Fujitsu BS2000 openNetworking is a future-oriented concept for communication in Internet and Intranet that takes the heterogeneous infrastructure into account and protects existing investments.
Introduction
Meeting the challenge of doing more with fewer resources and supporting corporate objectives in a more flexible manner requires an architecture that offers more reliability, economic efficiency and flexibility. Such features are covered by the term Dynamic Infrastructures.

Internet technology plays a central role in Dynamic Infrastructures. Its standardized network types, protocols and tools are the decisive basis for interconnectivity within Dynamic Infrastructures and the external clients and servers.

3.1 Overview
In the early days, the Internet was simply a means of communication. Since then it has developed into a central hub for business processes across the entire added-value chain. Nowadays, the infrastructure needs to take into account the fact that users of information systems are becoming more and more mobile. Wherever you are, at work, at home or on the road, you can be ready for business as soon as you have logged on to the Internet. The most important prerequisite for successful IT infrastructure is without doubt the ability of a company's hardware and software system to perform all the business processes involved in IT-supported business in an efficient, consistent, secure and flexible manner.

For this reason, Fujitsu is further developing its high-performance mainframes from the BS2000 range in order to meet these requirements.

This forward-looking concept, called openNetworking, embodies all the characteristics needed for Business Critical Computing. BS2000 supports all the relevant protocols and interfaces for Internet technologies. Hence, the BS2000 is an ideal high-performance Internet, Extranet or Intranet server.

openNetworking for BS2000 mainly supports Internet technologies, but also reflects the developed infrastructure, thereby protecting existing investments.

Here are the advantages of openNetworking at a glance:

- A completely open network architecture reflects all market-relevant, standardized network types and transport protocols. This leaves all the options open for future expansion.
- Supplying technologies for the Internet, Intranet and Extranet considerably extends the range of application of the BS2000 server and provides maximum investment protection.
- The independence of the communications application from the Internet provides a cost-effective use of various network types.
- Modern network technologies, such as Gigabit Ethernet or Fibre Channel, can be used straight away and newly developed network technologies can be integrated as soon as they become available.

Communication via Internet and Intranet with BS2000 openNetworking represents an advantage and an opportunity for forward looking innovative companies.
3.2 openNetworking

The Fujitsu BS2000 operating system provides all the necessary Internet protocols and services through its product portfolio in the context of the openNetworking concept, leaving you safe in the knowledge that the BS2000 provides the complete functionality of an Internet server without any restrictions.

Fujitsu BS2000 openNet Server is the central communications manager in the BS2000 and embodies the consistent implementation of the openNetworking strategy. It offers communication services for all relevant protocols and networks. The emerging open system and communications platforms that are becoming available everywhere reduce costs and enable optimum mix configurations of products from a variety of suppliers. The openness of protocols and data formats guarantees efficient communication between the systems from different suppliers. This reduces, or even eliminates, the costs for compatibility tests.

Standards are the constants in a rapidly changing technical environment. They fuel competition among manufacturers and reduce prices, they protect your investments and they provide fast distribution of innovative solutions.

openNetworking meets the demands made on Business Critical Computing such as supporting standards for optimum connectivity in heterogeneous multi-vendor networks and supporting mobile terminals, just as it meets the needs for availability, reliability or integration of existing data. The development strategy for openNetworking therefore homes in on the requirements as discussed, with the emphasis on these aspects:

**Business Critical Computing (BCC)**
- High availability and reliability
- Optimum performance to cope with continually growing demands (number of partner systems, transactions, data volumes)
- Protection of data and applications from unauthorized access or corruption

**Best possible connectivity in heterogeneous multi-vendor networks**
- Support current network technologies
- Support standards
- Support mobile devices

**Full complement of technologies for the WWW, Internet, Intranet and Extranet.**

**Ease of use and simple administration.**

The future of the BS2000 operating system is secured in the long term by innovative further development in all relevant areas of IT. The scalability of this system platform up to the highest performance range ensures a flexible response to increasing demands in the field of communications performance. High availability of systems and error tolerance – also very important features in the area of autonomic systems – are essential requirements for successfully running business critical processes.

