Introduction

CENTUM VP is an integrated production control system used to manage and control the operation of plants in a wide variety of industries: petroleum refineries, chemical, food and beverages, steel, power, and so forth.

This manual: System Overview (general overview) provides a simple overview of the CENTUM VP system. After reading this manual, see the other documents, such as System Overview (HMI), System Overview (Controller), General Specifications, and so forth, for more detailed coverage of various topics.

Relevant Manual

TI 33M01A11-40E CENTUM VP System Overview (HMI) (*1)
TI 33M01A12-40E CENTUM VP System Overview (Controller) (*2)
TI 33M01A13-40E CENTUM VP System Overview (Solution Package) (*3)
TI 32S01B10-01E ProSafe-RS System Overview (*4)

*1: planned to be issued in August, 2008
*2: planned to be issued in September, 2008
*3: planned to be issued in 2009
*4: planned to be issued in June, 2008

Target Readership for This Manual

This manual is mainly intended for:

Managers who are planning to purchase a new control system.

Instrumentation and Computer Engineers who are evaluating CENTUM VP for purchase or who will be in charge of installation.

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1. CENTUM VP Overview

Yokogawa is the world first company that introduced Distributed Control System (DCS) in 1975 – the first series of CENTUM System. We have been paying careful attentions to what plant managers, engineers, and control room operators said to develop and to enhance our products, and to comply with their requirements. The generations of CENTUM advanced as time goes by, and Yokogawa maintained the quality of the product and its reliability always at the highest level in the market. It is our pride that the CENTUM systems are adopted and supported by many customers to control and monitor the industrial plants around the world.

In 2005, Yokogawa celebrated the 30th anniversary of our CENTUM series DCS and came up with a business concept of “VigilantPlant” to aim to become No. 1 supplier in the field.

1.1 History of CENTUM

The process industries have come a long way since the days of panel-mounted loop controllers. With the introduction of DCS, operators’ ways of working have drastically changed. In early 1970s, there was one panel operator assigned per panel. After DCS was introduced, the operators could sit in a place called central control room (CCR) and they can grasp the plant-wide operation without moving around. The only negative aspect was that the scope of work of one operator has been greatly widened.

All along, CENTUM has kept evolving, driving productivity, and improving plant operations while securing consistency and a smooth migration path. Yokogawa has always been the front-runner to take in the latest technologies of the time to operate the plants safely. We never forget to spare thoughts on return of investment (ROI) and the life cycle of the assets to reduce the total cost of ownership (TCO). Therefore, Yokogawa kept offering our customers smooth migration paths from the existing CENTUM systems into the latest ones. In this way, customers are able to keep using the CENTUM systems as long as they wish, and to make the best use of the existing assets. With this concept, the replacement of the CENTUM systems can be done quite smoothly to minimize the shut down of the plants.

CENTUM VP is the 8th generation of the CENTUM Series. Yokogawa continually endeavors to meet its customers’ needs by providing highly reliable enhancements to the CENTUM series based on leading edge technology.
1.2 CENTUM at Work

Yokogawa sold more than 19,000 projects of CENTUM Series in all types of process plants around the world. Our customers are from oil and gas, petrochemicals, chemicals, power, pulp and paper, pharmaceuticals, food, iron and steel, waste, and water and sewage treatment.

Our majority of the clients come from petroleum and petrochemical industries. It means that many of the CENTUM series have been delivered to large scale and critical plants. Once the plants started their operations, they cannot let them stop. And Yokogawa kept complying to those demanding requirements with our high reliabilities. We are proud to declare that over 19,000 projects sold in more than 30 years are the results of customers’ appreciation to Yokogawa.

Yokogawa has been approved as the sole vendor to some clients by making global purchase agreements. We only need one project to prove ourselves capable to earn trust from customers, as once they used, they stay with Yokogawa.

