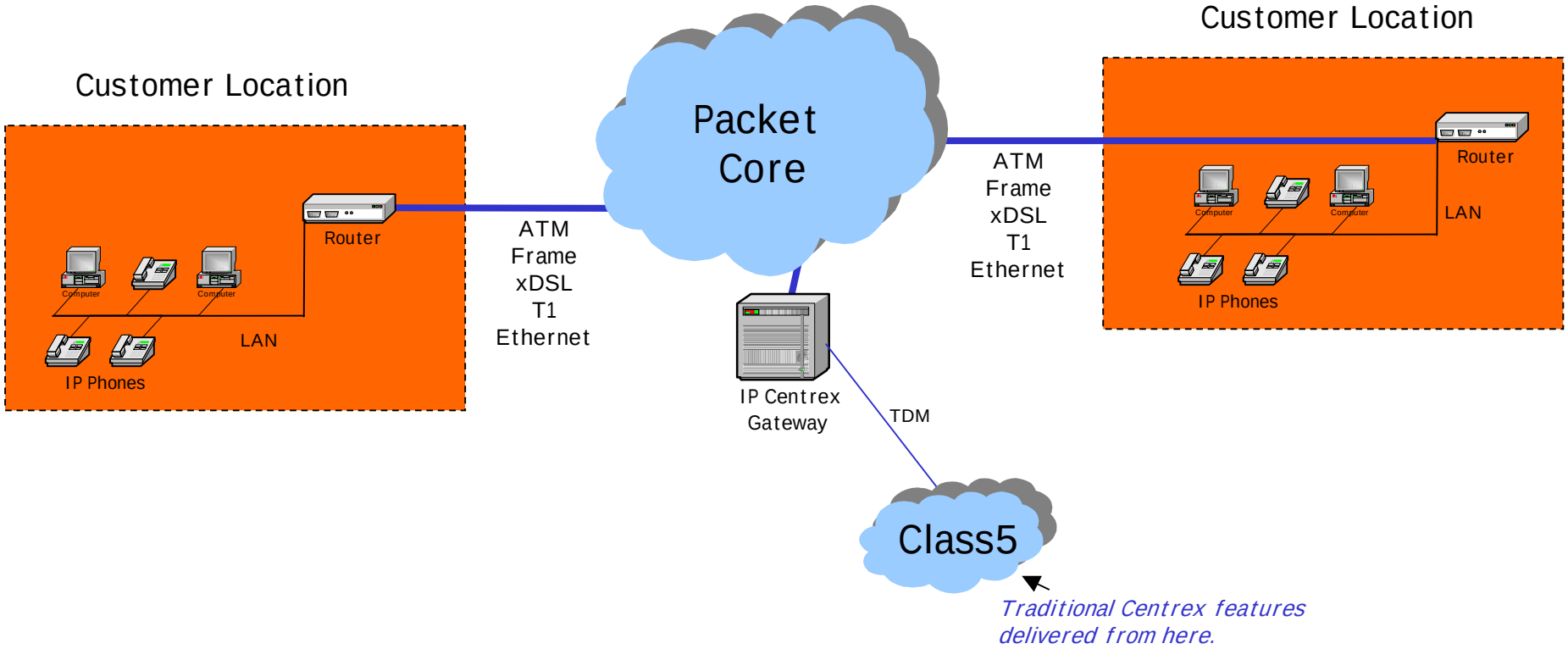
# IP PBX

- **Initially Popular among enterprises**



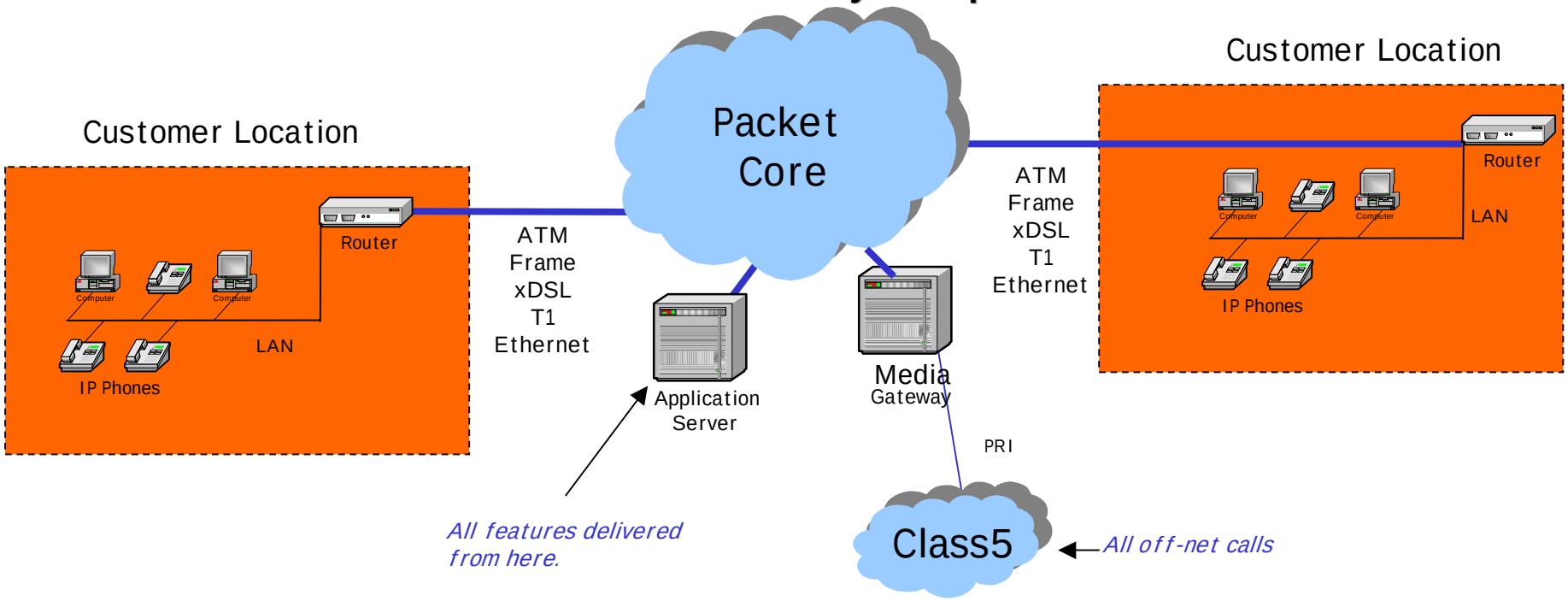
# Traditional IP Centrex

- **Network-hosted solution**
- **Leverages traditional Class 5 based Centrex service to provide Class 5 based Centrex features**

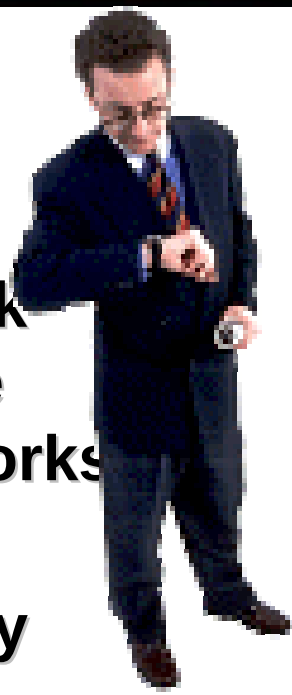


# Enhanced IP Telephony

- **Fast gaining popularity among enterprises, small-medium businesses**
- **Network-hosted**
- **Provides multi-media voice over an IP network, in addition to basic Centrex features.**
- **Increased demand for this service by enterprises in India!**