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### eBusiness requirements

- Easy client access, mobility
- High-availability network
- Standards
- Security functions
- High-availability servers
- High scalability
- Integrate existing data and applications and new applications

### openNetworking BS2000

- Web infrastructure
- Redundant TCP/IP network
- Standard protocols, Internet servers
- Virtual private networks, efficient encryption
- High availability > 99.999%
- Managing between ten and hundreds of thousands of users and connections
- openSeas concept, Web server APACHE, Java

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Figure 1: E-business requirements and solutions
3.2.1 BS2000 communications features

The Fujitsu BS2000 openNet Server communications manager has been consistently expanded to become an open communications platform with a central role for the BS2000 business server’s data communication. The very name openNet Server emphasizes that the communications manager provides comprehensive communications service not just for the Internet, but also for all previously relevant networks in the BS2000. This means consistent implementation of the openNetworking strategy.

Hardware support

The openNet Server communications manager supports communication with partners across different network technologies. This means that different net connectivity components such as Fujitsu BS2000 HNC (High-speed Net Connect) or integrated net controllers for LAN networks can be used.

The flexible connection options allow optimum configuration options for the most diverse applications. They also represent excellent protection of investment, because they allow existing servers to work with new network connections and new servers to work with existing network ones.

Dynamization

The dynamization of address information via DNS protocol (Domain Name Service protocol) saves a great deal of effort when manually creating and managing address lists for communications partners; moreover, it avoids potential sources of error, thereby increasing the overall availability of the system.

Interfaces and protocols

The openNet Server communications manager has provided TCP/IP, ISO and NEA transport services for a long while. This has resulted in comprehensive configuration options in heterogeneous networks. openNet Server uncouples the applications from the transport protocols and network technologies. Applications are therefore not affected by any changes arising from switching network technologies (and their fundamental transport protocols). This is a very important contribution to protecting software investment. It enables the operator to always use the most cost-effective network topology and in particular to change network topologies when cost structures change.

The openNet Server communications management provides the following tried and tested transport system interfaces:

- **SOCKETS**
  Interface corresponding to the Berkeley Unix BSD Interface for TCP/IP transport service. The Sockets interface enables communication in accordance with IPv6 conventions (RFC 2553).

- **ICMX**
  (Communication Manager for UNIX platforms) Program-program communication interface for ISO transport service.

- **IDCAM**
  (Data Communication Access Method) Program-terminal or program-program communication interface for ISO and NEA transport service.

- **ITIAM**
  (Terminal Interactive Access Method) Interface for dialog input/output for communication in dialog mode.

- **IKDCS**
  (Compatible Data Communication Interface) Interface for transaction-oriented applications with the functions for controlling messages, programs and transactions as well as data storage functions.

3.2.2 Standards – IPv6 and IPSec with IKE

For interoperability purposes, the kind of communications and transport protocols are provided that are needed for applications to interact with each other. Since the communications and transport protocols determine the logical and physical relations between two communications partners or applications, implementing standards is an indispensable prerequisite for smooth communication within heterogeneous multi-vendor environments.

The Internet, which brings together a huge number of networks around the globe and lets them communicate with each other, is a huge success story. Millions of users move enormous data volumes across the Internet every day. Although the family of Internet protocols comprises a multitude of protocols, these are commonly known as TCP/IP (Transmission Control Protocol and Internet Protocol). TCP/IP implementations are available on practically all widely used operating systems.
The openNet Server communication manager also supports the IPv6 protocol. IPv6 not only increases the available address space, other requirements for further development of the current Internet protocol are also realized. The extension of the address size to 16 bytes eliminates problems with the address space in the Internet as it currently stands (based on IPv4). The broader address also allows a more flexible routing hierarchy, speeding up the transfer of IPv6 data packages through the Internet and paving the way for optimum utilization of high-speed networks. Further can be compressed the IP packages before the transfer. The data quantities, transported over the network, are reduced by it. That increases the transfer speed additionally. IPv6 will make plug and play configuration of network components possible. Support of mobile computing is one of the basic function complexes in the IPv6 protocol, so it is homogeneously integrated into the network layer and easy to handle.

The Communication manager openNet Server offers support for the IPSec protocols in the framework of expanding the IP protocol. IPSec supplements the TCP/IP protocol stack with those functions that the standard protocols lack: encoding, integrity and authentication of security relevant data.

