Rubin, Bednarek and Associates
Washington, DC

TECHNICAL MEMORANDUM

Date: May 9, 1991

To: Al Caprioglio
Fm: Philip Rubin

Sb: Budget for Video Compression Project

Phase 1 - Product Development

This phase involves the design of the product, fabrication of several units and laboratory testing. In our plan, the first version is NTSC, and the second is PAL but this could change. The second version would be available within three months of the first. Because of time constraints on production of the first units, documentation would be minimal, but enough to allow us to construct the first batch.

For design of the NTSC encoder and decoder we would require:

3 design engineers and program manager for 12 months - $270,000
Equipment costs - $40,000
Parts - $30,000

PAL encoder and decoder:

1.5 design engineers for 10 months - $85,000
Equipment costs - $15,000
Parts - $20,000

Phase 2 - Production of Codecs - For the initial run of fifty units made by RBA at our lab:

$30,000 per encoder
$5,000 per decoder

Time to produce: Three months

(go to next page)

Phase 3 - Outside production

Best assumption is: encoder - $15,000 *
decoder - $ 2,500 *

Time to produce units - estimated six months for 500 units, some available much sooner. Actual final cost depends on number produced.

* CLI is selling Spectrum Saver units at present for:

encoders - $70,000
decoders - $ 4,000

Broadcast quality units would cost more than twice as much since production would be lower and unit is more complicated.

None of these prices include the uplink modem, nor the downlink demod. We will have to talk to Comstream about these costs. At worst, the uplink modem is the CM121 which retails for $7500, and this is probably what it will be. The demod is much less, but at present we don't know how much. We understand CLI pays $400 for their card, but we are not certain of this. My worst estimate is $2,500. My best estimate is $750.

FACSIMILE COVER SHEET

COMMUNICATIONS SYSTEMS DEVELOPMENT
1610 Q STREET NORTHWEST
WASHINGTON, D.C. 20009
FAX: (202) 986-2116
VOICE: (202) 328-9232

TO: Tom

COMPANY: CWA

FAX #: (703) 847-8804

DATE: May 10, 1991 TIME: 1:15 pm

FROM: Al

Including this cover sheet, there will be 5 pages

Tom -

This is a preliminary assessment of the Panamsat demonstration/codec survey.

How can we compare perf?
eg RBA ?

	G1	CL1	RBA	SA
Cost Encoder	1500-2000	<50K	30K	
Decoder		1500	5K	
BER avail demo	10/29 92 TDM	30 91	—	
Int demo BC			9/92	
BC sig/high	2-4		10-11	
BC bit rate		10-11	var→3	
$ investment			500K	

Clay Whitehead Associates

MEMORANDUM

To: Tom

From: Al

Date: May 10, 1991

Subject: Panamsat - Video Compression Survey

GI VideoCipher - Mark Medress

Configuration: GI's system allows from 2 to 10 NTSC channels per satellite transponder. The video channels are multiplexed on a single 30 Mbps TDMA carrier, requiring 24 Mhz of transponder bandwidth. GI will develop a modification in the future which will allow SCPC operation.

Performance: Ranges from entertainment through broadcast quality; the number of channels which can be multiplexed on the 30 Mbps signal is a function of the quality desired and the program source:

Quality Level	Video Source	Film Source
Broadcast	2-4	6-8
Cable	4-6	8-10
Entertainment	6-8	10

Cost: Medress would not quote prices without a non-disclosure agreement (he has discussed this with Fred Landman), but stated that the decoders would be comparable to the VideoCipher decoders: $1500-2000 each. He would not estimate encoder figures (pricey, I'm sure).

Schedule: Field test of prototypes is planned for late '91, early '92, followed by equipment production. He would not speculate on the number that would be available, but said that the demonstration could use either prototypes or production. Five prototype decoders would be available by the end of the year. The encoders would be built to order.

Operational Issues:

- Multiple signals must originate from a single source.
- The system approach favors film over video sources by a factor of almost two.

