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FSAN:

Project and xDSL activities within BU-NWS

The Full Service Access Network (FSAN) project started in December 1996 under the responsibility of the Business Unit Network Services, Planning and Development department, NWS-PD. This project was motivated by recent innovations in the area of high-speed communications. It was strongly driven by the growth of data traffic and in special by the spreading of Internet-based services, in the light of the increasing competition among different Service Providers (SP) and, on another level, among Network Operators (NO), in the multimedia domain. The purpose of this article is to present the objectives and development of the Full Service Access Network (FSAN) project and to bring forward the main results achieved with its conclusion. No detailed information on the technical level will be given here, as a wide FSAN documentation is available, treating each issue in detail.

HÉLIA LANÇA BURGUNDER, BERN

FSAN Project

Mission and objectives

The mission of FSAN was to analyse, evaluate and compare technical Access Network (AN) implementations, suitable for the delivery of integrated NarrowBand (NB) and BroadBand (BB) multimedia services. The quick introduction of new interactive services should be possible over a reduced platform with initial low investments, with a certain degree of flexibility and scaleability from the customer, service and functionality points of view.

Project Organisation

The project was organised in three phases:

- Pre-analysis: service parameters, area models, technical variants selection and market surveys (Request for Information, RFI)
- Pre-concept: Requirements specification, Request for Quotation (RFQ), Request for Offer (RFO), evaluation and supplier short-list, equipment testing, elaboration of a Pre-Business Plan and order for pilot realisation
- Detail concept: Pilot realisation, Business Plan and order for realisation

Several Sub-project Teams (SPT) were established according to *Figure 1*.

Phase I: Pre-analysis

Services and area models

The several different services were characterised and classified into two general groups, Distributive and Interactive. Within this last class, a distinction was made between BB and NB transmission, which includes e.g. the classical Plain Old Telephony Service (POTS) and Integrated Services Digital Network Basic Access (ISDN-BA), as well as NB Internet access. BB service transmission includes among others fast Internet, real-time video, Games-on-Demand (GoD), Teleconferencing, etc. Typical topologies for city center, suburb and countryside areas were set, and the potential market was studied.

Technical variants selection

From the technologies available in the Access Network for the transmission of distributive and interactive NB/BB services, some priorities were set within the FSAN project for the following main areas of study, as indicated in *Figure 2*:

1. Digital Subscriber Line (xDSL) transmission systems (x stands for A, S, V, etc.)
2. Hybrid Fiber Twisted-Pair (HFTP) systems
3. Radio-in-the-loop (RITL) systems
4. Hybrid Fiber Coaxial (HFC) systems

Issues such as technical feasibility, identification of problematic points, adaptation to the current Swisscom network and strategy, market surveys and testing of products were addressed. This joint effort was carried out by several teams, created to treat specific subjects, with the participation of different regions and several units within Swisscom.

ADSL/xDSL pre-analysis

Technology overview:

Digital Subscriber Line (DSL) technology is a digital line coding technology that exploits the recent trend in the telephone network toward digital switching and trunking, with advanced digital processors that convert the distribution segment of the network (copper access plant) from analog to digital.

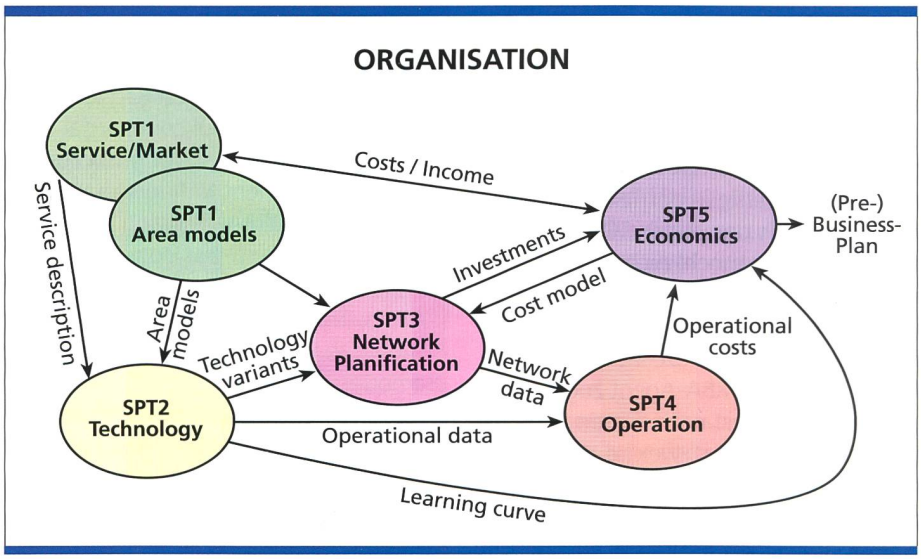

Figure 1. FSAN Project Organisation, Sub-Project Teams (SPT) and related activities.

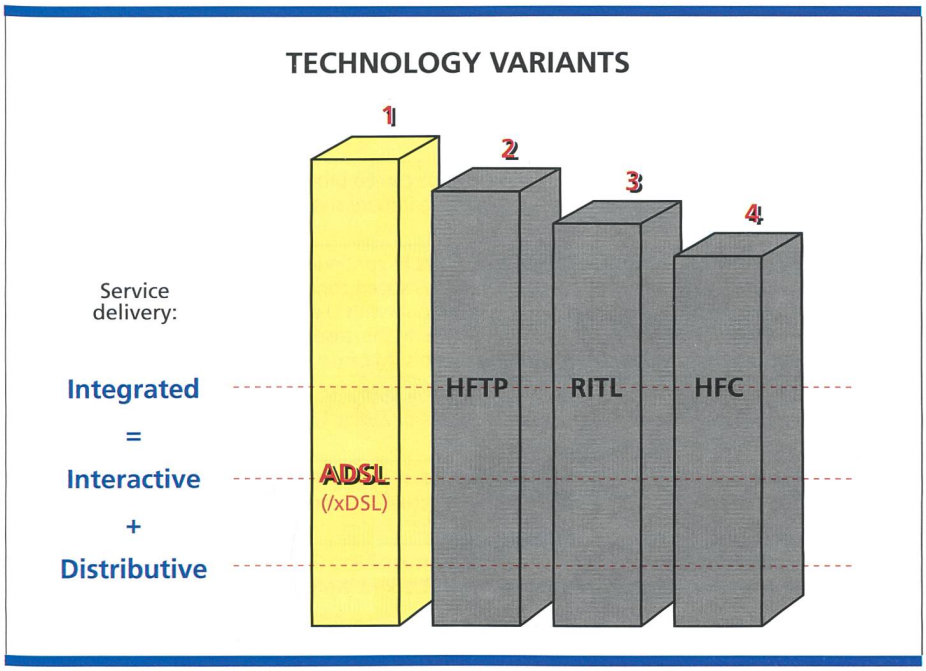

Figure 2. Technology variants and priorities.

