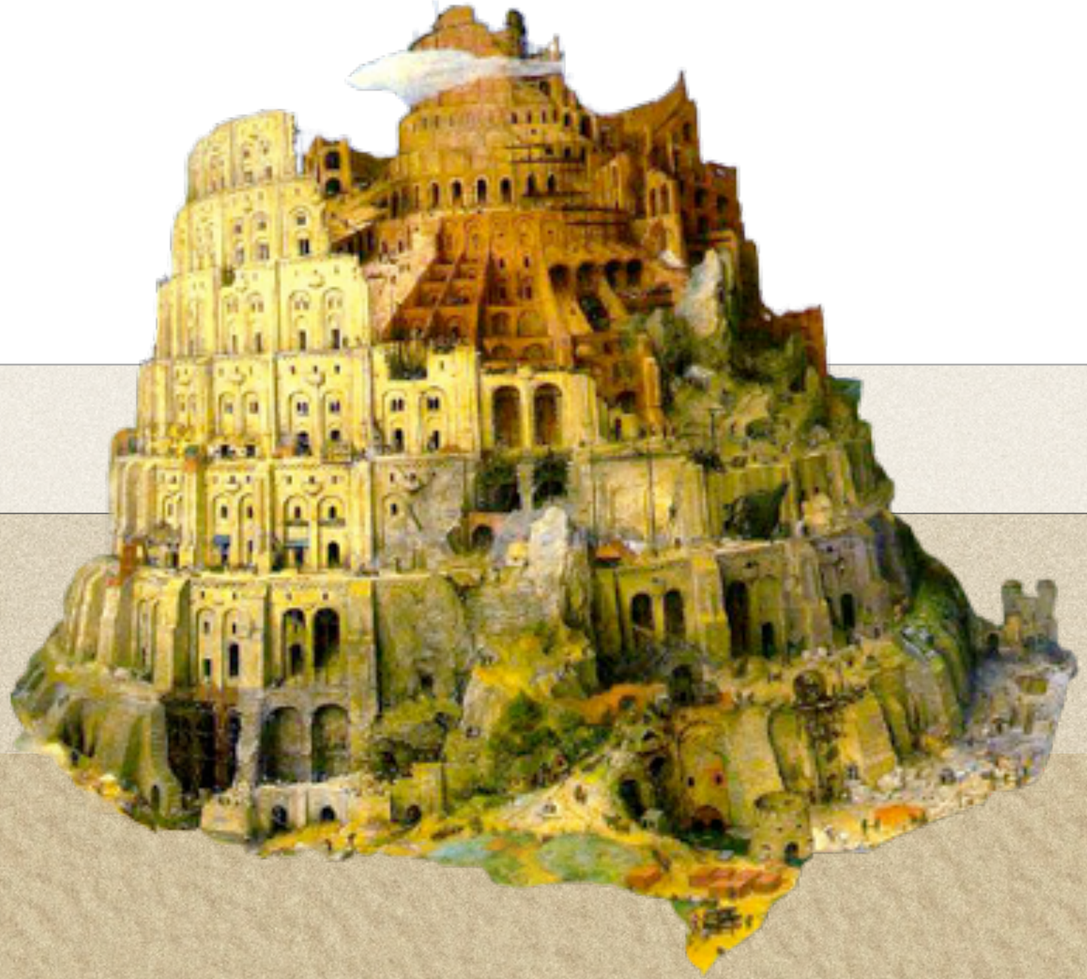
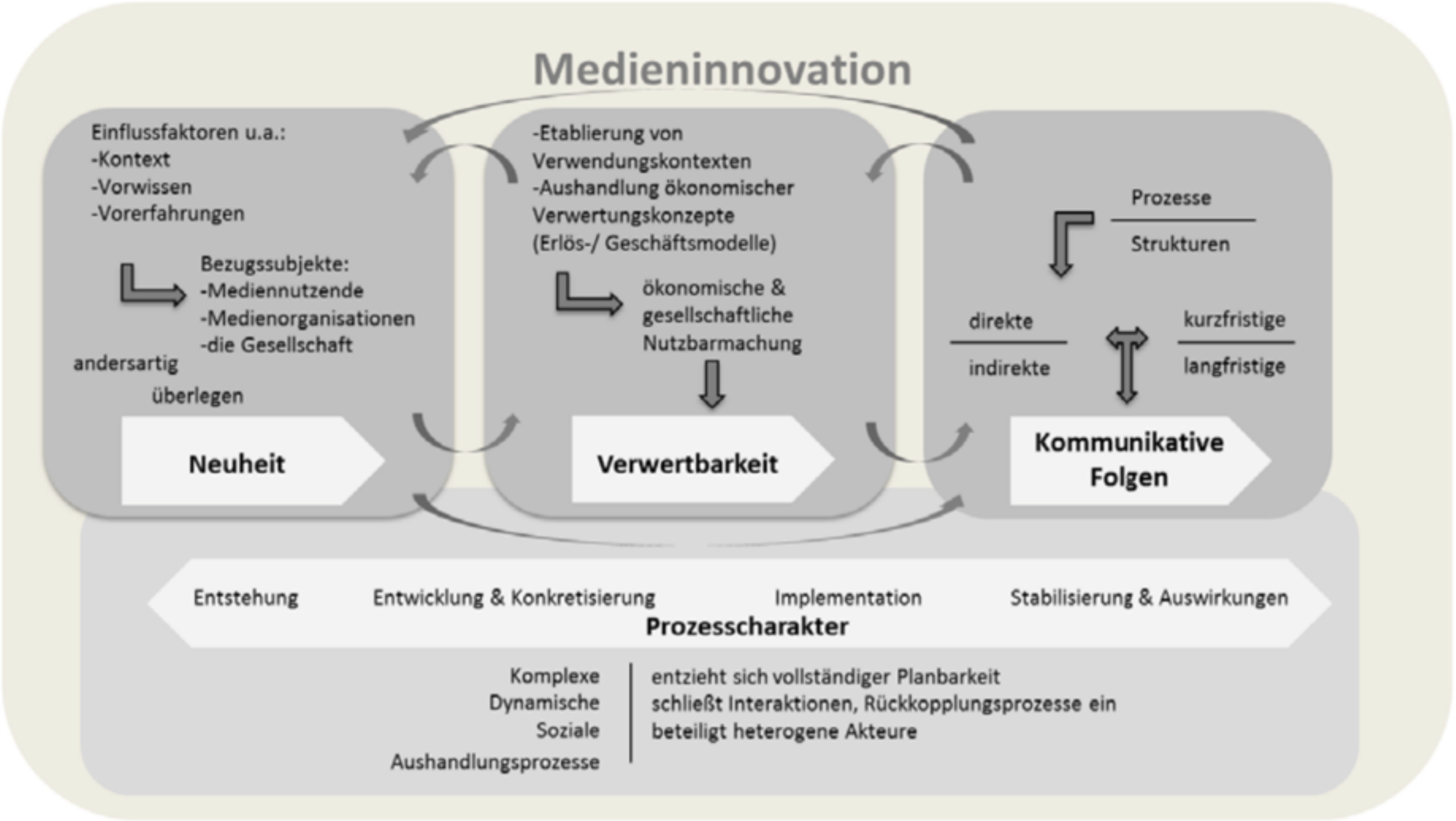
Die Erfindung des Internets



Media Innovations

Prof. Dr. Jochen Koubek

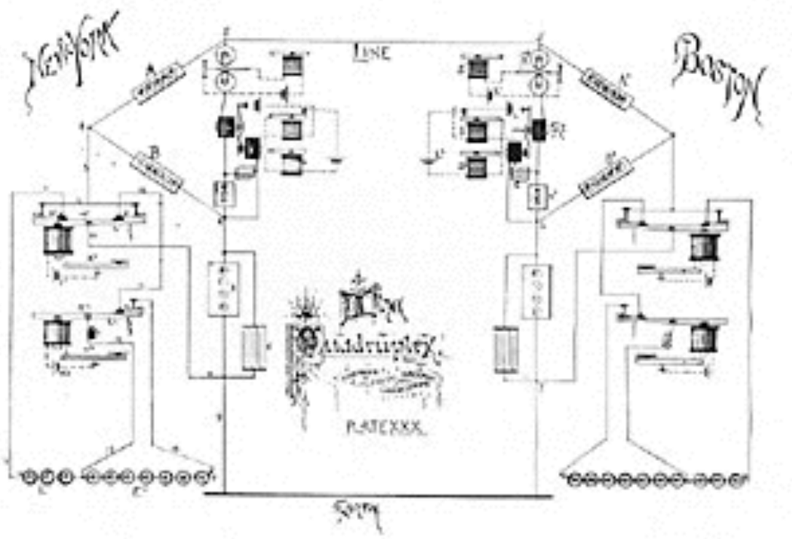


Leyla Dogruel (2013): Eine kommunikations- wissenschaftliche Konzeption von Medieninnovationen. Begriffsverständnis und theoretische Zugänge, S. 367.

Telegrafenamt

Wachstum als Innovationstreiber

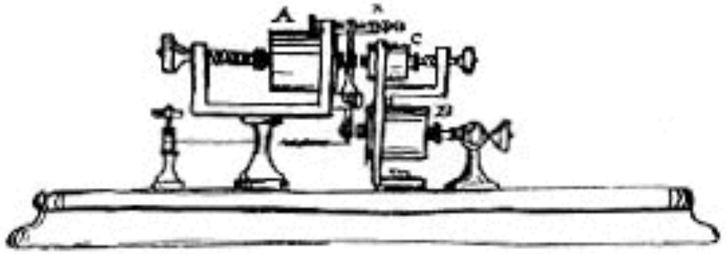
Multiplex-Telegraphie



Thomas Edison

Innovation als Suche

Quadruplex instruments



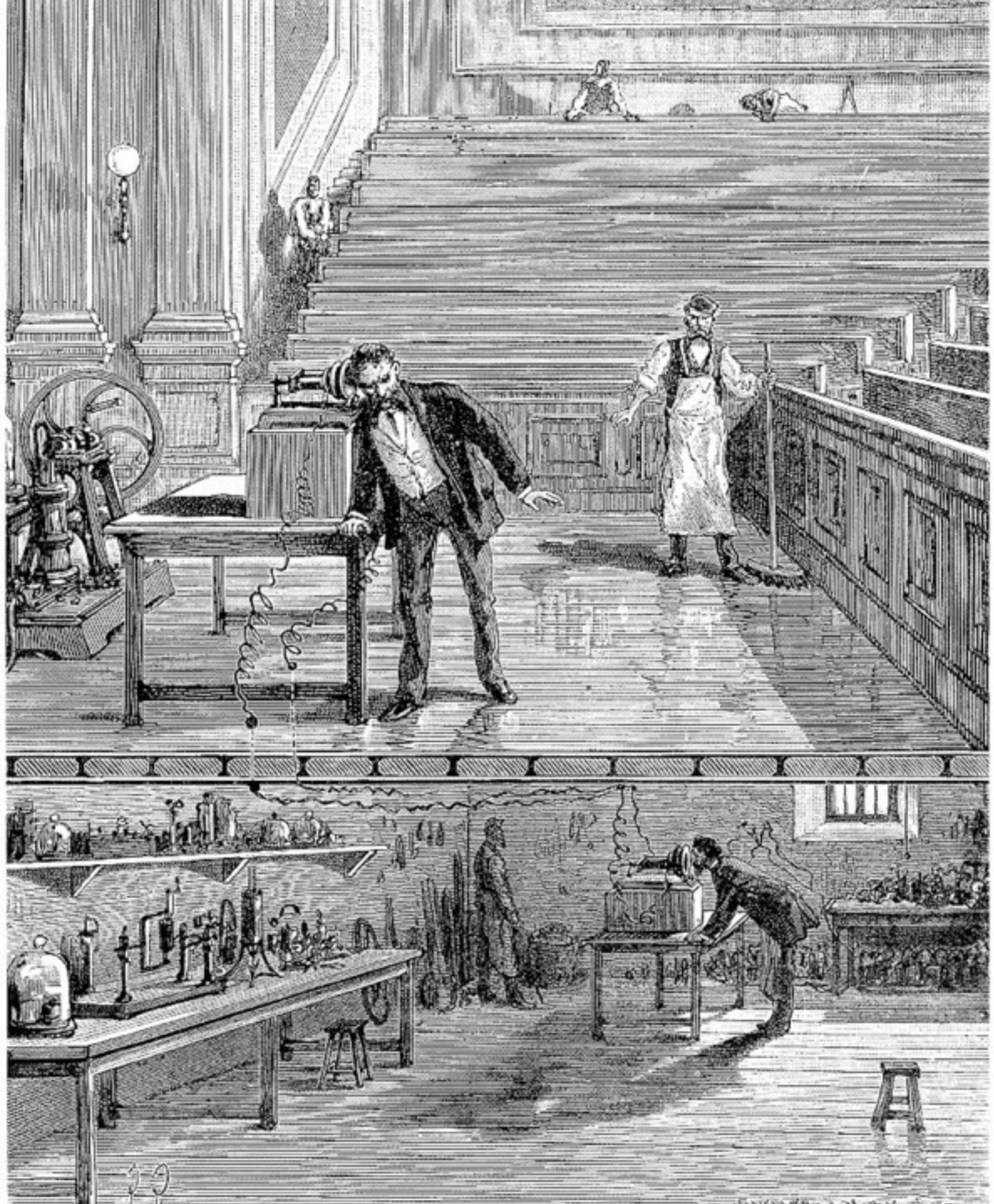
Quadruplex, 1873

Harmonischer Telegraph

Elisha Gray, 1876

»Of all the men who DIDN'T invent the telephone, Gray was the nearest.«
E. M. Barton

Innovation als Nebeneffekt



Telefon

Innovation als Durchbruch

Bell 1876

SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. XXXVII., No. 14.] NEW YORK, OCTOBER 6, 1877. [$3.20 per Annum.

THE NEW BELL TELEPHONE.

Professor Graham Bell's telephone has of late been somewhat simplified in construction and also arranged in more compact portable form. It consists now of but three metal portions and is contained in a casing of wood or light hard rubber, but five and five eighths inches in length and two and seven eighths inches in diameter at the enlarged end. It will be remembered that this telephone differs from all others in that it involves the use of no battery nor of any extraneous source of electricity whatever. The only current employed is that generated by the voice of the speaker himself.

The simplicity of the construction is clearly shown in Fig. 1 of our engravings, in which both sectional and exterior views of the device are given. Referring to the sectional view, A is a permanent magnet, held by the screw shown in the rear. Around one end of this magnet is wound a coil, B, of fine insulated copper wire (silk covered), the ends of which are attached to the longer wires, C, which extend to the rear and terminate in the binding screws, D. In front of the pole and

Fig. 1.

BELL'S NEW TELEPONE.

coil, B, is a soft iron disk, E. Finally the whole is inclosed in a wooden casing having an aperture in front of the disk, and which, besides serving to protect the magnet, etc., acts somewhat as a resonator.

The principle of the apparatus we have already explained in some detail, but it may be summarized here as follows: The influence of the magnet induces all around it a magnetic field, and the iron diaphragm, E, is attracted towards the pole. Any alteration in the normal condition of the diaphragm, produces an alteration in the magnetic field, by strengthening or weakening it, and any such alteration of the magnetic field causes the induction of a current of electricity in the coil, B. The strength of this induced current is dependent upon the amplitude and rate of vibration of the disk, and these depend in turn upon the air disturbance made by the voice in speaking, or in any other similar source. Therefore, first, a wave of air throws the diaphragm into vibration; second, each movement produces a change in the magnetic field; and third, an induced

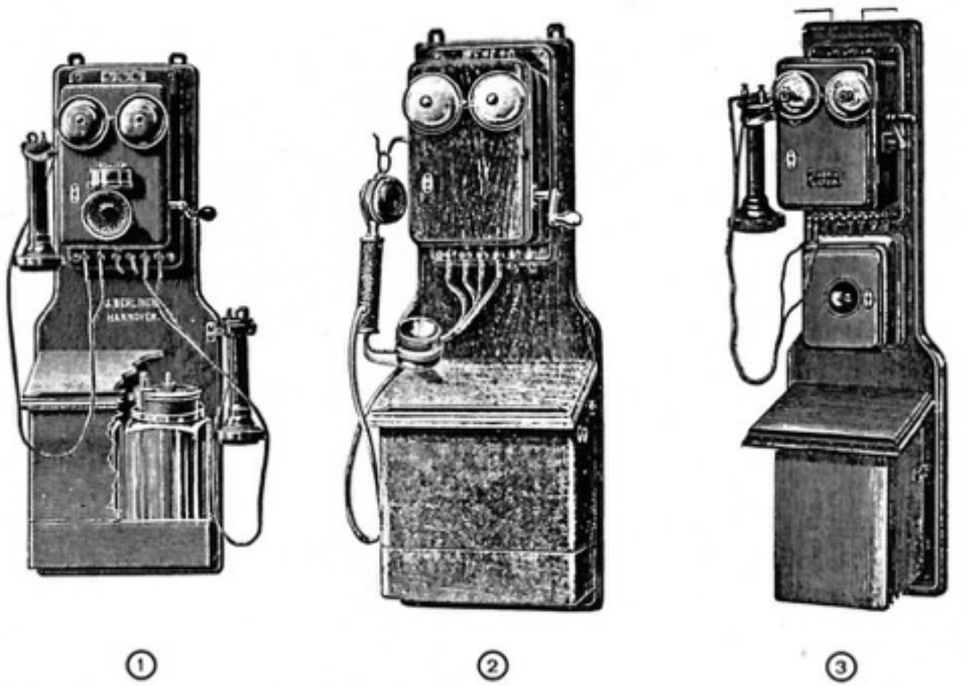
[Continued on page 222.]

