Great Ideas in Networking

• The Internet has a long history and did not spring to life fully-formed with the advent of the web in the mid-1990s.
• Despite much mythology to the contrary, the Internet and its predecessors were funded by public research funds for most of the history of the field.
• The Internet has evolved in ways quite different from those envisioned by its creators.
• The Internet was originally designed for experimental flexibility, not as reliable infrastructure.
• The Internet is a hugely complex system and is therefore subject to both emergent behavior and system failures. Fortunately, the designers understood these ideas better than most systems developers.

The Victorian Internet

Many of the ideas that seem so new in the Internet have deep historical roots. In 1998, Tom Standage wrote a fascinating book about the history of telegraphy. In his book, Standage describes how the telegraph gave rise to many of the social structures of the Internet, including chat rooms, online romances, and its own breeds of entrepreneurs, cryptographers, and hackers.

Paul Otlet

Vannevar Bush and the Memex

Vannevar Bush and Hypertext

One of the earliest proponents of developing a global information network of the form we have today in the web was Vannevar Bush, President Roosevelt’s Director of the Office of Scientific Research and Development. In a 1945 article in *Atlantic Monthly* entitled “As We May Think,” Bush anticipated many of the ideas that are central to the modern Internet, including the idea of hyperlinked documents.

Some quotes:

—Vannevar Bush, *As We May Think,* 1945

When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (when it is) by tracing it down from subclass to subclass. It can be in only one place, unless duplicates are used; one has to have rules as to which path will locate it, and the rules are cumbersome. Having found one item, moreover, one has to emerge from the system and re-enter on a new path.

The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. . . .
Vannevar Bush and the Memex

It consists of a desk, and while it can presumably be operated from a distance, it is primarily the piece of furniture at which he works. On the top are slanting translucent screens, on which material can be projected for convenient reading. There is a keyboard, and sets of buttons and levers. Otherwise it looks like an ordinary desk. . . .

All this is conventional, except for the projection forward of present-day mechanisms and gadgetry. It affords an immediate step, however, to associative indexing, the basic idea of which is a provision whereby any item may be caused at will to select immediately and automatically another. This is the essential feature of the memex. The process of tying two items together is the important thing.

Ted Nelson and Hypertext

Many of the notions of the modern web were anticipated by Ted Nelson, who introduced the word hypertext in the early 1960s.

In 1974, Nelson published *Computer Lib*, a two-sided book that is more reminiscent of a graphic novel than one’s traditional conception of a book. In it, he describes how computers will empower people as technology develops.
Life among the Wizards

The history of the Internet has been told in several books. One tells the following interesting story:

A small circle of friends at BBN had gotten hooked on Dungeons and Dragons, an elaborate fantasy role-playing game in which one player invents a setting and populates it with monsters and puzzles, and the other players then make their way through that setting. The game exists only in the minds of the players.

Dave Walden got his introduction to the game one night when Eric Roberts, a student from a class he was teaching at Harvard, took him to a D&D session. Walden immediately rounded up a group of friends from the ARPANET team for continued sessions. Roberts created the Mirkwood Tales... One of the regulars was Will Crowther...
A Challenge

Given a map such as the one shown on the preceding slide, how would you design a reliable communication strategy for sending messages between nodes in the network, given the following facts:

- Nodes are unreliable.
- Nodes are heterogeneous, in the sense that they come from many different manufacturers, with incompatible instruction sets and word sizes.
- Connections are unreliable.
- Connections are slow.
- Network traffic is bursty, in the sense that there are usually delays between messages that are themselves relatively long.