The implementation of IPSec realizes a wide range of security mechanisms under usage of Fujitsu BS2000 openCRYPT™ products (see Chapter 7.5.6). It offers flexible control technologies with which it is possible without necessary intervention into existing communications applications, keys dynamically exchange, messages codifies and transfers and, to enforce a reliable authentication of the communication partners.

With this new development, BS2000 users can be sure that the openNet Server communication manager will continue to supply them with open, global communication facilities in the future.

3.2.3 High performance

Data, voice, audio and video are transferred across a variety of networks: Local networks (LAN), wide area networks (WAN), mobile networks (GSM, optical broadband networks (Dark Fibre, WDM, SDH)). Connection to networks is via special network access points. Network transfers enable interworking of different network types and structures, in particular the combination of legacy networks with high speed networks. Consistent orientation to open networks requires the standardization of networks and enables the use of products from different manufacturers. Constant development in the fields of bandwidth, scalability, configurability, service features and costs not only affect the development of new network types, but also traditional network technologies, thus protecting existing investments.

The further development of transfer processes for copper cable and fiber optic cable has created the conditions for wider bandwidths. The BS2000 Communication Server will ensure in the future that the performance required for Business Critical Computing can be taken securely onto the data highway. The developments of the openNet Server impressively document the increases in performance that have been provided in step with the advances in networks and the demands on the application side.

The adjoining diagram shows the significant improvements in performance, which have been provided by the continual improvement of BS2000 openNetworking and the HNC (see Chapter 7.5.5) network access product.

Future product releases will support widened connection technologies and increase throughput through the channel.

Figure 2: Performance increases in openNetworking
3.2.4 High availability

Installing virtual hosts increases the availability of business-critical applications and servers. The openNet Server communication manager provides autonomic computing mechanisms to enable short switching times and maximum availability in the case of disruption or scheduled interruptions (e.g. for maintenance). For every server whose availability is to be increased, network definitions are made both on the system to be protected against failure and also on the backup system. Applications can then be handled by a backup system when a failure occurs.

Virtual hosts allow transparent on-the-fly switching of network addresses between different servers. Any number of virtual hosts can be defined for each server. They have different network addresses to the one standard host per server and can be activated and deactivated during operation. If the system being backed up fails, the appropriate virtual host is activated on the backup system. A new connection is then created for the client without changing the network address. The Fujitsu BS2000 HIPLEX-AF product is capable of detecting server and application failures and of taking the necessary steps when such a failure occurs.

Scheduled changeovers can also be arranged. Different virtual hosts allow static load balancing, in which different clients are assigned to server applications using different network addresses. Virtual hosts can access current server applications using host aliasing.

![Diagram of high availability through backup system](http://fujitsu.com/lts/bs2000)

With distributed (or coexistent) applications, static load distribution can be supported by virtual hosts and host aliasing. Clients that are assigned to a virtual host are assigned to a different application instance on a different server. When an application instance fails, these mechanisms of the openNet Server communication server can provide a solution that economizes on resources. Quick change-over times and hence maximum availability are guaranteed.
3.2.5 Redundancy

The BS2000 openNetworking redundancy concept is designed to serve redundant network topologies, in which certain components are available more than once, thus providing better total availability when one of the components fails. Using standards further improves availability.

The redundancy concept maximizes route availability between the BS2000 and a partner system, as well as the functionality of connections made in this way. The redundancy concept for Ethernet, Fast Ethernet and Gigabit Ethernet can be realized using Fujitsu BS2000 High-speed Net Connect (HNC) for network access.

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**Figure 4: Redundancy concept using Gigabit Ethernet**

BS2000 openNetworking does not use a special protocol to integrate the largest possible number of partners in redundant networks. In TCP/IP environments, the base protocols ARP, ICMP and OSPF are used. If one network component fails, the substitute network components take on the functions of the one that is defective.

The mechanisms above initiate the following reactions when a network component fails:

- If the whole device (HNC or integrated LAN controller) fails, the system switches to another functioning LAN access device.
- Detection of a router system failure leads via ICMP to a search for an operable router system, to which a switchover is made. OSPF provides a comprehensive information basis for finding an alternative router.

