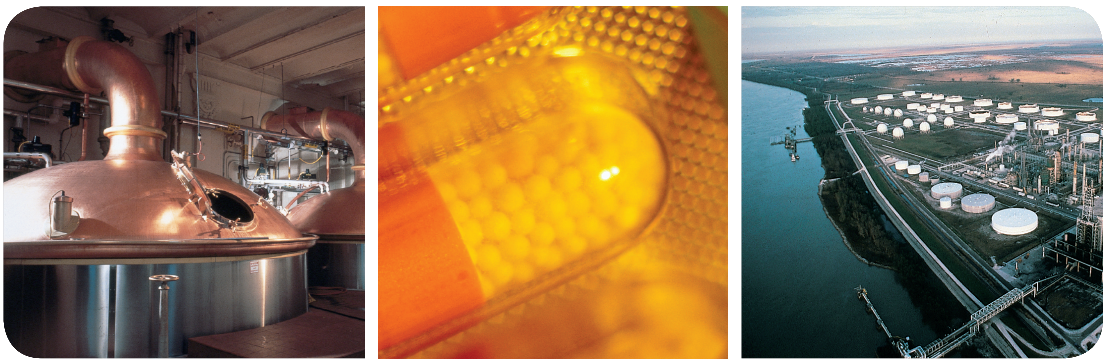

Achieving High Availability in Process Applications

Process industries don't have to accept one-size-fits-all solutions that do – and cost – more than necessary. Learn about scalable technologies that can provide high availability and a significant return on investment.

By Art Pietrzyk, Segment Manager, Rockwell Automation

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Introduction

In process automation, maintaining critical operations requires doing your engineering best to make sure nothing gets lost, stops working or is damaged. This generally involves implementing a highly available automation system. Without this precaution in place, manufacturers can experience unscheduled downtime and poor quality, which impacts production schedules, the ability to meet customer commitments and, of course, company profitability.

The global process industry loses $20 billion, or five percent of annual production, due to unscheduled downtime and poor quality, according to the ARC Advisory Group. ARC estimates that almost 80 percent of these losses are preventable and 40 percent of the preventable losses are due to operator effectiveness issues in the control room.

Thanks to ever-evolving technology, scalable product offerings and design best practices, stakeholders now have more ways to improve operational effectiveness and achieve high availability. The key is – end users shouldn't have to apply a "one-size-fits-all" solution. Manufacturers need to examine their critical processes and apply the method(s) and technology that best safeguard their critical operations and match their economic and performance requirements.

High Availability Defined

Defined as the probability that a system is operating successfully when needed, availability is most often expressed as a percentage and referred to as the "number of nines." Simply put, availability is the proportion of time a system is in functioning condition and able to perform its mission. Availability = MTBF / MTBF+MTTR, where MTBF is the mean time between failure and MTTR is the mean time to repair. Today, suppliers deliver control systems with availability typically ranging from 99 to 99.9999 percent. As reliability affects uptime and maintainability affects downtime, these two elements are important contributors to availability.

Reliability can be measured in various ways, including:

- Mean Time Between Failure in hours (MTBF or MTTF)
- Lamda or failure rate
- Probability to Fail on Demand (PFD)
- Failures in Time (FIT)

To help products meet the end user's expectations, reliability can be designed in using techniques such as Component Derating and Design through Six Sigma. A product's Safety Integrity Level (SIL) rating is another excellent indicator of reliability, as specific availability, failure rate and diagnostic requirements must be met.

While reliability impacts system MTBF, it does not reflect how long it will take to return the under-repair unit to working condition – that's where maintainability comes into play. Measured by Mean Time To Repair (MTTR), maintainability is the total corrective maintenance time divided by the total number of corrective maintenance actions during a given period. Since technical advances have improved reliability and MTBFs are often measured in many hours or years, better maintainability (i.e., shorter MTTR) increases availability.

For example, a system with a MTBF of two years equates to a failure every 17,520 hours. If MTTR is one hour, availability = 17,520 / 17,520+1, delivering 99.99 percent availability.

