

Pure 3 Codec Technology

High Quality Video over IP



ELECTROSONIC

Electrosonic PURE-3 Codec Review

- ❑ Electrosonic & PURE-3 Codec Development
- ❑ PURE-3 Codec
- ❑ Product Positioning
- ❑ Applications
- ❑ Technical Requirements
- ❑ Quality
- ❑ Advantages / Disadvantages Summary
- ❑ Extra Features & value
- ❑ Summary



Electrosonic & PURE-3 Codec Development

- ❑ Videowall Processing Requirements in 1990s
 - ❑ Low delay
 - ❑ Large Images (High Quality)
- ❑ Quantity of HD & SD Inputs were exceeding bus technology
- ❑ Codec Technology Development
 - ❑ Fulfill: HD Video and Computer Graphic application requirements
 - ❑ Make the IP network into 'The Distribution Bus'
 - ❑ Chip set not available to accomplish Electrosonic goals
 - ❑ Similar to Cobranet (Audio over IP Distribution)



Electrosonic & PURE-3 Codec Development

❑ Development Objectives:

Objective	Rationale
Low Delay	Electrosonic customers required real-time
Visually lossless Image quality	Electrosonic customers use Large screens
Low bit rate	Low enough to support scalability switching on networks
Reliable delivery on IP Networks	Given: Networks drop packets

❑ Technology & Tools Available in 2003

Objective	Technology Assessment
Low Delay	MPEG-2 GOP (or any GOP) not acceptable
Visually lossless Image quality	JPEG2000 interesting, but still emerging
Low bit rate	JPEG2000 lacking temporal compression Wavelets more efficient than Discrete Cosine Transform
Reliable delivery on IP Networks	Forward Error Correction, not acceptable Extra bandwidth and extra delay required



Technology Deployment	Outcome
<p>Wavelet transform (WT)</p> <ul style="list-style-type: none"> - Lossless - 5 levels - Integer 2/10 	<ul style="list-style-type: none"> - Preserve image quality at efficient bit rates - Simple design implementation
<p>Tree coder for spatial compression</p> <ul style="list-style-type: none"> - Aligns with spatial location of WT coefficients - Exploits self similarity of a WT - Results in many coefficients to be insignificant - Very efficient coding - Self describing bit stream 	<ul style="list-style-type: none"> - Increased compression efficiency - Greater coding efficiency - Simplified calculations - Programmable into a single FPGA - Simple design
<p>Temporal compression</p> <ul style="list-style-type: none"> - Unique concept of absolute temporal coding - Wavelet signatures to achieve absolute coding - Temporal coding is lossless - Reuse by means of error concealment 	<ul style="list-style-type: none"> - Absolute frame quality preserved (editing) - No coding differences over time - Low delay preserved - Robust transport over lossy networks