When the reason for the failure has been eliminated, the original status of the network can be restored following a reconfiguration. Transport connections in place when the failure of a network component occurred remain intact. Connections may be cleared down when a time-out occurs in remote switching actions. But the connection can be re-established using the same address information.

**Planned extensions in openNet Server V3.6:**

With the new openNet Server version 3.6 the following functions will be offered in addition:

- **Performance measures:**
  - Increase in throughput and reduce the CPU need for multiprocessor systems (Processing oversized IP segments, Link Aggregation at RSC, optimization of queue sizes, larger TIDU-size).
  - Interact with X2000 / HNC optimize (Segmentation offload to the device, large receive from the device, RSC chaining for X2000),
- **Change Requests** (Reverse canceling IP@ / Lookup implementation PING, send-/receive-order with timeout limit, treatment OWN-address),
- Support of SE servers (Preconfigured at the factory for the required Net-Unit base configuration),
- Rebasing of LWRESD (on BIND 9.9).
3.3 Internet services

The product Fujitsu BS2000 interNet Services includes all the functions, services and protocols for operating on the Internet. The levels of standardization in the Internet community and the market determine what is needed both now and in the future. interNet Services in the BS2000 is therefore continually being expanded and customized. Fujitsu BS2000 APACHE is the ideal base for your stable, future-proof Web presence and for up-to-date e-business solutions in the BS2000 landscape. This software is available free of charge as an expansion of BS2000 Internet communication. APACHE is currently installed on more than half of all Web servers across the world. That means that here too, Fujitsu works with the international standard in the Internet sector.

BS2000's electronic mail service uses a mail server based on SMTP, POP3 and IMAP. It is part of the product interNet Services. User agents are available for processing and sending electronic mail from applications; in addition these mails can be evaluated and post processed by BS2000 applications. In the current versions of the mail services, also this services are offered as certain variation, in which the mail traffic from and to the mail server and between the mail servers can be encode (with SMIME).

Information is general one of the most important resources within a company. The functions provided by openNetworking give more comprehensive security. The accesses on some services (TELNET, FTP, HTTP and DNA), can be safeguarded the transfer of the data between servers and client with symmetrical and/or asymmetrical encoding-algorithms.

Through the code conversion of the standard OpenSSL and OpenSSH into the BS2000 is enabled the encoding of the data and the authentication of the communication partners also for socket applications (like for example FTP, TELNET and APACHE). The encoding can take place through the services 'Secure Socket Layer (SSL)' and 'Transport Layer Security (TLS)' in the software or through the encryption-products openCRYPT™ (see chapter 7.5.6). The services of OpenSSL and OpenSSH are offered with the product "interNet Services" and may get used from the provided socket applications.

The table summarizes all the essential services of the BS2000 Internet server. The product column indicates the Fujitsu product in which the services are implemented.

<table>
<thead>
<tr>
<th>Internet services</th>
<th>Protocols</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP/IP communication service interface</td>
<td>TCP, UDP, IPSec, ICMP, IGMP</td>
<td>openNet Server</td>
</tr>
<tr>
<td>Simple network management protocol support</td>
<td>SNMP</td>
<td>SNMP-Basic-Agent BS2000</td>
</tr>
<tr>
<td>Hypertext transfer protocol services</td>
<td>HTTP, HTTPS</td>
<td>APACHE (BS2000)</td>
</tr>
<tr>
<td>Internet domain name service</td>
<td>DNS</td>
<td>interNet Services</td>
</tr>
<tr>
<td>Terminal and file transfer services</td>
<td>TELNET, FTP</td>
<td>interNet Services</td>
</tr>
<tr>
<td>Mail services</td>
<td>SMTP, POP3, MAP</td>
<td>interNet Services</td>
</tr>
<tr>
<td>Print services</td>
<td>IPP, BSD, LDP</td>
<td>RSO, [DPRINT]</td>
</tr>
<tr>
<td>Client booting services</td>
<td>DHCP, BOOTP, TFTP</td>
<td>on request</td>
</tr>
<tr>
<td>Time services</td>
<td>NTP</td>
<td>interNet Services</td>
</tr>
<tr>
<td>Directory services</td>
<td>LDAP</td>
<td>on request</td>
</tr>
</tbody>
</table>

Figure 5: Internet services
3.3.1 APACHE Web server in BS2000

The most widely used Web server in the world, APACHE, is also available for the BS2000 business servers. This opens up areas of application for Web servers on BS2000, such as dynamic web page creation with access to SESAM and Oracle databases on BS2000 and provides extensive support for innovating existing BS2000 applications. Web programmers can easily develop and maintain Web applications on the BS2000. A large number of finished solutions in particular can be accessed on the Web.

