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*Reference
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Quarterly Management Report No. 15
Covering the Period 1 August 1976 through 31 October 1976
Stanford Research Institute Project 2325-*NS*

PACKET RADIO SYSTEM DEVELOPMENT

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Sponsored by

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I RESEARCH PROGRAM PLAN

The packet radio program is currently in the first of two phases. This phase is intended to demonstrate experimentally the packet radio technology that has been under development since early 1973. SRI has been charged with integrating several network components based on this technology into an experimental testing facility and with using this facility to demonstrate packet radio network (PRnet) capabilities. The components include terminals, repeaters, and a station, all of which have as a common element the packet radio unit (PRU).

The first realization of this network concept is an experimental PRnet located in the San Francisco Bay Area and centered at SRI. Some of the sites may be computing facilities (hosts) as well as user terminals. This PRnet now being brought together will be used both to demonstrate the characteristics of packet radio operation and to provide the basis of a working technology. However, elements of the PRnet could conceivably be used as components for other applications.

Packet radio also provides an alternative approach to the sharing of the radio spectrum. Where radio channels are individually assigned to users with low traffic density, packet radio may offer a more efficient use of the available spectrum. Finally, packet radio provides a natural communications format for the data-processing equipment that is finding ever-widening use.

II MAJOR ACCOMPLISHMENTS

During the reporting period, SRI:

- Acting in the SETD role:
 - Wrote a critique on BBN's PRTN No. 194, "Point-to-Point Routing Proposal."
 - Called a meeting among CRC, SRI, and ARPA on 20-22 October, in Dallas, to discuss PRU performance.
 - Initiated action to have packet radio simulators made sufficiently realistic to set achievable standards of an actual PRnet.
 - Reviewed BBN's PRTN No. 191, "Terminal-on-Packets Proposal."

- Expedited completion of the design goals for measurement software in the PRU and the station.
- Generated and distributed a weekly report from a remote site using the radio network including the station gateway and TCP end-to-end protocols. ☆
- Tested intranet forwarding between two LSI-11 terminals running the internet protocol TCPO. Each was one hop from the station. The LSI-11 also handles user interface dialogue. ☆
↑
TCP
+
- Participated with BBN in the functional demonstration of the capabilities embodied in LADs 1 through 7. This included channel access, hop transport protocol, station forwarding, preliminary network initialization, and gateway function.
- Suggested to BBN modifications of station loading procedures that would enable local generation of object code and project loading from the station disk. PRTN No. 186 discussing this and other station design issues was written. It was entitled "Station Integration and Design Tasks."
- Conducted extensive performance testing on the PRU with CAP2 software. Results were reported to Collins and ARPA.
- Upgraded PR station memory to 128K words of core memory, to accept larger station code.
- Brought up a TCP server on SRI-AI TENEX to use with TCPO in terminals. (The TCP has been bothered unexplainably by a slow run-time.) ☆
- Made extensive modification to the ELF operating system-- particularly in I/O speedup--which were placed in the ELF directory.
- Made preliminary measurements on the delay through the station via the gateway. These showed delays of the order of 40-50 ms.
- Conducted a packet radio demonstration in which the network consisted of a station, one repeater, and two terminals. The terminals operated with an end-to-end protocol (TCPO), and the station used an internet gateway to a TCP server at BBN and SRI-AI hosts. Exercises included terminal-terminal intranet ☆

communication with one terminal at a remote site and an ARPAnet access (to BBNF, SRI-AI, and ISIC). A natural language program called LADDER was exercised from a packet radio terminal as part of the demonstration.

- Completed a station file package that permits:
 - Compatibility with ELF EXEC routines
 - A server file transfer program (FTP) that will eventually transfer measurement files to UCLA.
- Constructed maps of the PRnet that satisfied a set of logical maps requested by UCLA.
- Submitted a set of modifications needed in future PRUs, based upon user needs.

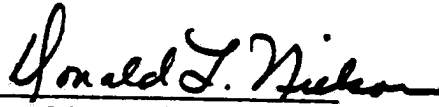
III PROBLEMS ENCOUNTERED

No major problems have been encountered during this period.

