Avinta Communications, Inc.

White Paper

SOHO & Residential Networking

Myth & Challenge

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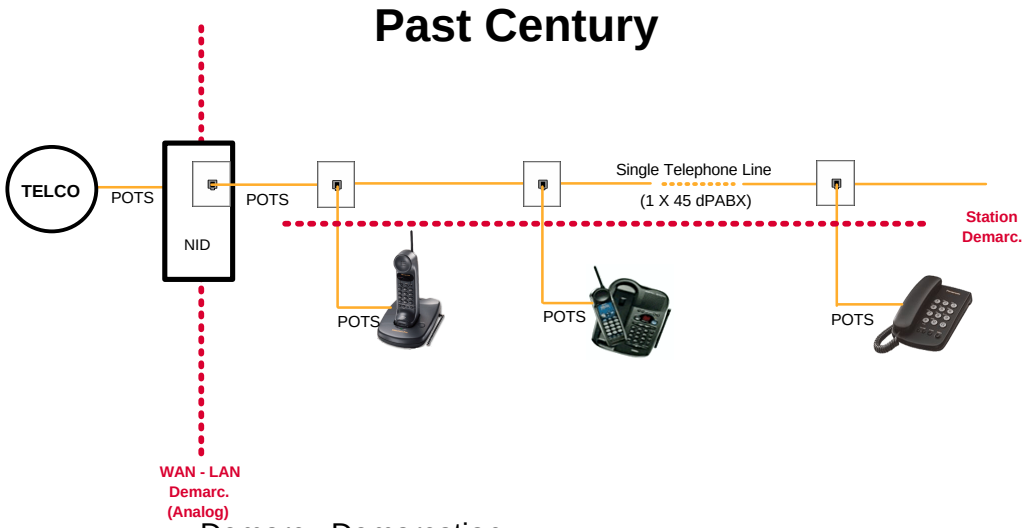
1. Introduction:

It is generally agreed that SOHO (Small Office Home Office) networking is the next communications frontier. However, after more than a decade of intensive efforts by the industry, the resulting products and services still do not meet the standards for ease of use and reliability associated with consumer electronics. As a result, market growth has stalled because consumers are reluctant to purchase products and services that are functionally quite capable, but too difficult to use.

This paper presents an analysis of this frustrating situation from an end-user's perspective, and proposes a plan that may be able to restart the growth in this market.

2. Background:

During most of the past century, POTS (Plain Old Telephone Set / Service) – a part of the world wide PSTN (Public Switched Telephone Network) was the only consumer product / service in the communications category.



Demarc.: Demarcation
dPABX: distributed Private Automatic Branch eXchange
NID: Network Interface Device
POTS: Plain Old Telephone Service or,
Plain Old Telephone Set
TELCO: TELephone COmpany

Fig. 1

Fig. 1 depicts a schematic of the POTS with respect to a subscriber. Besides telephone wiring which is interfaced to users via modular jacks, most consumers regard telephony as a

service provided through the Plain Old Telephone Set. Until questions about service arise, few are aware of the existence or the role of the Network Interface Device (NID) normally located at an exterior corner of a building where service enters the premise. To diagnose the source of a problem, a consumer is directed by TELCO staff to test the modular jack at the NID with a known-working telephone set. Thus, Demarcation is a very significant concept in traditional telephony. And,

POTS is
- Simple, user-friendly, time-tested, reliable, affordable, etc.

But, it
- Has limited bandwidth capacity and,
- Is not addressable in SOHO, therefore not suitable for networking.

Note that Electricity, Gas & Water are the other three public utilities also with vast connectivity. However, unlike POTS, they have been mostly providing one-way delivery services only.