The Fujitsu BS2000 APACHE Web server provides the conditions for a wide range of application by supporting a variety of standard development and process environments. The outstanding features of APACHE are virtual hosting and persistent connections. Virtual hosting means that several Internet domains can be used independently of one another on one computer. Persistent Connections maintains connections for a specified period without having to disconnect and re-connect for each document and each image, reducing overheads and saving resources.

Fujitsu BS2000 APACHE V2.2 is based on the versions 2.2.8 released by the Apache Software Foundation and is supported also the encoded transfer of the data on basis of the SSL-Protocol and is useful consequently also for sensitive scopes. For the implementation of encoding-tasks Fujitsu BS2000 openCRYPT can be used as encoding-unit. This will enable users to realize solutions on the basis of an encrypted client-server communication.

The scalability of the BS2000 system platform ensures a flexible response to increasing demands in the field of computing performance. High availability of the systems is an essential requirement for executing business-critical processes using Internet technology. The versatile, available components open up all the possibilities of the Internet. Everything is available in the APACHE environment: from ready-made solutions to cost-effective rapid innovation of existing BS2000 and openUTM applications with WebTransaction options, the provision of data that resides on the BS2000 over the Web, to customization of application and system data.

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Figure 6: Web-technology for business critical applications
Complete JAVA-Servlet support through Tomcat

Apache Tomcat provides a runtime environment for Java code (servlets) which can be addressed via the web; in other words, it is a servlet container. With the aid of the Jasper JSP compiler, it can also convert Java server pages (static content such as e.g. HTML with embedded Java code) into servlets, which can then be executed.

JAVA servlets are JAVA applications that run in the JAVA environment of the server. This gives access to all the server’s local resources, such as SESAM or Oracle® databases with JDBC (“Java database connectivity”). The results of the JAVA application are transferred to the client in the form of HTML code, which does not therefore require an environment for running JAVA.

Java server pages enable JAVA code to be embedded directly in HTML files, which makes creating and maintaining these web pages considerably easier. The JAVA code is automatically compiled the first time it is called.

JAVA applets are JAVA applications that are transferred from the server to the client and run in the JAVA environment of the server.

SESAM and Oracle database connection

PHP (“PHP: Hypertext Preprocessor”) is a script language that is embedded in HTML and interpreted by the server. It was specially designed for Internet application development and provides powerful tools for creating Web pages with dynamic content.

In BS2000 APACHE V2.2 are ready with PHP 5.2 a whole row of functions, which now also permit SESAM and Oracle databases to be processed from within PHP scripts. It is now easy to provide the contents of existing databases on the Web and also to enable write access to them. New entries can be added to the database, and existing ones can be modified or deleted. The application logic therefore remains hidden to the Web user, so that even the most stringent security requirements can be met in full.

Perl script language

Perl (“practical extraction and reporting language”) has been gaining ground in the Internet arena. Perl is not specialized for a specific purpose, but can be put to many uses through countless modules and expansions. Experts appreciate the convenience and wide range of functions the language offers them. A continuously increasing number of ready-made Perl modules for all kinds of applications are becoming available on the Internet. Perl is fully integrated into the BS2000 APACHE Web server, guaranteeing high-performance script execution.

WebDAV

WebDAV (“Web-based Distributed Authoring and Versioning”) is an accepted Internet Engineering Task Force (IETF) standard. WebDAV enables easy and secure management of documents based on Web technology. Microsoft products already contain a WebDAV connection. WebDAV allows users in different locations to access central documents, which can then be edited as if they were local documents. Security mechanisms prevent more than one user from editing the same document at any given time.

WebDAV is particularly well suited to managing Web content. On BS2000 systems, WebDAV facilitates such content related activities. Documents can be edited with direct access, for example from a PC. This obviates file transfers of the modified documents to the BS2000.