VI FUTURE PLANS

During detailed performance tests of the PRU, certain problems in the channel access operation were discovered. SRI notified Collins, and changes to correct the problems are to be made soon. Subsequently, SRI will retest the channel access and hop transport capability of the PRU, using a third release of software. With the delivery of several PRUs using a detector with a longer integration period, SRI will conduct mobile tests during the next period. These tests will be made while the PRUs are in motion. Further demonstration of intra- and internet transmissions will also be made, and, following the successful installation of new station software, we will begin some basic station measurements of throughput and delay. Repeaters will be installed at several more sites.

Prepared by:



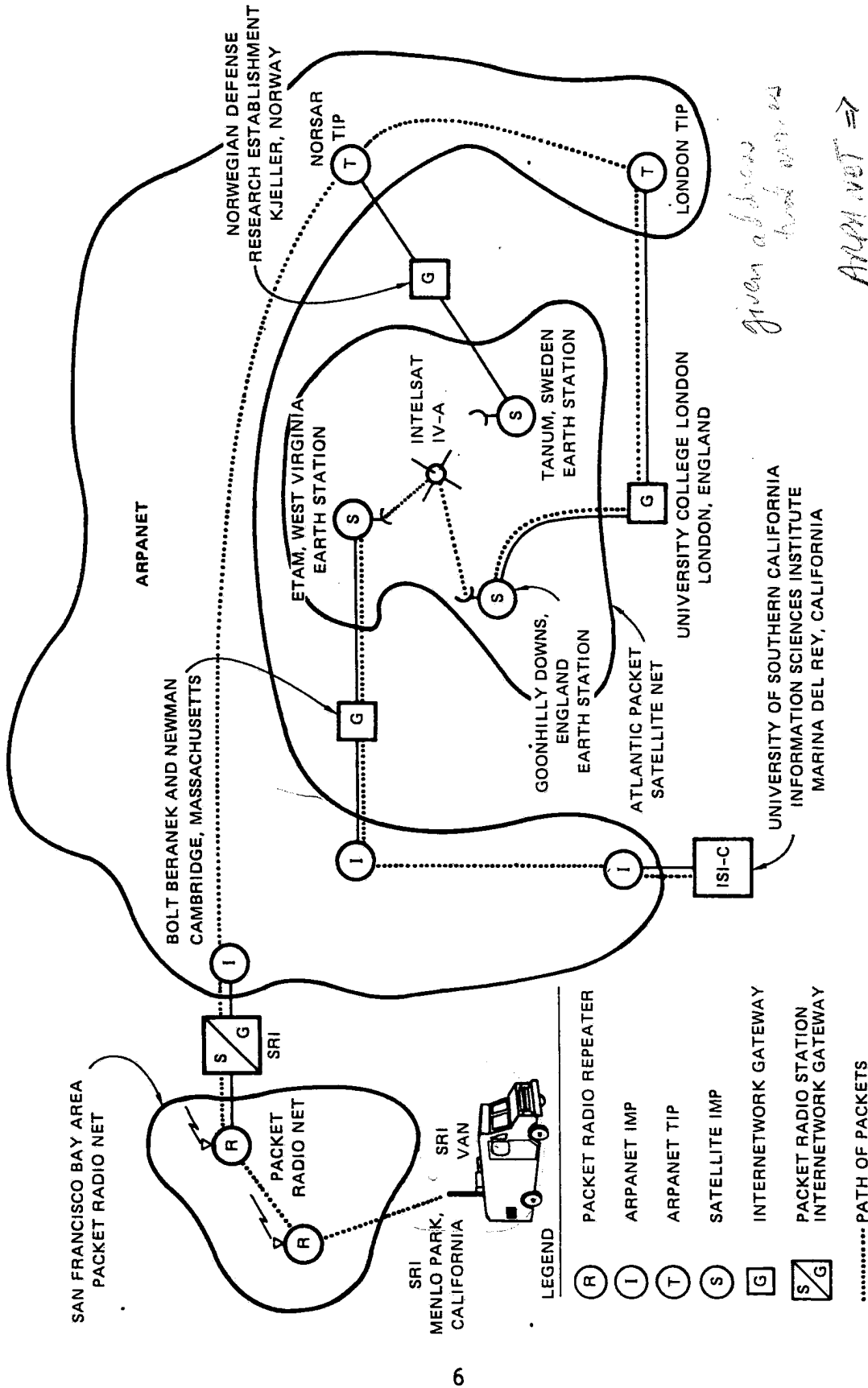
Donald L. Nielson

Principal Investigator

II PACKET RADIO DEMONSTRATIONS

Demonstrations of the San Francisco Bay Area packet radio network continued at a rapid pace during the reporting period: Eight demonstrations were held during the quarter. As in the past, the planning, coordination, equipment setups, software debugging, internetwork testing, and system checkout necessary for successful demonstrations occupied much of our time. These eight demonstrations are briefly described below.