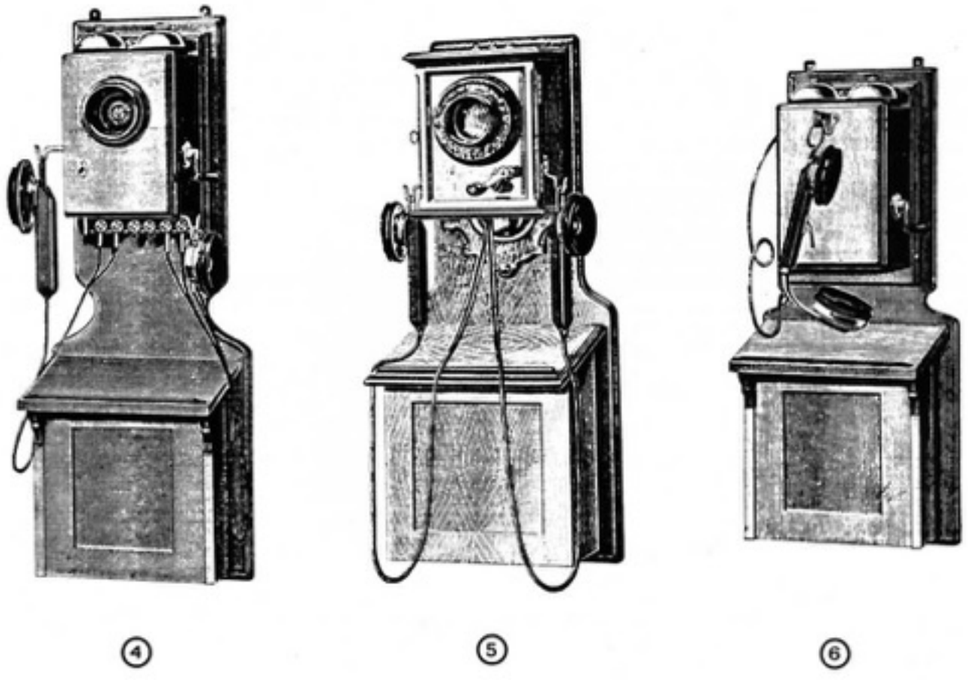
Telefon

Innovation als Marktdurchdringung

Scientific American
6. Oktober 1877

Telefon

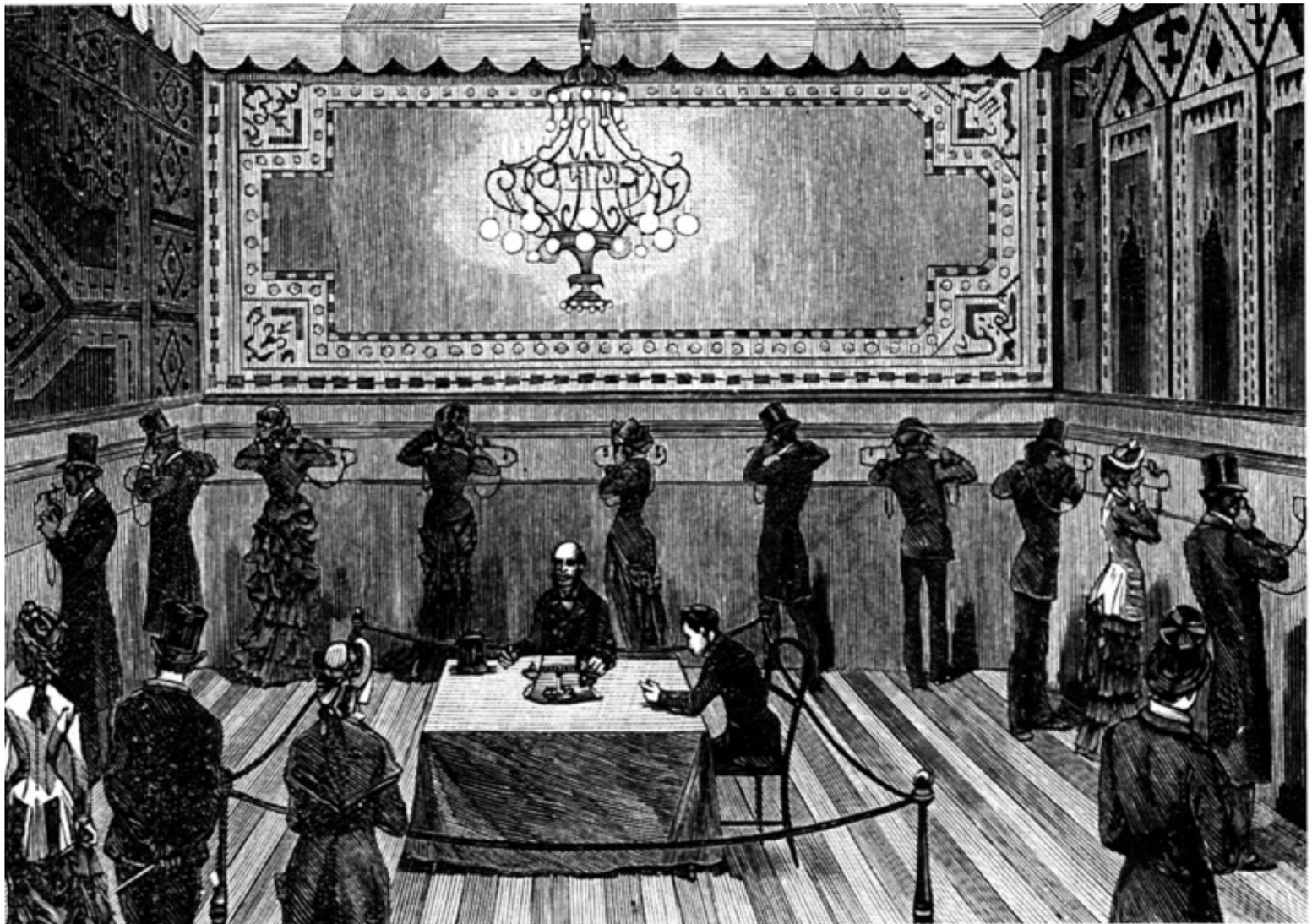




Stabilisierung der Innovation

Telefone um 1900

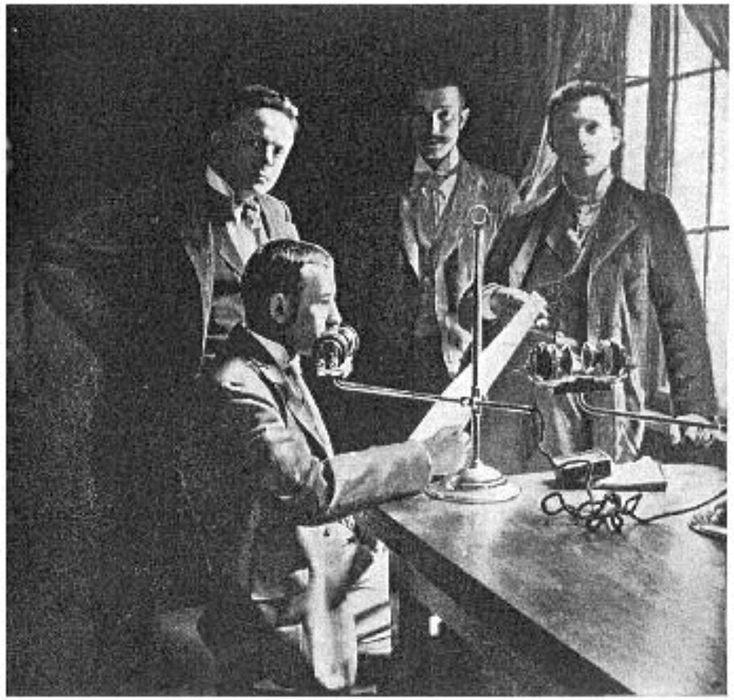
Telefon-Oper



Innovation
inspiriert Visionen

Telefonische
Opern
Übertragung
in Stereoton
Paris 1881

Telefon-Zeitung



A STENTOR READING THE DAY'S NEWS TO 6200 SUBSCRIBERS.

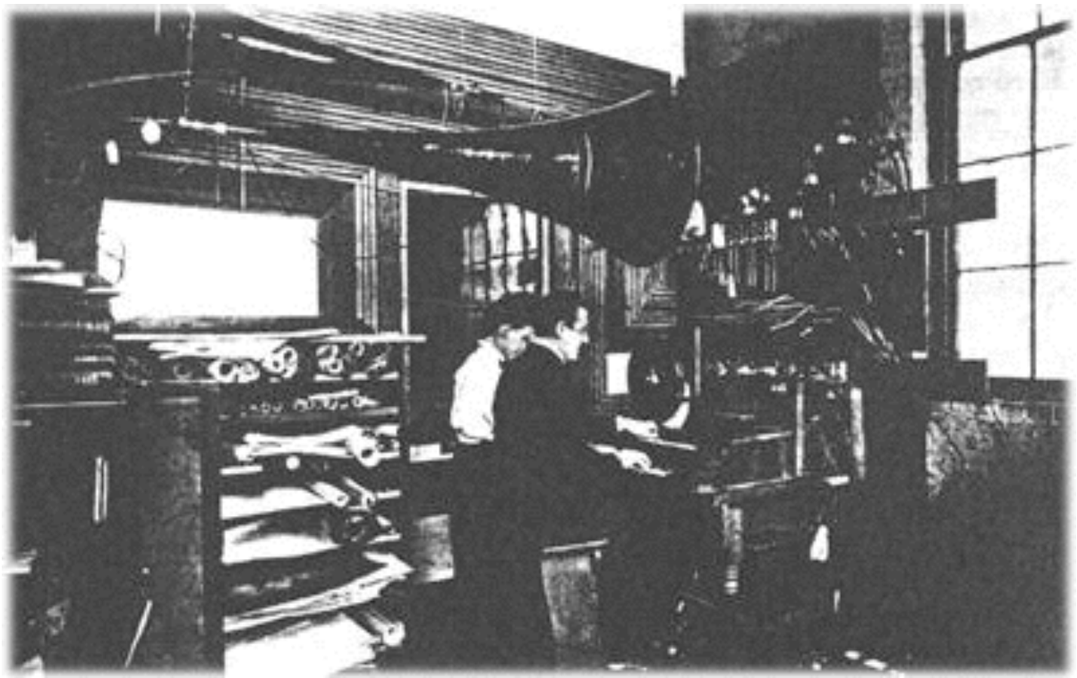
IN THE CONCERT ROOM OF THE TELEPHONE NEWSPAPER

Telefon-Hirmondo in Budapest

Telefonischer Rundfunkdienst

Ab 1884

Telefon-Muzak

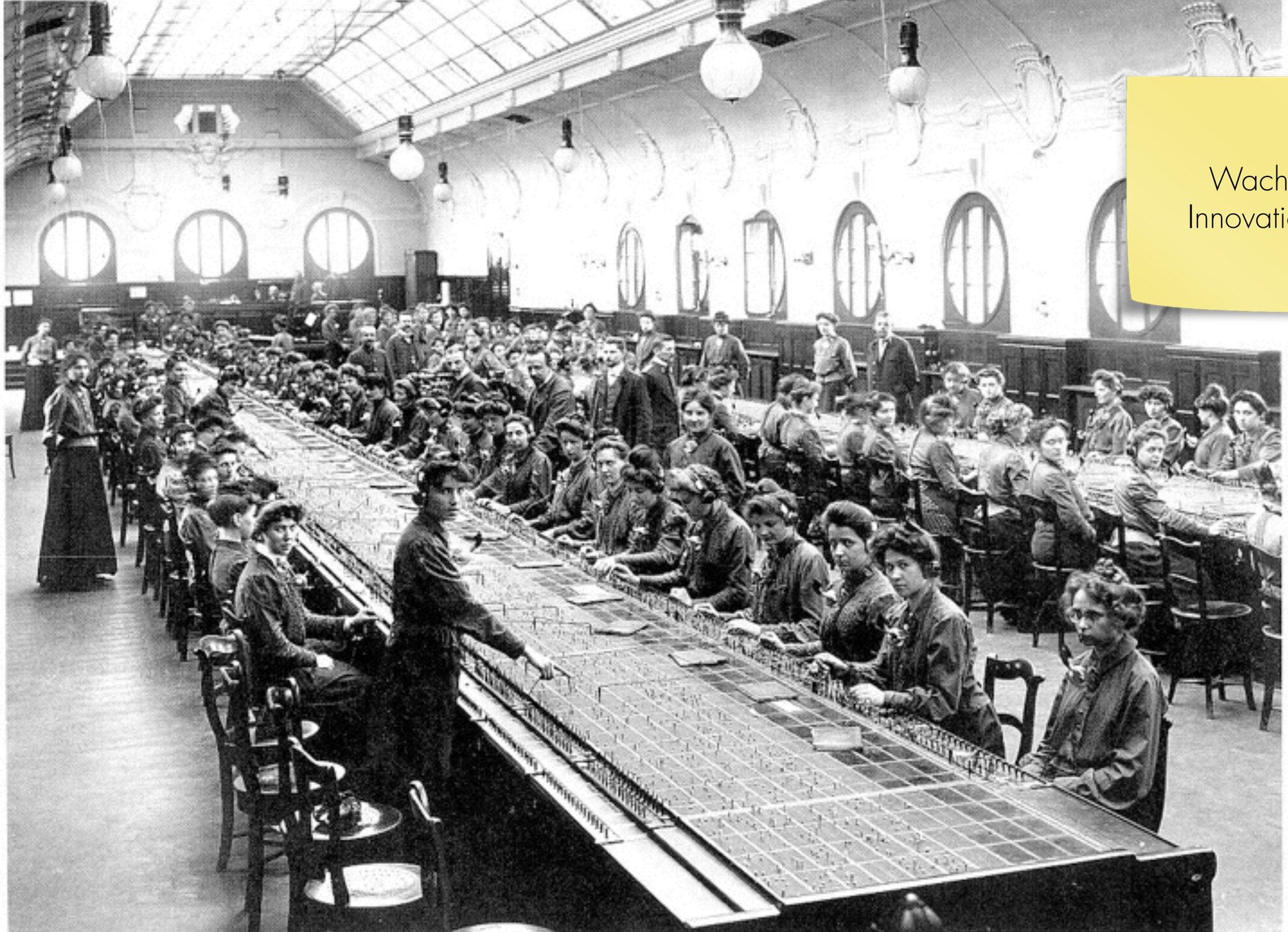


Th. Cahill: Tellharmonium, 1906

Telefon-Learning

Albert Robida

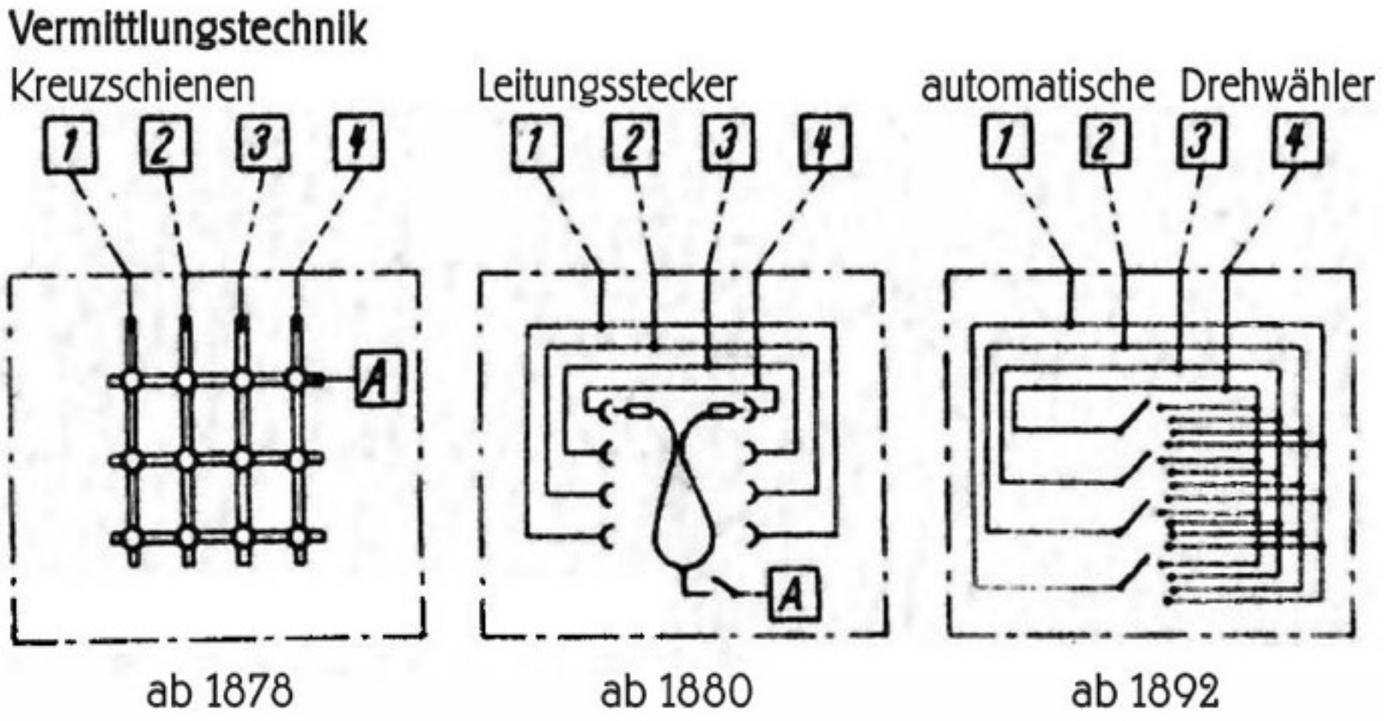
Draner; Barret

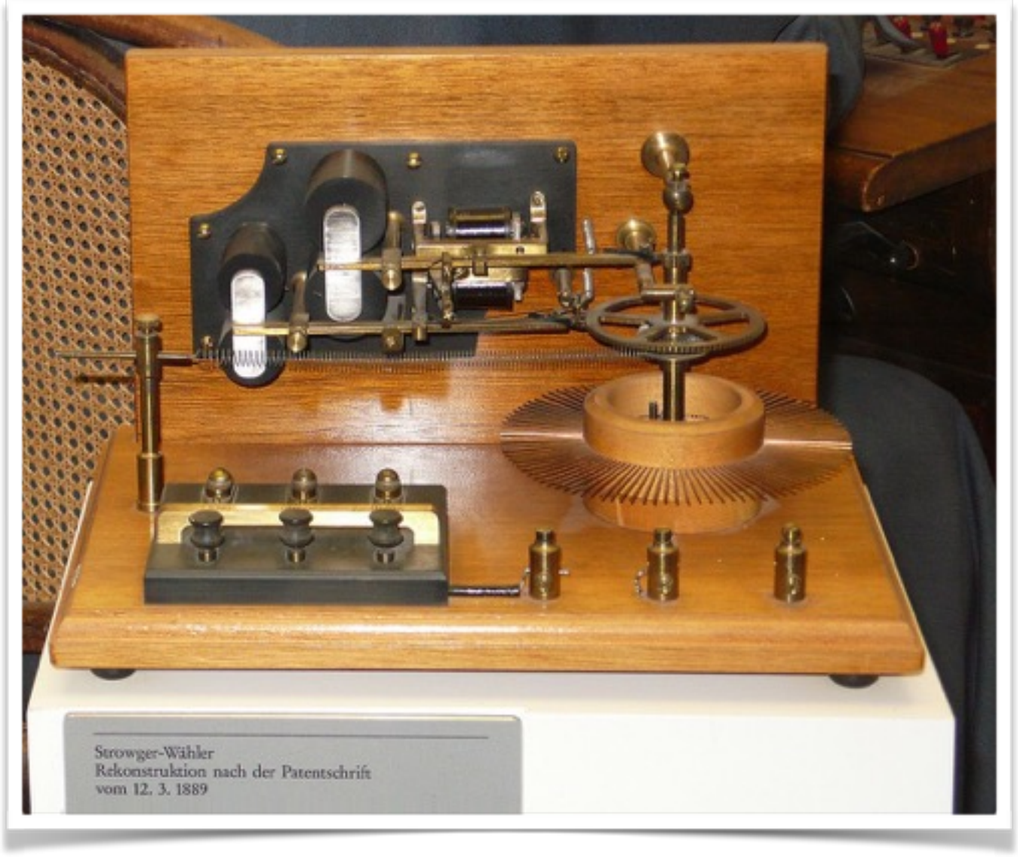


Wachstum als Innovationstreiber

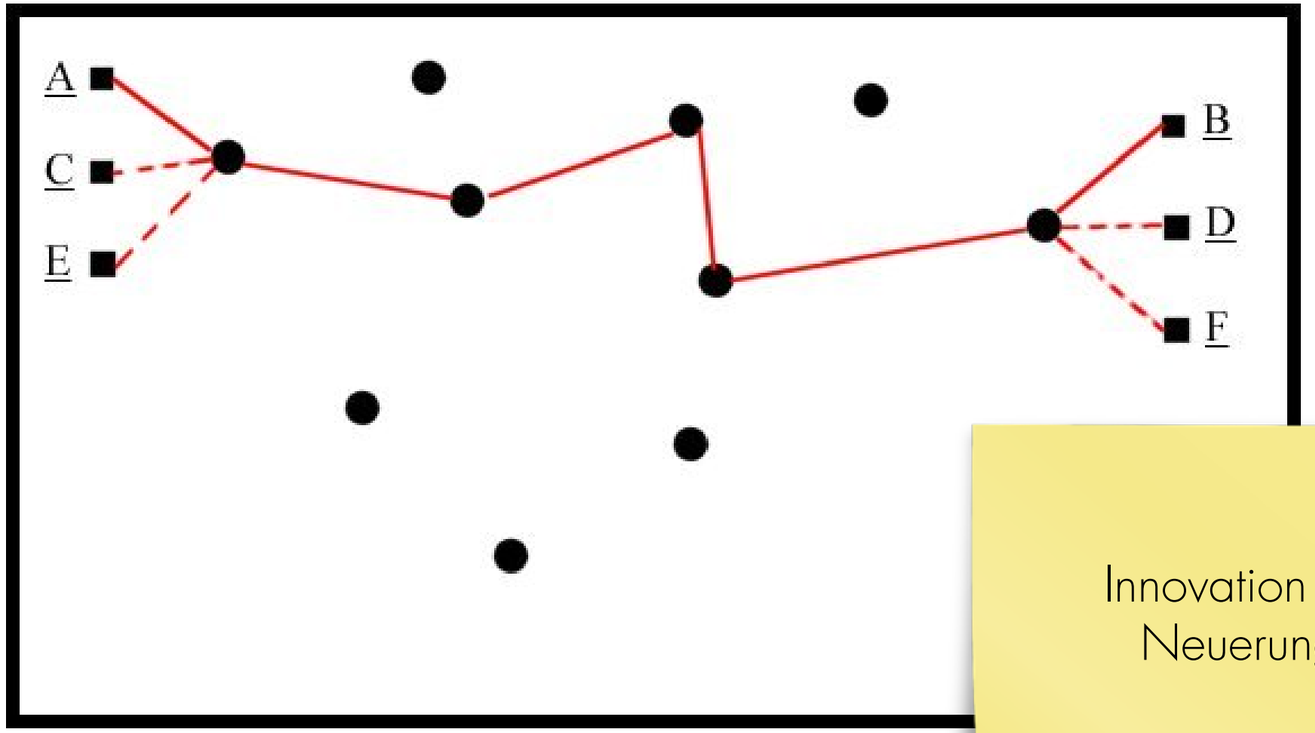
Vermittlung

Unzufriedenheit als Innovationstreiber





Leitungsvermittlung



Innovation als Neuerung

Bis 1969 waren zivile Kommunikationsnetze zentralisiert, analog und leitungsvermittelt – aus historischen, kommerziellen, politischen, militärischen und technischen Gründen.

Welche Gründe führten also zur Errichtung eines dezentralen, digitalen, paketvermittelnden Netzes?