Unicode support

BS2000 APACHE V2.2 also supports the BS2000-specific Unicode variant UTF-E (modified UTF-8), the various 8-bit EBCDIC-DF04, the 7-bit equivalent national EBCDIC-DF03 code variants and the 8-bit ISO codes 8859-x, together with a host of other standardized character sets, as well as the conversion between these code sets during input and output.

Storage saving installation

By supporting dynamic reloading of modules and with the interactive and modular installation the APACHE Web server can be combined with the components and functions that are really needed. Inclusion of your own modules is possible on request.
3.3.2 Mail service (e-mail)

Mail server (Mail Transfer Agent):
Sending and receiving electronic mail (e-mail) is one of the most important services provided by the Internet. In this respect, the mail servers can be compared to post offices. They transfer e-mails through the network and deliver them to mailboxes. Mail user agents offer user-friendly interfaces for writing and sending e-mails and for accessing mailboxes, as well as for presenting and processing e-mails.

The Internet's electronic mail service is based on SMTP (Simple Mail Transfer Protocol). The addresses of the sender and of the receiver have the format username@computername, the computer name being represented in DNS format.

Originally, only texts could be transferred. Nowadays that has changed, and a wide range of formats, e.g. images and videos, can also be transferred. The Post Office Protocol (POP3) and the Internet Mail Access Protocol (IMAP) allow users to (remote) access mailboxes through user agents that run on the remote computer (in the general conditions a PC).

The mail service in the BS2000 is realized by a SMTP mail server, a code conversion of the open-source product Postfix, just as a POP3/IMAP server, a code conversion of the Cyrus server of the Carnegie Mellon University.

Mail client (Mail User Agent):

- **Mail sender**
  There is a local user agent for sending e-mail in native BS2000. This allows automatic transfer from BS2000 procedures and programs of files as lists or in error situations notifications as e-mail to the local mail server in POSIX or to remote mail servers. In BS2000 both commands SEND-MAIL and MAIL-FILE are realized for sending e-mails and appendices, which can be called from all BS2000 procedures and programs of the user.

- **Mail reader**
  In BS2000, the mail reader is used to retrieve and process e-mails via the access services (POP3 and IMAP). Both a procedure and a program interface are provided in BS2000 for this purpose. The message header, message body and attachments of an e-mail can be accessed via these interfaces.

Mail security:
For a secure transfer of e-mails, the mail services can use as an option in BS2000 an encryption by means of SSL/TLS between the involved mail servers and between the mail servers and the mail clients. The e-mails themselves can also be signed and/or encrypted with S/MIME. BS2000's mail server, mail sender and electronic mail reader in BS2000 are supplied as part of interNet Services.

Outlook:
With the steady development of BS2000, the mail services are ported to the current code basis and change requests are also implemented.

3.3.3 File Transfer Protocol (FTP)
Data exchange is of central importance when combining several computers in a network. The vast number of computer types available on the market makes it absolutely essential to apply a vendor-independent standard. With FTP protocol, data can be transferred independent of the structure and the operating system of the computers involved. It is based directly on TCP and can transfer all manner of files (e.g. text, image, sound, video or program files).

The user communicates with the FTP client through the user interface, and the FTP client sets up a connection to the FTP server through port 21 (control connection). The client sends commands to the server through this connection and the server acknowledges their receipt. Then the FTP server establishes a second connection to the FTP client using port 20 (data connection) for the data exchange proper.
BS2000 supplies both the server and the client functionalities of FTP. In addition to the standard protocol, the following functions are offered:

- Support of BS2000 file formats (SAM, PAM).
- Selection of code conversion tables for EBCDIC to ASCII and vice versa.
- To enable secure data transfer using FTP, the socket application FTP can also optionally make use of encryption via the SSL/TLS interface. Authentication and data transfer can be performed using encryption. Data transfer using SSL/TLS is possible either only for the monitoring connection or for both the monitoring and the data connection.
- Additionally security functions through connection to the optional security product Fujitsu BS2000 openFT-AC. The FTP access authorization and login authorization can be handled separately, user-specific access authorizations can be defined and access checks can be logged. Alternatively there is a system exit on the FTP server for expanded access checking and modified processing of FTP commands.
- Expansion of the system exit for an individually programmable code conversion in client and server for file transfers.
- SNMP connection for the FTP server for reading important data of the server and its connections as well as write access for starting and ending, for changing important settings and setting server traces of an FTP server.
- Restart mechanism for data transfer.
- Batch support for the FTP client.
- Run of FTP-Client optionally under BS2000 native or POSIX.

