UMSL INTERNATIONAL BUSINESS CASE COMPETITION

INAUGURAL COMPETITION

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MASTERCLOCK, INC

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Masterclock, Inc.,

"Time is money"

- Benjamin Franklin -

BRIEF HISTORY

When the era of railroads was ushered in by a new wave of locomotive technology and an expansive public commitment to connecting people in an unprecedented way, new worlds were opened in the minds of many in those countries where the railroads boomed. Goods could be delivered across vast distances in a fraction of the time previously required and millions of people were now interconnected in a very real way.

A byproduct of this railroad revolution was the increasing need of keeping the various stations on the same time schedule to avoid train collisions. Previously, each town would have a local sundial used to establish a time reference to the position of the sun at any given point during the day. Differences of terrain between different geographical aspects of towns had to allow for a possible variation of up to +/-60 minutes in the time as displayed by the sundial in different locations, creating confusion and a need for a consistent reference.

The advent of the electric telegraph ushered in a new means of communication. Electrical wires were installed along railway lines and provided station operators with an efficient means to ensure that their station clocks were synchronized to each other. In the 1840s, operators decided to synchronize their time schedules of their stations to that of a central location known as Greenwich Mean Time (GMT) at the Greenwich Observatory in Greenwich, England. GMT signal information was distributed to all stations along the route, ensuring that each station had a central reference. Many of these stations were hundreds of kilometers away from each other and needed a way to

accommodate the geographical delay in time. Today, time zones wrap the globe and give users a means to understand their reference to other places on Earth – St. Louis is "GMT-6", or 6 hours behind whatever time is currently understood in Greenwich, England.

The concept of providing a singular reference to multiple places on Earth at the same time took off with the advent of the Global Positioning System (GPS) in 1973. With 24 satellites circling the Earth at a given time, any point on the globe is within direct line-of-sight with at least 4 satellites. This ability to communicate timing information globally and instantly ushered in a new era of navigation and synchronization.

Each satellite provides two types of information in each message that it relays-

- the time the message was transmitted
- satellite position at time of message transmission

A GPS receiver will calculate the amount of time each message took to arrive and will multiply this time by the speed of light (186,000 miles/second), giving each signal a transmit distance. These distances are then compared against the satellite positioning information included in the original message and the instrument's location against those of the satellites can be calculated.

Accurate time signals were of the highest importance in the invention of the GPS system. Each satellite contains 4 atomic clock references and uses the average of the group as a time reference. An atomic clock is a clock device that uses an electronic transition frequency in the microwave, optical, or ultraviolet region of the electromagnetic spectrum of atoms as a frequency standard for its timekeeping element. The atomic clocks installed in each GPS satellite offered a level of accuracy in timing previously unavailable to much of the world and could now be tracked anywhere on Earth.

MASTERCLOCK'S ORIGINS

Masterclock was originally started by William "Bill" Clark in 1994 in the family garage. Mr. Clark was looking for ways to incorporate personal computers more fully into the traditional broadcast operations and realized the need to achieve synchronization between the PC and the various other pieces of equipment. Live broadcasts required all of the instruments in the facility to be working simultaneously, leading to the invention and utilization of a timing signal known as time code. Time code is a repeating set of information messages generated at regular intervals to provide a reference to devices connected to the same system. Personal computers needed to have a way to synchronize to the available time code in a studio so Mr. Clark began marketing the company's first product, the TCR-100 time code reader card. These cards could be installed in computers to enable producers to utilize computer-processing power alongside their existing equipment.

The company added more products related to the generation and distribution of time code and over the next 5 years saw an annual growth rate above 30%. Broadcasters would use GPS receivers to generate time code referenced in real time to GMT –this enabled stations in far-off geographic locations to be synchronized to each other. The Masterclock GPS200 time code generator provided an accurate time code signal referenced to GPS and helped the company grow throughout the decade.

The development and growth of the Internet opened up new possibilities for time distribution using a signal called Network Time Protocol (NTP). NTP data can be sent over standard Ethernet connections and includes an accurate time stamp message. Varying locations could now synchronize their systems without needing a GPS reference but accuracy was limited. Many industries require accuracy within their electronic systems much greater than Ethernet distribution systems can accommodate and preserved the need in the market for GPS based time references.

Currently, Masterclock offers products that generate/receive time code, NTP, and a variety of other signals used by many types of equipment. In addition to these timing devices, the company manufactures both analog and digital clocks with varying features and functions and a suite of accessories to enhance the utility of the displays.

