KVM Solutions: Dedicated vs. IP Solutions

When qualified IT personnel are at hand and with high-bandwidth LANs becoming increasingly more affordable, many companies looking for KVM (Keyboard-Video-Mouse) solutions now have a natural preference for IP-based systems rather than dedicated cable approaches. However, most high-end KVM solutions within today's trading floors and control centres are still based upon dedicated twisted-pair cabling.

Will analogue signal distribution across dedicated cabling become outdated in the modern digital world? Find out how these two transmission technologies compete for the pole position in this market.

Background

The Rise of the Gigabit LAN

The network equipment costs for Gigabit LAN infrastructures have fallen significantly in recent years, so that Gigabit LANs are now the de facto standard. The resulting upgrade in bandwidth has triggered new developments and products for KVM-over-IP solutions.

True, there are many Remote Desktop IP solutions on the market already, i.e. Microsoft's Remote Desktop, RealVNC, and others. However, they mostly target IT administrators who need to access their servers from anywhere and mobile workers who require access to their office PCs from home or while travelling. In both cases, the goal is to provide easy, global, remote desktop access with a workable user experience over low-bandwidth channels.

Now suddenly, with the availability of Gigabit LAN infrastructures, real-time transmission of high-resolution images becomes feasible for remote PC users. They can enjoy the same desktop experience as if they were directly connected to their local PC.

Content

Dedicated Solutions

Dedicated Solutions deliver quality remote

Conventional dedicated solutions (otherwise known as "extender solutions") have long delivered a high quality experience for remote users.

A hardware transmitter at the remote computer is linked to a receiver at the desk via a dedicated cable connection providing lots of non-shared bandwidth. The transmitter receives the video signal via the external physical computer port intended for the monitor and transforms it for real-time transmission (60 frames per second) over point-to-point cable. Latency is negligible. The signal is continuous with very little redundancy as it carries full uncompressed screen display information.

The receiver adjusts the signal from any skew and attenuation effects resulting from the cable medium and distance. For CAT-x copper-based cabling, distances up to 300 meters are possible. For fibre, distances up to 500 meters for multi-mode cable and several kilometres for single-mode cable can be achieved.

In general, signals are not subject to unpredictable degradation. In

addition to the all-important video, bi-directional audio and transparent USB (for keyboard/mouse) are also supported by today's products. Security is guaranteed by the dedicated point-to-point cable and the proprietary transformed signal. Also, signal information is never stored – neither at the transmitter nor at the receiver.

IP Solutions

IP Solutions deliver standardized interfaces
Similar to the dedicated solution, the IP-based solution also consists of transmitter and receiver components, either software or hardware.

The session-based communication between receiver and transmitter follows the classic client-server model. Remote computer signals are received by the transmitter, which must provide fast compression – with or without (video) data loss. The compression must comply with given bandwidth constraints. (See chart "The Need for Compression".)

Before the compressed image stream is sent across the fixed-bandwidth IP network, it must be reformatted and encapsulated into packets for transmission. These size-limited packets include an additional overhead arising from protocols such as TCP, RTP etc. In general, the compression method in combination with the transport protocols is key to a successful solution.

Encryption
The network itself is indifferent to the nature of the data and treats all digital information in a standard way.

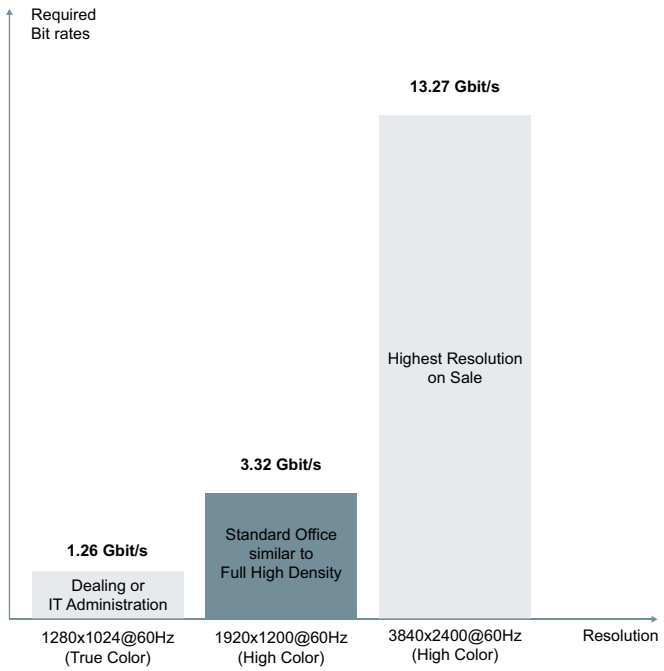
Security can be achieved by well-established encryption techniques (e.g. AES). As for signal information storage, a copy of the last image frame is usually stored in the receiver.