- . A PRNET briefing and demonstration was given at SRI on 7 November 1977 by Colonel Russell of ARPA for General Starry and Major General Hilsman of the Army. Also attending this demonstration were Dr. George Heilmeier, ARPA Director; Mr. Don Looft, ARPA Deputy Director; and Dr. Robert Young of ARPA. Using a portable packet radio terminal cart, the conference room portion of the demonstration showed internetwork communication with several ARPANET hosts, as well as local (intranet) communication with other packet radio terminals in the SRI van and SRI four-wheel-drive vehicles. Concurrently with the conference room briefings and PRNET/ARPANET demonstrations, the four-wheel-drive vehicle carried out a 45-minute military-oriented scenario entailing an exchange of real-time messages between the mobile unit and ARPANET computer systems. A 30-minute mobile van ride then demonstrated the PRNET's capability to reroute traffic automatically through available repeaters in response to radio connectivity changes.
- . On 15 November 1977, SRI gave a PRNET briefing, demonstration, and facilities tour to Lt. Col. Reed Phillips (USMC) of Quantico, Virginia.
- . On 22 November 1977, the first ARPA three-network demonstration was successfully carried out as shown in Figure 1. Simulating a connection from a packet radio terminal in Europe to a host computer in CONUS, a packet radio terminal in the van at Menlo Park was connected to the ISIC computer in Marina Del Rey, California through the Atlantic Packet Satellite Network and the ARPANET. As Figure 1 shows, the CONUS/Norway/London spur of the ARPANET was used to simulate placement of the packet radio net in Europe. Packets from the van flowed through the Bay Area PRNET, through the station/gateway in Menlo Park to the ARPANET, through the NORSAR and LONDON TIPS to the London gateway, back



Given address had errors

ARPANET =>

US ONLY

Look for p of th (dupl

FIGURE 1 FIRST ARPA MULTINETWORK DEMONSTRATION

across the Atlantic via the SATNET to the ETAM (West Virginia) earth station, to the ARPANET gateway at BBN in Boston, and finally across the ARPANET to the ISIC host in Southern California.

- . On 29 November 1977, a PRNET terminal operator in Menlo Park established a real-time link with a group of DoD officials assembled at MITRE-Bedford in Massachusetts, as part of a demonstration of ARPANET and PRNET capabilities.
- . On 12 December 1977, we assisted Dr. Cerf of ARPA in giving a PRNET briefing, demonstration, and facilities tour to Mr. Bill Boenning of NSA.
- . On 14 December 1977, Dr. Cerf of ARPA and Jim Mathis of SRI operated a PRNET terminal in Menlo Park as part of ARPA's demonstration of ARPANET and PRNET capabilities to a large number of Army officials assembled at Fort Gordon. Multinet traffic routing (similar to that shown in Figure 1) was used for this demonstration.
- . On 16 December 1977, SRI gave a mobile demonstration to several members of the Packet Radio Working Group after the PRWG meeting at SRI.
- . On 21 December, 1977, SRI gave a PRNET briefing and facilities tour to Dr. Frank Kuo of the University of Hawaii.

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TITLE

What: (Description of the technology)

Impact: (How the technology was used; effect on science, engineering, business, society)

Genesis: (Reasons for development, who responsible for the research, how funded, how introduced to the community)

Reasons for Success: (Perseverance by researchers, solved a problem, filled a need)

(Include any supporting visuals, i.e., photos, articles)

Another project: Looking for artifacts to display in Building A lobby.