3. Environment Characteristics:

Compared to a WAN (Wide Area Network) or a business LAN (Local Area Network), there are certain unique SOHO network parameters that traditional consumer electronic products must address:

- Customer: The Buyer, Installer, User and Repairer could all be the same person
- Media: Limited and restricted (no new wires)
- Connectivity Interface:
  - For the most part, only power outlet jacks
  - Some with dedicated interconnections
- Functions & Features: Vastly diversified

POTS in particular;
- Transmits 2-way information through a pair of telephone wires via modular jack.
- Connectivity diagnostics: Utilize dialtone from POTS (used as an instrument)
- Demarcation: Segregates responsibilities between service provider and subscriber

To succeed in the SOHO environment, products and services should strive to satisfy these criteria and characteristics.

4. Broadband Revolution:

As broadband services began to reach the mass consumer markets over a decade ago, the traditional customer premise POTS wiring appeared to be incapable of supporting the requirements of modern SOHO communication. Consequently, alternative media were sought after and developed. Regarded as a new field, data networking developed without reference or comparison to any prior art. Most products in this field are therefore designed according to the requirements necessary for providing data services.

5. Consumer Expectation:

From the consumer's point of view, any new technology such as broadband, intended to upgrade and expand existing products and services for better communication, richer information and improved entertainment, should:

- Enhance daily life without burdening the users
- Be simple to set up, use, maintain, reconfigure and upgrade
- Be modular in nature so as to allow handling one device at a time, only when and where desired
- Provide toll quality voice, entertainment quality video and music
- Be reliable
- Be affordable

The market's current response indicates that these requirements have not been well satisfied during the development of broadband technologies for data applications. But, they will nevertheless be the final checkpoints for products and services that are targeted for the mass consumer market.

6. Conventional CTI Approach:

Most SOHO networking technologies and products have been based on the CTI (Computer Telephony Integration) approach, in which data applications are primary, with voice and other services as add-on features. This has led to a number of issues and questions:

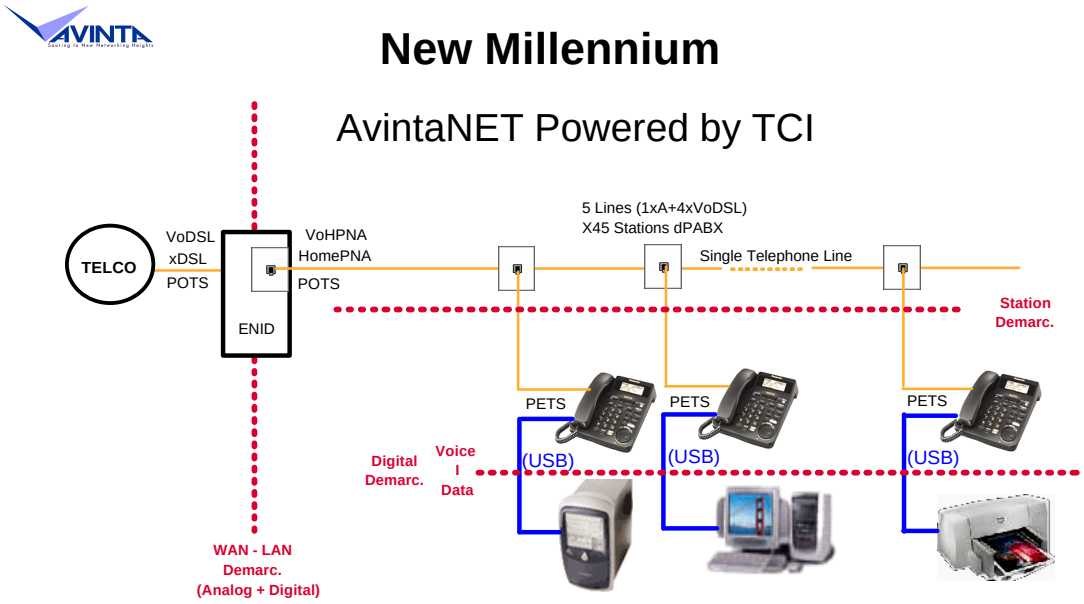
- The narrowband analog voice signal is compressed for transmission in a broadband digital facility, contrary to normal operational logic.
- QoS (Quality of Service) in digital voice remains an issue because voice has to compete against data for service.
- SOHO broadband "Pipes" are being under utilized:
  - Pipes get "fatter" as the signal travels from "last-mile" WAN into SOHO.
  - They get even fatter as the signal is distributed among information consuming devices.
  - Therefore, there is no need to derive any service out of broadband signal until it has reached the consuming End-Point device. Otherwise, an additional transmission facility would be needed.
- With built-in Interoperability among products, why are there concerns about "Fragmented Market" and "No Killer Application"?
- Does the need for broader bandwidth justify the data application be a system's primary design focus? Why not make another application the design focus, instead?
- The data network addressing convention is too cryptic to the average consumer to be used for voice network station numbering.