As of December 2007
1.3 Future Vision of Industrial Automation (IA)

Yokogawa’s over 30 years of business in Industrial Automation, Yokogawa came up with a business concept of “VigilantPlant” in 2005. It is designed to empower all members in the production value chain to “See Clearly, Know in Advance, and Act with Agility.” Peter Drucker said that “A well managed plant is quiet and boring.” This means that the plant is either operated without problem or problems are managed easily because the essential information is delivered to the right people at the right time to let them take appropriate actions. This is what Yokogawa aims as the ideal plant and we kept developing our products to realize this concept.

The Goal of VigilantPlant

The ultimate goal of our customers is the profitable growth of their business, and it is a Yokogawa commitment to contribute to both their growth strategy and productivity initiatives.

Yokogawa enables Operational Excellence in our customers’ plants through our solution to manufacturing activity.

![Figure Aim of VigilantPlant](F010301.ai)
VigilantPlant Operational Excellence Model

To establish a clear focus on our VigilantPlant strategy, we created the VigilantPlant Operational Excellence Model. It is a visual representation of the focus of the VigilantPlant solution. We aim to bring excellence in production, asset, and safety sustained over the life cycle of our customer’s plant.

The key excellence initiatives have specific objectives to serve. Safety Excellence is for health, safety, and environment protection. Asset Excellence is for asset availability and utilization. Production Excellence is for operational agility and adaptability. As the common center piece, Lifecycle Excellence improves and sustains the excellence initiatives for long-term success.

We put Safety Excellence and Asset Excellence at the bottom of the model since safety and asset utilization set the foundation for agile production and sustained performance.
VigilantPlant value propositions

To realize the best practice which Yokogawa call it as Operational Excellence, we set the See/Know/Act vigilant cycle at the heart of our VigilantPlant philosophy.

Seeing clearly means reducing blind spots in your plant. Yokogawa help to avoid guesswork, instability, and sub optimization that might otherwise arise from having a lot of blind spots in the plant.

Knowing in advance means avoiding surprises in your operation. Yokogawa helps to minimize reactive measures, unexpected downtime, and quality variations that might otherwise plague a plant where information is not well integrated.

Acting with agility means preempting bottlenecks of business performance. Yokogawa helps to reduce delays, lost opportunities, and knowledge silos that might otherwise constrain the flexibility of your business.
1.4 CENTUM VP advantages

CENTUM VP ushers in an operating environment that keeps everyone fully aware, well informed, and ready to face the next challenge.

Information Visibility (See Clearly)

CENTUM VP makes critical plant information visible in a meaningful and actionable manner. CENTUM VP captures plant-wide data without delay and delivers the right information to the right people at the right time. Reducing blind spots while preventing information overload, CENTUM VP keeps people’s attention firmly focused on operational targets and business goals.

Performance Foresight (Know in Advance)

CENTUM VP delivers the knowledge necessary to anticipate changes and to make fast, informed decisions. CENTUM VP enables quick synthesis of analytic insights from the historical, real-time, and future-predictive perspectives. Allowing people to make fast intelligent decisions every day, CENTUM VP helps your business avoid costly surprises.

Operational Agility (Act with Agility)

CENTUM VP helps to implement decisions throughout the value chain without delay. CENTUM VP speeds up task coordination and navigation, enhancing the flexibility of production and adaptability of business. Constantly systemizing and automating operational best practices, CENTUM VP prevents delays and preempts bottlenecks.

For Operations

- **Safe and unified plant operations**
  Universal interface for control, safety, and asset intelligence.
  Embedded mechanisms to prevent information overload
- **Non-stop improvement**
  Continuous systemization of operational best practices and context specific operational advisories.

For Production Management

- **Faster Plan, Do, Check, and Act cycle for agile adaptation**
  MES and enterprise system integration is enabled by using S95 and B2MML standards
- **Secure and standard-based information integration**
  Built-in control network security certified by experts
For Maintenance

- **Continuous evolution without compromising asset availability**
  Evergreen evolution with online upgrades and modifications. It is the most reliable platform with no single point of failure

- **Long-term investment protection**
  Step-by-step phased migration paths incorporated before any new release. We have over 30 years of backward compatibility.

