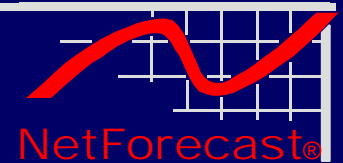


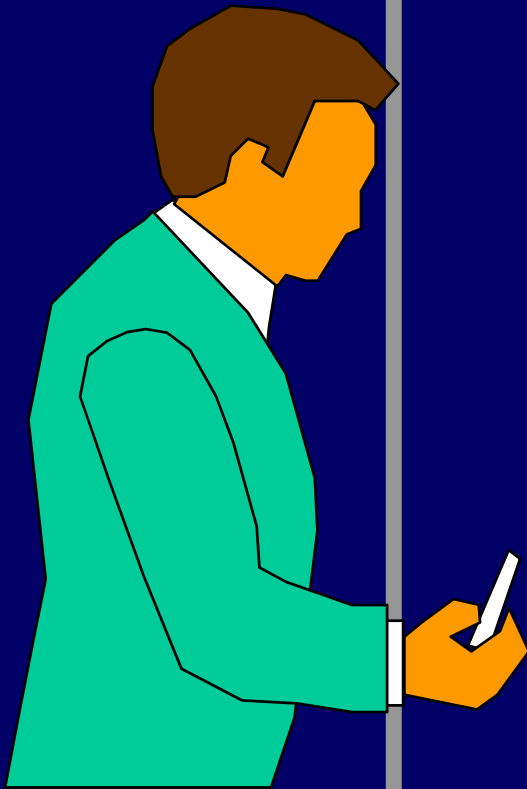
Quality of Service (QoS) and Quality of Experience (QoE)

VoiceCon Orlando 2008



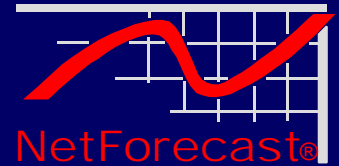
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Agenda



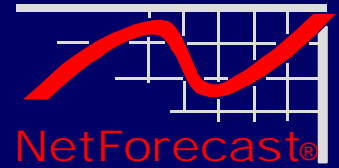
- **Why is real-time traffic different?**
- **The need for QoS**
- **Steps to implementing QoS**
- **Measuring Service Delivery**
- **How is QoE different than QoS?**
- **How is QoE measured?**
- **QoE Enhancement**
- **Q&A**

VoIP Deployment Realities



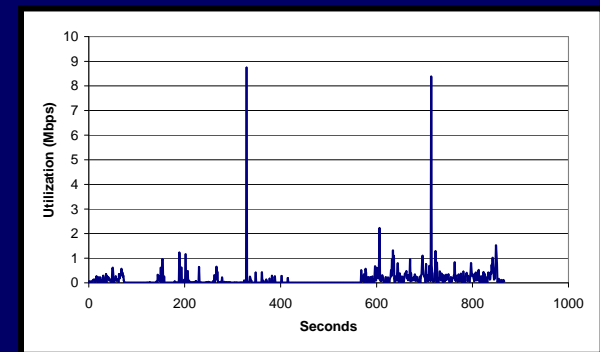
- **VoIP is not just another application**
 - Real-time traffic is different
 - Expectation of reliability and quality is high
- **VoIP is difficult to scale**
 - Need to understand network impact
 - Need careful and complete QoS deployment
 - Need new monitoring methods
- **VoIP needs new monitoring tools**
 - End to end testing is necessary to validate real-time traffic support
 - Legacy data monitoring tools are insufficient
 - Legacy tools average too much information
 - Legacy tools don't test end-to-end
- **Quality of Experience – QoE**
 - Measuring above the network layer
 - Understanding and measuring the experience of the user

Real-Time Traffic is Different!