- Final production equipment will be export controlled due to the use of DES encryption; an experimental (demonstration) approach may modify this. (GI apparently is participating in the European Broadcasting Conference in Montreux in June.)

Credibility: GI's reputation is a good one; the standard allowance for sales optimism in estimating schedule should be factored in. Performance should be demonstrated to Panamsat's satisfaction.

CLI - Mike Stauffer

Configuration: CLI is developing a dual-mode system which will accommodate both business-quality (entertainment) and cable-quality video performance. A broadcast quality system is in the works, but won't be available until later; a prototype is planned for first or second quarter 1992.

Performance: Data rates for entertainment and cable quality performance are 3.6 Mbps and 7.2 Mbps, respectively (video rates are 2 Mbps and 5 Mbps). The lower data rate has motion problems from video sources (i.e., sports). CLI claims that at the higher data rate video is indistinguishable from film. The broadcast-quality system will be at 10-11 Mbps (video 7-8 Mbps).

Cost: Per Stauffer, the decoders will be in the $1500 range, with the encoders under $50K.

Schedule: The dual-mode product will be available in the 3rd quarter of '91; per Stauffer, 2 - 5 dual-mode encoders and 30 decoders are "no problem". A prototype of the broadcast quality unit may be available in the 1st quarter '92. One possible approach is to have an early demonstration of a cable-quality system, transitioning to the broadcast-quality units, probably six months later. Phil's take on the broadcast quality codec is that it hasn't been started yet. Stauffer's comment had been that money was almost available for the broadcast quality codec.

Operational Issues:

- This unit is compatible with SCPC operation.
- The lower data-rate of the dual-mode system is not usable for sports video.
- The dual-mode unit is not compatible with the broadcast-quality unit in process; however, the units could be traded for the broadcast equipment when available.

Credibility: CLI is also a credible organization. As in all things video-related, there is a large amount of subjective evaluation associated with performance; Panamsat must assure themselves of the acceptability of the compressed video to themselves and their clients.

Scientific-Atlanta - Alan Eckert

After explaining Panamsat's objectives to him, Eckert had requested a meeting, rather that going over his system on the phone; he had asked that we (you and I and Phil) attend a briefing/demo in Atlanta. Per discussions with you and Phil, a meeting in Atlanta won't be possible; I will contact Eckert to propose a combination of telephone, fax and the mail to gather the data we need.

Preliminary discussions with Phil and Bill Meeker don't leave me optimistic about SA's system vis-a-vis broadcast quality performance.

Rubin and Bednarek - Phil Rubin

Configuration: Phil proposes a system that will be variable, allowing a performance range from entertainment quality through cable quality, to broadcast quality.

Performance: Compressed video rates will range from approximately 3 Mbps through 10-11 Mbps for broadcast quality.

Cost: Development costs are estimated to be $460K; beta test units are available at the conclusion of the development phase. For the initial run of fifty units produced by RBA, the decoder price is estimated at $5000; $30K for the encoders. Prices are proposed as cost plus 20%. In the outside production phase, encoder and decoder prices are estimated to be $15K and $2500, respectively.

Schedule: Development will take one year from go-ahead, with up to fifty production units available three months after completion of development testing (production long-lead parts would have to be ordered prior to completion of development testing).

Operational Issues:

- The unit would be compatible with SCPC operation.
- Units would have broadcast quality at the outset of the demonstration.
- Equipment availability is approximately 15 months from go-ahead.

Credibility: Although the standard organizational infrastructure to develop and produce new codecs doesn't already exist, the combination of direct experience in codec development (Bill Meeker) and the track record in delivering PAS-1, is positive. Appropriate attention and focus, of course, is required.

Preliminary Assessment

GI's TDMA approach imposes an operational limitation inconsistent with Panamsat's objectives; it is not clear to me that an SCPC approach is planned for the near future.

CLI's dual-mode system does not produce broadcast quality. but its availability is consistent with the objective of an early demonstration. One approach would be to configure a demonstration using the cable-quality codec, followed by integration (actually, replacement) of the broadcast quality unit when it is available. However, development of this unit probably has not started, since CLI tells me that they are just about to finalize funding for that project. The schedule of prototype in the first quarter of '92 may be soft.

