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# **SmartBuss<sup>®</sup>**

**The Comprehensive Network Solution**  
**Converging**  
**Performance Audio-Video-Data Systems**

**Intelligent Media Technologies, Inc.**

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## The Next, Next Generation

The varied approaches for interconnecting professional audio-video equipment reveal shifts in systems and network paradigms. The shifts are most noticeable with new designs favoring "stackable" (de-centralized) configurations with embedded network functions. This is in contrast to centralized processing engines that are closely coupled to host PC's. As stackable networks become more capable, the network boundary or "Edge" is pushing further out to the system's analog I/O end-points. The new Edge is where digital moves to directly service input and out appliances such as touch pad control panels, surveillance cameras, audio sources or amplified speakers. These converged network edges are where great utility and performance advantages exist and added value resides.

The next generation audio-video-data system may eliminate centralized network equipment altogether in favour of an array of "tunable" I/O channels positioned in close proximity to their analog clients. These networks & their applications will manage all input and output signal processing in the network Edge device. In distributed architectures this means utilizing the network as a matrix router. To make this functionality possible, the network must have the granularity to route individual channels to and from all locations across the network fabric.

Intelligent Media Technologies (IMT) has developed a new network technology called SmartBuss. SmartBuss delivers new levels of performance by reducing network installation and infrastructure cost while delivering convergent services with a comprehensive assortment of embedded network processors and Edge products.

When comparing cost competitive networks as used in professional or commercial environments, most are Ethernet variants that are *not* optimized for streaming applications. The SmartBuss IP is a streaming media network solution, delivering coherent audio-video-data content, for as little as \$5 per audio channel and \$10 per MPEG2 video channel.

## The SmartBuss Solution

The latest generation of Field Programmable Gate Array (FPGA) chip technologies makes SmartBuss (Scaleable Matrix Audio/video Receive Transmit) possible. The FPGA executes IMT programs as an embedded network solution, eliminating large external rack mount network components that are typically required for streaming media service. SmartBuss improves reliability, expands features and delivers significant cost reductions in materials and installation labour for complete network deployments.

SmartBuss handles all input and output signal processing functions with local, "direct to network" formatting and communication, eliminating the need for "hydra" type homerun cabling to equipment closets. All SmartBuss functions, including matrix routing, are performed 100% virtually with add-drop functionality on Cat5 cable and/or fiber.

Because SmartBuss is the only product in its price class to stream high quality MPEG2 video, digital audio and control data it bridges market boundaries between professional and consumer "prosumer" products.

### SmartBuss Options

SmartBuss embedded products include Core and Video, each utilizing the same low cost Altera FPGA targeted to OEM's of audio & video equipment.

### SmartBuss Core

SmartBuss Core facilitates network audio, video and control data with the lowest possible implementation cost. The SmartBuss Core FPGA is programmed and priced according to the number of channels enabled (scaled) up to 64 channels @ 48kHz via 8 standard serial data I<sup>2</sup>S lines per Core. Core latency is fixed at 21µs each for input and output plus 840ns per node throughput. Network connection is via Category 5 cable (the same type cable used for Ethernet) in a daisy chain configuration at 100Mb/s. Up to 64 audio channels or 16 equivalent DVD channels (4 audio=1 DVD) may be processed in each Core, and there's no hub requirement for up to 256 networked Cores.

## SmartBuss Video

SmartBuss Video is the powerful extension to SmartBuss Core that integrates The Moving Picture Experts Group (MPEG2) standards for coded representation of digital audio and video.

SmartBuss Video formats video packets into serial data that is identical to SmartBuss Core's I<sup>2</sup>S audio stream. When combining audio and video within the same appliance, the bandwidth each video channel consumes equates directly to numbers of audio channels. A DVD quality video channel = 4 audio channels and a CCTV channel = 2 audio channels, @ 48 kHz.

SmartBuss Video reference designs including schematics, PCB layout and micro-controller code are available for purchase by OEM's that prefer to outsource a complete development bundle. Additional implementation and design assistance for NRE projects is available.