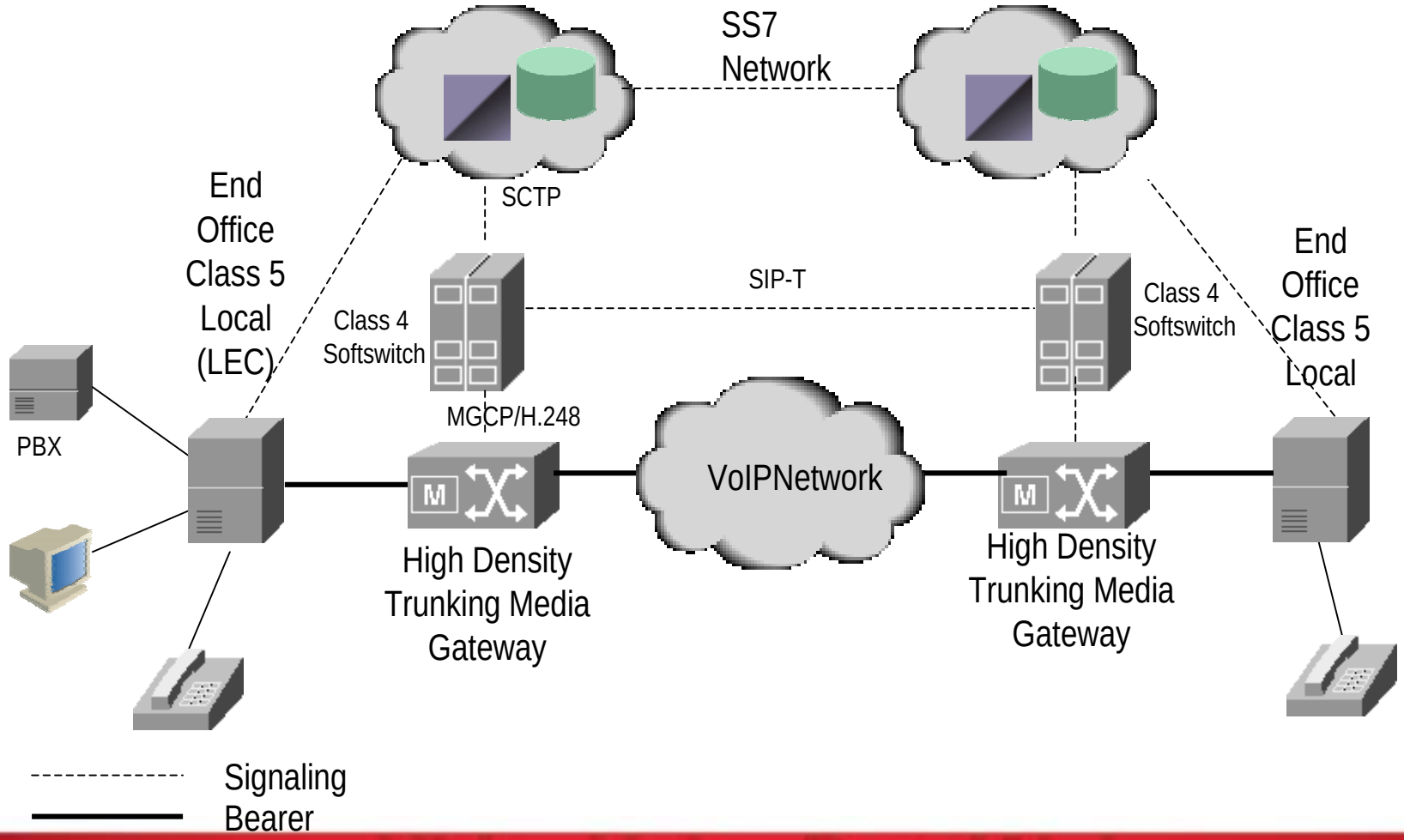


# Class 4 replacement



- ILECs, CLECs, IXCs, Large Corporations
- Benefits
  - By-pass traditional long distance toll network (Class 4) carriers and their per-minute usage rates and run their voice traffic over IP networks for a reduced cost.
  - Lower costs with higher bandwidth efficiency
- Issues
  - Traffic engineering of IP network for PSTN QoS
  - Migration from Circuit to Packet-based Network