Masterclock currently serves a variety of industries with their catalog. Major customers and projects that Masterclock has completed over the years include:

- NASA
    - Re-design of the timing system for the Kennedy Space Center in Florida
- Microsoft
    - Digital clocks standardized throughout Microsoft corporate for use in their facilities
- CBS
    - GPS-based NTP server standardized throughout CBS radio and TV stations
- Chrysler
    - Design and installation of Central Timing system in all factories
- General Atomics
    - GPS-based NTP server designed and used in ground control systems for Predator Unmanned Aerial Vehicles (drones)
- Canadian Broadcasting Corporation (CBC)
    - GPS-based NTP server standardized for CBC radio and TV stations
- Saudi ARAMCO
    - Design and production of Central Timing system for multiple oil refineries
- Estádio do Maracanã– Rio De Janiero, Brazil
    - Design and production of Central Timing System for upgrades to stadium clock system prior to 2014 FIFA World Cup
- Thailand Tollway Authority
    - GPS-Based Time code servers used along toll way route at each tollbooth.

Masterclock currently receives approximately 60% of sales from the worldwide broadcasting market. For fiscal year 2012, 47% of Masterclock's total revenues were from International Sales.

The company currently has 25 employees in the following roles:

Administration - 3
- o Accounting
- o Shipping/Receiving
- o Human Resource Issues

Sales and Marketing – 3
- o Respond to direct customer inquiries
- o Sweep industry websites and publications to identify potential customers
- o Utilize customer feedback to develop product and system improvement ideas
- o Identify and attend pertinent trade shows
- o Maintain awareness of competitor offerings and pricing

Engineering and Product Management– 5
- o Mechanical Design
- o Software implementation
- o Maintain company network and computer systems
- o Write and maintain product manuals
- o Work with marketing to identify feasible upgrades and additions to product line

Production/Quality Control– 14
- o Utilize various manufacturing methods to build products
- o Purchase required materials
- o Estimate lead times for quotes
- o Handle Return Merchandise Authorizations (RMAs)
- o Inspect outgoing and incoming materials to ensure conformance
- o Provide feedback for engineering for product improvements

TIMING INDUSTRY

Through the 1970s and 80s, a company called Leitch was the dominant player in the broadcast clock market. Leitch Time Code driven clocks set the standard for studio timing and helped the company lead the way in establishing a well-known international presence. Early Masterclock PC cards were sold in the Leitch catalog as an accessory to their systems. Leitch was eventually acquired by Harris Corporation which sought to provide complete solutions to broadcast professionals by combining the offerings of many smaller companies into a single, one-stop shop.

During this time, other companies such as ESE of California and Alpermann-Velte of Germany introduced competing clocks and time servers. These companies entered primarily into broadcasting and eventually evolved into providing timing systems for other industries as well.

The traditional broadcast market has been shrinking domestically as mass media has moved towards a more individually driven model. Media is being consumed more than ever by smart-phone and Pay-Per-View services, diminishing the need for traditional broadcasting methods and facilities. Content creators can now communicate directly with their consumers, eliminating the need for geographically-based TV channels to act as middle-men.

The timing market that Masterclock occupies evolves closely with available technology. In the early 2000s, sales increased as the company developed additional products to serve network timing applications as more and more industry equipment was designed to be included on company networks. As the market increased, competition also increased, leading to more and more competitors from all over the world entering the market.

These newer technologies have introduced players such as Sapling, Inova, and Innovation Wireless. These companies focus on the middle to lower end of quality requirements in systems. Hotels, factories, schools, hospitals – many of these facilities can benefit from precise time but do not rely on it

As potential applications for synchronized timing systems continue to grow in number, more and more companies are beginning to take interest in the timing market. Previously, the market size was small enough that many players chose to avoid the market as the volumes weren't high enough to justify entrance. These new-to-market companies are utilizing offshore manufacturing practices to introduce lower-cost systems based off of the same concepts pioneered by Masterclock and others. These less-expensive, lower-quality systems are flooding the timing market as it expands into various other industries including healthcare, education, sporting events and arenas – essentially anywhere where synchronized, accurate time can encourage efficiency within an organization.

Three technologies are currently driving change within the synchronized timing industry:

1. Power-Over-Ethernet (POE) – POE technology allows both data and power to be sent over a standard ethernet cable, eliminating the need for an AC outlet to be located within a short distance of each clock location. This makes installation much easier for traditional users as it's less wiring and does not require the assistance of someone with electrical knowledge to install clocks in locations not previously accounted for in building design. Installing the clocks on the network allows an operator to use two-way communication with the devices, including the ability to e-mail a user if a clock does not accept updated timing signals. This feature makes these devices very appealing to large installations utilizing Building Management Systems (BMS). A central BMS computer will be used to monitor all the automated aspects of a facility including HVAC systems, sprinkler systems, automated locks, automatic lights, security systems, and clocks. This requires all attached devices to have networking capabilities in order to communicate their status back to the central computer. Masterclock was one of the first-to-market with this technology. Major players include Masterclock, ESE, Alpermann-Velte, Inova, and others.

