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A Novel Tele-Working Platform supporting Public Administrational Bureaus

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Abstract:- A novel Tele-Working Platform is presented, the basis of a ready-to-be-applied multi-level Tele-Working Service supporting electronic commerce and other value-added applications business plans. Being the outcome of a large-scale common project, this Platform's features plan to satisfy the demands of possible B2B providers and subscribers. The entities of the Platform and its major characteristics as issued from the Service's pilot implementation are presented along to an extensive evaluation procedure utilised during this period of time.

Key-Words: - ATM: Asynchronous Transfer Mode, B2B: Business to business, DBMS: Data Base Management System, DCS: Distributed Computing System, DSL: Digital Subscriber Line, ISDN: Integrated Services Digital Network, ORB: Object Request Broker, PAB: Public Administrational Bureau, TWP: Tele-Working Platform, TWPL: Tele-Working Layer, TWS: Tele-Working Service

1. Introduction

In order to satisfy the tele-communication service provider market trends, a large-scale common project aiming to a special value-added network service began 4 years ago by the Hellenic PTT (OTE) and the University of Patras. This project was set to outcome into a novel integrated Tele-Working Platform (TWP) and a ready-to-be-applied Tele-Working Service (TWS) meeting the demands of clients (subscribers) to be. Thus, a market investigation was performed and its results thoroughly analysed so as to sketch out TWP and TWS characteristics [5], [6].

In addition, a number of already mature technological fields was utilised so as to comply with the many prototyping specifications [9], [12], [13] such as personal computer-based design, tele-communication networking facets, and software applications as the tool towards remote collaboration between distant parties (a must-have for up to date enterprises) [10], [15].

This TWS was already tested and evaluated for a period of over 9 months by a network of 10 nodes situated in local Public Administration Bureaus (PAB) of Thessaly, Hellas (Europe).

Due to the success of the proposed TWP, the project was expanded to support 5 extra nodes, at the local PAB of Edessa, Hellas, augmenting the project's duration by a year. These PABs were chosen due to their geographic particularity, their sparsely populated regions, and the need they had to offer better quality of service at any time. Summing up its specifications, the TWS offered:

- **Access Security**. No unauthorized admission was permitted to the service.

- **Performance**. Special attention was given to achieve small access/response times, so as so to augment the citizens' faith to the utilisation of the new technology.
- **Scalability**. The TWS was to handle a few to large numbers of simultaneous connections.
- **Multi-platform architecture**. The TWP was strategically built to enact a Distributed Computing System (DCS) thus permitting the exploitation of printers, file servers, etc. while facing resource-consuming tasks calls. Data, that are present within the DCS, may be shared across all TWPs (nodes) of the system. This task-scheduling facet gave the platform flexibility, robustness, and nearly limitless access potential.

The TWP was developed so as to manage fault tolerance and enable non-stop availability. By making use of idle processing power within the distributed system, the overall efficiency could be increased by 'load balancing' all the utilized nodes. Also, synchronization across the TWS system presented a particular management challenge that required specialised technologies to be implemented; moreover, security enforcement was harder than trivial to achieve [11].

Section 2 describes the TWP/TWS application environment, whereas Section 3 their architecture and Section 4 their pilot implementation. Evaluation of the Platform and the Service is reviewed in Section 5. An overall look to the presented work and its future potential concludes the paper.

2. Application Environment

The TWS was designed to back up the "J. Kapodistrias" [5] national Hellenic project that handles our counties administration and recently commended the merging of a great number of small country towns into single municipalities. TWS offered the means for the PABs to remote collaborate and is in accordance to the Hellenic Department of the Interior relative standards.

The aforementioned merging, "forced" citizens to travel to distant municipal locations in order to acquire certificates, legal papers or resolve public matters. Hence, it resulted in many lost working hours and the location of these headquarters turned out to be a social problem. The solution came by the foundation of the Citizen's Service Offices as part of the PABs. Citizens apply to these offices for they needed paperwork; the offices archive and process those applications; then the TWS facilities set out and an application is processed, the certificate composed and finally dispatched to the citizen by mail.