ALL-MAGNETIC LOGIC

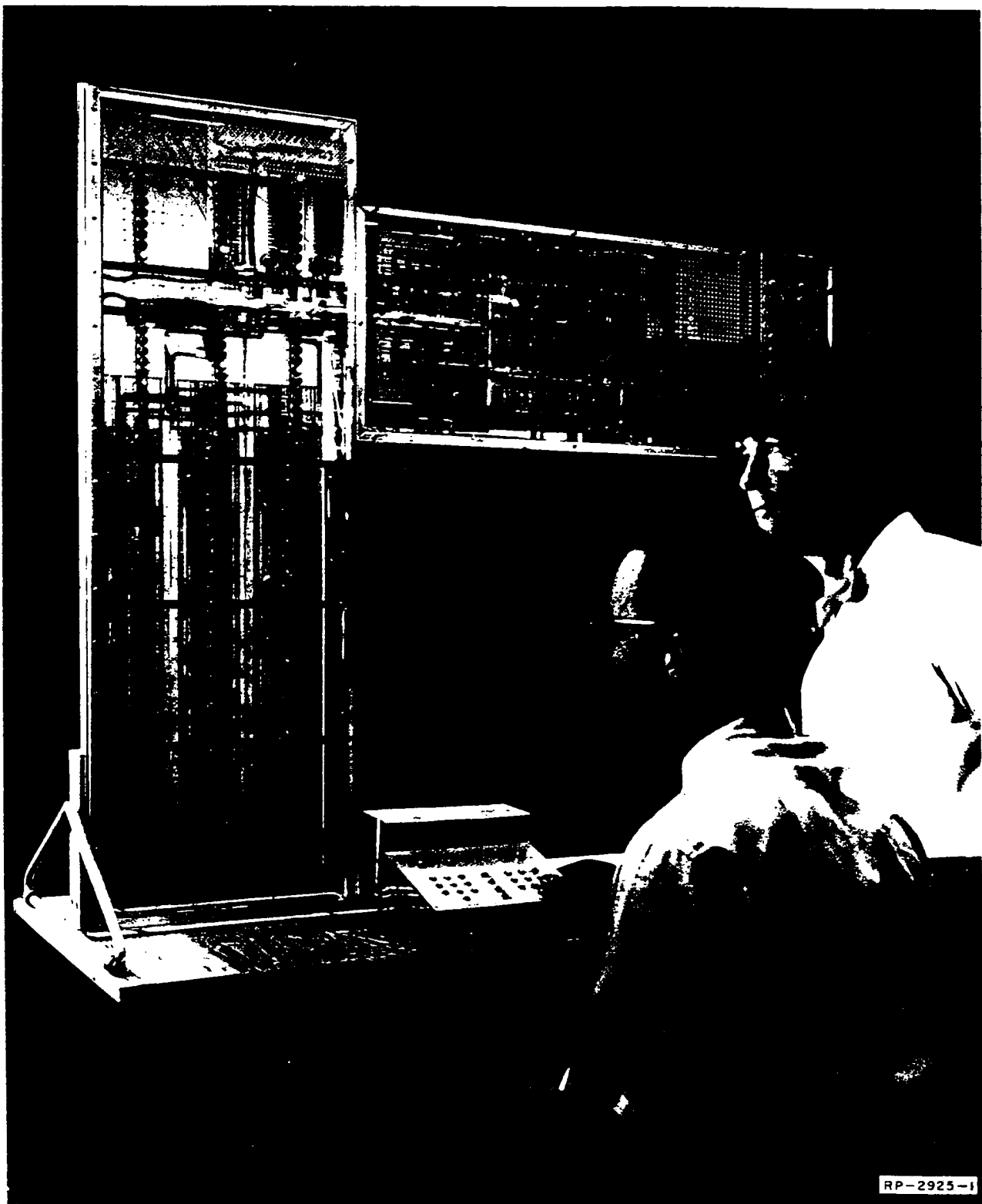
What: Multiaperture devices, or MADs, are magnetic ferrite elements of complex shape which can be interconnected solely by windings of copper wire. They were developed by Hew Crane, working from the notion of controlling the direction of bit flow in adaptations of magnetic ferrite memory cores to achieve complete logic capability. The goal in trying to develop logic circuits composed solely of magnetic elements and interconnecting wire—ultimately known as all-magnetic logic—was that they are essentially indestructible, in contrast to the vacuum tubes and transistors of the day. Another important advantage was that they do not draw power when not in use.