Factors that affect maintainability include:

- Diagnostics for detecting and isolating failures
- Annunciation of faults
- Troubleshooting tools
- Trained personnel
- Accessibility
- Ability to add components or make changes online

Figure 1. Availability is measurable as a percentage, commonly known as "number of nines."
(10 Hours is a common time period used for MTTR calculations)

Availability Percentage	Possible Downtime Per Year
99%	3.65 days
99.9%	8.76 hours
99.99%	52.6 minutes
99.999%	5.26 minutes
99.9999%	30 seconds

Investing in a high availability system over simply "an available one" can make a significant difference in lost time or costs – seconds vs. days or hundreds vs. millions of dollars. The average hour of plant downtime roughly costs $12,500, but is substantially more at many continuous process plants, according to ARC research. Using the $12,500 average, downtime for users with 99 percent availability can cost an estimated $1,050,000 per year, compared to just $104 for users with 99.9999 percent availability.

Figure 2: When a device does not perform its intended function, significant loss in productivity and revenue often results.

% Availability	Possible Downtime Per Year	Estimated Cost Per Year, based on $12,500/hour*
99%	≈ 3.5 days	≈ $1,050,000
99.9%	≈ 9 hours	≈ $112,500
99.99%	≈ 53 minutes	≈ $11,000
99.999%	≈ 5 minutes	≈ $1,000
99.9999%	≈ 30 seconds	≈ $104

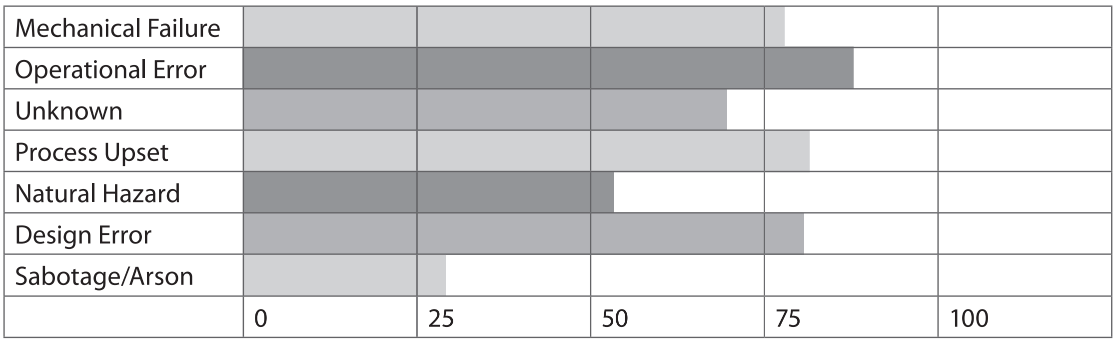
* Based on data from the ARC Advisory Group

Workplace Trends Impacting System Availability

Several key trends contribute to unscheduled downtime and overall system availability. First and foremost is the changing workforce. Baby boomers are starting to retire in droves, taking with them decades of experience maintaining availability in their respective facilities. Also, manufacturers are trimming their workforce to save costs. With fewer trained engineers and operators manning today's facilities, it is no surprise that operational errors are the leading cause of slowdowns and unscheduled shutdowns.

Finding it difficult to get suitable replacements, manufacturers are leaning more heavily on outside service providers. This workplace trend can extend downtime, especially for minor incidents or for manufacturers in remote areas. Meanwhile, the current economic downturn has reduced manufacturers' financial resources to upgrade and replace aging equipment, leading to increased downtime. This drives manufacturers to look for systems that are reliable and yet easy to maintain.

Figure 3: Average dollar loss per major incident by cause (number indicates millions of dollars).



Source: J & H Marsh & McLennan, Inc.

The Use of Redundancy

Redundancy is generally the method of choice for increasing availability if a control system shutdown or loss of visibility causes a major loss of revenue, loss of equipment, injury to people or a disruption to public services. Redundancy in these situations means the duplication of equipment that is needed to operate without disruption if and when the primary equipment fails during the mission.