For Project

- **Faster project execution with fewer integration risks**
  Single-source integrated solutions for control system (DCS), safety instrumented system (SIS), embedded plant information management system (PIMS), intelligent RTU & SCADA, and turbine controller.
2. System Configuration

CENTUM VP has a simple & common architecture consisting of human machine interfaces called human interface station (HIS), field control stations (FCS), and a control LAN. These three basic components support facilities from the small to very large and complex with up to 1,000,000 tags.

The Design Concept of CENTUM VP System Configuration

CENTUM VP is designed based on the concept to keep the plant operation availability high. Customers expect Yokogawa products to perform its functions without failure so that the plant operations shall not stop. Yokogawa developed our own FCSs so that we can meet up with the customers’ expectations. Quite a number of FCSs are still in operation even after 20 or more years passed since those are originally installed. It is owing to the high quality of the products themselves that has been supported by the total serviceability such as skilled manufacturing, quality control, after sales service and appropriate training.

Self-independent Controller

CENTUM VP’s FCSs are designed to work without HIS. The fundamental controls can be done only by the FCSs, and all the process data, control logic, and procedures are contained in the controllers. HIS works only as a monitor screen under the normal condition. In Yokogawa’s system configuration, FCSs are acting like servers and HISs as clients. The hardware availability of FCS (=server) is 99.99999% which comes from the basic policy in product designs. Our FCSs are designed; (a) not causing failures easily (fault-avoidance), (b) to continue controlling the plant even it fails (fault-tolerant), and (c) to recover from failures as quickly as possible (maintainability). It is the crystallization of Yokogawa’s leading edge technology.

Why CENTUM VP does not have Client-Server Concept?

In a typical server-client configuration, when the server fails, all the client HMIs come to stop. It means that all the controls and the data of the plant are lost until the server is recovered. This is certainly not an acceptable situation for plant operations in reality. In order to prevent server down as much as possible, an expensive server machine is needed or to have a redundant configuration.

CENTUM VP’s Field Control Stations (FCSs) are far superior to the PC servers on account of availability, even those with redundant configuration. Each FCS runs independently that hedges the risk of causing serious damage to the plant by a single failure.

PC servers become obsolete in a few years of cycles, but FCSs with appropriate maintenance runs for many years. The robustness of FCS saves the cost of repairs and damages to the plants as the plant does not fail. In the viewpoint of total cost of ownership (TCO), Yokogawa’s FCS is more economical.
CENTUM VP Equipments

Human Interface Station (HIS)

Used for operation and monitoring the plant.

- **Desktop Type HIS**
  A commercial off-the-shelf PC with option of specialized operator keyboard

- **Console Type HIS**
  Provided by a commercial off-the-shelf PC with specialized console assembly. It can be composed of dual stacked LCD, touch panel function, eight-control-key operation keyboard, and auxiliary contact I/O.

Field Control Station (FCS)

A Yokogawa manufactured hardware that controls the plant. This is the core of CENTUM VP’s high availability and reliability, continuing throughout the CENTUM heritage.

Control LAN (Vnet/IP)

An IEEE802.3 Ethernet compliant redundant network operating at 1Gbps that links stations such as HIS, FCS and BCV. This incorporates Yokogawa’s technology, achieving deterministic, reliable, and secure communications.

Engineering Station (ENG)

A commercial-off-the-shelf PC that performs CENTUM VP system generation and maintenance management. Both ENG and HIS functions can reside in the same PC.

System Integration OPC Station (SIOS)

A commercial-off-the-shelf PC that integrates other companies Process Control Systems with the CENTUM VP.

Generic Subsystem Gateway (GSGW)

A commercial-off-the-shelf PC that integrates subsystem to the CENTUM VP.

Digital Fieldnetworks

CENTUM VP supports FOUNDATION fieldbus, HART, PROFIBUS-DP, DeviceNet, Modbus, Modbus/TCP, and Ethernet/IP.

Bus Converter (BCV)

A Yokogawa manufactured product that connects previous CENTUM series to CENTUM VP.

Layer 3 Switch (L3SW)

A commercial-off-the-shelf product that connects multiple control networks.
Safety Instrumented System (ProSafe-RS)

ProSafe-RS is Yokogawa’s TÜV SIL3 certified premier safety instrumented system. It incorporates Yokogawa’s own Pair and Spare and Vnet/IP technologies and offers unprecedented synergy with CENTUM VP.