Impact: SRI's multiaperture device technology was broadly commercialized by AMP, Inc. For instance, MADs were used to build a control system for the Canadian National Railroad Hump Yard in Toronto, the largest switching yard of its kind in the world, because semiconductors could not withstand lightning surges and lightning was frequent. They were used to control a significant portion of the New York subway lines where the aim was to assure safe operation against all sorts of transients. Lockheed and Ford Aeronutronics used them to provide a secure access decoder to make certain no unauthorized agency could access or control intelligence satellites. They were used similarly in the B-50 bomber for the IFF (identification friend or foe) system. The Minuteman launch control system used them to ensure immunity to the electromagnetic pulse from any nuclear detonation. The ABC television station in Hollywood, as well as other television stations, used MADs for the audio part of video switching. Patents from the SRI work went to Burroughs (16 patents) and AMP, Inc. (6 patents).

Joseph Sweeney of AMP, Inc., tells of going to see the subway control installation ten years later and finding it several levels down at Grand Central Station. According to employees, the control box had never been opened. Sweeney opened it, vacuumed away a decade of coal dust left by the railroad trains, and the system kept right on functioning, sweet-as-ever.

Genesis: Hew Crane began working on multi-aperture devices during the mid-1950s at David Sarnoff Laboratories, and continued that work after joining SRI in 1956. He introduced the basic all-magnetic logic approach at the Fall Joint Computer Conference in March 1959. In 1961, the SRI magnetics group reported on and showed off a multiaperture logic system (funded by the Air Force) that was, in essence, the world's first and only all-magnetic computer.

Reasons for Success: From the end of the 1950s and through the beginning of the 1970s, multi-aperture magnetic devices were of great interest, as evidenced by the publication of many papers from many organizations (at SRI alone, there were over a dozen journal articles, and a book chapter by Hew Crane). In 1969, McGraw-Hill published a book on MAD technology by Dave Bennion, Hew Crane, and David Nitzen called *Digital Magnetic Logic*. What prevented the all-magnetic logic from developing a permanent niche in the computer market was the advent of the integrated circuit and the silicon chip. However, MAD-like units may yet be needed for long space flights or for very remote installations where maintenance and replacement may be impossible.



RP-2925-1

TOPICS IN NOTEBOOK 8/9/96

Title

All-Magnetic Logic
Communication Aids for the Deaf
Blood Pressure Monitor
Computer Networking
ERMA Computer
Eyetracker
Ionospheric Research
Laser Photocoagulation
Lidar and Optical Sensing
Neuristor
Optacon
Pen-Input Computers
Personal Computing
Printing, Printing Inks, and Toners
Robotics
Signature Verification Pen
Speech Recognition
Switching Amplifier
Tactical Air-Combat Training Ranges
Ultrasonic Imaging

Candidate ERG Items for Lobby Display (dln 1/22/96)

Item and Date of Origin	Artifact	Photos	VG/Diag.	Videos	Comments
1. Early mouse and 5-finger keyboard - abt 1967	x	x		x	Call Engelbart
2. ERMA check processing system - late 1950s	?	x			Harvard Review, call Jack Goldberg
3. Optacon tactile reader for the blind - 1971	?	x	x		Call Jim Bliss
4. Signature pen - ?1970s?	likely	x			Call Hew Crane
5. Laser Photocoagulation - ?1970s?		x			Call Hew Crane
6. Ionospheric/auroral research - 1950s to present		x		likely	Call Murray Baron
7. Vacuum microelectronics	x	x	x	x	Call Capp Spindt
8. Lidar and optical sensing - 1960s and 1970s	?	x		unlikely	Call Ed Uthe
9. Ocean-sensing sled - present	likely	x	x	likely	Call Robert Maffione
10. Ultrasound - 1970s	likely	x	x	likely	Call Ajit Shah
11. Optical recording - 1960s, 70s, 80s	x	x	x		Call Lou Schaefer
12. Network Information Center - 1970 to 1991	likely	x			Call Jake Feinler
13. Packet radio - 1970s	x	x	x	likely	Contact Boyd Fair, Barry Leiner
14. Deafnet - 1978	x	x	x		Terminals
15. Acoustic modems - 1960s		x			Van Geen and Weitbrecht patents
16. Expert system: Prospector - 1968		x	x		Call Ray Perrault
17. Speech recognition - 1990s		x	x	x	Ref. to Interactive Display in Lobby
18. Mobile robots: Shakey (1968) and Flakey ('90s)		x	x	x	Use Alda tape and others
19. Over-the-horizon radar: WARF - 1960s to pres.		x	x	x	Call Taylor Washburn
20. Active noise cancellation - 1990s		x	x	likely	Call Raul Martinez
21. High-speed printing - 1960s		x	x		Call Fred Kamphoeffner
22. Electrostatic discharge - 1950s plus Lockheed aw.	likely	x	x		Call TCI?; use Lockheed award
23. FM spectroscopy - 1980s		x	x		Call Dave Cooper
24. Flight test ranges - 1970s to present		x	x	likely	Call John Prausa
25. NEXRAD - 1990s		x	x		Call Murray Baron

