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Nederlands Elektronica- en Radiogenootschap
Postbus 39, 2260AA Leidschendam. Gironummer 94746
t.n.v. Penningmeester NERG, Leidschendam.

HET GENOOTSCHAP

De vereniging stelt zich ten doel het wetenschappelijk onderzoek op het gebied van de elektronica en de informatietransmissie en - verwerking te bevorderen en de verbreiding en toepassing van de verworven kennis te stimuleren.

LIDMAATSCHAP

Voor lidmaatschap wende men zich tot de secretaris. Het lidmaatschap staat open voor academisch gegradueerden en hen, wier kennis of ervaring naar het oordeel van het bestuur een vruchtbaar lidmaatschap mogelijk maakt. De contributie bedraagt ƒ 60,- per jaar.

Studenten aan universiteiten en hogescholen komen bij gevorderde studie in aanmerking voor een junior-lidmaatschap, waarbij 50% reductie wordt verleend op de contributie. Op aanvraag kan deze reductie ook aan anderen worden verleend.

HET TIJDSCHRIFT

Het tijdschrift verschijnt zesmaal per jaar. Opgenomen worden artikelen op het gebied van de elektronica en van de telecommunicatie.

Auteurs die publicatie van hun wetenschappelijk werk in het tijdschrift wensen, wordt verzocht in een vroeg stadium kontakt op te nemen met de voorzitter van de redactie commissie.

De teksten moeten, getypt op door de redactie verstrekte tekstbladen, geheel persklaar voor de offsetdruk worden ingezonden.

De abonnementsprijs van het tijdschrift bedraagt ƒ 60,- . Aan leden wordt het tijdschrift kosteloos toegestuurd.

Tarieven en verdere inlichtingen over advertenties worden op aanvrage verstrekt door de voorzitter van de redactiecommissie.

In memoriam Prof.Dr. H. Groendijk

Ons bereikte het droevige bericht dat Hendrik Groendijk op 18 januari 1987 op de leeftijd van 69 jaar, in volle vrede van ons is heengegaan. Als vertegenwoordiger van het bestuur van het NERG, maar ook als een van zijn medewerkers uit de vakgroep Elektronica op de faculteit Elektrotechniek van de Technische Universiteit Eindhoven, waarvan Groendijk 18 jaar de leiding had, woonde ik de in de Friese taal gesproken rouwdienst en de ter aarde bestelling in Rijperkerk bij. Ik was daar in de gelegenheid zijn vrouw en kinderen onze deelneming te betuigen, en hen kracht te wensen voor deze moeilijke dagen.

Groendijk studeerde Wis- en Natuurkunde aan de Rijksuniversiteit Groningen. Na zijn studie bleef hij daar aanvankelijk als medewerker werkzaam. Hij promoveerde in 1949 op een kernfysisch onderwerp. Vanwege zijn bekwaamheden op het gebied van de elektronenoptica werd hij gevraagd als medewerker op het Natuurkundig Laboratorium van de N.V. Philips te komen werken, waar hij opklom tot groepsleider van de researchgroep Elektronenbuizen. In 1964 werd hij benoemd tot gewoon hoogleraar in de Elektrotechniek, welke funktie hij tot zijn 65ste jaar in 1982, vervulde. Gedurende deze jaren doceerde hij Elektronica, Microgolftechniek en Elektronenoptica. Groendijk begeleidde vele promovendi. Binnen de Universiteit heeft hij bijgedragen aan het werk op bestuurlijk niveau. In 1980 en 1981 was hij decaan en beheerder van de faculteit Elektrotechniek. In deze periode was hij in de gelegenheid de plannen tot het inrichten van een kleine productie eenheid voor halfgeleidercomponenten tot uitvoering te brengen. Voor het huidige elektronica onderwijs is dat van beslissende betekenis gebleken.

Groendijk was van 1971 tot 1977 bestuurslid van het NERG. De voortgang van de publicaties van het genootschap werden door hem als zeer belangrijk gezien. Door zijn medewerking en stimulatie konden deze ook na de periode van samenwerking met het Koninklijk Instituut van Ingenieurs op publicistisch gebied, zonder onderbreking worden voortgezet.

Groendijk was vaak wat stil en teruggetrokken. Hij was een aimabel man en steeds strikt rechtvaardig. Hij had een grote wetenschappelijke belangstelling ook buiten zijn vakgebied.

Hij ruste in vrede.

M. Steffelaar

Akoestische Bepaling van Stroomsnelheden

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Acoustic current velocity measurement is generally considered as an accurate and reliable method to determine current velocity. The major attraction of this technique is its remote measuring capability. Accuracy and precision of the method depend on both controllable variables (frequency, pulse length, signal processing) and uncontrollable variables (backscatter strength, current regime and platform stability). This paper briefly reviews the different acoustic backscatter techniques and describes some of the ongoing research at the TNO Institute of Applied Physics (Technisch Physische Dienst TNO-TH).

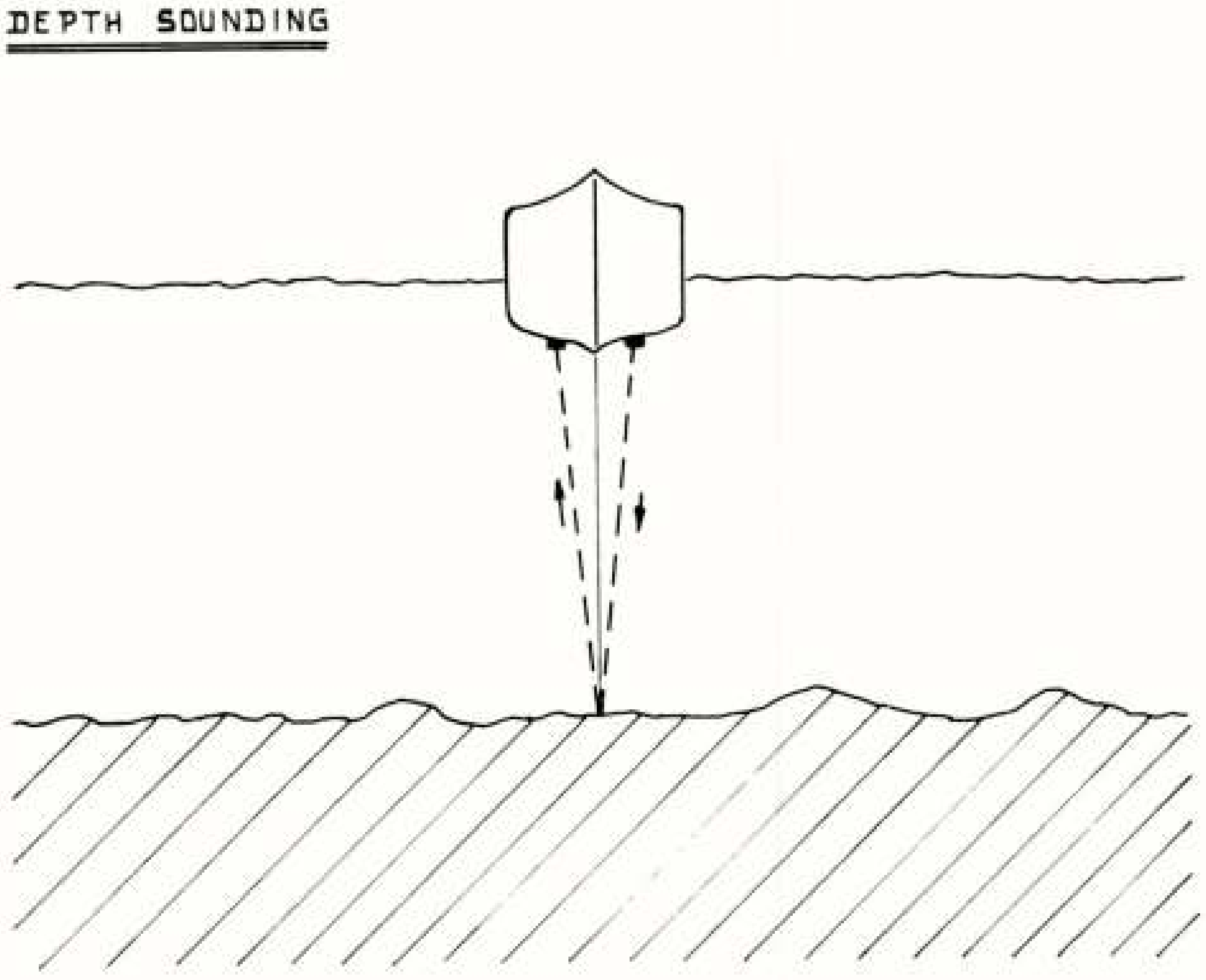
Inleiding

De nauwkeurige bepaling van stroomsnelheden in de Nederlandse wateren is voor de Rijkswaterstaat om diverse redenen van groot belang. Allereerst zijn er de aktiviteiten gericht op algemeen beheer. Om die reden worden de verschillende stormingsregimes in Nederland zo nauwkeurig mogelijk in kaart gebracht. De stroomsnelheid vormt tevens een belangrijk aspekt bij de bouw van waterbouwkundige constructies, zoals bruggen, dammen en sluizen. Tenslotte speelt de stroomsnelheid een niet onbelangrijke rol met betrekking tot het milieu, o.a. in verband met het transport van sediment en de biologische aktiviteit in het water.

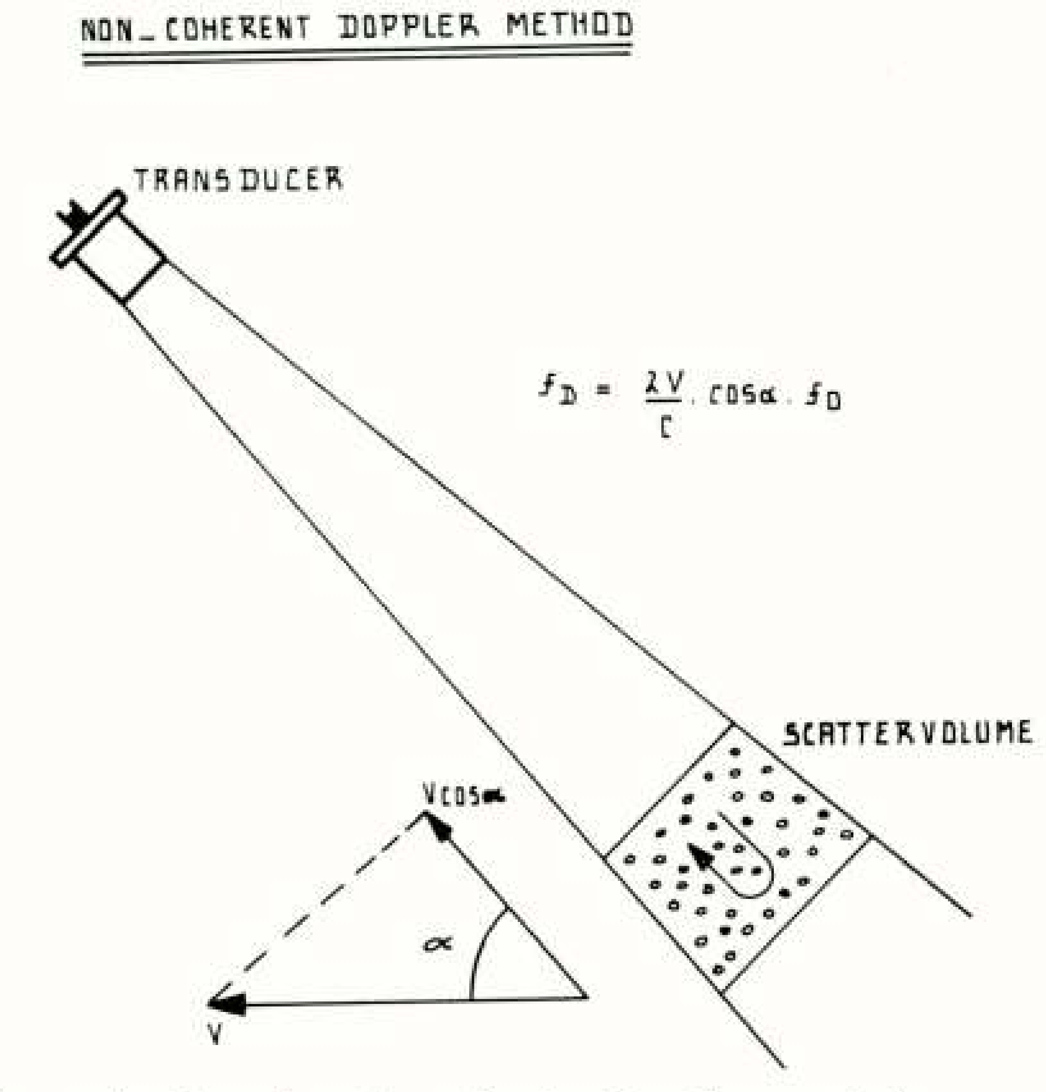
Er zijn talloze methoden bekend om stroomsnelheden te meten. Het meest voor de hand liggend zijn waarschijnlijk die methoden, waarbij de stroomsnelheid wordt bepaald langs mechanische weg, bijvoorbeeld met een draaiend schoepenrad, vergelijkbaar met de windmolen. Daarnaast wordt ook gebruik gemaakt van eleketromagnetische, optische en elektrische methoden.
Het grote voordeel van de akoestische methoden ligt in het feit dat deze op basis van een echometing op afstand kunnen meten ('remote sensing'). Met een akoestische methode kan op die manier de stroomsnelheid worden bepaald op verschillende afstanden van de bron/ontvanger, resulterend in een stromingsprofiel over de waterkolom. Dit in tegenstelling tot de andere 'in situ' systemen die een lokale meting uitvoeren en per definitie een verstoring van het meetvolume veroorzaken.

Akoestische echometingen

De toepassing van akoestische echotechnieken is in de afgelopen 10 tot 20 jaar enorm toegenomen. Momenteel biedt de zgn. 'echo-akoestiek' mogelijkheden om nauwkeurige afbeeldingen te maken van de geologische opbouw van de aardkorst (seismiek), de struktuur van het menselijk lichaam (medische echografie) en de integriteit van industriële produkten (niet-destruktief materiaal onderzoek).
Bij velen is de echo-akoestiek echter het meest bekend door de toepassingen onder water, de zgn. SONAR-techniek (SOund Navigation And Ranging). Sonar stelt de gebruiker in staat de afstand tussen schip en bodem en eventueel andere objekten onder water nauwkeurig te bepalen. Het opsporen van scheepswrakken, het visualiseren van de bodemopbouw, het lokaliseren van scholen vis zijn slechts enkele van de vele denkbare toepassingen.
Het principe van de echo-akoestische methode is weergegeven in figuur 1. Met behulp van een akoestische bron, bijvoorbeeld gemonteerd in de romp van een schip, wordt een pulsvormig akoestisch signaal uitgezonden. De uitgezonden energie plant zich in het water voort naar de bodem en wordt daar gereflekteerd.



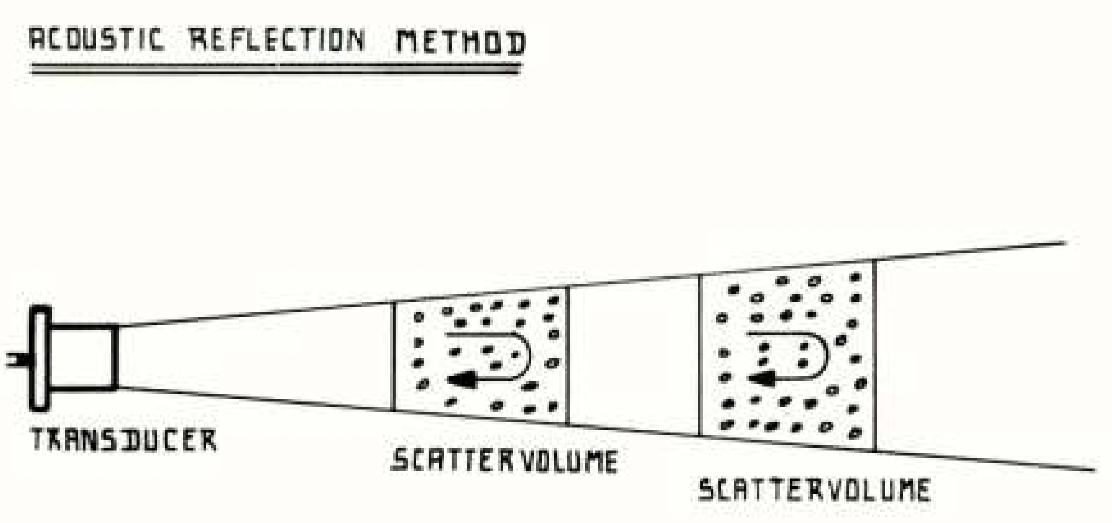
Figuur 1. Het principe van de puls-echo meting.



Figuur 2. De echo-akoestische Doppler methode.

Een deel van deze gereflekteerde energie zal via de waterkolom weer de onderzijde van het schip bereiken, waar het door een ontvanger wordt gedetekteerd. Op basis van de tijd die is verlopen tussen het uitzenden van de puls en het ontvangen van de echo, en de (bekende) voortplantingssnelheid van geluid in water, kan nu de hoogte van de waterkolom, cq. de diepte van de bodem worden bepaald.

Bij de bepaling van stroomsnelheden wordt niet gekeken naar de bodemecho, maar proberen we echo's te detekteren van kleine inhomogeniteiten (bellen, micro-organismen en anorganisch materiaal) in het water. Hierbij gaan we ervan uit dat deze inhomogeniteiten worden meegevoerd met de waterstroom. Afhankelijk van de grootte van de snelheidskomponent in de richting van de akoestische bundel, zullen de echo's van deze 'deeltjes' een zgn. Doppler verschuiving ondergaan (zie figuur 2).



Figuur 3. Onderscheid tussen verschillende waterlagen.

De grootte van de Doppler verschuiving bedraagt:

$$f_D = \frac{2 \text{ v} \cos\alpha}{c} f_o, \qquad (1)$$

waarin

f_D = Doppler frekwentieverschuiving (Hz)
v = stroomsnelheid (m/s)
α = hoek tussen stroomsnelheid en akoestische bundel (rad)
c = geluidsnelheid (m/s)
f_o = uitgezonden geluidfrekwentie (Hz).

De betrouwbaarheid en nauwkeurigheid, waarmee op deze wijze de stroomsnelheid kan worden bepaald, is afhankelijk van diverse grootheden. Allereerst is daar de keuze van de systeemparameters, zoals het uitgezonden vermogen, de uitgezonden frekwentie(s) en de lengte van het zendsignaal. Vervolgens spelen de globale eigenschappen van het medium een rol. Met name de verzwakking is bepalend voor de uiteindelijke signaal-stoorverhouding.
Een zeer belangrijke grootheid tenslotte is de strooisterkte van de inhomogeniteiten in het water; samenstelling, grootte en concentratie van deze 'deeltjes' bepalen welk deel van de invallende energie wordt gereflekteerd in de richting van de ontvanger. Bij het ontwerp van een akoestische stroomsnelheidsmeter dienen al deze grootheden optimaal op elkaar te worden afgestemd. Verschillende toepassingen monden dan ook uit in verschillende data acquisitie en/of verwerkingsmethoden.

De niet-coherente Doppler methode

De niet-coherente Doppler methode is de meest direkte realisatie van de hierboven beschreven Doppler techniek Het zendsignaal bestaat uit een eindige sinustrein waar mee een quasi monochromatisch signaal in het water worden gestuurd. De lengte van deze sinustrein is bepalend voor de resolutie waarmee in de diepte individuele waterlagen kunnen worden onderscheiden (zie figuur 3).
Vanuit het terugkerende echocomplex wordt de gemiddelde Doppler verschuiving berekend, waarmee de snelheidscomponent in de richting van de akoestische bundel wordt bepaald. In de praktijk wordt met behulp van een speciale bron/ontvanger configuratie (3 tot 4 transducenten) in verschillende richtingen een akoestische bundel uitgezonden.
De grootte en richting van de stroomsnelheid volgen nu uit een eenvoudige ruimtelijke relatie tussen de afzonderlijk gemeten snelheidscomponenten.

Bij een gegeven vaste meetconfiguratie (i.e. v, c en α mogen constant verondersteld worden) geeft vergelijking (1) aan dat een enkele uitgezonden frekwentiecomponent resulteert in een enkele Doppler verschuiving; een breedbandig zendsignaal (meerdere frekwentiecomponenten) zal een breedbandig Doppler spectrum opleveren.

Het zal duidelijk zijn dat het bepalen van een enkele Doppler verschuiving in de praktijk eenvoudiger is dan de bepaling van een volledig Doppler spectrum. In het laatste geval moeten we immers gebruik maken van een vorm van spectrale analyse om een eenduidig verband te kunnen leggen tussen de uitgezonden frekwentiecomponenten en de ontvangen Doppler verschuivingen.

Om die reden is de niet-coherente Doppler methode een voor de hand liggende techniek, waarmee in de praktijk zeer bevredigende resultaten worden behaald.

Samenvattend geldt voor de niet-coherente Doppler methode dat:

- de methode quasi monochromatisch is en gebruik maakt van eindige sinusvormige zendsignalen;
- de nauwkeurigheid van de meting sterk wordt bepaald door de lengte van het zendsignaal, waarbij lange zendsignalen een nauwkeuriger resultaat opleveren;
- lange zendsignalen resulteren in een afnemende diepteresolutie, i.e. onderscheid tussen individuele waterlagen of 'bins';
- iedere individuele meting in principe een stroomsnelheidsprofiel over de hele waterkolem oplevert;
- het stromingsprofiel snel mag variëren als funktie van de tijd, maar slechts langzaam als funktie van de diepte.

De coherente Doppler methode

De coherente Doppler methode, ook wel pulsed Doppler genoemd, is voortgekomen uit de behoefte aan een grotere diepteresolutie, die met name bestond in de medische echografie, waar men geïnteresseerd is in het meten van de stroomsnelheid van bloed. Deze coherente techniek is sterk verwant met de pulsed Doppler radar.
Bij de coherente methode wordt, gedurende een aantal opeenvolgende metingen de beweging van een volume strooiende deeltjes gevolgd. Dit 'volgen' is gebaseerd op het meten van de verandering van de fase van een enkele frekwentiecomponent.
Om een goede diepteresolutie te verkrijgen worden bij deze methode korte breedbandige signalen uitgezonden. Binnen een instelbaar tijdvenster wordt het ontvangen echocomplex vervolgens complex gedemoduleerd. In formule-vorm leidt dit tot:

$$Q(f_o) = \int_{t_1}^{t_2} s(t)\, \exp(-j2\pi f_o t)\, dt$$

$$= \int_{t_1}^{t_2} s(t) \left\{ \cos 2\pi f_o t - j \sin 2\pi f_o t \right\} dt, \qquad (2)$$

waarin:

$s(t)$ = ontvangen echosignaal
t_1 = begin van het tijdvenster ($t_1 = 2z_1/c$)
t_2 = eind van het tijdvenster ($t_2 = 2z_2/c$)
f_o = centrale frekwentie van het uitgezonden signaal

We zien dat vergelijking (2) feitelijk een Diskrete Fourier Transformatie (DFT) beschrijft over het tijdinterval $t_2 - t_1$.
Dientengevolge is $Q(f_o)$ een schatting van de spectrale component $S(f_o)$, i.e.:

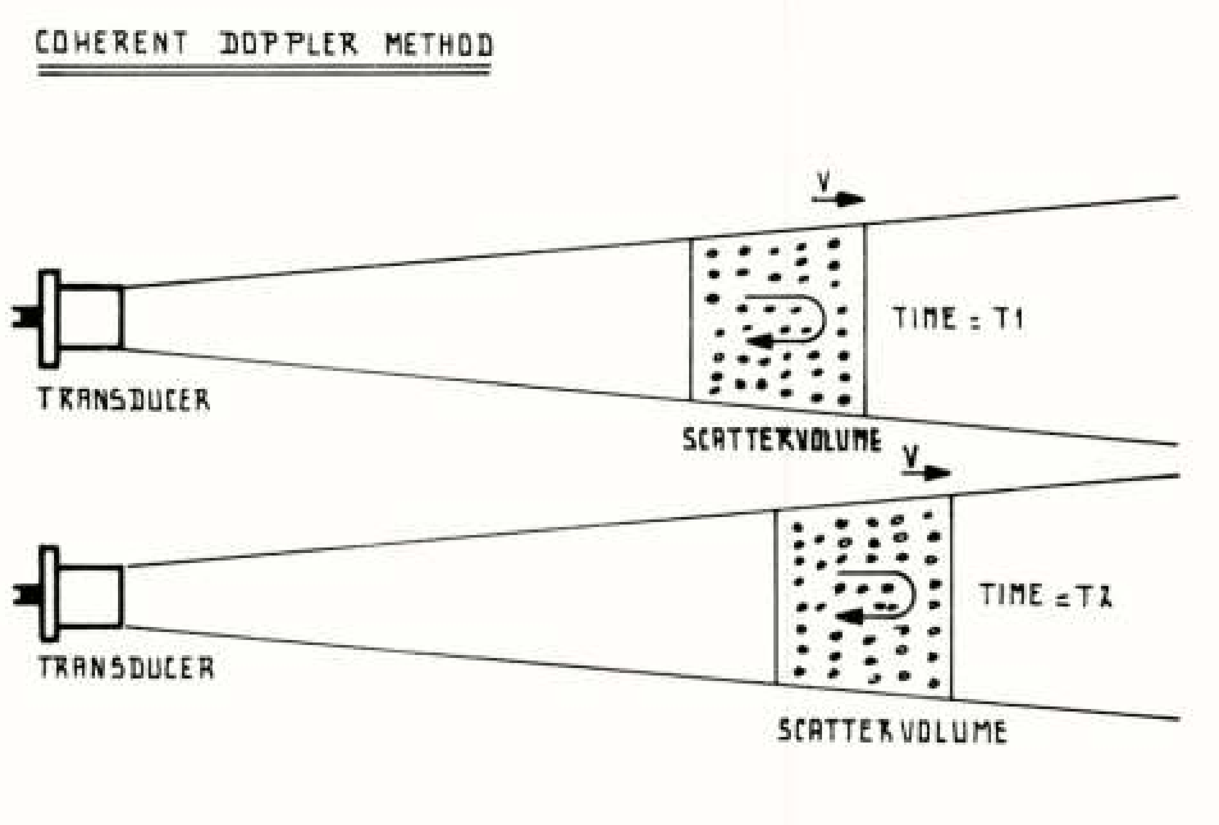
$$Q(f_o) = E \left\{ S(f_o) \right\}, \qquad (3)$$

waarin $S(f)$ het frekwentiespectrum van $s(t)$ voorstelt.