Discussion of SA's system awaits further data.

Rubin and Bednarek's proposal has the advantage of delivering a product specifically tailored to Panamsat's requirements: broadcast quality performance for a video (as opposed to film) product originating from different locations. However, demonstration units would not be available until fifteen months after go-ahead.

An approach which would allow early demonstration while permitting development of a broadcast quality codec consistent with Panamsat's objectives is to utilize CLI's codec for an early demonstration in parallel with development of Rubin and Bednarek's broadcast quality codec. That codec would then be utilized in the operational system.

Panamsat's customers are interested in a transparent system that gives them performance at an economical price. The multiple-video channels per transponder system should produce the latter. The former requires broadcast quality codecs, which are not available for an early demonstration. Using CLI's codecs to get the customers' attention, followed by the RBA high-performance operational system looks like it may fill the bill.

Clay Whitehead Associates

1320 Old Chain Bridge Road, McLean, Virginia 22101 Phone 703-847-8787 Fax 703-847-8804

FACSIMILE MEMORANDUM

To: Fred Landman

Fax: 1-203-622-9163

From: Clay T. Whitehead CT

Date: May 17, 1991

Subject: Digital Compressed Video Demonstration

As we discussed, I have had Al Caprioglio research the digital compressed video (DCV) field to see how we could do an early demonstration. The results are as follows:

General Instruments is focused exclusively on its TDM product. It will provide variable bit rates per video signal, permitting anything from home VCR quality to broadcast quality, but with the restriction that all uplinking for a transponder must be from only a single site. Prototypes will be available in the first quarter of 1992, but the inability to handle signals from multiple uplink locations makes it unacceptable for our use.

CLI is developing a variable-rate system that can be used SCPC, but only for 2 Mbps "entertainment quality" or 5 Mbps "cable quality." The 5 Mbps mode should permit 5 - 6 signals per 36Mhz transponder. These units should be available for a demonstration late this year. CLI is very vague about when a broadcast-quality system might be available.

The key issue is the quality of the CLI cable-quality mode for our purposes. Phil Rubin thinks it is inadequate for video (as opposed to film) sources. I think we have to see it to make a judgment. They will send a half-inch video tape demonstration if you can locate a half-inch tape player; we can then go to California if we want to see more.

Scientific Atlanta says they are developing something, but Phil thinks it is inadequate and absent going to Atlanta for a presentation, Al tends to agree.

Rubin Bednarek wants to develop their own system. Phil believes none of the above players see enough of a market for broadcast quality units to justify putting resources on it for the time-being. Al concurs since there is no great pressure from the broadcasters for such a capability. Phil says he can develop a broadcast quality system in about nine months for about $460,000. He very much wants to do this and is talking to other companies about funding it. Enough units for our demonstration might be available by May or June next year.

Discussion: Our market requires broadcast quality transmission. The Rubin system would give us the earliest availability of such capability, but would be 6-9 months later than the CLI cable-quality system. If the Rubin system turned out well and if we had control of it, we could not only be the first to have such a capability, but could establish it as some kind of industry standard.

However, if the CLI system would provide adequate quality for both video and film sources, we could use it for the U.K. cable and C-SPAN applications and also for the Olympics in Spain next summer. I doubt that we could count on Rubin for the Olympics, but Phil might want to give it a try.

The final production cost of the equipment for the CLI and Rubin systems should be about the same in quantities. However, for the demonstration, the CLI equipment will be less expensive since the decoders will be produced in volume while the initial Rubin decoders will be produced in small quantities. For a demonstration with ten encoders and 50 decoders, the costs are estimated to be as follows:

	CLI	Rubin
Development		460,000
10 encoders	475,000	375,000
50 decoders	125,000	300,000
Total for demo	600,000	1,135,000

Remember this is apples and oranges. The CLI system is an interim demonstration system, and the Rubin system is broadcast quality that can be taken to quantity production. CLI has said they will allow us to trade in their equipment for their broadcast quality equipment when it is available.