2. Wireless Networking – Some clocks on the market have built-in wireless capabilities which allow them to tap directly into a building's wireless network for synchronization. This eliminates the need for a clock to be connected physically to a central network system. The drawback is that this type of system still requires a power source – most available battery devices do not provide the lifetime required to eliminate the need for maintenance personnel to change batteries in order to maintain observation of operation. Major players include Sapling and others

3. RF clock systems – A central transmitter will emit a radio frequency throughout a given area and all clocks within that area will automatically synchronize to the

signal. Normally used for much larger insallations requiring hundreds of clocks, these systems still require either a power source to be located near a clock or maintenance personnel to replace batteries. The clocks do not send any data back to the transmitter so accuracy must be confirmed visually. Major players include Innovation Wireless and others.

Clients such as NASA, General Atomics, and various other high-end clients require robust, high-quality solutions will continue to look for solutions produced by American companies for security reasons. Bill Clark's Air Force past qualifies the company as a Veteran-Owned business while the company's size qualifies it as a Small Business –this combination is very favorable for larger corporations who are encouraged with tax breaks to purchase from a diverse group of suppliers such as women-owned businesses, minority-owned businesses, veteran-owned businesses, etc.

TIME TO BUY!

A basic system as defined for this case study consists of a GPS-based Time Server providing NTP to two display clocks.

COMPANY	AVERAGE COST FOR BASIC SYSTEM	QUALITY 1-10
Masterclock	$2046	9
ESE	$2884	9
Alpermann Velte	$2121	8
Sapling	$1724	6
Inova	$1423	5
Innovation Wireless	$1398	5

Most companies that produce these types of products are manufactuers only– they require a separate company based near the project site to perform the installation. A systems integrator is a person or company that specializes in bringing together component subsystems into a whole and ensuring that those subsystems function together. Think of it as a cook preparing a meal – the food items come from different sources but require one entity to combine them correctly according to a recipe. A cook requires baking instructions to know what to put into a meal and how to prepare everything – in the industrial world, these instructions are known as specifications.

Integrators on any given project receive a set of specifications detailing what products are to be installed in the new facility. These specifications can come from a variety of sources including architects, IT directors, third-party engineering consultants, and companies themselves. A key part of Masterclock's sales strategy is to ensure that Masterclock products are specified or can meet specficiations for upcoming projects, i.e. ensuring that cooks use Masterclock sauce instead of another company's sauce to bake their pasta. A single company being specified as the primary manufactuerer on a given project can occur because of:

1. Reputation

- Customers will seek out Masterclock products for their installations because of good results they've heard from other projects. Example – If NASA selects Masterclock products for their facilities then other companies infer a high level of quality in the products.

2. Relationships

- If a company has a good relationship with key decision makers then they can be given preferential treatment during bids. Example – Technician has a good experience with Masterclock products at one TV station and eventually gets a job offer with more responsibilites at a new station, bringing his/her relationship with Masterclock along.

3. Product Qualities

- Having unique equipment eliminates competition when a specific function is required that other equipment can not duplicate. Example – Clock system sold to Duke University Medical center required blue digits for displays and no other manufacturers produced a blue display in the required size.

Many of these integration companies prefer to work with a single company on all of their projects to increase the amount of business done and request larger quantity discounts, thus increasing their margins. These integrators are generally industry specific, limiting their scope within their geographic location. Integrators who specialize in building broadcast studios will not usually be qualified to install an airport timing system.

Developing and maintaining these relationships with integrators is crucial to growing business in a region.

WHERE IN THE WORLD?

Different cultural practices make a single selling model hard to implement globally. Masterclock exhibits at four annual trade shows around the world:

- Broadcast Asia – Singapore

- Cable and Satellite Middle East – Dubai, UAE

- International Broadcasting Convention – Amsterdam, Netherlands

- National Association of Broadcasters - Las Vegas, USA

In addition to these four primary shows, Masterclock currently supplements other shows to try to expand into new locations or markets. This year we're adding:

- National Space Symposium – Colorado Springs, USA

- International Security Conference – Las Vegas, USA

- Mediatech – Johannesburg, South Africa

- International Telemetering Conference – Las Vegas, USA

- Precise Time and Timing Interval Conference – Bellevue (Seattle), USA

Exhibiting at these trade shows allows us to meet our customers and integrators face-to-face and understand their needs better. We also grow the brand to others in the area and gain insight into the business climate and how we can better work within it. Each geographic region has different requirements regarding customer interaction, expected discount levels, paperwork requirements, etc.

Integrators in the Far East tend to be very strict about adhering to specifications when proposing alternative products to those called out by the designer. Success with selling to this market generally requires companies to develop products with unique specifications to ensure that competing offerings will not match up exactly with the required features, eliminating them from the discussion. In most cases where two products both meet the required specifications then bidding comes down to price alone. For FY 2012, around 23% of our International Sales came from the Far East countries.