We veronderstellen nu dat we de fase van $Q(f_o)$ mogen beschrijven met de volgende formule:

$$\text{Fase 1} \left\{ Q(f_o) \right\} = 2\pi\, (2z_1/c)\, f_o. \qquad (4)$$

Na een korte tijd $\Delta\tau$ wordt de bovenbeschreven meting herhaald. In die korte tijd heeft ons volume met strooiende deeltjes zich met een snelheid $v \cos\alpha$ van de transducent verwijderd, waarbij het een afstand heeft afgelegd van $\Delta z = v\Delta\tau$ (zie figuur 4).



Figuur 4. De coherente Doppler methode.

De fase van $Q(f_o)$, op basis van deze tweede meting, wordt nu beschreven door:

$$\text{Fase 2} \left| Q\,(f_o) \right| = 2\pi \frac{2z_1 + 2\Delta z}{c} f_o. \qquad (5)$$

Het faseverschil tussen beide metingen bedraagt in dit geval:

$$\text{Fase 2 - Fase 1} = 2\pi \frac{2v \cos\alpha}{c} f_o \Delta\tau. \qquad (6)$$

Tenslotte bepalen we op basis van vergelijking (6) de fasedraaiing per seconde, Φ:

$$\Phi = 2\pi \frac{2v \cos\alpha}{c} f_o = 2\pi f_{CD}, \qquad (7)$$

waarin f_{CD} de resulterende frekwentie voorstelt. We zien dat f_{CD} volledig identiek is aan de uitdrukking voor de Doppler verschuiving f_D in vergelijking (1).

Bij de coherente methode wordt de stroomsnelheid nu bepaald door vergelijking (6) over een aantal opeenvolgende metingen te evalueren. De nauwkeurigheid neemt toe naarmate meer metingen in beschouwing genomen (kunnen) worden.

We zien dat het faseverschil in vergelijking (6) zowel bepaald wordt door het tijdinterval $\Delta\tau$, i.e. de pulsherhalingsfrekwentie, en de stroomsnelheid v. Wil dit faseverschil volledig eenduidig zijn dan moet de absolute waarde van dit verschil kleiner of gelijk zijn aan π radialen:

$$1/\Delta\tau = f_{prf} \geq 2f_{CD}. \qquad (8)$$

waarin f_{prf} de pulsherhalingsfrekwentie aangeeft.

Vergelijking (8) beschrijft de theoretische beperkingen van de coherente Doppler methode met betrekking tot het maximale (diepte)bereik ($\Delta\tau$) en de maximale stroomsnelheid v (f_{CD}) en mag beschouwd worden als een Nyquist criterium.

Opvallend is dat hoewel de coherente Doppler methode gebruik maakt van breedbandige signalen, de fase slechts voor een frekwentiecomponent wordt geëvalueerd. Een verwerkingsmethode die de fasedraaiing evalueert voor alle signifikante frekwentiecomponenten zal zonder twijfel nog betere resultaten opleveren.

Samenvattend geldt voor de coherente Dopplermethode dat:
- hoewel gebruik wordt gemaakt van breedbandige signalen, de verdere verwerking in principe monochromatisch geschiedt;
- de nauwkeurigheid van de methode sterk wordt bepaald door het aantal metingen dat wordt geëvalueerd;
- de breedbandige zendsignalen resulteren in een goede diepteresolutie;
- de methode theoretische afstandsbeperkingen kent, die afhankelijk zijn van de maximale stroomsnelheid;
- het stromingsprofiel snel mag variëren als funktie van de diepte, maar slechts langzaam als funktie van de tijd.

Bouw Sonar Werkstation

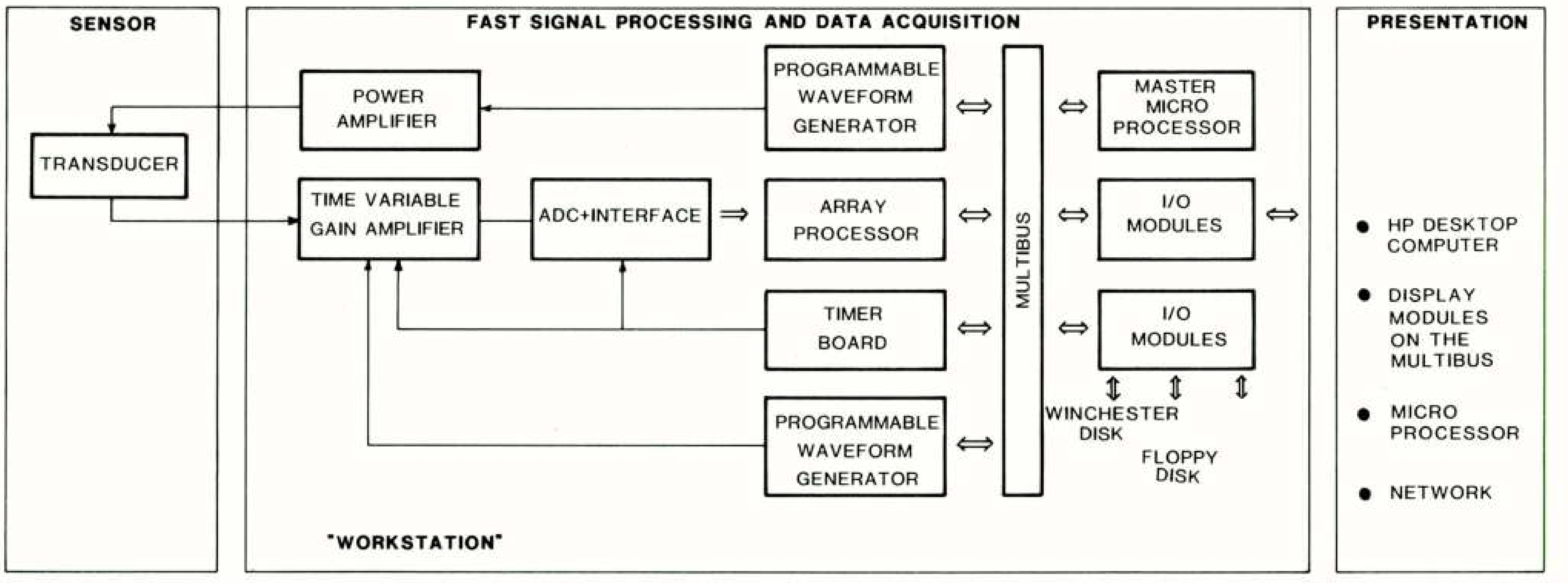
In 1985 heeft de Technisch Physische Dienst TNO-TH een zogenaamd Sonar Werkstation ontwikkeld in opdracht van de afdeling Hydro-instrumentatie van de Rijkswaterstaat, dat beschouwd mag worden als een algemeen akoestisch research instrument voor de onderwaterakoestiek en de akoestische bepaling van stroomsnelheden.

Met dit werkstation zullen de komende jaren verschillende methoden van data inwinning en data verwerking worden geëvalueerd. Op basis van de met dit werkstation behaalde meetresultaten zullen vervolgens voor specifieke toepassingen zgn. doelsystemen worden ontwikkeld.

Het werkstation bestaat uit drie specifieke onderdelen: een onderwater deel, een data inwin- en verwerkingsdeel en een presentatie- en opslagdeel.

Het onderwater deel is specifiek voor een gegeven toepassing, e.g. breedbandige evaluatie van strooiingsparameters, coherente en/of niet-coherente Doppler. Dit deel bevat de gewenste transducent configuratie, aanpassingsnetwerken, voorversterkers voor iedere individuele transducent en schakelelektronica. De beide andere systeemdelen zijn volledig applicatie-onafhankelijk.

De belangrijkste kenmerken van het data inwin- en verwerkingsdeel zijn:
- een timerkaart voor het genereren van alle gewenste timing funkties, waarbij alle parameters onder software instelbaar zijn;
- twee programmeerbare 'waveform' generatoren (PWG) waarmee zowel zendsignalen als regelcurven voor de tijdafhankelijke versterking worden gegenereerd;
- vier tijdafhankelijke versterkers met een dynamisch bereik van 80 dB;
- een 'board level' array processor met 512 kByte digitaal geheugen (Mercury ZIP 3216).



Figuur 5. Schema van het Sonar Werkstation.

De systeemconfiguratie is gebaseerd op de zogenaamde Multibus. Figuur 5 geeft een schematisch overzicht van het werkstation.

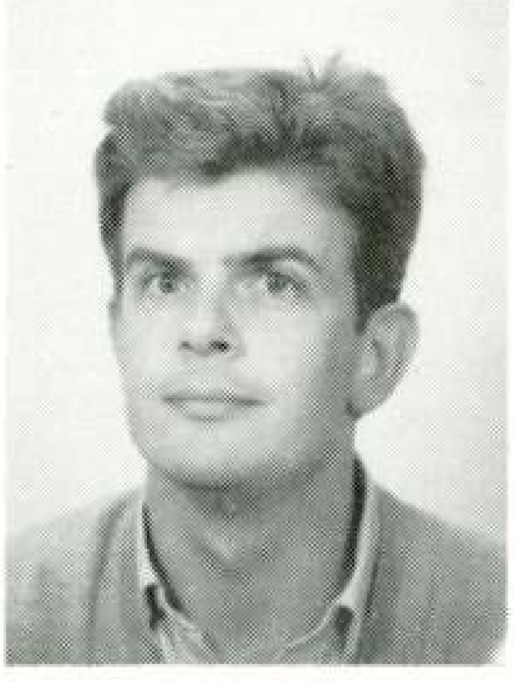
Het presentatie- en data opslagdeel tenslotte is gebaseerd op een HP-310 'desk-top' computer systeem, dat met het Multibus deel verbonden is via de HP-IB bus. Op de HP-310 worden de bewerkte data nader geëvalueerd en grafisch weergegeven.

Literatuur

1. L.F. van der Wal, 'A wave theoretical approach to acoustic current profiling', Proceedings of the IEEE Third Working Conference on Current Measurement, May 1986, IEEE 86CH2305-1, p.p. 203-212.
2. L.F. van der Wal and C. van den Berg, 'Design and construction of a Sonar Workstation', Proceedings of Oceans '86, September 1986, IEEE 86CH2363-0, p.p. 472-475.

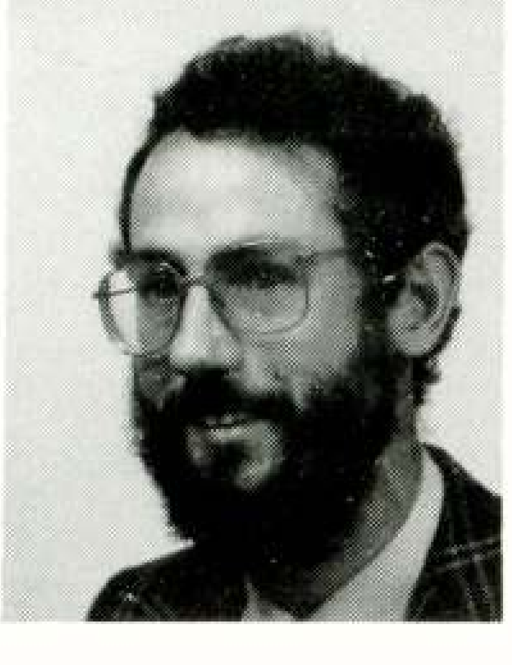
Voordracht gehouden tijdens de 346e werkvergadering.

NEDERLANDS ELEKTRONICA- EN RADIOGENOOTSCHAP
(346ste werkvergadering)
AFDELING TELECOMMUNICATIE VAN HET KIvI
IEEE SECTIE BENELUX



IR. L. VAN DER WAL

MR. J. L. MICHEL



IR. L. VAN DEN STEEN

UITNODIGING

voor de lezingendag op **donderdag 30 oktober 1986** in het gebouw van de **Faculteit der Civiele Techniek** van de **Technische Universiteit Delft, Collegezaal D**, Stevinweg 1, Delft.
Thema: ONDERWATER COMMUNICATIE.

PROGRAMMA

9.30 - 10.00 uur:	Ontvangst en koffie.
10.00 - 10.15 uur:	Uitreiking Vederprijs aan Dr. Ir. H. C. Nauta (TU-Delft), door Prof. Dr. J. Arnbak (uitgesteld van 16 september).
10.15 - 11.00 uur:	**IR. L. VAN DER WAL**, (Technisch Physische Dienst TNO-TU, Delft); ACOUSTIC CURRENT PROFILING.
11.00 - 11.30 uur:	Koffiepauze.
11.30 - 12.30 uur:	**MR. J. L. MICHEL**, (IFREMER, France); DISCOVERY OF TITANIC: TECHNOLOGICAL ISSUES.
12.30 - 13.45 uur:	Lunchpauze.
13.45 - 14.30 uur:	**PROF. IR. C. VAN SCHOONEVELD**, (Fysisch en Electronisch Lab. TNO, Den Haag); NIEUWE SIGNAALVERWERKINGS TECHNIEKEN IN DE SONAR.
14.30 - 15.15 uur:	**IR. L. VAN DEN STEEN**, (SHELL Research, Rijswijk); DE TOEPASBAARHEID VAN ELEKTROMAGNETISCHE VELDEN IN DE BESTURING VAN ONDERWATER SYSTEMEN VOOR DE PRODUKTIE VAN OLIE EN GAS.
15.15 - 15.45 uur:	Theepauze.
15.45 - 16.30 uur:	**IR. C. KAMMINGA**, (TU-Delft, Informatie Theorie); BIOSONAR EN COMMUNICATIE BIJ DOLFIJNEN.
16.30 uur:	Sluiting.

De voertaal zal Engels zijn tijdens de ochtendlezingen en Nederlands tijdens de middaglezingen.

Aanmelding dient te geschieden door inzending van aangehechte kaart, **gefrankeerd** met een postzegel van **55 cent**, alsmede overmaking van de verschuldigde kosten op girorekening 94746 t.n.v. Penningmeester NERG, Leidschendam onder vermelding van „Onderwater Communicatie".

De aanmelding is slechts geldig, indien de aanmeldingskaart en overschrijving zijn ontvangen vóór 23 oktober 1986. De deelname kosten zijn nihil voor leden van NERG, KIvI en IEEE; zij bedragen *f* 15,— per deelnemer voor introducees. De lunchkosten bedragen *f* 15,—.

Het gebouw van de Faculteit der Civiele Techniek is gelegen langs de Mekelweg recht tegenover de hoogbouw van de Faculteit der Electrotechniek en is bereikbaar met buslijn 63 (half-uurs dienst) vanaf de stations Delft Centraal en Delft-Zuid.

Namens de samenwerkende verenigingen,
DR. G. W. M. VAN MIERLO, NERG.
Tel. 070 - 264221 tst 307.

Den Haag, september 1986.

1985 DISCOVERY OF RMS TITANIC

TECHNOLOGICAL ISSUES

J.L. MICHEL - IFREMER

1.- INTRODUCTION

One of the missions of IFREMER, the French Institute for the Exploitation of the Sea, is to develop and offer for the national and international community oceanographic working means.

In mid 82 IFREMER decided to develop a new deep towed "acoustic imaging" system called SAR.

The two years construction involved two main companies :

- THOMSON CSF for acoustic equipment (mainly a side looking sonar and a sub bottom profiler) and "image" transmission,

- ECA for fish, others sensors and overall integration.

In 85, the SAR a 6000 meters depth capability system was completed.

For its first long duration sea trials IFREMER decided to operate the SAR as the first search tool in a joint French US program aiming to the RMS Titanic discovery.

U.S. on their side offered to use their optical deep towed systems ARGO for TV and ANGUS for stills.

Those systems were complementary regarding their acoustic and optical imaging capacities.

2.- SAR DESCRIPTION (Fig. 1, 2 and 3)

2.1.- SAR main objectives

The SAR (Système Acoustique Remorqué = Towed Acoustic System) provides an acoustic image of the sea floor by means of two sonars.

- a side scan sonar which is able to detect reliefs in the order of a few meters high and extending over several meters at a range of 600 meters on each side of the vehicle,

- a sub bottom penetrator able to penetrate over 50 meters of abyssal mud with a resolution less than 1 meter.

The SAR may be fitted with a CEA LETI magnetometer extremely sensible (0.01 gamma) towed in a separate fish behind the main acoustic body.

2.2.- SAR components

2.2.1.- Triaxial electric cable

Lenght	: 8500 m.
Diameter	: 19.4 mm
Breaking strenght	: 20 tonnes
Electric power transmission	: 1500 V - 1 A - 50 Hz

Data transmission :

. main : digital multiplex 250 Kbauds (0 to 600 KHz bandwith) for sonars transmission

. others sensors : multiplexing and FM modulation around 1 MHz

. single acoustic navigation synchronisation signal modulated at 1,2 MHz

2.2.2.- Fish

Length	: 5 m.
Weight	: 2,4 T
Buyancy	: 20 Kg

2.2.3.- Side scan sonars

Range : ± 600 m.

Frequencies : 170 KHz and 190 KHz for left and right transducers

Signal length : 20 msec ; 2.5 KHz modulation

Signal level : 125 dB

Coherent processing gain 17 dB

Range resolution : 0.3 meter

Directivity : longitudinal 2 theta 3 = 0,5 degree
transversal 2 theta 3 = 80 degrees

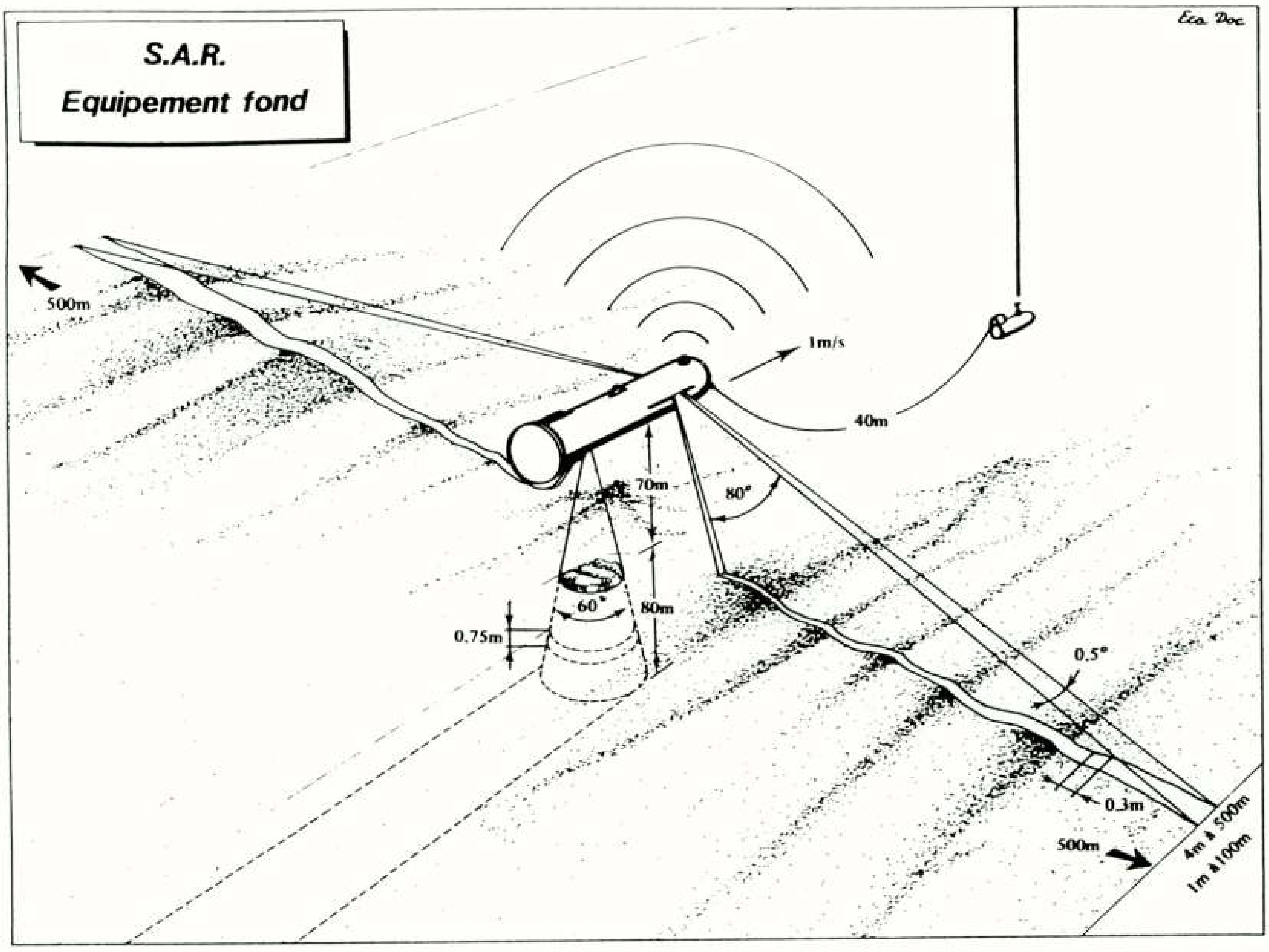


Figure 1 : SAR UNDERSEA EQUIPMENT

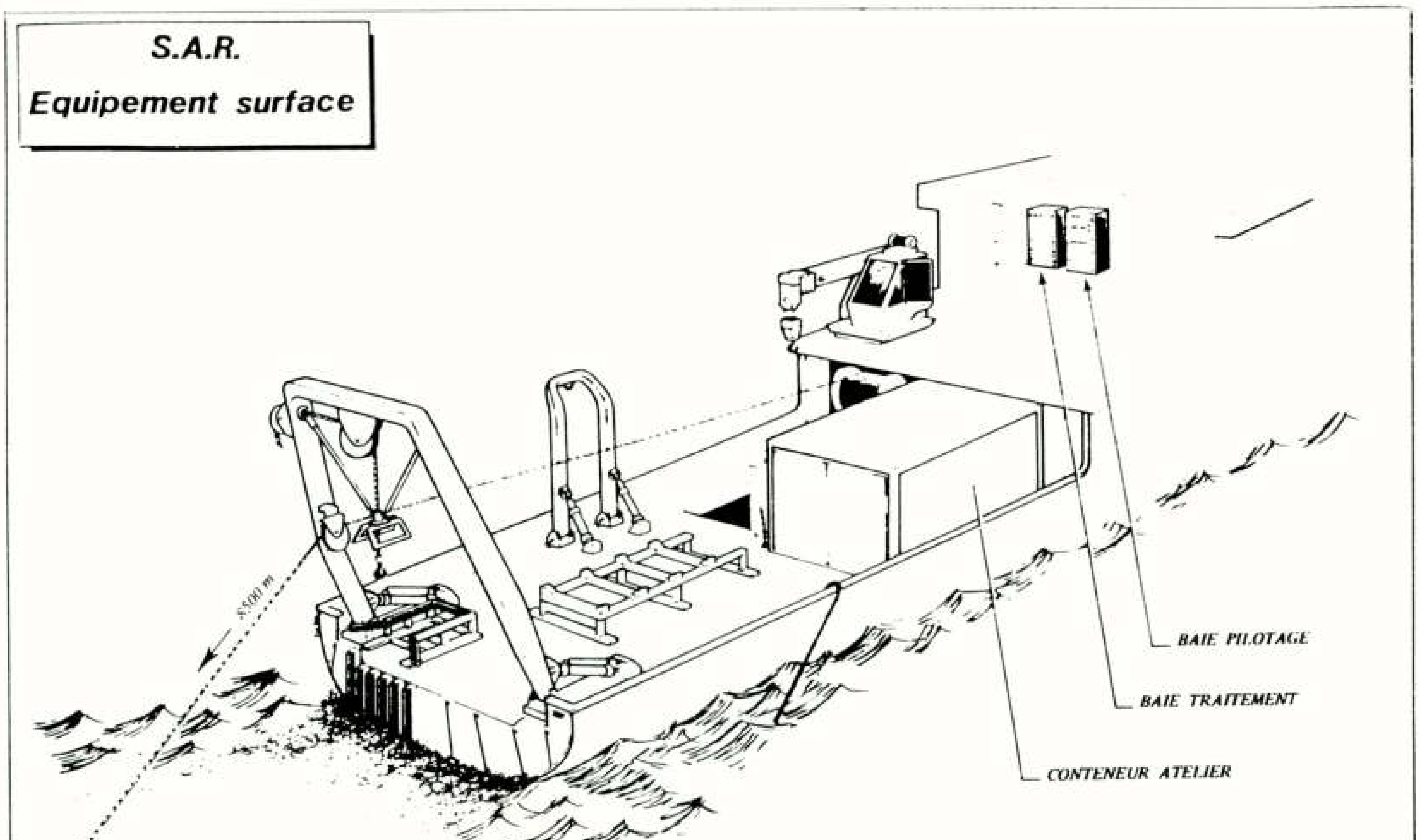


Figure 2 : SAR SURFACE EQUIPMENT

2.2.4. - Sub Bottom profiler

Penetration	: 50-80 m (on soft abyssal mud)
Frequency	: 3.5 KHz
Signal length	: 7.5 msec ; 1 KHz modulation
Signal level	: 117 dB
Coherent processing gain	: 8 dB
Directivity	: 60° conical

2.2.5. - Other Equipments

Depth	: resolution 10^{-4}
	precision 10^{-3}
Heading	: resolution 0.5 degree
	precision 1 %
Speed	: resolution 0.1 m/sec

Altitude given by side scan sonar or mud penetrator.

Transponder for long base live positioning.

3. - SAR DEPLOYMENT AT SEA

3.1. - Deck installation

On board the research vessel the main 3 tons vehicle is disposed on a cradle just as :

- the 2 tons depressor weight
- the 100 kg optional magnetometer fish.

A mobile winch with its associated hydraulic power unit permit to manage the 8500 meters of cable at a speed of 1 meter per second.

The total weight of the mobile system is around 50 tons.

3.2. - System operation

The main vehicle is towed 50 to 70 meters above the sea bottom at a speed of 1 to 2 knots.

The images collected by the sonars are transmitted in real time through the cable in the control room on the surface ship. Thoses images are displayed on two graphic recorders, they are corrected for slant range and vehicle speed.

On a seperate graphic monitor, the necessary datas for guidance are represented :

- bottom profiling
- fish height
- heading, speed, hour.

All data are stored on magnetic tape for post processing either by the system itself when on stand by or by shore based computer facilites enabling image processing and trajectography reproduction (system TRIAS = submarine acoustic image processing software).

