AVIONIC SYSTEMS STANDARDISATION COMMITTEE

VIDEO SYSTEMS SUBCOMMITTEE

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REQUIREMENTS FOR THE DISTRIBUTION AND TRANSMISSION OF VIDEO IMAGES FOR AIRBORNE PLATFORMS *

0 EXECUTIVE SUMMARY

This document has been prepared by the ASSC Video Systems Subcommittee to provide guidance regarding the digital data rates which are anticipated to be required for interconnection of existing and future avionic video systems. It has been produced to assist other ASSC Subcommittees to address these requirements, covering video distribution within an avionics system architecture.

The document encompasses three areas of the anticipated requirement, addressing interconnection between sensor to processing, processing to display, and sensor to display. These are termed processing, display and direct links. It deals with the data payload requirements for display modes ranging from VGA, through VXGA, to HDTV, and a table is provided showing data rate requirements for thermal and daylight cameras. Consideration is also given to issues of latency affecting video distribution.

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Figures and tables

2 GENERAL REQUIREMENT

This document has been produced by thein response to the DERA action from the ASSC Video Systems Subcommittee to define potential data rates for future distribution and transmission of video images in airborne platforms. There are three areas of requirements:-

1. Data rate from sensor to processing (Processing link)
2. Data rate from processing to display (Display link)
3. Date rate for direct video links, from sensor to display (Direct link)

Note that not all video data from sensor to processing will be fed to displays. For example data from a Defensive Aid System (DAS), may well only be fed to processing for data fusion and subsequent automatic deployment of suitable counter-measures. For example Defensive Aid System (DAS) warners may well only be fed to processing.

3 DATA RATE FROM SENSOR TO PROCESSING (PROCESSING LINK)

Table 1 attached shows the single sensor bandwidth that could arise from future operational requirements.

The very high frame rates [200Hz] relate mainly to potential DAS warner sensors. It should be noted that it is likely that there will be multiple DAS Warner sensors on the vehiclean air platform for all round coverage with a requirement to pass the data to central processing. [sensor overlap processing issue]. For some detectors, there are methods for avoiding the high data rates by window scanning, but this is not available across all potential detectors. A processed version of them [at low data rate] may be used for close in awareness.

Another aspect that should be considered in the prediction of bandwidth requirements, is the need for multi spectral systems and hence multiple video data streams being fed to central processing areas.

Note that compression [as discussed at the ASSC meeting] would be undesirable for these data streams. Also for a serial bit stream, overhead for run length limiting, clock recovery etc. has not been added. This will further increase the bandwidth required.

4 DATA RATE FROM PROCESSING TO DISPLAY (DISPLAY LINK)

Table 2 shows the data payload requirement for many current display types. Note that any necessary coding and link management requirements will increase the actual bandwidth requirement. A suitable standard is required to accommodate transport of data to display and to provide drive for a flat panel display, without reverting back to analogue signal formats. At present the best candidate for this is the VESA Plug and Display standard, which is based on PanelLink technology, a digital communication link between processor and display.

Mode	Definition (H x V)	Frame Rate (Hz)	Pixel clock (MHz)	Data rate (Mb s^{-1}) (@ 24 bits/pixel)
VGA	640x480	60	25	600
VGA	720x400	70	28	672
SVGA	800X600	60	40	960
XGA	1024X768	30	23.59	566.16
XGA	1024X768	60	65	1560
SXGA	1280X1024	30	40	672
SXGA	1280X1024	60	112	2688
UXGA	1600X1200	75	250	6000
VXGA	2048X2048	30	120	2888
HDTV	1280X720	30	82.92	663.36
HDTV	1280X720	60	77.54	1860
HDTV	1820X1080	30	62.2	1492.9
HDTV	1820X1080	30(i)	77.2	1852.8

Note: see Glossary of terms for abbreviations.

Table 2: Data payload for display types

5 DATA RATE FOR DIRECT VIDEO LINKS, FROM SENSOR TO DISPLAY (DIRECT LINK)

The third category relates to the requirement for simple and direct video links, ranging from video conferencing, and simple surveillance applications. Links need to accommodate lower data rates to support direct link applications, as shown by table 3.

Application	Typical data rate requirement	Transport mechanism
Direct video link (Compressed)	6 Mb s^{-1}	FO or Co-ax. link
Simple Surveillance	270 Mb s^{-1}	FO or Co-ax. Link
Linescan Recce Sensors	30 Mb s^{-1}, 240 Mbs^{-1}, 270 Mbs^{-1}	FO or Co-ax link

Note: Data fusion on signal paths having different latencies will be likely to affect the engineering solution required

Table 3: Requirements for direct video links

6 LATENCY

Associated with the high bandwidths, is the need for latency definition for video distribution systems.