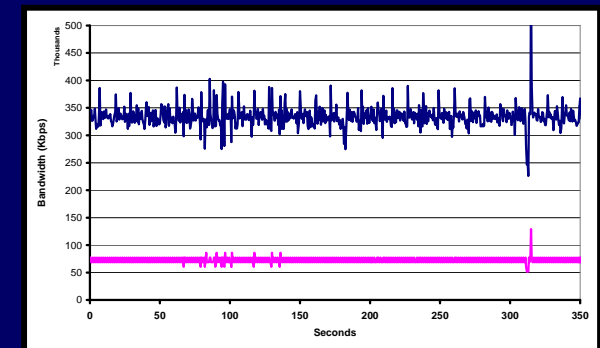
- Data applications focus on moving blocks of info from one computer to another
- Bandwidth use is bursty
- Packet loss is expected, packets are recovered, loss is a part of the bandwidth management strategy (TCP)

Data Traffic

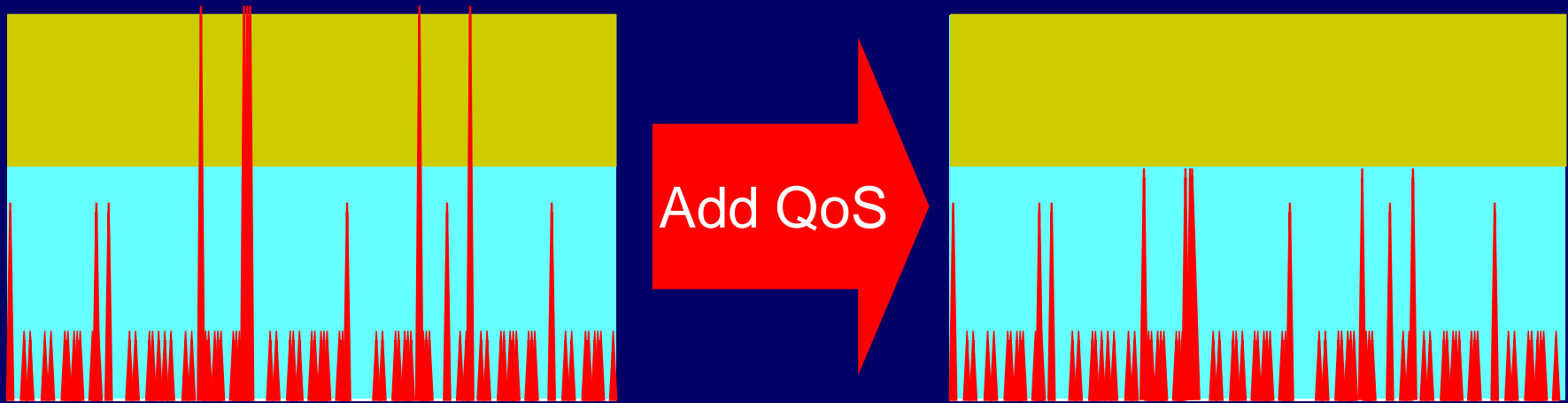


- Voice / Video move a continuous stream of data to recreate an analog event
- Bandwidth use is constant
- Real-time traffic does not recover lost packets, and degrades quickly when packets are not delivered

Real-Time Traffic

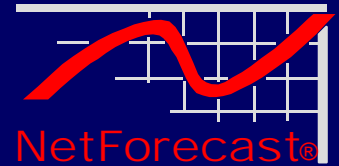


Data and Voice Interference



- **QoS gives priority to the real-time traffic**
- **This holds down the peaks of the data packets, and prevents packet loss and jitter in the real-time streams**
- **This is a critical first step to delivering high quality voice and video streams**

Five Steps of QoS



● Clean up the network

- Implementation problems may be causing packet loss that TCP is covering up
- Bad cables, terminations, poor switches, duplex-mismatch, etc.