3.3. - Positioning (Fig. 4)

The position of the vehicle is given by a long base line system owing to ranges measured from a net of acoustic transponders moored on the sea bottom.

On the research vessel a subsurface towed fish permit to interrogate and listen to the transponders.

The frequencies may be choosen from 9 and 16 KHz by 0,5 KHz steps.

The operations of positioning with a long base line must include :

- launching the transponders owing to a surface positioning system (Loran C, Navsat or other),
- calibrating the transponder net,
- operating with the vehicle,
- recovering of transponders.

4. - RESULTS OBTAINED DURING THE TITANIC OPERATION

The SAR system has been deployed during twenty two days on the Titanic search area.

The surface current was specialy important with an average of 2.5 knots which slowed down the operations.

The area was crossed by a small canyon of 50 to 80 meters high at a depth of 4000 meters.

The area was systematicaly covered with the side scan sonar permitting to survey 300 square kilometers of sea bottom on the continental slope.

Results given by the sonar are spectacular thus dunes of a few meters high has been detected.

Good control of this complex system (surface vessel, cable, fishes) permit to maintain a quasi

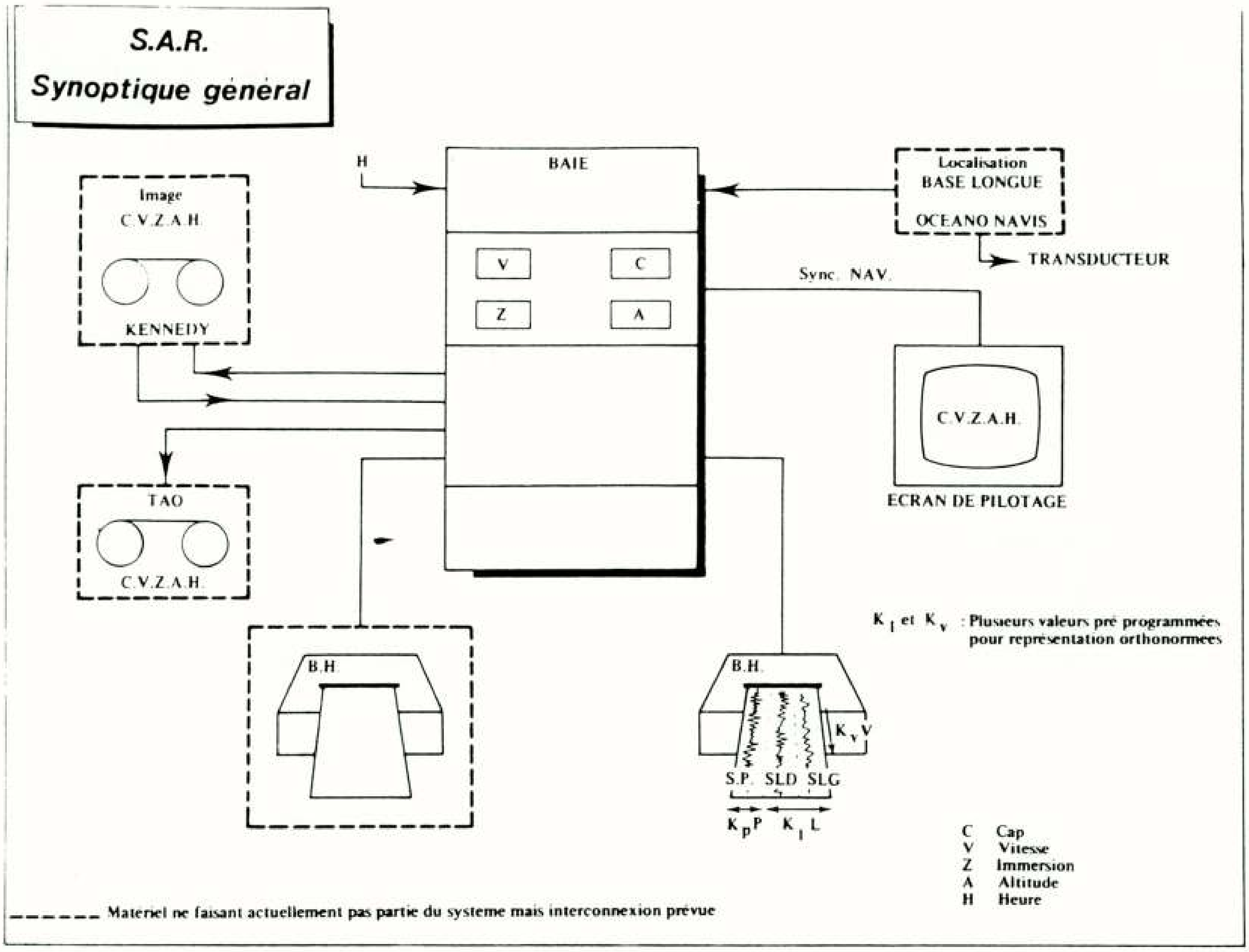


Figure 3 : SAR GENERAL SYNOPTIC

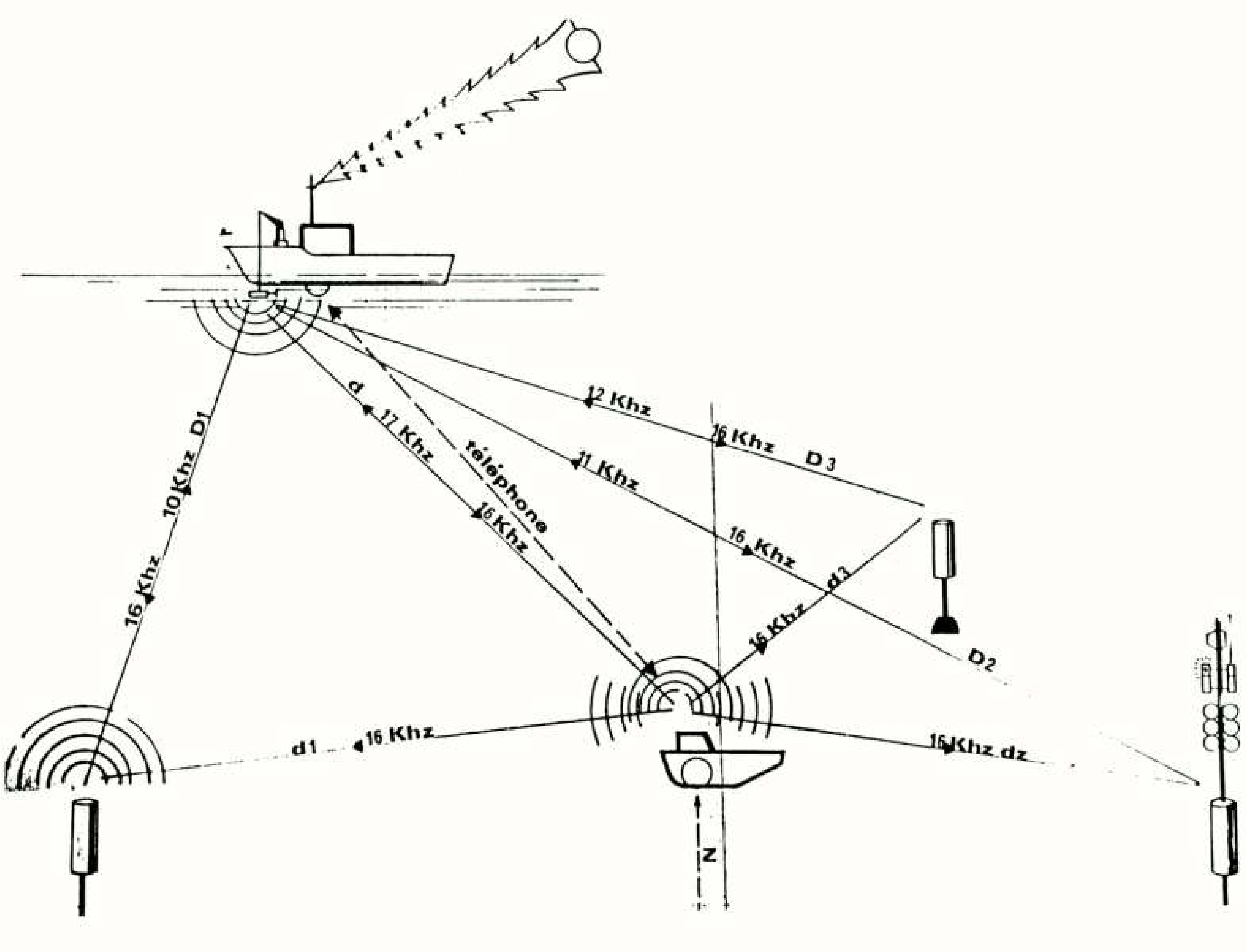


Figure 4 : ACOUSTIC POSITIONING

systematic overlap between each track owing to the positioning systems (long base line Océano Instruments and Loran C).

The preparation time for the deployment of the long base line has taken a significant 25 % of the total operational time.

A large mosaïc of the area has been processed owing to the TRIAS processing system and will be soon presented.

5. - CONCLUSION

The SAR sonar images (fig. 5 and 6) fill well one part of the large gap in range and resolution existing between the informations given by surface bathymetry and bottom optical images.

The Titanic 85 operation, beyond its success with the discovery of RMS TITANIC, showed that new efficient means are now available for deep ocean exploration.

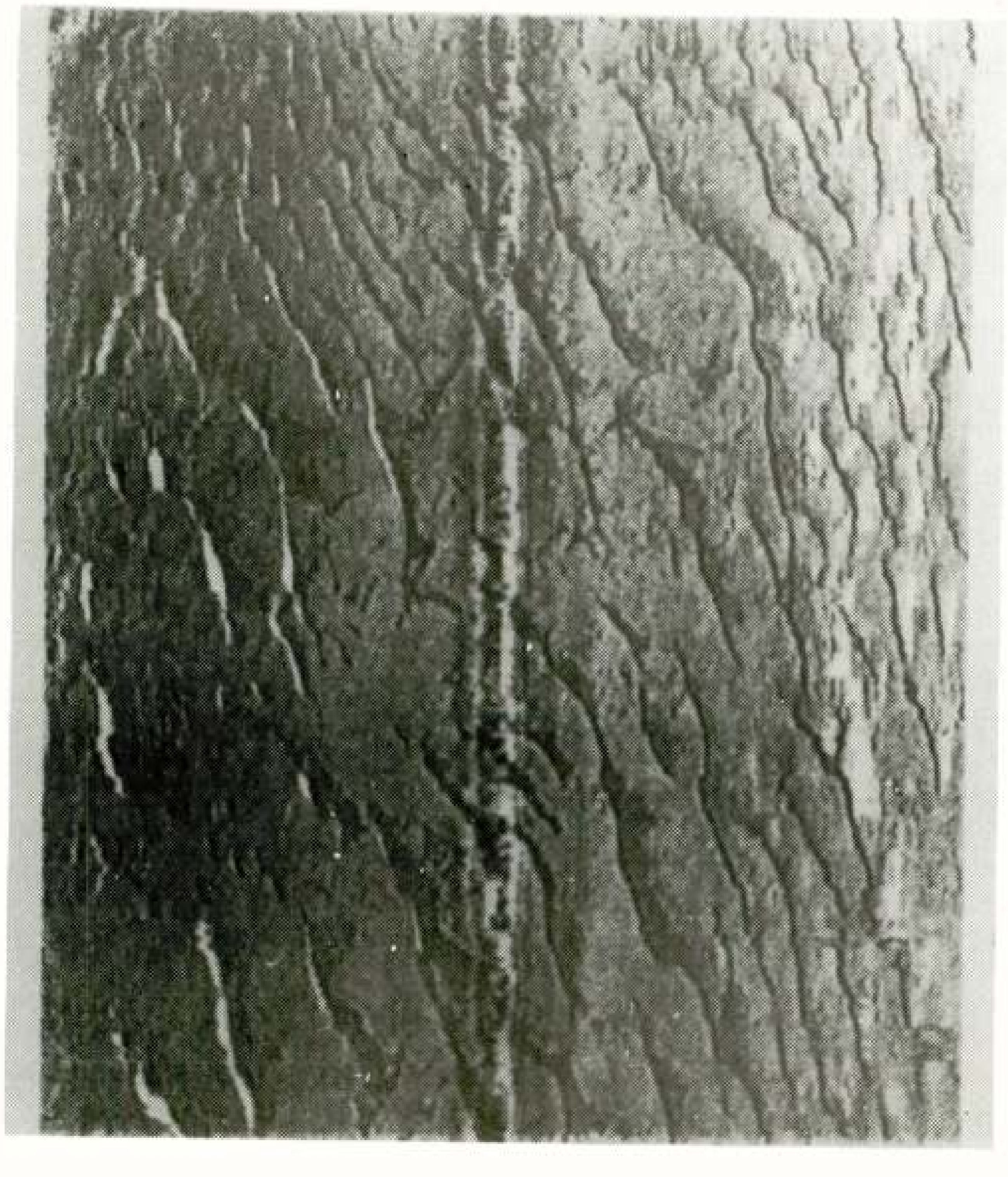


Figure 5

This picture shows a field of assymetrical dunes. When looking downslope, on the left side, the white acoustic shadows are cast by the dune crests. These bedforms are about 3 meters high (estimated from shadow length) and 80 meters in wave lenght.

On the other side, the slip slope facing downwards returns a strong reflection. The high acoustic reflectivity patches on the crests suggested that these bedform are made of coarse sediments as gravel.

These dunes should result from un usual flow conditions which could have been strong downslope one-way bottom currents.

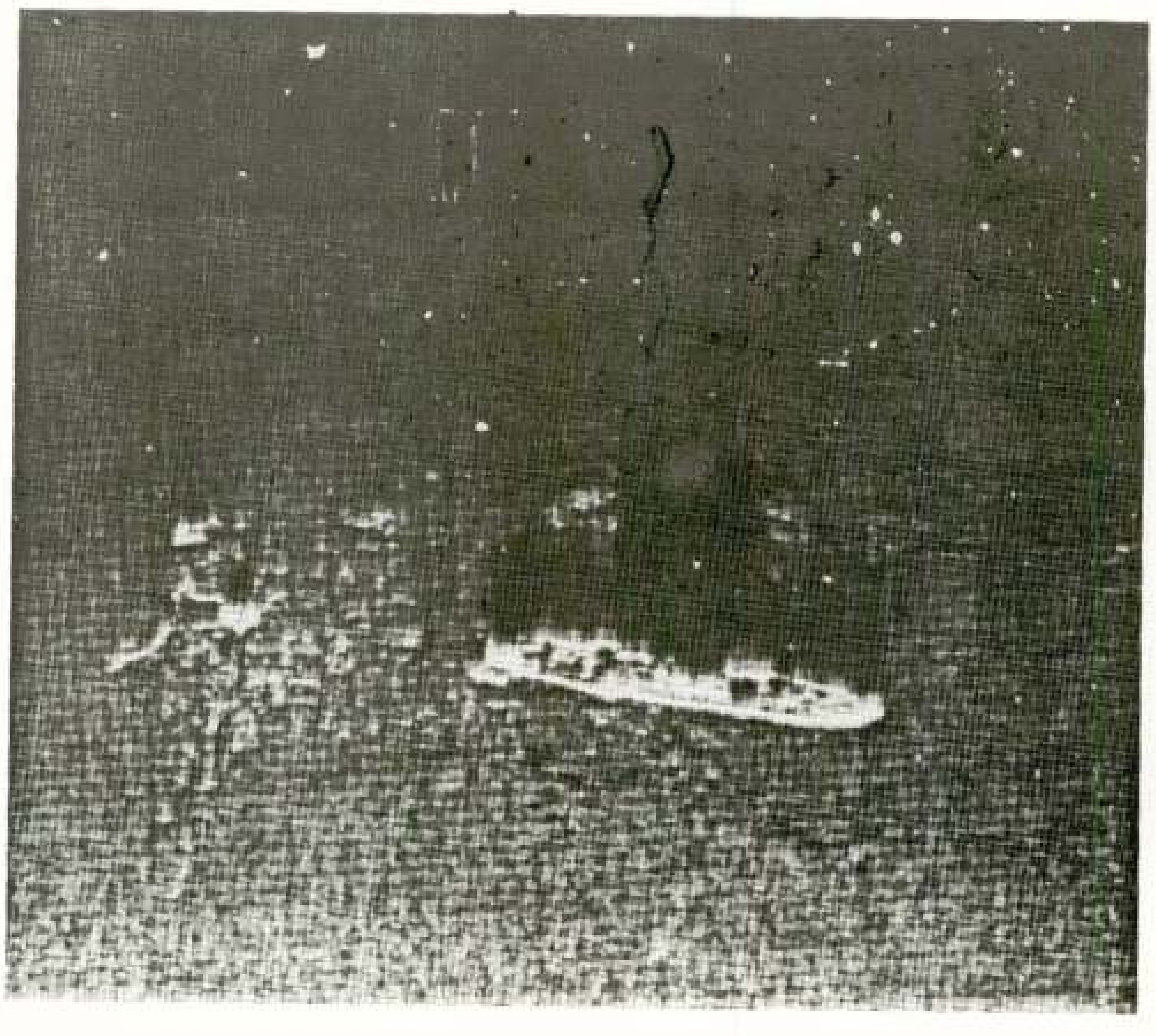


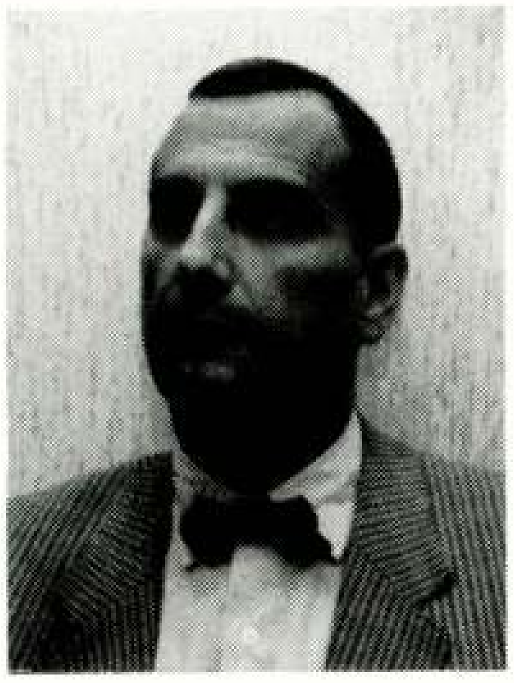
Figure 6 : WRECK

Voordracht gehouden tijdens de 346e werkvergadering.

NEDERLANDS ELEKTRONICA- EN RADIOGENOOTSCHAP
(347ste werkvergadering)
AFDELING TELECOMMUNICATIE VAN HET KIvI
IEEE BENELUX SECTIE

UITNODIGING

voor de lezingendag op **woensdag 10 december 1986**, georganiseerd door de Afdeling voor **Telecommunicatie van het Koninklijk Instituut van Ingenieurs** en te houden in het **Jaarbeurs Congrescentrum** in **Utrecht.**
THEMA: **Bedrijfsnetten.**



Ir.J.B.F. Tasche

TOELICHTING:
Naast de openbare telecommunicatie-voorzieningen, die door hun omvang de meeste aandacht krijgen, is er een groeiende hoeveelheid van private netwerken in bedrijf. De lezingendag van 10 december wil deze groep van telecommunicatie-voorzieningen, die veelal in de luwte functioneren, speciaal belichten.

De redenen waarom een bedrijf een eigen netwerk bouwt, zijn van verschillende aard. Het kan zijn dat de kosten van de eigen operatie lager zijn, dat men meer funkties vraagt dan de openbare dienstenleverancier kan bieden, of dat men door internationale aard van de telecommunicatiebehoeften besluit om het heft in eigen hand te nemen.

De voordrachten geven een gevarieerd beeld van de verschillende verschijningsvormen van bedrijfsnetten en behandelen nationale en internationale netten, vaste en mobiele verbindingen, netten voor spraak en data of gespecialiseerde netten. Aan het eind van de dag zullen de Professor Bählerprijzen voor het beste afstudeer-verslag en het beste proefschrift op het gebied van de telecommunicatietechniek, worden uitgereikt.

PROGRAMMA:

10.00 uur:	Opening.
10.05 uur:	Bedrijfs-communicatienetten; ALGEMENE INLEIDING, **IR. H. VAN KAMPEN.**
10.25 uur:	Bedrijfsdatanet; EEN NATIONAAL BEDRIJFSNET VOOR DATACOMMUNICATIE, Ir.J.B.F. Tasche
11.00 uur:	Het Sita-netwerk; HET INTERNATIONALE DATACOMMUNICATIE NETWERK VAN DE LUCHTVAARTMAATSCHAPPIJEN, **HR. M. DEKKER**, Sita, Benelux.
11.35 uur:	Koffiepauze.
11.55 uur:	HET RADIO-TRUNKING SYSTEEM OP SCHIPHOL; **ING. J. SCHELTUS**, N.V. Luchthaven Schiphol.
12.30 uur:	Lunch.
14.00 uur:	DAS NEUE INTEGRIERTE KOMMUNIKATIONSSYSTEM DER DEUTSCHEN BUNDESBAHN; **DIPL. ING. R. SCHOTT**, Siemens AG Munchen.
14.45 uur:	Professor Bählerprijzen 1986; Uitreiking van de twee Professor Bählerprijzen voor resp. proefschrift en afstudeerwerk op het gebied van de telecommunicatietechniek.
15.10 uur:	Lezingen door de twee prijswinnaars.
15.40 uur:	Receptie.

dagvoorzitter: Ir. H. van Kampen.

Aanmelding dient te gebeuren door het inzenden van de aangehechte kaart, gefrankeerd met een postzegel van 55 cent en door overmaking van het verschuldigde bedrag op postrekening 576595 t.n.v. penningmeester afdeling voor telecommunicatie te Zoetermeer, onder vermelding van "bedrijfsnetten".

De kosten van deelname zijn nihil voor de leden van de organiserende gezelschappen, de kosten voor de lunch bedragen voor hen *f* 30,—. Introducee's zijn voor toegang en lunch *f* 40,— verschuldigd.

Het Jaarbeurs Congrescentrum is gelegen achter het Centraal Station te Utrecht. De ingang bevindt zich aan de Croeselaan. Voor parkeren is gelegenheid op het Jaarbeursparkeerterrein aan de overzijde.

De Prof. Bählerprijs is door de Afdeling voor Telecommunicatie ingesteld voor het beste afstudeerwerk (jaarlijks) en het beste proefschrift (één maal in de vijf jaar) op het gebied van de telecommunicatietechniek, dat verricht is aan een technische universiteit in Nederland. De voorzitter van het afdelingsbestuur zal in deze vergadering de prijzen uitreiken, waarna de prijswinnaars een korte samenvatting van hun werk zullen geven. Aansluitend is er een receptie, waarbij alle aanwezigen hartelijk welkom zijn.

Namens de samenwerkende verenigingen,
hoogachtend,
IR. W. F. VAN ROOKHUIJZEN
Tel. 070 - 814501

Den Haag, november 1986.

THE APPLICABILITY OF ELECTROMAGNETIC COMMUNICATION IN THE CONTROL OF UNDERWATER SYSTEMS USED TO PRODUCE OIL AND GAS

Ir. L. van den Steen
Koninklijke/Shell Exploratie en Produktie Laboratorium

Because of the high cost and vulnerability of subsea cables, ways of circumventing their use in the underwater systems that are used for the production of oil and/or gas have been studied. One means of wireless communication, namely electromagnetic communication, has been investigated as an alternative to hydro-acoustic techniques. Maxwell's laws show that electromagnetic waves are heavily attenuated in (conductive) seawater at all but the lowest frequencies. The most promising methods utilise the surrounding media (i.e. the air above or the seabed below) as the main propagation medium. Communication distances of the order of eight kilometres are considered possible in the North Sea, but for these long range applications the method is less cost-effective than the conventional seabed-cable option. An example of an interesting shorter range application is the read-out of battery-powered sensors temporarily installed in the wellhead area.

1. INTRODUCTION

Since the rise in oil and gas prices in the seventies, which made the production of oil and gas from many offshore provinces profitable, the world has seen a mushrooming of large production platforms at sea (Fig. 1). In essence, the production of oil and gas from such a platform does not differ from that onshore. The main function of the structure is to support the equipment and materials required for the operations and to provide accommodation for the crew. Obviously, this means of production has its limitations with respect to the water depth. Moreover, the high cost of the structures does not justify application in smaller fields. Here subsea completions may offer a more cost-effective solution.

Fig. 1: Offshore oil/gas production

A subsea completion is a well that is drilled from a semi-submersible or a drill ship and that is subsequently provided with all the necessary ancillary equipment (the "completion equipment") at or just below seabed level. The equipment includes a number of valves to control the fluid flow, various sensors at different locations, and a control system to provide the interface with the platform or floater from which the system is controlled. The fluid produced by the subsea completion is transported to the surface production facilities via steel pipelines or flexible hoses, or a combination of the two. Subsea completions, or clusters thereof, can form an economically attractive extension to fixed platform production facilities. The Shell/Esso underwater manifold centre in the Central Cormorant field, in the northern North Sea (Fig. 2), is a good example of a sophisticated underwater production system.

This manifold centre has several functions, including the collection of well fluids and the distribution of injection water to maintain reservoir pressure.

Furthermore, subsea production systems in combination with floating production systems offer an alternative to a fixed platform for use in particularly deep water.