The conversion of the distribution network from analog to digital would require the conversion of all Customer Premise Equipment (CPE) to digital terminals as well. Although digital phones offer a variety of new features, they remain relatively expensive and difficult to configure and to install. Moreover, most customers needs are perfectly filled with traditional analog telephone – it is the data connection that is more frustrating.

DSL technology was developed to address this need: preserve traditional analog POTS service, but increase the possible bandwidth of telephone lines without requiring significant infrastructure upgrades (such as fiber installation).

Whereas most traditional analog modems are limited to the 4 kHz frequency band allocated to each telephone circuit, DSL technology was designed to make use of the actual available capacity of the line, which may go up to 1 MHz or even 10 MHz, depending on the DSL transmission type. DSL solutions all operate by the placement of modems at each end of a Twisted Pair (TP) line, transforming it into a set of high-speed digital channels and changing that particular line from analog NB into BB transmission. DSL solutions are therefore only suitable for subscribers served by a dedicated copper line (Point-to-Point (PP) system).

Several types of DSL transmission can be identified, the most common ones being briefly described in *Table 1*, commonly referred as xDSL (x stands for the different solutions). From these, the accent of the FSAN project was put into the ADSL transmission type, which principle is illustrated in *Figure 3*. Usually, the DSL Access Multiplexer (DSLAM) is located at the Central Office (CO), making use of the already existing TP infrastructure.

Main conclusions from ADSL pre-analysis:

- ADSL/xDSL systems are ready for deployment today, out of the shelf, from a wide variety of suppliers.
- Different types of xDSL may be combined in the same DSLAM, upon customer specific needs, offering permanent and dedicated bandwidth per user and allowing a gradual and flexible introduction of NB and BB multimedia interactive services.
- ADSL preserves the POTS or the ISDN-BA service on a given copper line, while transmitting digital NB/BB services simultaneously. This is done through POTS/ISDN-BA splitters located at the CO and at the Customer Premises (CP) which combine and split digital services and POTS/ISDN-BA.
- Reusing of the already existing telephone TP infrastructure, no substantial investments in the plant being necessary (except for VDSL).
- In spite of performance versus distance limitations, ADSL technology is generally well adapted to swiss TP infrastructure – in average, more than 70 %

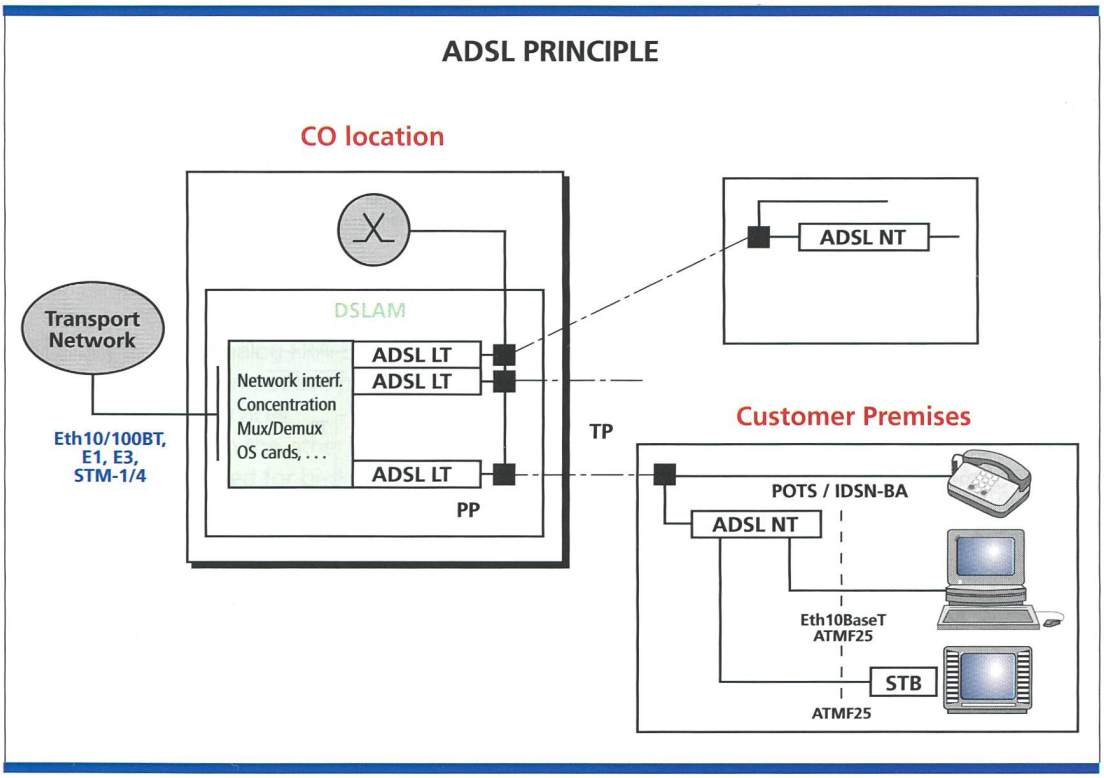

Figure 3. ADSL principle.