Example: The below e-mail from our integrator in Singapore is in reference to the attached specifications for National University of Singapore. Our contact was wanting

to find reasons to exclude another company from participating in the tender. Please see the full specifications for the project on page 17 below:

From:
To: "'John Clark'" <jclark@masterclock.com>
Cc: "'Ramiro Benitez'"
Date: Wed, 27 Apr 2011 11:11:36 +0800
Subject: <u>Need immediate advise for university clock tender.</u>
Hi John,

Need your immediate help.
This needs to reach the consultant ASAP!!!

I need some strong technical reason to throw Moba time out of my tender.

Attached is the technical statement we have to comply to and Moba time's proposal.

"Mobatime ECO-DC.57.4.R.N.N.PoE 95pcs

LED digital clock, single sided, for wall mounting. Red LED 7-segment display of hours and minutes.

Digit size 57mm. Plastic case in anthracite colour.

Option PoE: LAN Ethernet input for NTP synchronization and PoE powered

Case body size: 342 x 123 x 44mm

Viewing distance: up to 30m.

Mobatime DC.100.4.R.N.N.PoE 10pcs

LED digital clock, single sided, for wall mounting. Red LED 7-segment display of hours and minutes.

Digit size 100mm. Black anodized aluminium case. IP 40 casing.

Option PoE: LAN Ethernet input for NTP synchronization and PoE powered

Case body size: 510 x 169 x 44mm

Viewing distance: up to 50m.

NMS Network Management System 1pc

Administration software for NTP slave clock: configuration and supervision and more (device auto detection...). Display of devices status (status, time, error) and capability to create logical groups of slave clocks. "

Our proposal for Masterclock is

NTDS24 95pcs

NTDS44 10pcs

Below are some technical non-compliance I have complied.

**PLS NOTE THAT WE NEED MOBATIME'S NON COMPLIANCE TO THE
TECHNICAL DOCUMENT AND NOT DETAILS ABOUT HOW WE ARE SUPERIOR**

2.1.3, CLOCK ENGINEERING REQUIRMENTS AND PERFORMANCE

a) iii) Network clock engineering general specification

- - The network clocks shall be designed to provide years of reliable and maintenance free service and shall be constructed of all metal enclosures with high impact, UV stable lenses to ensure structural integrity and maximum durability.

- - Mobatime Eco DC series uses plastic casing.

g) ii)
- - The network clocks shall utilize an internal maintenance free rechargeable battery backed real-time clock (RTC) to retain the internal time in the event of a power outage or for conditions when the NTP server(s) is not available.
- - I am not sure if "an internal maintenance free rechargeable battery backed real-time clock (RTC) to retain the internal time" function is available
- - During such "free-wheeling" periods and while in operation, the network clocks shall provide a visual indication that the device is relying on the internal oscillator and is not currently synchronized to the network timeserver.
- - No sure if this function is available from their manual.

Regards,
Broadcast Communications International Pte Ltd

Integrators in the Middle East tend to earn business more by building relationships with the client than strict adherence to specifications. Many times a company will have a preferred integrator in mind prior to awarding the project – this requires manufacturers to work closely to build relationships with specific integrators to try to position themselves to win projects by offering "protection" on projects. If a local integrator has an existing relationship with a company looking to build a new factory nearby, the integrator will work to ensure a specific brand is called out in the specifications. If Masterclock products only are specified through the work of the integrator then we'll prohibit other local integrators from proposing our products on that project, thus protecting our

integrator and their efforts. This protection allows these integrators to charge higher prices by eliminating the need for contractors to try to outbid each other. At the same time, these integrators do not always work to achieve the highest cost savings – generally the higher the cost of the equipment, the more money they receive for installing it. For FY 2012, about 13% of our International Business came from the Middle East countries.

Example: The below e-mail is in reference to our distributor Bond Communications about an upcoming project

From:
To: "'Ramiro Benitez'"
Cc:
Date: Wed, 8 Jul 2009 08:44:42 +0400
Subject: <u>zayed university</u>
Dear Mr. Ramiro,

Thanks for your request regarding Zayed University,

We have the tender document, the project still under development, we must give them solution for master clock system. They didn't define the specs yet.

We trust your confidential and we appreciate your support for Bond communications.

Advise if masterclock had make any similar project, it is campus of 21 blocks and we have to design the system, they already define the location of the digital clock.

Regards,

Bond Communications

These two examples help demonstrate the need for different approaches for different markets. Even more importantly, product design and development must take these cultural differences into account. Desiging a high-tech, expensive device for specific applications limits what integrators can and desire to use your products but gives you a niche to develop and maintain. Sugar is cheap and is used in countless recipes around the world, but multi-colored kosher sprinkles are expensive and specifically used by certain people at certain times. Designing clock systems can follow the same trend – do we design based on finding the most applications for our products? Or design our products for specific applications?

PRODUCTION

Masterclock continues to manufacture and source many key components of their production locally. Rising parts costs contribute to shrinking margins which have to offset by increases in volume to maintain consistent profit margins. As market competition drives down prices, Masterclock must determine which direction to take the brand.

