

revised AVC 714 as it will be going to the ATM Experts meeting (LAN VII

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LAN	Local Area Network
MIPS	Million Instructions Per Second
MM	MultiMedia
MOS	Mean Opinion Score
NGBW	Non-Guaranteed Bandwidth
PDU	Protocol Data Unit
QOS	Quality of Service
WAN	Wide Area Network

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BACKGROUND

There seems to be one fundamental reason why ISO-ethernet and "guaranteed bandwidth" solution are preferred over "other LANs" - namely that a perception exists that the ITU-T should recommend a "good quality" solution with a high level of reliability and evenness of operation. Since most types of LANs can never, even in a switched mode, assure a 100% bandwidth guarantee since there is always the possibility of delay due to a long packet or group of packets from some other application, a perception exists that "non-guaranteed BW LANs" are not a suitable subject for ITU-T recommendations.

On some level this is a methodological issue relating to a common understanding of what the ITU is and what kind of things the ITU should recommend. Our perception is that the technical "agreement" against "non-guaranteed BW LANs"(henceforth to be called NGBW LANs) is based on the above plus one other point, namely that a LAN connected to ISDN via a gateway could not meet some network echo standards. The nature of this possible problem requires further examination. We also note that the ITU-T must take a world-wide view, and it may not be appropriate to work toward the most restrictive regional standard.

WHY STANDARDIZATION?

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Here are some reasons for an ITU-T H.32? on NGBW LAN standard:

1. The vast bulk of LANs in use are of the NGBW variety, and the GBW variety will play only a small role in the market for the next several years. Specialized LANs such as iso-ethernet that offer GBW will probably be eclipsed by ATM systems over a 5 year timeframe. Thus, if the ITU recommendation is to have any large-scale significance, it must address the existing LAN networking infrastructure; not to do so is to make the ITU's efforts less generally useful, and not in the same direction as the marketplace.
2. If LAN/WAN gateways for MM are not standardized, a variety of proprietary solutions will result. In all probability, H.320 will be the basis of WAN interoperability, but on the NGBW LAN some other coding will be used, with the goal of minimizing the MIPS used to implement the video/audio coder. This will require re-coding in the LAN/WAN gateway, which could add significant delay, result in video quality degradation and increase the cost of the LAN/WAN

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gateway. This delay will result in a poor quality of service for NGBW LAN MM users connected to WAN endpoints, which is not desirable from the ITU-T's point of view. Even if some LANs use H.261 coding and thus avoid the delay, the customer may still be faced with wide variance of delay on LAN/WAN calls. A major goal of LAN/WAN gateway standardization is to avoid these QOS problems, and in doing so, increase the total MM market. In addition to the problems mentioned above, the use of various multi-media protocols that are not operationally compatible may cause user confusion, and result in a very limited level of interoperability.

3. At the core of the objection to standardization of MM on NGBW LANs lies the notion that since a particular QOS cannot be assured, there is no value in having an ITU-T recommendation. This logic does not seem generally applicable to ITU-T recommendations. For example, the speech coders specified in G.711 and G.728 offer different QOS levels under nominally error-free channel conditions. The advantages of

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G.728 (low bit rate) outweigh the additional complexity and slight loss of quality. The actual QOS of both codecs will degrade as digital channel impairments increase, so neither codec specifies a constant QOS, only an upper limit on QOS.

There is a clear parallel among the LAN proposals. The QOS for NGBW LAN will likely be lower than the QOS for GBW LANs under the nominal channel conditions for which they are designed. However, the advantages of wide applicability for NGBW LAN systems may outweigh the loss of quality. Again, the actual QOS of both systems is dependent on the digital channel impairments and/or LAN conditions.

It should also be noted that H.32P will not provide the same QOS as H.320, yet H.32P is being recommended by the ITU-T to address an existing infrastructure not addressed by H.320.

4. The NGBW LAN technology is undergoing rapid evolution, specifically in the direction of switched, full-duplex, and higher-bandwidth operation, along with micro-segmentation. These trends, while not providing GBW on the LAN, greatly increase the QOS offered to MM applications on the LAN. An ITU-T recommendation can take note of such trends by specifying that a minimum quality of service must be present for the NGBW recommendation to provided an acceptable MM QOS. The

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use of QOS requirements in the ITU-T recommendation can be used to exclude heavily loaded 10Mbit/sec ethernet as appropriate vehicles for MM traffic.

