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A Proposal for Internet and Public Switched Telephone Networks (PSTN) Internetworking

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1. Introduction

The purpose of this Internet Draft is to start discussion on the issues involved in interconnecting Internet and Public Switched Networks so as to provide more effective media than either network type can do presently. Interworking of the Internet and PSTNs, based on open well-defined interfaces, will promote interoperability of both the networks and systems built by different vendors.

This Internet Draft specifically proposes a type of interconnection that involves only an Internet application, the TCP/IP suite being the only transport means considered. Although many such types of interconnections are possible, only one is considered here--the one based on the architectural concept (introduced later in this document) called the Intelligent Network (IN). IN has been standardized internationally by the International Telecommunications Union Telecommunications Standardization Sector (ITU-T) and is being widely implemented in the telecommunications networks around the world.

Still, even when restricted to IN, several interconnection choices can be made. Again, to narrow the subject of discussion,

this proposal makes one choice. To this end, the document outlines specific interfaces between Internet and IN and proposes the method to carry out the work. The proposal makes it clear which interfaces are to be standardized by IETF and which are to be standardized by ITU-T; since both sets of interfaces are mutually exclusive in that respect, there is only a minimal need for coordination between the two bodies. The proposal addresses the coordination issues.

The rest of this document is as follows:

Section 2 briefly describes the services offered to the end user. It is the support of these services that necessitates the proposed internetworking project.

Section 3 describes the scope of the proposed project by introducing its overall architecture, identifying the interfaces to be standardized, and suggesting the coordination steps that need to be taken to ensure consistent results of standardization should it be undertaken by both IETF and ITU.

Sections 4, 5, and 6 respectively address security considerations, supply references, and provide the authors address, as required by [1].

Section 7 is the Appendix, which contains the figures (available only in the PostScript format).

2. Service Description

The common denominator of the services introduced in this section is bringing telephone services (provided by PSTNs) to Internet users. Successful interworking of the Internet and Public Switched Telephone Network (PSTN) should enable integration of PSTN services (e.g., a telephone call) with those offered by the Internet through the World-Wide Web. Examples of such services are Click-to-Dial, Click-to-Fax, Click-to-Fax-Back, and Voice access to content, and they can be briefly described as follows:

With the Click-to-Dial service, a Web user can initiate a PSTN call by clicking a button during a Web session. Such a call can be either incoming or outgoing. (An example of the former is when a user, while browsing through a catalogue, clicks the button inviting a sales representative to call him or her.)

With the Click-to-Fax service, a Web user can send a fax by clicking a button during a Web session.

With the Click-to-Fax-Back service, a Web user can request

(and subsequently receive) a fax by clicking a button
during a Web session.

With the Voice-access-to-content service, a Web user can have access to the Web content by telephone. The content is converted to speech and transmitted to the user on a telephone line.

3. Scope of the Proposed Project

A somewhat general view of the proposed project is presented in Figure A of the Appendix. The figure distinguishes the two types of end-users: 1) the Web users, whose PCs (or other Internet access devices) are connected to the Internet, and 2) the telephone users, whose telephones or fax machines are connected to PSTNs. In this context, the proposed internetworking involves interconnection of Internet service providers and network operators (who own PSTNs).

In order to proceed with a more specific definition, this document introduces the concept of Intelligent Network (IN) in the next subsection. The subsections that follow respectively outline the overall architecture, identify the interfaces relevant to the project, demonstrate the involvement of the interfaces in the function of the Click-to-Dial service, and propose the steps necessary for carrying out the work.

3a. Intelligent Network (IN)

IN ([2], [3]) is an architectural concept that provides for the real-time execution of network services and customer applications in a distributed environment consisting of interconnected computers and switching systems. Also included in the scope of IN are systems and technologies required for the creation and management of services in this distributed environment.

In PSTNs, user's telephone terminals and fax machines are connected to telephone switches. The switches (which can be Central Offices--for wireline communications and Mobile Switching Centers (MSCs)--for wireless communications) are specialized computers engineered for provision of services to the users. The switches themselves are interconnected in two ways: 1) through trunks on which the voice is carried and 2) through a specialized fault-tolerant data communications network, which is (principally) used for call setup and maintenance. This network is called (after the ITU-T standard protocol suite that it uses) Signalling System No. 7 (SS7). In addition, the switches are connected to general purpose computers that support specialized applications (called Operations Systems) whose role includes network management, administrative functions (e.g., billing), maintenance, etc. Operation systems are not connected to the

switches through the SS7 network, which is, again, engineered only for set-up and real time maintenance of calls. In most cases, X.25 protocol is used for communications between operations systems and switches.

