

# The Fish and the Wind-Turbines

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## 1. Introduction

The first major U.S. offshore windfarm, Vineyard Wind, has received final approval. There will be about a dozen more major windfarms on the East Coast by 2025, and probably a few more (plus expansions of the initial projects) thereafter. The offshore buildout on the West Coast will probably start in a few years.

In this work the offshore wind developers have faced several foes. The most credible of these are probably the fishermen. The developers appear to be using a familiar tactic: assemble a consortium of groups that support their development, and simply steamroller their opponents. This may be good for the fish, but, I fear, not for our nation.

I would suggest a different tactic – a bit of political horse-trading. That is, trade something that will cost the developers very little (compared to overall project costs), they probably need to build anyway, and the fishermen will need very badly in the future. This would come with the tacit understanding that this would gain the fishermen's support (sorry fish). The bargaining-chip would be an Offshore Secure Cloud Access & Communication Network.

I have identified two technology candidates for this network as described below.

## 2. Technology and Development

First I must add a brief caveat: Although I was involved with (mainly 3G) digital cellular networks for several years as part of the automatic meter reading part of my career, I am certainly not an expert, particularly when it comes to more modern systems, but I believe two candidates are probably viable for this role, and there may be others.

The first candidate is a proven terrestrial cellular network, the Fourth-Generation Cellular (4G). The second candidate is an emerging satellite network: Starlink.

### 2.1. Fourth-Generation Cellular

Fourth-Generation Cellular (4G) is over a decade-old technology that combines a reasonable compromise between large cell footprints (with reasonable cell-edge coverage), support by a wide range of connectivity hardware, performance and application support. Although 5G offers much better throughput, it typically requires much smaller cell footprints and is not as proven nor widely supported as 4G.

*In November 2008, the International Telecommunications Union-Radio communications sector (ITU-R) specified a set of requirements for 4G standards, named the International Mobile Telecommunications Advanced (IMT-Advanced) specification, setting peak speed requirements for 4G service at 100 megabits per second for high mobility communication (such as from trains and cars) and 1 gigabit per second for low mobility communication (stationary users)...<sup>1</sup>*

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<sup>1</sup> Wikipedia Article on "4G", <https://en.wikipedia.org/wiki/4G>

*As opposed to earlier generations, a 4G system does not support traditional circuit-switched telephone service, but instead relies on all-Internet Protocol (IP) based communication such as IP telephony. ... The spread spectrum radio technology used in 3G systems is abandoned in all 4G candidate systems and replaced by orthogonal frequency-division multiple access (OFDMA) multi-carrier transmission and other frequency-domain equalization (FDE) schemes, making it possible to transfer very high bit rates despite extensive multi-path radio propagation (echoes). The peak bit rate is further improved by smart antenna arrays for multiple-input multiple-output (MIMO) communications.*

As proposed for offshore communication, the 4G system would probably be a private domain that would be coupled to the larger Internet through security appliances. Physically this would rely on a collection of MIMO antenna arrays, with each array mounted high on a wind-turbine supporting structure.

## **2.2. Limitations**

A user would need to be either in, or within a few tens of miles from a wind farm to receive service, although this could be extended (see the subsection 2.5 below).

There is also the possibility that rotating wind-turbine blades may interfere with the RF signal, forcing the antenna arrays to be placed lower on the supporting structure. This would shorten the coverage distance at the edge of each windfarm. There is probably a work-around for this – see subsection 2.5 below.