	Transmission rate (max.)[1]	# TP lines	Line Code	Remarks
HDSL High bit-rate DSL	↓↑ 2 Mb/s	2 or 3 (1 with HDSL-2)	2B1Q CAP	most commonly used for trunking, primarily designed for low-cost alternative to T1/E1 lines (without repeaters), for business applications. Maximal reach: typically around 6 km
SDSL Single Pair DSL	↓↑ 768kb/s or 2 Mb/s	1	2B1Q CAP	Enhancement of HDSL so that T1/E1 service can be provided over a single line instead of 2 or 3. SDSL also supports POTS, making it more suitable for consumer applications. Maximal reach: typically around 4 km
IDSL ISDN-based DSL	↓↑ 128 (/64) kb/s	1	2B1Q	The concept consists on allowing customers to continue using their existing Customer Premises Equipment (CPE) to make 128 kb/s speed connections, such as bridges, routers or ISDN-BA terminal adapters (but only with U-interface; in CH, S-interface terminals are installed). Also supports POTS. In this case, when the analog service is used, the transmission rate comes down to 64 kb/s. Maximal reach: typically around 6 km
ADSL Asymmetric DSL	↓ 8 Mb/s ↑ 1 Mb/s	1	CAP DMT	POTS or ISDN-BA may run over the same line (ISDN-BA requires a frequency band reduction and therefore a performance loss of about 15% in reach). Maximal reach: typically around 4 km.
RADSL Rate-adaptive ADSL	Non-standard ADSL technology, viewed rather as a technological advancement to ADSL. It allows the configuration of the modems at the maximal possible transmission rate, during the setup phase, depending on the actual line conditions (it cannot dynamically adapt the bandwidth during operation).			
VDSL Very high bit-rate DSL	13/26/52[2] Mb/s (symmetrical or asymmetrical)	1	CAP DMT	Intended for use mainly in Fiber-To-The-Curb/Building (FTTC/B) configurations, due to its limited reach (typically less than 1.5 km). Not widely commercialised yet. Maximal reach: typically below 1 km.
Splitterless DSL	Key development in the DSL area that will advance the wide-scale availability of high-speed access services. The Splitterless DSL is being promoted since beginning of 1998 by the Universal ADSL Working Group (UAWG), a key industry initiative supported by numerous companies, such as Microsoft, Intel, Compaq and many DSL suppliers. The UAWG goal is to accelerate the adoption and deployment of high-speed digital Internet access for the mass market, through the creation of a set of technical requirements to be submitted to the ITU G.Lite subcommittee. These are designed to assure carriers and consumers about the interoperability of products and services created by multiple companies. The UAWG work will also provide a migration path from today's DSL modems to the next generation of modems, in the form of an easy-to-install DSL type, generally named as splitterless DSL. With no need for POTS splitter at the customer premises, the idea behind this product is to sell fast access integrated in the PCs, and leave the home installation responsibility to the customers (which can be easily done simply by plugging a cable from the PC into a telephone plug). This helps maximising the economy, speed and efficiency of DSL use, since no in-house wiring installation is necessary. Some proprietary solutions are currently being launched in the market.			

Table 1. Short overview on the most common xDSL solutions.

[1] Symmetrical or asymmetrical, depending on DSL solution; ↓ and ↑ stands for downstream and upstream transmission, respectively

[2] only downstream

of the POTS subscribers in the whole Switzerland can be reached within 3 km from the CO.

– Some ADSL products include multicasting facility (reduces traffic congestion in the backbone network). Future developments in the compression techniques may increase the number of channels to be transmitted simultaneously to each CP.

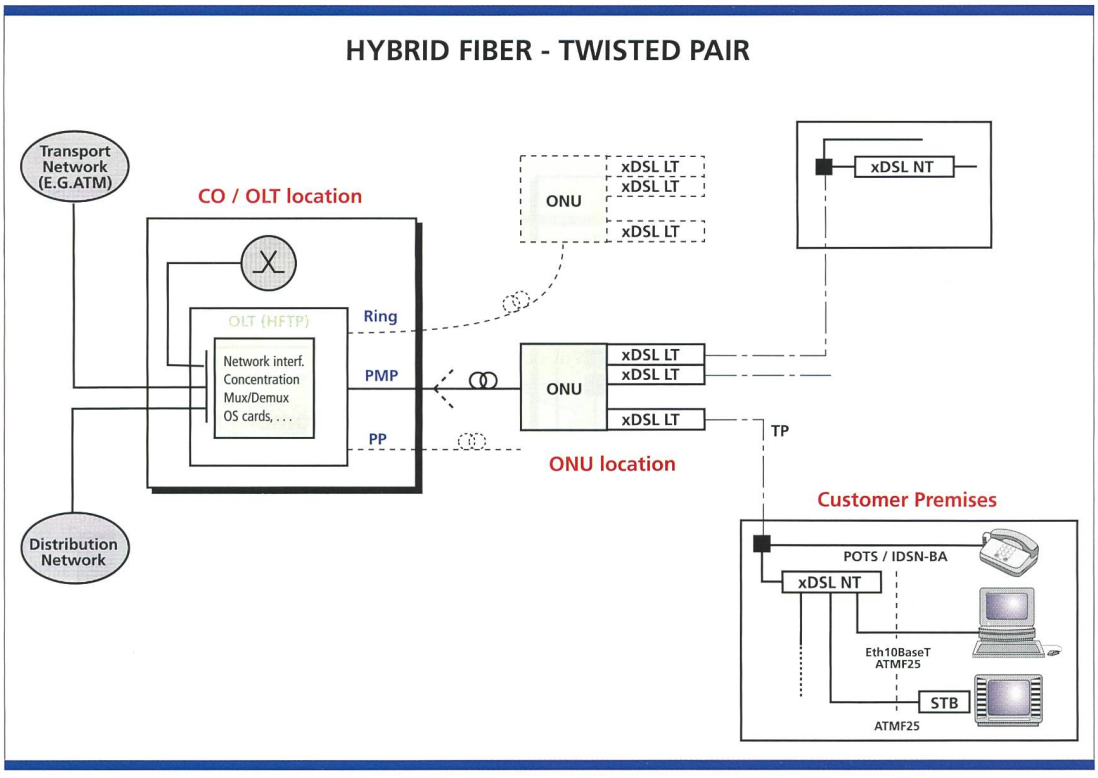

Figure 4. Hybrid Fiber-Twisted Pair (HFTP) principle.