*The cost to obtain streaming video performance from other network systems is at minimum 2x-3x the cost of SmartBuss. SmartBuss is only embedded product in its price class that streams MPEG2 video with audio & data.*

## SmartBuss AVIO Edge Servers

SmartBuss AVIO (Audio-Video-Input-Output) Edge Servers combine a SmartBuss Core processor with one of IMT's Input/Output modules to produce a stand-alone series of networking products delivering full multimedia functionality. The AVIO series of media processors affords many design options by reducing network installation labor and physical infrastructure cost while delivering convergent services.

Using IMT's optional "Dual Buss" architecture, the AVIO SHSB (Serial High Speed Buss) Edge unit combines Gigabit SmartBuss on single mode fiber (for wide area or EMF sensitive applications) with local area 100Mbit "Tributaries" using standard Ethernet physical layer "Look-A-Like" busses. SmartBuss AVIO SHSB fiber networks deliver 800 audio channels or 150 channels of MPEG2

compressed DVD quality audio/video in any combination.

If SHSB Gigabit performance is not required, select standard AVIO Edge units using the 100Mb buss configuration exclusively that deliver 70 audio or 12 video channels with 100m distances per hop using standard Cat5 infrastructure cabling.

AVIO Edge Servers can be commingled with SmartBuss Core enabled OEM products to create product mix-and-match opportunities for a multi-service or multi-brand network.

Any audio, video or data signal originating in any AVIO Edge unit (Gigabit SHSB or 100Mb Cat5) is available at every other unit on the overall network.

- Gigabit Version: 800 audio or 150 MPEG2 compressed DVD a/v channels. SHSB Serial High Speed Buss to 10km on Fiber Optics (80km available)
- 100Mb Version: 70 audio or 12 MPEG2 compressed DVD a/v channels on 100m hops over Cat5 cable
- Low Latency: 840ns network node latency – Data in to Data out
- Granularity: Any single input channel can be individually routed to any output
- Low Cost: Cost effective modular approach yields the best performance and highest value
- Compact: Small 8.25" wide x 10" deep x 1.7" tall package with up to 8 audio or 2 MPEG2 audio/video compression or decompression channels – or combinations.

## SmartBuss Product Evolution

IMT has partnered with hundreds of customers, spanning many market segments including high level U.S. Department of Energy projects at Nuclear Weapons facilities, U.S. Military Security and Access Control, Surveillance CCTV, as well as Performance Audio, Public Announce and Paging at professional sports facilities and theme parks.

*IMT's product evolution is the roadmap to system convergence.*

**1998**

### **OMNInet POP-14**



SONET based integrated fiber optic card cage systems. Applications include complex, high level, multi-service applications- integrating media conversion, communications, and matrix

**2001**

### **OMNInet POP-4**

SONET based distributed fiber optic companion to the POP-14 for deployments with few local network appliances requiring minimal channels



**2005**

### **SmartBuss AVIO Edge Servers**



Modular Media “Bricks” that daisy-chain using Category 5 cable or optional fiber optics. A great stand alone solution providing many configurations from simple, low cost, point-to-point applications - to expansive, high capacity, complex arrays.

**2005**

### **SmartBuss Network Interface Module (NIM)**

Designed for OEM partners to “drop in” and evaluate SmartBuss with their products.



**2005**

### **SmartBuss Core**

IMT's “Highly Embedded” solution is implemented as a programming device to load appropriate configuration code with access to the substantial reference material available for Video Compression and low cost Audio DSP.