Dedicated vs. IP

Compression
Dedicated systems have a significant advantage over IP systems, as there is no need to compress the data. The full screen information is transmitted constantly at the full frame rate. Consequently, the latency is negligible, consistent and fully independent of the image input characteristics.

This is fundamentally different from the compression approach used in IP solutions. Compression causes computational complexity that leads to latency. The inverse relationship "Quality – Bit rate – Latency" follows.

The Need for Compression



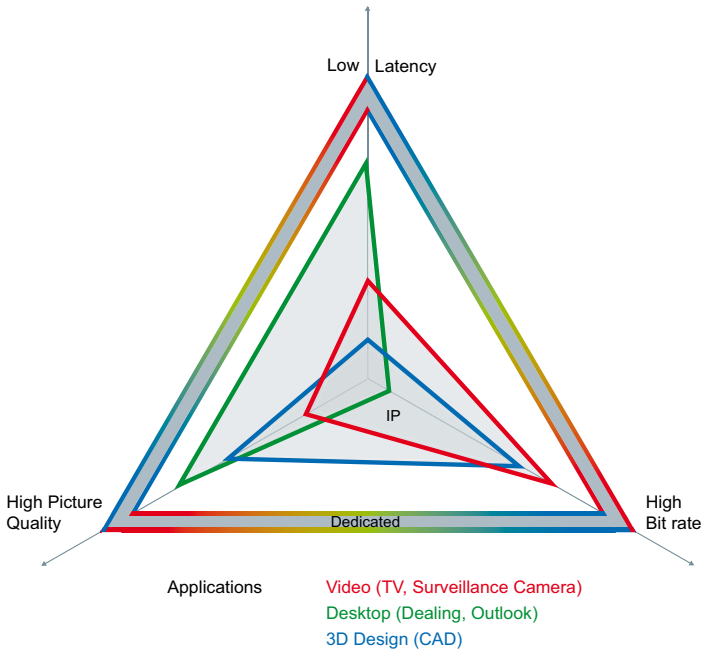
If images are to be distributed by computer networks, they must be in digital form. A bit rate of approximately 3.32 Gbit/s is required for today's standard monitors. Keyboard, mouse and audio data contribute less than 0.1%.

As typical Ethernet link speeds are 100Mbit/s or 1Gbit/s, compression of the video data is unavoidable. Reduction of colour bits and data frames may not be sufficient to satisfy the link speed requirement.

Keeping the goal of "visually lossless" quality in mind, the application of more aggressive (lossy) digital image compression methods will be required. These sophisticated mechanisms will exploit redundancies within synthetic images (e.g. desktop, cartoon, CAD) and natural images (e.g. movie, photos). However, computational complexity arising from data compression must not introduce delay in information delivery, which undermines operational effectiveness and degrades the end user experience.

Input Characteristics
Performance of IP Solutions depends on the input characteristics of the video image and bandwidth available on the LAN. Picture quality and latency of high bit rate images are affected and vary according to adjustments and tradeoffs. For example, when picture quality and bit rate are kept constant – latency increases for more complex images. Or, reducing latency leads to higher bit rates. Adjusting any characteristic in one direction negatively affects the others and quality tradeoffs are unavoidable.

Dedicated solutions are input neutral. Low latency and real time transmission are guaranteed, even for highly complex images. Performance is stable and predictable, ensuring high-performance delivery for demanding applications. (See diagram "The Dependency on Input Characteristics".)



The Dependency on Input Characteristics

Transmission Errors
If we look at transmission errors, we see that a small error in a dedicated system simply goes unnoticed. In the point-to-point environment of dedicated solutions, an error will only affect that particular line and not propagate to other users. This is very important for trading floors and control centres.