PURE.3 CODEC

OPTIMIZED FOR NETWORKS

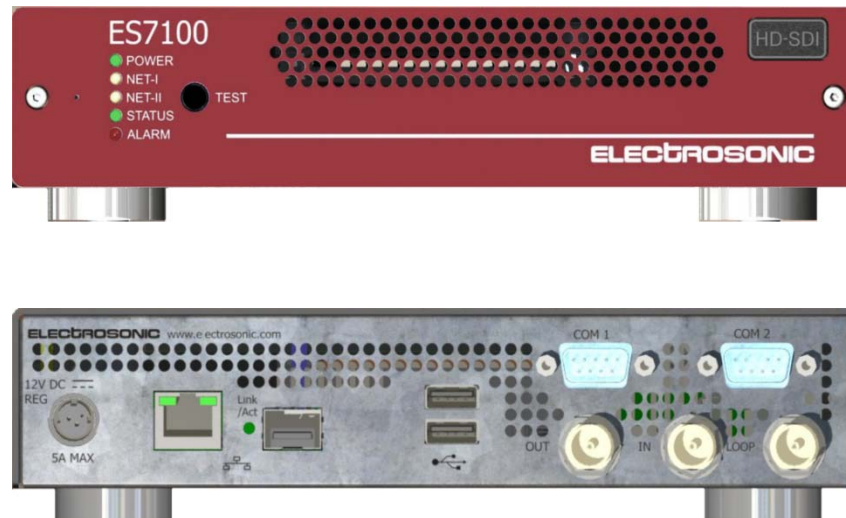
Feature/Attribute	Rationale
Support for Video Resolutions: - SDI, HDSDI & 3G SDI	- Full range of signal inputs in ES7100 range
Computer Resolution Support: XGA, SXGA, UXGA, WXGA... many more	- Computer graphic signal support implemented in ES6100 range
4:4:4 Color Sampling	<ul style="list-style-type: none"> - Quality preservation - Color sensitive applications - Computer graphics
10 Bit Depth	- Preserve SDI bit depths
Low delay (maintained in all conditions)	- No compromise on delay for user interaction and total system delay
Independent Spatial & Temporal Compression	<ul style="list-style-type: none"> - Preserve Quality - Increased compression efficiency

PURE.3 CODEC
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Feature/Attribute	Rationale
Embedded Error Concealment	<ul style="list-style-type: none">- Reliable delivery on lossy networks- No need for FEC on video bitstream- Greater variety of network options- Greater economic network options
Licensed upgrade path	<ul style="list-style-type: none">- Preserve investment value- SDI > HDSDI > 3G SDI
Small footprint	<ul style="list-style-type: none">- Dimensions: 215 x 310 x 55 mm- 30 Watts Power, very quiet
Licence Free	<ul style="list-style-type: none">- Customer avoids fee
Interoperability	<ul style="list-style-type: none">- Interoperable with Serial Digital Video Stds.- Application of standard does not guarantee interoperability

Electrosonic ES7100 Encoder/Decoder

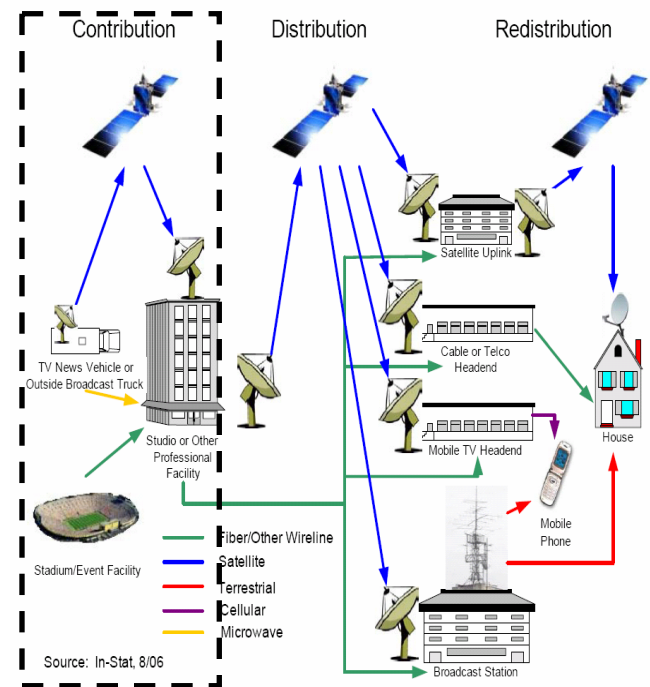
- The Electrosonic ES7100 Codecs distribute and switch SDI, HDSDI and 3GSDI contribution quality video across IP networks.
- We have set out to provide “wired” qualities at reasonable IP bandwidth



ES7100 Video over IP Requirements – Live & Produced Media

Performance	Contribution	Primary Distribution	Distribution & Redistribution
Delay	Low and High	Low and High	High
Bit Rate	Low and High	Low and High	Low
Destinations	Few	Few to Moderate	Many
Connectivity	Closed Form	Closed & Open	Open
Application Focus	High Quality	High Quality Interoperability	Interoperability Low bit rate
Low delay	Valuable	Valuable	Not critical
Example Compression	PURE-3 MPEG I-Frame JPEG2000	PURE-3 MPEG I-Frame JPEG2000	H.264 MPEG-2