## Performance Benchmarks

During SmartBuss' development, IMT engineers adhered to a set of benchmarks & expectations for network functionality that have become defining requirements. They include:

- Video-Audio-Data Convergent Services
- High channel count – 64 minimum for networked audio plus control channel(s)
- Category 5 cabling Physical Media Capability utilizing existing infrastructure
- 100m minimum distances between devices
- System latency that's low enough for use in "live" applications
- Channel *matrix routing* and *add/drop* granularity in single channel increments
- Scales up for large deployments with many add/drop locations or nodes
- Acquisition cost that's in line with the systems' utility & value

Emerging issues requiring new definitions include video integration, compliance with EU code - EN60849 - for life safety applications in public buildings and sports venues, future cost reduction opportunities, cross-platform compatibility and new appliance integration.

- Video Integration capability
- EN60849 compliance
- "Portable" solution allowing for cost reductions as technology advances
- Immediate compatibility with complimentary products
- Simple business relationship with the supplier

The specific competence of our approach is in the comprehensive nature of SmartBuss technology and IMT's business model. We have already encountered, solved, and implemented solutions for the broadest range of network-centric issues.

*An assessment of embedded solutions currently on the market shows that most service a specific niche in the application range - only SmartBuss offers complete coverage from low cost, simple systems - to complex, distributed, and highly integrated systems.*

## Applications

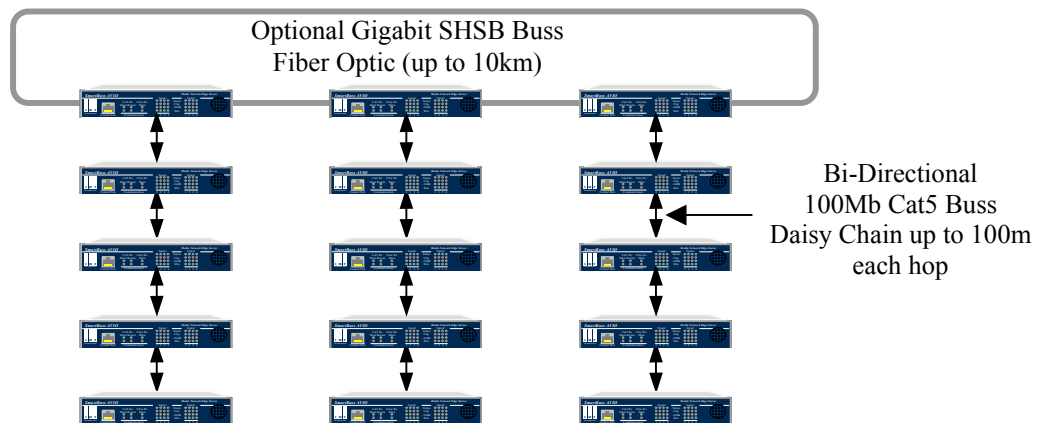
There are several complimentary embedded SmartBuss products. The Core FPGA is available as a programmed FPGA and also as a complete plug-in Network Interface Module (NIM). SmartBuss AVIO Edge Servers are implementations of the embedded Core FPGA for network I/O.

The embedded SmartBuss Core solution is appropriate for manufactures of audio, video and data network products that are ideal for:

- Houses of Worship
- Professional & collegiate sports facilities - arenas & stadiums
- Themed entertainment - theme & amusement parks
- Performing Arts Centers
- Digital Cinema's
- Theme retail - chains using music & video as a merchandising tool
- Restaurants and clubs
- Surveillance and security situations
- Traffic monitoring

*With SmartBuss there is no exclusion of non-network enabled products and MPEG2 video networking is a standard option.*