For an IP remote desktop system, however, small errors can have serious repercussions depending on where the error event occurs. Also when decompression does not work correctly, "small" errors propagate over time. This is why IP solutions need to implement sophisticated error recovery algorithms.

Security and Stability
Even with a competent IT staff able to handle most network related issues, there is never a guarantee that they can solve all issues related to the IP remote solution. Full 2nd and 3rd level analysis and trouble-shooting requires an in-depth understanding of the solution's behaviour, and this is usually available only from the hardware/software producer. In addition, IP remote solution faults can affect all users on the network.

For an IT manager, the isolated nature of a dedicated system implicitly guarantees high security. This cannot be matched by an IP solution – even one using sophisticated encryption methods. Encryption is still based on standard transmission protocols that can be made available to the whole world – either intentionally or not.

Costs

Investment Costs
At first glance, IP extender solutions appear to offer economic and operational advantages. Customers usually have LANs installed and in-house IP expertise. So there is no need to install cables, buy additional network components and train people. This sounds like a cost effective investment - but this is not necessarily the case!

Every IP solution places new requirements on the existing network, in terms of bandwidth, latency and error rates. Companies must carefully assess if they want to transmit additional critical and high-peak data traffic over LAN segments currently used for other applications. Of course, they can implement new LAN segments, but this may well require new investments in cable as well as additional equipment like Ethernet switches for plugging in IP transmitters and receivers. Or, additional resources for IP multicasting or VLAN support may be required.

Dedicated solutions, on the other hand, are closed and independent systems consisting of point-to-point connections requiring cables and conduit space. Although the greater transmission reach of an IP solution is clearly a competitive

advantage over a dedicated solution, performance is negatively affected by latency due to bandwidth restrictions, distance and network components.

Operational Costs
Power consumption for both transmitters and receivers are as low as 5W for dedicated solutions. But for IP solutions, power consumption starts at 20W and goes up to 200W when a software receiver requires an additional local PC.

It is not recommended to deploy IP remote software products in time critical user environments. Software transmitter modules installed on host computers absorb CPU and memory resources, which can result in significant reductions of performance capabilities.

Conclusion

Dedicated remote desktop solutions invariably deliver a brilliant visual experience. Performance is not dependent on input characteristics and existing networks. This is not true for IP-based remote desktop solutions today. Their use is limited and should be carefully assessed from case to case.

The Future

As standard LAN bandwidth climbs towards 10 Gbit/s and compression technologies continue to improve, we will begin to see a major shift from dedicated to IP remote solutions in the next 3 - 5 years. Nonetheless, the dedicated market for highly critical deployments such as in control centres and on trading floors will remain.

The Author

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Comparison between Dedicated (WEY) and IP Solutions (Representative)

Features	WEY WSR IV DVI[0]	WEY SPTx	WEY D-DVI	IP Solutions
Power Consumption	2 x 6W	2 x 6W	2 x 10.5W	2 x 20 - 200W
Form Factor	External Hardware	External Hardware	External Hardware	Ex. Hardware/Software
Point-to-Point Cable	Yes	Yes	Yes	No[1]
Transmission	Copper (CATx)	Copper (CATx)	Optical Fibre	IP (Ethernet 100/1000)
Distance	< 300m	< 300m	< 4000m	< unlimited[2]
Real-time[3]	Yes	Yes	Yes	No
Latency[4]	25ms	30-60ms	20ms	30ms - unlimited[5]
Video Support	Single 1920x1200	Dual 1920x1200	Single 1920x1200	Dual 1920x1200
Audio Support	Yes	Yes	Yes	Yes
USB Support	Yes, Transparent	Yes, Transparent	Yes, Transparent	Partially[6]
Video Compression	No	Yes (20Hz)	No	Yes (lossy-lossless)
Video Quality	Perfect	Perfect	Perfect	Bad - Perfect[5]

0 Ready in Q1/2009, feature value according to targets.
1 Hardware solutions require an extra Ethernet port for transmitter and receiver, for software solutions it is recommended.
2 Longer distances introduce quality degradation due to available bandwidth and network latency.
3 Real-time means there is 100% guarantee to receive data by a fixed deadline.
4 Latency here means the time delay of a screen change between the remote and the local monitor.
5 Depends on input characteristics and configured quality (compression), available bandwidth and network latency.
6 Full transparency is achieved rarely, rather certain device classes are supported such as HID and SCSI mass storage.