Figure 2. Real-Time Broadcast MPEG Encoder Segments



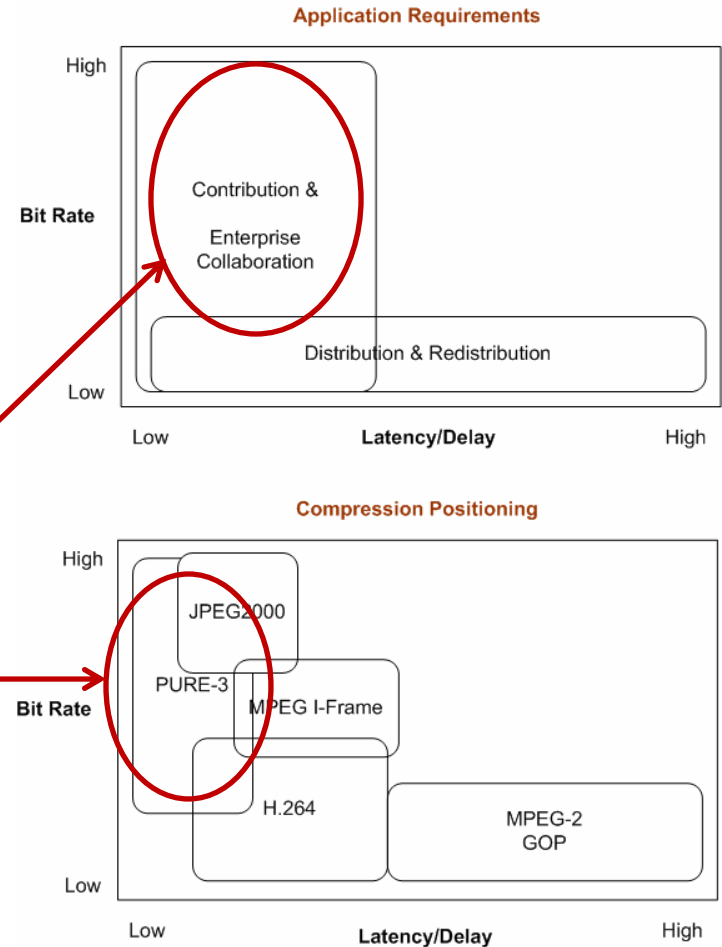
Application Focus:

- High Quality Applications
- Low Delay
- Closed Form Solutions



ES7100 Encoder/Decoder Compression Positioning

- **Contribution & Enterprise Communication:**
 - High quality
 - Editable
 - Low delay
- **Distribution & Redistribution requirements:**
 - Low bit rate
 - High delay acceptable
- **PURE-3 Codec & ES7100 Positioning:**
 - Contribution Grade Applications
 - High Quality
 - Low Delay
- **Use MPEG-2 and H.264 for super-low bit rate applications**



The ES7100 Encoder / Decoder Application in Contribution Grade Applications

Video over IP transport: Quality Critical

- High Quality Applications
 - Sports Contribution, e.g. Sports & Events
 - Primary Distribution
 - Fixed point ENG

- Low Delay Applications
 - Remote Voice Over
 - Interactive Broadcasts
 - Studio-Studio – Interview
 - Live Events
 - Enterprise Communication

- IP Network Application Utility
 - Redundant Links
 - Signal Monitoring
 - Delivery – alternate Networks