7. New Enabling Technologies:

Recently, two new voice and data networking technologies operating over POTS infrastructure have demonstrated the feasibility of satisfying the consumer's desire for broadband services while maintaining traditional POTS simplicity:

A. An analog narrowband Distributed Private Automatic Branch eXchange (dPABX) system (U.S. Pat. No. 5,596,631) that provides basic functionality of conventional business PABX by enhancing the electronics inside the telephone station instrument. There is no need to change anything else in the existing POTS setup. This essentially completes the long-waited SOHO POTS capability. (See Fig. 1)

B. A digital broadband peer-to-peer data transmission technology (U.S Pat. No. 5,696,790) over existing telephone wiring (HomePNA technology from Home Phoneline Network Alliance) that networks data equipment, such as personal computers, printers, cameras, etc. within a SOHO premise, to transfer data among one another and to simultaneously share a common Internet access.



ENID: Enhanced Network Interface Device (with xDSL/HomePNA Gateway)
PETS: Plain Enhanced Telephone Service, or,
Plain Enhanced Telephone Set
TCI: Telephony Computer Integration
USB: Universal Serial Bus

Fig. 2

Utilizing technology A. as the base to harness and manage the capabilities of technology B, a new telephone station instrument PETS (Plain Enhanced Telephone Set) can be developed to take advantage of the broad bandwidth now available to provide additional voice channels, while maintaining POTS simplicity. In addition, since PETS is essentially a

data network terminal once voice has been transmitted through broadband, it can provide network access service to all data equipment in its Proximity via standard data interface technologies, eliminating the need for individual networking hardware and software in various devices. Collectively, these two technologies are the foundations of a new system architecture dubbed AvintaNET. One embodiment of which is shown in Fig. 2. Such architecture offers users the benefit of modern digital broadband services while maintaining the simplicity of traditional analog narrowband telephony.

To utilize WAN broadband xDSL (Digital Subscriber Line) service on the internal telephone line, media conversion Gateway circuitry is installed in the NID, resulting in an Enhanced Network Interface Device (ENID). An USB interface on each PETS allows data equipment such as a PC, printer, etc. to exchange data through the local network, as well as to share Internet access through xDSL.

Since POTS connectivity is based on unstructured wiring, this Telephony Computer Integration (TCI) approach, applies equally well to other similar transmission technologies, such as Power Line Carrier (PLC) and Wireless.

8. AvintaNET Architecture:

In accordance with the above observations, Fig. 3 presents a generalized view of the AvintaNET architecture. It consists of six building block elements in two groups:

- Transmission Media:
  - A. WAN (Last-mile): Cable, Dial-Up, ISDN (Integrated Services Digital Network), Optical, RF (Radio Frequency), xDSL, etc.
  - B. HAN - On-premise signal distribution: HomePNA, PLC, Wireless, etc.
  - C. PAN - Data interface: Cordless, FireWire, InfraRed, USB, etc.