FTP is supplied as part of interNet Services.

### 3.3.4 Domain Name Service (DNS)

DNS is a global network of servers that maps names to IP addresses. Neither the Internet nor the operation of intranets would be possible without DNS.

The DNS names have a hierarchical tree structure covering various domain levels. The root domain is the starting point for all search processes within the entire DNS name range. DNS also contains addresses and other information.

The Domain Name Service is a distributed duplicated database with DNS servers and DNS clients (resolves). The data is administered by several DNS servers, each being responsible for one or more DNS domains. Redundant DNS servers may be used to enhance fail saving. The resolves do not have a local database. With each DNS query, a client contacts one or several DNS servers in order to obtain the information it requires. These DNS queries can optionally be signed.

BS2000 supplies its users with both the DNS server functionality and the DNS resolved functionality. Both the server and the resolved functionality have been ported from the BIND coding, which is the standard implementation for DNS. The DNS servers in the BS2000 run under POSIX. This provides BS2000 users with access to DNS functions and services. In addition, the high availability of BS2000 ensures equally high availability of the DNS servers in the network.

DNS is supplied as part of interNet Services.

### 3.3.5 Time service (NTP)

The Network Time Protocol (NTP) allows a reference time (Universal Coordinated Time, UTC) to be distributed within the network on the one hand, and, on the other hand, it co-ordinates all clocks within a network of any size. Time servers are hierarchically structured; a secondary time server receives its time through the network from a primary time server. One of the servers in the network should be equipped with a hardware radio clock which receives a signal generated by an atomic clock to supply the network with the UTC. A BS2000 server can perform the function of a precise time server and of a client.

Time service is supplied as part of interNet Services.
3.3.6 Secure Internet services

Information is one of the most important resources within an enterprise. IT systems, servers, networks and terminals are all exposed to the same threats: loss of confidentiality by unauthorized access, loss of integrity by unauthorized modification of information, and loss of availability by unauthorized restriction of functionality. It is therefore essential that certain activities are clearly allocated to the person who is in charge (accountability).

System and Internet security is therefore mainly concerned with protecting IT systems from these basic threats. Disturbances of normal IT operation can emanate from a variety of sources. Depending on region and location, IT components may be threatened by natural disasters.

Technical faults, which are minimized by implementing high standards and a comprehensive quality assurance system, coupled with intelligent hardware management and high availability solutions, and user mistakes, caused by negligence or laziness, may prove to be a security hazard. Malignant attacks, such as unauthorized access to, or use of, data, unauthorized modification of data and interventions that may seriously impair the operation of an IT system (denial of service) pose risks to system security. However, a highly secure operating system platform such as the BS2000 has powerful countermeasures at its disposal.

![Figure 8: Threats and security mechanism](image)

The BS2000 has been subjected to a security assessment. Its Fujitsu BS2000 SECOS (Security Control System) mechanism restrict access to authorized users, isolates users strictly in terms of their rights, and protects system components against illegitimate access. openNetworking in conjunction with its operating system thus fulfills the criteria for a safe IT system (“hardened” operating system).

The downside of the Internet with its open and flexible approach is the potential security risk. The functionality within openNetworking provides far-reaching protection. Thanks to the openNet Server communication manager you can define very clearly which partner systems can actually communicate with the BS2000. Within this framework, it is possible to restrict access to certain services. You have the option, for example, to restrict communication for production applications to specific partner systems, but grant unrestricted access to the APACHE BS2000 WWW server. With the exception of the access control mechanisms, these functions are delivered by means of cryptographic procedures. The much faster encryption rates achieved by symmetrical cryptographic procedures mean that they are used for the protection of data transfers. Asymmetrical procedures on the other hand are used for authentication and code allocation.
SSL (Secure Sockets Layer) and IPSec (Internet Protocol Security) have established themselves as the most important security mechanisms for risk-free communication between IT systems. In order to maintain uninterrupted communication between IT systems, which is essential for Business Critical Computing, these mechanisms were done within the openNetworking framework available of course. To keep pace with the ongoing standardization efforts, the Internet services in the BS2000 are equipped with additional security mechanisms. In the first instance, Internet security standards are applied, and, where necessary, extra security features are added. The FTP Internet service, for example, offers enhanced access protection over and above the security features of the local system, and hence increased security by using security features of the Enterprise File Transfer product openFT-AC.