However, the aforementioned example is only an aspect of the TWS effectiveness. The ultimate goal was the economic growth to be achieved by the country towns merging. To achieve such a goal, new municipalities had to both absorb the economic resources provided by the State and European Union funds and to enforce their economy by creating new ways to exploit their local resources (tourism, business, etc.) and job opportunities.

The TWS achieved the first part by providing the means so that consulting services in collaboration with authorized legal advisors were constantly on-line. Messaging Services, Agenda and PAB Client Catalogue facilities, as well as Video-conferencing and application sharing services were built into the TWS in order to comply with the nature of the aforementioned e-consulting services. Transferred data included the audiovisual conversational data, transferred during the on-line sessions and in accordance to the ITU H320 video-conferencing standards. Also, shared or transferred application data by the various TWPs were handled by utilizing the standard norms of the T.120 standard for data conferencing [9].

Local economic resources exploitation was achieved by transforming the PABs to web and electronic business providers and the citizens had access to Web

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Application Services to expand their dealings and to further the advertising of their products. Consequently, TWP were assembled in order to provide 24-hour operational support, so that it would facilitate a Distributed Computing System and several joined service providers and networks. Its infrastructure should allow for adaptability to the customer's intranet, extranet, or other network requirement.

3. Architecture

The novel system's architecture is described by five sub Sections. The first one gives the TWP general characteristics and the key points of the TWS architecture. The second one refers to the TWS efficiency and security management and introduces the TWP Layer (TWPL). Sub Sections 3 and 4 portray the client Service Provider domain structure, respectively. Finally, Sub Section 5 shows the TWS operational modes.

3.1 General Characteristics

Its infrastructure's sharing and the support team's experience ensured that the TWP would present a high quality of service, while significantly reducing operation costs. ISDN over DSL was adopted, due to the fact that DSL network is only available to major Greek Cities for the time being and the operational costs are high. DSL very high cost comparing to the rest European Countries were only announced by the National Post Telegraph & Telecommunications Committee on 20 of November 2005 (e.g. in Greece access via 1 Mbps is charged at 86€ per month vs. France where the cost rate per month 1,5€) [17]. Access via private networks is configured on a client (subscriber) per client basis.

The TWS's DCS consists of a TWPL addressing, linking the communications facilities each node provides and the required application from the Service [2]. The TWPL acts like an in-between service amid application programs and networks, managing the interactions among disparate applications across heterogeneous computing platforms. The introduction of a set of TWP components, as the middle tier, serves to decouple client applications requests from the data access code as shown in more details in Fig. 1.

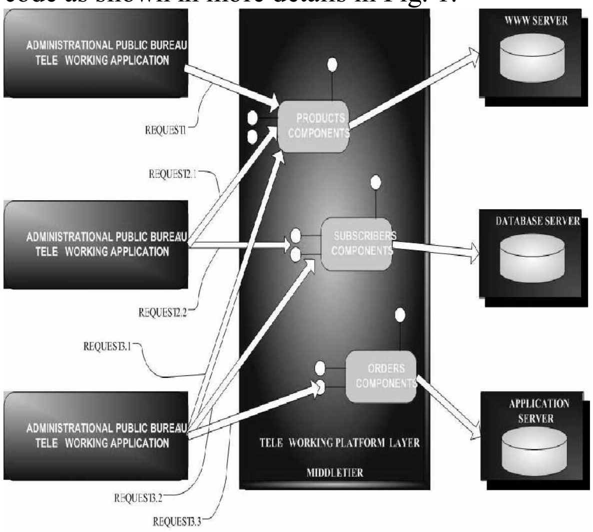

Figure 1: Role of the Middle Tier

The introduction of this tier also eliminated costly dependencies between TWP client applications and multiple DBMSs up to 70%. The TWPL:

- provides a security framework to safely distinguish different clients or different groups of clients. The TWP acknowledges who is trying to perform an operation on a component.
- hides a component's location; it also hides the security requirements of a component. The same binary code that works in a single-machine environment, where security may be of no concern, can be used in a distributed environment in a secure fashion [15].
- achieves security management by letting administrators configure the security settings for each component and it stores access control lists for components. These simply indicate which clients or groups of them have the right to access a component of a certain class.