- Electronic Modules:
  - A. Gateway: Bridges one type of Last-Mile WAN technology with one type of HAN technology.
  - B. PETS: Bridges one type of HAN technology with one type of PAN technology.
    - Voice service is derived at PETS for both user convenience and connectivity diagnostic purposes.
  - C. EP – Data application End-Point devices: Alarm, Appliance, Audio, Camera, PC, Printer, Scanner, TV, Utility Meter, etc. communicate with one another and Internet through HAN via PAN connectivity provided by PETS.

xDSL, HomePNA & USB represent one possible set of broadband pipes, as detailed in Fig. 2. The same AvintaNET architecture applies to any other possible combinations of components shown in Fig. 3.

If desired, multiple technologies can be converted through either Gateway or PETS by implementing media conversion circuitry for desired intersections in the connection matrices shown.

Once a set of Transmission Media is decided, Electronic Modules can be built. From a consumer's perspective, Transmission Media are just interconnecting cables (In the case of Cordless, Infra Red, RF or Wireless, the Media would appear to be "air" or simply "nothing").

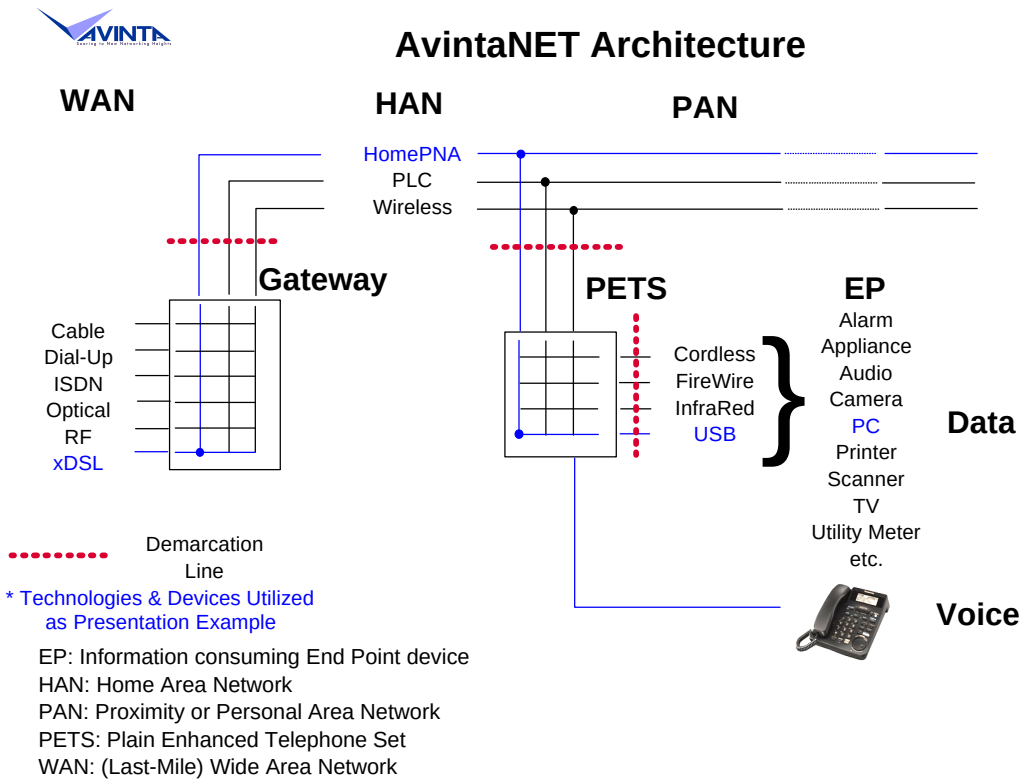


Fig.3

At the module level, AvintaNET has the following advantages:

- To establish the network, data application End-Point devices are not needed.
- Gateway is simply one of the nodes on the HAN and would preferably be out of consumer's sight.
- Only PETS (with familiar POTS appearance and user interface) is needed to establish SOHO networking.