# Class 4 Replacement



# Class 5 Replacement

**ILECs, CLECs**

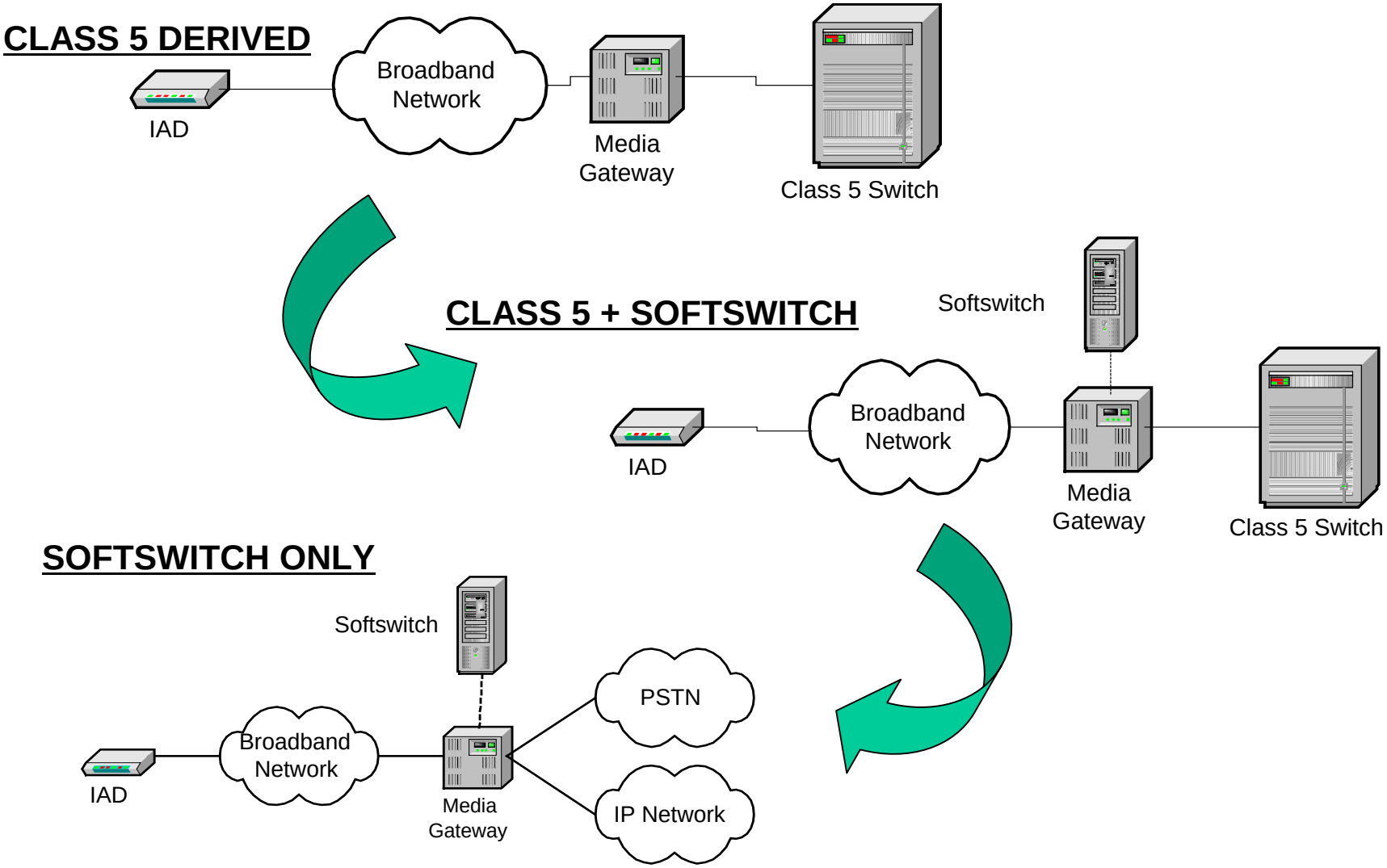
**Benefits**

- **Flexibility - Enable Rapid Deployment of New Services**
- **Distributed Architecture rather than Hierarchical Class Model**