In simple set-ups the control system is usually all-hydraulic, but if the production system is complex or the response-time of an all-hydraulic system will be too large this can often dictate the application of an

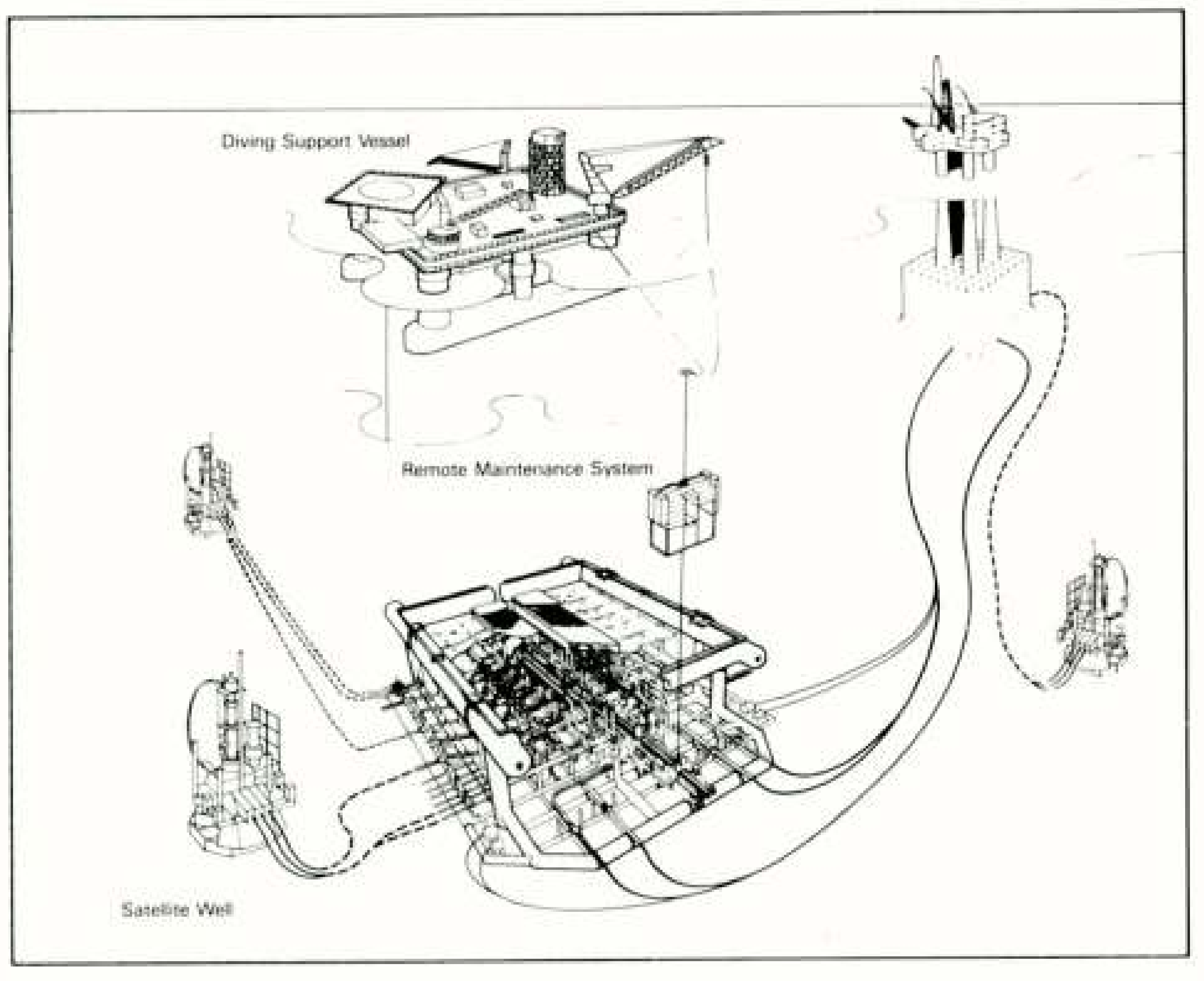


Fig. 2: The Central Cormorant underwater manifold centre with associated satellite wells

electro-hydraulic control system. The command centre of such an electro-hydraulic control system is connected to the subsea system by a bundle of electric cables and hydraulic conduits, called the umbilical. Because this umbilical is generally one of the most expensive components of a subsea control system and because it is vulnerable to damage by fishing and anchoring gear, Shell have been studying ways of circumventing the need for the umbilical. First, however, a number of problems need to be solved, such as the local generation of power near the subsea well, and the wireless communication; the latter is the subject of this paper. The aim of the current scouting study was to identify the most suitable method for a "wireless" underwater communication link.

2. REQUIREMENTS FOR THE SUBSEA COMMUNICATION CHANNEL

The requirements for the downlink (from platform to subsea system) and the uplink are different and are summarised in Table 1.

Communication distance	2 - 10 km
Water depth	100 - 1000 m

	platform to subsea system (valve control)	subsea system to platform (sensor read-out)
Communication speed	25 bits/s	25 bits/s
Number of bits per message	≃ 20	≃ 30
Allowable error probability per message	10^{-7}	10^{-5}

Table 1: Specifications of the communication channel

A typical message may contain up to eight address bits, 1 to 12 data bits and 8 to 12 error check bits. The return messages (containing sensor data) are somewhat larger than the downward messages. The error probability, however, must be less for the downlink in view of the consequences of undetected errors: a false downward command can cause the well to shutdown for some time, whereas a false sensor read-out will nearly always become evident as a discontinuity in a series of data samples.

Generally the noise near the platform will be considerably greater than that in the vicinity of the subsea well. Moreover, the permissible power consumption of the (platform-installed) downlink transmitter is considerably larger than of the uplink transmitter which has to use a local power source. Hence, despite its lower error tolerance, the downlink is the least difficult, and our discussion will be restricted to this downlink.

3. POSSIBLE COMMUNICATION METHODS

Various principles may be utilised to realize the desired communication link, most of them being based either on acoustics or on electromagnetic methods. In both cases the propagation can take place either along the flowline between the transmitter and the receiver location or via the seawater. A considerable amount of work has been done during the last two decades on hydro-acoustics by many laboratories all over the world, and ranges in excess of seven kilometres at low Baud rates have been reported (High, 1985; Knott, 1985). However, these systems are still in the experimental stage and are rather complex because they have to cope with seasonal variations in the characteristics of the communication channel. This spurred us to investigate electric and electromagnetic alternatives.

3.1. Electric communication via the flowline

For protection against corrosion underwater flowlines are usually covered with a coating, such as a bitumen-type material, which has good electrical- insulating properties. The metal is in direct contact with the surrounding seawater only at a few points, for instance at flanged connections or anodes belonging to the galvanic protection system. Hence, if a current is induced in a flowline near the platform, part of it will leak away via the exposed metal parts. The remaining current, however, will reach the subsea receiver location and return via the seawater to the transmitter on the platform. The system is illustrated in Fig. 3.

Laboratory measurements and computer simulations indicate that communication via this system may be possible if the number of (uninsulated) flanges is limited to typically about five. However, the applicability of this type of system is restricted to situations where the flowline is insulated over the major part of its length. We will limit the rest of

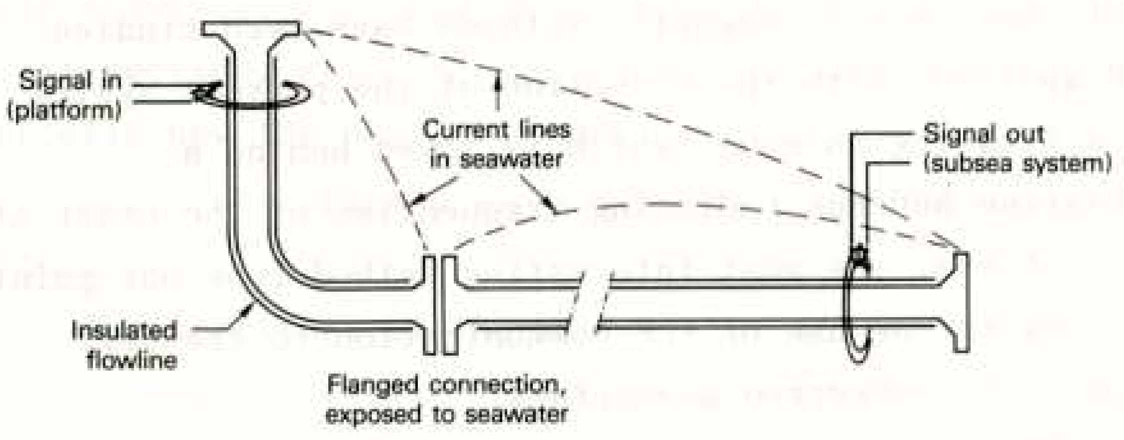


Fig. 3: Transmission of electric signals over an insulated flowline

this discussion to direct electromagnetic communication, which has a more general applicability, though it is more restricted in its range.

3.2. Electromagnetic communication

To investigate why the behaviour of electromagnetic fields in a conducting medium (seawater conductivity is of the order of 4 S/m) differs so markedly from that in free space, we consider Maxwell's equations:

$$\nabla \times E = -\mu \frac{\partial H}{\partial t} \quad (1)$$

$$\nabla \times H = J + \varepsilon \frac{\partial E}{\partial t}$$

where E and H are, respectively, the magnetic and electric field strength, μ is the magnetic permeability, ε is the permittivity and J is the current density. If E and H are assumed to be sinusoidally time-dependent, with a radial frequency ω, and if $J = \sigma E$, the right-hand part of the second equation becomes:

$$\sigma E + i\,\omega\varepsilon E \quad (2)$$

In air or free space, where the conductivity σ is virtually zero, only the latter term (the displacement term) is significant. Solving the resulting equation for a plane wave yields the well-known equation for an unattenuated wave (e.g. Wangsness, 1979). In a conducting medium, however, the first term, i.e. the conduction term usually dominates. This term exceeds the displacement term in magnitude; in addition, it is real rather than imaginary. Solving the equation for a plane wave in the z-direction yields a damped wave:

$$E = E_o\, e^{-iz/\delta}\, e^{-z/\delta} \quad (3)$$

where

$$\delta = \sqrt{\frac{2}{\omega\sigma\mu}}\,, \quad (4)$$

which is called the skin depth.

The term $e^{-z/\delta}$ denotes an attenuation by a factor of e (=2.718...) over each skin depth δ. The higher the frequency, the smaller the skin depth and the less the penetration. For very high frequencies the conductivity of seawater decreases (Wangsness, 1979, Section 24-8) and the displacement current gradually starts to dominate. However, the part of the spectrum where this effect becomes significant is strongly affected by scattering and, with the exception of visible light, by absorption.

At the high end of the relevant spectrum, underwater experiments with laser beams have shown that communication by visible light can be established over a few hundred metres, provided the water is very clear (Hunter, 1984). Also, interesting experiments to communicate with submarines are being carried out using laser signals fired from satellites (Jones, 1985; Fox, 1986). However, scattering by microscopic and larger particles in the seawater in most offshore locations prohibits the use of visible light as a long distance communication medium in the application envisaged.

Therefore, we have directed our attention to the extremely low-frequency (ELF) part of the spectrum. As an example we consider a signal of 25 Hz which has a skin depth of about 50 m in seawater. Such a signal will be attenuated by about 350 dB over a distance of 2 km, which demonstrates the limited potential of ELF waves in seawater. The more successful electromagnetic underwater communications therefore utilise methods in which the electromagnetic fields propagate mostly in the air or along the seabed, and not through the seawater.

To conclude this section, some other aspects of an electromagnetic wave in a conducting medium are described.

The term $e^{-iz/\delta}$ in eq. (3) is a phase shift factor and implies a wavelength of

$$\lambda = 2\pi\delta \quad (5)$$

It should be noted that the wavelength underwater is much smaller than in air. For instance, a 50 Hz signal has a wavelength of 6000 km in air, but in seawater the skin depth is 36 m, giving a wavelength of only $2\pi.36 = 223$ m.

Another interesting observation is that the phase velocity

$$v = \lambda f = 2\pi\delta f = \sqrt{2\omega/\sigma\mu} \quad (6)$$

is frequency-dependent, i.e. dispersion occurs. Hence the higher frequency components in the signal will arrive at the receiver before the lower frequency components, thus corrupting the signal. Although the original signal can be restored, this complicates the receiver electronics.

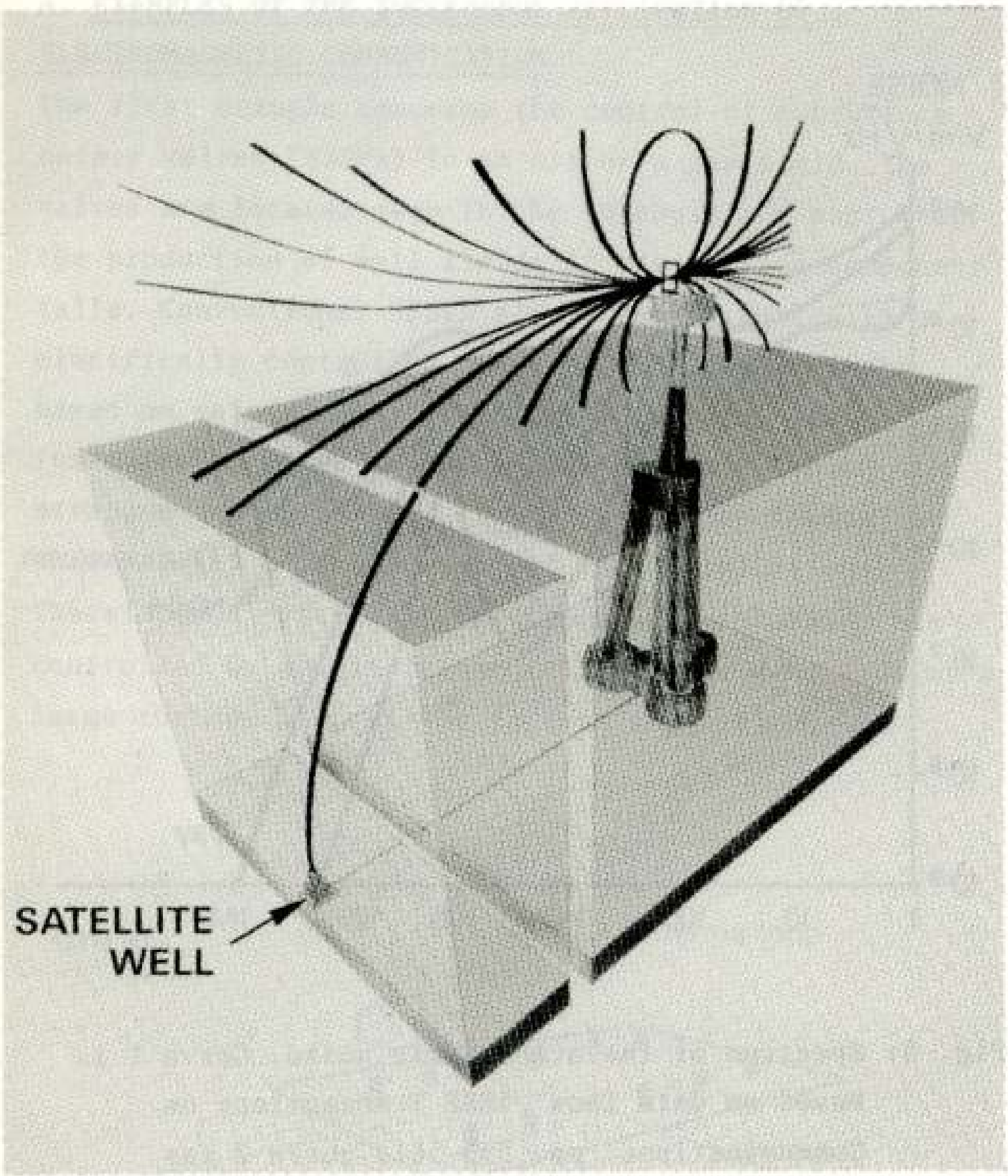


Fig. 7: Mainly-through-air communication by a current loop transmitter, located on the platform in low-frequency approximation (refraction of the flux lines by the seawater, which increases with the frequency, is ignored).

The flux lines generated by the loop also penetrate the sea at the receiver location. In addition to the attenuation inherent to the dipole field, these particular flux lines experience further attenuation over the length of their path through the seawater, i.e. over a distance about equal to the water depth. This system was found to have a possible communication distance of roughly several kilometres in shallow water (less than 100 m depth). Communication in deeper water may be established by installing the receiver antenna on a submerged buoy.

However, the computations of the communication range may have been optimistic in that the influence of the platform structure on the flux lines and secondary effects such as the roughness of the sea-surface were ignored. The practical range is expected to be somewhat less than that mentioned above. This, in combination with the practical and operational consequences of a large current loop in the vicinity of the platform, led us to disregard this system.

5.2. Seabed communication

The idea of using the seabed rather than the seawater as the medium for the transmission of electromagnetic fields was proposed by Prof. J. Westcott and Dr. E. Burt from the Imperial College of Science and Technology, London (Westcott and Burt, 1984; Burt and Rigby, 1985) and elaborated upon at the request of Shell. The method is based on the distribution of electromagnetic fields along the interface of two media, and is outlined in Fig. 8 for a horizontal electric dipole transmitter with a vertical electric dipole receiver in the seabed.

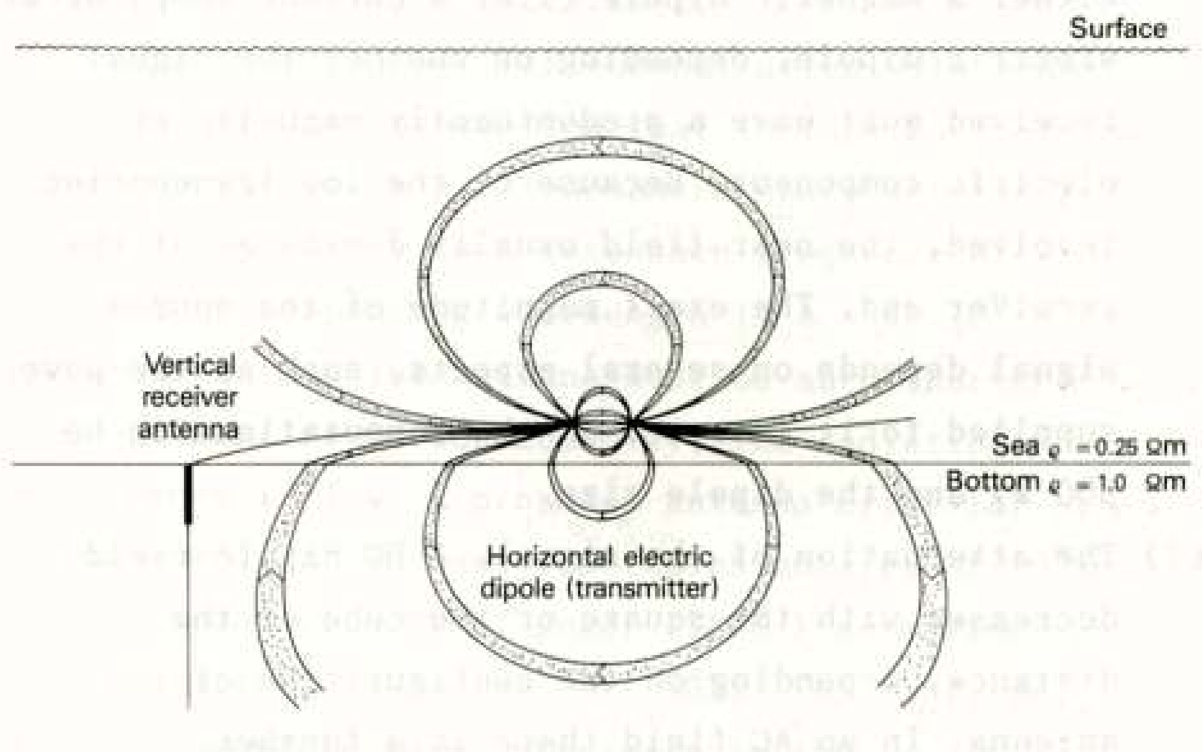


Fig. 8: Field distribution from a horizontal electric dipole near the seabed.

The dipole transmitter is located in the seawater. Because of the presence of a less conductive medium (i.e. the seabed), the electromagnetic field will experience less attenuation along the boundary than in the seawater-only situation. The exact field distribution can be determined by solving Maxwell's equations with the proper boundary conditions. This was done numerically for a number of cases: with the transmitter dipole located horizontally or vertically, and for both magnetic and electric dipole transmitters. Comparison of the various results showed that the system of Fig. 8 (the horizontal electric dipole transmitter with a vertical receiver antenna) has the longest range. It should be noted that the orientation of the receiver antenna is favourable with respect to the ambient noise, which is expected to have its electric and magnetic components predominantly in the horizontal plane, as mentioned at the beginning of this section. The lower the conductivity of the seabed, the longer the range of the system. Unfortunately, the conductivity of the seabed is relatively high in those locations where Shell are most interested in using the communication method, i.e. in the North Sea. The bottom consists mainly of clay and sand with an effective conductivity of the order of 1 S/m, which is only a factor of four less than the seawater's conductivity. Here the communication range was found to be limited to about two kilometres at a communication speed of 25 bits per second. Reducing the communication speed to 1 bit per second increases the range to about 8 km. Possible constraints, discussed in the next section, may limit the communication distance to shorter distances.

A factor, ignored in the calculations, is the presence of the pipeline between the transmitter and the receiver location. Its effect is to increase the seawater's conductivity locally, thus apparently increasing the contrast between the conductivities of the seawater and the seabed. The importance of this effect should be considered further. It should be noted that such a seabed telemetry system with the presence of a pipeline is of a type kindred to the pipeline communication system discussed in Section 3.1.

Theoretically, the range of the system can be extended by using (battery-fed) subsea repeater stations, spaced at distances of several hundred metres. However, their adverse influence on the system's reliability and the need for regular renewal of the batteries led us to discard this solution too.

6. POSSIBLE CONSTRAINTS

In addition to the fundamental limitations with respect to the communication distance, the use of electromagnetic communication has some possible consequences which require further investigation.

The first is the effect of electromagnetic fields on living organisms: Physiological effects of ELF fields, such as a change of time perception, have been observed. People with some form of electric/magnetic prosthesis, for instance a pacemaker, are at increased risk. A hazardous situation might also arise for divers working in the vicinity of underwater electric transmitter dipoles. Practical problems with respect to the installation arise from the high-magnitude low-frequency electric currents. These introduce the risk of electrochemically induced corrosion, firstly of the dipole transmitter, but also of any metal parts in the vicinity of the transmitter. Before ELF underwater communication systems can be applied in practice these subjects need to be addressed further.

7. DISCUSSION AND CONCLUSIONS

The study outlined above was not exhaustive. Only the simplest part of the communication channel was studied, i.e. the communication from the platform to the underwater system. However, an increase in the communication range may be expected as a result of improving the encoding/decoding techniques and of optimising the antennae (or arrays).

The most promising system is the seabed communication system, with an expected range of the order of 8 km (at a speed of 1 bit/s). Further improvements are considered possible; The transmitter antenna may become more effective if the top half of the dipole is covered with insulation material to limit currents in the seawater (as they do not contribute to the received signal). The directivities of the transmitter and the receiver antennae can be improved, considering that the wavelength of electromagnetic waves in seawater is much shorter than in air, thus enabling antenna arrays to be constructed.

However, these possible refinements are considered unlikely to improve the competitive position of electromagnetic underwater communication sufficiently with respect to the alternatives, such as the use of acoustics via the flowline, via he seawater or via the seabed (seismic communication). Even if the comparison were favourable for electromagnetic communication, much development work would be required before these systems could be put into practice. This would include a more detailed study of the local noise spectrum, the development of the improvements mentioned above, a study of the possible constraints mentioned in the previous section and the detailed engineering of all system components.

Therefore, at present conventional seabed-installed cables remain the most cost-effective option for providing a power and communication link to subsea systems. Consequently, Shell have decided not to pursue the electromagnetic communication option further. Nevertheless, the idea of using electromagnetic fields to communicate with underwater systems remains interesting and may find application in short-distance communications, such as:

(1) with divers (Momma, 1976),
(2) within a subsea system,
(3) for the control of subsea pipeline shutdown valves in the vicinity of a platform,
(4) for sensor read-out in the wellhead area (which is of particular interest in temporarily installed battery-powered equipment), or
(5) in the control of remote operating vehicles if the transmission of video images is not required.

Another application, for which the seabed communication method was initially developed, is:

(6) in dynamic ship positioning.

ACKNOWLEDGEMENT

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BEDRIJFSNETTEN

Ir. H. van Kampen
Philips Telecommunicatie en Data Systemen.

Op 10 december 1986 organiseerde de Afdeling voor Telecommunicatie van het Koninklijk Instituut van Ingenieurs een lezingendag over het thema BEDRIJFSNETTEN in Utrecht. Daar werden achtereenvolgens voordrachten gegeven door ir. Tasche van de RABOBANK over het nationale Datanetwerk van deze organisatie, door de heer Dekker van SITA over het grote internationale netwerk van de luchtvaartmaatschappijen, door ing. Scheltus van de luchthaven Schiphol over het nieuwe netwerk voor mobiele communicatie van het vliegveld en door Dpl.ing. R. Schott van Siemens over het nieuwe geïntegreerde netwerk van de Duitse Spoorwegen. De dag werd ingeleid door ir. H. van Kampen (Philips TDS).

Hij stond stil bij de redenen die een bedrijf of organisatie er toe kunnen brengen om het communicatieheft in eigen handen te nemen en een eigen netwerk te construeren. Voor zover het netwerk zich buiten de poorten van het eigen bedrijf uitstrekt, is dat niet mogelijk zonder de transportdiensten van de PTT te benutten, maar alle andere netwerkfunkties, zoals schakelen, moduleren, (de-) multiplexen, foutcorrecties, protocolconversies en beheer zijn onder eigen vlag te realiseren.

De inleider voorzag een aantal oorzaken voor groei in dit soort telecommunicatienetwerken. Privé-datanetwerken zijn geen nieuws meer, er zijn tal van voorbeelden te noemen zowel uit de particuliere sector, maar ook uit overheidskringen. De laatste tijd echter worden ook de telefoniediensten realiseerbaar in besloten netwerken, die dan bovendien voor datacommunicatie kunnen worden benut. Dit is mogelijk door het beschikbaar komen van de digitale PABX, die in een netwerkconfiguratie in de eigen organisatie kan worden toegepast. Een mooi voorbeeld is het PABX-netwerk dat voor de Centrale Directie van de PTT zelve in opbouw is en dat gebruikt wordt voor de interne communicatie binnen de geografisch verspreide afdelingen van dit bedrijfsonderdeel. Vandaag zal ook een ander en grootschaliger voorbeeld van zo een geïntegreerd netwerk worden gepresenteerd: het digitale net van de Bondsspoorwegen.

Het ISDN zal volgens de spreker van grote invloed kunnen zijn op de bedrijfscommunicatienetwerken. Enige mogelijke voordelen voor de zakelijke gebruikers daarvan zijn:

* uniforme aansluitingen voor de verschillende openbare diensten
* minder physieke aansluitingen nodig op de openbare netten
* goede datacommunicatiefacilitieten (64kbps circuit-switching) beschikbaar, ook voor de kleinere vestigingen van een organisatie
* snelle automatische verbindingsopbouw (auto-dial) mogelijk
* deur open voor simultane spraak- en datacommunicatie, over één aansluiting of één bundel, flexibel te regelen.
* een intelligente signaleringsinterface met het net maakt goede uitwisseling mogelijk van besturings- en beheersinformatie tussen de gebruikersorganisatie en het openbare net
* huurcircuits (voor spraak en/of data) zijn zeer snel automatisch aan te vragen en af te sluiten. Dus snelle aanpassing aan wijzigende verkeersomstandigheden mogelijk.