Der historische Grund: Sputnik-Schock, 1957

Bedrohung als Innovationstreiber

Dwight D. Eisenhower

ARPA

Innovation braucht Förderung

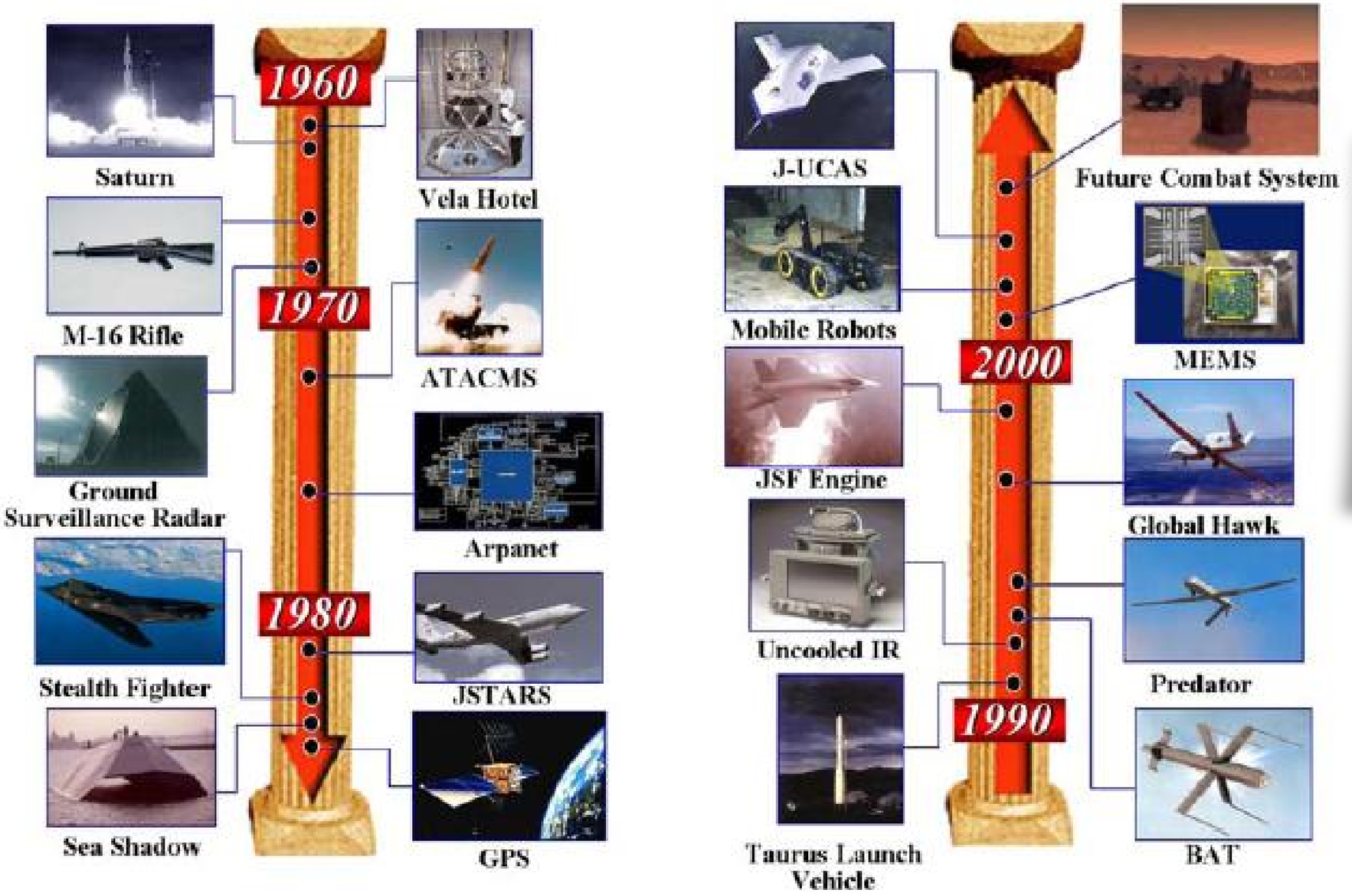
Advanced Research Project Agency

ARPA – DoD directive 5105.15 establishing the Advanced Research Projects Agency (ARPA) was signed on February 7, 1958. The directive gave ARPA the responsibility »for the direction or performance of such advanced projects in the field of research and development as the Secretary of Defense shall, from time to time, designate by individual project or by category.«

1960 wurden zivile Raumfahrtprogramme an die NASA, militärische an die Air Force, Navy etc. abgegeben, das ARPA-Budget drastisch gekürzt. ARPA konzentrierte sich auf die Förderung von Grundlagenforschungen.

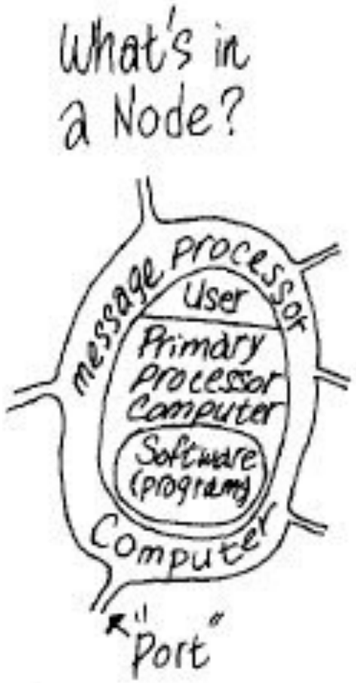
http://www.arpa.mil

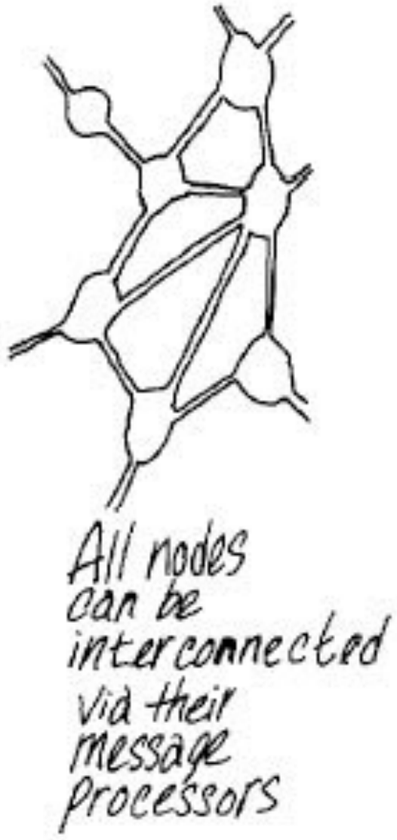
ARPA-Projekte



Medieninnovation als Infrastrukturmaßnahme

Der visionäre Grund: Synergie





Innovation als Ergebnis von Bisoziation

J. C. R. Licklider, 1915-1990

1950 MIT Lincoln Lab

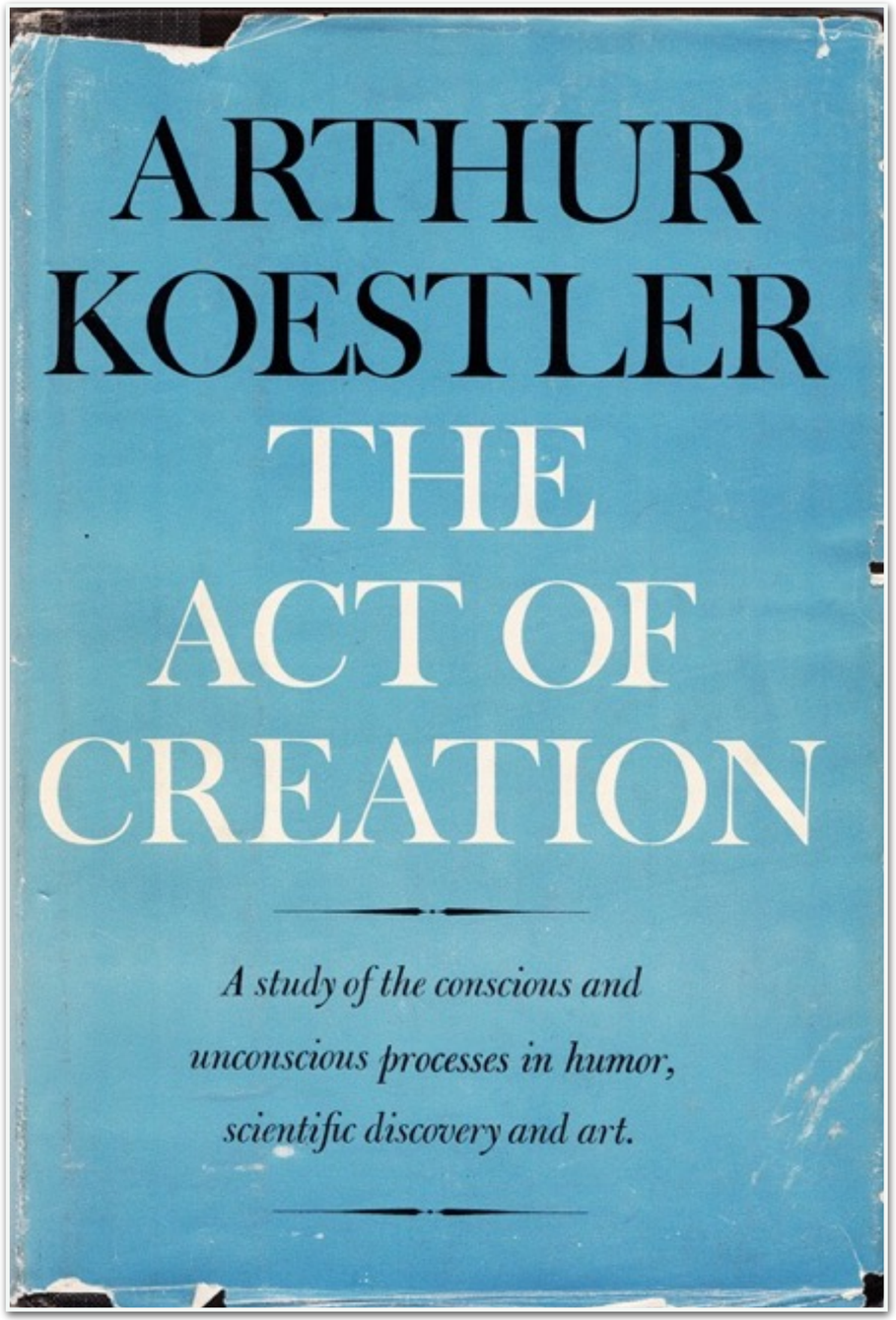
1959-1962 BBN, PDP-1, time-sharing

1960 *Man-Computer Symbiosis*

1962-1964 ARPA (IPTO)

1968 MIT, Project MAC

1968: The Computer as Communication Device



Bisoziation

Arthur Koestler
(1905-1983

Innovation als Kombination verschiedener Berzugsrahmen

IPTO

Information Processing Techniques Office

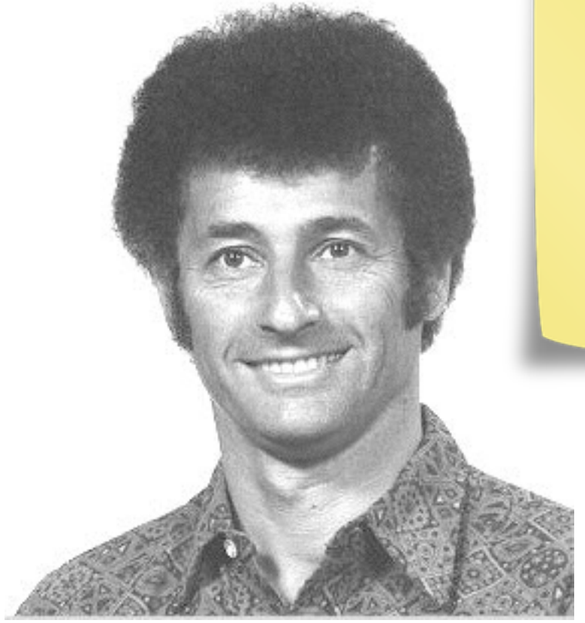
Innovation als Institutionalisierung einer Idee dank zur Verfügung stehender Ressourcen

Ivan Sutherland,
2. Leiter des IPTO 1964-1966

Bob Taylor
Projektleiter ARPANET
3. Leiter des IPTO 1966-1969

Lawrence Roberts
Chefentwickler ARPANET
4. Leiter des IPTO 1969-1973

Der technische Grund: Ressourcenknappheit



Leonard Kleinrock

MIT, 1959

Innovation als Bewältigung von Mangel

Theorem 3 - proof:

The system considered in this theorem of the Birth-Death Process examined earlier, wi

$$b_n = \lambda$$
$$d_n = \mu(C-\overline{C_n})$$

Thus, by Eqn. (A3), we find

$$P_n = P_0(\lambda/\mu)^n \; / \; [\prod_{i=1}^{n} (C-\overline{C_i})]$$

or

$$P_n = P_0 \rho^n \; / \; [\prod_{i=1}^{n}{}' (1-r_i)]$$

where $\rho = \lambda/\mu C$

$r_i = \overline{C_i}/C$

and $P_n = P_0$ for n=0, by definition.

Let us now solve for P_0:

$$\sum_{n=0}^{\infty} P_n = 1 = P_0[\,1 + \sum_{n=1}^{\infty} R_n \rho^n\,]$$

where

$$R_n = 1 \; / \; \prod_{i=1}^{n} (1-r_i)$$

Der militärische Grund: Robustheit

Institutionelles Beharrungsvermögen als Innovationshemmer

Paul Baran,

RAND, 1964

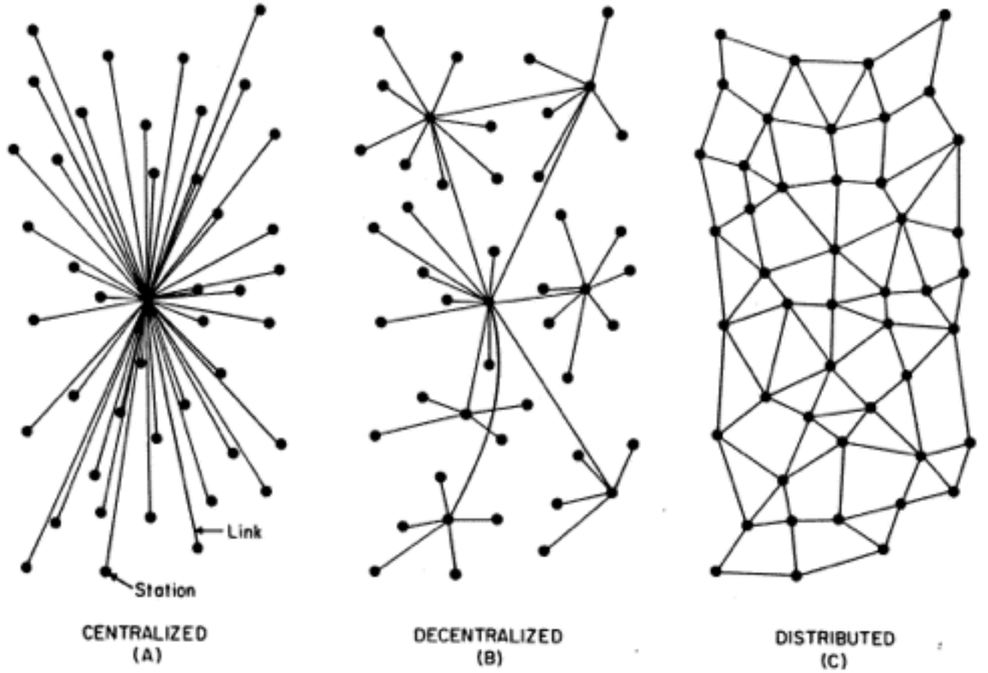


FIG. 1 — Centralized, Decentralized and Distributed Networks

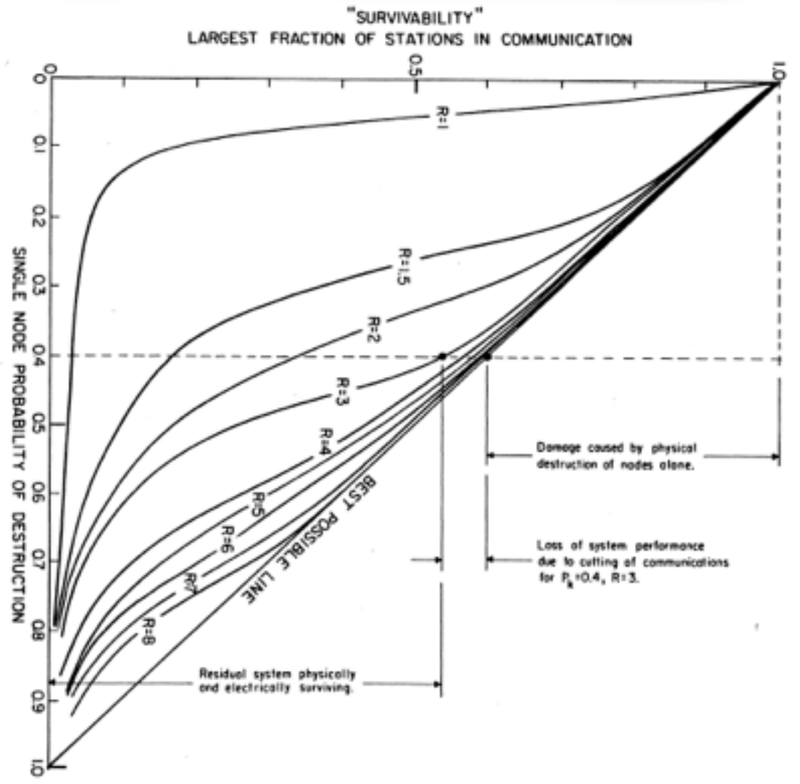
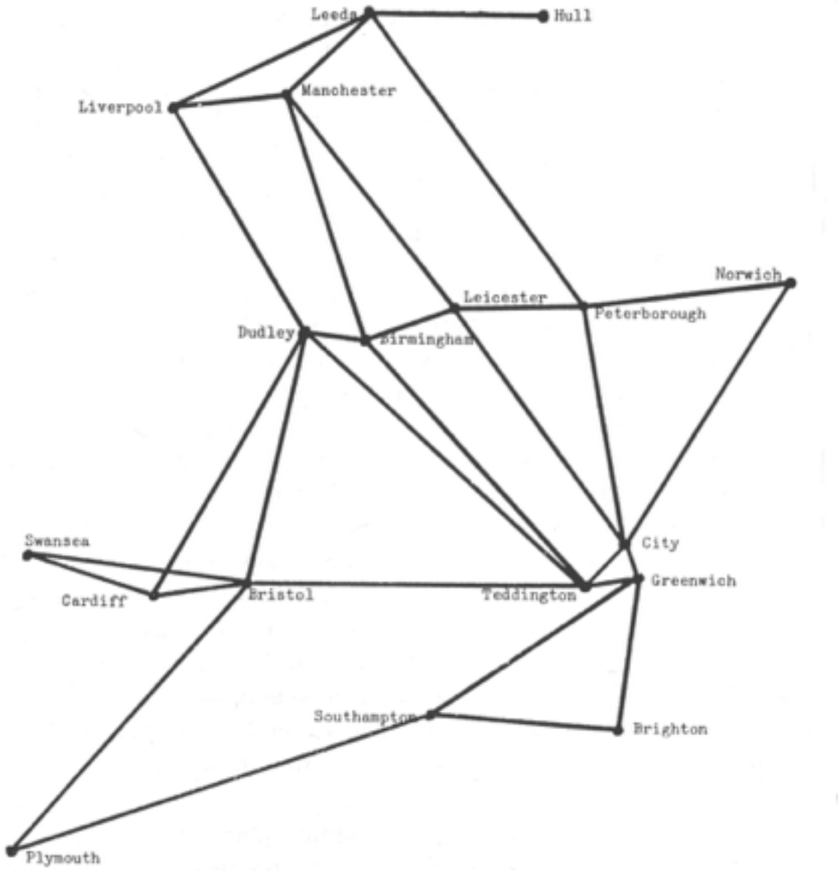


FIG. 4 — Perfect Switching in a Distributed Network — Sensitivity to Node Destruction, 100% of Links Operative.

Der ergonomische Grund: Benutzerfreundlichkeit

Donald Davies, NPL 1966
National Physical Laboratory

Innovation als Wettbewerb verschiedener Ideen



Die nationale Vision. Gebaut wurde ein Ein-Knoten-Netz

Arthur Llewellyn vom britischen Verteidigungsministerium erzählt Davies von den Arbeiten Barans .

Octal	ASCII	Meaning
HEADER		
201	SOH	characters for monitor
202	STX	characters for user
221	DCI	data for monitor
232	SS	data for user
END OF MESSAGE		
203	ETX	end of message
ACKNOWLEDGMENT		
225	NACK	message in error, repeat
234	FS	message OK, but wait
206	ACK	message OK, send next message
QUERY		
230	CNCL	resend last acknowledgment
SYNCHRONIZATION		
226	SYNC	ignore
SPECIAL FUNCTIONS		
220	DLE	help/break
233	ESC	panic.