↑← no prioritization intended

Lobby Display Ideas // STG

#	<u>Item and Date of Origin</u>	<u>Artifact</u>	<u>Photos</u>	<u>Poster</u>	<u>Videos</u>	<u>Comments:</u>	<u>Phone: Org</u>
1	Optical Memory & Communications	x		✓	✓?		R Kachru 3727 330
2	Excimer Lasers (>20 years)	x		✓	✓?		D Huestis 3464 330
3	Atmospheric Chemistry & Space Physics	Award		✓	?		T Slanger 2764 330
4	Combustion Mechanisms and Diagnostics	x	✓	?	Demo?		D Crosley 2395 330
5	Optical Sensors and Process Control Diagnostics	x?	?	?			J Jeffries 6341
6	Fullerine-Based Materials "Bucky" Balls & Tubes	Hologram	✓	✓			R Malhotra 2805 330
7	DNA sequencing using SALI (Surface Analysis by Laser Instr.?)	Instr.?	✓	✓			C Becker 5130 330
8	Breathec; breath monitoring instrument for ¹³ CO ₂ / ¹² CO ₂ Prototype?			✓			D Eckstrom 4398 330
9	Pharmaceutical drug discovery & Development; Tirazon Example?	x	x	Press			M Tracy 3528 372
10	Drug development (>30 years)	Example?		?	?		A Cheung 3106 381
11	PAT (Proficiency Analytical Testing) Program	Kit		✓			H Parish 6177 320
12	Toxic Substance Regulations (>20 years)	x		Regulations			T Mill 3605 320
13	Chemical Synthesis: new structures-of -matter & syntheses	Physical	✓	✓	?		R Schmitt 5579 320
14	Solar Cell from SRI Si Process (~1980)	Prototype		✓			A Sanjurjo 5215 340
15	Whirlpool Oven Coating; non-stick coating developed & Instr.?	Instr.?		✓	?		A Sanjurjo 5215 340
16	Practical solutions (Catalysis & Coatings)	Glow plug	✓				J McCarty 5215 340
17	Non-Scuff Formica	Example??					
18	In Vitro Models for Studying Drug Metabolism and Toxicity	x	?	?	x?	Proprietary concerns	C Green 385
19	Failure Prevention in Aircraft, Trains, Automobiles	Model	✓	✓	✓?		J Colton 2208 310
20	Pipeline Explosion Video: prediction, experimentation, d	x	x	x	✓		G Greenfield 3645 310
21	MacBomb program to predict structural damage	x	x	✓	✓		M Sanal 3377 310
22	Airline safety - explosion containment	?	?	?	✓?		M Sanal 3377 310
23	FRASTA - computerized fracture surface analysis	✓	✓	✓	Image?		T Kobayashi 320
24	Heart disease precursors of congestive heart failure	x	x	✓	?		K Webster
25	Hydrogen						
26	Catalysis						
27	Phosphors	Prototype?					R Wilson 320
28	Next						L Schneider 340

get stuff from Steve C-B

X = not
✓ = probable

John Fombro@joneav.com
Steve
George

- Don Nielson = displays artifacts } packet radio
= voice recognition / telepresence } radio comm.
now a "v-p" }

- web page → SRI.com } computer history
↳ Jack Goldberg

- Jean Summit language manual

- COO Asahi Chem paying for SRI "heroes" SO Engineering heroes

① ^{New} Hugh Crans = magnetic computer (ferrite + copper) Joe Sweeney

1. Don Nielson display
2. "heroes" publication
3. archive committee on-line oral history
4. index to collection

Gates Bldg + SRI

① Kleinsch: map

Don Parker (SRI) = computer crime database

① union catalog - Terry
of items

① old Soviet computers

Bill Jones } ILLIAC IV storage tape.
Mary Smith }