HFTP pre-analysis

Technology overview: Very generally, Hybrid Fiber-Twisted Pair (HFTP) systems consist on Fiber-to-the-Curb (FTTC) or Fiber-to-the-Building (FTTB) type of topologies. These architectures represent the natural evolution from the traditional telephone architecture, through the addition of fiber optic cabling in the distribution network. The HFTP principle is illustrated in *Figure 4*. The fiber is brought down to Optical Network Units (ONUs), where the optical-electrical conversion takes

place (O/E). From there, NB and BB services are delivered to the subscribers via TP drops. Different supplier concepts are available for the fiber trunk, which may be PP or PMP based (Point-to-MultiPoint), PDH or SDH star configurations or SDH rings, Active Optical Network (AON) or ATM Passive Optical Network (APON, focus of the study). ADSL, VDSL and other xDSL technologies are usually used in conjunction with these architectures (but not necessarily). They benefit from the shorter copper drops, which increase the possible bandwidth rates and favour the use of VDSL.

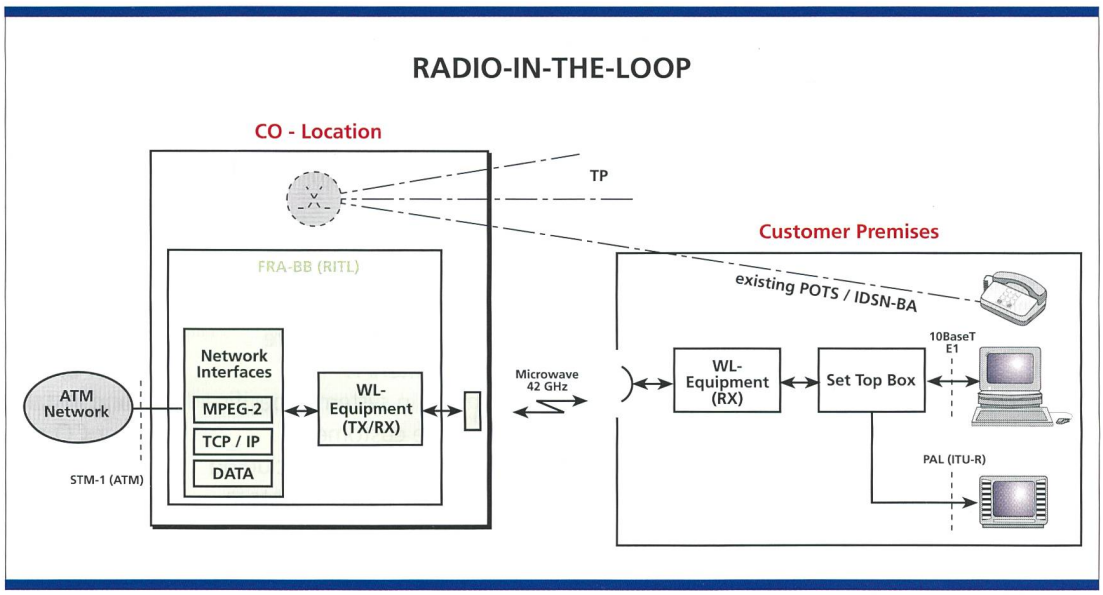

Figure 5. Radio-In-The-Loop (RITL): Fixed Radio Access-BroadBand (FRA-BB) principle.

Main conclusions from HFTP pre-analysis:
- HFTP systems are not ready for deployment before mid 1999, according to most suppliers.
- Offer similar advantages as xDSL from the CO. Additionally, allow higher transmission rates, higher service penetration and subscriber coverage, due to the reduction of TP lengths. HFTP systems have a typical maximal reach around 10 to 20 Km (fiber trunk).
- TV-channels multicasting is more realistic with this type of transmission systems, as the bandwidth per customer may be enough to guarantee 2 to 3 channels simultaneously.
- Investments in civil work and infrastructure are much more important
- Powering remote ONUs constitutes a challenge to telephone operators and a non-negligible cost factor.
- A high penetration rate is necessary to justify the use of HFTP types of systems. From this point of view, it can be considered as an interesting approach for greenfield areas or as a migration path from plain xDSL deployment

RITL / FRA-BB pre-analysis
Technology overview:
Wireless transmission, generally referred as Radio-In-The-Loop (RITL), also offers the possibility of delivering combined NB and BB, distributive and interactive services, using for this purpose digital systems. Figure 5 shows a possible configuration of an interactive Fixed Radio Access-BroadBand (FRA-BB) system (PMP). Considering for instance the downstream traffic[3], the signals are transmitted from the backbone network to the transmitter / receiver location (usually at the CO). The wireless equipment (WL) modulates and converts the signals in the microwave frequency range, where they can be sent by a sector antenna, generally named Base Station (BS). Each BS may serve subscribers within approximately a 5 km radius.
At the customer site, an antenna and a low noise block converter is mounted at a suitable location near the roof.
A flexible system concept allows a widespread spectrum of possible applications. The radio kernel always remains the same, the individual applications being determined by the equipment at the network node interface or at the CP.

Main conclusions from FRA-BB (RITL) pre-analysis
- Analog FRA-BB systems are available at competitive prices for broadcasting services.
- On the other hand, digital systems used for bi-directional transmission are still proprietary, no common description concerning their characteristics can be given. Additionally, the market survey revealed very high initial investments in equipment per BS, as well as substantially high cost increments in a per customer basis. Considering the delivery of integrated services (distributive + interactive), FRA-BB may be cheaper than HFTP if no fiber infrastructure is available in the AN. Otherwise, FRA-BB is generally more expensive than HFTP, for integrated service delivery.
- In comparison with HFTP systems, offers the advantage of unlimited number of parallel broadcasting channels at the CP.
- The deployment of FRA-BB is worth in case of very high service penetration and topologically concentrated centres (max. cell radius ≈ 5 km)

HFC pre-analysis
Technology overview:
Hybrid Fiber-Coaxial (HFC) networks are usually considered the domain of cable operators, which evolve from the tree-and-branch coaxial network into more reliable fiber-trunk-and-feeder networks. HFC networks typically bring fiber from a centralised core switching or headend source through feeder lines to Fiber Nodes (FNs), which perform the necessary O/E conversion. The signals are then sent to all CPs attached to the same FN through the (existing) coaxial PMP shared medium (the more customers connected to a FN, the less bandwidth they individually get).