## **2.3. SpaceX Starlink**

*Although Starlink is still in its infancy, Starlink satellite internet is undergoing a public (invitation-only) beta in limited parts of the US, Canada, and the UK. Starlink is currently the only unlimited satellite provider in the US—offering truly unlimited, full-speed data.<sup>2</sup>*

*But, Starlink has its problems. In addition to limited availability, periodic outages are common. (Remember—Starlink is still in beta.) There just aren't enough satellites yet to deliver constant connectivity. And although Starlink is launching more satellites at a rapid pace, it'll take a year or so before all North Americans can get continuous (uninterrupted) Starlink service.*

*As of late June, 2021, with roughly 1,800 satellites in orbit, SpaceX's Starlink is well on its way towards providing internet access to users across the globe. But before the high-speed satellite internet system manages worldwide coverage, Elon Musk has announced a more recent and meme-worthy milestone for Starlink.<sup>3</sup>*

*That 1,800 sounds like a big number. And it is—Starlink has long been the world's largest satellite constellation. But that doesn't mean that Starlink is ready to offer full-fledged satellite internet service yet. Starlink will need to have up to 42,000 satellites in its constellation—which means it's still a long road ahead for Starlink. Thus far, only*

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<sup>2</sup> Kristin Cooke, Satellite Internet, "SpaceX Starlink Satellite Internet Service." May 17, 2021, <https://www.satelliteinternet.com/providers/starlink/>

<sup>3</sup> Simon Alvarez, Teslarati, "Elon Musk's Starlink reaches meme-worthy milestone of 69,420 active users," June 27, 2021, <https://www.teslarati.com/elon-musk-starlink-69420-users-milestone>

*12,000 Starlink satellites have been approved by both the FCC (Federal Communications Commission) and the ITU (International Telecommunication Union).<sup>2</sup>*

*Starlink's 69,420 activate users hint at the rapid deployment of the satellite internet system. Just this past February, SpaceX disclosed that it had 10,000 Starlink customers. It was already an impressive number then, considering that the service is still in its beta phase, but it pales in comparison to the recent milestone that Musk announced on Twitter. These, however, were not all that Musk announced.<sup>3</sup>*

*Musk also shared some notable improvements coming to Starlink. The CEO stated that all 72 orbital planes of the system should activate in August, and together with several other improvements, global coverage should be possible.*

SpaceX CEO, Elon Musk has also announced that his new space launch vehicle, Starship, will take over deployment of Starlink Satellites from the Falcon 9. Starship has been under development for several years and is nearing suborbital test flights. It also is much larger than the Falcon 9. Each Starship flight could potentially launch up to 400 Starlink satellites, which would require six and a half dedicated Falcon 9 missions.<sup>4</sup>

#### **Starlink Costs:**

- \$99/mo. satellite internet service
- Download speeds vary: 50–150 Mbps
- Unlimited data
- \$499 one-time equipment fee

I believe that Starlink will be the best satellite communication alternative in a year or two, given Elon Musk's technical expertise, and his tendency to eventually dominate any market he goes after (see the next subsection for potential alternatives).

## **2.4. Other Satellite Networks**

Reference 2 Identifies two other service providers (with links, pricing and I assume, reviews).

- ViaSat
- HughesNet

## **2.5. Potential Development**

It is assumed that either the offshore windfarm developers or a consortium of these developers, fishermen and other offshore users will deploy and manage the Offshore Secure Cloud Access & Communication Network.

Since the coverage of the 4G network is limited to the general area of the windfarms, it might be desirable to widen these areas. Outside of the windfarm area this might be done via anchored floating buoys with antenna arrays. These might use telescoping

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<sup>4</sup> Eric Ralph, Teslarati, "SpaceX CEO Elon Musk says Starship will take over Starlink launches," June 11, 2021, <https://www.teslarati.com/spacex-starlink-launches-starship-takeover>

masts with the antenna arrays on top of these. The masts could be lowered in the worst weather. Power would probably come from solar arrays and/or wave-powered generators.

**For the 4G candidate**, the primary development activities might involve:

- Setting up the organization
- Identifying a firm to deploy the network and possibly manage the network.
- Purchasing the capital equipment (mainly the antenna arrays, network support and IT infrastructure)
- Possibly equipment and services to extend the network beyond the windfarms (see above)

It assumed that service charges from users will fund the operating expenses plus a small profit for future expansion/upgrades.

**For the Starlink candidate**, the primary development activities are:

- Setting up the organization
- Negotiating a contract with SpaceX for service and equipment
- Ongoing administration