- **Safety Control Station (SCS)**
  A Yokogawa manufactured safety controller that executes logics for systems including interlock, emergency shutdown and fire and gas protection.

- **Safety Engineering PC (SENG)**
  A commercial-off-the-shelf PC that performs SCS generation and maintenance management.

Basic System Configuration

The system configuration below shows representative components in a basic CENTUM VP system.

System Specifications

- No. of tags that can be monitored: 100,000 tags
- No. of stations that can be connected: 256 stations
Overall System Configuration

The system configuration below shows an overall system linked to previous CENTUM, Safety Instrumented System and Business LAN.
Very Large System Configuration

A very large system configuration is shown below. CENTUM VP can expand the system specifications for the very large system.

System Specifications

- No. of tags that can be monitored: 1,000,000 tags
- No. of stations that can be connected: 512 stations
Small System Configuration (CENTUM VP Entry Class)

The system configuration below shows a small scale system called CENTUM VP Entry Class. Other than the number of tags, CENTUM VP Entry Class has all the functionalities available with the CENTUM VP. When the customer plans for expansion of the plant, it can easily and economically be migrated into large scale systems.

System Specifications

- No. of tags that can be monitored: 8,000 tags
- No. of stations that can be connected: 256 stations
3. Safety and Reliability are the Core of All the Production Activities

Yokogawa developed all the CENTUM Series Field Control Stations (FCSs), including hardware and software, by our own selves. We know every corner of the software and the hardware and that knowledge enables us to sustain the service record of 99.99999% availability.

Compact Design
The size of each component is designed compact that reduces the overall “footprint” of the control system. It allows make efficient use of the limited spaces of the control and equipment rooms. Both the FCS and its I/O node units can be placed in remote classified locations (IEC Zone2/Class I Div. 2), that provides savings in installation costs.

Dual-redundancy and Reliability
There is no single point of failure in Yokogawa’s FCS! The processor modules, power supplies, and I/O modules, including the communication bus, support a redundant configuration. The robustness of the FCS comes from this configuration known as “Pair and Spare” and the reliability of calculation results is guaranteed through real-time validation. Two processor modules have two CPUs each. CPU 1 and CPU 2 in the primary processor module are always comparing the calculation result, and if the results do not match, the first processor module goes into maintenance mode while the secondary processor module takes over process control. In order to make this switch over seamless, CPU 3 and CPU 4 are also calculating and comparing the results while the primary processor module is active. Pair and Spare is Yokogawa’s unique technology, supporting impressive levels of availability for CENTUM and ProSafe-RS. This architecture has been approved by TÜV Rheinland for safety instrumented systems. The ProSafe-RS certification was granted to Yokogawa in exceptionally short period of time, and it was due in-part to our Pair and Spare technology.

Online Maintenance
Through an online maintenance function, FCS applications can be modified without shutting down the FCSs. It means, you can change logics and parameters without interrupting the process control. This is useful for expansion or modification of the plant in operation.

Open Structure and High Reliability
Yokogawa is committed to reduce costs for our customers by enabling the use of commercial off-the-shelf technology where appropriate. Third-party cables, switches and other network communication devices can be used with Yokogawa’s Ethernet based Vnet/IP. Plant reliability is in no way compromised as the communication response is guaranteed (deterministic as opposed to probabilistic) thanks to Yokogawa’s renowned reliability, dedicated protocol, and redundant configuration.
Function Blocks

The CENTUM VP provides functional blocks for monitoring, control, manipulations, calculations, logic functions, and sequences. Not only continuous control but also advanced control, complicated sequence control, and batch control are all executed in a redundant, secure, and reliable controller environment. Plant systems can be flexibly designed, ranging from small- to large-scale, through the combination of these control blocks.