Whenever a client submits a request to access a component, the TWPL obtains the client's current username associated with the current process (actually the current thread of execution). The TWPL then passes the username to the machine or process where the component is running. The TWPL on the component's machine then validates the username again using the authentication mechanism that is configured and checks the access control list for the component.

These components ensure a high degree of independence between the underlying systems (DBMSs, www Servers, Application Servers, etc.) and the TWS applications. Each client TWP's operating system had to be provided with a software object in order for it to support the set of distributed applications required for the host to participate in the DCS. Generally, this TWPL provides a set of services specifically geared towards supporting DCS. The services ensure that TWP is scalable, reliable, secure, and available for use and gives high performance.

Another advantage is that a middle-tier programmer can update the TWP components without requiring a re-compilation and re-distribution of client applications [2]. Thus, the process of changing a TWP application's data access code is facilitated and the client applications are screened from the system's infrastructure. A system's data can change storage formats and new database servers can be brought on-line with little effort. The necessary modifications are made in the TWPL, allowing client applications to remain always on-line and in-operation.

TWS architecture's key points are as follows:

- Access from the Internet, is protected by firewalls. The Service Provider Domain consists of a local area network (LAN) and provides all the services to web users including application-, www- servers, etc. The LAN substructure includes 2 routers; the first one is connected to a wide area network through a 34MBps line; the second one to a PRI (30B Channels) used for the establishment of dial-up ISDN connections between the TWS clients (e.g. PABs) and OTE, including a virtual server [4] for combined accessing as many number of channels as the LAN and the free database server ports allow.
- Hosting, Network Support, and Surveillance are supplied by OTE.
- The Communication Entity (§3.4) satisfies the ITU standards, such as SMTP, POP3, IMAP4, LDAP version 3, and NNTP for handling data exchange [8].
- The Administration Entity (§3.4) bridges the interoperability of the multiple database servers that are integrated in the TWS network, the calls, and the router connections according to the number of free server ports in the network layer.
- Local and remote databases and apposite servers are used, incorporating service, querying, and maintenance tools as well as the user interface.

3.2 The Service's Efficiency and Security Management

Using the TWP for building the distributed the TWS network is challenging not only because of the physical limitations of its bandwidth and latency. It also raises new issues related to the security between clients and service components. Since many operations are physically accessible by anyone with access to the network, admission to the TWS had to be restricted.

Without security support from the TWPL, each application of the TWS would be forced to implement its own security mechanisms. The security of the application data is achieved through the activation of several levels of password-locked, firewalls, and encryption procedures, which are maintained by the PTT Service Provider (OTE). Also, within the client's domain the review and the report of the received application data are handled as two independent core-applications requiring additional passwords from the client.

3.3 The Client Domain Structure

A client-PAB's interaction with the featured TWS is facilitated by the application of multi-media information technology and visual programming that provide for an interactive user interface (Fig. 2).

Figure 2: Interactive User Interfaces

There are also software tools exchanging multimedia data (audio/voice/data) and a user-friendly supporting help desk. In addition:

- The Network Terminal connects the TWP to the ISDN.
- The PC-ISDN router handles up to 2 ISDN BRIs.
- Special communication software modules handling up to 3 ISDN BRIs, have been designed to deal with the administrational and the application needs of the TWP. Also included are procedures managing operational scenarios depending on particular needs.

The aforementioned modules are responsible for the on-line use of the TWS supporting transfer rates up to 384Kbps and, for the off-line use, up to 256 Kbps. Their implementation follows the H.320 and T.120 ITU-T recommendations (on-line use), and the LDAP (X.500) and DAP protocols [7], [8]. TCP/IP handles off-line file (data) transfer.