At the system level, AvintaNET offers the following unique and desirable characteristics:

- Distributed Peer-to-Peer system using PETS: The only shared module for accessing WAN is the Gateway which is made as simple as possible to minimize operational complexity and to maximize system reliability.
- Clear Demarcations:

- Responsibilities among WAN service, PETS and End-Point data equipment are segregated
- Basic broadband services deployed to the outside of the customer's building
- Data network node addressing managed by consumer based on voice networking
- Professional operation without WAN operator involvement
- Ease of reconfiguring and upgrading functional devices
- Minimum expenditure to extend WAN connectivity hierarchy deep into customer premise, ready to deliver any service that might be desired

- Separate Application from Connectivity:
  - Complexities of Datacom Application are decoupled from fundamental Telecom Connectivity.
  - All data application End-Point devices become simple local terminal devices, while continuing to provide relevant functionality to the consumer.

- Conforming to standards: AvintaNET Gateway and PETS use industrial standard transmission technologies for interconnection. Thus, they are fully compatible with existing SOHO products.

- The Last-Mile WAN provider is responsible for Gateway. The consumer purchases and plugs in PETS units as needed to establish a HAN. In turn, all EP devices plug into PETS units and are classified as consumer electronics, not networking devices.

9. Unified SOHO Networking:

For a site at which more than one transmission technology is desired, it is advisable to select one as the primary or backbone medium and then utilize media conversion bridges to link with the others to form a consistent single network.

Fig. 4 is an example that starts with HomePNA as the backbone. Each additional network based on different transmission technologies such as, PLC and Wireless appears to be a separate physical node on the HomePNA backbone via its respective media bridge. However, the addressing scheme is universally applied so that the combined networks will behave as one unified system.

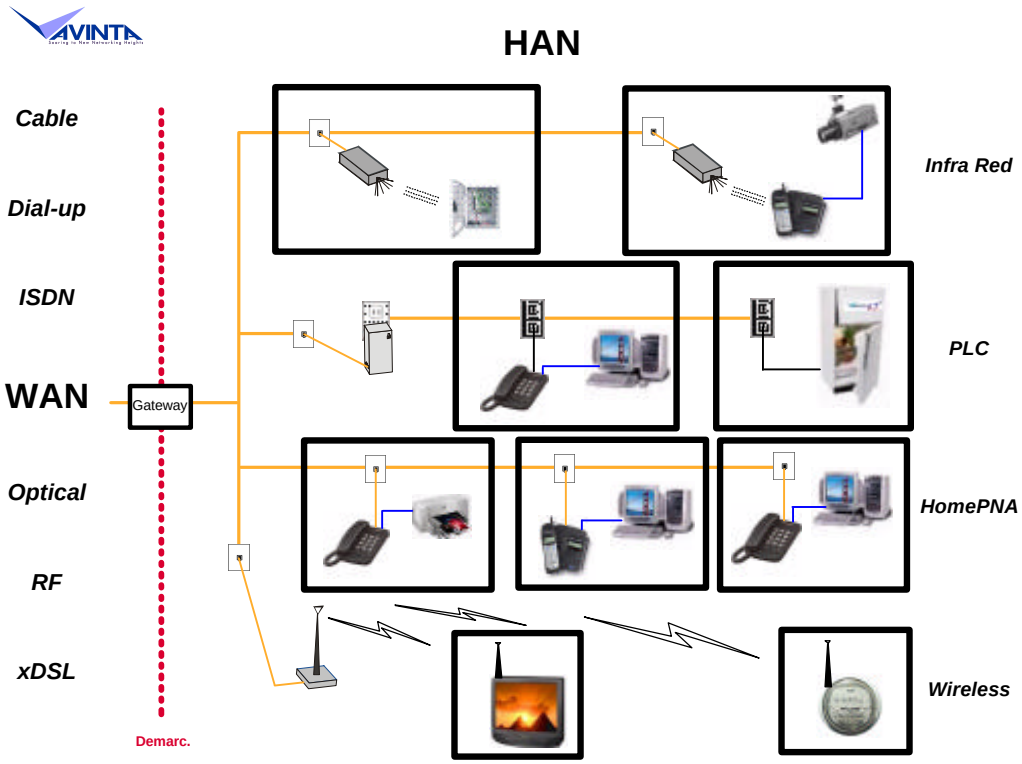
One important advantage of this architecture is that the consumer retains the flexibility of using all types of SOHO transmission technologies. Even after initial deployment, switching to a different technology simply means replacing only the directly affected modules. For example, by replacing an installed Gateway with another one that supports a different technology, the SOHO network backbone will be switched to that technology. With bridges between different technologies already in place, the overall network operation will not be disrupted.