FOCUS OF ITU LAN WORK

The focus of ITU standardization is on WAN solutions using the public network. Thus, an Internet protocol based on RTP/RSVP is not an area that the ITU-T should pursue since it involves a private network. Instead, the natural domain of ITU-T activity is that LAN/WAN gateway and any QOS issues that must be met for the LAN/WAN interface to be successful. By implication, this may require a specification of what protocol the LAN must present to the LAN/WAN gateway for QOS requirements to be maintained.

DISCUSSION OF QUALITY OF SERVICE ISSUES

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The approach we suggest to NGBW LANs requires that:

1. A QOS metric(s) be defined that are required of the NGBW LAN, such that, when used with the H.32Z endpoints and gateways, a given MOS for audio/video will result. Thus, the MOS for H.32Z endpoints will be defined relative to a common audio/video benchmark.
2. An audio/video benchmark must be established as a quality objective, so that MOS reductions can be measured relative to this benchmark. A reference embodiment of an H.320 terminal is a possible starting point. It is recognized that agreeing on this reference embodiment may prove difficult.
3. It is understood that the MOS for H.32Z/H.22Z over NGBW LANs will not be the same as, and indeed will probably be lower than, the MOS for H.221/H.320 over GBW LANs or ISDN, just as we would expect a lower MOS for H.32P/H.22P endpoints using the PSTN network.

Please note that MOS scores from subjective tests do not have a meaning in an absolute sense. They only have meaning when they are specified as a difference from the MOS score of some recognized quality benchmark, such as G.711 for speech. The benchmark system is more complex for video MOS, since video quality is highly dependent on the source material when sources are unrestricted (still talking head to MTV). The concept of video benchmarks is in the process of being developed in some regional standards bodies, but it is not widely used in the ITU, mainly because the ITU-T recommendations specify only decoders.

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It also should be noted that MOS is not a complete measure of quality, and should be used with care. It may be appropriate to define other quality of service metrics to be used in addition to MOS. To illustrate this point consider a comparison of G.728 and G.711. Due to a very stringent set of requirements and an extensive testing process it is known that G.728 is "toll quality," which is to say that it is robust for a lot of the CPE and/or network applications for which it could be used. MOS alone doesn't provide this information; another 16 kbit/s codec (other than G.728) might very well give a higher MOS than G.728 -- but that wouldn't make it better. In fact, even if only one point-

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to-point coding were to be done (i.e. excluding tandeming considerations), G.728 could still be better because it was tested over a wide range of input levels, different speakers, and noise conditions.

The following terms will be used in discussing NGBW QOS issues:

1. LAN/WAN gateway: a device that connects a NGBW LAN to a ISDN or other digital network that is connection oriented and has guaranteed bandwidth.
2. Local LAN: The LAN equipment that is between the endpoint and the LAN/WAN gateway, and over which LAN QOS is measured. Note that this may include a router, bridge, or switch, so long as the QOS metric is met.
3. Average Packet Delay (APD): Over a N minute interval, the average packet delay.
4. Maximum Packet Delay: Over the course of a call, what is the maximum packet delay. This will define the worst case situation that H.32Z must handle.
5. Packet Loss Ratio (PLR): Number of packets lost over a M hour interval.

The methods used for achieving the LAN QOS are beyond the scope of standardization, but a few are mentioned here:

1. Controlling the data driver window size, so a blast of in/out bound data traffic does not create a significant momentary delay.
2. Invoke a mechanism within the Etherswitch (e.g. fast bridge, router, or regular bridge) for the duration of the call to expedite all real-time packets from/to that end station. RSVP is an example of such a capability.

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3. The use of a mechanism to get the real-time traffic out of the shared media environment ASAP and onto a deterministic path, or a semi-deterministic path such as a pool of high-priority packets.

SUGGESTED ITU-T DIRECTION #1

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Instead of defining LAN MM protocols per se, the ITU recommendation H.320 would simply describe a generic LAN/WAN gateway and place a set of QOS metrics on the device. In particular, end-to-end delay would be limited to a value that excludes any transcoding (e.g. 300 msec) in the LAN/WAN gateway, and delay would be defined as terminal to terminal, not gateway to terminal. In this vision, there may be no need for an H.32Z that deals with NGBW LANs.

The following three cases would need to be considered in specifying an end-to-end delay requirement, with the possible consideration that the requirement might be tighter for the LAN/LAN case:

1. LAN/WAN(one endpoint on the LAN, one on the WAN).
2. LAN/WAN/LAN(both endpoints on LANs with a WAN in the middle).
3. LAN/LAN(both endpoints on LANs, with no WAN in the middle).

This approach would hopefully limit the amount of transcoding undertaken in LAN/WAN gateways without the need for a detailed protocol specification. LAN/WAN operations involving transcoding should be explicitly marked as being "for further study."