3.4 The Service Provider Domain Structure

The Client/Service Provider domain have modular structures including diverse type of entities, each one performing a specific set of processes. This structure allows the service developer to utilise diverse operational and development tools in order to implement any entity and to introduce the appropriate functions and facilities for the client's supported application.

Parts of the data that clients exchange consist of private information and are inaccessible to the provider of the TWS. The rest are data being administrated and containing the following general entities and interfaces (Fig. 3 shows this Domain Structure):

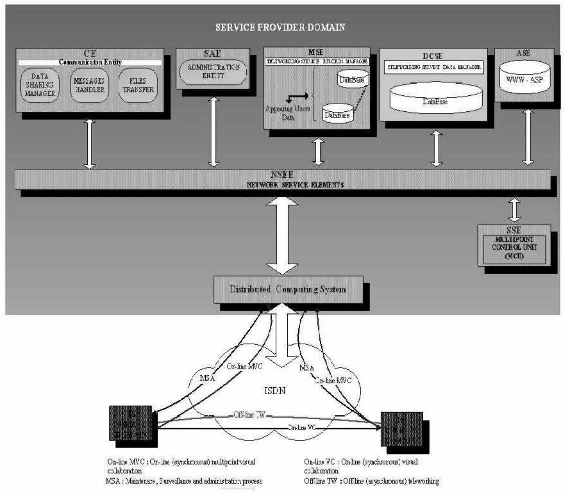

Figure 3: The SP Domain Structure

- The Communication Entity is responsible for the administration of the TWP [1].
- The Network Service Elements Entity is responsible for the safe data transfer between the collaborating clients (i.e. PABs) [1], [10], [3], [8].
- The Service Administration Entity (SAE) is responsible for the correct timing of the combined procedures: the time-schedule of the main application, the timing of asynchronously started operations while in an active application (e.g. participants' identification) [6], and the various procedure synchronization levels [1].

- The Storage Service Entity is responsible for compensating the high cost of the l data amounts that multi-user applications exchange. Hence, the ITU [4] suggests the insertion of a virtual server (MCU) to temporally store or collect all information [8].
- At the Application Service Entity the clients/PAB catalogue is hosted. This information is derived from the clients' personal databases and can be arranged to appear in web sites through the central database. These sites may also contain active web pages.
- At the Messaging Service Entity (MSE) are hosted several databases. Every client-PAB accesses a local database where private information is stored, and exchanges data with the remote DBMSs. This facility handles the asynchronous mode of collaboration.
- The Data Centre Service Entity (DCSE) contains the clients-PABs' directory. This is a database where the data of the SP clients are kept.

3.5 Operational Modes

The TWP provides the clients-PABs with on-/off-line communication, advertising of their enterprises, interactive participation in chat-like conferences, set-up of real-time collaborative conferences, file transfer utilization, access agenda/client-PAB catalogue facilities, and exploitation of a central databases facilities. All data interchange takes place safely.

By means of off-line communication a client can start applications that do not involve conferences (i.e. electronic mail messages/attachments, agenda data, publicity and application forms). It mainly relates the data exchange between the (DBMS).

Similarly, on-line communication refers to conference services (i.e. chat-like and real-time collaborative conferences), where audio, video, and data collaboration take place among the clients-PABs. Fig. 4 shows a diagram of a real-time collaborative conference.

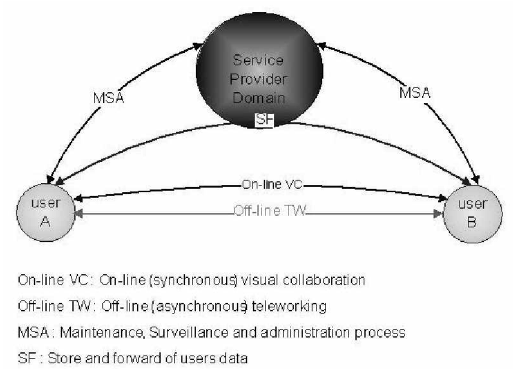

Figure 4: Schematic Representation of Real-time Collaborative Conferences

4. Pilot Implementation

The implementation of the pilot project and its expansion took place at the rural areas of Thessaly and Edessa, both agricultural Hellenic counties. The selection criterion was their geographic particularity, where the main cities are in the lowland and the towns and villages are in the highland. As aforementioned, the TWS facilitated the citizens' business.