Even a simple two-party call in most cases involves several switches, which may also be located in different PSTNs. To this end, the switches alone comprise a complex distributed processing environment. As far as the end users are concerned, the switches are ultimately responsible for delivering telecommunications services. Certain elementary services (such as provision of the dial tone, ringing the called line, and establishing a connection between two users) are called basic services, and all switches can presently cooperate in delivering them to end users.

In addition, a multitude of services (such as Freephone [a.k.a. **800 number in North America], Conference Calling, Call** Forwarding, and many others) require much more than basic call processing. Such services are called Supplementary Services, and their implementation requires that specialized applications (called Service Logic) be developed. Developing switch-based service logic for each supplementary service would be an extremely expensive (if at all possible) task, which--in the presence of multiple switch vendors--would also require an extensive standardization effort.

The IN architecture is the alternative which, in a nutshell, postulates using a network-wide server (called Service Control Function [SCF]). The SCF executes service logic and instructs the switches on how to complete the call. A switch is involved only in executing the basic call process, which is interrupted (at standardized breakpoints called triggers) when specialized service logic needs be executed. On encountering such a breakpoint, the switch issues a query to the SCF and waits for its instruction. In addition (and this is essential for supporting the services described in section 2), the SCF may initiate a call on its own by instructing switches to establish necessary connections among themselves and to the call parties.

Physically, the SCF may be located in either stand-alone general purpose computers called Service Control Points (SCPs) or specialized pieces of equipment called Service Nodes (SNs). In addition to executing service logic, a service node can perform certain switching functions (such as bridging of calls)as well as a set of specialized functions (such as playing announcements, voice recognition and text-to-speech conversion).

An important distinction between an SCP and SN is that the former is connected to switches via the SS7 network while the latter communicates with the switch via Integrated Services Digital Network (ISDN) Primary or Basic Rate Interfaces (PRI or BRI), which combine both the signaling and voice paths.
With the present state of IN standardization, in principle,

either an SCP or SN could be connected to an Internet server in order to support the services outlined in section two. To further narrow the scope of work so as to produce tangible results as soon as possible, the proposed project specifically addresses only interconnection between a server and SN.

Within the IN architecture, the relevant administration of the network entities (i.e., setting the triggers in the switches, transferring externally developed service logic to SCPs and SNs, and maintaining the network databases with the customer-related data) is performed by a specialize Operation System called Service Management System (SMS).

3b. Overall Architecture

Figure B demonstrates the overall architecture addressed by the proposed project. This figure may also serve as an illustration to the IN discussion of the previous subsection.
The PSTN users are depicted connected to both the central office via wireline and mobile switching center via wireless communications. The IN entities that contain the Service Control Function (i.e., the SN and SCP) are shown with their respective interfaces to, first of all, the switches. Specifically, the ISDN-based interfaces from the SN to the MSC and center office are respectively marked I and C; the SS7-based interfaces from the SCP to the MSC and center office are respectively marked F and G. (The latter two interfaces are depicted with the dotted line because they are not within the scope of the proposed project). Finally, the SMS is depicted together with its respective interfaces to the SN (D) and SCP (H). (Again, the interface H is depicted with the dotted line because it is not within the scope of the project.)

On the Internet side, Figure B exhibits a Web user connected to the Web server. As far as the proposed project is concerned, the server has two interfaces: interface A to the SN and interface B to the SMS. (As before, a feasible, but not considered within the scope of the project, interface E to the SCP is depicted using the dotted line.) It is proposed that the A interface be based on TCP/IP, and the B interface, on Simple Network Management Protocol (SNMP).

3c. Interfaces Relevant to the Project

With the present proposal, the interfaces that are relevant to the project are A, B, D, I, and C.

The interfaces between the SN and switches (interfaces I and C), as well as the interface between the SN and SMS have been studied in ITU-T Study Group 11; the interfaces between the Web server and SN (interface A) and Web Server and SMS (interface B) are proposed for standardization within the IETF.

The following subsection presents an example Click-to-Dial service scenario, which should give an idea of how the

interfaces are used.

3d. A Click-To-Dial Service Scenario

For the purposes of this discussion, it is assumed that the Web user exemplified here has telephone access while using the Web (this can be achieved, for example, by having an ISDN connection). We find this Web user in the act of browsing through a sales catalogue and deciding to speak to a sales representative.