Main conclusions from HFC pre-analysis (only a brief qualitative analysis was made on this subject):
- Attractive technology as an upgrade of an existing CATV network (or in case of a Greenfield situation).
- Presently, most coaxial networks

[3] For the upstream traffic, the procedure is identical

owned by swiss CATV operators are one-way transmission (return channel generally uses the telephone network). Significant investments for the implementation of two-way services have to be done once for the whole network – even if only one part of the subscribers will require interactive services and will be charged.
This being said, a high penetration of new interactive services is preferable from the beginning (significant risk for smaller CATV operators). In spite of the important investments in the upgrading, CATV operators have already started moving in that direction (as well as public operators which own coaxial infrastructure).
- Shared medium is more adapted to distributive services or Internet type of traffic (best effort). Less suitable for services requiring guaranteed bandwidth and high reliability.
- Customer data security is an issue HFC access providers have to elaborate on.
- Unlike HFTP systems, where the powering of ONUs would require deployment of many power sources throughout the network, coaxial cables can easily carry from a centralised source the required power for remote optical FNs.

Technological options comparison
As a basis of comparison between the mentioned technologies (except HFC) from an AN investment point of view, a simplified modelling for NB and BB interactive services delivery is illustrated in *Figure 6*, for a quantity of 10 000 customers (drawing not in scale).

The following costs[4] for the AN are represented in different patterns:
- Initial investment in civil work, infrastructure and installation before connecting customer#1.
- Initial investment in system's specific equipment before customer#1.
- Total cost for 10 000 users, including equipment and total investments in civil work, infrastructure and installation for 10 000 users.

For the HFTP option, two cases were assumed: fibers already laid in the AN or fiber installation required.
After analysing the technical options from a qualitative and quantitative point of view, one may conclude that xDSL transmission is by far the one offering the most advantages:
- it allows a rapid introduction of new services and a progressive penetration in a «per-customer» basis.
- offers a certain flexibility in the customer bandwidth, in spite of the distance constrains.
- assures a permanent link and dedicated bandwidth per customer (as far as the AN is concerned).
- transparent transport of multiple services in parallel.
- reuses the existing TP infrastructure.
- maintains existing POTS or ISDN-BA services.
- xDSL transmission is by far the most cost-effective one: minimum civil work and installation costs, low initial costs per CO equipment (DSLAM) and reasonable cost increments per customer.
- suppliers' projections on xDSL area indicate that equipment prices shall suffer important reductions over the next months.
- major breakthroughs in the xDSL area, such as the splitterless DSL, will bring further cost reductions in the installation of the CP equipment (no splitter required at the CP; for classical ADSL, the in-house rewiring to adapt POTS/ISDN-BA and ADSL is a time and money consuming activity).

ADSL/xDSL was therefore retained for the next FSAN phase II, Pre-concept.

[4] Sources: average pricing from market surveys as of July 1997 and Swisscom's internal tariffs

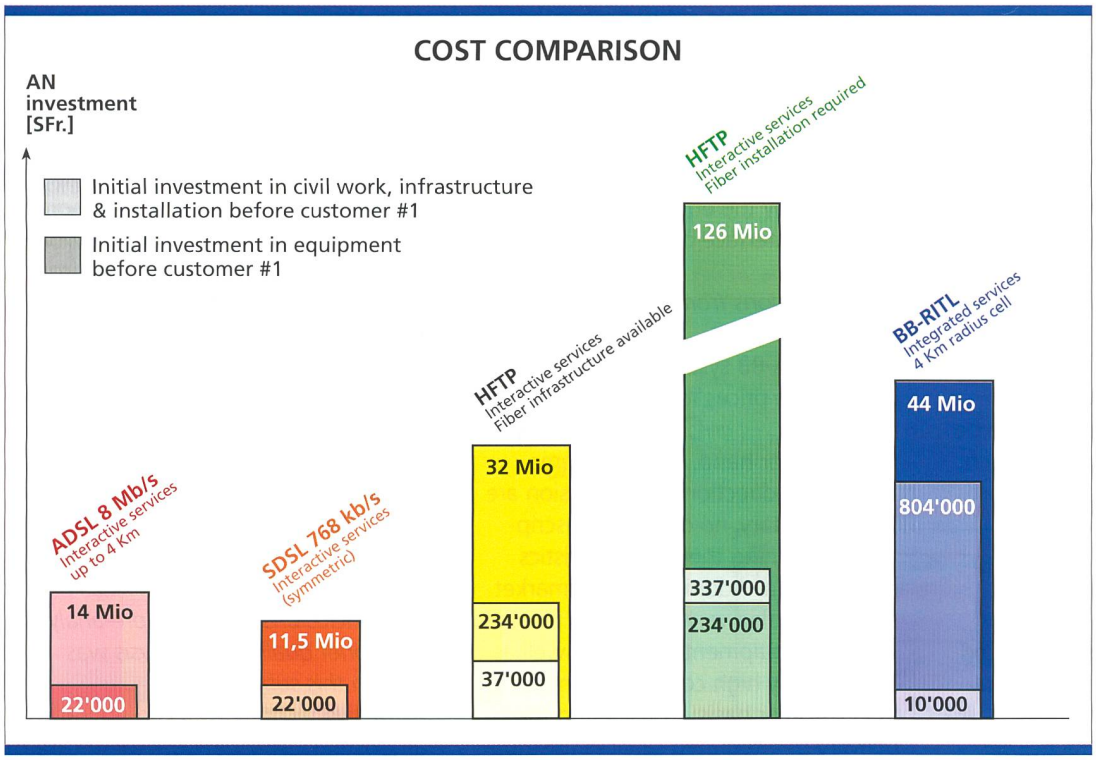

Figure 6. Cost comparison between different technical solutions for the delivery of NB and BB interactive services (simplified model).