Marill; Roberts: Toward A Cooperative Network Of Time-Shared Computers, 1966

Thomas Marill und Lawrence Roberts verbinden MIT Lincoln Labs *TX-2* mit System Development Corporations *Q-32.*

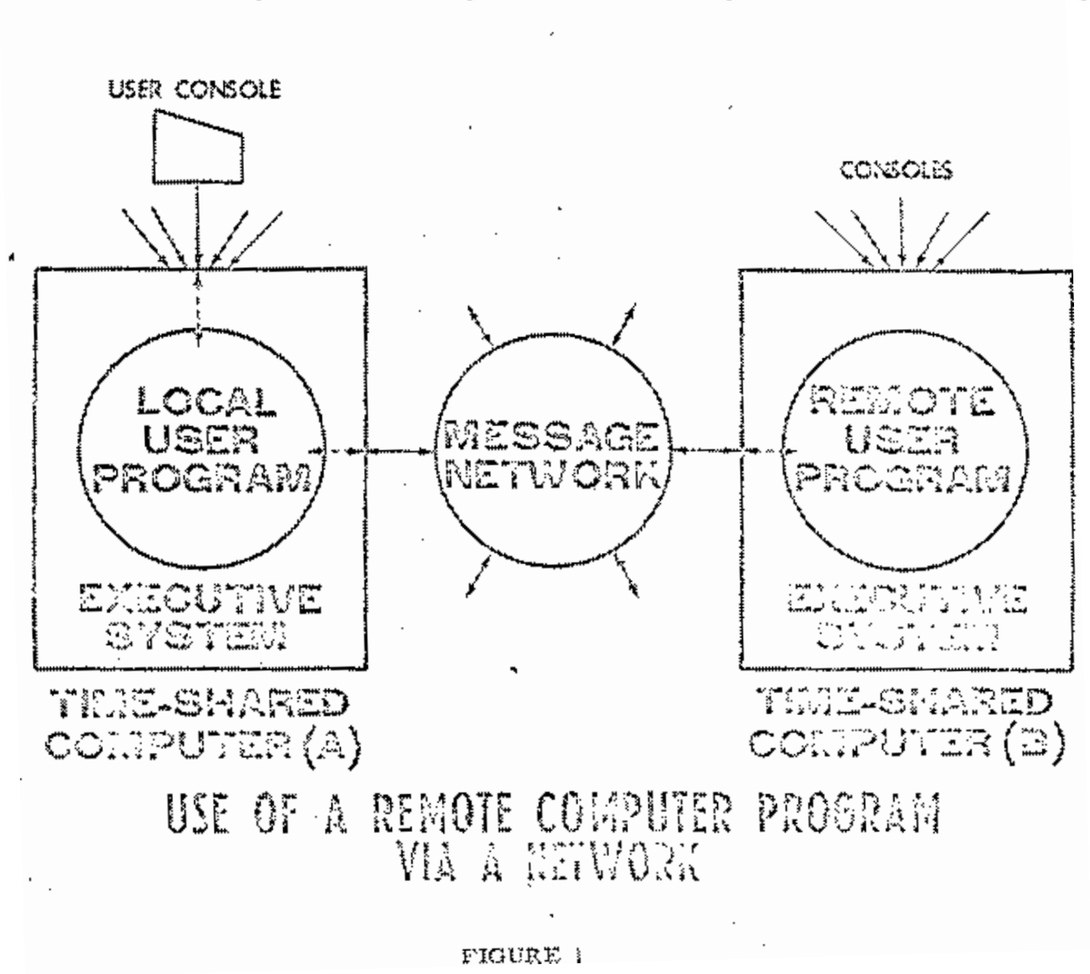
Marill führt den Begriff *Protocol* ein.

TX-2

Innovation als technische Studie

Ann Arbor, April 1967

IPTO Principal Investigator Meeting, ARPANET Design Session



Roberts: *Multiple Computer Networks and Intercomputer Communication.*

Roberts Plan, jeden Rechner durch eine eigene Software mit dem Netz zu verbinden, findet wenig Zustimmung.

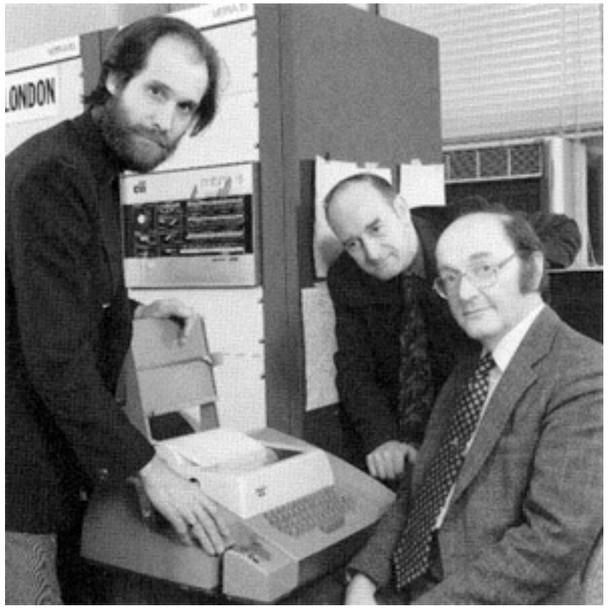
Wesley Clark schlägt vermittelnde Computer vor.

Wesley Clark, Laboratory Instrument Computer (LINC) , 1962

Innovation als Kompromiss

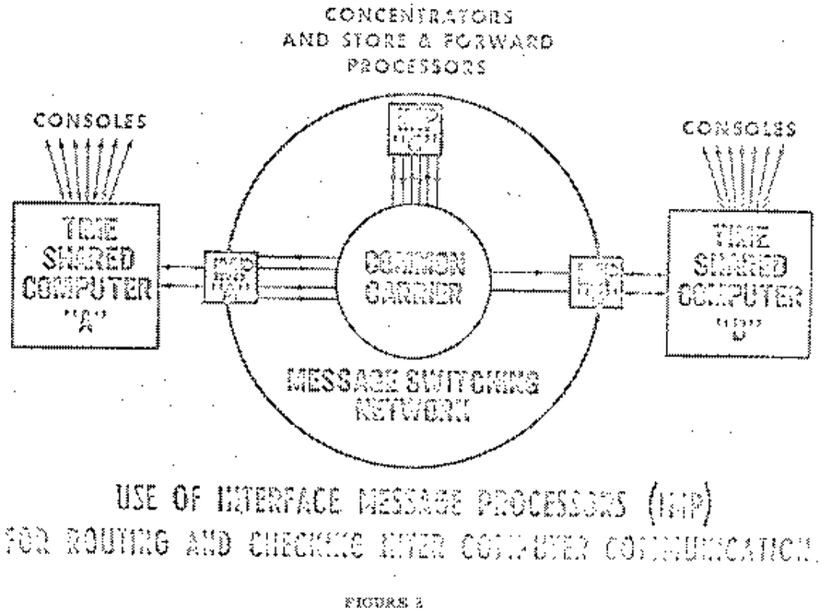
Gatlinburg, Oktober 1967

ACM Symposium on Operating System Principles



NPL: Roger Scantlebury, Derek Barber, Donald Davies

Innovation als Wissensnetzwerk



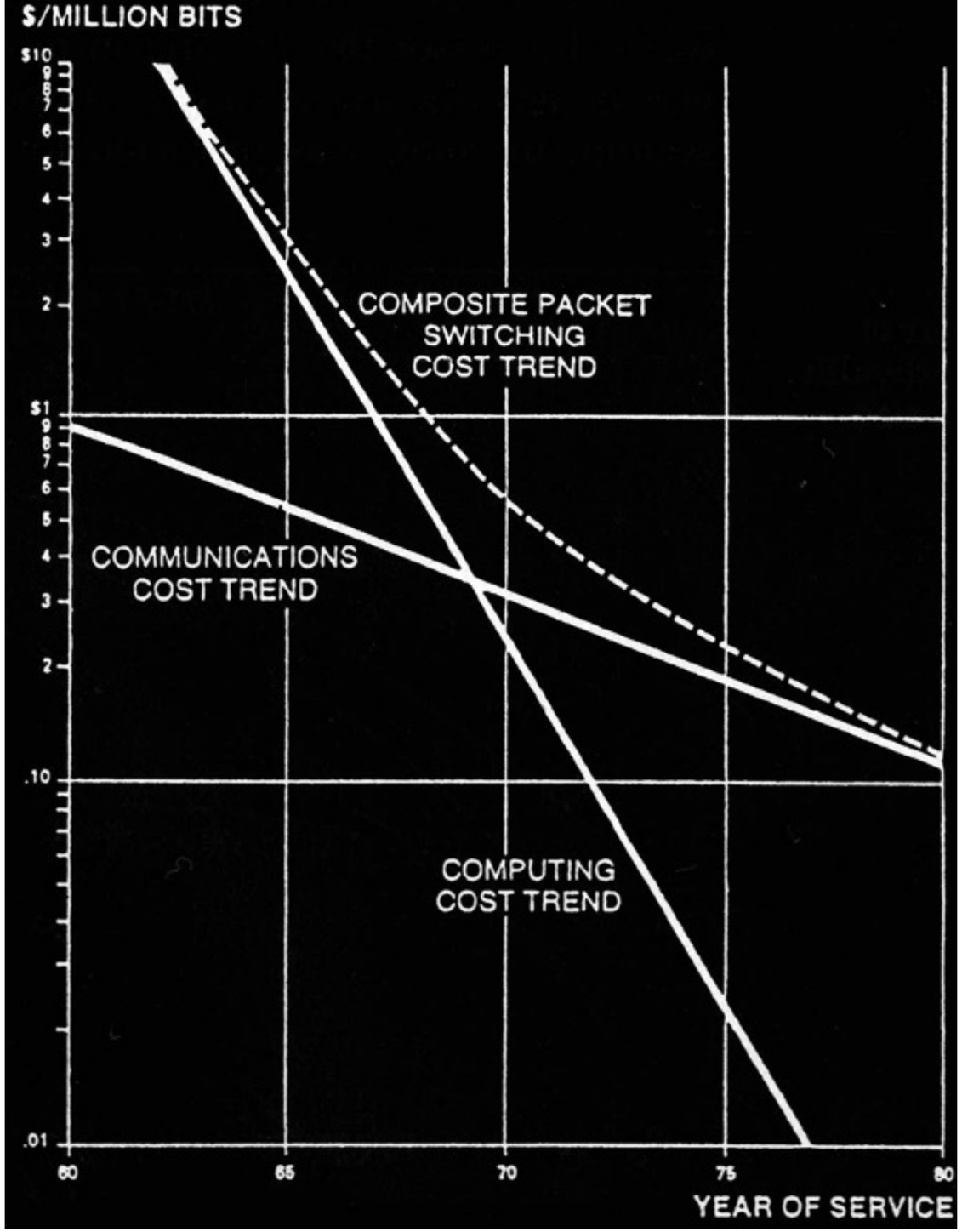
Roberts: *Multiple Computer Networks and Intercomputer Communication.*

Larry Roberts stellt die Ziele und Prinzipien des ARPA Net vor:

Load Sharing, Message Service, Data Sharing, Program Sharing, Remote Service

Er trifft Roger Scantlebury vom NPL und hört von den Arbeiten Davies' und Barans.

After the Gatlinberg meeting, Roberts read the Rand work and met with Baran. Although the UK work convinced Roberts to use higher speed lines (50 KB) and to use the word packet, the Rand work had no significant impact on the ARPANET plans and Internet history.
(Roberts, http://www.packet.cc/internet.html)



ARPA Net - Paketvermittlung

Innovation und ökonomische Rahmenbedingungen

Kosten:
point of break even

Bolt Beranek Newman

Two professors at MIT, Richard Bolt and Leo Beranek, established a small acoustics consulting firm, and soon added a former student of Bolt's, Robert Newman

Interface Message Processor (IMP)
Honeywell DDP-516,

BBN Headquarters

IMP-Team: Truett Thach, Bill Bertell--Jim Geisman, Dave Walden, Frank Heart, Ben Barker, Marty Thrope, Will Crowther, Severo Ornstein, Bob Kahn

Innovation braucht technische Umsetzung

Request for Comments

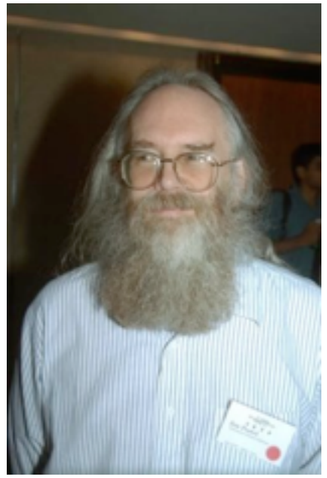
```
Network Working Group                                        Steve Crocker
Request for Comments: 1                                             UCLA
                                                             7 April 1969

                        Title:    Host Software
                       Author:    Steve Crocker
                         Installation:    UCLA
                         Date:    7 April 1969
                Network Working Group Request for Comment:    1
                                    …
```

Steve Crocker

Innovation braucht Standardisierung

RFC 768 (UDP)
RFC 791 (IP)
RFC 792 (ICMP)
RFC 793 (TCP)
RFC 959 (FTP)
RFC 1034 (DNS - Concepts and Facilities), RFC 1035 (DNS - Implementation and Specification)
RFC 1094 (NFS Version 2 Protocol Specification)
RFC 1459 (IRC)
RFC 1661 (PPP)
RFC 1738 (URLs)
RFC 1813 (NFS Version 3 Protocol Specification)
RFC 1939 (POP3)
RFC 2131 (DHCP)
RFC 2440 (OpenPGP)
RFC 2445 (iCalendar)
RFC 2616 (HTTP 1.1)
RFC 2821 (SMTP)
RFC 2822 (E-Mail-Format)
RFC 3174 (SHA)
RFC 3530 (NFS Version 4 Protocol Specification)



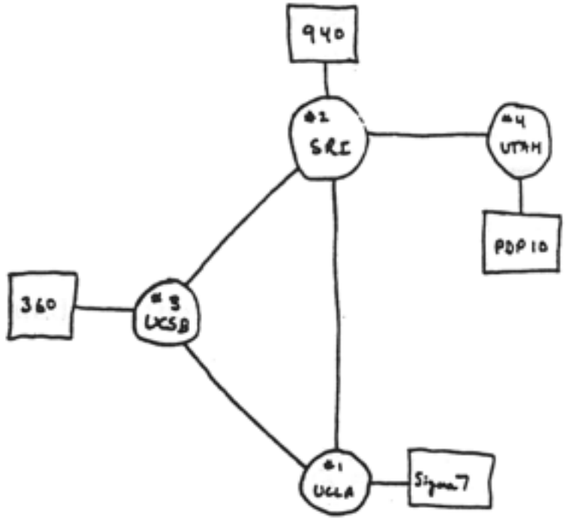
John Postel 1943-1998

ARPANET 1969

THE ARPA NETWORK

SEPT 1969

1 NODE



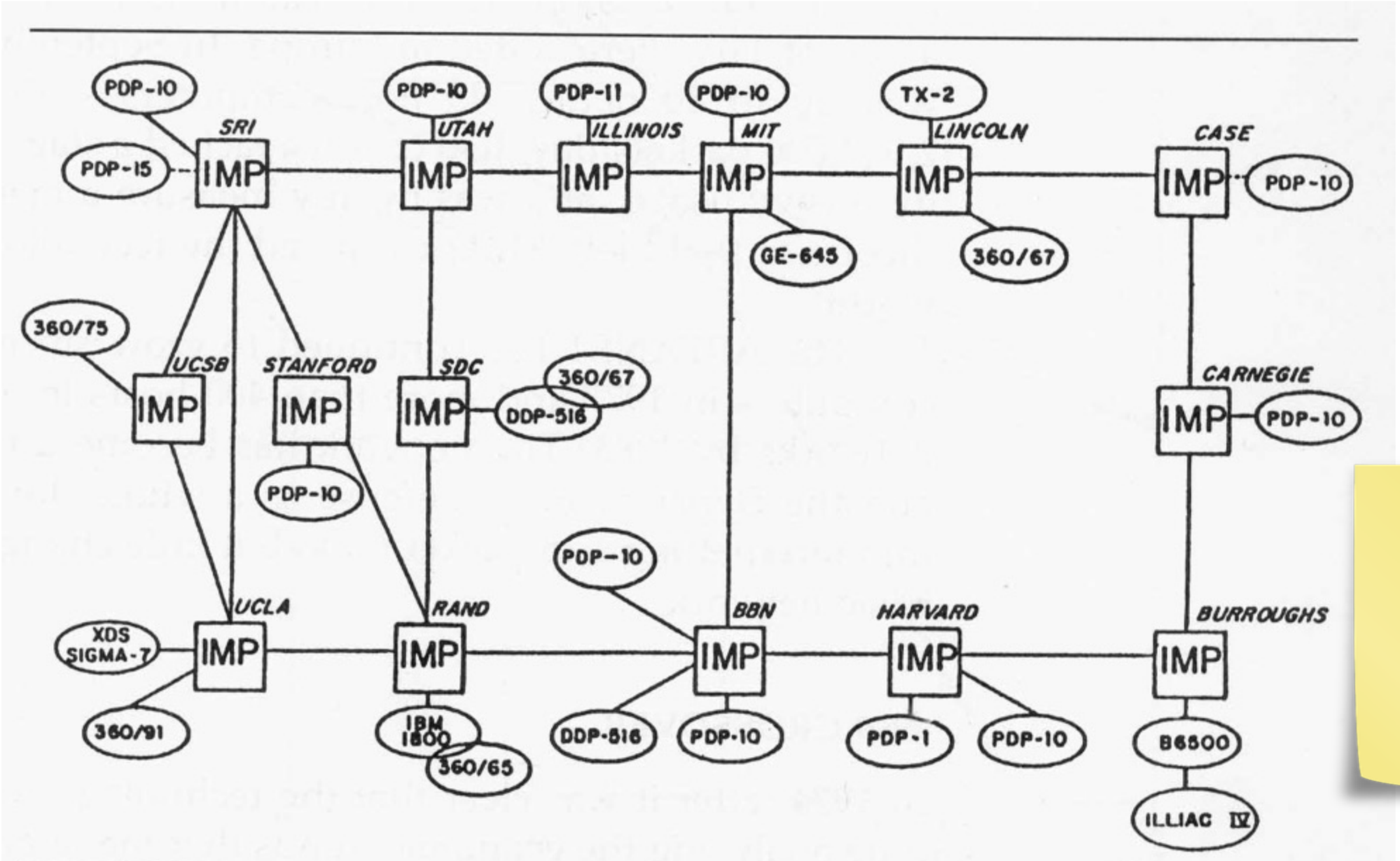
THE ARPA NETWORK

DEC 1969

4 NODES

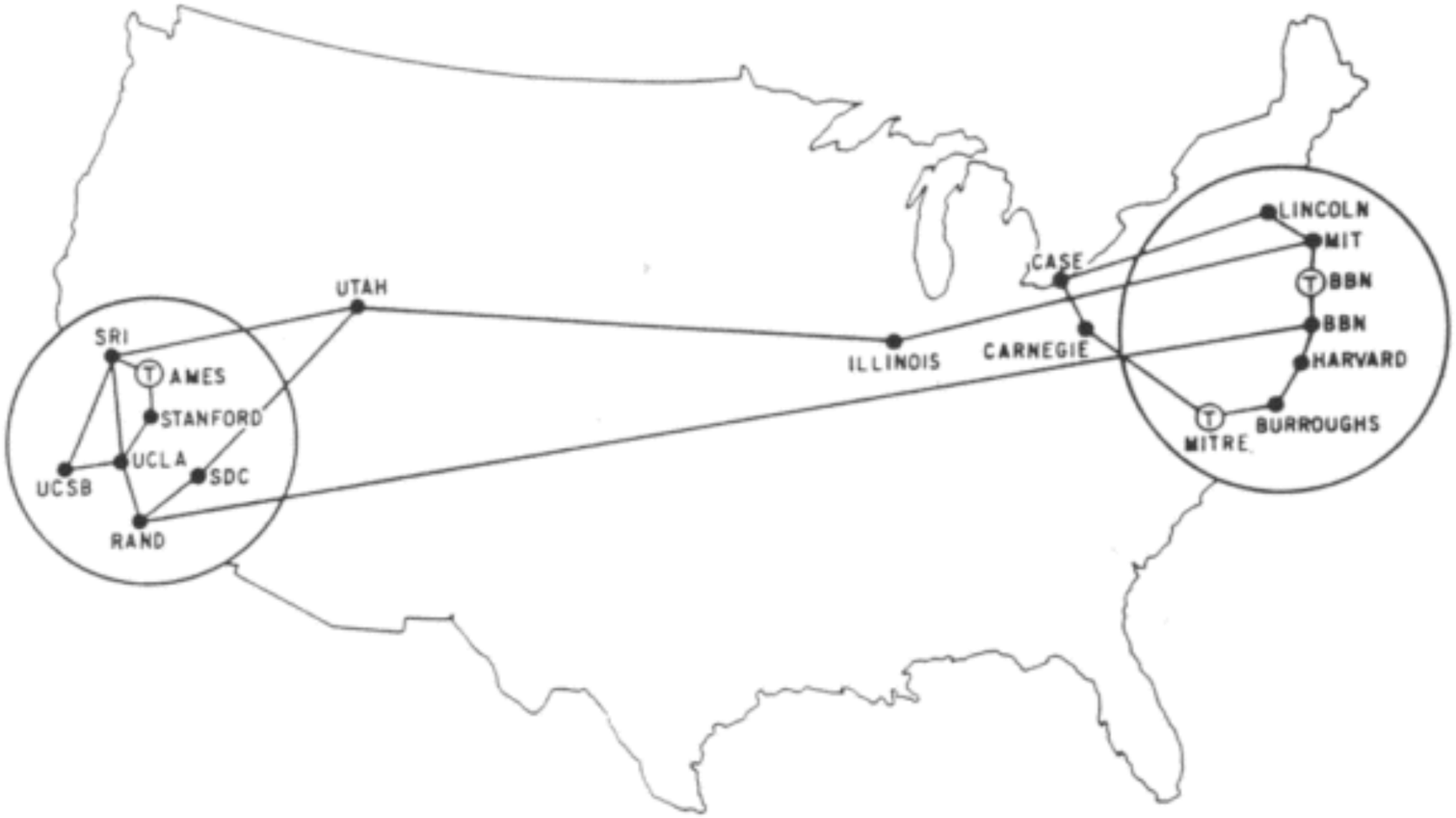
Jede exponentielle Verbreitung beginnt bei einem ersten Schritt