Willen de beheerders van bedrijfsnetten met deze mogelijkheden rekening gaan houden in hun planningen, dan zal er meer gedetailleerde informatie over de nederlandse ISDN-situatie beschikbaar moeten komen. Verwijzing naar CCITT-specificaties en een paar algemene uitspraken uit Brussel of Den Haag zijn dan niet genoeg. Het wachten is nu op de interface- en dienstenspecificaties, beschikbaarheidsdata per regio, type-goedkeuringsfaciliteiten en uiteraard prijsindicaties. Ook in gebruikerskringen zal voor introductie van het ISDN veel moeten gebeuren en het is in het belang van de gehele nederlandse telecommunicatiegemeenschap dat partijen communiceren over de communicatie.

Voordracht gehouden tijdens de 347e werkvergadering.

ANNOUNCEMENT

WORKSHOP ON SAFETY OF PROGRAMMABLE ELECTRONIC SYSTEMS

On tuesday April 7, 1987, a Workshop is organised by the Working Group on Electrical Engineering and Safety of the Delft University of Technology.

The Workshop is designed for those concerned with reliability and safety in programmable electronic systems (PES) in:
- research and education;
- industry;
- regulatory and normalization bodies.

OBJECTIVES

The objectives of this Workshop are:
- to present the state-of-the-art in software reliability in a system safety context;
- to establish the consequencies for engineering education of developments in this field.

WORKSHOP REGISTRATION AND PAYMENT OF FEES

A registration form can be acquired through the secretariat and should be received by April 3, 1987 at the latest. The workshop fee is DFl. 150,- and includes attendance at the workshop, proceedings, luncheon, coffee and tea.

FURTHER INFORMATION

For further information concerning the workshop, please contact the secretariat:

Mrs. Y. Smits
Department of Electrical Engineering
Delft University of Technology
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Data communication within the Rabobank

Ir. T. Schaap*, ir. P. K. Tilburgs* and ir. C. J. Vermij**

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1 Introduction

The Rabobank organization comprises a central institution, Rabobank Nederland, and some 950 local branches which together operate approximately 3,000 offices throughout the country [1].
The data processing for over 8 million savings-accounts and over 3 million current-accounts, generating a daily average of 3 million transactions, takes place in two computer centres.
Each local bank, also called member bank, makes use of these central facilities. The data is prepared by the member banks and transported by car to these facilities, batch-processed overnight and returned the next morning before opening hours. The member banks check the output, produce the statements and deliver them to their clients.
In order to increase the service to customers, Rabobank started some years ago to formulate an information and automation plan for the eighties.
The most important aim of the plan is to extend the function of the Data-processing facilities to include the processing of management and customer information and to allow member banks to have fast and direct access to this information. The need to incorporate advanced technologies, to secure large investments in application software and to enable a direct mutual communication between member banks are also key requirements of this plan.

This led to the design of a communication system, the Rabobank Terminal Network (RTN), to which ultimately all the offices will be connected. This article describes the development and implementation of RTN for which specialists of the Rabobank and of the Dutch PTT worked closely together.

2 Communication within the Rabobank organization

2.1 Introduction

During the late Sixties / earlier Seventies, many banks all over the world started to automate their data processing. Due to the technological state of the art, most banks, including the Rabobank, opted for centralized computer centres. At the moment the Rabobank has two computer centres with large IBM mainframes for batch processing. (Batch processing because of the large number of accounts – more than approximately 12 million – and the large number of transactions made on these accounts in a 24-hour period – approximately 3 million).

The late Seventies saw the price of hardware decrease significantly, while at the same time the processing capability increased. This made it possible to install systems in member banks, starting with off-line back-office functions. Today, the Rabobank has a base of 800 branche controllers for back-office functions; 200 offices of members already converted their front-office functions as well. Now it is possible to install a branch controller in every member bank on an economical base, or more where required. This trend will continue for many banks, especially as member banks automate more functions. Table 1 gives the growth of the number of computers in the Rabobank.

Tabel 1 *Growth of the number of computers within the Rabobank*

Year	number of computers
1973	6
1978	60
1983	600

2.2 Data transport

In banking, the primary product is provision of information about accounts, loans, mortgages, etc. To provide this, relevant data must be available at the member banks. The master data is, however, held at the two centralized computer centres. This means that the transactions are collected at the member banks, transported to the central computer centres, processed overnight and the updated data transported back to the member banks. This is repeated on a 24-hour-cycle. Up until now, the Rabobank has transported the data by car, which has been possible due to the relatively short distances involved in the Netherlands and the density of the Rabobank network of offices. In other countries, with longer distances, this is not so easy and may be the reason why communication networks made an earlier entry into their bank automation developments.
In the Rabobank system, the data has to be transported twice in a 24-hour period. Networks must also be available for applications like Automatic Teller Machines (ATMs), Point Of Sale terminals (POS), etc. This means that there is a rapidly growing need for on-line real-time information systems. To prevent fraud, for example, a data-refreshing time cycle of once per 24-hours is insufficient for the applications mentioned above.
The influence of electronic communication is making itself felt in banking and will be the most important function in the near future affecting viable continuance of banking.
Long-term communication plans must therefore be developed and the decision as to which type of network is to be used is the most important strategic decision to be taken in this decade.

2.3 Basic Communication Strategy

Over the past few years, the Rabobank has applied much effort to devising a communications strategy which is not only capable of satisfying many applications but which will also support Rabobank requirements well into the next decade. In forming this strategy, several arguments had to be taken into account:
– Due to the cooperative structure of the Rabobank, every member bank must be given the same service, independent of size or location. This means: providing a full network covering the Netherlands to which all member banks and the two computer centres can be connected for data exchange on an equal basis.
– In the near future, many on-line real-time applications,

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** PTT, Commercial Affairs Telecommunications

such as electronic mail, videotex, bank applications, Management Information Systems, etc., will become available at the central computer centres. To obtain the required efficiency, all the applications must also be accessible from each VDU in the Rabobank network [2]. Data must be transported without the network knowing which type of data is concerned. The network must therefore be fully transparent for all types of data.

– Communication must be possible with several hosts with differing protocols. It is therefore necessary to combine many communication protocols, such as Teletype, Videotex, 3270, etc., in one multifunctional workstation. It is not feasible to have more than one VDU per workstation, each with a different protocol and/or network connection. This means that each terminal must behave as a multifunctional workstation with one connection to the network only.

– The Rabobank is a banking organization and not a telecommunications company. This means that where possible telecommunications facilities must be supplied and maintained by a telecommunications organization. It must be possible to connect systems from different suppliers to these facilities.

– The Rabobank has 950 member banks, each of which will have at least one computer per location. Considering current trends, it may be expected that in the next five years the number of computers in the Rabobank will increase drastically. This should have minimum influence on initial investment and future cost of telecommunications. This means that the telecommunications network must be capable of growing considerably without a disproportional increase in costs.

– In view of current rapid technological developments it is difficult to forecast which communications media and protocols will be available in ten years time. It must be possible to use new technologies such as optical transmission, satellite links, etc., without changing the application. The Rabobank already invested several hundreds of millions of guilders in application development. This means that there must be a clear separation between applications and communications functions.

– Within the Rabobank a large range of different equipment is being used, e.g. IBM for batch processing, Tandem for on-line systems, Philips and Nixdorf for branch controllers, DEC Pro 350 for word processing and information systems, DEC 2060 for time-sharing functions, NCR for ATMs, etc. And it is almost impossible to predict which new systems will be introduced in the near and distant future. Defining a communications strategy based on protocols of one vendor was, and is, no solution since there is no guarantee that other vendors will commit themselves to implementing and maintaining these protocols for a long period. This means that general, worldwide agreed standards have to be chosen.

– Many applications will be defined and built in the near future, at first within a centralized concept. But the need for decentralization will grow and it must be possible to decentralize applications without rewriting all the applications software. It may even be necessary to implement applications on other types of hardware. To do this in a manageable way, applications must be ignorant of the location of the peer application. This means that for communication between applications a general communication path has to be defined.

2.4 Conclusions

Considering the arguments above, several conclusions can be drawn:

1. There must be a clear separation between telecommunication, communication and application parts. As is common practice, the telecommunication part has to be defined by the PTT and the communication and application parts have to be defined by the user.
2. All the applications must be defined in such a way that it is possible to give the same service to every member bank, i.e. the applications should be such that it can be run anywhere in the network. Communication and application parts should be separated.
3. In view of the load caused by 10,000 terminals that can be expected on the network, communication between the banks must be possible without necessarily being routed via the central system.
4. Where applicable, general worldwide standards must be used and maintained by computer suppliers.

In order to meet all the requirements resulting from these conclusions, there is only one solution: Definition of the communications strategy of the Rabobank must conform with Open Systems Interconnection.

3 Open systems interconnection

3.1 Introduction

The past 20 years have seen a steady increase in the use of data communications for an ever increasing number of applications. This has led to a variety of networks, meeting more or less, specific requirements of various organizations. This multiplicity of approaches, used for basically similar aims, has caused both computer manufacturers and suppliers of traditional communications equipment and services to reconsider their position. This has led, in turn, to the development of architectural concepts, on which the design of future products is going to be based. The importance of this development lies not so much in the fact that the system design is 'architectured' (because most designers would claim that their system is modular and their approach systematic anyway), but rather in the fact that the type of architecture used is common to all systems.

In this section the communication architecture called 'Open Systems Interconnection' (OSI) is outlined. Some of the basic concepts are addressed, and the current status concerning international standardization is presented. Further information on architecture and protocols can be found in [3].

3.2 Concepts related to Open Systems Interconnection

Open Systems Interconnection (OSI) is concerned with the relation (exchange of information) between systems involved in a certain application. OSI is not concerned with the application itself, only with the 'communication needs' of an application, independent of the type information, e.g. text, graphics, data, voice (see Figure 1).

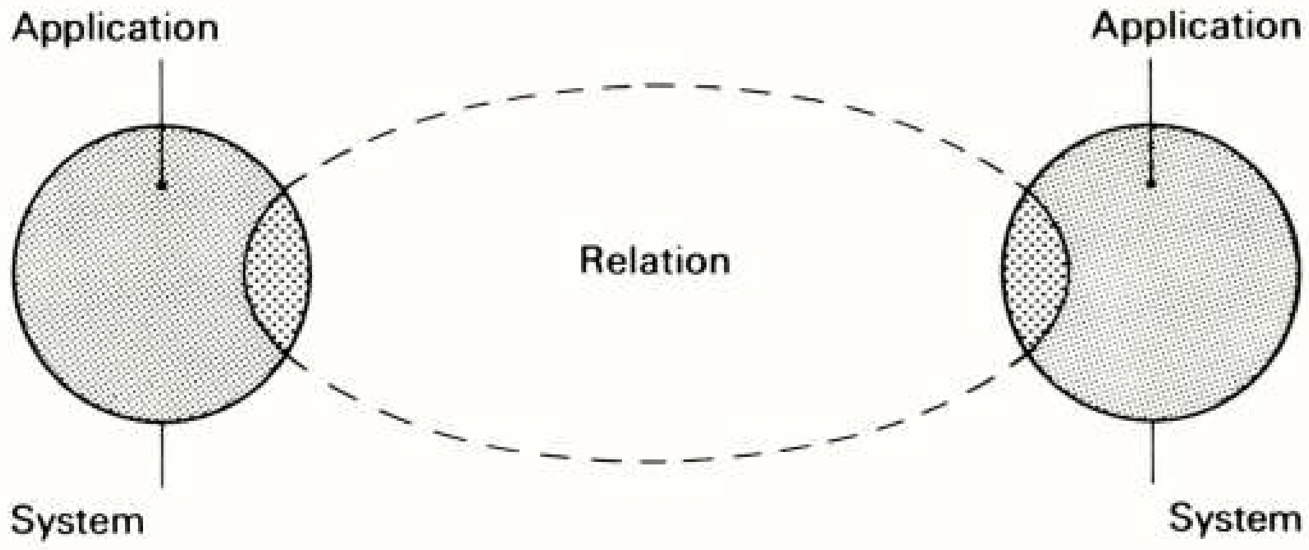

Figure 1 Systems and their relation.

The architecture of a communication system is the definition of the functions to be performed in terms of their functional appearance to the user. An important element in this definition is that it clearly underlines the significance of the definition of functions. This is basically related to the structuring technique used for the architecture. Within the OSI architecture this structuring technique is 'layering', which permits a communication to be considered as logically composed of a succession of layers, each 'enveloping' the lower layers, and isolating them from the higher layers. Layering therefore splits the problem into smaller pieces and if the principle of layering is properly applied, the independence of each layer is ensured. This is done by defining the services a layer provides to the next higher layer, without taking into consideration how these services are performed. The advantage of this method of external definition is that changes made as regards the way in which one or more layers operate internally do not influence other layers, providing they still offer the same service to the next higher layer. This means that the internal operation of a layer can be changed, for example, due to the availability of new products making use of new techniques.

For communication between systems a protocol is needed in each layer. A protocol is a set of conventions governing the format and control of interactions between two or more communicating parties.

3.3 OSI Reference Model

For OSI, the architecture is given in the form of a model, which serves as a reference in the development of new communication standards. Within both the CCITT (Comité consultatif international télégraphique et téléphonique) and ISO (International Standards Organization) agreement has been reached on the OSI reference model (this agreement has been formally approved by the CCITT during its October 1984 Plenary Assembly).

When using the model, we must bear in mind that:

– the word 'open' does not refer to a particular implementation, but indicates that the systems support internationally agreed (manufacture-independent) standards which enable these systems to exchange information with each other, e.g. between terminal devices, computers, people, network and processes;

– the area of relevance is the interconnection of systems and not the internal functioning of the systems;

– the standards form an interconnection architecture, which means that the approaches to interconnection have to be architectured. The various procedures used have functions in common and the allocations of specific functions to particular parts have been made systematically.

If two systems are not directly connected, a transit through one or more systems is needed and the model is as shown in Figure 2. The OSI model identifies seven layers.

The logical starting-point for a description is the *application* layer, since the ultimate aim is to achieve that the

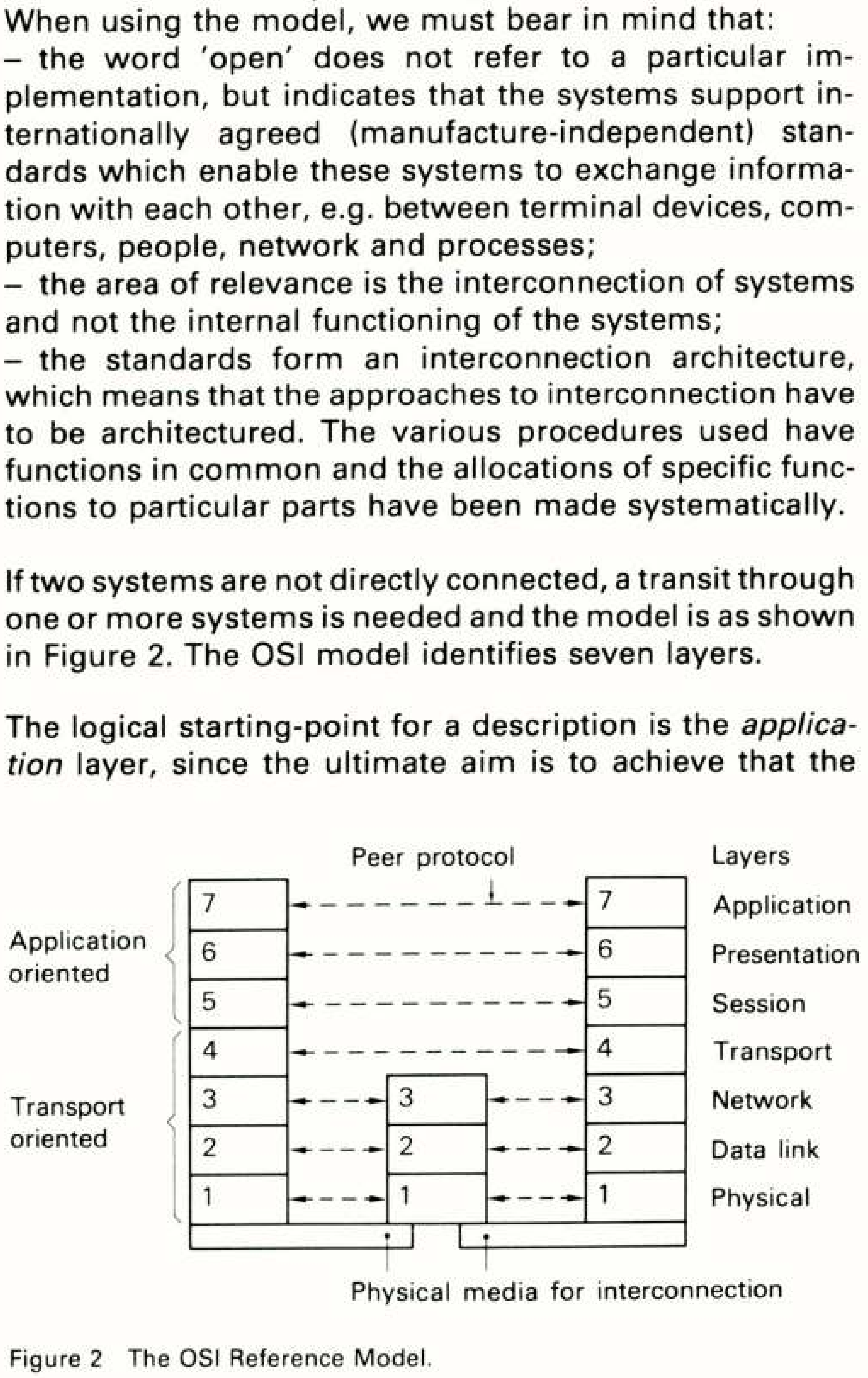

Figure 2 The OSI Reference Model.

applications are going to communicate with each other. This layer comprises that part of the application process which is charged with communication between systems.

The purpose of the *presentation* layer is to present information to the application layer in a meaningful way, by detecting and removing differences in syntax during the exchange of information.

The *session* layer coordinates the interaction within each association between users. It therefore controls the data exchange and synchronizes the dialogue.

The three layers mentioned above are called the *application-oriented* layers.

The *transport* layer provides a transparent transfer, meeting the requirements for throughput, reliability, minimum cost, etc. It relieves the higher layers of knowledge about and responsibility for the detailed way in which the transfer of data is achieved and optimizes use of the available telecommunication resources.

The protocols of the four layers mentioned so far, are only supported in the end-systems themselves. The lower three layers are concerned with networking, e.g. routing and transmission.

The *network* layer provides the means for establishing, maintaining and terminating network connections between systems containing communicating applications and the means for exchanging information over a network connection. The network layer delivers data transparently. It selects a route and transfers the data by switching it in accordance with that route. Therefore, the transport layer operates independently of routing and switching considerations.

The *data link* layer provides the means for activating, maintaining and deactivating one or more data link connections. This layer overcomes the limitations inherent in physical circuits and detects and corrects errors in transmission.

Finally, *the physical* layer contains the means for activating, maintaining and deactivating physical connections for the transmission of bits over the physical media. The physical layer represents the most basic level of the model and transmits a bitstream transparently over a circuit established on some physical communications medium.

The information that has to be transferred progresses down through the layers and is transferred, via the physical medium, to the receiving system, where it progresses upwards through the layers. When one or more transit systems are involved, the information is moved up at each transit system through the layers to the network layer (relay function) and then back down to the physical layer for interconnection with the final destination or another transit system.

The OSI reference model, in its current version, describes a connection-oriented mode of operation. This means that a connection between peer entities in each layer has to be established before the exchange of user information can take place. On an existing connection it is possible to perform functions such as flow control and synchronization. The protocols can support these functions, thereby adding to the complexity of the protocols but relieving the applications of these functions. A connectionless mode of operation is now being studied. When operating in this mode, user information can be exchanged without prior connection establishment. Such functions as flow control and synchronization are not covered by a connectionless type of protocol, but for specific applications, using networks with good quality, this mode of operation can provide an excellent solution.

The management functions are very important as regards the reliability of the communication. In the architecture there is a need for initiation, termination, monitoring and coordination of ongoing activities, as well as for the handling of abnormal operations. Within the framework of the architecture only those management activities which are relevant to the communication need to be identified. A study of these aspects concerning OSI networks has started meanwhile within CCITT and ISO circles.

3.4 Standardization

Only the relevant CCITT Recommendations are discussed. There is a corresponding ISO standard for each CCITT Recommendation mentioned, the two being technically identical.

The reference model itself is described in Recommendation X.200 (ISO: IS 7498). The service definition of the layers is given in Recommendation X.21m and the protocols are specified in Recommendation X.22m, where m indicates the number of the associated layer.

The actual information transfer is supported by the physical network and is affected by its performance. For packet-switching networks, X.25 defines a protocol for layers 1, 2 and 3. The OSI network service is specified in Recommendation X.213. The latest version of X.25 supports this network service [1]. The OSI service definitions of layers 1 and 2 have not yet been approved.

The transport service (Recommendation X.214) and the protocol (Recommendation X.224) are defined in such a way that the quality of service is independent of the network used.

The highest layers are defined and the protocol can be implemented, regardless of the network used. A general connection-oriented session service (Recommendation X.215) and session protocol (Recommendation X.225) are available.

CCITT definitions of a number of services which include application-oriented functions, are being drafted. These new services conform with OSI. One of the applications is Message Handling. A number of recommendations (X.400 series [2]) defining different aspects of message handling systems are available. A message handling system can offer a number of standard distribution facilities for all kinds of messages. Protocols on the application layer are available for communication between these systems. Use is made of the general OSI services and protocols of the underlying layers.

4 Rabobank and open systems interconnection

4.1 Introduction

Section 4 describes the architecture of the communication infrastructure to be used by the Rabobank, its relationship to OSI and the way in which the network is to be implemented.

Attention is also given to the management of the network.

4.2 Architecture of the Rabobank Terminal Network

4.2.1 Use of the OSI Reference Model

Over the past few years experts within the Rabobank have applied much effort into devising an open systems strategy, based on OSI. By participating in the Netherlands ISO working groups and studying the results (in early 1981), Rabobank could draw some important conclusions which had a great influence on the final implementation of Open Systems Interconnection within the Rabobank. The most important conclusions reached in late 1981 were:

– The OSI Reference Model is based on a layered structure which makes it possible to implement functions that can easily be replaced without changing the upper and lower layers. For the Rabobank the real implementation effort is in applications. These must be developed regardless of the final recommendations concerning communication standardization and telecommunication media.

– In 1981 ISO/CCITT were still in the study phase of defining the protocols associated with the OSI Reference Model and only draft documents were available. The Rabobank problem had to be solved within a short period of time, however, due to critical applications which had to be operational because of loading and time constraints. Rabobank therefore started to define its own protocols and services, while at the same time keeping in touch with the standardization activities of the different committees of ISO, CCITT, ECMA, etc., so that, wherever possible, agreed draft standards were taken as the basis for the Rabobank standards. No agreed proposals were ready for protocol definitions, but some documents were available for service definitions and these were used as a basis for further development.

– To be in line with international standardization, the choice was made for CCITT Recommendation X.25 as the access method for networking, and Recommendation X.121 was adopted as the addressing scheme for all the telecommunications within the Rabobank, including Local Area Networks.

Based on these conclusions, the decision was made to define application-to-application communication based on the layered structure of OSI, but in such a way as to allow a migration path for Rabobank to develop towards an OSI implementation making use of ISO/CCITT standards as implemented by different suppliers.

This decision had the following consequences:

– As far as the Rabobank applications are concerned, the major conclusion was that the full functionality of a connection-oriented implementation was not needed. Bearing in mind the expected load and the reliability of the underlying network, it was therefore decided, with guidance from some preliminary working papers, to use the connectionless protocols on all layers above X.25, despite standardization activities concerning OSI, following connection orientation in all layers. This meant defining a special Rabobank Network Protocol (RNP) which performs functions to match the connection-oriented X.25 service to the connectionless Rabobank Network Service.

– For the Rabobank Communication Protocol (RCP) a connectionless protocol specification and service definition are used. For the service definition, Rabobank anticipated the future and defined the service from working papers of the standardization committees. As regards the protocol definition, no working papers were available and Rabobank had to define and implement its own Communication Protocol.

– Within the OSI definitions, the session layer had the possibility of negotiating a session connection, in order to make orderly data exchange possible between all kinds of applications. Within Rabobank, such negotiation is not necessary, since in a banking environment a transaction is rather simple and is fully-defined by specifying the messages and their sequence for each banking application. Rabobank therefore decided not to implement a negotiable session layer, but to define fixed sessions between all

[1] the OSI network service, as provided by a real network, is only visible within the communicating end systems.
[2] Corresponding ISO standards are not yet available.