The current strategy has Masterclock positioned as a higher-end brand focused on delivering the best value over the lifetime of the product. Products are designed using high-quality materials and assembled under a strict quality control system. These high quality materials are carefully combined to provide product lifespans in excess of 20 years in most cases.

Many competitors have outsourced their manufacturing and in many cases purchase similar designs from the same sources with the only difference being the brand label. These clocks serve the same purpose with many of the same features but lack the materials and design required to ensure longetivity and reliablity. While Masterclock analog clocks continue to utilize sturdy brass movements, many other competitors have moved to flimsier plastic movements designed to keep intial costs down. These competitors specifically look to be low-cost alternatives and are taking advantage of an online culture where many times end-users never have any hands-on experience with the products before issuing purchase orders.

Masterclock must decide what types of opportunities to focus on. With direct foreign labor rates at ¼ of domestic labor rates in many countries, U.S. companies struggle trying to maintain a competitive pricepoint on products. In addition to cheaper labor, many countries in the world have lesser requriements for insurance, unemployment expenses, facility maintenance, etc. These factors all contribute to rising costs associated with manufacturing in the U.S. and have led countless American companies to move their manufacturing overseas. Masterclock has maintained our domestic manufacturing presence and has taken advantage of the "Made in America" belief in superior quality but is currently under seige from others trying to emulate our success.

Moving forward, the biggest question management faces is how to push the company's next evolution. Do we continue to develop higher-quality, feature-filled products in lower volumes for more security sensitive domestic users? Or do we take advantage of the growing lower-cost clock market and move larger volumes of products?

Developing higher-quality, feature-filled products to take advantage of higher profit margins while maintaining lower annual volume presents many benefits and challenges. Better quality control, more interfacing between engineers and production, faster product turn-around, and better understanding of design-to-manufacturing principles all help urge us to continue down this trend. We can also focus more on innovation and take advantage of the latest technologies and trends much more effectively and be a market leader.

Riding the latest wave of technologies also presents many issues. Computing continues to evolve at a tremendous pace and implementing new features and abilities also requires knowledgeable staff to prepare the proper coding and design characteristics. Small businesses such as ours don't have as much room for error with product designs and issues can cascade quickly. A new product can quickly lose any realized profits when engineering issues force us to assign staff to fix a problem which arises from lack of knowledge about new protocols. Additionally, complex network setups for many large installations can lead to issues with product integration and tie up valuable engineering time as we try to figure out why our products won't properly communicate across networks with security features beyond what many of our products are designed to handle.

Focusing less on technology and more on higher-volume of lower-tech units allows us to build our brand globally much faster. When growing into a new area, the use of completed projects as testemonials to promote our success and encourage more business is vital. The more projects you have in an area, the more likely customers and other integrators are familiar with your products. The more projects our products are used in, the more exposure Masterclock receives. By simplifying features and lowering technical requirements we also expand the pool of integrators around the world who can utilize our products. Many integrators for small projects in more remote parts of the world have limited technical expertise and opt for simpler designs to keep within their scope of knowledge. By developing more complicated products and systems we lose out on projects where the advanced technology is not required.

The time has come for Masterclock to decide how to move forward – do we build off of the brand we've established and continue to design more specialty products for smaller customer bases? Or do we transform our brand to work across more industries by finding more universal features and making our products more appealing to a wider audience?

Technical Specifications for National University of Singapore

2. TECHNICAL SPECIFICATION – GPS SYNCHRONIZED CLOCK SYSTEM USING NETWORK TIME PROTOCOL AND POWER OVER ETHERNET

2.1 REQUIREMENTS

2.1.1 General System Requirements

The synchronized clock system shall meet or exceed the requirements of this specification in all aspects.

2.1.2 Operational Requirements and Environmental Specifications

a) Operational Requirements

i) The clock system shall be located and operated in an indoor environment, within the parameters of a standard network configuration, and utilizing standard industry provided network equipment and distribution methods, including standardized POE distribution technology.

ii) The clock system shall operate autonomously and provide software configuration options for time zone offsets, automatic daylight saving time corrections without scheduled operator intervention or maintenance.

iii) The clock system shall be configured via software control and shall allow for remote monitoring and configuration changes while providing password protection.

iv) Environmental specifications

The system shall operate under the following environmental conditions:

- Operating Range: 32° F to 122° F (0° C to 50° C)
- Storage Range: -40° F to 70° F (-40° C to 70° C)
- Relative Humidity: 0-90%, non-condensing

v) Compliance specifications

All equipment shall be tested, labelled and certified by a nationally recognized and approved testing laboratory to meet the following low voltage safety and electromagnetic compliance requirements of the United States and European Union.