A significant issue with this approach is that it limits the scope of standardization, and thus of interoperability to the WAN environment. We can be certain that some manufacturers will pursue de facto standardization of the endpoint to LAN/WAN gateway interface.

SUGGESTED ITU-T DIRECTION #2

This position could be taken instead of, or in addition to DIRECTION #1. In it, H.32Z is transmuted into a description of a LAN/WAN gateway, including the following parts:

1. An overall requirement of H.320/H.32Z interoperability.

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2. QOS requirements for the LANs, including average and maximum delay per packet, and perhaps jitter. This

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should exclude heavily loaded non-switched LANs in a generic fashion, and place the burden on the customer to provide a proper MM environment in a fashion of their choosing.

3. A multiplex for LAN operation, perhaps similar to RTP. This protocol would have facilities(i.e. timestamps) for dealing with the type of problems typically found on LANs, such as sudden long packet delays. It might also be similar to the H.32P multiplex.
4. Low MIPS audio protocols, perhaps taken from the H.32P world, that are compatible with H.320 standards, if possible, in addition to G.711 and G.728. Note that audio transcoding in the LAN/WAN gateway may be acceptable if the added delay is minimal. Generally, audio transcoding requires on the order of tens of milliseconds. This allows for the possibility of using a very low bit rate H.32P audio coder on the LAN, and transcoding to G.728 or G.711 in the LAN/WAN gateway. Alternatively, the LAN audio coder can be selected to minimize MIPS required in the endpoint.
5. A requirement for echo cancellers in the gateway to meet network echo requirements, if found to be useful.
6. A description of PDUs for call signaling over the LAN(see AVC 696 as a possible basis).
7. A set of PDUs for implementing an adaptive virtual busy. Several specific signals that are needed include:
 - +o H.221/H.230 BAS signals that the LAN/WAN gateway will use to inform the WAN endpoints of network congestion. This is essential so that the user holds the network and not the standard accountable for any quality degradation that does occur.
 - +o Procedures for determining that the LAN is too loaded to support an additional MM call, and for returning a busy signal to the WAN endpoint.
 - +o Procedures for determining that the LAN is too loaded to support an additional MM call, or that the LAN/WAN Gateway is too loaded to support an additional MM call, and for returning a busy signal to the LAN endpoint.

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+o Procedures for noting increasing LAN congestion during a call, and returning appropriate messages to users so that, once again, the network is held accountable for the degradation and not the endpoint or the protocol. A message such as "Your call is encountering network congestion, and quality cannot be maintained" would be appropriate.

8. An end-to-end delay requirement that excludes transcoding in the gateway.
9. A description of how a video rate reducer(see AVC 689) could be used to increase MOS for a given LAN QOS. The general notion is that the multiplex would have some facility for noting increasing packet delay, and would respond with automatic bit-rate reduction to reduce LAN load while maintaining frame rate.
10. A discussion of the MOS that could be expected from the system, including the gateway, if the underlying LAN meets the specified QOS level. It is known that if the LAN does not provide the specified QOS level, then the overall MOS specification in H.32z will also not be met.
11. Procedures for multipoint operations are envisioned using (1)point-to-point links and an MCU, and (2)multi-cast by the LAN/WAN gateway on the LAN. The protocol developed should support both possibilities.

The hope in such a more elaborate approach would be to move the boundary of standardization back from the LAN/WAN gateway interface to the public network to the workstation/gateway protocol, allowing endpoint multimedia protocol software from different manufacturers to interface with a variety of LAN/WAN gateways over various LANs. It should be noted that interoperability between endpoints on the same LAN requires a common underlying LAN protocol in addition to the H.32Z equipment. H.32Z will contain a definition of an interface between the H.32Z equipment and a generic set of LAN protocols.

EXPERIMENTS TO BE CONDUCTED

A quantification of what MOS can be expected using H.22Z for a LAN with a given QOS needs to be made. This requires a standard method of measuring LAN QOS such as is provided by RTP (AVC 649), combined with a method of supplying an arbitrary LAN QOS to the H.22Z layer so that the resulting MOS can be evaluated. After this, a discussion needs to be

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held concerning the LAN QOS values to be included in the recommendation.

CONCLUSION

This document has attempted to outline a different path than that taken to date with H.32Z. Since there is a considerable amount of work required to complete this outline, it is probably unrealistic to cover NGBW LANs in H.32Z. We suggest that the H.32Z effort be split into two parts, H.32Z.1 to focus on GBW LANs, and H.32Z.2 to focus on NGBW LANs, with an associated H.22Z and H.24Z (note that this might well be the same as H.24X, which will be used for ATM and PSTN).

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