- Would the Internet we have today be much better if it was based on the ISO/ OSI 7-layer model rather than TCP/IP?
- Consider the availability, influence and impact of server and desktop tools and environments and where they came from (Commercial sources vs. Open source).

• 'Rough Consensus and Running Code' and the Internet-OSI Standards War

By the mid-1990s, however, ISO's slow stan-
dardization process had failed to keep up with alternative, informal mechanisms that were more effective at coordinating rapid technological change.

TCP/IP →ultimate goal was to make the network transparent, "a seamless whole," invisible to the user who would be more interested in accessing information over the network instead of the operation of the network itself.

Network transparency and **application autonomy** are the **two key elements** of a design philosophy first articulated in 1981 by David Clark, Jerome Saltzer, and David Reed, three veterans of ARPA-sponsored networking experiments at the Massachusetts Institute of Technology's (MIT's) Laboratory for Computer Science.

end-to-end principles form the heart of the
conventional understanding of the "Internet
philosophy": freedom of action, user empowerment, end-user responsibility for actions undertaken, and lack of controls "in" the Net that limit or regulate what users can do.

By the early 1990s, participation at IETF meetings—which were held three times a year and open to anyone interested—continued to increase at an explosive pace, reflecting growing interest from the research community as well as from the commercial community. The increasing size, value, and internationalization of the IETF and Internet standards process brought significant legal and practical problems to the fore, such as antitrust liability, copyright protection, and the needs to detach the process from the US government and to accommodate international participation.

the TCP/IP Internet and the open systems interconnection (OSI) model were designed as **nonproprietary** networks that would allow users **more flexibility**.

OSI is an example of a broader movement toward "open systems" that "encouraged compatibility between systems from different manufacturers.

For computer networks, open systems such as OSI and the TCP/IP Internet emerged as alternatives that could challenge the dominance of IBM and its System Network Architecture.

The goal of this seven-layer OSI Reference Model was not to define the internal operations of networks, but only to **standardize** the external interfaces between networks: in other words, to set the ground rules for network interconnection.

ISO's organizational culture—concerned with defining and controlling the future of information and telecommunication services on behalf of its representatives from national governments—resembled contemporary **democratic bodies insofar as it featured voting**, partisan compromises, and **rule-making behavior designed to protect financial interests.** Such processes stand in stark **contrast** to **the research and military orientation** of the people and institutions that **developed Internet protocols.**

To better understand the competing standards, the DoD asked the National Research Council in 1983 to evaluate TCP and TP-4, its functional counterpart in the OSI Reference Model.

The final 1985 report presented three options: keep the two as costandards; adopt TP-4 as soon as it was shown to be ready for military networks; or keep TCP and defer indefinitely a decision on TP-4.

- The DoD supported the second option and planned to "move ultimately toward exclusive use of TP-4."

For example, in their 1983 paper describing the similarities between the ARPA and ISO protocol architectures, Danny Cohen and Jon Postel painted the ISO model as an abstraction, far too rigid in its reliance on seven interrelated levels, and inappropriate to be used "as a model for all seasons".

The resentment of Cohen, Postel, and their Internet colleagues stemmed from their frustration with the technical aspects of OSI as well as with ISO as a bureaucratic entity. Where TCP/IP was developed through continual experimentation in a fluid organizational setting, Internet engineers viewed OSI committees as overly bureaucratic and out of touch with existing networks and computers.

Mike A. Padlipsky, characterized the ARPA Internet Reference Model as "Descriptive" and ISO Reference Model as "Prescriptive." Another networking pioneer, David Mills, agreed in a 2004 interview: "Internet standards tended to be those written for implementers. International standards were written as documents to be obeyed."

Padlipsky wrote, "is that whereas the Descriptive approach is suitable for technology, the Prescriptive approach is suitable for theology".

in the late 1980s revolved around addressing and routing problems built into the current version of TCP/IP (IPv4): the finite amount of address space in IPv4 was projected to be running out quickly. If the exponential growth of Internet users continued, the bottleneck would prevent new connections to the network.

- The IAB perceived that a solution might be reached through the OSI functional counterpart to IP called ConnectionLess Network Protocol, or CLNP.6

Additionally, the IETF, consisting mostly of academic and government researchers, resented that OSI was a complex and costly system, driven by the political concerns of ISO—the "standards elephant." This cultural conflict—which was, by 1992, over a decade old—made CLNP especially unpalatable to the IETF as a replacement for their favored Internet Protocol.

Rough consensus and running code" generated and sustained this level of enthusiasm because of the way it framed the successful aspects of the IETF process in opposition to the ISO process.

In short, rough consensus was an apt description of this informal process in which a proposal must answer to criticisms, but need not be held up if supported by a vast majority of the group. To IETF participants, this process was vastly superior to the bureaucratic and political approach of ISO.