4.1 General Characteristics

Two terminal schemes were considered for the implementation of the client domain:

- A unique terminal, integrating all entities. This choice allows the lowest possible hardware complexity as well as simplicity in terminal operation and maintenance.
- A number of terminals, each one integrating different sets of entities. The terminals may be interconnected through a LAN composing an Intranet that allows the optimum handling of distributed resources within the client domain.

Both terminal schemes achieve full compatibility on the level of the system's basic structure and management functions. Data generated by different systems, are uniformly handled independently of the

TWP, the employed communication, and the computing infrastructure.

On the other hand, for the implementation of the Service Provider domain, the design aspects were focused on the size, the total number, the geographical distribution of clients and traffic load, the data security and the service's reliability (low or no traffic congestion).

4.2 Implementation Choices of the Client Domain

The current version of the client's terminal is based on MS-Windows 2000 Professional Workstation (Thessaly's Platforms) and MS-Windows XP Professional (Edessa's ones) operating systems. All the software entities that are included are implemented as modules using the MS-Visual Basic v6.0 programming language. MS-ADO (database) function calls are used for communication between the implemented databases, the GUI and the software modules.

4.3 The implementation of the Service Provider Domain

The Domain includes a fast Ethernet LAN and suitable Entities, the LAN being based on 2 CISCO 3640 servers. The first is connected to a PRI (30B Channel with an ISDN PRI and fast Ethernet interfaces). It allows for communication with the clients' domains through Nx64 Kbps channels (e.g. 8B channels, resulting in 512Kbps available bandwidth) according to the TCP/IP protocol as supported by the operating system. The second one is connected to a wide area network by a 34MBps line. The CISCO IOS software implements the Communication Entity.

However, due to the nature of the TWS requirements, a potentially huge number of simultaneous clients must be able to perform a great number of requests while maintaining fast response times. The TWS thus is designed to allow the applications to be scaleable: it is possible to add more server machines to accommodate more clients.

Because the client service components and the TWS ones do not maintain any shared states between invocations, it is possible to simply run multiple copies of them on different machines. The problem is thus to efficiently share the data services between different machines running replicas of the client and business service components.

The SAE (§3.4) consists of 3 software modules implemented using the MS-Visual Basic v6.0 programming language, and MS-ADO function calls. The first module implements the DCSE, the second the MSE, and the third the ECE management.

The on-line sessions are implemented using the virtual server MCU Model 2020 (that follows the ITU H.320 and T.120 standards), supporting up to 48 clients participating in one/multiple active sessions. The administration and management functions of the MCU include its hardware configuration, the management of a directory (sites, participants, calendar), as well as the scheduling, monitoring, reporting and handling of the sessions. These functions are performed remotely by a PC-based system, which is connected with the MCU through an RS-232 serial communication, or TCP/IP or dial-up connection protocols.

5. Evaluation

A combined network of 15 nodes was installed and shortly after updated with the purpose to link all the local and main PABs and simplify/accelerate the work of their employees, hence serving public in a better way. Alternatively, it provided their counties' citizens with new services such as automatically obtaining certificates, advertising their region/business, acquire legal maps of their properties for compiling notary contracts, etc., all very time-consuming tasks.

The TWS responded successfully all over the duration of the pilot project (21 months), while the project itself is considered a success. For this period of time well over 250 cases were serviced (75/190 ratio of test/real cases); a total of 249,124,692MB were exchanged amid the nodes; usage time during collaborative sessions was 90min in average; the topics covered were 72% service in nature, 9% administrative, 10% financial, and 9% social talk.