- FCC, part 15, Class B limits for radiated and line conducted emissions
- Electromagnetic Compatibility 89/336/EEC; 92/31/EC; 93/68/EEC; 2004/108/EC
- Low voltage directive 2006/95/EC

2.1.3 Clock Engineering Requirements and Performance

The network clocks shall meet the following engineering and performance requirements.

a) Network clock engineering general specification

    i) The network clocks shall be designed to provide years of reliable and maintenance free service and shall be constructed of all metal enclosures with high impact, UV stable lenses to ensure structural integrity and maximum durability.

    ii) A wall mounting bracket, or other means, shall be provided for mounting to the surface of a wall.

    iii) The finish of the network clocks shall be of a high quality, durable, painted textured powder coat finish and available in a choice of colors.

    iv) The network clocks enclosure shall be available in optional unpainted stainless steel material and finish for special applications.

    v) The front display panel should be anti-scratch and anti-reflection.

    vi) The network clocks shall be available in double faced or dual mount options for applications in hallways or corridors.

    vii) The network clocks shall be designed for easy, cost effective, and reliable installation and use standard RJ45, 10MB Ethernet style connectors.

b) Accuracy

The networks clock displays shall be accurate to within 50 milliseconds of the UTC time reference provided by the NTP server(s), when synchronized.

c) Protocol

The Ethernet wired clocks shall support the following protocols:

d) SNTP, Simple Network Time Protocol

    i) The network clocks shall operate with an internal reference time that is set to UTC (Universal Coordinated Time) via a built-in the SNTP client, from up to two NTP timeservers.

    ii) Selection of the primary and secondary servers shall be automatic, but configurable by either static IP address or DHCP provided IP address configuration methods.

    iii) The network clocks shall be configurable to operate as an SNTP client in the following operational modes: unicast (or query), broadcast, or multicast.

e) DHCP, Dynamic Host Configuration Protocol

    i) The network clocks shall utilize DHCP (Dynamic Host Configuration Protocol), by default, as a means of automating the configuration of all required network settings utilizing the optional settings area of a DHCP server.

    ii) All DHCP network and optional NTP settings shall allow for enabling or disabling at each clock, in order to use static IP address mode network and NTP settings.

f) Power

   i) The network clocks shall utilize a standardized Power over Ethernet (POE) technology to power the clock in compliance with the IEEE 802.3af Power over Ethernet specification.

   ii) The network clocks shall be considered to be and to operate as Powered Devices (PD); and shall utilize a 48V DC nominal voltage supplied over the spare Ethernet network cable pairs, and/or the shared data/pairs, from an IEEE 802.3af compliant Power Sourcing Equipment (PSE) device, with a10/100 MB rating, for a distance of up to 100m (328 ft).

   iii) Power consumption shall be less than12.95 Watts maximum for all PD equipment. Each network clock PD shall have a typical power rating of less than 7.5 W.

   iv) The network clocks shall be made available with an optional AC power. The power input shall be made as a universal type with an input power range of 90-264 VAC, 47-63 Hz and utilizing a standard IEC power jack.

g) Connectors

   i) Type Connector

   • Ethernet 10/100 Base-T: RJ45

   • The network clock system shall utilize standard Cat 5 or Cat 6 cabling for the distribution of either data, or data and power using the same standard cable, and eliminating the need for an AC power source at the clock location.

   ii) Configuration settings:

   • The time displayed on the face of the network clocks may either be UTC time or local time and shall be configurable via software.

   • Clock displays shall offer flexibility to allow for any international time zone offset and automatic Daylight Saving Time (DST) adjustment and shall provide maintenance free reliable operation.

   • Configuration changes shall be retained in non-volatile flash.

   • The network clocks shall utilize an internal maintenance free rechargeable battery backed real-time clock (RTC) to retain the internal time in the event of a power outage or for conditions when the NTP server(s) is not available.

   • The network clocks shall not display the time during a power outage, but shall recover from such power outage as a system without intervention.

   • During such "free-wheeling" periods and while in operation, the network clocks shall provide a visual indication that the device is relying on the internal oscillator and is not currently synchronized to the network timeserver.

2.1.4 Digital Clock Engineering Specification

The displays shall utilize LED's (Light Emitting Diodes) such that they are easy to read in various lighting conditions, allow for large viewing angles up to 160 degree, maximum viewing distances, long life expectance, and do not require back lighting.

The LED's shall be available in various colors including red, amber, green, and blue displays for various visibility requirements and in various sizes including 2.3" [5.8cm], 4" [10cm], and 8" [20cm] character heights. In addition, the brightness of the LED display shall be fully adjustable via software to allow for the display to be dimmed or brightened remotely, in order to accommodate various lighting conditions and requirements.

2.2 SOFTWARE

2.2.1 Configuration Software

The network clock system shall be fully configurable and managed remotely through IP via software to simplify the costs associated with administration.

