If you could uninvent one thing what would it be and what would we lose by losing it?

The Erbium-doped Fiber Amplifier is fundamental to all of our intercontinental telecommunications; it provides the signal repeating required to transmit information by fiber optic cables over mammoth distances. As light is transmitted through fiber optic cables some of the signal is lost to absorption and scattering, so to maintain quality and strength of the signal, some form of repeater or amplifier is needed. Prior to Erbium-doped Fiber Amplifiers, electronic repeaters were placed every 40-80km; these were expensive and slowed down overall transmission speeds as the signal had to be received, converted to electric signals, clarified and retransmitted into light. Electronic retransmission was clunky, slow and subject to interference and losses. The economics and feasibility of this technology for submarine use was little to none. The Erbium-doped alternative splices a short section or loop of silica based fiber that has Erbium, the rare-earth element, infused throughout the fiber core. These do not block or reduce the signal in the fiber, rather they help amplify it. Erbium is an incredible element, it can be exited to higher (quantum-mechanical) energy levels by shining light of a specific wavelength onto it (980nm or 1450nm)

As photons in light signals pass the excited Erbium atoms they cause it to deexcite and release photons of the same wavelength, multiplying the intensity of the signal meaning it can travel greater distances with no interruptions(1). Other advancements further reduce losses meaning that EDF amplifiers are placed only every 500-800km in long-haul cables. To prevent the amplifier from damaging itself components like Faraday isolators are added, these ensure the signals are only travelling one way and are not reflected back into the amplifiers. Optical circuits containing EDFAs now exist in their thousands below our seas and across our continents.

The ability to communicate effectively and economically trans-continents is invaluable for modern society, to a point that I feel that the uninvention of EDFAs would instead have driven greater growth in other means, such as satellite communications. Whilst it is possible for fiber optics undersea without EDFAs, it becomes incredibly expensive, less reliable and slower(2). Optic capacity would be nearly abolished compared to what we know, save a few lines used for secure transmissions for diplomatic or incredibly high paying customers given the difficulties of their economics. The specific uses I landed on are in part due to the security of fiber optics, tapping requires a huge amount of expertise, physical access and resources. Satellites, in contrast, are the most exposed and easily intercepted forms of communication, at

which point the drive for encryption and data protection becomes even greater. Tech companies must thrive in different ways; satellite and encryption races would begin. Satellites, in their own rights, are great for point to area dispersal, as one satellite can reach a large quantity of receivers, so for broadcasts they are excellent, but traffic to and from specific devices adds complexity(3).

Imagine the space capability the global community would develop had we felt the need. From the 1990s through to the modern day, the space industry has been sidelined in comparison to fiber and communications. Bearing exception to the fantastic Artemis 2 mission, the public image has reflected the fading space craze. Elon Musk's ingenuity to reuse launch rockets dramatically increased the viability and economics of getting satellites into orbit since the closing of the space shuttle programme. Integrated satellite systems could have been a deeply interesting networking system to explore at the scale we use fiber optics for driving the development of space-tech. To take another approach, we could assume that such a network of satellites would be unfeasible and as such, instead we simply don't have the capacity for internet use that we currently do and what the implications might be. Access would be more limited, or expensive to get online, local networks might be more prevalent, limiting resources to national collaboration but in turn driving a different type of development. The Global data market would be tighter and harder fought, the right for the space to transmit down certain electronically amplified fiber optic cables or specific satellites would be incredibly valuable. It could lead to it being more economically viable for mega-companies like google, microsoft, amazon ect. to fund their own satellites and space-communications-systems. How those choose to interact with governments and other organizations once the infrastructure is up there could be key to a whole new section of law and legislation and the potential fallout of data interceptions/breaches of the encryption methods would be massive given the potential volume of information transmitted, and largely undetectable eavesdropping. The other consideration would be the impact on the trade markets, with the inevitable delay in transmission between continents there is a much greater potential to exploit gaps and short term delays in market response - scalping techniques. By having methods of communication that have significantly different (to a computer) time delays, there becomes an incredible tactical advantage to having the fastest access to information from your own and other international markets. The Wall Street effect, buildings in the surrounding area wanting the fastest connectivity possible to the markets and driving up the price of real estate hard is only amplified when a difference in communication speed

could be felt by using fiber rather than a more widely used satellite. This would be particularly visible if fiber were so exclusive as to be only accessible to say, those with diplomatic power or with enough connections to the telecom industry. There emerges a massive potential for individuals with access to advantaged technology to generate immense wealth. The implications of this spectacular wealth are beginning to be felt in the modern day and time will tell whether they help or hinder our global development.

I enjoy the thought that our entire fundamental system of communication across every corner of the globe could be so completely different, and that the direction of innovation pivoted about one invention so hard that it enabled lightspeed data transmission around the world. The basis of national infrastructure would be different and the potential for space exploration would be massive, not to mention the methods with which our high speed markets would be different with all kinds of new opportunities to explore and exploit. I think the EDFA has brought an incredible amount of digital capability to our world and I'm grateful for its implementation.

You know the real kicker? Professor Sir David Payne - the inventor of the EDFA - did not patent it.

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