ARPANET – Netztopologie 1971



Durchsetzung von Innovation in verschiedenen Kontexten

ARPANET 1971



MAP 4 September 1971

Skalierbarkeit von Innovationen

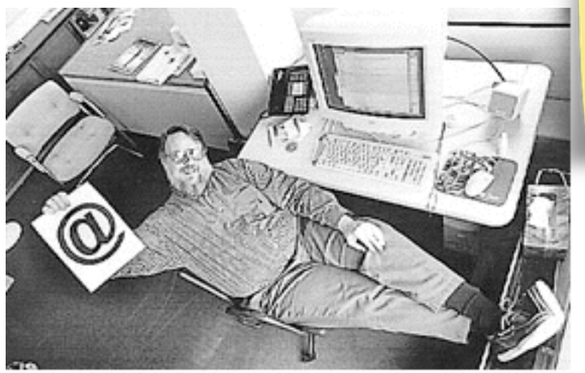
Netzdienste

An der PDP-10 von BBN verschickte Ray Tomlinson 1971 die erste Email.
William Crowther vom IMP-Team schrieb um 1975 das Videospiel *Adventure.*

1971

E-Mail (RFC 385)
Remote Job Entry (RFC 105)
Telnet (RFC 137)
FTP (RFC 114)

Innovation befördert neue Innovation

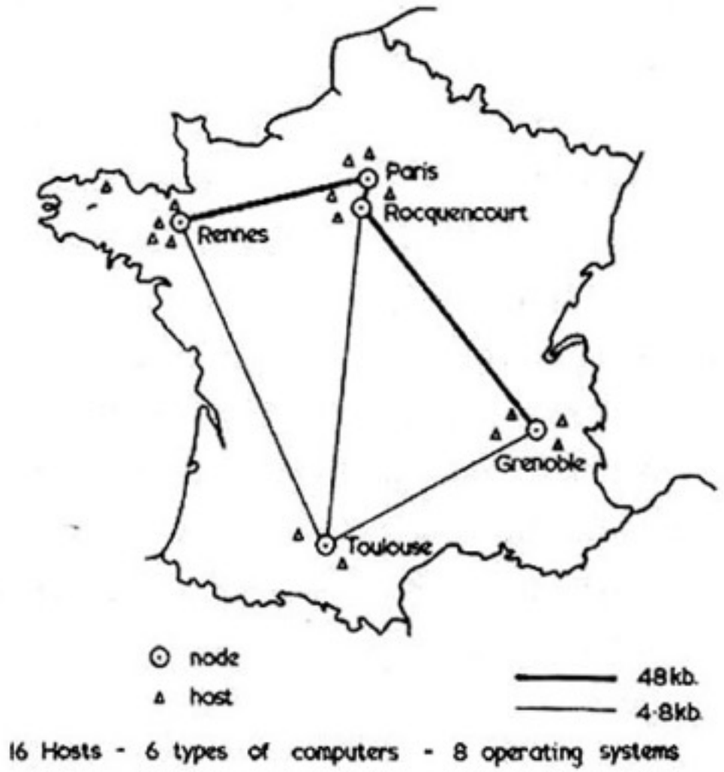


Ray Tomlinson

Text der ersten Email: QWERTYUIOP

Cyclades/Cigale

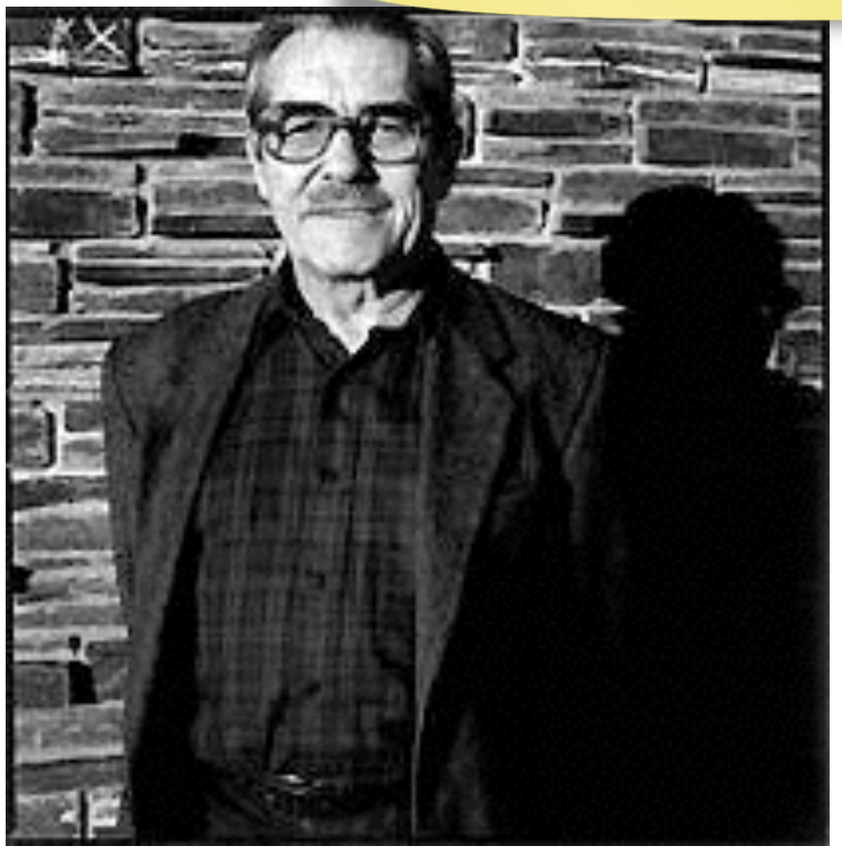
1972-1978



Datagramme und Logische Adressierung

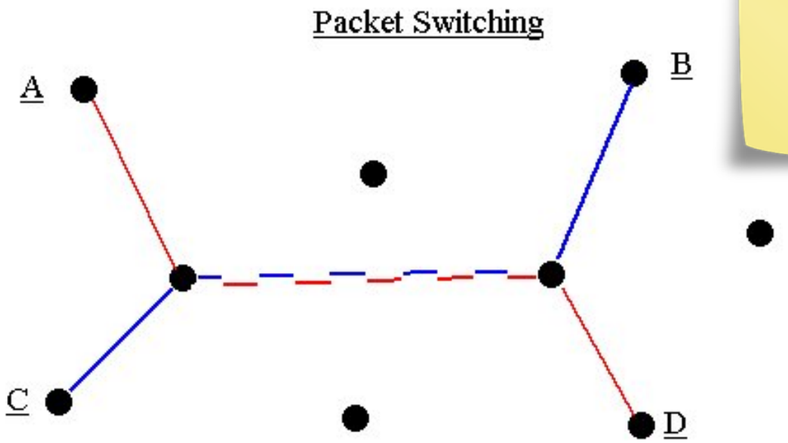
statt Virtuelle Leitungen

Innovation braucht politische Rahmenbedingungen

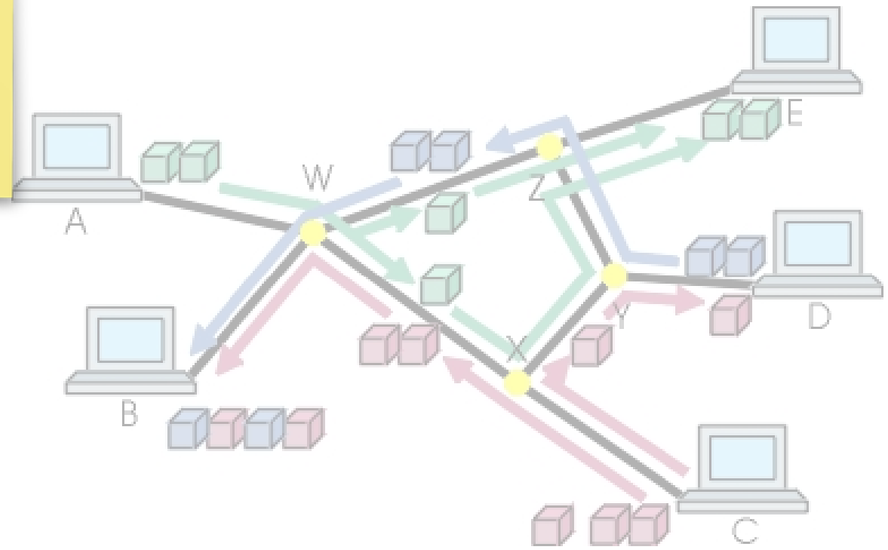


Louis Pouzin

Paketvermittlung: Virtuelle Leitungen vs. Datagramme



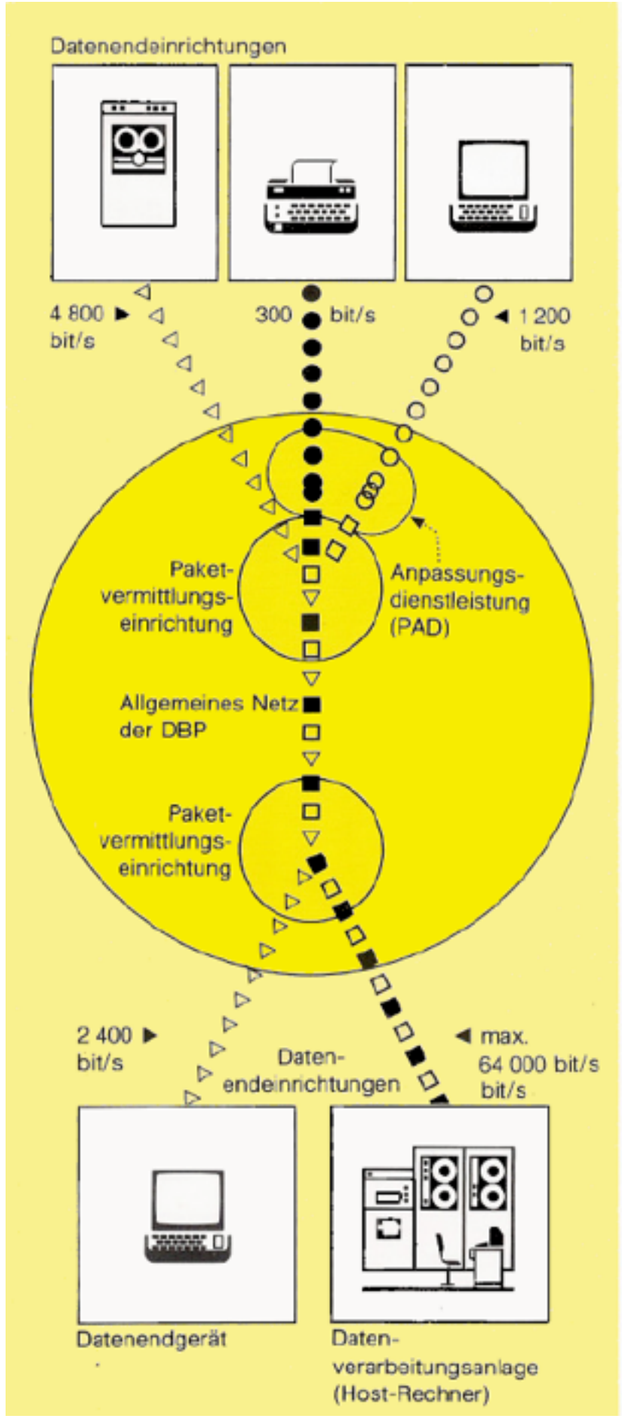
Innovation als Medium



Virtuelle Leitungen

Logische Adressierung

X.25



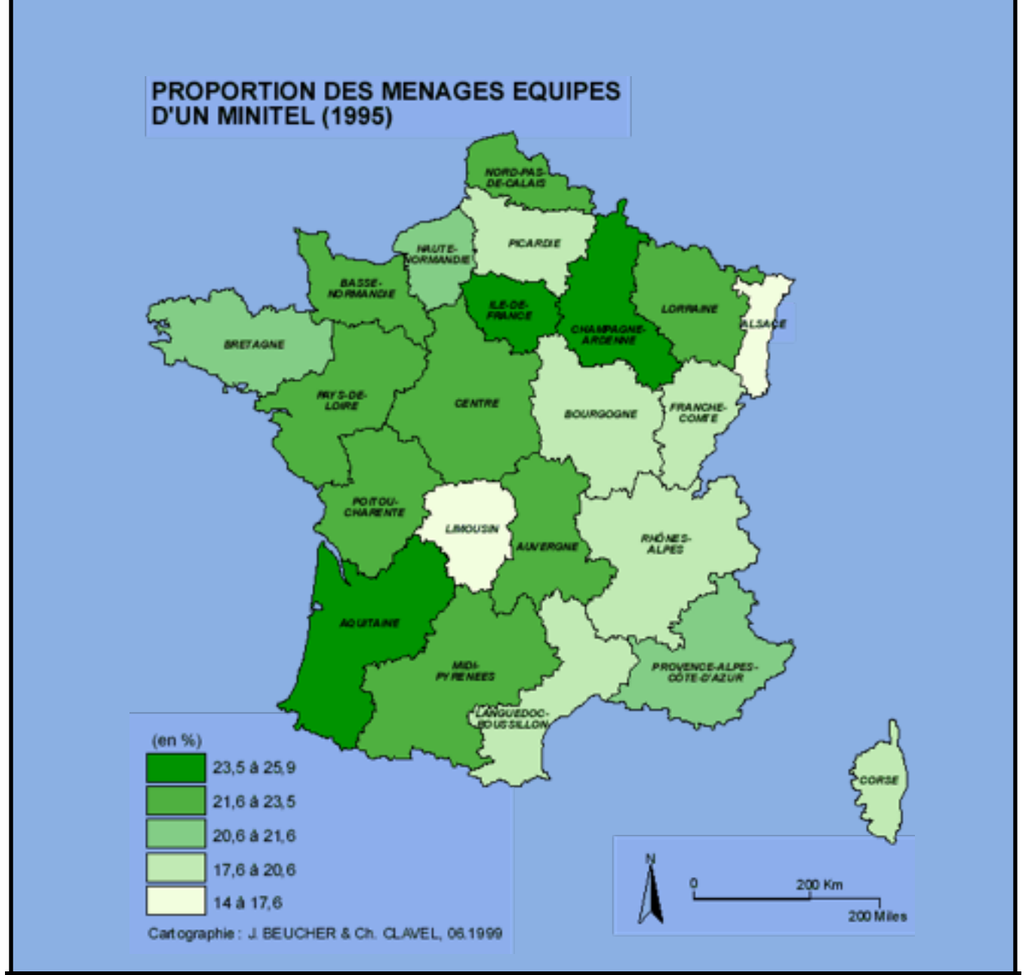
Internationalität braucht technische Normen

Datex-P
Transpac

Minitel

1974 Prototyp
1981 Testbestrieb
seit 1983 Regelbetrieb
Vorteil gegenüber BTX:
Kostenlose Hardware

Nachfrage-orientierte Verbreitung



Bildschirmtext

1977 IFA Berlin

1980 Testbetrieb

1983-2000 Kommerziell

Chat, Mail, Newsticker

eBanking, eCommerce

Proprietäre Hardware

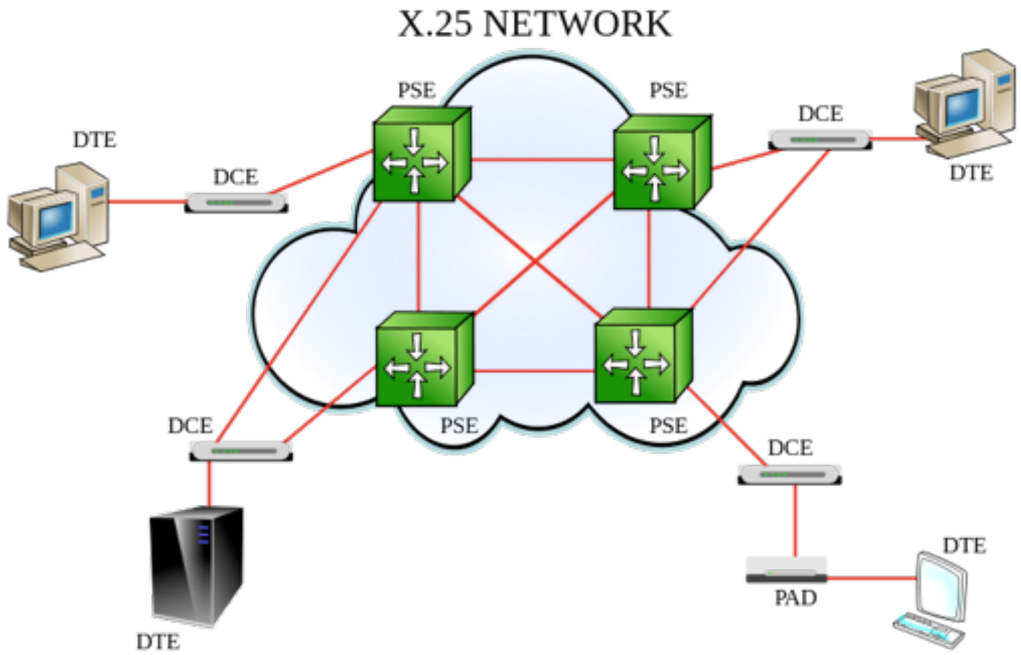
2007 Eingestellt

Anbieterorientierte Verbreitung

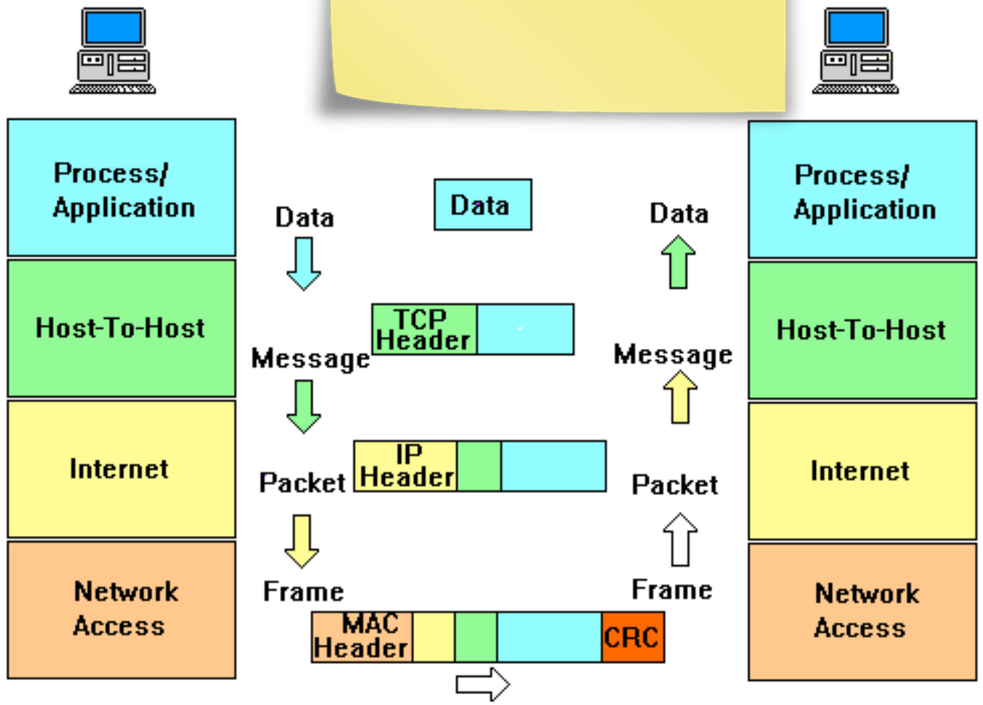
Technische Normen: X.25 vs. TCP/IP

»The nice thing about standards is that you have so many to choose from.«
Andrew S. Tanenbaum