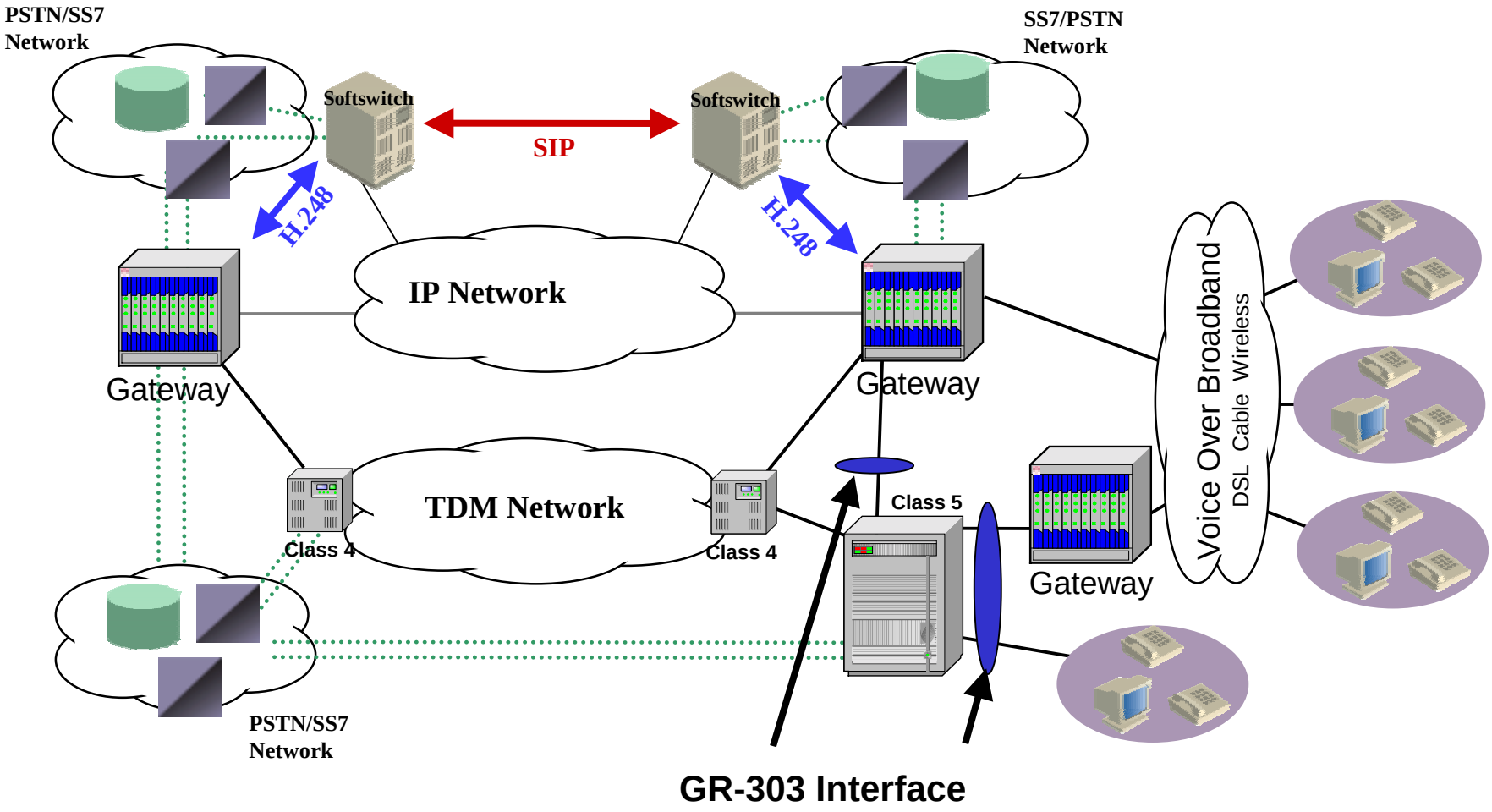
**Issues**

- **Maturity of softswitch technology**
- **Ability to support all legacy systems supported by a Class 5 switch**

# Conservative Migration and Evolution



# Voice over Broadband Network Architecture



# The Indian Scene

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# The Indian Scene..

- A View of some Statistics…
  - Post IP Telephony legalisation in 2002, to-date about 15 ISPs in India have licenses for offering IP Telephony services
  - Voice market in India estimated at ~ 33 crores (330 million)
  - ~ 1.5 million overseas calls are made from India everyday
  - Calling rate to US has fallen from to ~ 20% of 3-5 years ago
- Almost Every Biz doing some form of IP Telephony
  - Corporates/Enterprises incorporating IP Telephones within network (LAN/WAN for intra/inter-office calling) for cost savings
    - Over 100,000 IP Phones have been sold in India across various vendors!
  - Increasing use of Audio/Video conferencing over IP for business communication with colleagues/vendors across the globe
  - Vertical segments like Educational institutions, Banks, Health Sector, Hospitality demanding Audio/Video/Data Collaboration services for E-education, E-consulation etc.
  - Spurt in Call Centres/BPOs has increased IP PBX/Centrex usage

# The Indian Scene..

- Almost every Service provider is trying to get a piece of this revenue
  - Softswitches being evaluated for Class 4/5 functionality
  - IP phones tested for broadband rollout to large/medium/sma businesses and residential customers as bundled offerings
  - Push-to-talk over wireless being implemented
  - Multimedia collaborative services for enhanced communication
  - Value added services like Internet call waiting, Unified Messagin Fax over IP
  - Virtual Call Centres
  - PC penetration in India is low, hence non-PC IP devices being tapped extensively
  - Communication Kiosks (Reliance's webworlds, Satyam's iway) to host value-added IP based services
- Partnerships (e.g. Data Access partnership with Dialpad for IP Telephony services to its customers)