ES7100 – Technical Requirements for ES7100

Requirement	Detail																				
Endpoint	ES7100 unit at network end points																				
Signal Input	- Serial Digital Video, ANC & Embedded Audio																				
Network Connectivity	- Ethernet or Optical Ethernet																				
Delivery	<ul style="list-style-type: none"> - IP packets, RTP (UDP or Multicast) - Fiber: Ethernet media conversion to CWDM <table border="1"> <thead> <tr> <th>Network type</th> <th colspan="2">LAN</th> <th colspan="2">WAN</th> </tr> </thead> <tbody> <tr> <td>Delivery</td> <td>Switched</td> <td>Routed</td> <td>Routed</td> <td>VPN</td> </tr> <tr> <td>UDP</td> <td>√</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>Multicast</td> <td>√</td> <td>√</td> <td><i>Rare</i></td> <td>√</td> </tr> </tbody> </table>	Network type	LAN		WAN		Delivery	Switched	Routed	Routed	VPN	UDP	√	√	√	√	Multicast	√	√	<i>Rare</i>	√
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Network QoS	<ul style="list-style-type: none"> - Best results: Packet loss Ratio not to exceed 1:10,000 - Connection maintained at Packet Loss 1:1,000 - Jitter and bit errors not a significant concern 																				
Signal Output	<ul style="list-style-type: none"> - Serial Digital Video - Embedded Audio 																				
Power	- 30W per unit (120/220VAC)																				

ES7100 – Technical Requirements for Contribution

Bit Rates, adjustable, depending upon:

- Available bandwidth
- Quality focus

Quality	Single-Generation	Multi-Generation	Sate-llite	IP	Micro-wave	Fiber
Application Focus	<ul style="list-style-type: none"> • Direct Viewing • Talking Head • Monitoring 	<ul style="list-style-type: none"> • Editing • Challenging Content 	•ASI			
SDI	10 Mbps	20 Mbps	X	√	√	√
HD-SDI	50 Mbps	100 Mbps	X	√	√	√
3G-SDI	100 Mbps	200 Mbps	X	√	√	√
Latency	<ul style="list-style-type: none"> • Hardware originated encode/decode latency consistent in all conditions • Network latency is independent of encoder/decoder • Customer makes choice on connection/quality/bit rate 					



Embedded ANC Data

Uncompressed Audio Groups:

- SDI (block of 4): 8 Mbps
- HDSDI (block of 4): 15 Mbps
- More blocks available
- Stereo Audio Only: 2Mbps uncompressed

PURE-3 Advantages: 4:4:4 & 4:2:2 Color Support

Electrosonic's PURE³ compression technology supports 4:2:2 and 4:4:4 color preservation

4:2:2



4:2:0



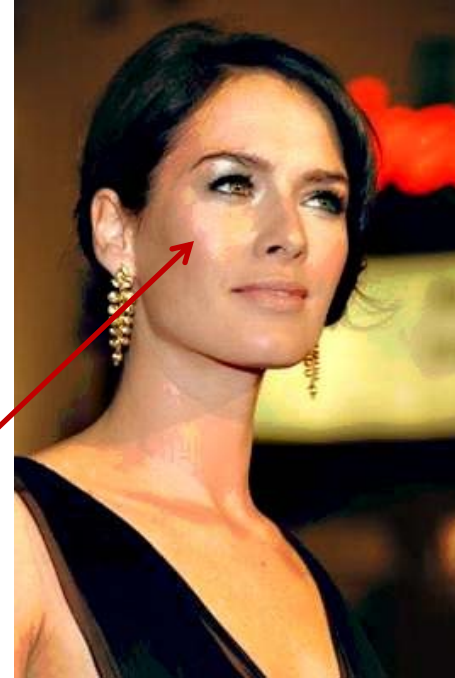
Advantage ES7100: Color Quality Preservation

- 4:2:2 Color preservation is rare in encoders
- 4:4:4 Color preservation is even rarer

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OPTIMIZED FOR NETWORKS

PURE-3 Advantages: 10 Bit Depth

Electrosonic's PURE³ compression technology supports 10 Bit video depth preserving video image detail