Medialität technischer Normen



Zuverlässige Netzknoten
Unzuverlässige Terminals:
Dem Netz (d.h. den Telkoms) kann vertraut werden, dem Nutzer nicht



Unzuverlässige Netzknoten
Zuverlässige Hosts:
Den Nutzern kann vertraut werden, dem Netz nicht

BTX-Modem

Apparate als geronnene Norm

Elektronisches Massenmedium

ITU V.23

The principal characteristics recommended for a modem to transmit data at medium speed in the general switched telephone network are as follows:

use of modulation rates up to 600/1200 bauds on the communication channel (see Recommendation V. 5);

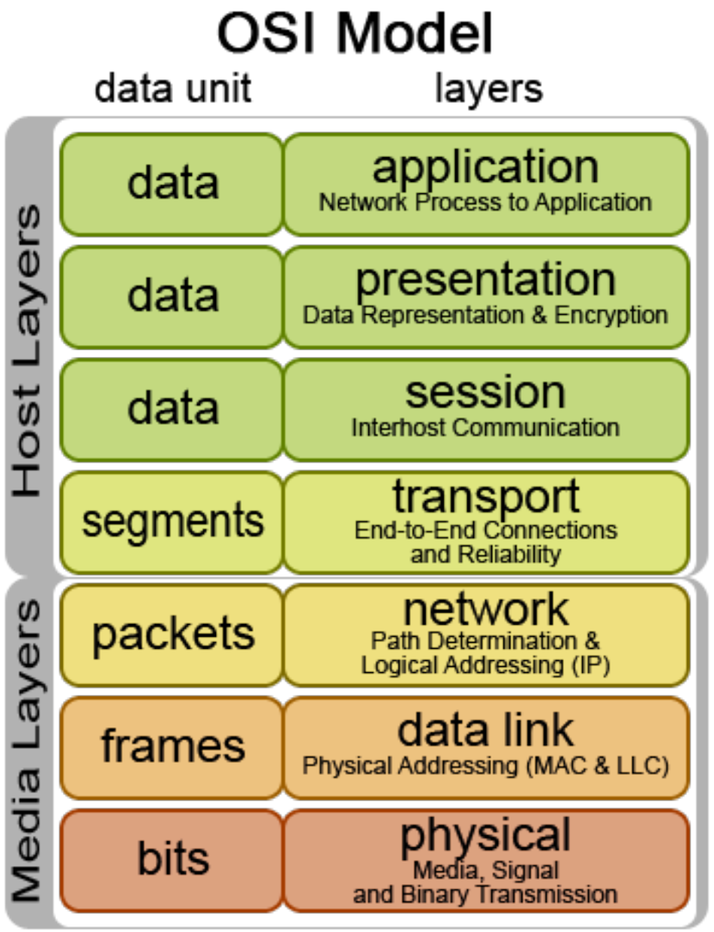
frequency modulation with synchronous or asynchronous mode of operation;

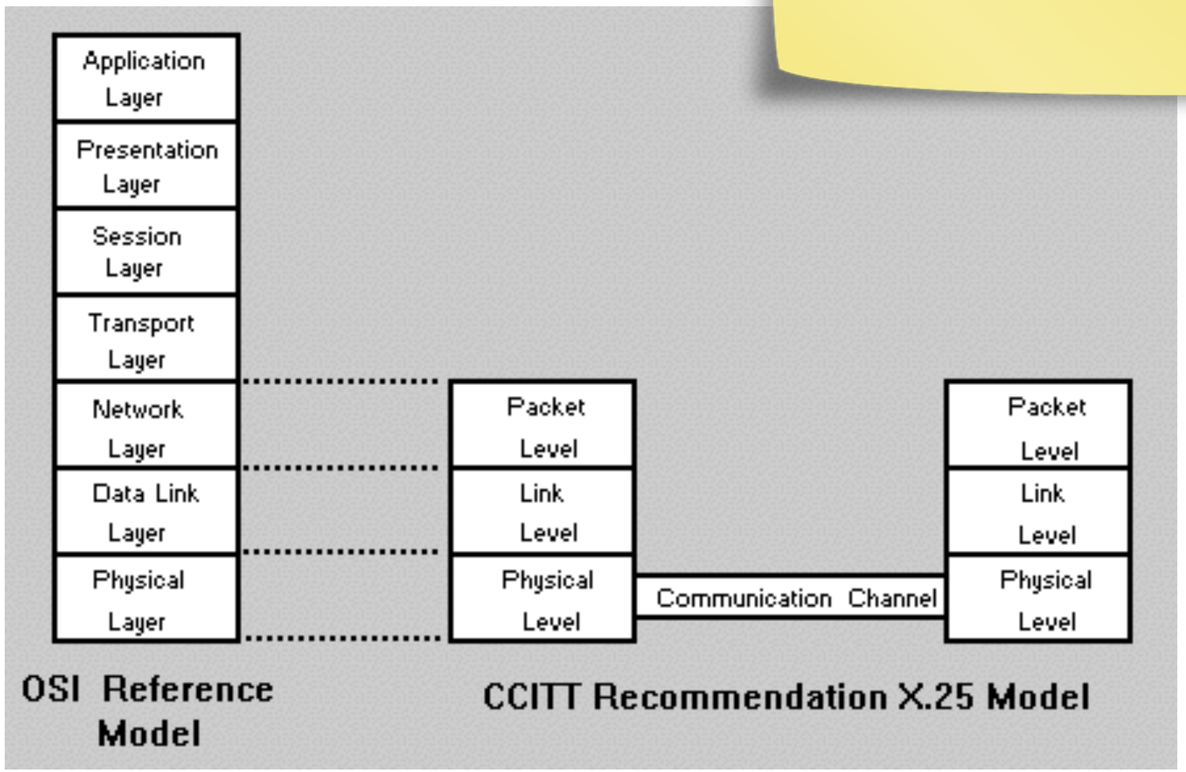
inclusion of a backward channel at modulation rates up to 75 bauds for error control, use of this channel being optional.

http://www.itu.int/rec/T-REC-V.23-198811-I/en

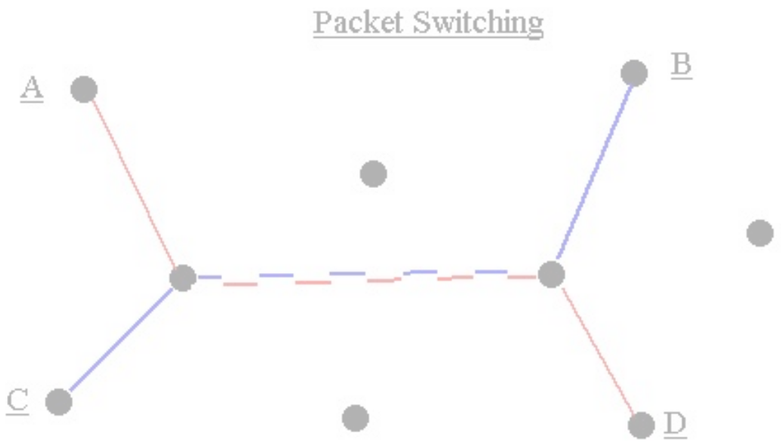
OSI / ISO 1983

Der Versuch einer Top-Down-Innovation

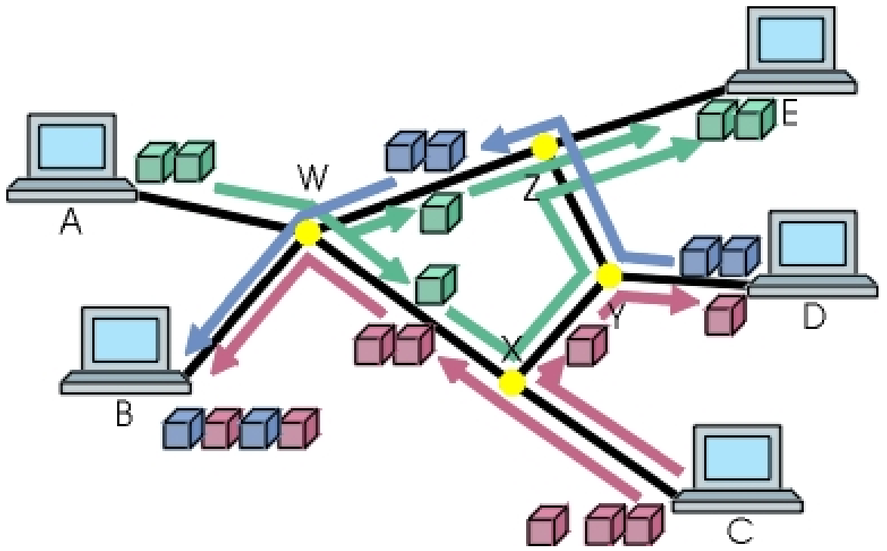




Paketvermittlung: Virtuelle Leitungen und Datagramme



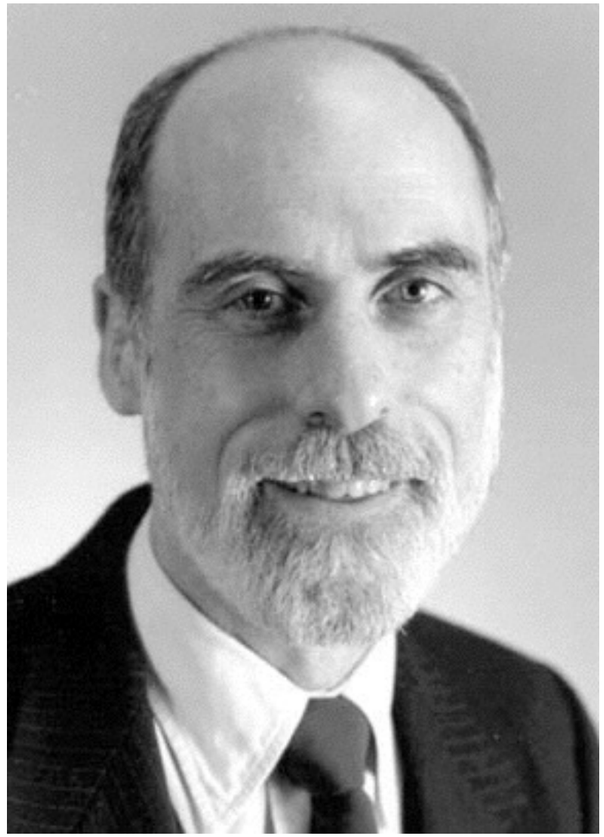
Virtuelle Leitungen



Logische Adressierung

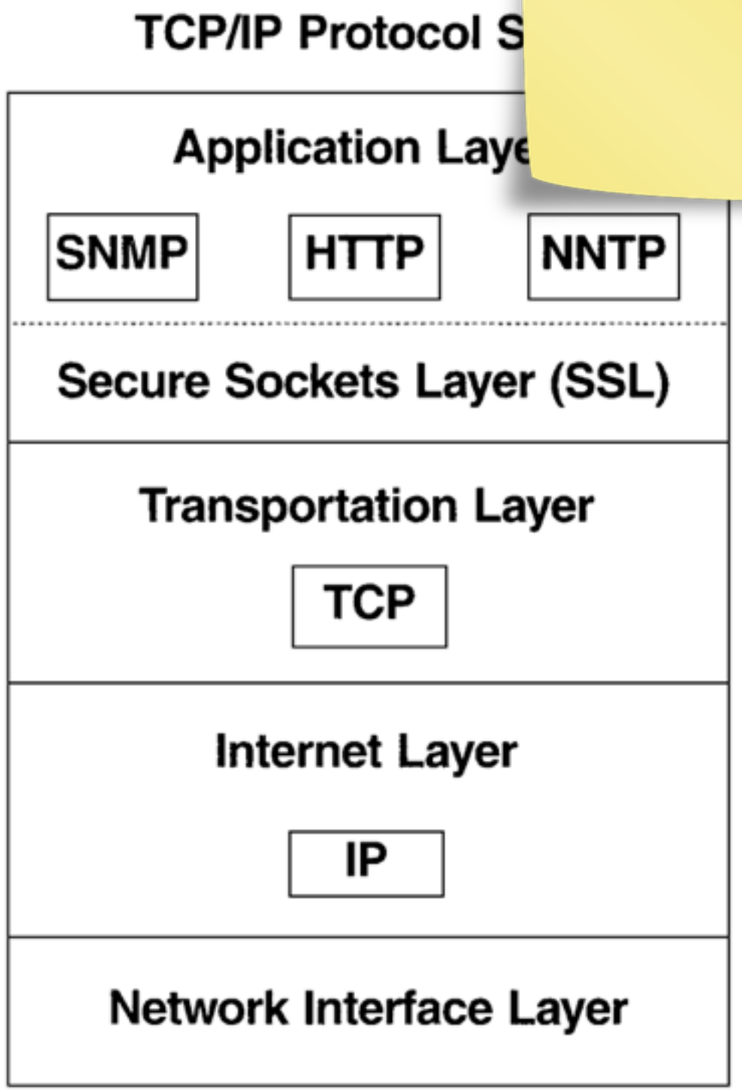
Internetworking: TCP/IP

Innovation braucht Abstraktion



V. Cerf

B. Kahn

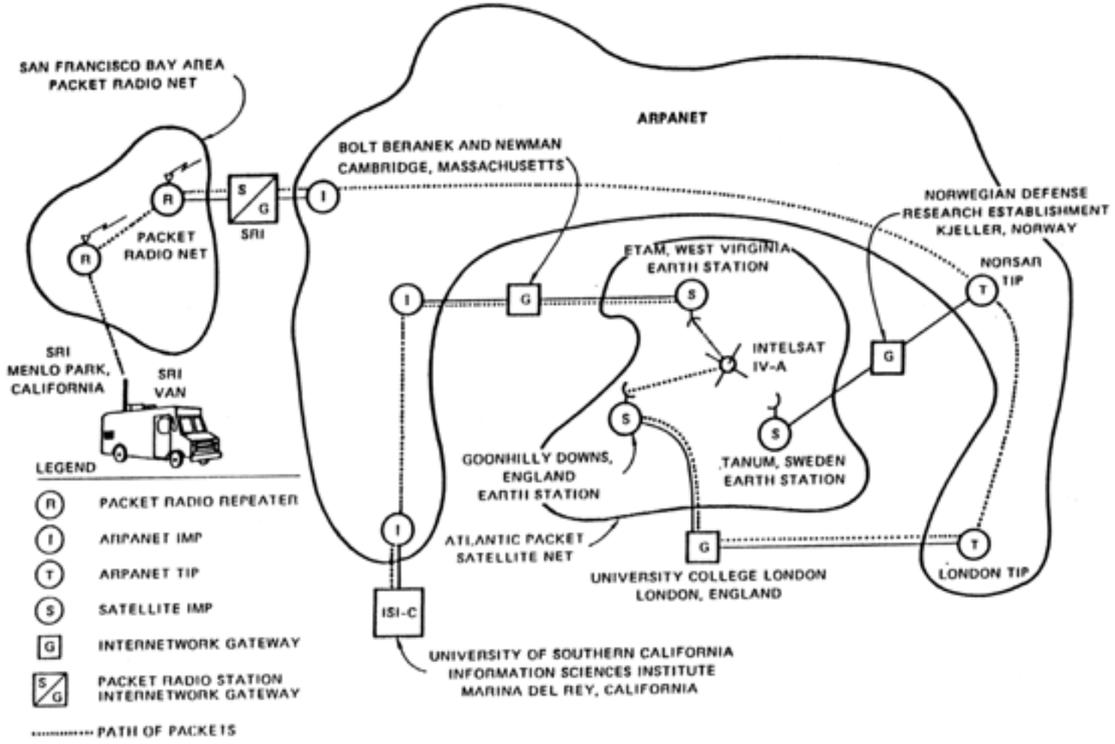


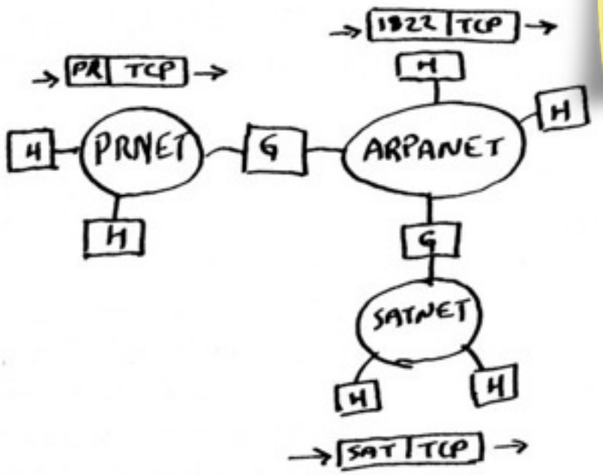
1974 *A Protocol for Packet Network Intercommunication*