As a complement to rough consensus, running code means "multiple actual and interoperable implementations of a proposed standard must exist and be demonstrated before the proposal can be advanced along the standards track.

Since most standards begin with a proposal from an individual or group within a working group—and not from the IAB or IETF leadership—the party behind the proposal must provide multiple working versions of the proposal. This burden of proof on the proposed standard facilitates the adoption of new IETF standards across the Internet's diverse computing platforms. Running code also evokes a major difference between the IETF and ISO approaches: where the IETF protocols represented "the result of intense implementation discussion and testing," ISO committees developed a theoretical model that was difficult to alter or implement fully.

Or, as Internet pioneer Einar Stefferud was fond of saying, "OSI is a beautiful dream, and TCP/IP is living it."

By the time National Institute of Standards and Technology (NIST) abandoned GOSIP in favor of TCP/IP in 1994, the grand future planned for OSI was on the rapid decline.

The market for network protocols had tipped in favor of TCP/IP, epitomized by the popularity of a new application—the World Wide Web—that was designed to take advantage of the Internet's end-to-end architecture.

OSI: The Internet That Wasn't

And yet, by the early 1990s, the project had all but stalled in the face of a cheap and agile, if less comprehensive, alternative: the Internet's Transmission Control Protocol and Internet Protocol. As OSI faltered, one of the Internet's chief advocates, Einar Stefferud, gleefully pronounced: "OSI is a beautiful dream, and TCP/IP is living it!"

Cerf's departure marked a rift within the INWG. While Cerf and other ARPA contractors eventually formed the core of the Internet community in the 1980s, many of the remaining veterans of INWG regrouped and joined the international alliance taking shape under the banner of OSI. The two camps became bitter rivals.

The layered OSI reference model also provided an important organizational feature: modularity. That is, the layering allowed committees to subdivide the work. Indeed, Bachman's reference model was just a starting point. To become an international standard, each proposal would have to complete a four-step process, starting with a working draft, then a draft proposed international standard, then a draft international standard, and finally an international standard. Building consensus around the OSI reference model and associated standards required an extraordinary number of plenary and committee meetings.

OSI's first plenary meeting lasted three days, from 28 February through 2 March 1978. Dozens of delegates from 10 countries participated, as well as observers from four international organizations. Everyone who attended had market interests to protect and pet projects to advance. Delegates from the same country often had divergent agendas. Many attendees were veterans of INWG who retained a wary optimism that the future of data networking could be wrested from the hands of IBM and the telecom monopolies, which had clear intentions of dominating this emerging market.

This uneasy alliance of computer and telecom engineers published the OSI reference model as an international standard in 1984. Individual OSI standards for transport protocols, electronic mail, electronic directories, network management, and many other functions soon followed. OSI began to accumulate the trappings of inevitability

While such edicts may sound like the work of overreaching bureaucrats, remember that throughout the 1980s, the Internet was still a research network: It was growing rapidly, to be sure, but its managers did not allow commercial traffic or for-profit service providers on the government-subsidized backbone until 1992. For businesses and other large entities that wanted to exchange data between different kinds of computers or different types of networks, OSI was the only game in town.

Two years later, the French networking expert and former INWG member Pouzin, in an essay titled "Ten Years of OSI—Maturity or Infancy?," summed up the growing uncertainty: "Government and corporate policies never fail to recommend OSI as the solution. But, it is easier and quicker to implement homogenous networks based on proprietary architectures, or else to interconnect heterogeneous systems with TCP-based products." Even for OSI's champions, the Internet was looking increasingly attractive.

Then, on 1 January 1983, ARPA stopped supporting the ARPANET host protocol, thus forcing its contractors to adopt TCP/IP if they wanted to stay connected; that date became known as the "birth of the Internet."

Engineers who joined the Internet community in the 1980s frequently misconstrued OSI, lampooning it as a misguided monstrosity created by clueless European bureaucrats. Internet engineer Marshall

Rose wrote in his 1990 textbook that the "Internet community tries its very best to ignore the OSI community. By and large, OSI technology is *ugly* in comparison to Internet technology."

Although Cerf and Kahn did not design TCP/IP for business use, decades of government subsidies for their research eventually created a distinct commercial advantage: Internet protocols could be implemented for free. (To use OSI standards, companies that made and sold networking equipment had to purchase paper copies from the standards group ISO, one copy at a time.)

"On one side you have something that's free, available, you just have to load it. And on the other side, you have something which is much more architectured, much more complete, much more elaborate, but it is expensive. If you are a director of computation in a company, what do you choose?"

OSI brought to light the deep incompatibility between idealistic visions of openness and the political and economic realities of the international networking industry. And OSI eventually collapsed because it could not reconcile the divergent desires of all the interested parties.