2.2.2 GUI Interface – Windows Configuration

a) The network clock system shall include a GUI (Graphical User Interface) based network software application, operating under the Windows OS, for configuration and maintenance of [the network time server and] all network clocks.

b) The GUI application shall include password protection of the clock configuration, encrypted communication, and the ability to enable or disable options that might reduce security.

c) A status display to remotely monitor the time displayed on the clock, the internal UTC time, synchronization status, and any error condition regarding the clocks network status shall be provided.

d) An optional advanced Windows based GUI configuration software package shall be available for separate purchase, for quickly configuring groups of clocks with the ability to save and load configurations.

2.2.3 Console Interface – Unix/Linux, Nonwindows Platform Configuration

A separate menu driven telnet console interface shall be provided for configuration, of the network time server and network clocks on a non-Windows OS such as UNIX, Linux.
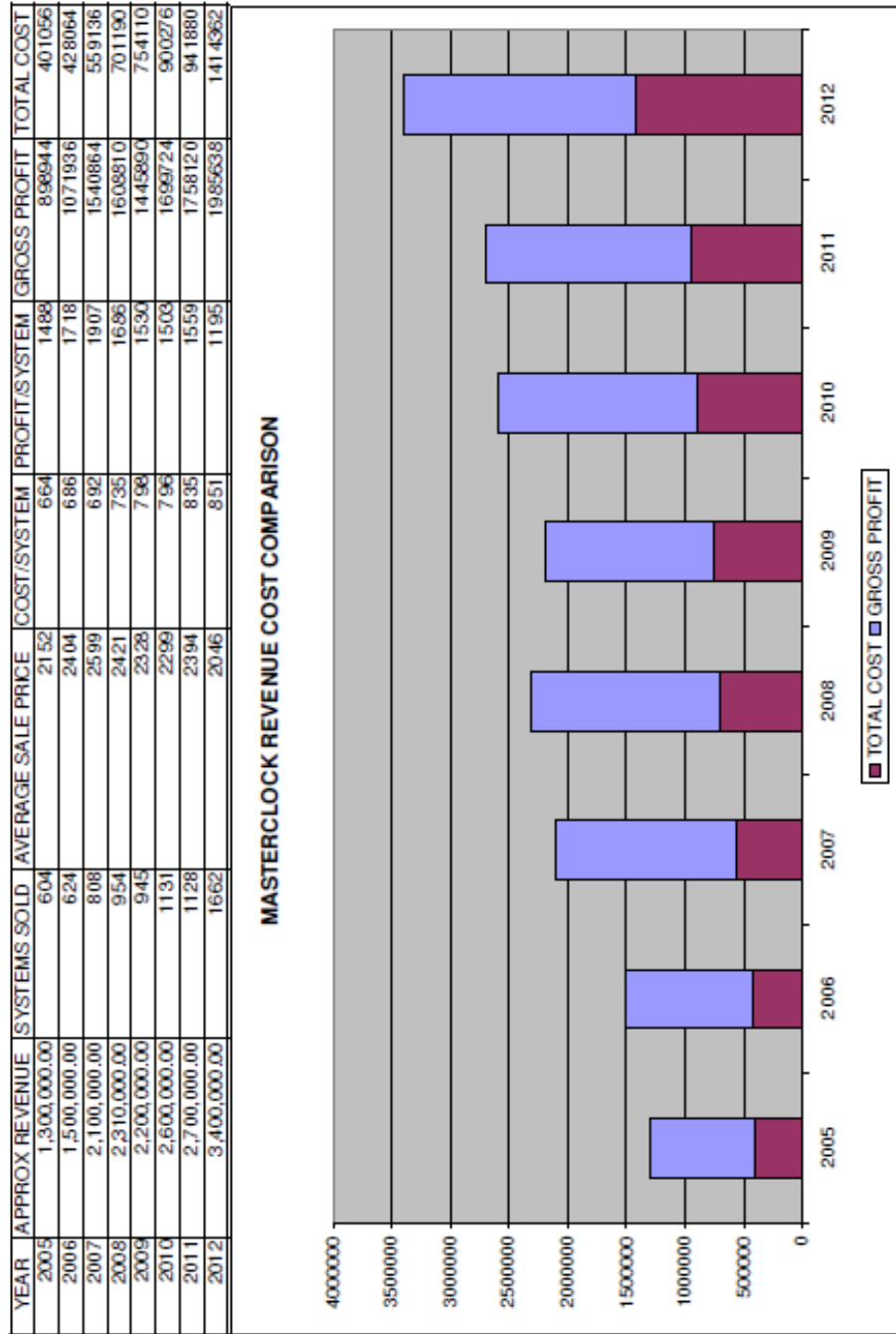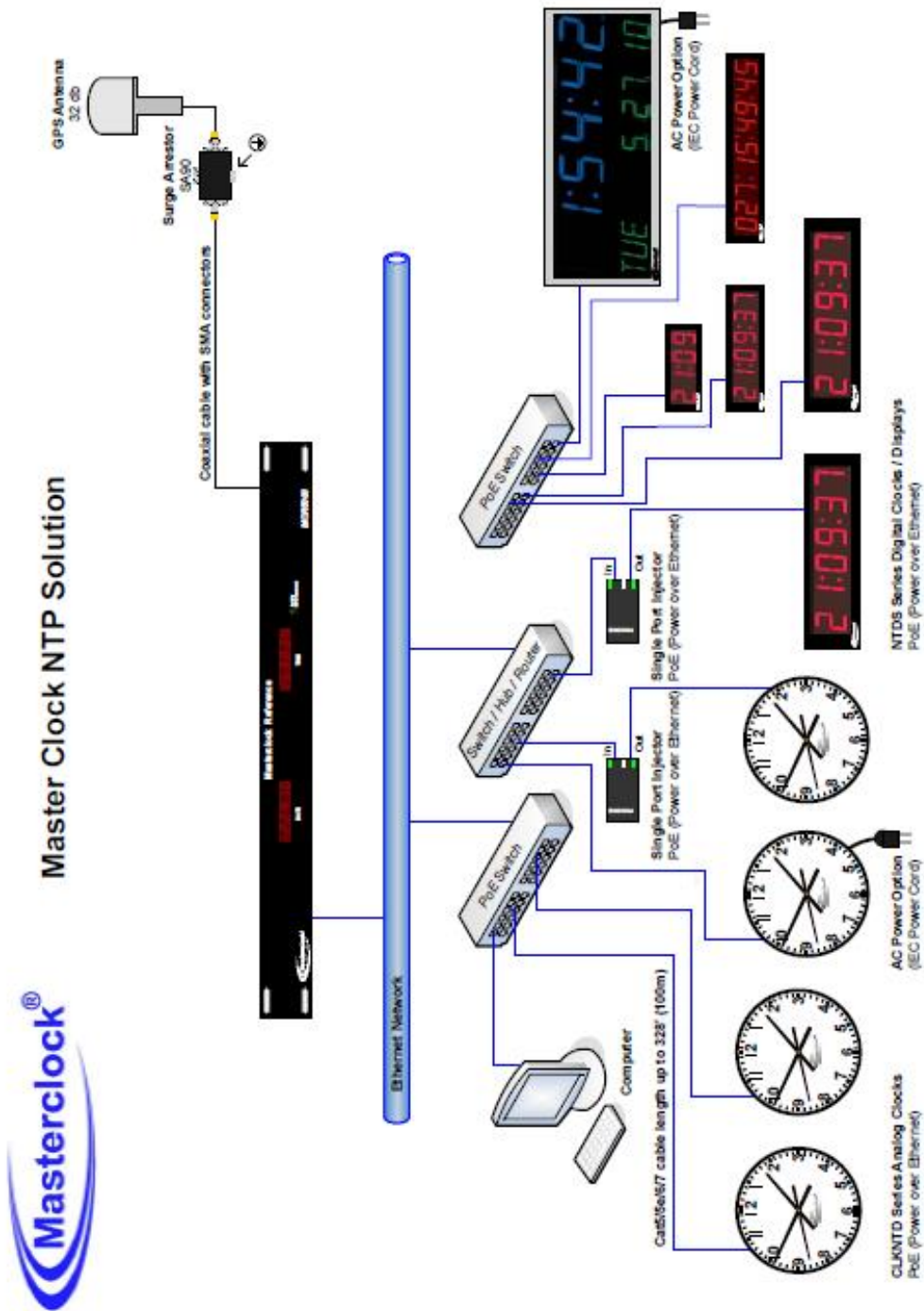
2.3 REPAIR AND MAINTENANCE