● Classification

- Determine the best scheme for marking packets that need priority

● Class of service mechanism

- Enable DiffServ and/or IEEE 802.1p in your networks

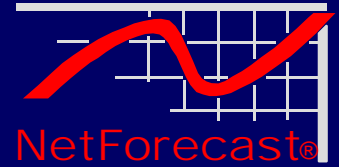
● Bandwidth Management

- Determine the right bandwidth for high priority traffic on each link
- Manage the application so these bandwidths are not exceeded

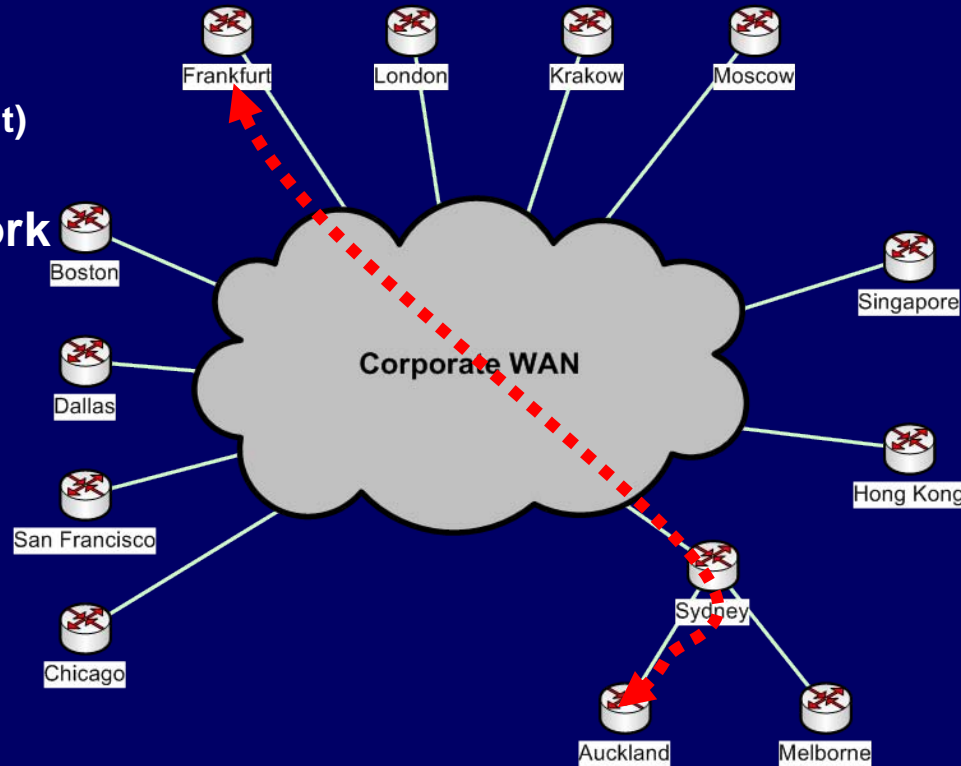
● Testing and Monitoring

- New testing methodologies are needed to watch the network and ensure that it continues to provide high quality transport over time

Measure End to End



- We have to test the network and monitor the call quality to know what is going on
 - Are we delivering the quality voice service we want to?
 - Is the problem with the voice equipment, or the transport?
 - Where and when is the network causing problems?
- Must test from end-to-end
 - Voice is subject to very local problems (echo, local connection, poor equipment) as well as network problems
- Must isolate problems in the network
 - So this call had poor quality, which part of this complex network caused the problem?
- Must find problems in time domain
 - Micro-outages cause momentary burst packet loss
 - Testing or sniffing after the fact has little value