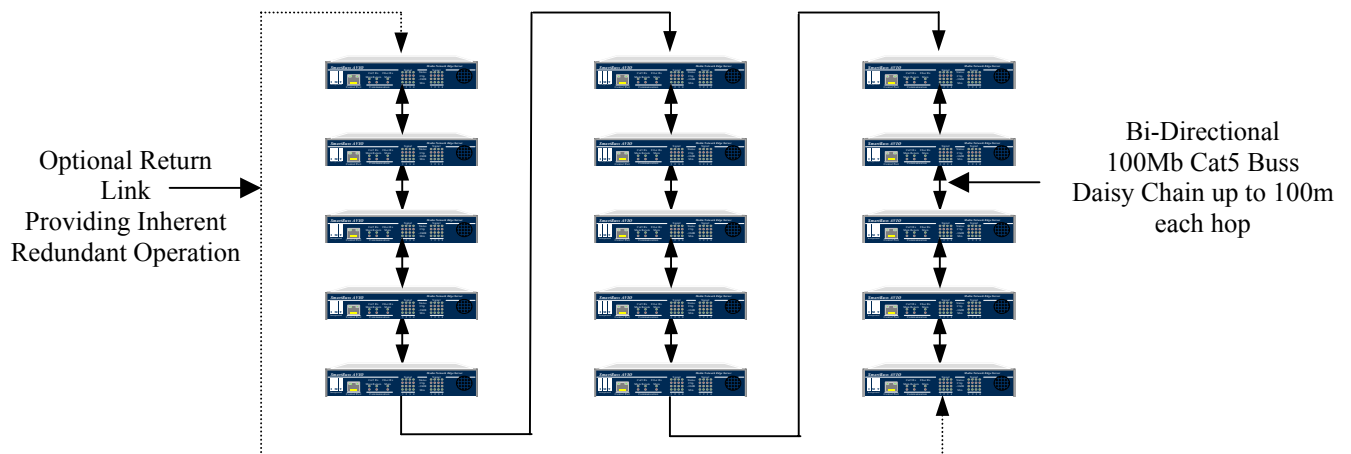
## Example SmartBuss Configurations



### Combination SmartBuss High Speed Serial Buss (SHSB) and 100Mb Cat5 Busses

The combination of the SHSB & 100Mbit Tributary implementation provides the most economical and powerful range of communications capabilities available today.

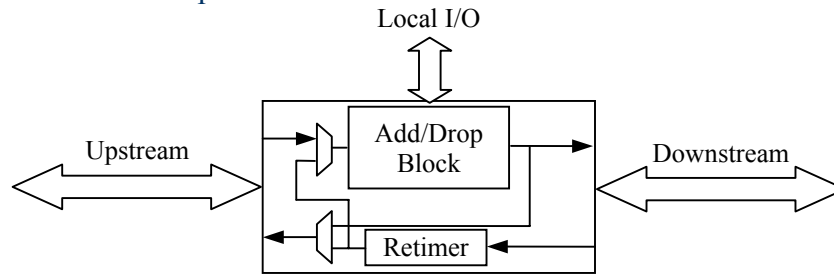
- Media Tributary *Ethernet PMD - daisy-chain 100 meters each hop - 70 channels*
- SHSB Fiber Optic *Single-Mode - daisy-chain - up to 10km each hop - 800 channels*



### Standard 100 Mb/s Network with "Redundant" Return Link

## Data Path through AVIO Edge Units

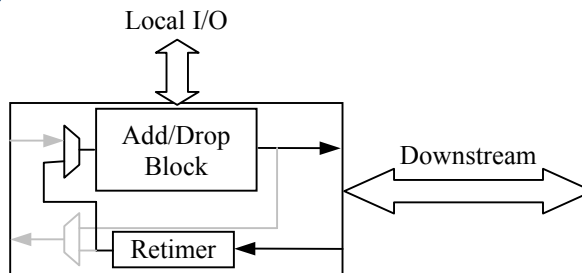
SmartBuss uses standard Ethernet Physical Media interfaces for its 100Mb communication although routing and buss management does not conform to the Ethernet protocol. The block diagram below shows the internal data pathways within the SmartBuss Core processor.