1978 TCP/IP

Internetworking

Innovation als Erweiterung





1977 Cerf/Kahn:

Gateways zwischen

ARPANET

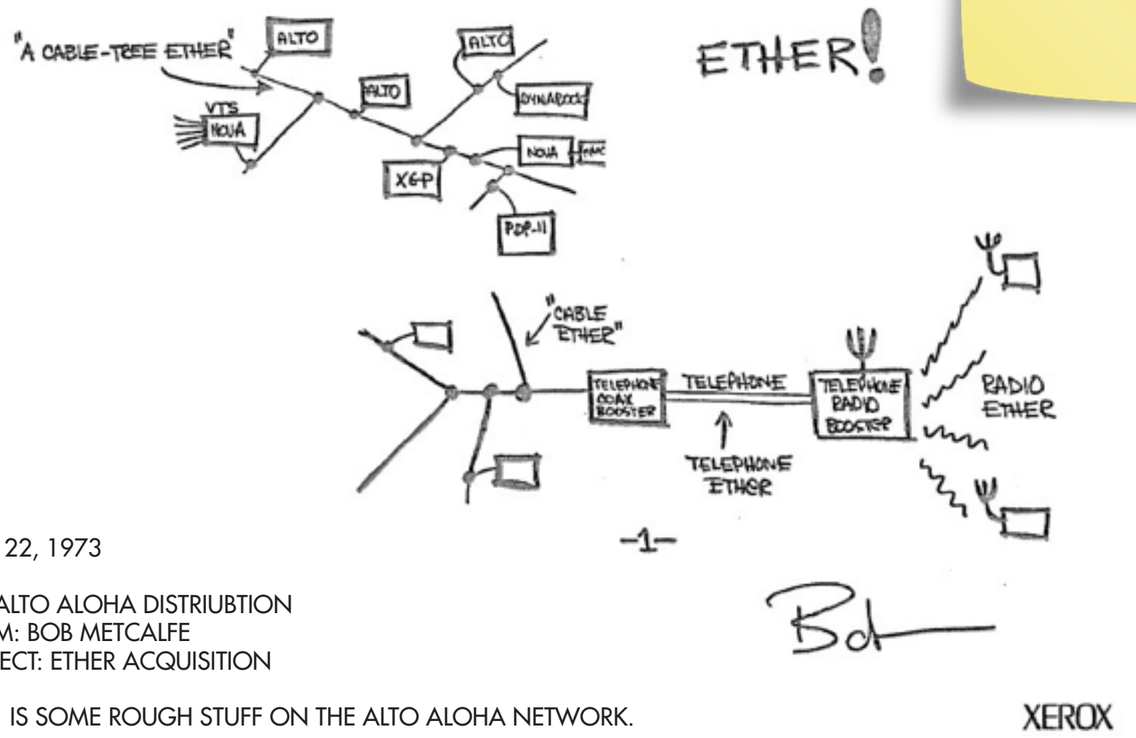
SATNET

P(acket)R(adio)NET

Intranetworking: Ethernet

Innovation als Analogie

Robert Metcalfe
PARC, 1973



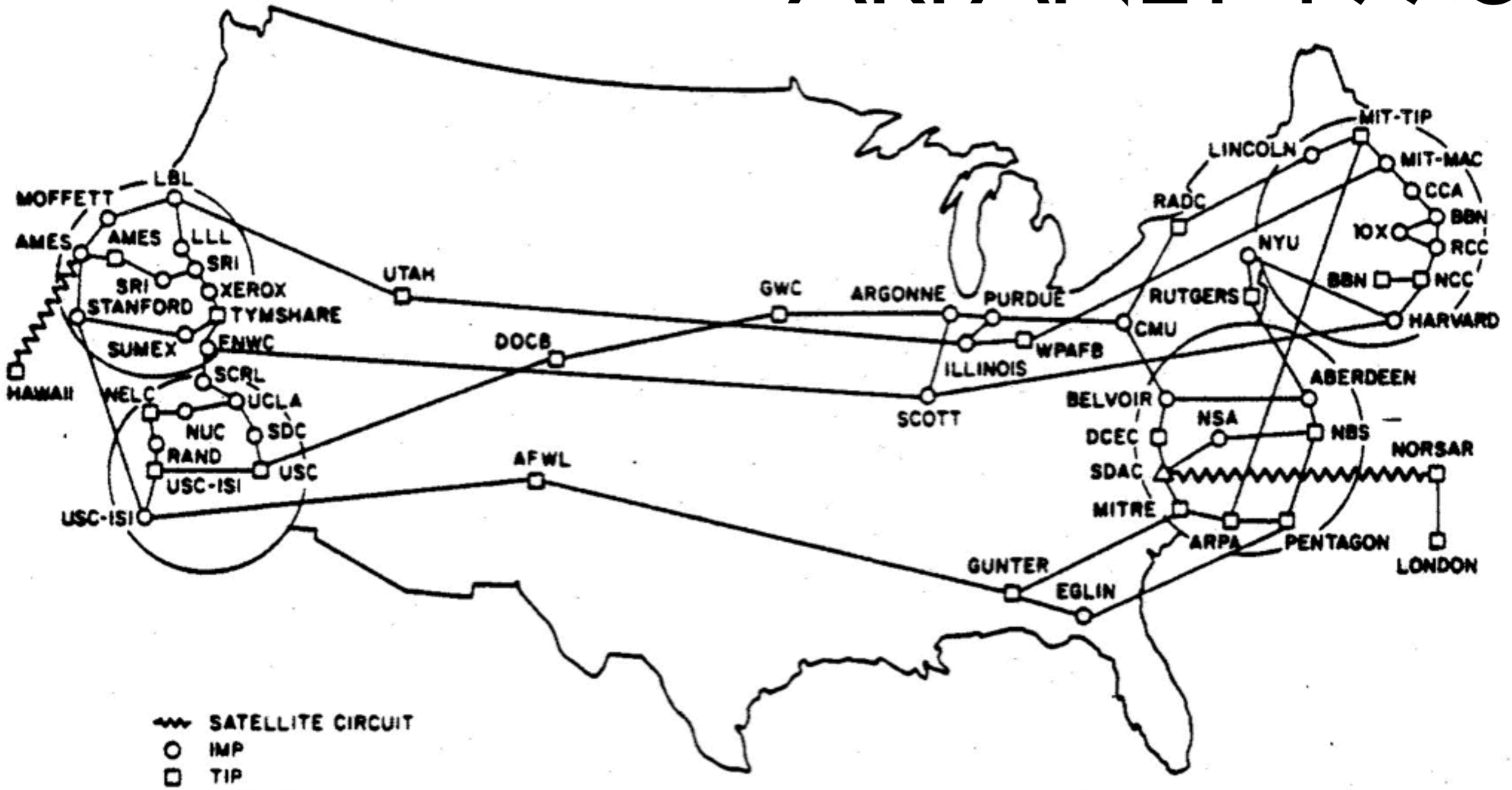
MAY 22, 1973

TO: ALTO ALOHA DISTRIUBTION
FROM: BOB METCALFE
SUBJECT: ETHER ACQUISITION

HERE IS SOME ROUGH STUFF ON THE ALTO ALOHA NETWORK.

XEROX

ARPANET 1975

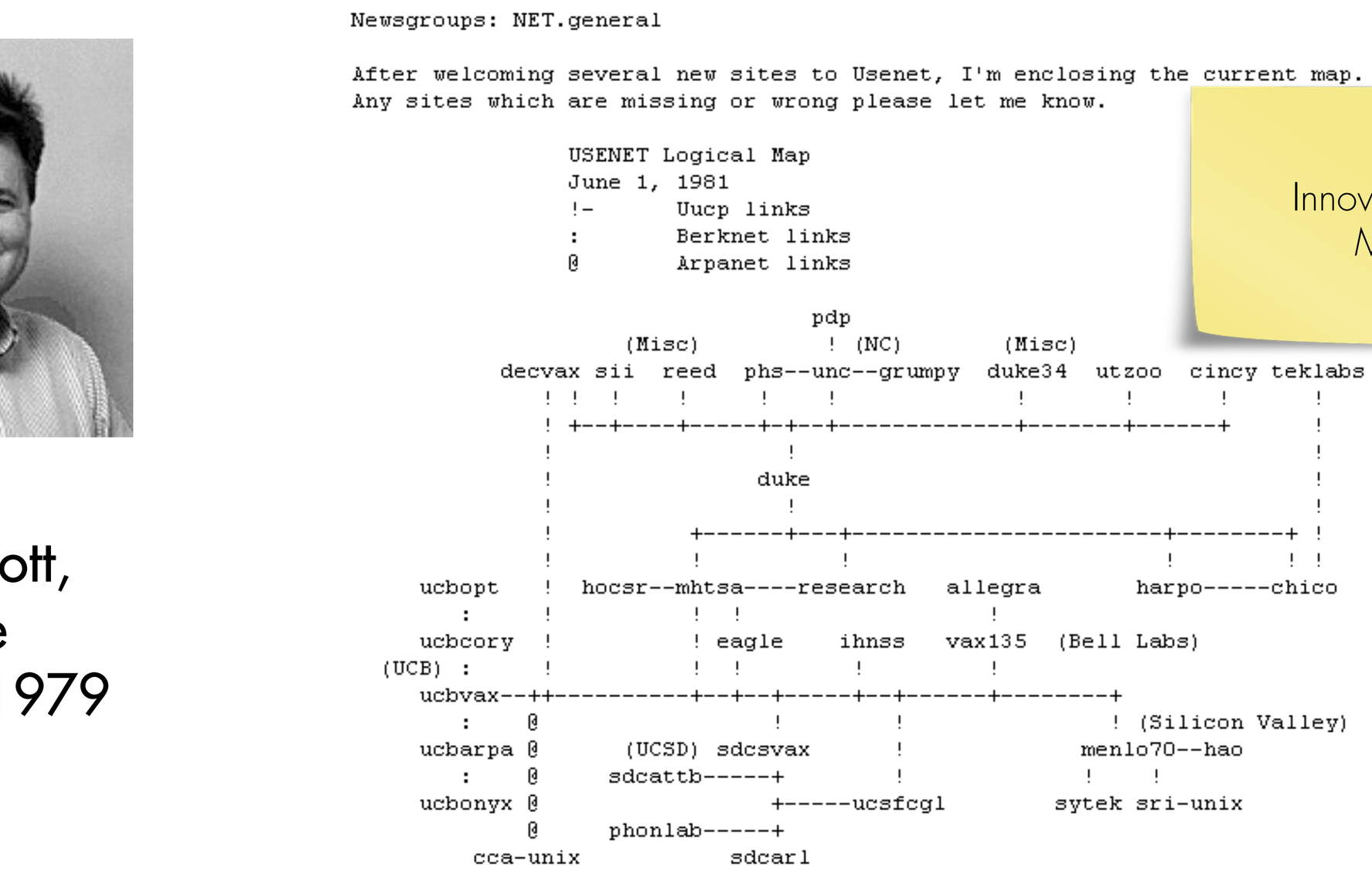


Der soziale Grund: Grassroot-Bewegung

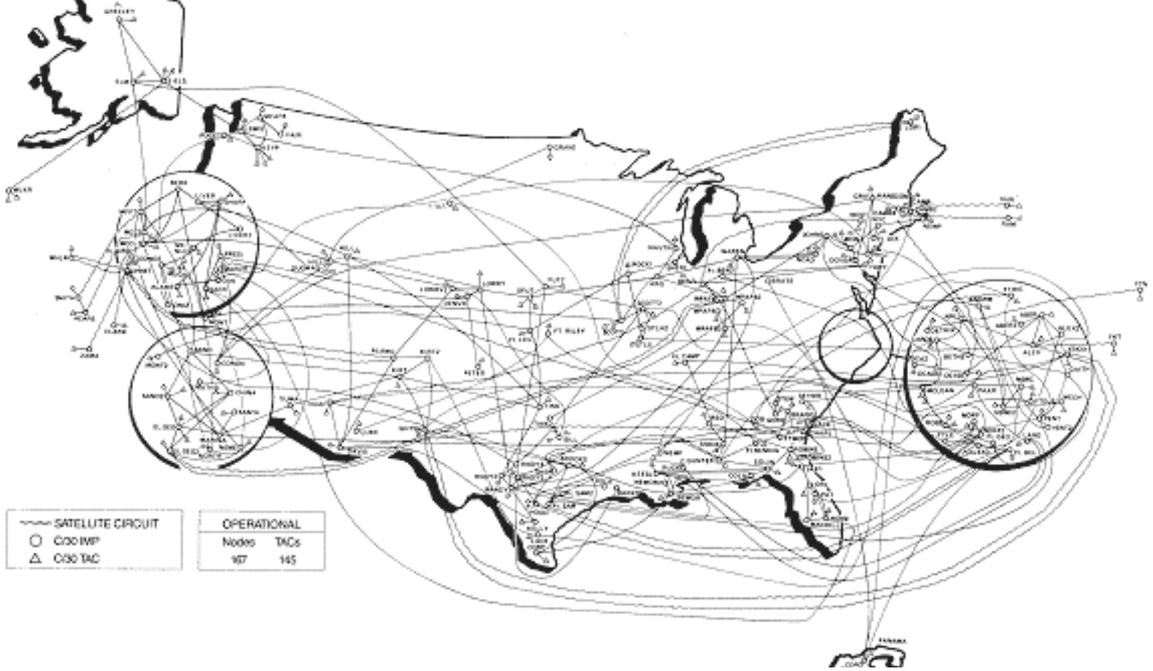
T. Truscott,
duke
Usenet, 1979

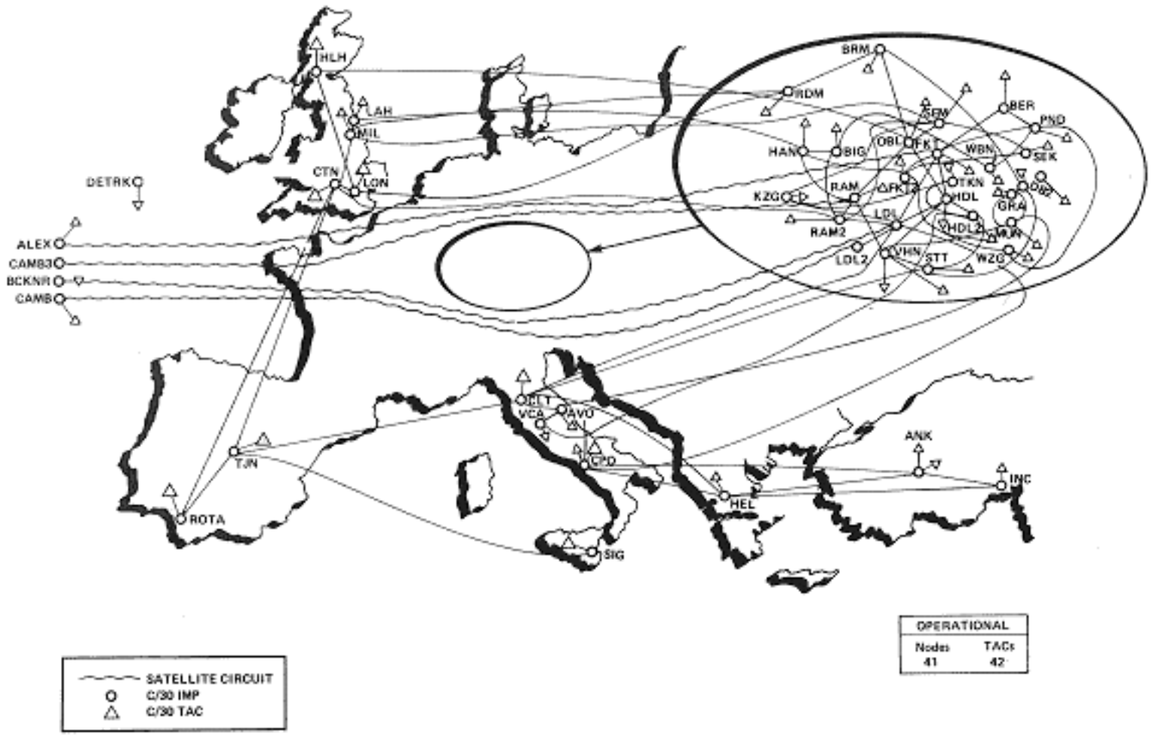
Newsgroups: NET.general

After welcoming several new sites to Usenet, I'm enclosing the current map.
Any sites which are missing or wrong please let me know.



Innovation braucht Menschen





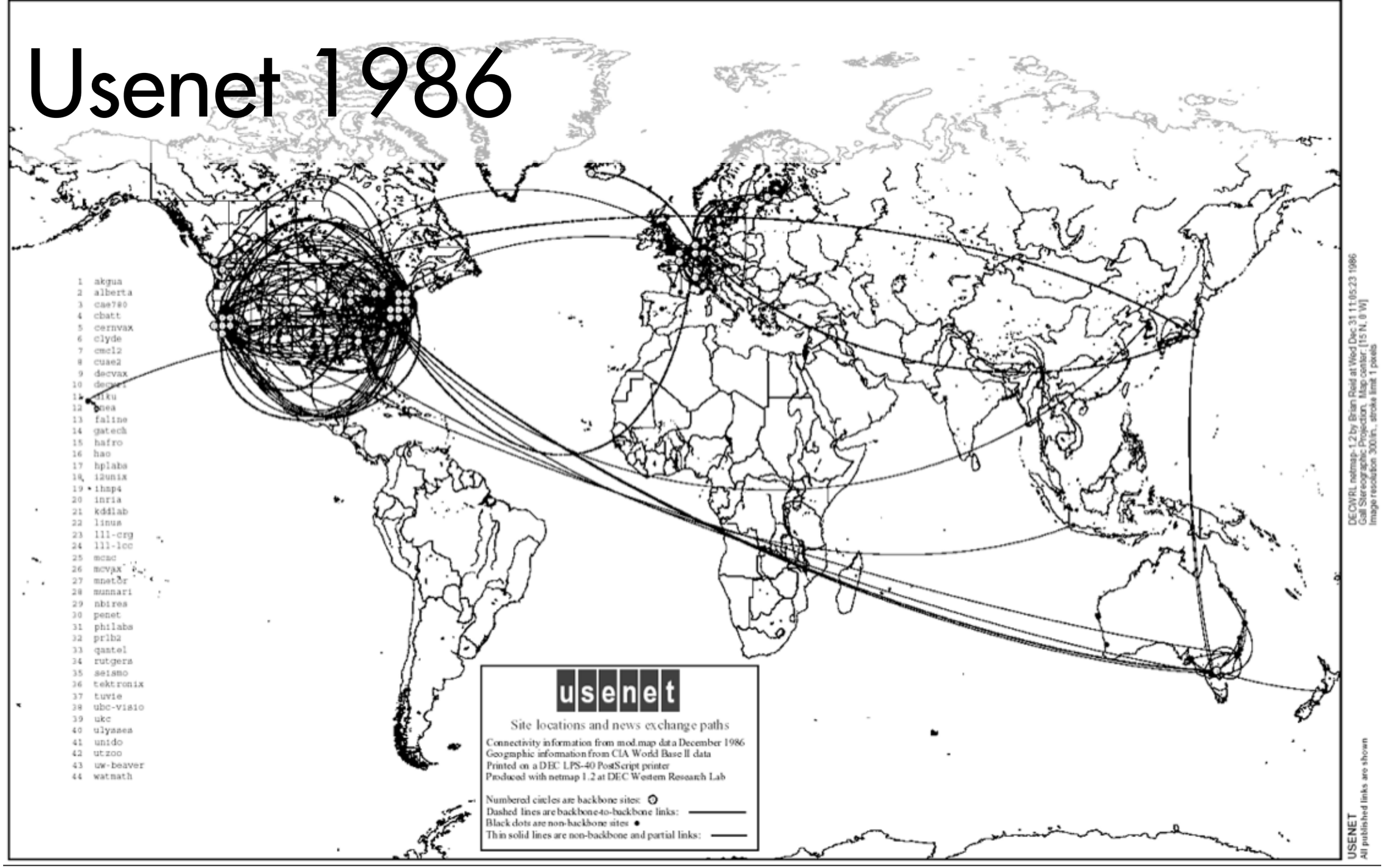
MILNET

Medieninnovation
organisiert
Kommunikation

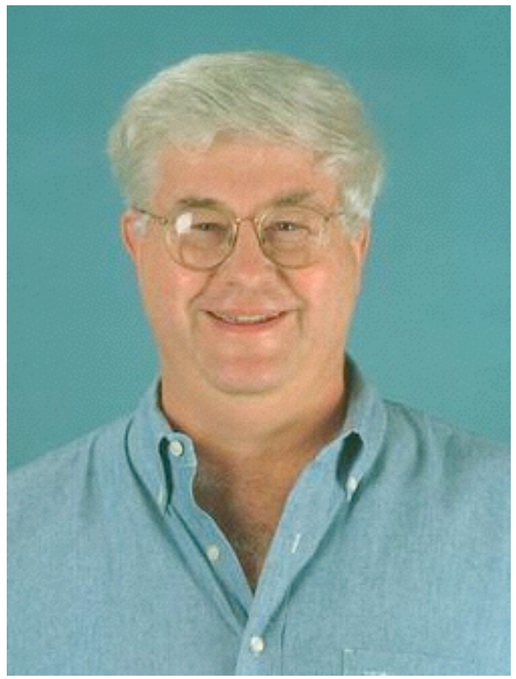
1972 DARPA
1975 Verwaltung des IPTO und des ARPANET durch Colonel David Russell

1983 Übergang zu TCP/IP
Spaltung in
MILNET (78 Knoten)
ARPANET (45 Knoten)

Usenet 1986


1 akgua
2 alberta
3 cae780
4 cbatt
5 cernvax
6 clyde
7 cmcl2
8 cuae2
9 decvax
10 decwrl
11 diku
12 duke
13 faline
14 gatech
15 hafro
16 hao
17 hplabs
18 i2unix
19 ihnp4
20 inria
21 kddlab
22 linus
23 lll-crg
24 lll-lcc
25 mcnc
26 mcvax
27 mnetor
28 munnari
29 nbires
30 penet
31 philabs
32 prlb2
33 qantel
34 rutgers
35 seismo
36 tektronix
37 tuvie
38 ubc-vision
39 ukc
40 ulysses
41 unido
42 utzoo
43 uw-beaver
44 watmath
usenet
Site locations and news exchange paths
Connectivity information from mod.map data December 1986
Geographic information from CIA World Base II data
Printed on a DEC LPS-40 PostScript printer
Produced with netmap 1.2 at DEC Western Research Lab
Numbered circles are backbone sites:
Dashed lines are backbone-to-backbone links:
Black dots are non-backbone sites
Thin solid lines are non-backbone and partial links:
DECWRL netmap-1.2 by Brian Reid at Wed Dec 31 11:05:23 1986
Gall Stereographic Projection. Map center: [15 N, 0 W]
Image resolution 300/in., stroke limit 1 pixels
USENET
All published links are shown

.alt Newsgroups



From: reid@decwrl.dec.com (Brian Reid)
Message-Id: <8804040154.AA01236@woodpecker.dec.com>
Date: 3 Apr 1988 1754-PST (Sunday)
To: backbone@purdue.edu, chiefdan@vax1.acs.udel.edu,
mejac!hoptoad!gnu@decwrl.dec.com
Subject: Re: soc.sex final results
In-Reply-To: Gene Spafford / Sun, 03 Apr 88 18:22:36 EST.
<8804032322.AA15650@arthur.cs.purdue.edu>

To end the suspense, I have just created alt.sex.
That meant that the alt network now carried alt.sex and
alt.drugs. It was therefore artistically necessary to create
alt.rock-n-roll, which I have also done. I have no idea what
sort of traffic it will carry. If the bizzarroids take it
over I will rmgroup it or moderate it; otherwise I will let
it be.