Subsystem Integration and Digital Fieldnetworks Support

To meet the growing need for communication with manufacturing equipment including variable speed drives, PLCs, and “smart” motor protection relays for operation and monitoring, as well as with analyzers, weighing machines, smart instruments, and other instruments used for product inspection, CENTUM VP supports a wide variety of communication interfaces and digital fieldnetworks such as FOUNDATION fieldbus, PROFIBUS-DP, Modbus RTU, Modbus TCP/IP, and DeviceNet.

Unit Instruments

The multiple devices of a process facility which would previously have been handled individually can now be defined, operated, and monitored as a single unit, simplifying operation. Unit instruments can be applied to batch processes and continuous control processes that require complex management, expediting overall plant operation.
4. Intuitive Human Machine Interface for Plant Operation

CENTUM VP introduces a new human machine interface (HMI) that let operators to access information more easily, quickly and intuitively. We changed the design of operation window intending to provide universal color design based on the ergonomics studies.

True Integration of Safety Excellence, Asset Excellence, and Production Excellence

CENTUM VP achieves the operational excellence that is the focus of Yokogawa’s Safety Excellence, Asset Excellence, and Production Excellence initiatives. It offers integrated viewing and data handling functions. For example, alarms from the ProSafe-RS Safety Instrumented System and Plant Resource Manager, Yokogawa’s Asset Management product, can be seen and handled seamlessly in the HIS. You can also see historical data from Plant Information Management System in a window at the HIS. All plant process data, device data, procedures, and documents are handled by CENTUM VP.

EEMUA Guidelines for Alarm System Design

Based on the latest edition of the EEMUA (*1) #191 guidelines, Yokogawa developed a Consolidated Alarm Management System for the process operator in the HIS. This software saves operators from alarm flooding and to deliver only necessary alarms at the right timing.

*1: Engineering Equipment & Materials Users’ Association

No Single Point of Failure

The HIS runs on Microsoft Windows and offers customers the convenience of using commercial-off-the-shelf hardware. Although the reliability of a PC is not so high, it does not affect the total reliability of Yokogawa’s process operator functions. CENTUM VP’s HIS does not have server-client dependent configuration. Therefore multiple HISs can support each other and there is no single point of failure.

Multiple-monitor Support

The scope of one operator’s responsibility widens, the amount of information provided to a process operator is increasing. It demands greater flexibility for the HMI. One HIS supports up to four monitors as well as wide flat panels (6:10 aspect ratio) of 24-inch and 30-inch sizes.
5. Integration with Safety Instrumented System

Safety instrumented system acts to prevent damage to plants in case of emergency shutdowns and aggravation of damage (protection from fire and toxic gas or explosion). Safety instrumented system contributes to increase plant safety and to protect people, facilities and environments with the aforesaid functions. ProSafe-RS realizes the integrated safety solution with control system, achieving both safety and high availability.

Integrated Operation Environment

IEC 61508 standard for functional safety set the guidelines for separation of functions of control system and safety system. However, in the actual applications, operators often desire to use the same operational environments for both the control & monitoring and the safety instrumented system. To comply with such demands, ProSafe-RS employs the same architecture of the CENTUM VP as its basic architecture, and by connecting CENTUM VP directly it realizes the integrated operational environment. ProSafe-RS can also connect directly to CENTUM CS 3000.

Achievement of both Safety and High Availability

ProSafe-RS ensures shutting down of plants (safety) as well as reducing the probability of stopping plant operation due to internal failures (low false trip rate or high availability).

Acquisition of Certification Conforming to International Standard

ProSafe-RS conforms to the safety integrity level SIL3 as defined by IEC 61508. It has been certified by TÜV Rheinland (TÜV), a German certification organization.

Improvement of Plant Safety

IEC 61508 defines a quantitative target for risk reduction in the context of industrial safety, sets guidelines for achieving the goals by specific means, and stipulates to manage safety related systems based on safety lifecycles. The concept of safety, on which this standard is formulated, is based on the idea that safety should be regarded as “Safety, freedom from unacceptable risk.” The concept of “protection layers,” in which independent safety measures are in layer structure from outside (local area) to the subject “plant (factory),” is required as a safety measure to materialize this allowable safety. It is required to introduce the concept of “protection layers” to achieve allowable safety, considering emergency measures not only in plant but also in cooperation with local society. ProSafe-RS is a safety instrumented system providing “prevention layer” and “mitigation layer” in “protection layers.”
6. How Does CENTUM VP Employ “Openness” in a Control System?