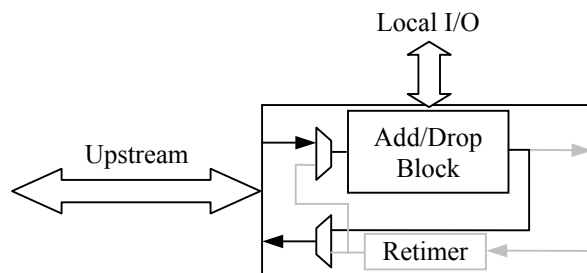
**SmartBuss Core Internal Data Paths**

SmartBuss units are connected in a daisy-chain configuration. Data received from upstream nodes are processed and local I/O data is either read from, or written to the network data stream. In turn, this data is transmitted to the next node downstream where the process is repeated.

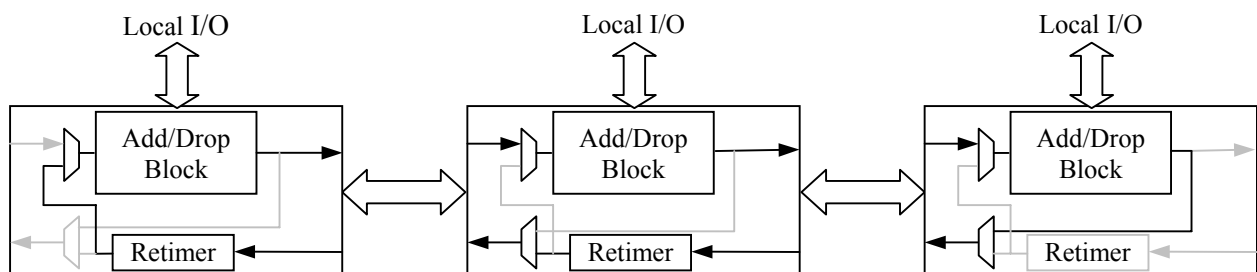
Data arriving from the downstream node is re-clocked to remove jitter and is transmitted otherwise unprocessed to the upstream node. If any node detects that there is no upstream node transmitting it will switch over to the Re-timed data from the downstream node.



Using the same method, if a node detects there is no downstream node transmitting, it will switch over to the upstream node from the internal add/drop processing block.

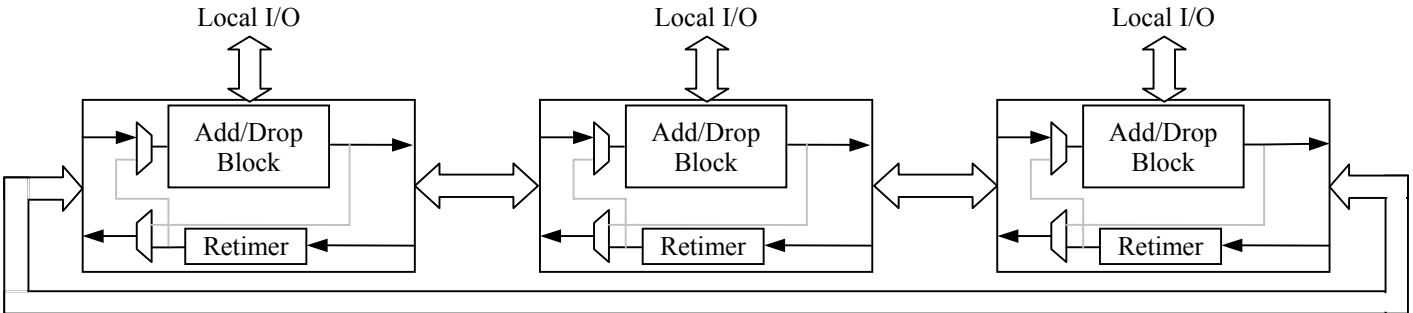


Although SmartBuss units are connected in a daisy-chain configuration, the automatic data path selection and routing creates “ring” architectures.



