Local–Battery Telephones on VoIP Systems

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—Provisional—

Voice–over–Internet–Protocol (VoIP) systems allow conversing over packet–switched data networks, in the same manner as over the "traditional" circuit–switched voice network. By the use of a special hardware endpoint, ordinary (common–battery) telephones can be connected to such systems, and used in a thoroughly conventional manner. This note explores the possibilities of connecting local–battery instruments.

1 The ATA

In the context of VoIP, an Analog Terminal Adapter is a small box (generally no larger than a paperback book) which contains a data–network interface, a microcomputer, and specialized circuitry for generating and measuring electrical quantities. (Server–rack ATAs with large numbers of ports are also available, but are of less interest to the home user or experimenter.) The net result is that it appears, to a connected telephone, just like a central office, and the user is able to place and receive calls just as though he were connected to the conventional telephone system.[1] This capability is used for a variety of purposes. For instance, a group of telephone collectors and hobbyists operates something known as C*Net, giving them a chance to use their equipment in calling one another. More prosaically, businesses may wish to integrate their voice and data networks without replacing large volumes of serviceable equipment.

A generic ATA has an Ethernet port and what is referred to as an FXS port, a term adapted from the PBX world to indicate that a "station" (ie, a telephone or some equipment which behaves like one) is to be attached there. Many models have two FXS ports, which may be configured separately. Some have two Ethernet ports, in which case one is usually meant for connecting the wide–area network, and the other for local equipment. This is a convenience feature, in case network links are in short supply. And a few models have what is referred to as an FXO port, intended to accept an incoming central–office line — another convenience, which simplifies integrating multiple telephone systems.

[1] So that there is no confusion, by "telephone" we mean an instrument which transforms the atmospheric vibrations constituting the sounds of speech into variations of electrical current passing through two connecting wires, and receives similar variations along those same wires, transforming them into sound vibrations.

2 The Local–Battery Telephone

All ATAs of which the author is aware are intended to work with common–battery telephones. The common–battery, or central–energy, instrument generates the electrical analog of sound vibrations by modulating a direct current supplied from an external source at the far end of the telephone line. By far the largest number of telephone instruments in existence are designed for central–battery working. Already by 1900, this system had proven sufficiently advantageous that new installations were largely of this type.

The local–battery system, which was developed first, encounters a notable difficulty in assuring that all connected instruments have adequate battery power for their operation. Further, it is not adaptable to the use of automatic exchanges using loop–disconnect signalling (although DTMF signalling is feasible). Its use rapidly became confined to special situations, such as small rural systems with long runs of wire and few subscribers, or armies in the field. Today, of course, the local–battery telephone in a quite different form, a mobile radio unit, has become ubiquitous ; but we are not concerned with that here.[2]

The distinctive feature of a local–battery telephone is a hand–cranked electrical generator — on this account they are also referred to as "magneto" telephones. This is used to signal to the party at the other end of the line (typically a switchboard operator) that a call is coming through. A common–battery instrument, on the other hand, signals automatically when taken off–hook, by drawing current from the central office. Hence, a local–battery telephone would be essentially useless if connected to a common–battery switchboard, or (more to the present purpose) the FXS port of an ATA. It is usually possible to convert a local–battery instrument to common–battery working, but that does not really answer the question.

3 Enter the FXO Port

The ringing current sent out by a common–battery central office is typically (in American practice) 100 volts alternating at 20 hertz, and the reason is that this is approximately what a vigorous turn of the magneto crank on a local–battery instrument would produce. Hence the ringers, and the ringing supplies used at local–battery switchboards to spare the operators' hands, were already available. It seems that a local–battery instrument might at least be connected, without causing any damage (as might happen if one were to attempt to crank on an FXS port), to the FXO port of an ATA so equipped. To actually communicate is a more difficult problem.

The first thing to observe is that the FXO port expects to see a potential difference on an active line. This should be 48 V DC from a central office (one side at ground potential, the other negative), but 24 V is common in PBX working owing to the much shorter loops, and is likely to be adequate. Since a local–battery telephone does not afford a path for direct current (except through the ringer, which might best be disconnected), this potential can be impressed on the line, if a suitable means is used to avoid shorting out the alternating currents. A large–value inductor is the obvious choice, and the coil of a 24 V relay might serve adequately, although it will present a substantially lower impedance at ringing than at voice frequencies. On a short wire loop, it may be permissible to put a resistor in series with the coil.

With the line energized, turning the crank should signal to the ATA that a call is incoming from the FXO port, and ring through to the FXS port. When the FXS port goes off–hook to pick up the

[2] Likewise, a common–battery instrument connected to an ATA could be considered as a sort of local–battery telephone, but that too is beside the point.

call, the FXO port will begin to draw current, say 20 milliamperes, and the relay will operate. This can be used, for instance, to light a lamp and show that the line is active, telling the caller to stop cranking and pick up the receiver, or (given an appropriate interlock switch and a local source of ringing current) to ring the bell if the telephone is on–hook.[3] In this way, if the ATA is configured to allow the user on the FXS port to dial out via the FXO port, the local–battery telephone can be called from the common–battery side.

4 VoIP Operation

So far, we have hardly done anything that actually required the interposition of an ATA. The FXO port looks to the line just like a common–battery telephone, and the kind of circuit discussed above will work perfectly well to connect a local–battery instrument to a common–battery instrument, allowing each to call the other (which will be useful for testing). The ATA allows the party on the FXS side to call either the FXO port, or a distant station via the Internet. The question is, can we make IP calls from the local–battery telephone?

It seems that there are two ways. The first is to treat the FXS port as a switchboard. In other words, the party on the local–battery telephone rings in ; the party on the common–battery telephone answers and is told the desired number, then "flashes" the switch–hook, putting the FXO party on hold, and dials out via the VoIP service ; when the distant party picks up, the FXS party flashes again to start a three–way call, and either remains on the line or hangs up, leaving the other two parties connected. (This description is of one possible procedure, depending on the programming of the ATA, but may be taken as typical.)

The other approach depends on advanced call–routing features which are present on some ATAs, such as the Obihai model Obi110.[4] (Even greater sophistication is possible through the use of the Asterisk software, a kind of virtual PBX for VoIP systems, but that is beyond the present scope.) In addition to supporting "call transfer" as described above, the Obi110 can be programmed to re–direct all incoming calls on the FXO port to a destination other than the FXS port. This can be a pre–defined telephone number reached via VoIP service, or something called the Automated Attendant, which accepts DTMF digits, allowing the caller to specify a number to which he wishes to be connected. A hand–held tone dialer may be put to good use here.

5 Conclusion

The author has not attempted to apply the above suggestions — his hobbyist tendencies extend only so far. He apprehends that, if they are followed carelessly, damage to equipment or even harm to persons could result. Nevertheless, he believes that they indicate a line of approach which, if followed with the necessary caution and creativity, should allow the question "can a local–battery telephone be connected to the Internet?" to be answered in the affirmative. Communications from anyone who attempts to put any of this into practice are cordially invited.

[3] A power supply built for PBX use, giving 24 V DC and 72 V 20 Hz ringing current from a 120 V AC supply, is available for $75 from "Phoneco" in Wisconsin. Something adequate could probably be assembled for less by the dedicated electronics hobbyist.

[4] Other devices would presumably serve as well, but the author is most familiar with this one. It is discontinued, and can be obtained quite inexpensively now that it is no longer supported by Google Voice service. For SIP–based VoIP services, which is most of them, it is quite satisfactory.