**Poor bit
depth**

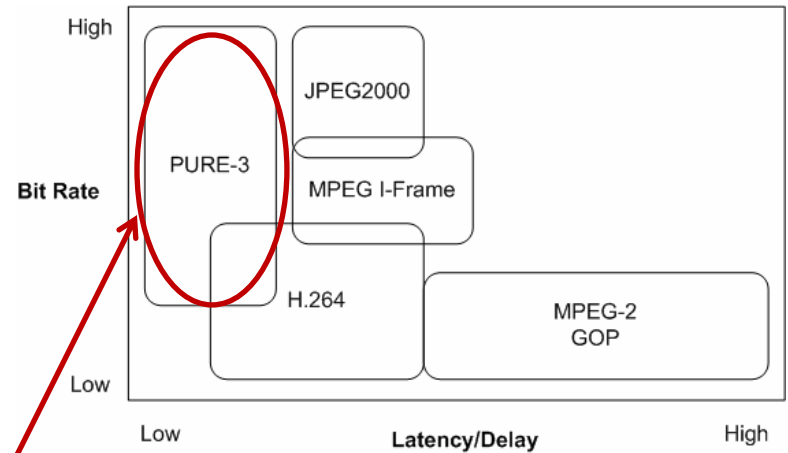
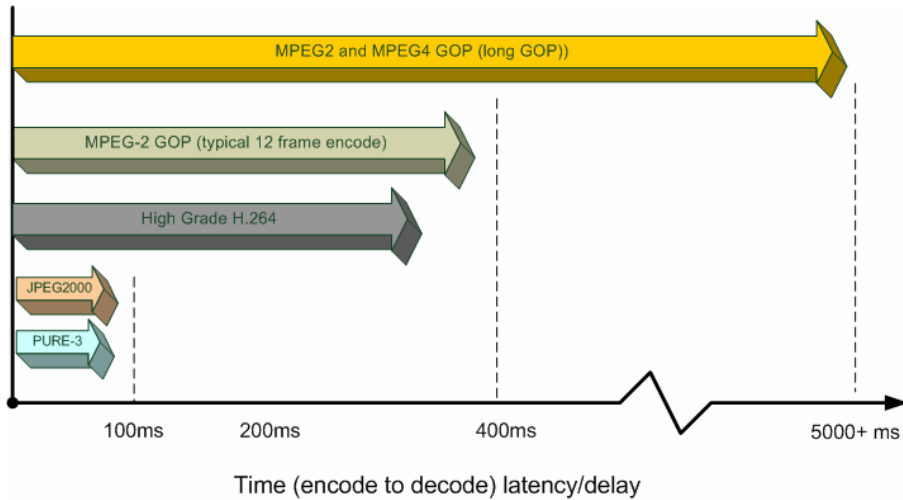
Advantage ES7100: Color Quality Preservation

- 10 Bit depth video
- H.264 and MPEG encoders are typically 8 Bit Video
- Compression introduces uncertainty to the bit depth topic

PURE³ CODEC
OPTIMIZED FOR NETWORKS

PURE-3 Advantages: Low Latency

Target - "Stay under 200ms"



Low delay

PURE-3 Advantages: Error Concealment

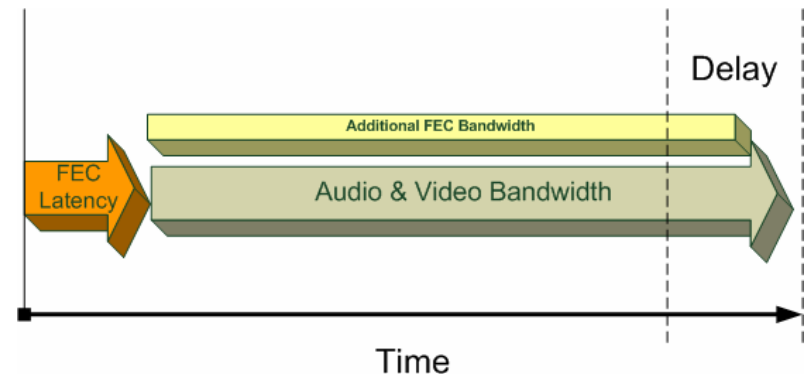
“All networks experience bit errors and dropped packets”

PURE-3 Embedded Error Concealment provides reliable delivery over IP networks, even under conditions of heavy packet loss.