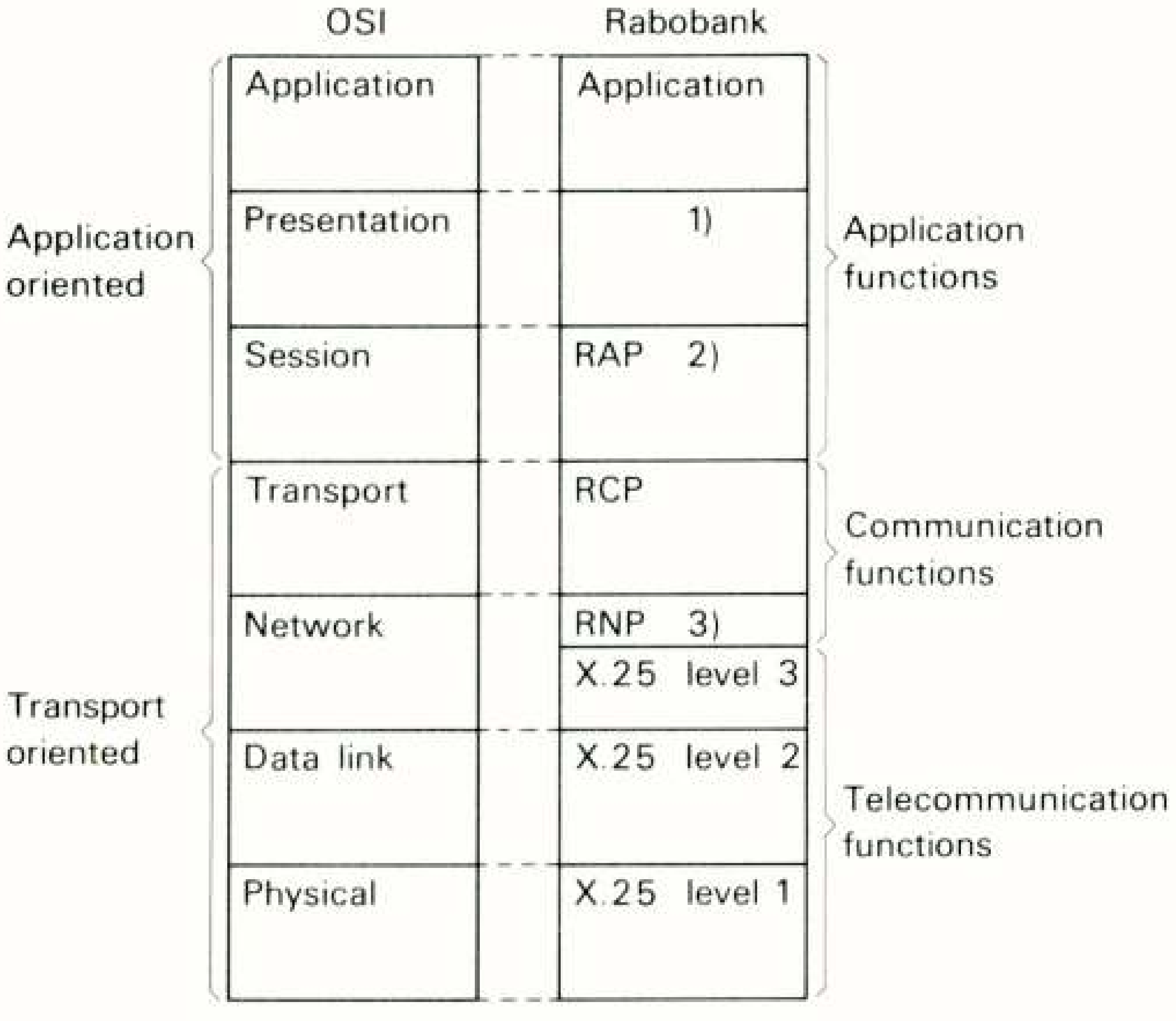

Figure 3 The relationship between OSI and Rabobank architectures.

Note 1: This layer is left empty since no connectionless OSI standards are yet available. The presentation functions needed are performed on the application level. Standards can be added, according as they become available.
Note 2: As soon as connectionless OSI standards (and implementation) become available, RAP wil be replaced.
Note 3: Use of RNP and the relation to OSI is explained in 4.2.3.2.

applications on a connectionless basis. These sequences of messages are now known as predefined 'dialogues'. As such, for all pairs of applications a new, complete set of messages and their sequence have to be defined before the application can be implemented. Once an application is implemented, the overhead of negotiation is avoided and the complexity decreased to an acceptable level for heavy load applications.
– For character coding and message layout in the presentation layer, a fixed definition was made, now known as the Rabobank Message Format (RMF). The RMF is in fact a data description and data directory. The result is that there is no need for an explicit presentation protocol since every application will be in 'Rabobank language'.
On the higher layers Rabobank uses the (draft 1983) OSI service definitions and Rabobank's own protocols. Figure 3 shows the relationship between the Rabobank implementation and the OSI Reference Model. Special attention was given to a migration path from the Rabobank specifications towards the OSI specifications.

4.2.2 Application functions

Communication between two or more computers involves dealing with co-operating, sequential processes. This makes it necessary to work with semaphores in one way or another. One possibility is to tell the peer application that the sending of the sequence of messages is finished and an answer is expected. This is the way that OSI has solved the problem in the session layer by using 'data tokens' and using tokens to put sync-points in the sequence of all the messages. This means overhead in the normal data stream to check that no error occurs and, if an error occurs, to have facilities for a fully-automatic error recovery mechanism. Another method is to send a message with an implicit sync-point, which means that a message can never be sent from one application to another application while waiting acknowlegement of a preceding message. To ensure that no dead-lock occurs because of not receiving an answer – due to network problems, communication protocol or a crash of a full application for example – timers have to be set to detect loss of messages.
The sequence of messages also has to be controlled in order to detect protocol errors of the peer party or possible fraudulent message exchange. If an error occurs during a dialogue, the whole dialogue is aborted and starts all over again. This is feasible if dialogues are short and underlying networks reliable, as is true for the Rabobank network. If all these controls have to be built into all the applications, problems will arise if other control methods are used because then complete applications will have to be rewritten. The control mechanisms supported by the Rabobank Application Protocol (RAP) are therefore built into a separate software layer. RAP contains all the relevant information about the possible dialogues for each pair of applications. To make an application independent of the place in the network where it and its peer entity are running, and to prevent the necessity of rewriting an application if the location in the network changes, the naming and addressing of applications, among other things, must be independent of the underlying protocols and networks. The Rabobank has therefore defined a structure of Global Application Names (GAN) which makes it possible for system development to implement an application without being aware of where the application is being executed.

4.2.3 Communication Functions

4.2.3.1 Communication protocol and service

Bearing in mind that the protocols and services should be connectionless, we opted in early 1982 for using the connectionless service definition as proposed in certain OSI working papers. This means that the only two service primitives are the Datagram-request and the Datagram-indication (see Table 2). This service is now known as the Rabobank Communication Service (RCS).

Tabel 2 *Definition of connectionless service primitives*

Primitive	Contents
Datagram-request	Source address, destination address, QOS, Data
Datagram-indication	Source address, destination address, QOS, Data

Note: QOS = Quality Of Service

In addition, for the communication protocol a connectionless strategy was chosen, based on certain datagram documents describing protocols with no handshake, and two-way and three-way handshake mechanisms.
A risk analysis was made for the underlying networks and stringent tests were executed to check the reliability and availability of the networks. As a result of the tests, bearing in mind the complexity of two-way and three-way handshake mechanisms, and the responsibility of the applications with regard to the final result, the no-handshake protocol was chosen.
This meant that the final definition was a true datagram-oriented protocol, now known as the 'send-and-pray protocol'.
The structure of Global Application Names has no relation to the underlying network and therefore a Global Network Address (GNA) was defined, with the mapping of GAN to GNA being performed in the communication protocol. If a particular application is replaced in the network, only the GNA needs to be changed in the mapping tables, resulting in a different Rabobank address. This network address is independent of the underlying networks.

4.2.3.2 Network protocol

An important function of the Rabobank Network Protocol (RNP) is the mapping of the connectionless protocol used in RTN into the connection-oriented X.25 network. The RNP maps the RCP messages to the relevant network protocol messages. The GNA is translated to the X.121 addressing scheme used by the public network and the Rabobank private data network.
A mapping of the message length is also performed by this network protocol, because the RCS allows a message length of 2000 bytes, whereas the packet-switched networks use only 128 bytes per packet. This entails a message to packet assembly/disassembly function.

4.2.4 Telecommunication functions

The strategic choice was made to use X.25 for the telecommunication facilities, with available implementation on the various hosts computers and the public packet-switched datanetwork Datanet 1 of which the management and operation are in the hands of the Netherlands PTT.

4.2.5 Management functions

The system and layer management functions were not, and are still not, defined by OSI. By defining the Rabobank protocols, a full set of management tools were defined through all the layers. In addition, two management applications were defined: a Local Management Application (LMA) and a Central Management Application (CMA).

A local management application has the possibility of checking error logs, statistic files, etc., concerning functions of all the layers. If any problems occur, traces can be started for problem solving. This LMA is also able to change the address mapping tables in the local system.

The central management application has knowledge of all RTN systems in the Rabobank: routing tables, hardware configurations, availability of systems, etc. Serious errors at local systems are also signalled to the central application from where they are reported to the operators in the network management centre. The operator can start a recovery mechanism and, if necessary, start traces in the local systems.

The communication between the central management application and the local management applications is effected in the same manner as for all other applications, i.e. with predefined dialogues.

4.3 Implementation of the Rabobank Terminal Network

4.3.1 Telecommunication Network

For the purpose of examining the telecommunication needs of the Rabobank and the solutions, we made a distinction between three major areas:
– The Rabobank has three large plants, namely a large office building in Utrecht, a large computer centre in Zeist and a combination of computer centre and office building in Eindhoven. Communication between these plants is by post and telephone. Following the introduction of office automation there will be a strong need for electronic communication. After a careful cost analysis Rabobank decided to purchase a complete Private Packet-Switched Network to interconnect the three central offices. The three packet-switch exchanges, one in each office, are connected by high-speed leased lines.
– As regards the communication between the central offices and the 950 member banks, a cost-risk analysis was made regarding the use of a full leased line network and use of the public packet-switch network.
Taking into account that within a few years several different

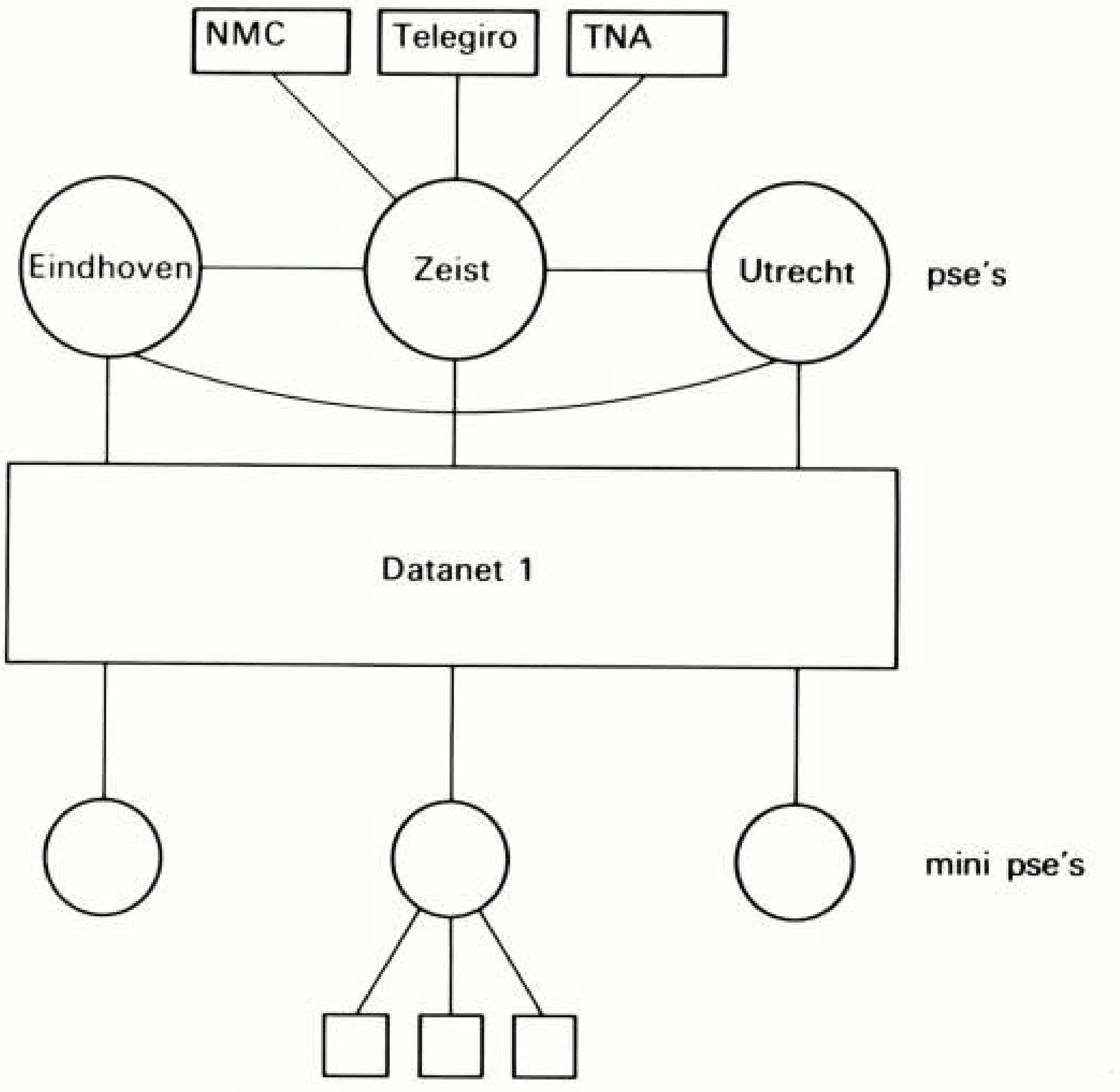

Figure 4 Rabobank Terminal Network (RTN).

applications would be implemented, it was foreseen that thousands of leased lines converging on the central computer centres would not be manageable. The Rabobank therefore decided to use Datanet 1 of the Netherlands PTT for communication between the member banks and the central offices and between member banks themselves.
– For communication between systems located at branches of member banks and the main office of a member bank, the most economical solution was to use local leased lines. As X.25 was chosen as the telecommunication standard, also an X.25 packet-switched exchange (pse) was selected to interconnect these systems. This pse is connected to Datanet 1, which resulted in a significant decrease in communication costs.

As a result of close cooperation with the PTT, from the beginning of the project, the overall Rabobank Terminal Network was defined and implemented as shown in Figure 4.

4.3.2 Communication part

Figure 5 shows the implementation of the communication between application and communication functions. The sending RAP entity puts the data (and the corresponding parameters) in the data buffer and calls the Operating System (OS). The OS activates an RCP function based on machine-dependent software rules. The RCS transmits the data to its peer entity, where the same process is performed in an upward direction. The RCS service primitives, as defined in 4.2.3.1, were translated into real implementation

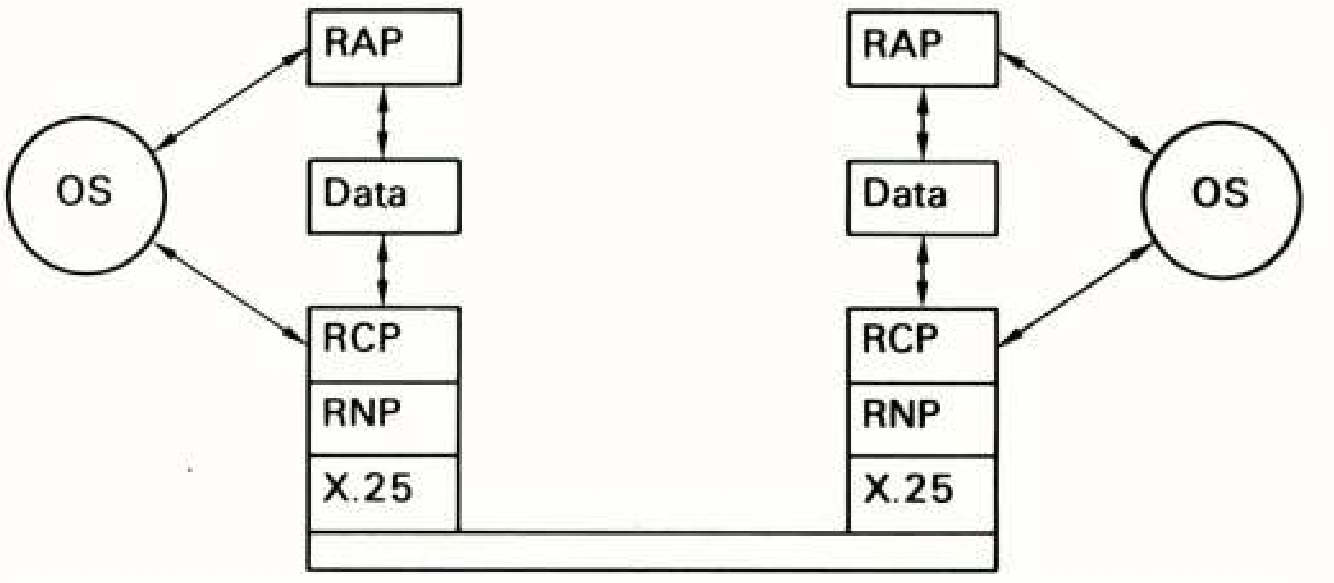

Figure 5 Implementation of the Rabobank Communication Service (RCS).

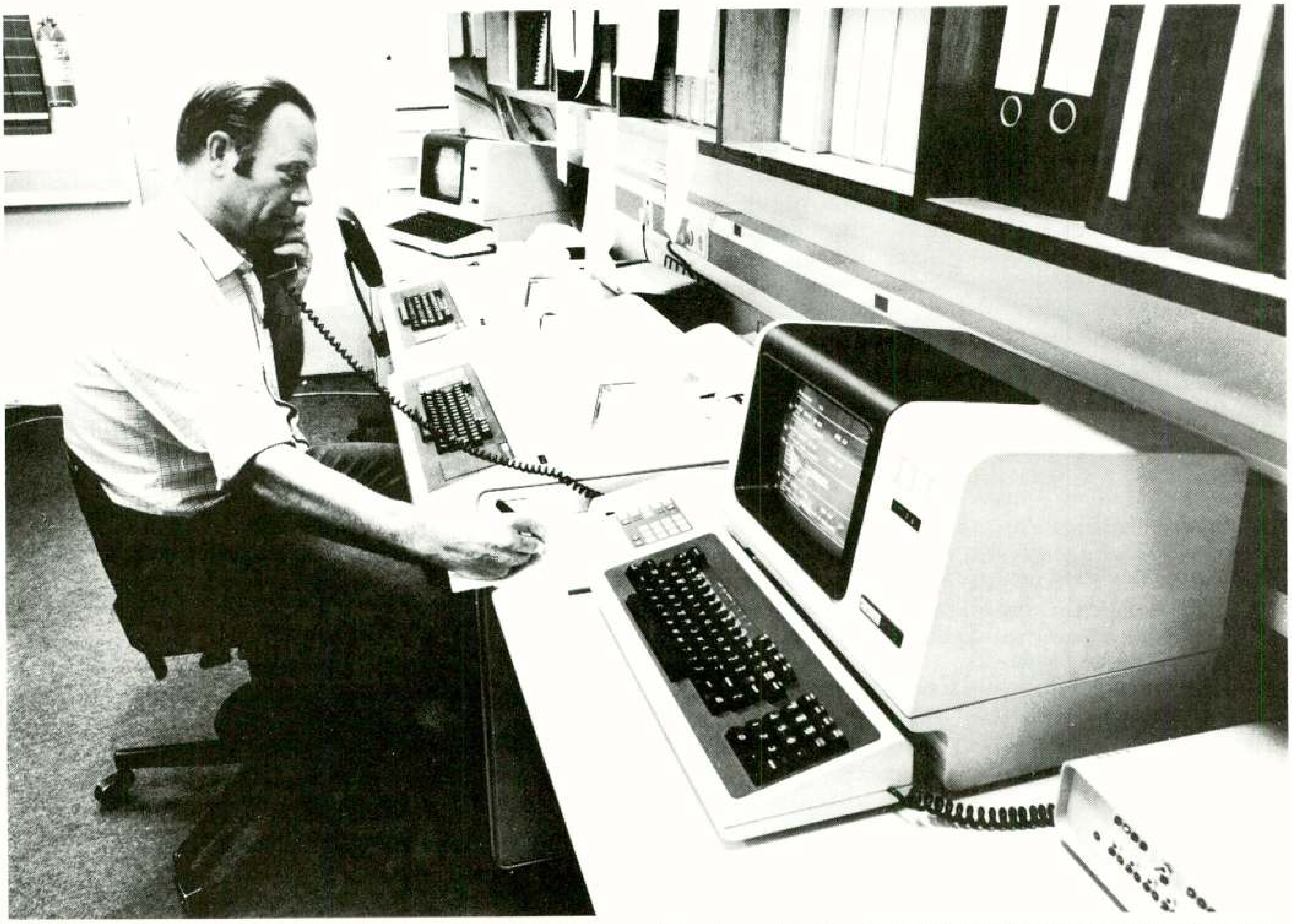

Figure 6 Network manager, executing looptests to check the performance of the network including the equipment at the network termination points.

specifications for all the systems regarding which the protocols were implemented. This implementation is machine-dependent. For reasons of efficiency the network and communication protocols have been combined in the implementation, but the functionality of both layers is independent.

4.4 Management

4.4.1 Network Management

The network management has been divided into two parts:

– For Datanet 1, the PTT has a Network Operations and Management Centre (NOMC), which is in charge of the overall control of the network including customer support, performance-monitoring and trouble-shooting [4]. Here the necessary tests can be made (Figure 6).

– For its private network, the Rabobank has its own Network Management Centre (NMC) which performs functions similar to those of the NOMC. Being an integral part of the management centre, all switching nodes at the member banks are under control of this centre.

4.4.2 System and Layer Management

The Local Management Application is an integral part of the first implementation, enabling all management functions to be performed from a local terminal. The specification of the Central Management Application is now being implemented. All management functions in all Rabobank systems can be performed from one management centre.

5 Rabobank applications

5.1 Introduction

Rabobank has developed several applications which make use of the Rabobank Terminal Network. The applications can be accessed via Packet Assembly/Disassembly functions (PAD) and a Telex Network Adapter (TNA) which functions as a gateway between the telex and X.25 networks. The general applications include an electronic mail system (SPRINTER) and an interactive videotex system (MIRA).

Banking applications which are making use of RTN are a.o. Telegiro and ATM. The former is explained in section 5.5.

5.2 Terminal access

5.2.1 PAD functions

To enable non-packet-oriented equipment (asynchronous terminals in most cases) to be connected to the RTN, the Rabobank uses PAD-functions. These PADs are in accordance with CCITT Recommendations X.3, X.28 and X.29. For economical reasons the emulation of the PAD has been integrated into the branch controller. To allow access from a member bank to an associated outside company, e.g. an insurance company, the emulation of an IBM cluster controller using BSC procedures and of a 3270 terminal has also been integrated into the branch controller.

The Display System Protocol (DSP) was selected to transport the BSC data stream over the RTN, because of the long field experience with DSP in other networks [5].

To obtain multifunctional workstations, additional software is located in the branch controller, in conjunction with the PAD software. This additional software allows a user to choose an application, whereby the branch controller selects the address to be called, at the same time connecting the terminal to the appropriate emulation software. The final result of this approach is workplace integration, i.e. all the applications can be used from every workplace by

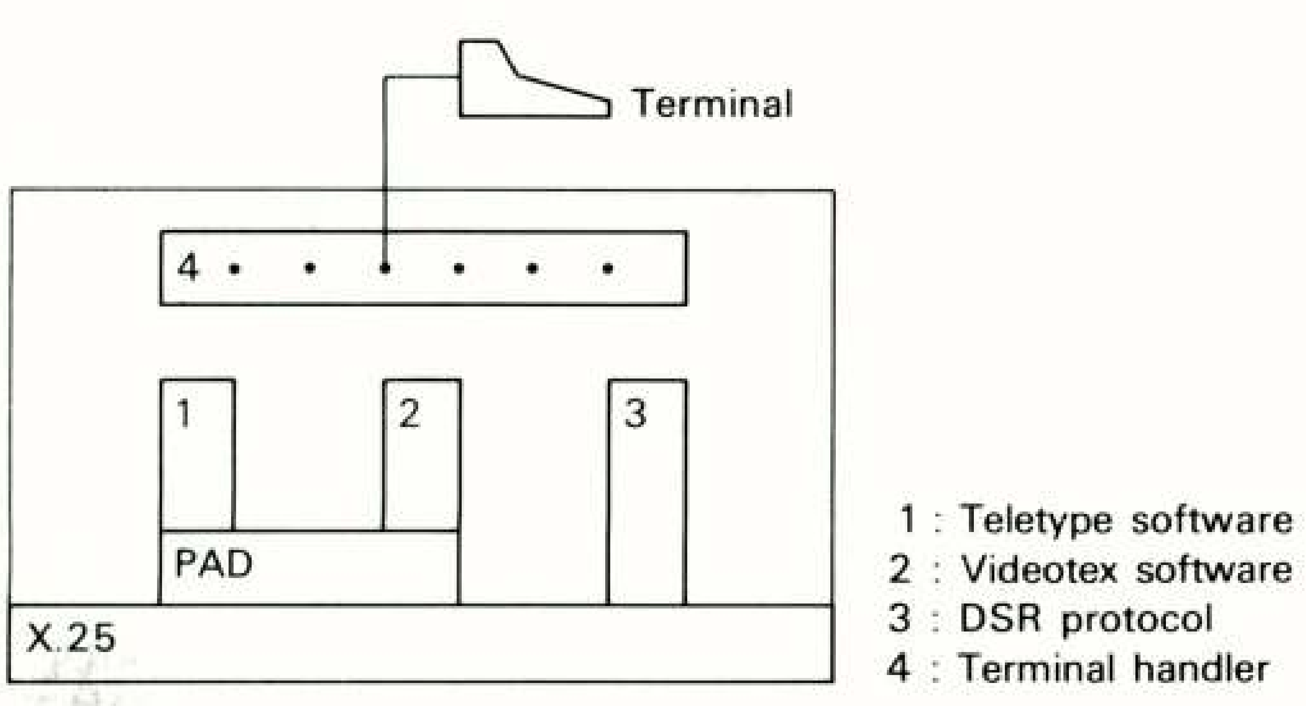

Figure 7 Multifunctional workstation.

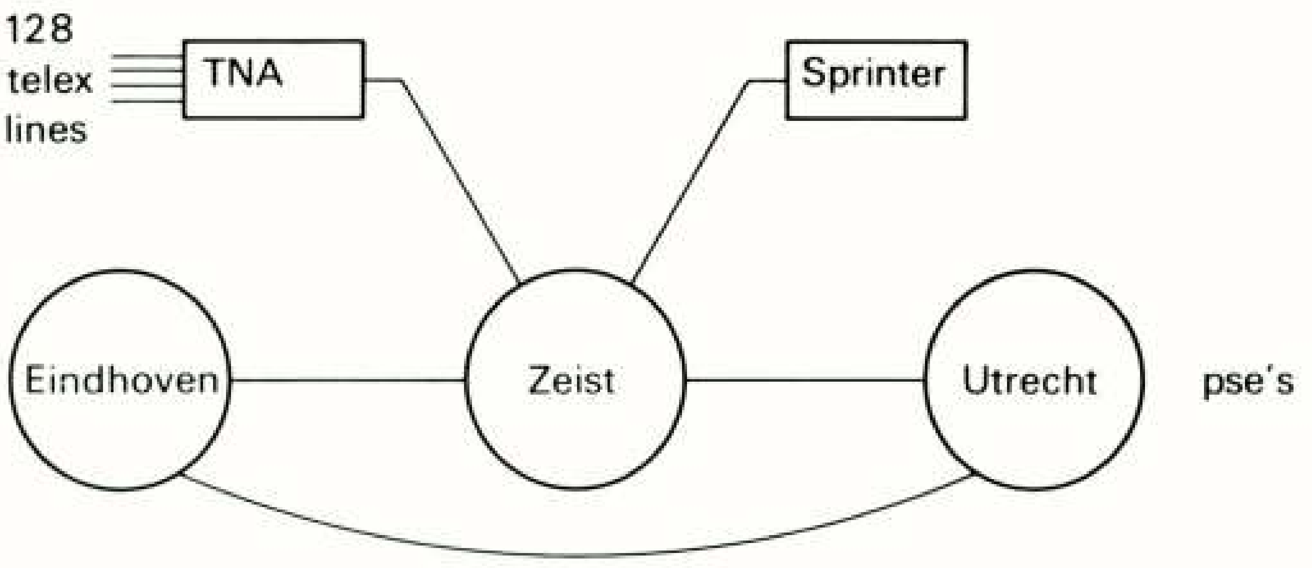

Figure 8 The TNA as a telex PAD.

means of one and the same terminal (see Figure 7).