The PAB's employees were trained by two-day Seminars by two-person teams of the original TWP and TWS developers. A day was used to demonstrate the capabilities of the Service by using presentation material (organizing two-hour repeating lectures) and another day for training each employee to a TWP (free training time). Local helpdesks were held for a week afterwards; those were replaced by the central helpdesk of the TWS but were seldom contacted. This procedure was held for both Thessaly's and Edessa's PABs.

After the pilot project's implementation time elapsed, the PAB's employees were asked to compile questionnaires with standardized metrics for evaluating both the TWP and TWS. Approximately 30 employees of varying ranks and task schedules contributed to the results that the following Tables summarize. The overall results are considered more than satisfactory.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Response/Task execution time	0	4	96
System Reliability	8	12	80
Recover Capability//Terminal Errors	12.5	12.5	75
Recover Capability/ Employees Errors	4.2	16.7	79.2
System Resources Management	4.3	17.4	78.3

Table 1: Service's Performance Rates

Table 1 shows how PBA employees judged the service's performance. All answers were positive; the best ratio was achieved for the one regarding execution time. Service reliability rated second, whereas recovery performance with regards to the service's and employees' errors was satisfactory. System resources management was also well accepted.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
On-line Help	9.1	13.6	77.3
User Documentation	0	4	96

Table 2: Manuals and On-line Help Rates

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Video Images Handling	0	0	100
Video quality	0	20	80
Sound Quality	0	12	88
Quality of User Interface	0	8	92

Table 3: Quality of Multimedia Agents

In Table 2 is shown that 77.3% of the employees found that on-line help was useful and easy to handle. The user documentation was found understandable and handy by 96% of them. As related in Table 3, 100% of the answers certify that the quality of video images captured, processed (real-time), and transmitted were very good. The illumination of the rooms was adjusted properly, in order to have clear video capture. Answers corresponding to Audio/Video quality were also good, only limited by the used standard Audio/Video equipment. The implemented graphical user interface was positively rated too.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Conference	0	4	96
Real Time Word Documents Processing	0	4	96
Agenda	0	4	96

Cases Enhancement	12	0	88
Citizen File	4	8	88

Table 4: Tele-Working Service's Tools

	Rates		
	(-2)+(-1)%	0%	(1)+(2) %
Learning Process	0	4	82
Main Functions	0	0	88
Advanced Functions	0	4	72
Learning Time	4	4	92
Exploration	8	0	92
Required Actions	4	12	84

Table 5: Functions Learning

In Table 4, the conference, MS-Word documents processing, and agenda utilities handling were judged very good. Employees found satisfaction in collaborating with and for the citizens cases or/and between themselves, utilizing all their remote resources (e.g. archives). As shown in Table 5, the learning process of the system is comprehensive for almost all the users. The main functions were rapidly learned, while the advanced ones required more training.

The requiring time for learning and exploring the full capabilities of the system was also good. PBA employees asked for more time to further utilize the terminal stations (TWP).

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Connection process	0	12	88
Connection time	0	8.3	91.7
Real Time Communication	0	0	100
File Transfer	8	8	84
Sharing Tasks	0	0	100

Table 6: Cooperative Sessions

Table 6 shows the results that relate to the collaborative sessions. PBA employees found the connection process and the needed time good. When handling data operations -both file transfer and application sharing- they were satisfied by the quality of service and required time. Utilization of real time communication and sharing tasks was also positive.

6. Conclusion

The developed Tele-Working Platform aims to establish the Hellenic PTT (OTE) Tele-Working Service in a most flexible, user friendly, foolproof, fruitful and most convenient manner. It seeks to convey unexploited human and material resources, to combine them with high-end technological solutions to facilitate labour and thus improve productivity.

Attributes of the TWP such as classification of important (professional) future clients'-PABs' data and their promotion, easy and quick retrieval of significant data from the web by means of secure connections, on- and off-line communication, real-time collaborative conferencing, and a friendly-man-to-computer interface, are met. Currently the Platform is entering a phase of upgrading and re-modelling of its entities' configuration thus formalising its features and offering a more standardized performance so as to become a ".net" Service [21].

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