When the Web user clicks a button inviting a telephone call from the sales office, the Web server sends a message to the SN over the A interface, thus crossing the Internet-to-PSTN boundary. By matching the information received from the Web server with the user profile that had been previously loaded and activated by the SMS over the D interface, the SN recognizes the signal.

At this point, the SN invokes service logic as indicated in the profile. The execution of this logic selects an appropriate sales person to call based on the time of the day. It is 8 P.M. in New York where the Web user is located, and the New York sales office has been closed. But the San Francisco office is still open, and so the SN selects an appropriate central office, establishes the connection (the interface C) to this central office, verifies that there is at least one sales agent line that is free, instructs the switch to establish a two-party call between the sales agent and the Web user, and--quite importantly--instructs the switch to charge the call to the Web content provider.

3e. On Carrying Out the Work

The interfaces relevant to the project fall into two classes:

1) the A and B interfaces, and

2) the C, D, and I interfaces.

ITU-T SG 11 will continue the work on the second class of the interfaces. It is proposed that the IETF start the work on the first class.

Naturally, coordination would be required to ensure that the data exchanged over the A and B interfaces are consistent with those exchanged over the rest of the interfaces. Furthermore, the amount and rate of delivery of data over any of the interfaces involved should be consistent with what both PSTNs and the Internet may support without jeopardizing the overall network performance of either network. The security considerations are discussed in a separate section of this document as required by [1].

It is proposed that the coordination be achieved by exchanging information between the IETF and ITU-T on the progress of the standardization efforts in the respective organizations. The

authors of this proposal (who participate in both organizations) volunteer to ensure that such information be exchanged properly and efficiently.

The authors also volunteer to deliver a tutorial on the Intelligent Network standards to members of the IETF who may be interested in participating in the proposed project.

4. Security Considerations

Internetworking of the Internet and PSTN necessitates the introduction of new interfaces, i.e., the A and B interfaces described in the previous sections. To ensure that their use does not put the networks at additional security risk, these interfaces should be designed to meet the basic security requirements such as follows:

+Peer entity authentication to allow a communicating entity to prove its identity to another in the network. Two types of peers should be recognized for the purposes of this project: end-user and the Web server, and Web server and SN.

Between the end-user and Web server the authentication could be accomplished by means of the user name and password combination. In addition, encrypted communications could be used in this case.

Same could be used between the Web server and SN, but it is proposed that additional security be accomplished by replicating a part of the server's data base relevant to the business providing the service.

+Non-repudiation to account for all operations in case of doubt or dispute. This could be achieved by logging all the information pertinent to the Web transaction. In addition, the PSTN network will maintain its own account of the transaction for generating bills.

+Confidentiality to avoid disclosure of information without the permission of its owner. Although this is an essential requirement, it is not particular to the proposed project.

+End-user profile verification to verify if the end user is authorised to use a service.

Of course, in the course of the project execution, additional requirements are likely to arise and many more specific security work items are likely to be proposed and implemented.

5. References

[1] J. Postel, RFC 1543, "Instruction to RFC Authors". October 1993

[2] ITU-T Q.12xx Recommendation Series, Geneva, 1995.

[3] I. Faynberg, L. R. Gabuzda, M. P. Kaplan, and N. J. Shah, "The Intelligent Network Standards, their Application to Services". McGraw-Hill, 1996.

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7. Appendix (Figures A and B)

FIGURE A:

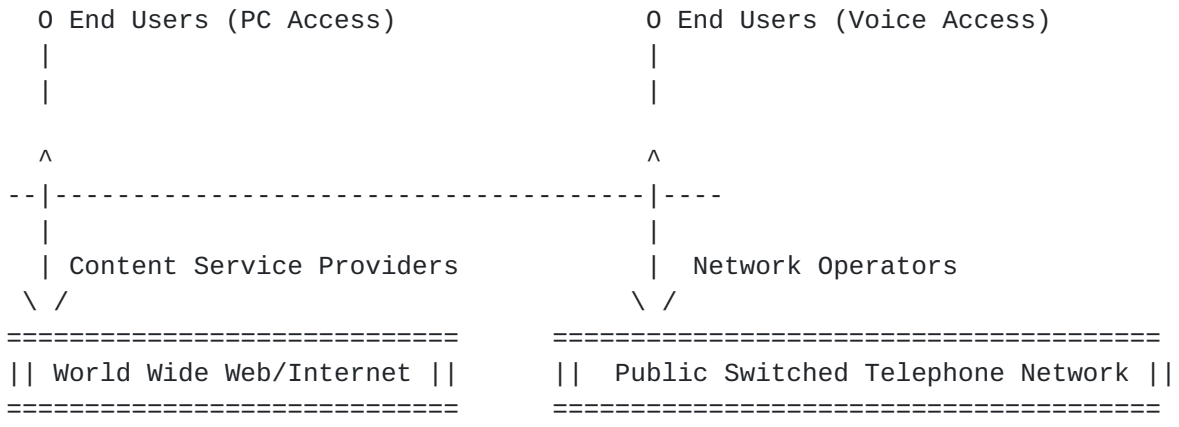
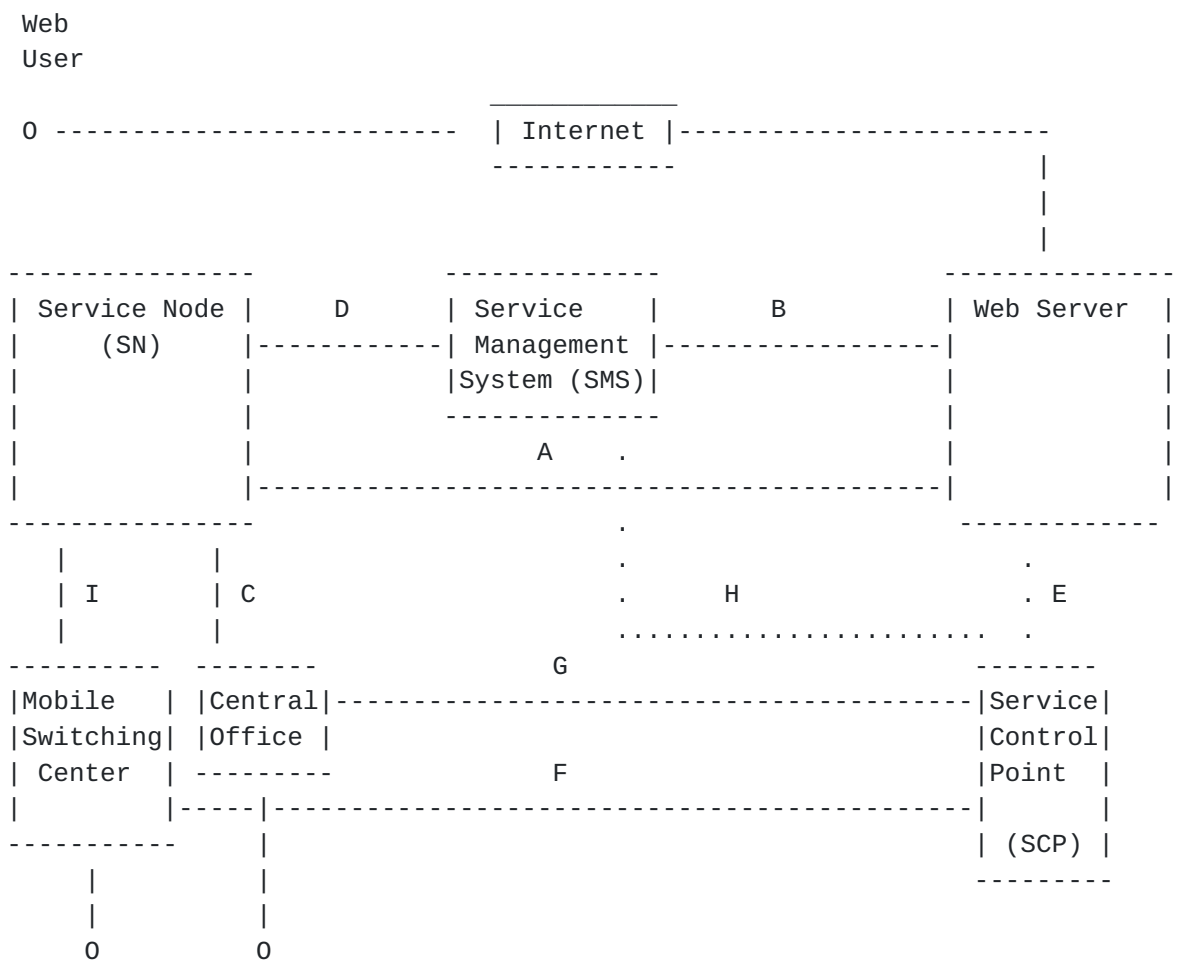


Figure B:


Web
User
Internet
Service Node (SN)
D
Service Management System (SMS)
B
Web Server
A
C
H
E
I
G
F
Mobile Switching Center
Central Office
Service Control Point (SCP)
Mobile Users
Wireline PSTN Users