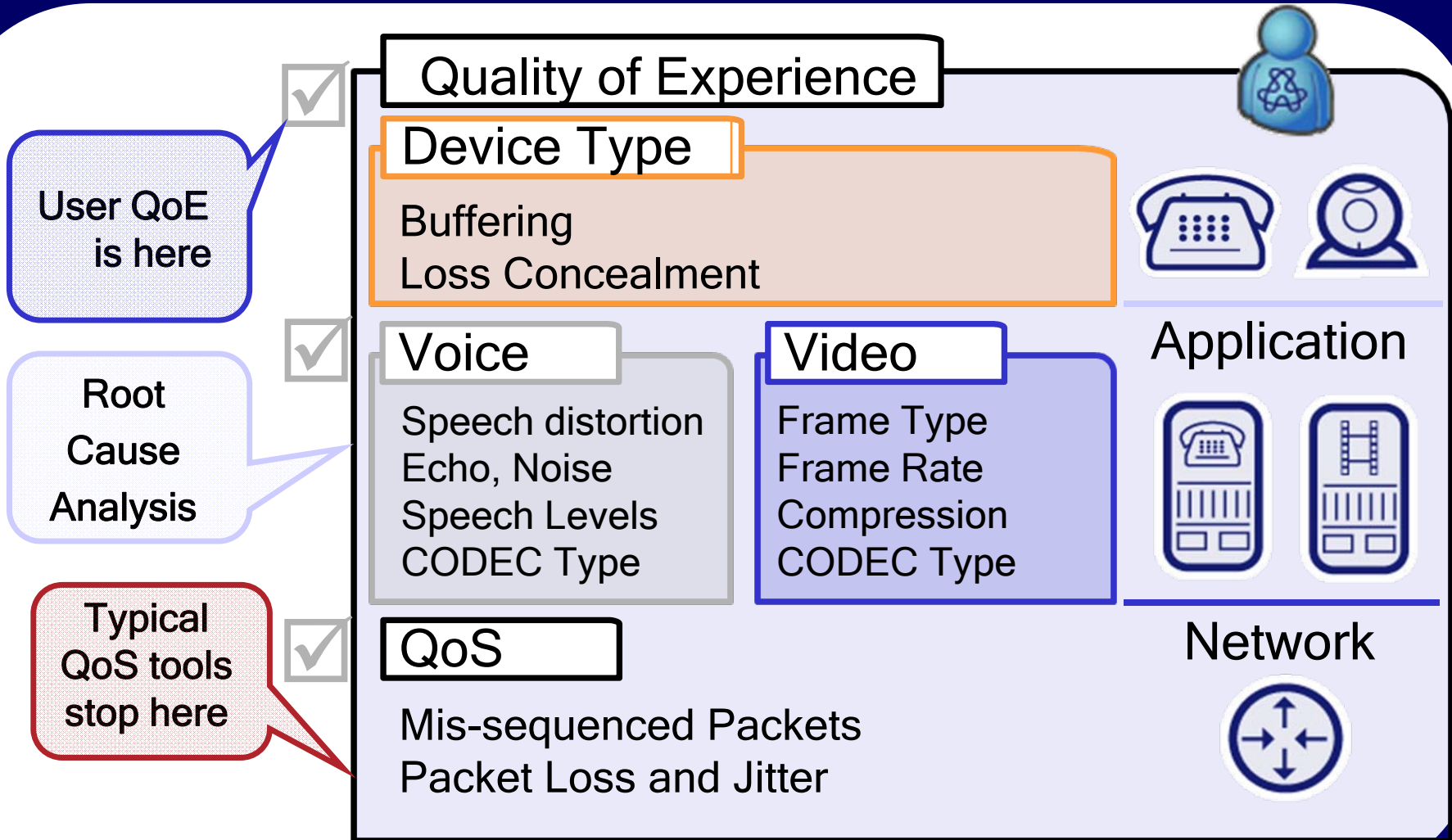


Measuring Service Delivery

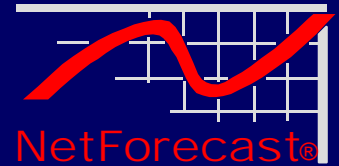
- Implementing QoS correctly will ensure packets are delivered in a timely manner
- But does delivering all the packets ensure that the voice or video quality is what we expected?
- How can we more closely measure the actual user experience?
- User Experience = QoE



What is QoE?