5.2.2 Telex Network Adapter
The Rabobank Telex Network Adapter (TNA) [3] is the gateway between terminals on the public telex network and RTN.
The TNA is in fact a telex PAD, which has the same function as an asynchronous PAD. The TNA deals with the properties of the telex network, such as speed, signal levels, call procedures, answer-back processing and code conversion. More technical details can be found in [6].

In the event of default, the TNA connects incoming calls to the Electronic Mail System, SPRINTER. In this way each telex terminal user is a user of the system.
The majority of telex lines connected to the TNA is reserved for member banks, or at least for persons registered by SPRINTER. For incoming calls on telex lines reserved for external relations, the TNA performs the log-on procedure (see Figure 8), removing the need for external relations to be familiar with SPRINTER procedures.

5.3 SPRINTER: The Rabobank Electronic Mail System
Rabobank has installed the electronic mail system called SPRINTER as one of its general applications. This system provides message exchange between registered users with facilities like urgent, receipt confirmation, private, etc. Rabobank's policy will be to conform with CCITT Message Handling Systems Recommendations (X.400 series). For general information about Electronic Mail facilities see [7].

An important feature of SPRINTER is the auto-delivery and station-delivery facilities, which enable the user to send messages to hardcopy devices on the RTN and, via TNA, to telex subscribers.

Via SPRINTER a message can also be composed of a predefined layout using a programmed dialogue with limited validation capability, as used by Telegiro (see 5.5).

[3] TNA has the following properties: Line capacity 126 (128 minus two lines for monitoring). Traffic capacity 100 calls in data transfer state and simultaneously 30 lines in call set-up mode. Built-in redundancy (single faults can affect 16 telex lines only). Connection between TNA and RTN: two X.75 lines at 19.2 kbps.

5.4 MIRA: The Rabobank in-house Interactive Videotex System
An in-house videotex system is operational conforming to the Prestel standard, which is also used in Viditel, the Netherland's public interactive videotex service. This standard was chosen because Rabobank's policy is to use generally agreed standards wherever possible. To optimize application within the Rabobank, a slight modification was made to reduce the number of packets sent from a terminal to MIRA. In other words, the packet forwarding condition was adjusted.

All the member banks can use MIRA, which provides three applications suitable for banking: supplying up-to-date foreign exchange rates, stock market prices, interest rates and other tariffs; calculation models for mortgages and cashmanagement; and ordering facilities for several items, etc.
The flexibility of MIRA allows existing and new applications to be implemented as and when required by the users.

5.5 Telegiro Application
Telegiro is a circuit over which fast payment transactions, of mainly large amounts such as house purchase transactions or tax remittances, can be made. Telegiro in fact delivers an advance notification to the recipient that a transaction can be expected as a result of normal batch processing.
Only 0.1% of the 620 million transactions processed by the Rabobank are also processed by Telegiro. This 0.1% however, represents 40% of the incoming and outgoing cash flow, the average amount involved per Telegiro transaction being about one million guilders. One of the requirements which is fulfilled by Telegiro is that a transaction including notification to the receiving client, has to be effected in less than two hours from the moment a customer initiates the transaction.
Before automation of Telegiro the complete process was manual and required many employees from member banks and the central bank exchanging messages via the telephone and telex.
As the two-hour time constraint could not be met, the Telegiro process had to be automated, with a migration path from the old to the new system. In this migration path towards a full use of the facility, four phases can be distinguished:
a. A bank uses the telephone and calls the central Telegiro department, where the transaction is typed directly into the Telegiro system.
b. A bank uses telex to make a call to SPRINTER via TNA where, by means of a programmed dialogue, a message is created with a predetermined layout. SPRINTER delivers the message to the Telegiro mailbox from where it is transferred into the Telegiro system by means of an application using the RAP, RCP and RNP protocols.
c. A bank uses the PAD emulation in its branch controller to make a connection to SPRINTER. From this point on the process proceeds as explained in *b.*
d. A bank uses a Telegiro data entry module in its branch controller to collect the data for a Telegiro transaction. After completion of the local data entry session, the Telegiro transaction is directly transferred into the Telegiro computer on the basis of RAP, RCP and RNP protocols.

During these phases, there will be compatibility between the old facility and the new.

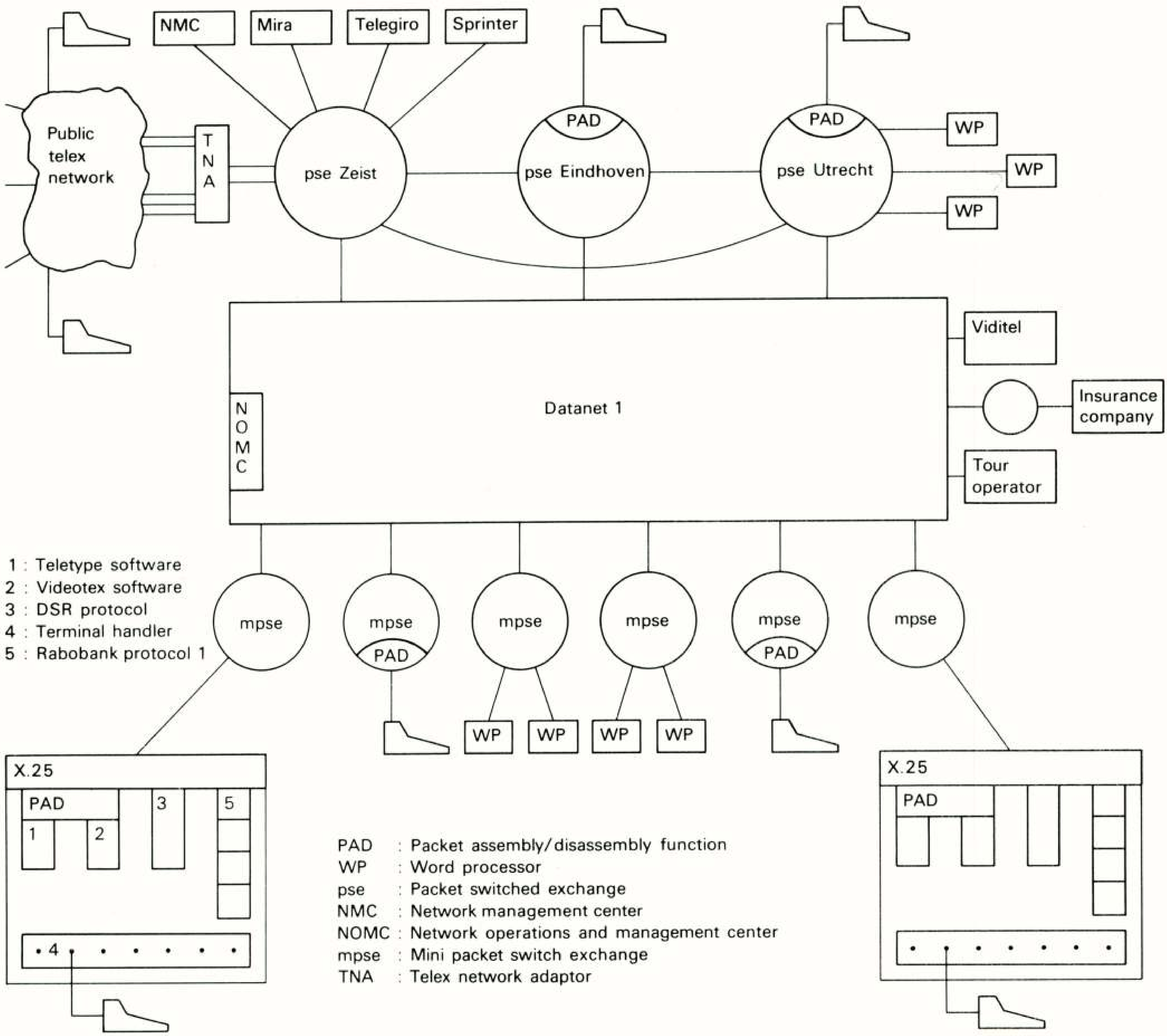

Figure 9 Rabobank Terminal Network overall configuration.

5.6 Overall configuration of the Rabobank Terminal Network
Figure 9 shows the inter-relationship of the component parts described above.

6 Conclusion

6.1 Current status
Parts of the RTN, after having been tested internally at the central offices, are now operational:
– The combination of private and public packet-switched networks has been operational since November 1982; a close cooperation between PTT's NOMC and Rabobank's NMC guaranties a smooth operation of the network.
– The Telex Network Adapter was installed in March 1983.

Both the private network and TNA were supplied by Plessey Controls Limited.

Currently available applications include SPRINTER, MIRA and Telegiro. These applications use Tandem TXP equipment because high availability is required.
Teletype, Videotex and 3270 DSP are in trial operation.

6.2 Migration towards OSI
By using the RNP as a bridge between the RCP and the telecommunication network-dependent protocol, only the RNP needs to be modified in case of changes in the 'underlying' telecommuncation network.
Implementation of the RCP is based on the draft ISO connectionless transport service definition. When the draft definition becomes available as an accepted OSI standard, the RCP can be replaced without functionally affecting the adjacent layers.
The RCP protocol will only be replaced, however, as soon as all the equipment to be used within the Rabobank has been provided with a supplier-supported implementation of the OSI connectionless transport protocol.
When OSI standards concerning connectionless session and presentation layer services and protocols become available, these can be added without functionally affecting the RAP.

The concept of the design and implementation of the communication infrastructure enables an easy migration to an infrastructure using a full set of OSI standards: Rabobank is prepared for the future.

Acknowledgement

The authors wish to mention in particular ir. F. Booij (PTT Commercial Affairs Telecommunications) for his advice, coordination and support. They are also indebted to ir. L. A. A. M. Coolen and ir. M. J. Heg (PTT Dr. Neher Laboratories) for the critical discussions which led to the final form of the article.

Samenvatting

In dit artikel wordt de aanpak besproken, die Rabobank toepast bij de ontwikkeling van haar infrastructuur voor datacommunicatie, het zogenaamde 'Rabobank Terminal Network'. Als belangrijke voorwaarde voor een modern datacommunicatienet wordt binnen de gekozen strategie uitgegaan van 'Open Systems Interconnection'. Het OSI-model wordt derhalve beknopt uiteengezet.
De kern van het betoog betreft de architectuur van de communicatie infrastructuur in relatie tot OSI, alsmede de wijze waarop de diverse hiërarchische functies geïmplementeerd kunnen worden. Daarnaast wordt aandacht besteed aan de behoefte aan verdere standaardisatie.
De stand van zaken bij Rabobank sinds november 1982 wordt aangegeven. De combinatie van een particulier net en het openbare X.25 pakketgeschakelde Datanet 1 is operationeel. Verscheidene applicaties maken van het 'Rabobank Terminal Network' gebruik, zoals een interactief videotexsysteem, een elektronische postservice en Telegiro.
Concluderend kan worden gesteld dat het ontwerp en de implementatie van het net in de toekomst eenvoudig kan voldoen aan nieuwe OSI standaards, zodra deze beschikbaar komen.

Résumé

Le présent article décrit l'approche choisie par la Rabobank pour le développement d'une nouvelle infrastructure de communication de données, le 'Rabobank Terminal Network'. Condition essentielle pour un réseau moderne, la stratégie choisie se base sur le modèle OSI d'interconnexion de systèmes ouverts. L'article comporte de ce fait une description succincte de ce modèle.
L'exposé décrit l'architecture de l'infrastructure de communication par rapport au modèle OSI, ainsi que la manière dont les diverses fonctions hiérarchiques peuvent être implémentées. L'on y consacre en outre une certaine attention au besoin d'une standardisation plus poussée.
L'article fait en outre le point de la situation à la Rabobank depuis 1982. L'interconnexion du réseau privé et du réseau public de commutation par paquets Datanet 1 (X.25) est opérationnelle. Le 'Rabobank Terminal Network' est mis à profit pour diverses applications, comme le Vidéotex interactif, un service de courrier électronique et le système Telegiro (système interne de virement électronique).
Pour conclure, l'on peut constater que la conception et l'implémentation du nouveau réseau pourront facilement être adaptés aux nouvelles normes OSI dès qu'elles seront disponibles.

Summary

This article describes Rabobank's approach as regards the development of their data communication infrastructure, the Rabobank Terminal Network. A communications strategy is being defined which includes Open Systems Interconnection as a major condition for a modern data-communication network.
The basics of the OSI-reference model and its protocols and services are briefly explained.
In addition, the article describes the architecture of the communication infrastructure and its relation to OSI, the way the communication and application functions are to be implemented in the network, and the need for standards.
A combination of a private and the public X.25 packet-switched data network Datanet 1 has been operational since November 1982.
Several applications make use of the Rabobank Terminal Network, including an interactive videosystem, an electronic mail system and Telegiro.
The concept of the design and of the implementation of the network enables an easy migration to a communication infrastructure using new OSI standards as soon as they will become available.

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Op de 347e werkvergadering werd door Ir. J.B.F.Tasche (Rabobank) een voordracht gehouden met als titel: "Een nationaal bedrijfsnet voor datacommunicatie". De inhouden van deze voordracht, en van bovenstaand artikel komen overeen. Het artikel is overgenomen uit: Het PTT-bedrijf Deel XXIII nr. 2-3 van maart 1985.

GEPLANTES NEUES INTEGRIERTES KOMMUNIKATIONSSYSTEM DER DEUTSCHEN BUNDESBAHN

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VORHANDENES ANALOGES FERNSPRECHNETZ

Die deutsche Bundesbahn betreibt im Augenblich ein analoges Fernsprechnetz mit ca. 1.800 Anlagen und ca. 130.000 Teilnehmer. Die Vermittlungsanlagen bestehen aus Anlagen mit schritthaltender Wahl wie HDW-Technik, EMD-Technik und in geringeren Umfang ESK-Technik.

Die Übertragungswege sind im Augenblick analoge Wege auf NF, TF und Richtfunkverbindungen.

Die Wahl erfolgt schritthaltend als Staffelwahl im gesamten Netz.

Das derzeitige Basa-Netz ist ein zweistufiges Netz, welches auf der Verwaltungsstruktur der 30-ger Jahre aufgebaut ist.

Für eine Leitweglenkung sind Übertragungen mit Weichenverkehr, Umsteuerwähler und Richtungswähler in den Anlagen installiert.

Vorhandene Datennetze

Die deutschen Bundesbahn betreibt neben diesem Telefonnetz ein eigenes Netz mit Fernschreibvermittlungen und ein Transdatanetz für die integrierte Transportsteuerung. Daneben sind weitere diverse Netze für Daten vorhanden.

Vorstellungen der Deutschen Bundesbahn über ihr integriertes Kommunikationsnetz

FOLIE INTEGRATIONSSTUFEN Fig. 1

Aus dem Bild ist die Vorstellung des deutschen Bundesbahn ersichtlich, in welchen Stufen der Weg zu einem integrierten Kommunikationssystem geplant ist. Die vorhandene Technik für Fernsprechen wurde bereits dargelegt. Die eigenen Datennetze wurden ebenfalls kurz angesprochen. Im Jahr 1986 wird das erste elektronische Basasystem, bestehend aus einer Kommunikationsanlage HICOM mit einem Netzserver, in der ersten Ausbaustufe installiert. Parallel hierzu integriert die deutsche Bundesbahn ihre Datendienste -ausschliesslich Transdata- in ein paketorientiertes Netz. Ca. ab 1990 plant die Bundesbahn die Integration aller Datendienste in ein integriertes Netz. Ca. ab 1995 wird begonnen werden, alle Kommunikationsdienste im ISDN, als Integration aller Dienste, zu installieren.

Ausschreibung der Deutschen Bundesbahn

Die deutschen Bundesbahn hat zusammen mit der Österreichischen Bundesbahn und der italienischen Staatsbahn ein Lastenheft für das elektronische Basasystem (EBS) herausgegeben.

Die wichtigsten Forderungen dieses Lastenheftes sind:

- volldigitale Durchschaltung in den Vermittlungsanlagen
- speicherprogrammiertes Vermittlungssystem
- Übertragungstechnik nach dem PCM-Verfahren
- Möglichkeit der Einführung zusätzlicher Dienste nach CCITT-Empfehlungen
- Forderung nach ISDN-fähigen Anlagen. Diese Forderung leitet ein neues Zeitaler der Kommunikation ein, in dem Sprache, Text, Bild und Daten integriert sind.
- neu Teilnehmersleistungsmerkmale
- Erhöhung der Leistungstätigkeit des Netzes durch vollautomatische Leitweglenkung
- Einführung einheitlicher Kennzahlen im Fernverkehr
- Verbesserung der Dämpungsverhältnisse durch weitgehend 4-drähtige Durchschaltung und Übertragungen, im Endausbau bis zum Teilnehmer
- Verringerung des Instandhaltungsaufwandes
- Verbesserung der Betriebsgüte

Dies bedeutet, dasz das elektronische Basasystem in das im Augenblick vorhandene bestehende analoge Netz eingefügt werden musz. Die Zurverfügungstellung der Schnittstellen für alle gebräuchlichen analogen Wählverfahren wird hierbei notwendig. Nur das Induktivwahlverfahren scheidet aus und wird durch Tonwahl 2280 Hz ersetzt. Das vorhandene mehrstufige Staffelwahlverfahren wird auf einstufige Numerierung umgestellt.

Im Sommer 1984 wurde neben dem Pflichtenheft auch der Leistungsumfang für 3 Erpobungsanlagen von der deutschen Bundesbahn der Industrie zur Verfügung gestellt. Im Februar 1985 wurden die Angebote an die Deutsche Bundesbahn übergeben. Die Firma Siemens hat daraufhin den Auftrag für die Erstellung eines elektronischen Basasystems im Bezirk der Bundesbahndirektion Köln erhalten. Hierfür wird eine Anlage mit 1.200 Anschlüssen, ca. 200 analogen Fernleitungen und einer angeschlossenen Unteranlage mit 400 Teilnehmern eingesetzt.

Da die Erneuerung des bestehenden Netzes nur schrittweise erfolgen wird, musz die Einbindung der digitalen Technik in die analoge umwelt mittels eines Anpassungsbausteines (Server) erfolgen. Dieser gestattet den Anschluss der analogen Leitungen an die ISDN-fähigen HICOM-Anlagen. Dieser Netz-Server ist solange erforderlich, wie analoge Leitungen vorhanden sind. Bei Umstellung der letzten analogen Leitung kann der Netz-Server entfallen.