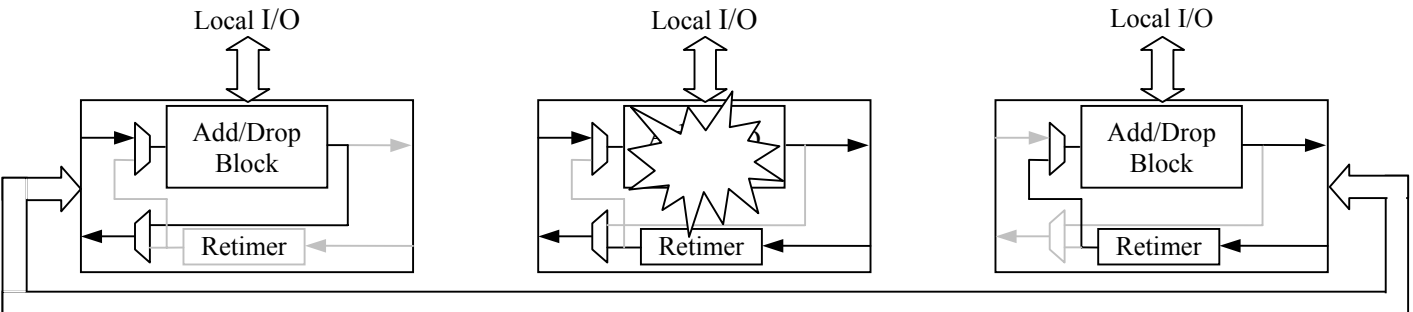
## Redundant Operation

By connecting the downstream feed of the last unit in the series back to the upstream feed of the first, a dual, contra-rotating ring is achieved.



**Dual, Contra-Rotating Ring Configuration**

If any unit or connection in the ring is lost, the downstream and upstream units will automatically re-configure to compensate. No functionality, other than that of the failed unit, will be lost. When the lost connection or failed unit is corrected, the system will restore to the original state automatically.



**Pathway Reconfiguration on Unit Failure**



## The SmartBuss Solution

The comprehensive nature of IMT's SmartBuss development program adds additional power to the network solution.

SmartBuss provides our OEM partners access to the widest range of projects, with performance and configuration flexibility that's adequate to satisfy very large array applications with a cost effective and simple to implement package.

IMT's experience base, refined over the years and targeted to the industry's latest FPGA technology, provides the lowest per-channel cost available. This low cost is an important *starting point* for future cost reduction strategies.

*A significant SmartBuss advantage is that it's the only product available in its price class that streams MPEG2 video, audio & data. The cost to obtain streaming video performance from competitive systems is typically 2x-3x the cost of SmartBuss.*

### SmartPath<sup>®</sup>

Management of SmartBuss networks is extremely easy with IMT's SmartPath reference application for Windows. SmartBuss is an add/drop network that's effectively a wide area matrix switch when controlled by SmartPath. Input and output assignments and I/O signal processing, matrix mixing, network monitoring, and provisioning are standard operational features that are controllable and monitored. This eliminates requirements for third party routing and switching hardware and greatly increases SmartBuss value when budgeting for network switching.

The Audio DSP versions of the AVIO Edge Server add a host of user configuration features including 12 band parametric EQ, high/low/band pass and notch filters, high and low shelving, delay up to 1 second, a limiter-compressor and digital make up gain. These functions add significant value to the SmartBuss network by positioning the signal processing as a closely coupled unit between the network and the client appliances they serve.

OEM's can create unique Graphical User Interfaces (GUI) using our DLL to function as part of their control and management application.

### NRE & Reference Design

SmartBuss AVIO Edge Server product licensing is available to OEM's that prefer to manufacture and distribute into their sales channels under their own brand. Each of the AVIO Edge Server modules is available as a complete reference design including schematics, PCB layout, and micro-controller code. This program has been created for OEM's to minimize up-front development costs and ensure fast time-to-market with predictable performance.

Non-Recurring Engineering (NRE) services are available to assist OEM clients in configuring the reference designs.

### In Conclusion.....

It is clear that customer requirements for increased network performance, convergence and simplicity are in proportion to market pressure for decreases in equipment and installation costs. The convergence delivered by SmartBuss technology shifts the existing network market paradigm and is an appropriate, cost effective, and flexible digital network for OEM's and systems integrators looking for next generation product solutions.