The redundant components needed for high availability often include:

- An uninterrupted power source (UPS)
- Redundant power supplies
- Redundant components (chassis, PCs/HMI, processors, networks, media, servers, databases, I/O modules, sensors and actuators)

But adding more components might have a negative effect on reliability – and certainly adds to the cost – so redundancy needs to be used wisely.

The Need for Scalable Redundancy

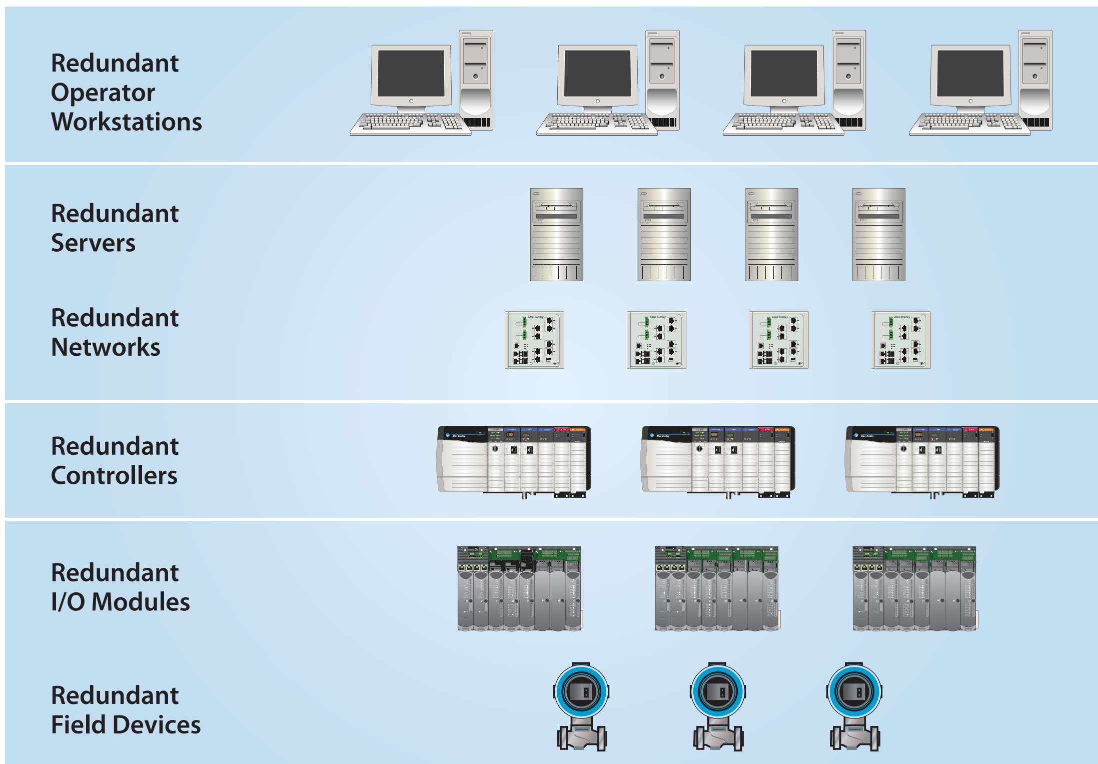
Using redundancy should help improve MTBFs and further improve availability. Economics can drive the use of redundancy, and help manufacturers scale it to protect critical assets and specific areas that are important to the enterprise.

Because most processes are enclosed in pipes and tanks and spread over large areas, process manufacturers rely on visualization systems and instrumentation to monitor the processes. In an oil and gas refining process, for example, instrumentation is the only way to monitor what's going on within the pipes and tanks. Therefore, redundant processors, networks, instruments, HMI and alarm management are critical, as well as some redundant I/O. Full system redundancy, meanwhile, might be required on an offshore, unmanned oil platform that could lose millions of dollars per hour if production is halted or tens of millions of dollars if equipment is destroyed.

In pharmaceutical production, a reactor may contain hundreds of thousands of dollars worth of product and so integrity of the product must be maintained at all times. For a food and beverage operation, FDA regulations require tracking and tracing of data so redundant networks and servers are required. But, since some operations are batch and less critical, only certain controller equipment may require redundancy.

Meanwhile, 100 percent control and information system availability may be required for water/wastewater treatment operations because people depend on water for survival.