Phase II: Pre-concept
BW+ initiative
In April 1997 the Marketing & Products Data Multimedia unit has shared with the Network Services unit its intention to enhance The Blue Window's network and Quality of Service (QoS) by launching a BW+ broadband access.
A decision was taken to start a commercial roll-out of 4000 ADSL links, with the following characteristics:
- 2500 ADSL links in Zurich city
- 1500 ADSL links in Geneva city
- First 1000 customers should be connected before December 1997
- Remaining customers connected until mid 1998
- Foreseen applications: Fast Internet, Small Office – Home Office (SOHO) application,

Teleworking, distance learning, video applications, etc.

Actions undertaken by NWS PD in the ADSL/xDSL domain

Based on the above initiative, it was agreed between M&P DM and NWS PD to start the appropriate actions as soon as possible, to enable such a quick implementation. These were integrated under the responsibility of the FSAN project pre-concept phase II.

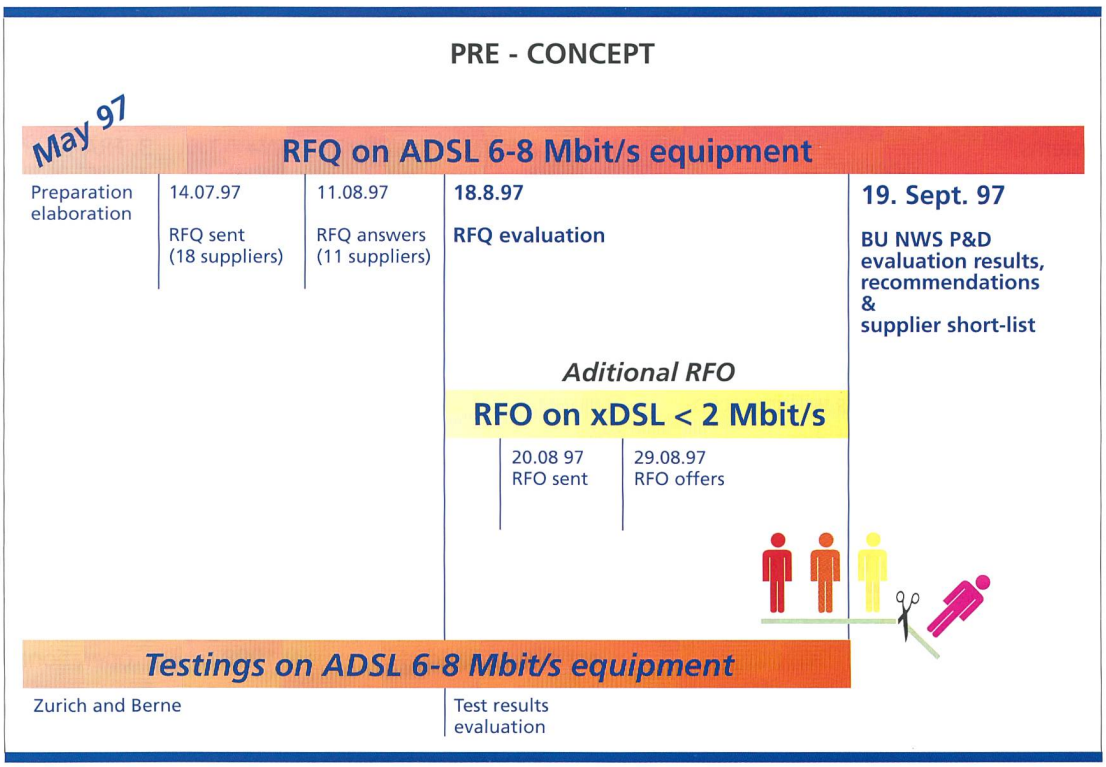

Figure 7. FSAN project pre-concept phase II activities.

With the collaboration of experts from CT and regions East and West, NWS PD developed intensive work in the following areas, as illustrated in *Figure 7*:

- Swisscom's requirements specification on ADSL transmission systems
- Request for Quotation (RFQ) on ADSL equipment; request for Offer (RFO) on ADSL and xDSL equipment
- Evaluation of the suppliers offers by expert team in the following areas:
  Team 1: General aspects and ADSL issues
  Team 2: ATM, IP and Core issues
  Team 3: EMC, security and mechanical design
  Team 4: Management requirements
  Team 5: Commercial requirements
- Laboratory testing on multiple ADSL products and prototypes: performance, compatibility and interference testing with other systems in the AN
- Study of the ADSL behaviour over different types of AN and in-house cabling: Electro-Magnetic Compatibility (EMC), interference, attenuation
- Elaboration of the ADSL/xDSL supplier's short-list
- Pre-Business Plan for commercial roll-out

Some of these items will be developed more in detail in the following sections.

ADSL compatibility and performance in the AN

The performance of ADSL/xDSL transmission systems depends mainly on the line characteristics (length and cable type) and on the noise environment. The noise environment is mainly constituted by the crosstalk (NEXT or FEXT) of other xDSL transmission systems and may decrease significantly the performance of ADSL in the AN. Therefore, the introduction of ADSL in the AN would have to be studied from a compatibility point of view, considering the other systems already available in Swisscom's portfolio (such as HDSL), as well as ADSL itself.

For that purpose, two software simulation tools were used, respectively SSP-WEI[5] and xDSL Expert 1.0[6], in order to evaluate the influence of a variable number of perturbing systems over a given perturbed system.

A performance calculation requires the following inputs:

- Description of the line characteristics (number of segments, respective length and cable type, ...)
- Description of noise environment (number ADSL systems, number of HDSL systems, ETSI noise, etc.)
- Description of the line code and spectrum of the systems
- Performance measurements of the systems (according to ETSI loops)

The simulations have taken into account typical examples of city, suburb and country areas. The same procedure can be done for other area definitions, if needed.

