What is Bell Labs?

1969 - 1983
Bell Laboratories

1984 - 1995
AT&T Bell Laboratories

1996 - 2005
Lucent Technologies
Bell Labs Innovations

2006 - now
Alcatel-Lucent
The Transistor
1947: Bell Labs’ John Bardeen, Walter Brattain, and William Shockley invent the transistor, replacing vacuum tubes and mechanical relays and revolutionizing the entire electronics world. The team was awarded a Nobel Prize in 1956.

Information Theory
1948: Bell Labs’ Claude Shannon introduces Information Theory. Shannon quantified "information" and gave engineers a math-based theoretical maximum information carrying capacity for any communications system.

Laser
1958: Bell Labs’ Arthur L. Schawlow (left) and Charles H. Townes (right) describe the concept of the laser (light amplification by stimulated emission of radiation), in a technical paper. Bell Labs registers a patent on the laser. In 1964 Charles H. Townes, Nikolay Basov, and Aleksandr Prokhorov shared the Nobel Prize.
**Telstar**
1962: Bell Labs designs and launches Telstar I, the first orbiting communications satellite. Telstar weighs 171 pounds and features 3,600 solar cells for power as well as a new traveling-wave tube for generating the radio signals.

**Evidence of the Big Bang**
1965: Bell Labs’ Arno Penzias (right) and Bob Wilson (left) discover cosmic background radiation that provided evidence for the Big Bang theory of the creation of the universe. They had been using an ultra-sensitive microwave receiving system to study radio emissions from the Milky Way when they found an unexpected background of radio noise with no obvious explanation. It came from all directions and, after repeated checks, it appeared to emanate from outside the Galaxy. The scientists won a Nobel Prize for their work in 1978.
Charge Coupled Device (CCD)
1969: Bell Labs invents the charge-coupled device (CCD), a solid-state chip that transforms patterns of light into useful electrical information. This invention is at the heart of modern products such as digital cameras, camcorders, high-definition TV, security monitoring, medical endoscopes, video conferencing and satellite surveillance. Willard S. Boyle (right) and George E. Smith (left), Nobel Prize 2009.

UNIX Operating System
1969: Bell Labs’ Ken Thompson and Dennis Ritchie develop the UNIX operating system, a simple but elegant time-share software system for computers. It is the first software system designed to run on computers of all sizes, making open systems possible. UNIX later became the foundation for the Internet.

C
1972: Bell Labs introduces the C programming language, which combined powerful logical instructions with the ability to manipulate individual bits and characters in the computer without using machine language.
First Digital Signal Processor (DSP)
1979: Bell Labs creates the first single-chip digital signal processor (DSP), which laid the foundation for today's cellular phones and modems.

First Cellular System
1978: The first service trial of the Bell Labs-developed cellular communications system begins in Chicago.

Smart Antenna Technology (BLAST)
2001: Bell Labs achieves the first commercialization of "smart antenna" technology for cellular base stations, based on BLAST (Bell Labs Layered Space Time), a multiple input/multiple output (MIMO) wireless network technology.
Commercial Lightwave Communications
1977: The first commercial installation of Bell Labs-developed fiber-optic lightwave communications system is installed under the streets of Chicago.

Long-Distance Lightwave Communications
1981: Bell Labs develops the first long-distance lightwave communication system, which connected Boston, New York and Washington, D.C.

First Trans-Atlantic Fiber Optic Cable
1988: TAT-8, the first transatlantic fiber-optic cable system uses technology from Bell Labs to link North America and Europe. The system is 3,148 miles long and can handle 40,000 telephone calls simultaneously.

First Commercial DWDM System
1995: Bell Labs demonstrates the first commercial DWDM (dense wavelength division multiplexing) lightwave system, sending digitized information over multiple wavelengths, or colors, of light.
**Raman Amplifier**
1999: Bell Labs creates the Raman Amplifier, a device that boosts the signal in an optical fiber by transferring energy from a powerful pump beam to a weaker signal beam. The amplifier disrupts data carried by light much less than other methods of amplification, eliminating costly equipment used to correct the signals. Raman amplifiers are used in almost all current-generation ultralong-distance systems.

**Theoretical Limits of Optical Communications**
2001: Bell Labs researchers calculate the maximum amount of information that can be transmitted over optical fiber, demonstrating that fiber optics technology will result in robust, long-term and scalable communications networks. The team determined that it is theoretically possible to send approximately 100 terabits of information, or roughly 20 billion one-page e-mails, simultaneously per strand of fiber.
100GB Ethernet Transmission
2005: Bell Labs reports the first transmissions of 100 Gigabit per second (Gb/s) Ethernet over optical.

First Commercial 100GB Coherent Receiver
2010: Alcatel-Lucent presents the first transmissions commercial 100 Gigabit per second (Gb/s) coherent receiver. The technology is based on Polarization-Division Multiplexed-Quaternary Phase-Division Multiplexing (PDM-QPSK). The equipment includes an application-specific integrated circuit (ASIC) with 70 million plus gates.
Where is it located?
What is the project about?
Recent experimental records are within a factor <4 of the nonlinear Shannon limit.

The Shannon Limit (video)

Recent experimental records are within a factor <4 of the nonlinear Shannon limit.
Multi-mode fibers can support hundreds of modes

Roland Ryf, et al.; “10-Mode Mode-Multiplexed Transmission over 125-km Single-Span Multimode Fiber”; European Conference on Optical Communications (ECOC); PDP.3.3; September 2015, Valencia (Spain)
The first optical 6 x 6 coherent MIMO experiment
Peter J. Winzer
Director - Optical Transmission and Networks Research Dept.
Bell Laboratories USA (Alcatel-Lucent)

Starting date  September 2016 - February 2017
Duration of the stay  6-12 months (12 months preferable)
Skills required from the candidates  Excellent academic records, fiber-optic communications, digital communications, signal processing, laboratory skills, Matlab simulation, VHDL, good English knowledge.
Number of positions  1
Rewards  1350 $/month.
More information

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