Figure 4: Redundancy is a common way to achieve availability . . . the question is, how much? Economics should drive what assets are protected with redundancy.



Beyond Redundancy

While most users traditionally leverage redundancy to achieve high availability, this method increases the number of components, thus increasing the number of potential component failures. Therefore, redundancy – if not applied properly – can decrease system availability.

To avoid weighing down a system with redundancy overload, process manufacturers should determine the cost of potential failures and make high availability investments accordingly.

Emerging technologies such as virtualization enables the consolidation of computing resources in such a manner that multiple operating systems and applications can share a single physical server. This approach reduces the reliance on a hardware-based infrastructure – a move that can significantly improve system availability.

Engineers are enlisting a number of additional methods to achieve higher availability:

- **Component derating** involves operating field instrumentation or systems at less than their maximum temperatures, power and other rated specifications.
- **Design using diversity** involves using a variety of devices, such as HMI devices in conjunction with local indicator lights, to prevent both devices failing for a common reason.
- **A client-server configuration** linking multiple clients centralizes resources to avoid problems caused by redundant and inconsistent data.
- **Controller-based memory backup** can store recent data and secure it from data loss such as if a single server would go down.
- **Ethernet rings,** with or without redundant media, can provide fault tolerance if the network is determined to be a weak link

In addition to proactive methods, manufacturers are looking to "reactive" measures – most commonly maintenance procedures and tools – to help increase system availability. A control system must be easy to troubleshoot, modify and repair during mission time. Personnel should be qualified and trained, and they should be able to remove and add components to the system without interrupting the mission. Consequently, replacements should not require rewiring or reprogramming.

Further, to best match a manufacturer's criteria, both now and in the future, forward-thinking suppliers have forged a new dimension of scalability. Modern process control systems can now manage more than process control – they manage batch, drives, safety, sequencing for packaging and information on a single control platform. This gives manufacturers the ability to scale the system to what is needed today and provides the flexibility to expand it in the future without unnecessary downtime.

This new dimension also involves designing reliability and maintainability into the control system and components themselves. Control systems, for example, now feature products with onboard diagnostics and indicators, graphical programming languages, HMI with built-in alarms, auto-tuning I/O, and software for asset management and predictive maintenance. Modern controllers also enable runtime modifications, including runtime partial import, online edits of the application, Hot Swap, and the ability to update firmware at runtime.

Emerging Technology Improves Availability, Data Flow

Smart instrumentation and advanced networking technologies improve system availability with real-time access to vital diagnostics that help predict and prevent component and system failure. This diagnostic functionality – along with additional process data these devices provide – is married to software that benefits users with upfront alarms, calibration and model information. This, in turn, allows for easier part replacement and inventory management.

EtherNet/IP has become the world's leading industrial Ethernet network. EtherNet/IP provides a simple yet robust communications platform enabling users to effectively manage real-time control and information flow from the instrumentation level to the IT enterprise. EtherNet/IP is the only protocol that enables discrete, process, safety, motion and drive applications on a single network. This eliminates the need for additional specialty networks that can complicate data sharing between applications and add components.

The introduction of new topology configurations for EtherNet/IP is further improving system availability. With the Device Level Ring topology, the EtherNet/IP network can be set up without additional switches and the wiring is daisy-chained from node to node. This helps improve network resilience when compared to the more traditional star topology.