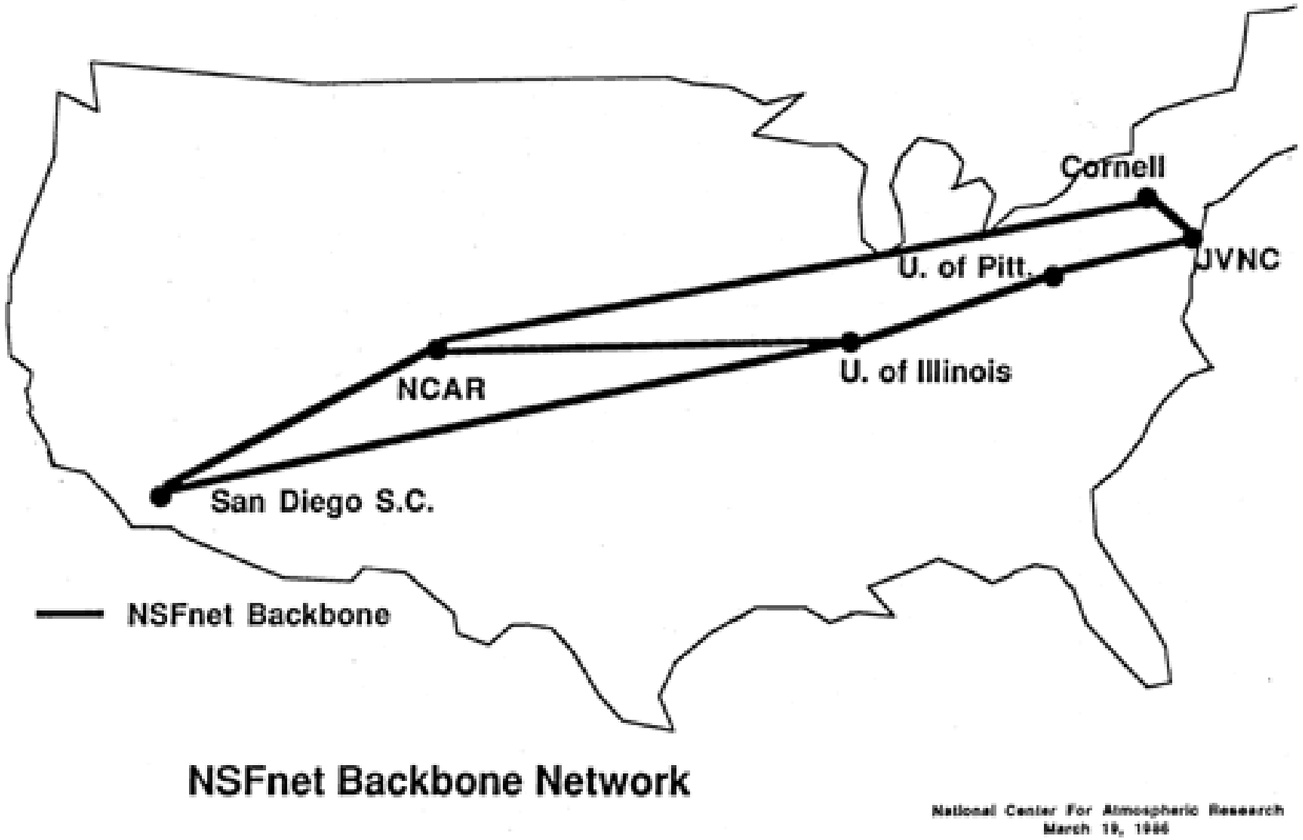
Brian Reid
T5 (5th thoracic)

Innovation braucht
Anarchie

NSFNET 1986

National Science Foundation

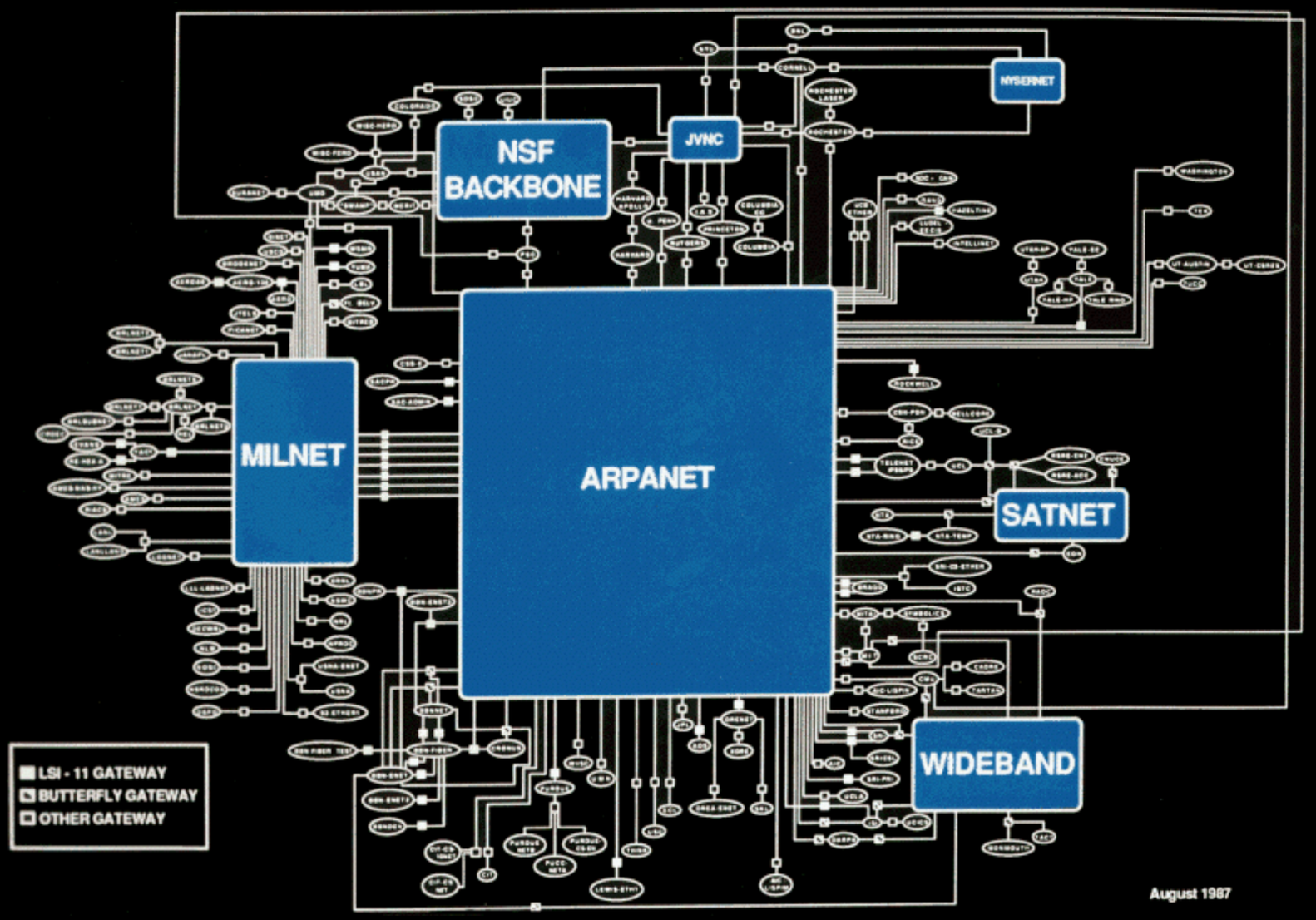
Medieninnovation
braucht Infrastruktur

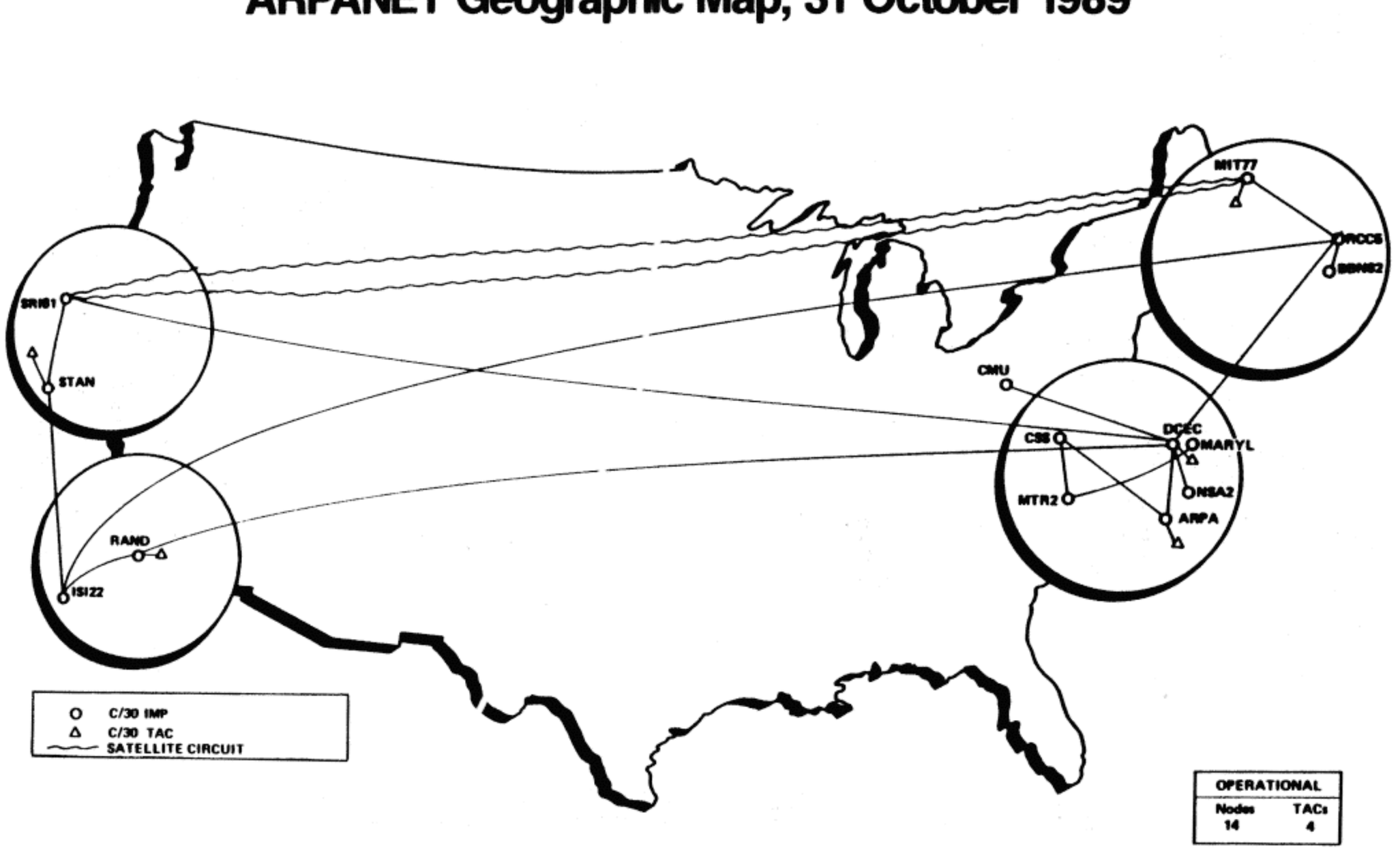


NSFNet Backbone services are provided to support open research and education in and among U.S. research and instructional institutions, plus research arms of for-profit firms when engaged in open scholary communication and research. Use for other purposes is not acceptable.

NSFNet Acceptable Use Policy (AUP), ca. 1989

Internet 1987

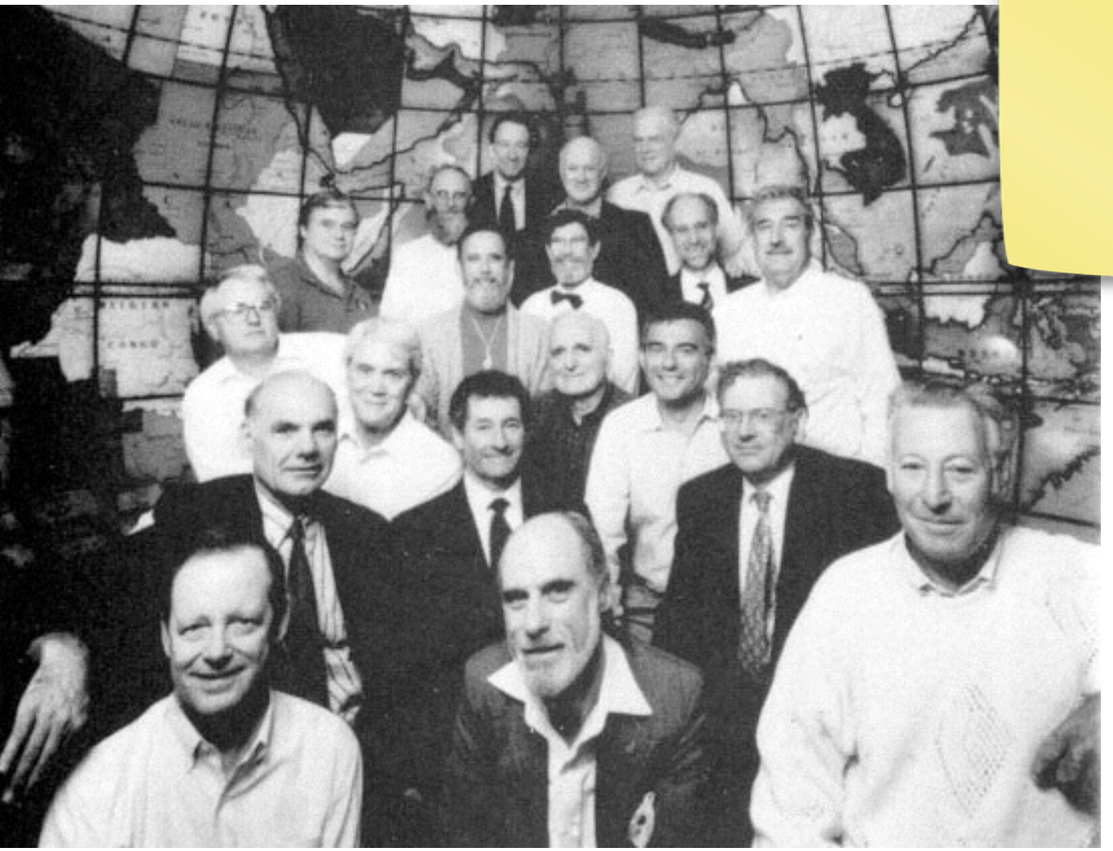




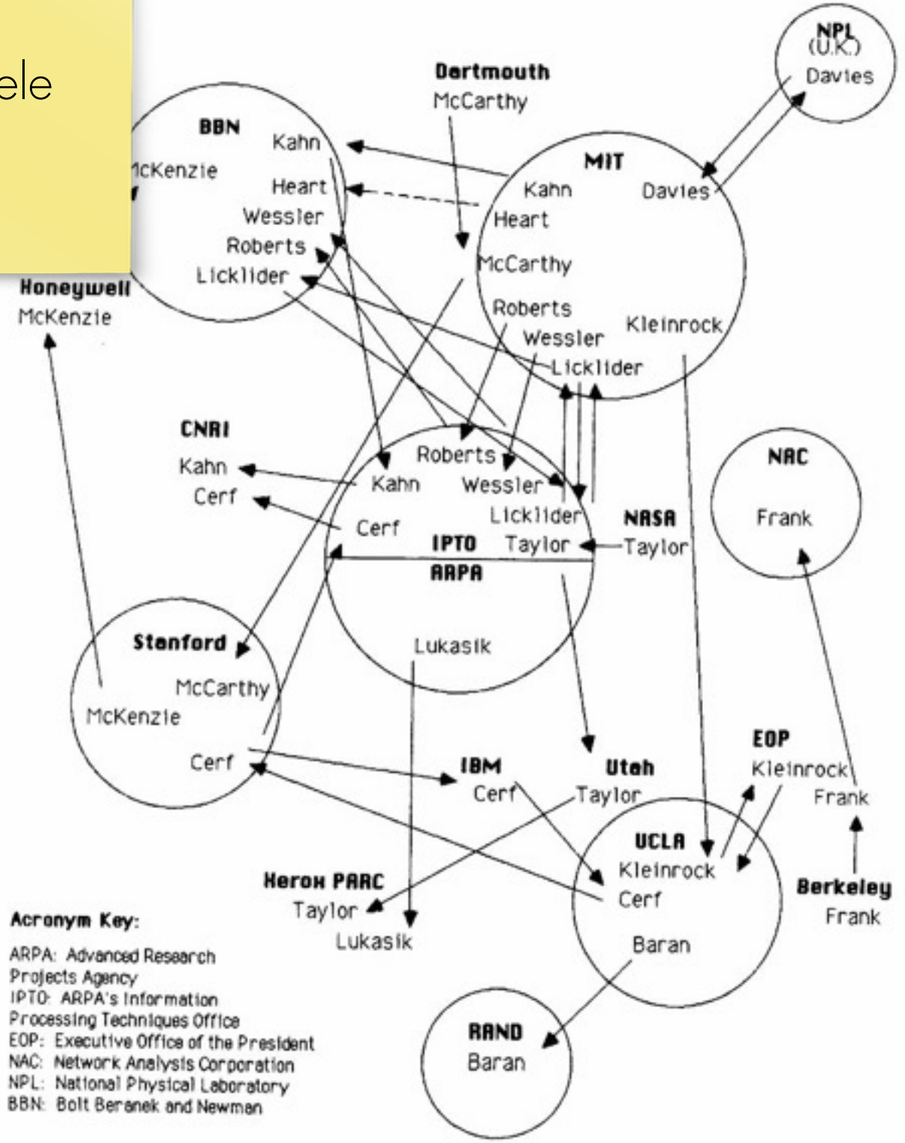
Im Mai 1990 wird der letzte IMP abgeschaltet.

Wer hat das Internet erfunden?

Innovation hat viele Eltern (Väter?)



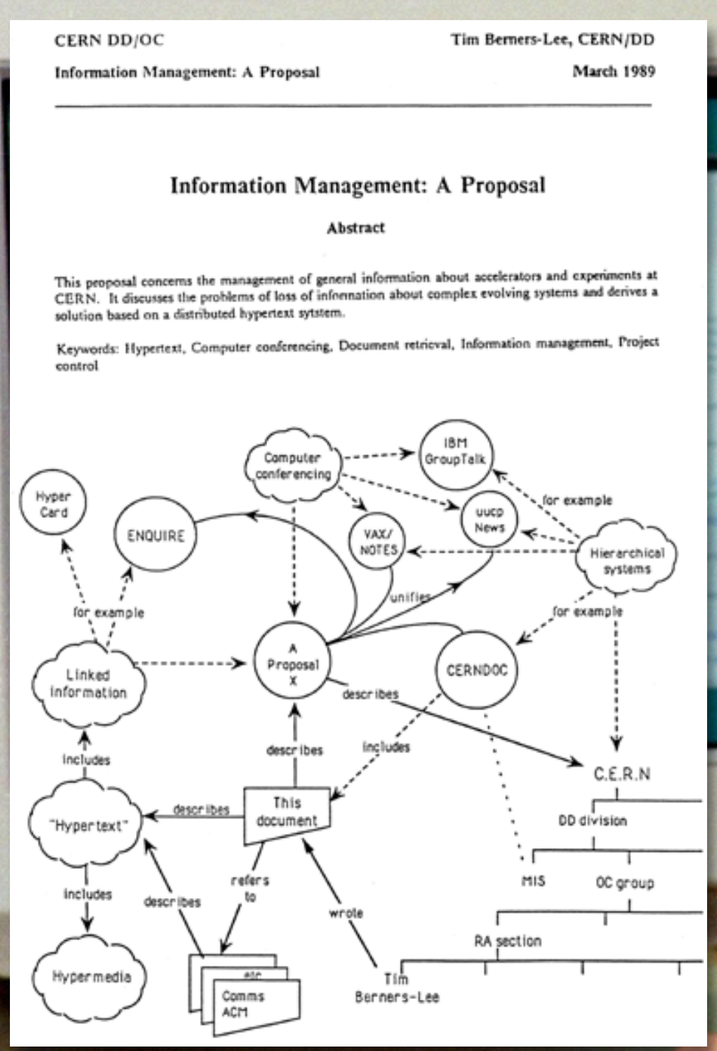
Pioneers of computer networking reunited in Boston in 1994 at the twenty-fifth anniversary celebration of the ARPANET, hosted by Bolt Beranek and Newman. *Left to right, front row:* Bob Taylor (1), Vint Cerf (2), Frank Heart (3); *second row:* Larry Roberts (4), Len Kleinrock (5), Bob Kahn (6); *third row:* Wes Clark (7), Doug Engelbart (8), Barry Wessler (9); *fourth row:* Dave Walden (10), Severo Ornstein (11), Truett Thach (12), Roger Scantlebury (13), Charlie Herzfeld (14); *fifth row:* Ben Barker (15), Jon Postel (16), Steve Crocker (17); *last row:* Bill Naylor (18), Roland Bryan (19). *(Photo © by Clark Quin, Boston, Massachusetts)*



Gopher

Innovation als Ideenwettbewerb

Informationsmanagement als Grund: World Wide Web



CERN DD/OC — Tim Berners-Lee, CERN/DD

Information Management: A Proposal — March 1989

Information Management: A Proposal

Abstract

This proposal concerns the management of general information about accelerators and experiments at CERN. It discusses the problems of loss of information about complex evolving systems and derives a solution based on a distributed hypertext sytstem.

Keywords: Hypertext, Computer conferencing, Document retrieval, Information management, Project control

Innovation braucht Geschichte

Tim Berners- Lee,

CERN, 1989