Quality of Service QoS

- **Problem Definition:** Matching the application to the network
 1. QoS *required* by the application (visual perceived quality)
 2. QoS *offered* by the network
- QoS can include correcting networks by FEC overhead
- But how much FEC do you need?
- To date: Unresolved network management problem

***“The cost of applying FEC is:
1.) Extra delay
2.) Extra bandwidth”***



PURE-3 Advantages: Network Economic Summary

- ES7100 can be used on a variety of network services
- Error concealment ensures expensive legacy networks are not required
- The cost of high QoS, legacy IP networks (ATM, MPLS) relative to Ethernet Data/Voice service can be:
 - 2x CAPEX
 - 2x OPEX
- Increasing demand for data/voice services will drive the cost of Ethernet/data/voice connections down faster than legacy, high QoS services
- Note: Network service cost will vary by geography and economic conditions.



Summary Advantages & Disadvantages

Category	PURE-3	JPEG2000	H.264	MPEG-2	Value
Latency	Low	Low	Medium	High	Interactive applications Total end-end delivery
Bit Rate	Medium	High	Low	Low	A range of connections Network economics
Absolute Frame Quality	Yes	Yes	No	No	Clean, editable frames
10 Bit, 4:2:2 Video	Yes	Yes	Yes	No	Video quality preservation
Error concealment	Yes	No	No	No	Low delay maintained Bandwidth not increased Range of network connections CAPEX & OPEX operating costs
Interoperability	No	???	Yes	Yes	
Use of standards based compression	No	Yes	Yes	Yes	Installation base Common industry knowledge
Upgradeable product SDI>HDSDI>3G SDI	Yes	No	No	No	Value over time preserved

Sample of Customer Applications

Application	Customer	Application
Broadcast	Traffic Updates – Netherlands	Studio to Studio delivered over DSL
Broadcast	HDSDI Video Transport	HD delivered over former fiber link
Broadcast	Remote Real Time Production	Multi-viewer Remote Control over IP
Enterprise	Control Room	Monitoring Extension, Microwave
Enterprise	King's College PCP	Staged Medical Telepresence
Enterprise	US Navy & Central Command	Video and Graphics Distribution
Sample Projects in Evaluation Phase:		
Enterprise	Post Production	Colour Grading with Customer - Telepresence
Enterprise	House of Worship	House of Worship, immersive large screen for teaching pastor
Broadcast	Sports	Link stadiums for sports event
Broadcast	Contribution	Studio – Studio over IP link
Broadcast	HD News Collection	Fixed IP collection points
Enterprise	High Performance Telepresence	3G SDI requirements, Large Screen

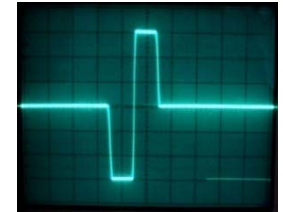


Note: Early projects, product launched prior to IBC

Future Potential

The ES7100 provides **Genlock** and **Framelock** performance

Framelock preserved even under conditions of **network packet loss**



- **Passive 3D video delivery**

- Contribution
- Telepresence



- **4k Streaming applications**

- 4 x 1920x1080 inputs (3840 x 2160)
- Contribution
- Telepresence



Simple integration across IP connections

Summary Points

- **Robust transport**
 - Embedded Error Concealment
 - Will allow greater use of lower cost network services
 - Riding cost curve of voice/data service
- **Increased customer use of low delay applications**
 - Predictable & Uniform
 - Far more useable
- **Uniform compression quality preserved**
 - Predictable quality over a variety of content
 - Visually lossless, large screens, low delay