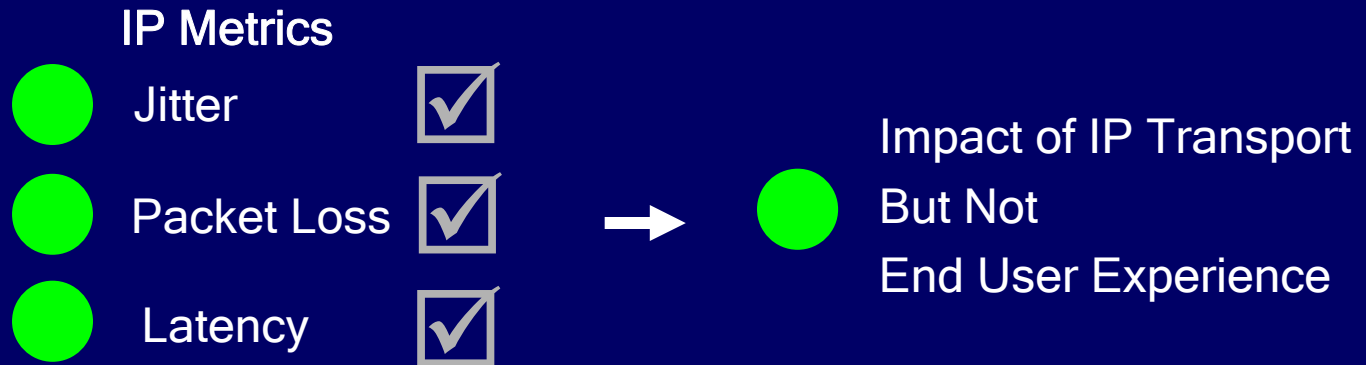


Header and Payload Monitoring



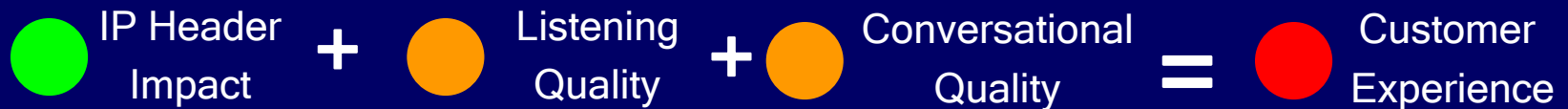
Header

- Monitoring the **HEADER** provides a view of the IP transport impairments introduced. However, measurements must reflect user experience – not just network performance:



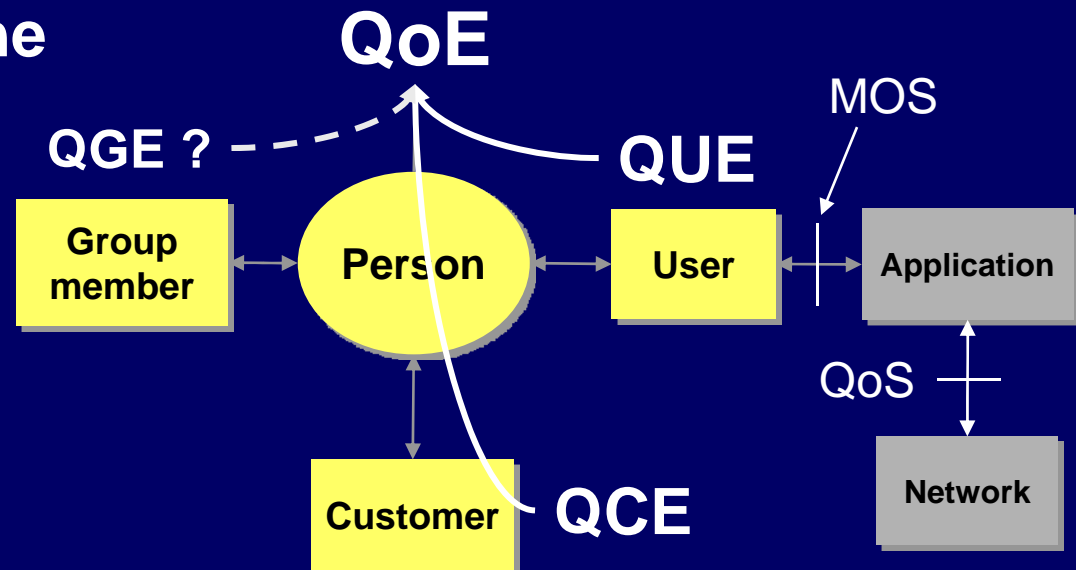
Payload

- Monitoring the **PAYLOAD** and **WAVEFORM** provides an additional and essential insight into the quality of the VoIP service as experienced by the end users:

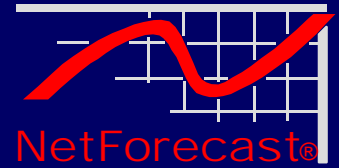


One more view - QoE

- QoS determines how well the network will deliver the packets
- MOS (if done right) is a measure of how well the application delivers sound or images
- QoE is a measure of the user experience in the context of the job he/she is trying to accomplish while using the service



How is QoE Measured?

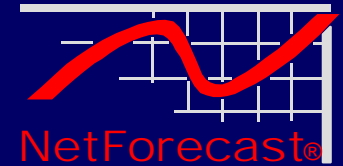


- You can measure it by asking the users who call and complain about voice or video quality

-- OR --

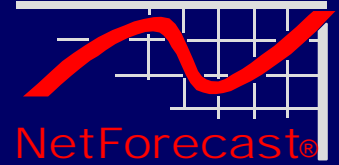
- You can look for vendors who are able to measure the quality of voice and video being transported on your network and be proactive about fixing it
- QoE Standards
 - Standards have been defined by the ITU to provide a consistent way of measuring the expected quality of a voice or video call
 - Useful for comparing measurements between vendors, service providers and across different implementations

QoE Standards



- **Passive Tests – These can be run on actual user calls**
- **IP Network – is the network affecting service quality?**
 - Older tools are based on the E-model (ITU G.107) which was designed as a planning tool
 - New standard (ITU P.564) created in 2006 for passive monitoring of RTP streams
- **Higher level stuff (echo, noise level, speech level, speech distortion)**
- **Speech Distortion**
 - Analysis of the waveform to determine if there is distortion in the speech content
 - Standard methodology described in ITU P.563
- **Speech Interaction (levels, echo, delay)**
 - Measuring echo, delay, speech level and noise level defined in ITU P.561
 - Combining these factors taking into account human perception defined in ITU P.562
- **Active tests – testing in a lab where source and result are both available**
 - PESQ is standard for active voice test quality ITU P.862

More Standards



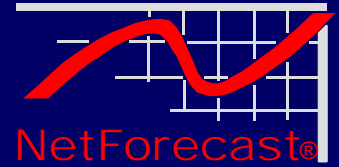
● Video QoE

- PESQ equivalent is J.144 (ITU), work being done to extend this through VQEG group
- Passive methods available thru vendors, but not yet standardized

● Data Application QoE

- Apdex – Consortium of vendors and enterprises standardizing how data applications are measured and reported
- Based on measuring user task time
- Specific algorithm for aggregating results and accounting for long tail performance
- Over 700 enterprise members
- www.apdex.org

How do I fix it?



● Improve Network Transport

- Clean networks (!) (congestion, misconfig, rogue firewalls, CAT 3)
- QoS implementation (get it right!)
- Packet loss concealment
- Forward Error Correction (FEC)
- WAN Optimization / Acceleration

● Improve Application

- Minimize recoding
- Wideband codecs
- Headsets / speaker phones
- Better Codecs

● Improve the Environment

- Acoustics
- Sound absorption
- Ambient noise
- Lighting (video)
- Paint colors