Das Bürokommunikationssystem HICOM arbeitet mit

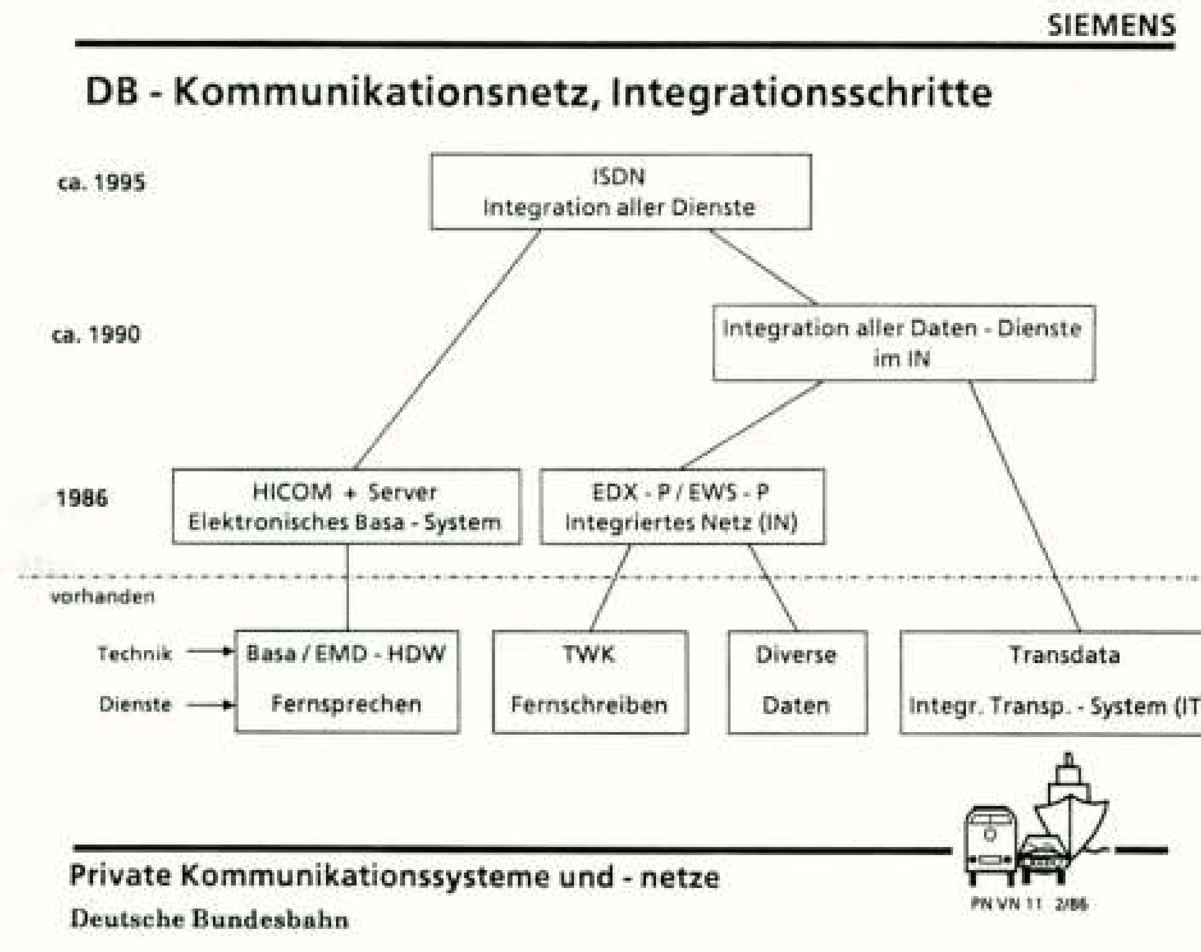

Fig. 1

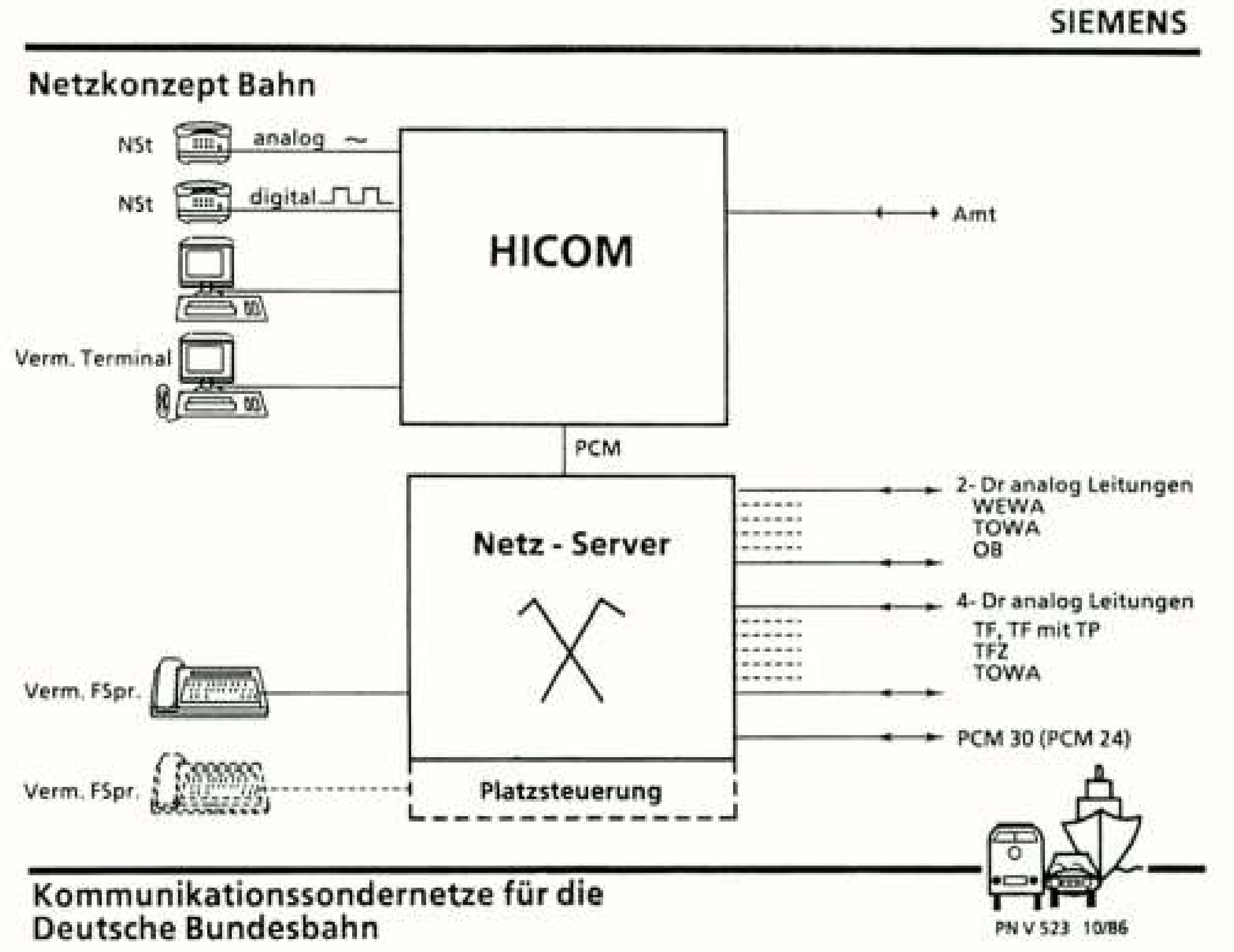

Fig. 2

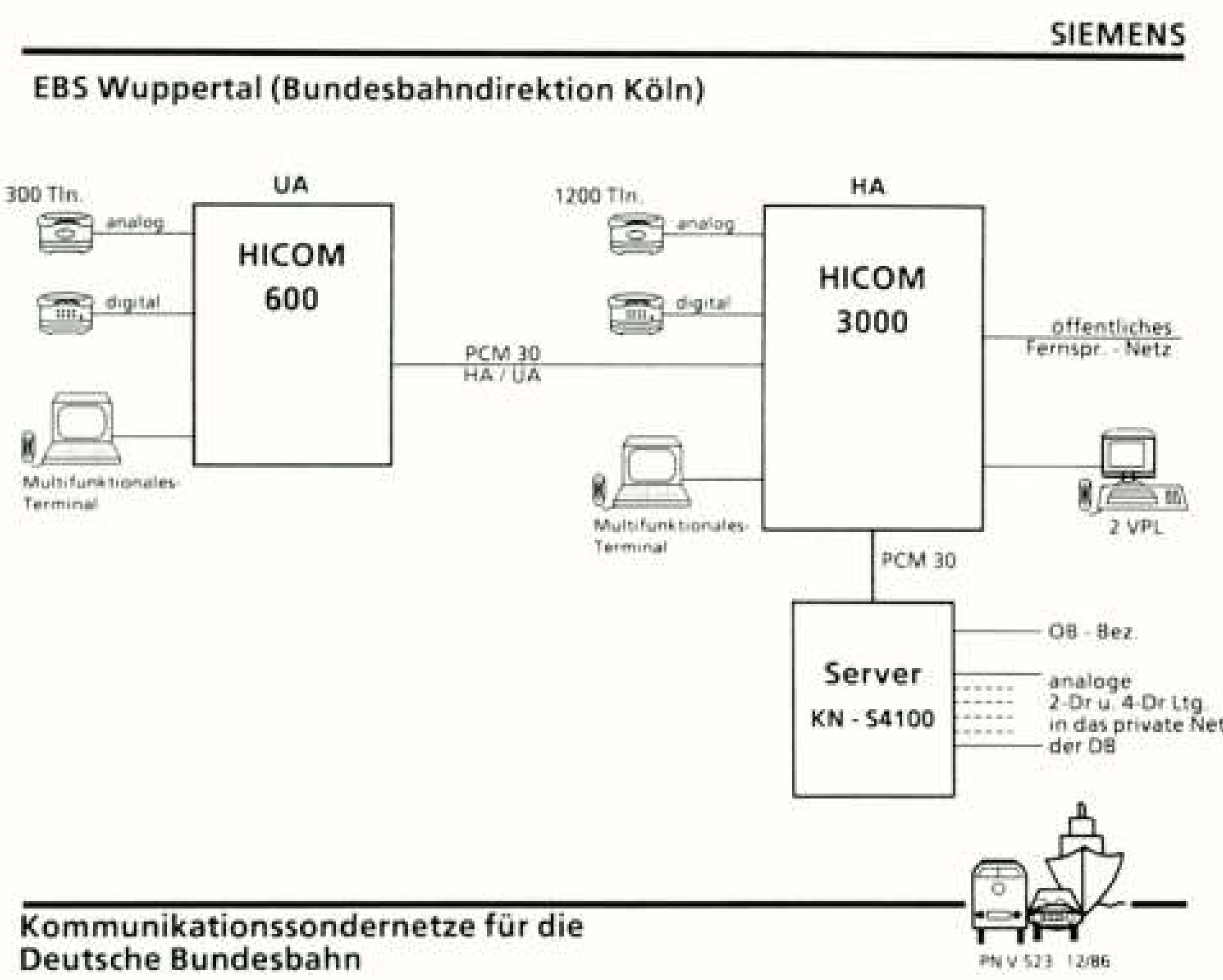

Fig. 3

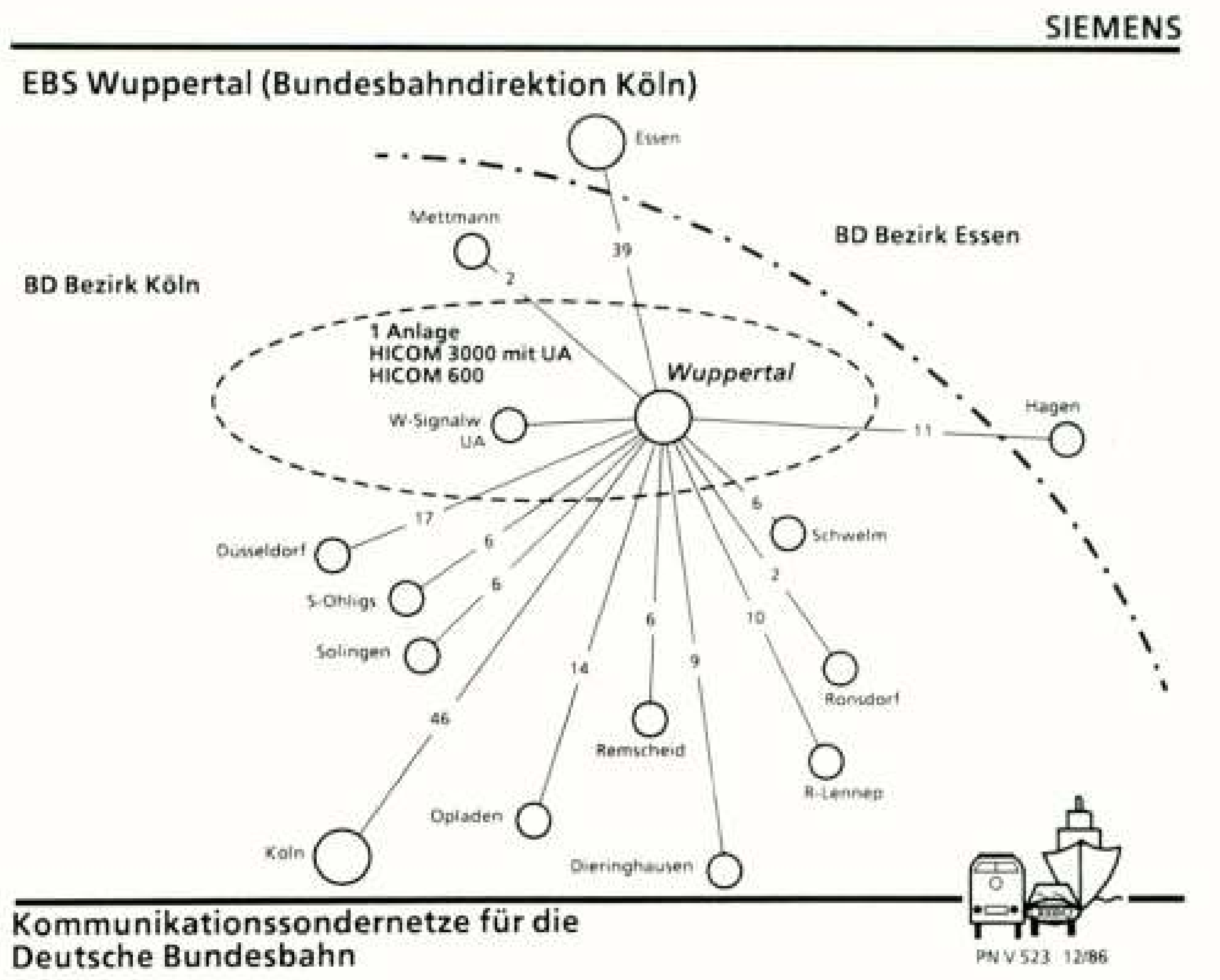

Fig. 4

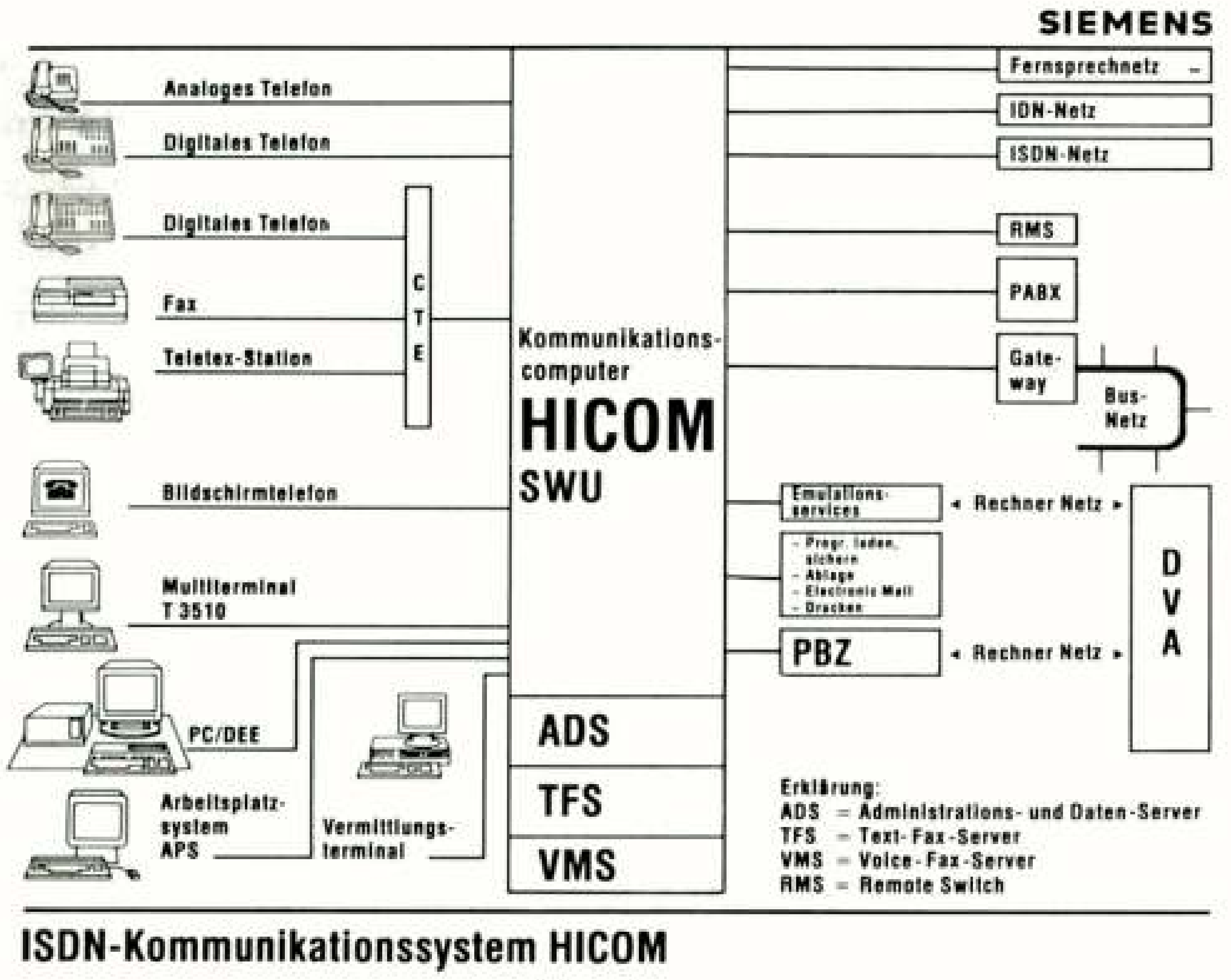

Fig. 5

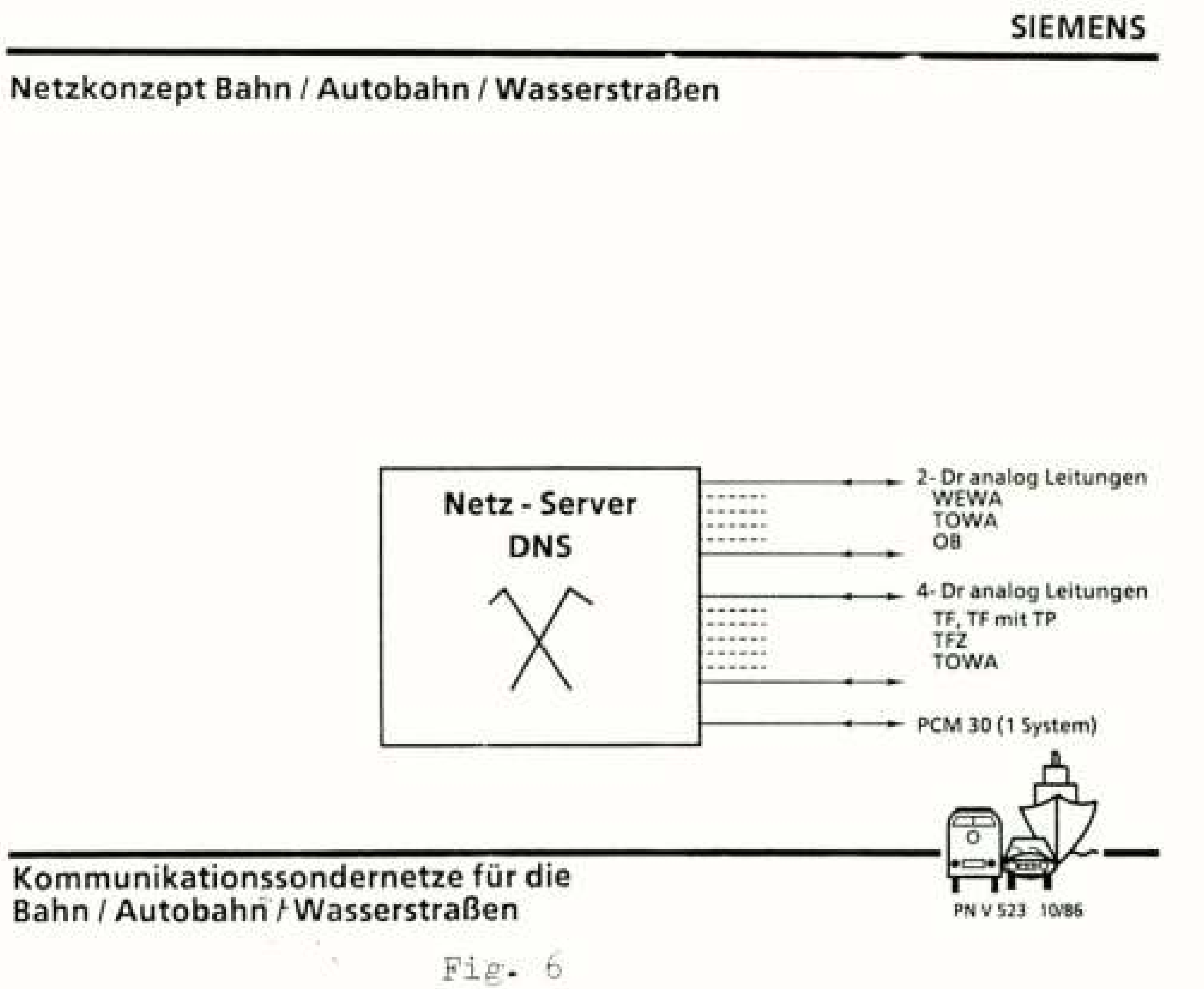

Fig. 6

moderner Digitalstechnik und Mikroelektronik, mit modularer Hardware und anwenderstrukturierter Software.

FOLIE EBS	Fig. 2
FOLIE WUPPERTAL	Fig. 3
FOLIE NETZ WUPPERTAL	Fig. 4

Diese neue Basa wird auf digitaler Basis arbeiten und im Zeitvielfach durchschalten. Es gelten die gleichen Normen wie für die digitale Übertragungstechnik, so dasz digitale Nachrichten ohne Umwandlung vermittelt werden können, wenn die notwendige digitale Übertragungstechnik zur Verfügung steht. Die Bitrate je Zeitkanal beträgt 64 kBit/sec. Die Bitintegrität ist gewahrt und für die Bitfolge gibt es keine Einschränkungen, so dasz alle digitalen Nachrichten innerhalb des 64 kBit/sec-Zeitkanals übertragen werden können.

Da im Vermittlungssystem nur digitale Nachrichten übermittelt werden können, müssen analoge Nachrichten in die digitale Form gebracht werden. Die Umwandlung von Sprache wird nach der CCITT-Empfehlung G711 vorgenommen werden. Erfolgt die Analog/Digital-Umwandlung im System, so kann die Teilnehmerstation wie bisher ausgebildet und die Anschlussleitung analog genutzt werden (z.B. analoges Telefon).

Bausteine des elektronischen Basasystems

A. HICOM

Dieses System ermöglicht den angeschlossenen Teilnehmern bereits bei Inbetriebnahme die Nutzung von ISDN-Leistungsmerkmalen inhouse.

FOLIE HICOM Fig. 5

Zu einem spätern Zeitpunkt, ab ca. Mitte bis Ende 1989, können evtl. über dann vorhandene digitale Ortsvermittlungsstellen der deutschen Bundespost diese ISDN-Leistungsmerkmale bundesweit genutz werden. Als Übertragungsmedium dient dann das ISDN-Netz der deutschen Bundespost.

Die Überführung des privaten bahneigenen Übertragungsnetzwerkes in ein digitales Netzwerk mit der Möglichkeit, ISDN netzweit zu nutzen, stellt den letzten Abschnitt dieses Ausbaues dar.

B. NETZ-SERVER

Die Netz-Server werden installiert, um das bestehende analoge Netz zu bedienen. Die Vielfalt der analoge Schnittstellen, welche in den privaten Netzen auftreten, können nicht von modernen Nebenstellenanlagen, wie z.B. HICOM, realisiert werden. Hierfür haben wir spezielle Systeme entwickelt, welche auch die Verarbeitung der Rufnummernpläne speziell bei Einsatz in gemischten analogen und digitalen Netzen verarbeiten können.

Es stehen uns zwei Arten von Netz-Servern zur Verfügung:

a. KN-S 4100

Dieses System wurde speziell für private Netze entwickelt. Es kann neben den o.g. Funktionen zusätzlich Teilnehmer analoger und digitaler Art und Amtsleitungen zum öffentlichen Netz aufnehmen.
Dieses System hat eine Kapazität von 4.096 Ports (Beschaltungsmöglichkeit). Je Port kann ein analoger oder digitaler Teilnehmer, je 2 Ports eine Leitung vorgesehen werden.
Dies ist speziell für Kunden vorteilhaft, welche sich für eine Übergangszeit noch nicht für ISDN festlegen möchten. In dieser Zeit können Teilnehmer und Amtsleitungen an den Server angeschlossen werden. Zu einem spätern Zeitpunkt kann der Server auf seine Netzfunktion zurückgebaut und ein ISDN-System nachträglich angeschlossen werden.

Die freiwerdenden Ports können mit analogen oder digitalen Fernleitungen belegt werden. Dies bedeutet, dasz das System keine Festgeschriebenen Ausbauformen erfordert.

b. DNS

Dieses System wurde als kleine Server-Variante entwickelt. Es kann max. 96 Fernleitungen + Teilnehmer. Die Aussage über die Ausbaubarkeit mit Teilnehmer gilt wie bei KN-System 4100. Hier ist jedoch die Einschränkung notwendig, dasz nur analoge Teilnehmer und keine Amtsleitungen angeschlossen werden können. Ebenso kann nur ein PCM 30-System verwendet werden. Sollte zu einem spätern Zeitpunkt ein Nebenstellenteil angefügt werden, musz diese PCM 30-Verbindung hierfür vorgesehen werden.

SIEHE FOLIEN DNS Fig. 6

Bei wachsenden Digitalisierung des Netzes wird die Verbindung neuer Anlagen möglichst mit digitalen Übertragungswegen vorgenommen. Hierfür kommen für die Signalisierung zentrale Zeichenkanäle zur Anwendung.

Neben den Wahlinformationen können damit weitere Informationen, z.B. für die netzweite Anwendung von Teilnehmer-Leistungsmerkmalen sowie Informationen für Betrieb und Wartung übertragen werden. Es werden hier CCITT-genormte Zeichengabesysteme, die die netztechnischen Forderungen ohne Einschränkungen voll erfüllen und für künftige Anforderungen entsprechend konzipiert sind, eingesetzt. Die Festlegungen hierüber müssen noch getroffen werden.

PCM-Systeme werden unmittelbar in das Vermittlungssystem mit einer 2 MBit/sec-Schnittstelle angeschlossen.

NUTZEN FÜR DIE DEUTSCHE BUNDESBAHN

Nach Inbetriebnahme der ersten ISDN-fähigen HICOM bei der deutschen Bundesbahn in Wuppertal können ISDN-Leistungsmerkmale inhouse genutzt werden.

Durch die Zurverfügungstellung eines zentralen Datenkanales (CDC) können die Wartungsfunktionen, die Verwaltungsfunktionen und die Funktion der Vermittlungsplätze zentralisiert werden.

SIEHE KN-S 4100 FOLIE CDC Fig. 7

Dies bedeutet, dasz auch in einem gemischt analog-digital betriebenen Netz bereits diese Leistungsmerkmale zur Verfügung stehen. Anschliessend möchte ich darauf hinweisen, dasz speziell bei der Grösse des Netzes, welches die Deutsche Bundesbahn besteht, diese Übergangszeit ca. 20-25 Jahre dauern wird.

SIEMENS

DNG - Leistungsmerkmale (APS 3)

Data Transfer auf ZZK (CDC)

Folgende Daten werden übertragen:

CAF	(Administration Commands)	= Verwaltungs - Daten
CMF	(Maintenance Testcalls)	= Wartungs - Daten
CAS	(Centralized Operator Service	= Zentralisierte Abfrage
AMA	(Automatic Message Accounting)	= Automatische Gesprächsdatenerfassung
TM	(Traffic Measurements)	= Verkehrsdaten

Privat- und Sonder-Kommunikationsnetze K PN VN

Fig. 7

Voordracht gehouden tijdens de 347e werkvergadering.

Op de Eurel General Assembly in Oslo werd besloten een proef te nemen met het opstellen en verspreiden van een "Eurel Newsletter".

Voor de uitvoering van dit besluit werd de eerste Newsletter samengesteld uit een aantal items, welke de landelijke verenigingen op verzoek van Eurel als mogelijke bijdragen aan deze eerste newsletter hadden toegestuurd. De zes items die werden geselecteerd werden door het bestuur van Eurel aan de besturen van de landelijke verenigingen toegestuurd met het verzoek te overwegen deze te publiceren.

De redaktie heeft slechts één item belangrijk genoeg gevonden om te publiceren. U vindt dit onder de titel "VDE Chairman's address to Eurel" hierna.

Tevens leek het nuttig de Resolution van Eurel op te nemen. Jaarlijks stelt Eurel zo'n resolutie op. Deze worden ter publikatie aan de verenigingen aangeboden. Dit jaar gaat de resolutie over kernenergie. Het onderwerp wisselt van jaar tot jaar.

VDE CHAIRMAN'S ADDRESS TO EUREL

Dr. C. Marnet, Chairman of VDE (Verband Deutscher Elektrotechniker) during 1985-86 and President of EUREL in 1987 addressed the 1986 EUREL General Assembly in Oslo on the subject of nuclear power after Chernobyl. He stressed the role of electrical engineers in reducing the risks associated with nuclear plants and ensuring that safety measures are co-ordinated and implemented worldwide. He pointed out that mankind now relies on technology and that everyone had a responsibility to maximise its usefulness while reducing the risks. Furthermore, those risks should be borne by the highly industrialised countries who could afford expensive nuclear power plants enabling less developed countries to burn fossil fuels.

Dr. Marnet also reported on some of VDE's activities. In particular he refered to the Technologiezentrum (Technology Centre) in West Berlin which has been run since 1978 by the German Association of Engineers with the co-operation of the Federal Ministry of Research and Technology. This is a private limited company with a full-time staff of almost 100. The centre's task is to initiate innovations in small and medium-sized business and stimulate the development and application of new technology - particularly microelectronics. The centre also offers a consultancy service giving advice on the formation of companies and on dealing with international competition. The Technology Centre also co-operates closely with a group of about 200 scientists, development engineers and managers who promote microelectronics through basic training, continuing education and intensive public relations work.

(from the General Secretary of Verband Deutscher Elektrotechniker).

R e s o l u t i o n on

"MORE SAFETY IN NUCLEAR TECHNOLOGY THROUGH INTERNATIONAL STANDARDS"

The accident in the nuclear power plant at Chernobyl in the Ukraîne has disturbed and occupied the minds of people all over the world. The question of the usefulness of power generation from nuclear energy and what limits should be placed on it has been raised once again.

EUREL has previously issued Resolutions on improving safety, reprocessing fuel and dealing with nuclear waste and, in particular, constructing in good time of up-to-date reactors. These resolutions issued in 1975 and 1981 stress the importance of expanding the contribution of nuclear power to the world's sources of energy.

As a consequence of the Chernobyl accident, the EUREL General Assembly at its meeting in Oslo in September 1986 looked again at the use of Nuclear Energy.

EUREL confirmed the views expressed in its 1975 and 1981 Resolutions and, in particular, that with modern professional engineering standards rigorously enforced there can be no practical objection to an expansion of the nuclear energy programme. However in the light of recent experience, EUREL agreed the following statement:

Nuclear energy should not be abandoned for short-term emotional reasons. Apart from the small portion of regenerative energies, the generation of nuclear energy is at present the only available large-scale technology by means of which electricity can be generated in a manner which is compatible with the environment and which helps to conserve resources. When using nuclear energy, emphasis should be placed on the principle of "Safety first" all over the world.

EUREL proposes that:

1. Research and development in the field of nuclear energy, nuclear safety, the treatment of nuclear waste and the operational use of nuclear power plants should be intensified on an international level.
2. There shall be international harmonization of safety regulations and standards.
3. In accordance with the IAEA conventions passed in August 1986 an international system should be set up for early warning to all countries in the event of breakdown and accidents in nuclear power plants.
4. A network of international monitoring stations should be set up for measuring excessive levels of radioactivity.

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BENELUX SYMPOSIUM OVER INFORMATIETHEORIE

Vanaf 1980 ontmoeten de beoefenaren van de Informatietheorie in de Benelux elkaar jaarlijks op een tweedaags symposium. Die symposia werden gehouden op verschillende plaatsen in Nederland en België. Het achtste symposium wordt gehouden in

Deventer op 20 en 21 mei 1987

Er worden voordrachten gehouden, vast te leggen in een boekje, en er is ruim gelegenheid voor onderlinge contacten in een prettige omgeving.
Beoefenaren van de informatietheorie die geen bericht hebben ontvangen en wel belangstelling hebben, worden uitgenodigd dit kenbaar te maken aan

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