In military applications, video systems may be regarded as part of a control-loop. These control-loops often need to be automatic, for example in target tracking applications and require the use of processing. In other instances, for example for example a Visually Coupled System (VCS) used for pilotage, has a human interface in the control-loop.driving of Land system platforms, there is a crewman in the control-loop.

Video transport and processing delays contribute to the overall consumption of the available system latency budget. Frame rate is insufficient to define the latency of the system. Latency may be defined as the time taken between video data being available at a sensor output and its presentation at crew-station display or processor stations. In the case of a VCS incorporating a Helmet Mounted Display (HMD), the overall latency also includes demand time, ie, Pilot moves head, sensor system aligns to head position, video data presented to pilot. Overall latency for the system should be less than 40 ms. Figure 1 below highlights the latency components.

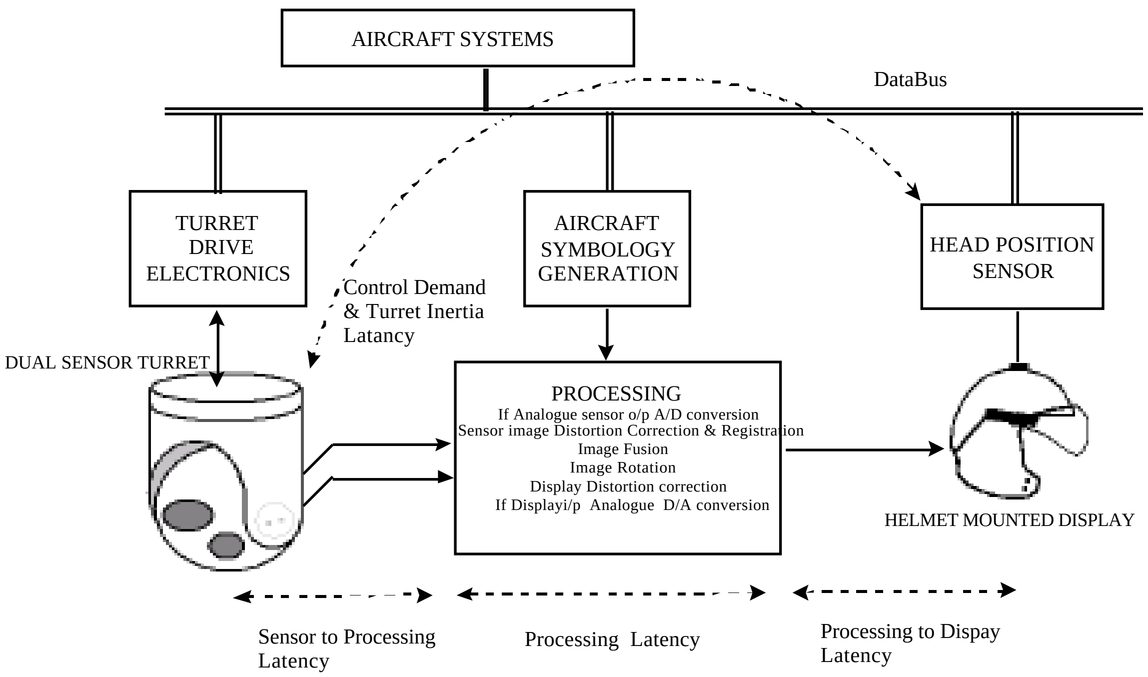

Figure 1 Visually Coupled System.

When manual or auto-tracking applications are required, latency in the system introduces tracking errors, the magnitude of which depend upon the rate of motion of the target and own-platform.

The latency is split into two factors, bearing in mind the fact that the distribution network is a separate entity that will join sensors, displays and processing within the IMA [or similar] architecture, and hence will need to be specified separately. In terms of high, medium and low latency, items 1,2,3 [of the following examples] are of medium latency. Item 4 would be a low latency and item 5 a high latency case.

The above is caveated with the statement that a sensor can have several modes that cover multiple cases. For example, a WASAD system could be used to fulfil item 5 as well as 3.

It is apparent that the shorter the control-loop reaction time, which is required, then the lower the latency that may be permitted in the video distribution system. Maximum latency will be determined by relative platform, target, and threat speeds; the maximum latency allowed will be constrained by the vehicle's speed.

Hence to take the example of the pilots sight, typically being allowed a maximum of two frames delay (<40 ms) to be useable, then the transport delays cannot be of this order, typically they would need to be less than a frame (10 ms), such that the overall system latency budget was met.