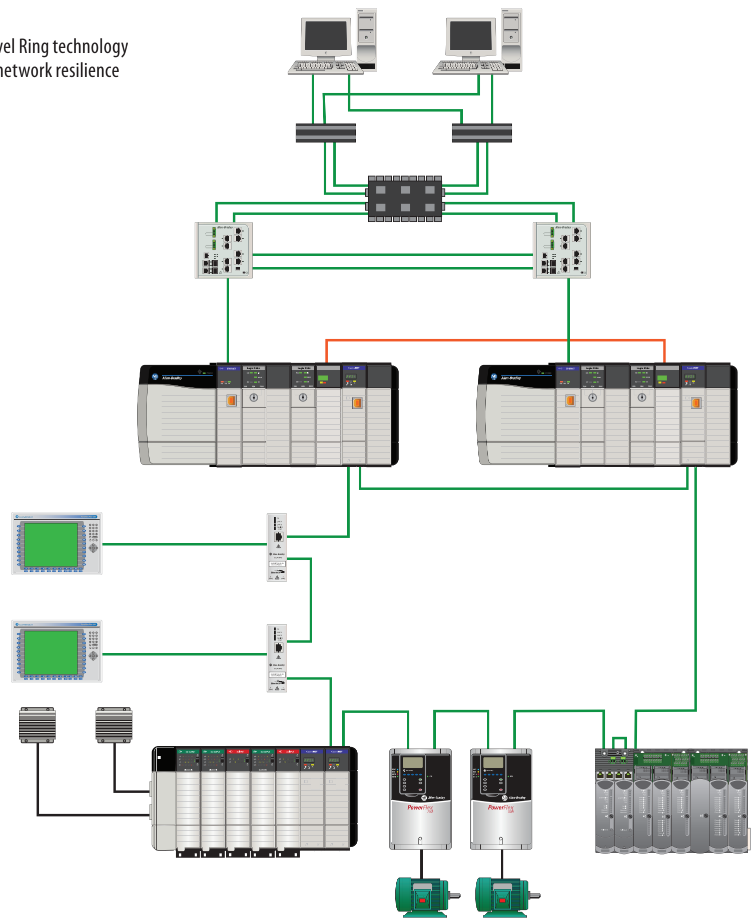


Figure 5. Embedding Device Level Ring technology into control systems increases network resilience and installation flexibility.

Maximizing Availability

Historically, the process manufacturing industry has viewed deploying full redundancy into systems as expensive but necessary. However, with ever-evolving technology, scalable product offerings and new design best practices, this view is shifting. Process manufacturers see the value and competitive edge gained from considering the full pendulum of choices and selecting the methods that best match application requirements and the company's size, location, staff expertise, financial resources, and availability of support.

Some manufacturers may specify a completely redundant system from the pendulum's virtual arc of choices. Or, a manufacturer that can tolerate some repair time might scale redundancy to only critical assets.

Process engineers must apply the high availability methods that best match their performance and economic requirements and, in so doing, mitigate potential hazards and protect important, expensive assets. This will help manufacturers achieve the level of availability they need at the lowest lifecycle cost to gain a competitive edge in today's global marketplace.

Automation Process Solutions
www.rockwellautomation.com/go/tj10pr

New Solutions Make High Availability Easier, Simpler

Rockwell Automation continues to expand its PlantPAx® Process Automation System to help meet high availability demands more easily and cost-effectively. The expansion includes:

- Allen-Bradley® ControlLogix L7 programmable automation controllers and RSLogix 5000 v19.50 firmware: The L7 controllers help improve performance and provide fast cross loading for redundancy systems.
- 1715 redundant I/O: 1715 I/O provides redundant input and output modules, including analog outputs configured by RSLogix5000 software and supporting redundant Ethernet adapters all with no additional programming required.
- FactoryTalk SE View 6.0: FactoryTalk View 6.0 supports alarm and event server redundancy for auto synchronization of device and tag-based alarms between active and standby servers and a single alarm history configuration.
- EtherNet/IP I/O: Device Level Ring, Star and other EtherNet/IP topologies provide scalable resiliency and fault tolerance to meet all network availability, cost and performance requirements.

Rockwell Automation offers a complete end-to-end, high-availability solution that helps protect production, product quality, critical equipment, plant assets, personnel, the environment and surrounding community.

For more information, please visit
www.rockwellautomation.com/go/prps.

According to telecommunications and reliability theory, the term availability has the following meanings:

- The degree to which a system, subsystem, or equipment is in a specified operable and committable state at the start of a mission, when the mission is called for at an unknown, i.e., a random time. Availability is the proportion of time a system is in a functioning condition. This is often described as a mission capable rate. Mathematically, this is expressed as 1 minus unavailability.
- The ratio of (a) the total time a functional unit is capable of being used during a given interval to (b) the length of the interval.

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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