Some general conclusions may be driven from these simulations (for BER=10-7):

- Most of the studied systems interact together with a very good quality of transmission (margin > 10dB)
- High bit-rate ADSL systems, or systems configured in high bit-rate (e.g ADSL configured for full 8Mb/s downstream) are more sensitive to noise than systems with lower bit-rate (or configured in lower bit-rate). Although they should run correctly in city and suburb areas (margin around 6dB), in country areas crosstalk problems should be expected.
- HDSL systems are generally not disturbed by ADSL systems
- HDSL 2B1Q systems seem to be slightly more perturbing for ADSL than HDSL CAP systems (both over 2 TP)
- POTS or ISDN-BA services may be transmitted simultaneously over the same TP as ADSL. The presence of ISDN-BA splitters instead of POTS splitters reduces the reach of ADSL modems of 10-15% according to manufacturers (CT estimations indicate that it can be even more important)

Study of the in-house cabling

A FSAN sub-working group named KAI (Untersuchung Kabel-Infrastruktur im

[5] Simulation of System Performance in a Wired Environment with Interference, developed at the EPFL Telecommunications Laboratory for Swisscom (1996)
[6] Developed in Corporate Technology

Anschlussnetz inkl. Inhouse) was created with the purpose to study the cable infrastructure and the Electro-Magnetic Compatibility (EMC) immunity of ADSL systems.
For that purpose, ADSL prototypes were used and tested over typical AN + in-house wiring configurations. It was concluded that ADSL transmission over existing cabling is possible without any changes, provided that the disturbance behaviour of the ADSL equipment itself and of its environment is within acceptable limits.

ADSL/xDSL Supplier short-list

Based on 11 answers received from the RFQ and RFO sent to 18 suppliers, as well as on the several prototype testing, the FSAN project has elaborated a 5-supplier ADSL/xDSL short-list.

Pre-Business Plan (PBP)

At the end of the above described procedures, NWS PD elaborated in October 1997 a PBP for a commercial roll-out, as defined and requested for the BW+ initiative.
This PBP presented several upgrading options and respective pricing, depending on the xDSL transmission capacity and its influence on the transport backbone network.

Current work and trials in the ADSL area

The Betriebslabor project, an initiative from NWS NBD unit, was approved by the NWS Management Board in October 1997. The Betriebslabor project is divided in several trials:

1. ADSL Trial (running) – the FSAN project was concluded in January 1998, activities continued in the form of this ADSL trial in the context of the Betriebslabor
2. IP backbone trial (running)
3. FRA-BB trial (not started)
4. Voice/fax over IP trial (on hold)
5. EWSD trial (on hold)
6. IP over SDH trial (not started)
7. External access Security trial (running)

ADSL trial objectives

As far as the ADSL trial is concerned, the main objectives can be mentioned:

- build know-how in the Regions on ADSL technology and on Internet Protocol (IP)
- build know-how on ADSL deployment and management in an operational environment
- elaboration of business plans, based on operational experience and data