Some examples [non exhaustive] are as follows:-

1. VCS pilot aid

Overall system latency	<40 ms (see figure 1)

1. Drivers viewing aid

Overall system latency	Seven frames typical maximum
Distribution Latency	less than a frame (572 lines) typical

2. IRST [wide scan]

Overall system latency [to declaration]	A few seconds typical
Overall system latency [for visual display]	One frame typical
Distribution Latency	A few lines typical

3. WASAD system

Overall system latency [to declaration]	One second typical
Overall system latency [for visual display]	One frame typical
Distribution Latency	A few lines typical

4. MAW system

Overall system latency [to declaration]	Much less than one second typical
Distribution Latency	probably less than one line typical

5. Data gathering/ reconnaissance

Overall system latency [to recorder]	not important [probably several frames acceptable, particularly if compression as per MPEG-2 is used]

Overall system latency [to download - off aircraft]	Possibly as above (however depends on requirement, some may require near real time attributes.
Distribution Latency	consistent with not blocking other traffic that is more important.

7 GLOSSARY OF TERMS

DAS	Defensive Aid System
GXGA	Giant eXtended Graphics Adapter
HDTV	High Definition TV
IMA	Integrated Modular Avionics
IRST	Infra Red Search and Track
MAW	Missile Approach Warner
SVGA	Super Video Graphics Adapter
SXGA	Super eXtended Graphics Adapter
UXGA	Ultra eXtended Graphics Adapter
VGA	Versatile Graphics Adapter
VSC	Visually Coupled System
VXGA	Video eXtended Graphics Adapter
WASAD	Wide Area Surveillance and Detection
XGA	Extended Graphics Adapter
DAS	Defensive Aid System
IMA	Integrated Modular Avionics
IRST	Infra Red Surface Tracking
MAW	
VGA	
WASAD	Wide Area Surveillance and Detection

8 REFERENCES

The following documents are of relevance to video systems for avionic applications.

ASSC/130/2/97 Guide to Avionic Video Systems

	Image Array Size									
Sensor Type	**Width** (pixels)	**Height** (pixels)	**Total pixels** (pixels)	**Frame Rate** (Frames/s)	**Video Rate** (Mpixels/s)	**Sample rate** (MHz)	**Pixel Resolution** (bits per pixel)	**Data Rate** (Mbits/s)	**Timescale**	**Comments**
Thermal Camera	320	240	76800	30	2.30		14	32.26	Now	
Thermal Camera	320	240	76800	60	4.61		14	64.51	Now	
Thermal Camera	320	240	76800	200	15.36		14	215.04	Now	
Thermal Camera	384	288	110592	25	2.76		14	38.71	Now	
Thermal Camera	384	288	110592	50	5.53		14	77.41	Now	
Thermal Camera	640	480	307200	30	9.22		14	129.02	Now	
Thermal Camera	640	480	307200	60	18.43		14	258.05	Now	
Thermal Camera	640	480	307200	200	61.44		14	860.16	Now	
Thermal Camera	768	576	442368	25	11.06		14	154.83	2000	
Thermal Camera	768	576	442368	50	22.12		14	309.66	2000	
Thermal Camera	1280	768	983040	25	24.58		12	294.91	Now	
Thermal Camera	1280	768	983040	50	49.15		14	688.13	2000	
Thermal Camera	1280	768	983040	100	98.30		14	1376.26	2000	
Thermal Camera	1280	1024	1310720	30	39.32		16	629.15	2003	
Thermal Camera	1280	1024	1310720	60	78.64		16	1258.29	2003	
Thermal Camera	1280	1024	1310720	200	262.14		16	4194.30	2003	
Thermal Camera	1600	1600	2560000	30	76.80		16	1228.80	?	
Thermal Camera	1600	1600	2560000	60	153.60		16	2457.60	?	
Thermal Camera	1600	1600	2560000	200	512.00		16	8192.00	?	
Daylight Camera	640	480	307200	30	9.22		24	221.18	Now	
Daylight Camera	640	480	307200	60	18.43		24	442.37	Now	
Daylight Camera	640	480	307200	200	61.44		24	1474.56	Now	
Daylight Camera	768	576	442368	25	11.06		24	265.42	Now	625 line standard
Daylight Camera	768	576	442368	25	11.06	13.50	30	331.78	Now	625 line, SDI, 4:4:4
Daylight Camera	768	576	442368	50	22.12		24	530.84	Now	
Daylight Camera	1280	1024	1310720	30	39.32		30	1179.65	2000	
Daylight Camera	1280	1024	1310720	60	78.64		30	2359.30	2000	
Daylight Camera	1280	1024	1310720	200	262.14		30	7864.32	2000	
Daylight Camera	4000	4000	16000000	30	480.00		48	23040.00	2000	
Daylight Camera	4000	4000	16000000	60	960.00		48	46080.00	2003	
Daylight Camera	4000	4000	16000000	200	3200.00		48	153600.00	2003	
WASAD System	768	360	276480	2	0.55		12	6.64	Now	

Table 1: Video data rates for Air and Land platform application