IEEE 802.11

TIME BASED SERVICES - QOS REQUIREMENTS ON A WIRELESS LAN

Robert S. Crowder
SHIP STAR Associates,Inc
36 Woodhill Drive, Suite 19
Newark, DE 19711
(302) 738-7782

At least four major users of Time Based Services (TBS) have been identified by the IEEE 802.11 surveys of User Requirements:

S1. Voice
S2. Video
S3. Industrial automation - monitoring and control
S4. Multi-media - not discussed further

UNDERLYING DATA TRANSFER REQUIREMENTS

These services all provide for "faithful reconstruction" and possibly alteration by feedback of natural processes (S1=speech, S2=live-action color & audio, S3=chemical reactions & robotic/machine motions, etc.)

Thus it not surprising that the general form (model) of Quality of Services (QoS) needed is quite similar for each of these services. Naturally the specific (numerical) requirements are determined by the characteristics of the underlying natural process, the "reconstruction faithfulness" required by the ultimate user (S1=human, S2=human, S3="control computer"), and the sophistication of the sampling, transmission and reconstruction equipment.

Both speech Encoding/reconstruction and the Video formats in major geographic areas (North America= NTSC) are well known processes,with standardized data transmission requirements, which I will call Underlying Data Transfer requirements.

QuS1 = ~4 Khz at 8? bit quantitization or ~ 64Kbs (ISDN Voice)

QuS2 Broadcast (non compressed) = ~70 frames/sec = 6Mhz (NTSC)
QuS2 Freeze Frame (non compressed) = ~0.2 frames/sec = ~20 Khz

QS2 illustrates the impact of the ultimate user's requirements on the required bandwidth and QoS.

Industrial processes have widely varying natural periods (10+Hz for many mechanical motions to 1/25,000 Hz for some liquid tank filling processes). In addition, current sampled data control algorithms do not allow for local buffering at the data source. This may be because the number of industrial processes precludes exhaustive study as was done for speech compression.

QoS3 Mechanical = 100 samples/sec as 40 bits (IEEE 754 + Status) = 4 Khz
QoS3 Liquid = 0.1 samples/sec as 40 bits = 4 Hz

The "ultimate user" data rates given above do not account for the overhead of WLAN operation. —.

These requirements can be further expanded and clarified in terms that are directly meaningful to WLAN operation:

TBS QOS MODEL FOR WLANS

Q1. Assured Bandwidth for transfer of variable values via the WLAN.

The most fundamental requirement is that roughly 10 samples/cycle of the highest frequency significantly present in the natural signal must be sampled and conveyed. (This compares to the theoretical Nyquist criteria of 2 samples.) If local buffering is allowed by the reconstruction algorithm and ultimate user, then the rate of transmission opportunities can be reduced proportionately.

If compression is allowed by the reconstruction algorithm and ultimate user, then the transmitted data rate can be reduced proportionately.

Q1S1 = 64 Kbs bandwidth

Q1S2Br = <= 50 Mbs

This service (un-compressed, Broadcast quality video) is obviously outside the scope of WLAN. It is provided by dedicated bandwidth on Broadband LANs along with 802.3 & and 802.4 in separate frequency bands.

Q1S2FF >= 160 Kbs

Q1S3M <= 160 Kbs

Q1S3L >= 0.160 Kbs

Q2. Regular (Cyclic) Media Access for timely reconstruction of or control actions on the variable.

The samples of the variable must be conveyed at regular, cyclic periods that allow "faithful, timely reconstruction.

Q2S1 = Transmit opportunities every ~100 ms

Q2S2FF = Transmit opportunities <= every 2/N sec
(to allow for limited data frame size) & complete video frames each 2 secs.

N= data frames per video frame

Q2S3M = Transmit opportunities >= every 10 ms

Q2S3L = Transmit opportunities <= every 10 sec

Q3. Acceptable levels of Jitter between transmission opportunities to allow "faithful" reconstruction or control action.

This requirement only applies when the reconstructed variable will be used in "real time". The jitter allowed is proportional to the user's sense of time. Normally jitter can be about 20% of specified time between Transmit opportunities.

Q3S1 < 20 ms

Q3S2FF - video frame jitter <= 0.2 sec

Q3S3M >= 2 ms

Q3S3L <= 1 sec

Q4. Discard of "Late Data"

None of the reconstruction or control algorithms for the TBS are designed to cope with data that arrive out of order or significantly beyond the designed time window (the transmission interval).

Q5. Dead spaces - Unused bandwidth

Q5S1& S2 - Speech and compressed video may have periods of very low traffic, due to pauses in speech or action.

Q5S3 - Due to simpler sampling algorithms, this does not typically happen in industrial systems.

Q6. Call Duration

Q6S1 5 sec to M hrs

Q6S2 10 min to infinite (security monitor)

Q6S3 4 hrs to infinite

CONCLUSIONS

It is obvious that speech, video and industrial control share the same general model of TBS QoS, but with divergent parameters.

Since most of the MAC proposers have indicated some level of support for TBS, the 802.11 WG should take care to provide TBS in a way that is useful for all the Time Based Services, when adequate bandwidth is available.

When adequate bandwidth is not available, certain TBS may not be possible.

NOTE:

The author requests contributions on the numerical QoS requirements for speech, video and multi-media from WG members.