If you assume $2 million per year in revenues for a transponder for analog video and $750,000 per year per DCV channel with four channels per 36 Mhz transponder, the payback on these two systems is about seven months for CLI and fourteen months for Rubin – not bad either way. Moreover, the Rubin system could be used for other transponders to generate more revenue from PAS-1 prior to the launch of PAS-2.

Phil thinks his system is a clear winner and is annoyed you haven't made a commitment to him on this. Al agrees that it is likely to be some time before a broadcast quality system is available. A shorthand comparison of pros and cons looks like this:

CLI	Rubin
Short-term cash flow	Higher quality video
Available sooner	Available later
Not useful for other transponders	More schedule risk
Short-run usefulness only	Long-run benefit

On balance, I would go for the Rubin system with some clear and tight controls:

- Alpha Lyracom should own the rights to the system, with some commission for Rubin on sales of future units.
- Alpha Lyracom should be free to drop the funding at any time and/or to buy the CLI demo equipment if Rubin isn't making satisfactory progress.

FACSIMILE COVER SHEET

COMMUNICATIONS SYSTEMS DEVELOPMENT
1610 Q STREET NORTHWEST
WASHINGTON, D.C. 20009
FAX: (202) 986-2116
VOICE: (202) 328-9232

TO: Tom

COMPANY: CWA

FAX #: (703) 847-8804

DATE: May 10, 1991 TIME: 1:15 pm

FROM: Al

Including this cover sheet, there will be 5 pages

Tom -

This is a preliminary assessment of the Panamsat demonstration/codec survey.

al

Clay Whitehead Associates

MEMORANDUM

To: Tom

From: Al

Date: May 10, 1991

Subject: Panamsat - Video Compression Survey

GI VideoCipher - Mark Medress

Configuration: GI's system allows from 2 to 10 NTSC channels per satellite transponder. The video channels are multiplexed on a single 30 Mbps TDMA carrier, requiring 24 Mhz of transponder bandwidth. GI will develop a modification in the future which will allow SCPC operation.

Performance: Ranges from entertainment through broadcast quality; the number of channels which can be multiplexed on the 30 Mbps signal is a function of the quality desired and the program source:

Quality Level	Video Source	Film Source
Broadcast	2-4	6-8
Cable	4-6	8-10
Entertainment	6-8	10

Cost: Medress would not quote prices without a non-disclosure agreement (he has discussed this with Fred Landman), but stated that the decoders would be comparable to the VideoCipher decoders: $1500-2000 each. He would not estimate encoder figures (pricey, I'm sure).

Schedule: Field test of prototypes is planned for late '91, early '92, followed by equipment production. He would not speculate on the number that would be available, but said that the demonstration could use either prototypes or production. Five prototype decoders would be available by the end of the year. The encoders would be built to order.

Operational Issues:

- Multiple signals must originate from a single source.
- The system approach favors film over video sources by a factor of almost two.

- Final production equipment will be export controlled due to the use of DES encryption; an experimental (demonstration) approach may modify this. (GI apparently is participating in the European Broadcasting Conference in Montreux in June.)

Credibility: GI's reputation is a good one; the standard allowance for sales optimism in estimating schedule should be factored in. Performance should be demonstrated to Panamsat's satisfaction.

CLI - Mike Stauffer

Configuration: CLI is developing a dual-mode system which will accommodate both business-quality (entertainment) and cable-quality video performance. A broadcast quality system is in the works, but won't be available until later; a prototype is planned for first or second quarter 1992.

Performance: Data rates for entertainment and cable quality performance are 3.6 Mbps and 7.2 Mbps, respectively (video rates are 2 Mbps and 5 Mbps). The lower data rate has motion problems from video sources (i.e., sports). CLI claims that at the higher data rate video is indistinguishable from film. The broadcast-quality system will be at 10-11 Mbps (video 7-8 Mbps).

Cost: Per Stauffer, the decoders will be in the $1500 range, with the encoders under $50K.