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## SmartBuss Core<sup>®</sup>

### Embedded Network Communications Processor

Where the **SmartBuss NIM<sup>®</sup>** Network Interface Module is the heart of the **SmartBuss AVIO<sup>®</sup>** units, **SmartBuss Core<sup>®</sup>** is the brain. All interfacing, formatting, signal routing, and communications management between the I/O level and the network is handled by the Field Programmable Gate Array (FPGA) configured with the **SmartBuss Core<sup>®</sup>** firmware.

This firmware initializes the FPGA and is available to OEM partners as a “code load” according to their required I/O capacity. The cost per socket is based on the required I/O capacity required in each unit.

A 2 channel device such as an amplifier has a lower cost than a 56 x 8 or 48 x 16 console. Once the FPGA is initialized the firmware can be uploaded to the device remotely across the SmartBuss Network or across the Internet.

**SmartBuss Core<sup>®</sup>** is the most powerful, flexible and cost effective “embedded” network solution available.

#### Features:

- Complete solution for Embedded Network Integration
- Low up-front development cost
- Low system deployment cost
- Fast Time-To-Market
- Simple business approach
- Predictable performance with IMT mature technology
- Can be used in conjunction with **SmartBuss AVIO<sup>®</sup>** units to facilitate development and deployment or, use **SmartBuss AVIO<sup>®</sup>** units as complimentary end point compatible OEM products
- Remotely updateable firmware
- MPEG2 Compressed Audio/Video support
- **SmartBuss AVIO<sup>®</sup>** products are available for sale as reference designs
- Low cost audio DSP reference designs are available for sale for “Network Edge” processing

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# SmartBuss CORE<sup>®</sup> Specifications

## SmartBuss Network Interface

Physical Media Connection	Cat5 or better Data Grade Cable
Connector	Dual RJ45
Connection Distance	100m each hop
Latency	840ns Data-In to Data-Out
Interface Standard	MLT-3
Data Rate	98.304Mb/s
Redundancy	Dual, Contra-Rotating Ring – Self Healing
Network Channel Capacity	70 Audio (@48kHz), 12 Audio/Video (or combinations)

## Optional Fiber Optic Interface

Physical Media Connection	Single-Mode Fiber Optic Cable (9nm)
Connector	Dual LC
Connection Distance	10km Standard – 80km Optional – each hop
Latency	840ns Data-In to Data-Out
Interface Standard	8B/10B Encoded Pulse Code Modulation
Data Rate	983.04Mb/s
Redundancy	Dual, Contra-Rotating Ring – Self Healing
Network Channel Capacity	800 Audio (@48kHz), 150 Audio/Video (or combinations)

## Circuit Specifications

Footprint	3.5" x 3.5"
Circuit Supply Voltage	3.3 Volt DC
Circuit Supply Current	300 milliamp (max)
Operating Temperature Range	0° to +70° Celsius
I/O Data Lines	8 Max (individually configurable as input or output)
Line Data Rate	Selectable – 3.072Mb/s or 12.288Mb/s
Local I/O Channel Capacity	64 Audio (@48kHz), 16 MPEG2 Video/Audio (or combinations)
Routing Granularity	Individual Byte Level Routing / Switching
Sample Packet Size	256 Bytes
I/O Data Packet Size	210 Bytes
Control Channel	32 Bytes
Link Synchronization	9 Bytes
System Status Reporting	5 Bytes
Control Port	HIO8 Emulation
Port Speed	DMA @ 12.288MB/s
Control Software	<b>SmartPath</b> <sup>®</sup> - DLL package with Matrix and DSP Control Screens

## Support Materials

Reference Designs	Reference designs are available for Audio Input, Audio Output (including a channel based "Edge" DSP suite), MPEG2 Video/Audio Compression and De-Compression Integration
BOM Support	Complete BOM support for OEM built NIM modules

*All specifications are correct at time of publication and are subject to change.*