Designed as solid-state devices, the clocks shall require no standard maintenance and shall have no user serviceable or replaceable parts inside in order to reduce the requirement for on-site maintenance and repair personnel.

Any necessary firmware updates shall be made available and able to be applied on location. Instructions and required update files shall be made available for download from the manufacturer's website.

A procedure for trouble-shooting typical installation, configuration, and operational issues shall be supplied as part of the documentation, as part of the user manual.

The manufacturer shall make warranty repair and service, as well as non-warranty repair service, available.

YEAR	APPROX REVENUE	SYSTEMS SOLD	AVERAGE SALE PRICE	COST/SYSTEM	PROFIT/SYSTEM	GROSS PROFIT	TOTAL COST
2005	1,300,000.00	604	2152	664	1488	898944	401056
2006	1,500,000.00	624	2404	686	1718	1071936	428064
2007	2,100,000.00	808	2599	692	1907	1540864	559136
2008	2,310,000.00	954	2421	735	1686	1608810	701190
2009	2,200,000.00	945	2328	798	1530	1445890	754110
2010	2,600,000.00	1131	2299	796	1503	1699724	900276
2011	2,700,000.00	1128	2394	835	1559	1758120	941880
2012	3,400,000.00	1662	2046	851	1195	1985638	1414362

MASTERCLOCK REVENUE COST COMPARISON

Legend: TOTAL COST, GROSS PROFIT

Master Clock NTP Solution