When using SSL and IPSec, the functionalities of the openCRYPT basic system can be integrated for handling the encryption functions. This way, Business Critical Computing and mobile computing receive the best possible protection. IPSec is a security protocol that has been standardized by the IETF for encrypting and authenticating IP packets on the Internet. IPSec introduces security features for risk-free communication between IT systems, in conjunction with the previous Internet protocol IPv4 as well as the current Internet protocol IPv6. In order to achieve the required levels of security, well-known encryption and authentication methods are used, whose application has been standardized so as to guarantee uninterrupted interoperability between IT systems. Since encryption for IPSec takes place at the level of the IP packet, a traffic analysis at application level is excluded. SSL is a security protocol at application level.

When using SSL and IPSec, the functionalities of the openCRYPT basic system can be integrated for handling the encryption functions. This way, Business Critical Computing and mobile computing receive the best possible protection. IPSec is a security protocol that has been standardized by the IETF for encrypting and authenticating IP packets on the Internet. IPSec introduces security features for risk-free communication between IT systems, in conjunction with the previous Internet protocol IPv4 as well as the current Internet protocol IPv6. In order to achieve the required levels of security, well-known encryption and authentication methods are used, whose application has been standardized so as to guarantee uninterrupted interoperability between IT systems. Since encryption for IPSec takes place at the level of the IP packet, a traffic analysis at application level is excluded. SSL is a security protocol at application level.

![Diagram](image_url)

**Figure 9: Encryption with openCRYPT**

It enables the use of encryption and authentication mechanisms between two communicating partners. In order to achieve the desired level of security, well established encryption and authentication methods are being used.
3.4 Client connection

Connecting clients to server systems has resulted in a wide variety of terminals. These clients were developed in many stages, which reflect trends past and present for terminal systems. Already in the 19-Nineties, with the advent of client/server architectures, traditional terminals began to be replaced by PCs. End users had access to terminals offering local intelligence. As more and more tasks were left to PC clients, these became “fat clients” that could be used with a variety of local and distributed applications.

The cost-intensive management of these “fat clients” caused an attempt to slim down to “thin clients”. Thin clients are less complex and have fewer system functions and fewer configuration options. The Web browser provides the central interface to the end user. All applications from the Internet are displayed on the terminal using Internet technologies (TCP/IP, HTML, WML, etc.) and the browser. The reduced scope language definition WML (Wireless Markup Language) and the standard WAP (Wireless Application Protocol) enable the input and output of low-complexity data on a range of mobile devices with limited display options. Different types of clients and mobile terminals require a specific solution to enable optimum connectivity. The most important solutions for using the different clients in the Fujitsu BS2000 server systems environment are:

3.4.1 Terminal emulation MT9750

The terminal emulation Fujitsu MT9750 (Windows) is a 32-bit Microsoft Windows application (executable on Windows 2000, Windows XP, Windows 2003, Vista and 7 [32bit and 64bit systems]) that can emulate the visual display stations of the terminal group 9750 to 9763 on a PC. The terminal’s properties are emulated on the PC. In addition, functions are available that go beyond the basic capabilities of the terminal. The Kerberos-authentication function offered for example for Fujitsu BS2000 SECOS as of V5.0 is supported by MT9750 as of V6.0. Unicode, a further character coding, is in version 7.0 additional supported to terminal input and output for the relevant European character sets. As of version 8.0, network connections are supported in addition with the IPv6 protocol.

3.4.2 WebTransactions

Fujitsu BS2000 WebTransactions transforms the original, usually character-oriented interface of an application to formats that can be processed by a Web browser. With WebTransactions, Fujitsu offers an integration product that has been successfully applied in various sectors and scenarios because it satisfies all the demands of a variety of Web integration scenarios.

For more information on WebTransactions, see chapter 2.

3.4.3 UPIC client

A further option for linkage is to implement UPIC client software for an openUTM application, with which client and server application communicates. See "section 4 "Database systems and openUTM"."