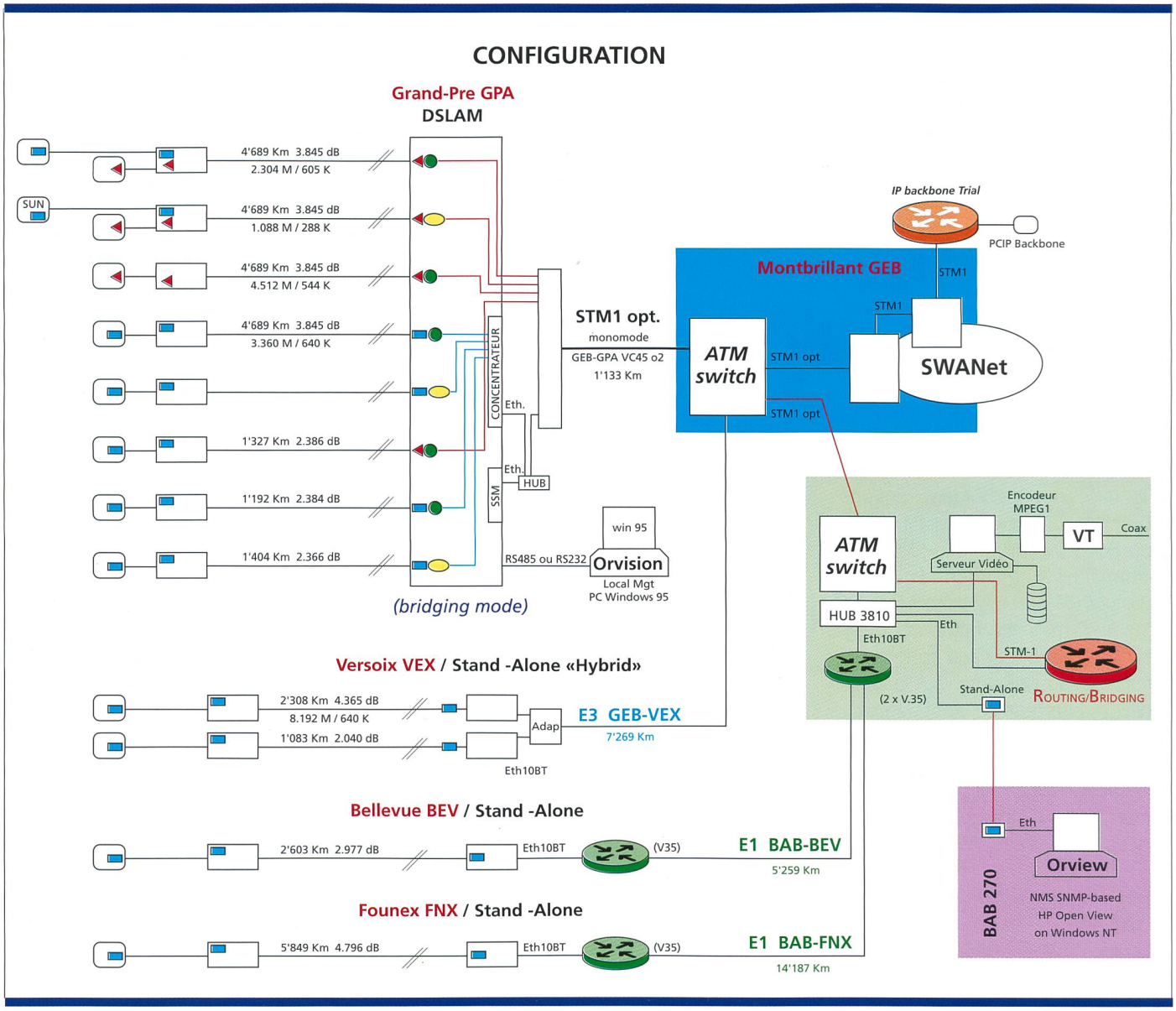

Figure 8. ADSL trial Region West configuration (Geneva).

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ADSL trial description

The following regions and locations are presently involved in the ADSL trial:

- Region West, 12 customers in Geneva, Orckit supplier (*Figure 8*)
- Region East, 8+8 customers in Zurich, respectively ECI and Paradyne suppliers
- Region Center, 11 customers in Bale, Alcatel supplier

Customer type: internal collaborators
Applications: Teleworking, Fast Internet, video transfer, connection to FS-Lab servers, etc.
Technical issues addressing: ADSL over POTS/ISDN-BA, ATM versus IP to the home, QoS, PVC management, backbone interconnection aspects, Network Management, DSLAM and customer premises installation, operation, performance, etc.
Training courses on ADSL technology and system operation have been organised by each supplier in each Swisscom region.

Future developments

The equipment was delivered around March 1998 to Swisscom, on a free-of-charge basis for a limited period of 6 to 8 months. The ADSL trials shall last until October 1998.
The ADSL trials are presently running, and interworking with the other Betriebslabor IP backbone trial.
Important operational data is being retrieved from this experience, for future implementation of ADSL/xDSL in a larger scale. 9.4

To those who have, in many ways, at different levels and from several Swisscom departments and regions, participated and put their effort into the FSAN project and subsequent activities, thank you for the excellent team work.

List of Acronyms

ADSL	Asymmetric Digital Subscriber Line
AN	Access Network
AON	Active Optical Network
APON	ATM Passive Optical Network
ATM	Asynchronous Transfer Mode
BB	BroadBand
BER	Bit-Error-Rate
BS	Base Station
BW	Blue Window
CATV	CAble TeleVision
CO	Central Office
CP	Customer Premises
CPE	Customer Premises Equipment
CT	Corporate Technology
DM	Data Multimedia
DSL	Digital Subscriber Line
DSLAM	DSL Access Multiplexer
EMC	ElectroMagnetic Compatibility
FEXT	Far-end crosstalk
FN	Fiber Node
FRA-BB	Fixed Radio Access-BroadBand
FSAN	Full Service Access Network
FTTB	Fiber-To-The-Building
FTTC	Fiber-To-The-Curb
GoD	Games on-Demand
HDSL	High Bit-Rate Digital Subscriber Line
HFC	Hybrid Fiber-Coaxial
HFTP	Hybrid Fiber-Twisted-Pair
IDSL	ISDN-based Digital Subscriber Line
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISDN-BA	Integrated Services Digital Network-Basic Access
KAI	*Untersuchung Kabelinfrastrukturen im Anschlussnetz inkl. Inhouse*
LT	Line Termination
MP	Marketing and Products
NB	NarrowBand
NBD	New Business Development
NEXT	Near-end crosstalk
NT	Network Termination
NO	Network Operator
NWS	NetWork Services
O/E	Optical/Electrical
OLT	Optical Line Termination
ONU	Optical Network Unit
PD	Planning & Development
PDH	Plesiochronous Digital Hierarchy
POTS	Plain Old Telephony Service
PMP	Point to MultiPoint
PP	Point-to-Point
PVC	Permanent Virtual Channels
QoS	Quality of Service
RADSL	Rate-adaptive Asymmetric Digital Subscriber Line
RITL	Radio-In-The-Loop
RFI	Request for Information
RFO	Request for Offer
RFQ	Request for Quotation
SDH	Synchronous Digital Hierarchy
SDSL	Single-pair Digital Subscriber Line
SP	Service Provider
SPT	Sub-Project Team
STB	Set-Top Box
TP	Twisted Pair
TX/RX	Transmitter/Receiver
WL	WireLess
VDSL	Very high bit-rate Digital Subscriber Line
xDSL	x Digital Subscriber Line, x stands for A, H, S, I, V, ...

Zusammenfassung

Projekt Full Service Access Network (FSAN)

Das Projekt Full Service Access Network (FSAN) startete Ende 1996 mit dem Ziel, die technischen Optionen für die gleichzeitige Übertragung von Schmal- und Breitband Multimedia-Diensten zu Privat- und Geschäftskunden zu beschreiben, zu bewerten und kostenmässig zu quantifizieren. Die Analyse kommt zum Schluss, dass unter Berücksichtigung des bestehenden Swisscom-Anschlussnetzes die Technologievariante ADSL (Asymmetric Digital Subscriber Line) die am besten geeignete Lösung für künftige interaktive Dienste darstellt. Die Hauptgründe dafür sind die mögliche Wiederverwendung der bestehenden Anschlussleitung (Kupferaderpaar), die schnelle Einsatzbereitschaft ohne nennenswerte Vorinvestitionen sowie die Möglichkeiten für flexible und individuelle Bandbreite pro Teilnehmer. Die Studie schliesst mit der Empfehlung, das für den Einsatz von ADSL notwendige Know-how in Bezug auf Planung, Realisierung, Betrieb, Internet- und Managementaspekte aufzubauen und damit wichtige Informationen für einen Businessplan zu erhalten. Diese Empfehlung wurde mit dem Aufbau des NWS Betriebslabors umgesetzt und es wurden wichtige Grundlagen für ein künftiges Dienstangebot über ADSL geschaffen.