Infra Red, which is classified in this paper as a PAN technology according to limitations of the residential environment, is included in this figure to demonstrate that with a proper media conversion bridge, an EP can be directly connected to the HAN backbone even without the use of a PETS.

By having PETS as the primary network access device, voice transmission quality is assured. Once different applications are all represented in one diagram, their priorities can be assigned coherently. For example, security Alarm for rare and unexpected events should have the highest priority. Voice signal gets second priority assignment, but operates essentially as first priority since Alarm signal is normally absent. Then, Video, Data and Appliance applications can have progressively lower positions. Lastly, even Utility Meter Reading can be included in this plan with the lowest priority assignment, since it has very low volume of information at low data rate, and can be serviced during the night hours when normally there is little to no traffic in SOHO or residential settings.

With a broadband "pipe" reaching every point of the premise, the design of each information-consuming EP device can be tailored to provide only one specific function that has clear demand. There is no more need to build products with extra functions that the consumer may not need.

Once consumers have the freedom of customizing SOHO networking to fit individual's ever changing life style, the growth of the industry can be expected to mirror that traditionally experienced in consumer electronics.



HAN: Home Area Network

Fig. 4

Because of the relatively small portion of the bandwidth required by and pre-allocated to voice, restricting data applications to use the bandwidth remaining after voice functions have been properly served would result in little or no observable data performance degradation.

Building AvintaNET on dPABX technology as the base not only solves a long time POTS handicap (addressing stations individually to route desired calls while stopping unwanted calls), but also enables broadband consumers to have full control of their SOHO network.

The AvintaNET architecture provides a configuration that is on the one hand very simple for the service provider, yet on the other hand is very versatile in its ability to meet the almost limitless combinations of individual consumer's needs. Furthermore, this approach allows manufacturers to concentrate on providing individual products tailored to specific applications, and allows them to break away from the current trend of building products with multi-functions in one module even before each function by itself has been fully validated.

10. Conclusion:

AvintaNET is a fundamentally new system architecture that decomposes current SOHO networking products into building block subsystems, which can then effectively and efficiently make use of transmission technologies optimized for their intended functionality.

In summary, AvintaNET is:

- Universal: Technology independent, simple system architecture leads to flexibility
- Economical: Implementation of AvintaNET modules only requires a subset of the capabilities in current products on the market
- Upgradeable: Change only the module that has to have new or expanded functions
- Scalable: Capacity of each network segment is limited only by transmission technology chosen.

By building a SOHO network based on POTS conventions and practices, AvintaNET offers consumers the familiar telephony context from which to try out new broadband products and services. Such familiarity should have a major positive impact on accelerating the growth of the SOHO networking market.

To implement AvintaNET architecture, the relative positions of the industrial segments would be as follows:

- Service Providers – deploy AvintaNET Gateway to the outside of subscriber premise for delivering basic broadband, or make Gateways available for the subscriber to install
- Consumer Electronics Manufacturers - provide PETS (Plain Enhanced Telephone Set) and EP devices for consumer to maximize the "mix & match" capabilities of the AvintaNET architecture
- IC Developers & Circuit Pack Manufacturers - provide AvintaNET compatible components for producing Gateways and PETS

The above relationship is essentially the same as traditional consumer electronics and POTS business conventions that the SOHO networking community could take advantage of.