The technological innovation achieves the world fastest, open, reliable and real-time communication. Customer centric mindset maintains the true interoperability.

Global Host Interoperability Support Test (HIST) Network

In the arena of FOUNDATION fieldbus, manufacturers are bringing new devices or upgrading older instrumentations to market all the time. Therefore, interoperability has always been a key issue with Yokogawa. To facilitate project management on a global basis, Yokogawa has formed a global HIST network. Test sites in Japan, the Netherlands, Houston (USA), and Singapore make sure the interoperability between Yokogawa systems and non-Yokogawa devices is acceptable. All test results are reported to Japan. This information is disclosed at: http://www.yokogawa.com/fbs/Interoperability/fbs-hist-en.htm

1Gbit, World’s Fastest Open Control Network

The real openness of a control LAN does not just come from using TCP/IP technology. Yokogawa’s Vnet/IP provides open, reliable, and real-time broadband communications. Both CENTUM and non-CENTUM components can be connected to the network. The open communication band does not affect process control data communications nor does it impact the performance and security aspects of the control communications band. The Yokogawa system guarantees data updates every second in the HIS, even with a 1,000,000 tag project. Vnet/IP offers one millisecond time synchronization among all stations on Vnet/IP. A third-party organization has certified the security robustness of Vnet/IP and communications to the CENTUM VP FCS.

True Interoperability

Interoperability of Yokogawa CENTUM systems with the “outside world” begins with OPC. CENTUM VP utilizes an OPC server that meets the demands of information flow, advanced control, and alarm/event management. Our customers enjoy solid performance and wide flexibility of our OPC server for their integration projects. Yokogawa maintains interoperability with all intelligent instrumentation and deployed fieldbuses.
CENTUM VP stands by its automation users over the entire plant lifecycle

CENTUM VP brings your cost down over the lifecycle of your plant. Maintenance is less frequent, upgrade is easy, expansion is smooth, and even revamp is speedy.

Precise Project Cost Estimation

In the CENTUM VP, FCS application load can be quickly calculated in the design stage and easily monitored on-line. During engineering design stage, the precise number of FCSs required is known. As the project progresses, with engineering changes, cost changes are minimized due to the simple licensing structure incorporated into CENTUM VP. This covers both the addition of stations and tags. To provide the most economical system, CENTUM VP has only two tag license boundaries: the 8,000 tags for entry level architectures, and the 100,000 tags for medium to large scale plant systems. When linking multiple plants together, then we have a one-time 1,000,000 tags.

Virtual Test Function

A virtual FCS and HIS environment is available where both the control and operator functions of the CENTUM database can be tested without FCS hardware. Application testing and engineering time are dramatically reduced, accelerating project progress and reducing engineering cost. For system expansion and modification, applications can be tested and verified without any impact on the actual plant operation. Where ProSafe-RS is also a part of the system, then virtual testing is also available together with CENTUM VP. Our virtual test function is also a key component in building an operator training system (OTS).

Upgrading

As part of lifecycle cost management, Yokogawa pays particular attention to upgrading all CENTUM systems. It is simple, quick, and direct. All PC-based CENTUM VP stations are upgraded with one mouse click. As for FCSs, upgrading is necessary only when you wish to use the new functions. Where the latest functions are desired, it takes just one mouse click to execute an FCS upgrade.

Multiple Project Connection

Customers are demanding different sites to be linked together so that bi-directional operation can be made more efficiently. Yokogawa provides a Multiple Project Connection package to connect several CENTUM VP sites together and link older CENTUM sites.

Migration

Migrating from CENTUM CS 3000 to CENTUM VP is accomplished without manual conversion. It is a standard function of our engineering configuration tool. Older CENTUM systems require Yokogawa conversion tools for the older database designs. Tools are also available for migrating from a few legacy/older third-party DCS systems to CENTUM VP.