Schedule: The dual-mode product will be available in the 3rd quarter of '91; per Stauffer, 2 - 5 dual-mode encoders and 30 decoders are "no problem". A prototype of the broadcast quality unit may be available in the 1st quarter '92. One possible approach is to have an early demonstration of a cable-quality system, transitioning to the broadcast-quality units, probably six months later. Phil's take on the broadcast quality codec is that it hasn't been started yet. Stauffer's comment had been that money was almost available for the broadcast quality codec.

Operational Issues:

- This unit is compatible with SCPC operation.
- The lower data-rate of the dual-mode system is not usable for sports video.
- The dual-mode unit is not compatible with the broadcast-quality unit in process; however, the units could be traded for the broadcast equipment when available.

Credibility: CLI is also a credible organization. As in all things video-related, there is a large amount of subjective evaluation associated with performance; Panamsat must assure themselves of the acceptability of the compressed video to themselves and their clients.

Scientific-Atlanta - Alan Eckert

After explaining Panamsat's objectives to him, Eckert had requested a meeting, rather that going over his system on the phone; he had asked that we (you and I and Phil) attend a briefing/demo in Atlanta. Per discussions with you and Phil, a meeting in Atlanta won't be possible; I will contact Eckert to propose a combination of telephone, fax and the mail to gather the data we need.

Preliminary discussions with Phil and Bill Meeker don't leave me optimistic about SA's system vis-a-vis broadcast quality performance.

Rubin and Bednarek - Phil Rubin

Configuration: Phil proposes a system that will be variable, allowing a performance range from entertainment quality through cable quality, to broadcast quality.

Performance: Compressed video rates will range from approximately 3 Mbps through 10-11 Mbps for broadcast quality.

Cost: Development costs are estimated to be $460K; beta test units are available at the conclusion of the development phase. For the initial run of fifty units produced by RBA, the decoder price is estimated at $5000; $30K for the encoders. Prices are proposed as cost plus 20%. In the outside production phase, encoder and decoder prices are estimated to be $15K and $2500, respectively.

Schedule: Development will take one year from go-ahead, with up to fifty production units available three months after completion of development testing (production long-lead parts would have to be ordered prior to completion of development testing).

Operational Issues:

- The unit would be compatible with SCPC operation.
- Units would have broadcast quality at the outset of the demonstration.
- Equipment availability is approximately 15 months from go-ahead.

Credibility: Although the standard organizational infrastructure to develop and produce new codecs doesn't already exist, the combination of direct experience in codec development (Bill Meeker) and the track record in delivering PAS-1, is positive. Appropriate attention and focus, of course, is required.

Preliminary Assessment

GI's TDMA approach imposes an operational limitation inconsistent with Panamsat's objectives; it is not clear to me that an SCPC approach is planned for the near future.

CLI's dual-mode system does not produce broadcast quality, but its availability is consistent with the objective of an early demonstration. One approach would be to configure a demonstration using the cable-quality codec, followed by integration (actually, replacement) of the broadcast quality unit when it is available. However, development of this unit probably has not started, since CLI tells me that they are just about to finalize funding for that project. The schedule of prototype in the first quarter of '92 may be soft.

Discussion of SA's system awaits further data.

Rubin and Bednarek's proposal has the advantage of delivering a product specifically tailored to Panamsat's requirements: broadcast quality performance for a video (as opposed to film) product originating from different locations. However, demonstration units would not be available until fifteen months after go-ahead.

An approach which would allow early demonstration while permitting development of a broadcast quality codec consistent with Panamsat's objectives is to utilize CLI's codec for an early demonstration in parallel with development of Rubin and Bednarek's broadcast quality codec. That codec would then be utilized in the operational system.

Panamsat's customers are interested in a transparent system that gives them performance at an economical price. The multiple-video channels per transponder system should produce the latter. The former requires broadcast quality codecs, which are not available for an early demonstration. Using CLI's codecs to get the customers' attention, followed by the RBA high-performance operational system looks like it may fill the bill.