Unlocking Technical and Market Innovation

Ecogy Energy

The Next Generation Utility

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AUTHOR'S NOTE

This white paper is targeted at those in the distributed energy and utilities sectors, it is particularly intended for those familiar with the role that information technology plays in this space. It is intended to broaden our collective horizons in terms of what's possible. Ultimately its aim is to accelerate the decarbonization of the energy sector.

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Introduction

The climate crisis is real and is the largest existential threat to humankind that we know of. A key solution is to transition society's energy mix away from fossil fuels and towards zero carbon renewable energy, as quickly as possible. We believe that Distributed Energy Resources (DER) are the quickest, cheapest, and most equitable way to get there (of course, electrification of everything is also a given). In particular distributed renewable energy generation coupled with energy storage, smart buildings and other such controllable loads is how we decarbonize the grid. It is the very near future of the grid, with DER providing services and energy to the grid, allowing the grid to remain resilient and stable as the carbon intensity of the grid is reduced over time. Based on current observable facts, this outcome seems obvious although not necessarily guaranteed as there are many challenges still to be addressed.

Source: Imperial College London

Now and in the future specifically, grid services are going to be more important than the kWh commodity that energy is becoming. This is evidenced by the fact that price points per kWh are dropping, while at the same time the need for grid services such as peak shifting and the like are increasing. Although these valuable services may not yet be fully appreciated, that will change and it must change quickly if the grid is to move towards decarbonisation in the fastest and most cost effective way [1].

Accepting that this change is underway, we can switch our mind to how best to enable this from a grid architecture and technology perspective (and getting this right will accelerate the process).

We need cohesive solutions that help solve the emerging problems (e.g. challenges like resiliency, energy security and very grid specific challenges like DER hosting capacity).

[1] https://www.vibrantcleanenergy.com/wp-content/uploads/2020/12/WhyDERs_ES_Final.pdf (DER benefits are not being appropriately modeled, leveraged or reimbursed for by Utilities and planners)

We need an ecosystem that engineers can work within, innovate within and be highly productive within, all the while retaining or improving existing levels of grid stability and providing and promoting best practice security. What might that look like?

Here we are going to propose that there are two things, silos and coupling, that need to be addressed to achieve this result. Specifically this looks like:

1. **Eliminating Silos** From Core Pieces of Grid Architecture

Silos, often created by proprietary tech are okay at the edge, but they must not dominate the core, otherwise that is where innovation is stifled and security issues can reside, often hidden within closed proprietary code.

2. **Separation of Concerns** Between DER Operators and the Grid

Separation will allow for simplification of problem domains, both for the facility operator/owner and for the grid operator, this then leads to accelerated innovation.

Ok, great, but what evidence do we have to support this and why might this be?

Historically the grid's core software architecture has been dominated by products with well known acronyms such as DMS / ADMS / EMS and SCADA and these solutions are largely speaking not ready to address the needs of proliferating DER. Also, these solutions are often proprietary solutions, hence preventing broad market participation in innovation (i.e. the customer is locked in via the constraints of the product and the constraints of the vendor’s vision and the associated development roadmap). This view of an outdated and constrained landscape is echoed by many in the industry looking at the DER proliferation and industries' ongoing attempts to define DER Management Systems (DERMS) that will address the challenge. For example, a recent white paper by mPrest had this to say “The large, monolithic applications built over the last 30 years to support DMS functionality are not suitable for the paradigm of DERMS opportunities'' [2].

[2] https://mprest.com/wp-content/uploads/2020/12/mPrest-White-Paper-V6.pdf (Where DERMS fit’s with respect to ADMS and DMS - Primary use cases for ADMS and DERMS)

An often overlooked and accelerating opportunity is what is happening with open source software platforms. Modern open source software tools and platforms (such as those supported by the Linux Foundation) are now starting to offer additional options in the DER space, many with different approaches and new benefits. Often these benefits are not immediately obvious, in sections 2 and 3 below we will attempt to expose some of these opportunities.

The opposite of open source is the proprietary silo. Proprietary silos mean that only a small number of people within one company (or maybe a consortium) get to innovate, it also means that they have the opportunity to practice security by obscurity which is a very bad idea (e.g. Stuxnet was made possible due to this). Eliminating proprietary silos means we are embracing open source.

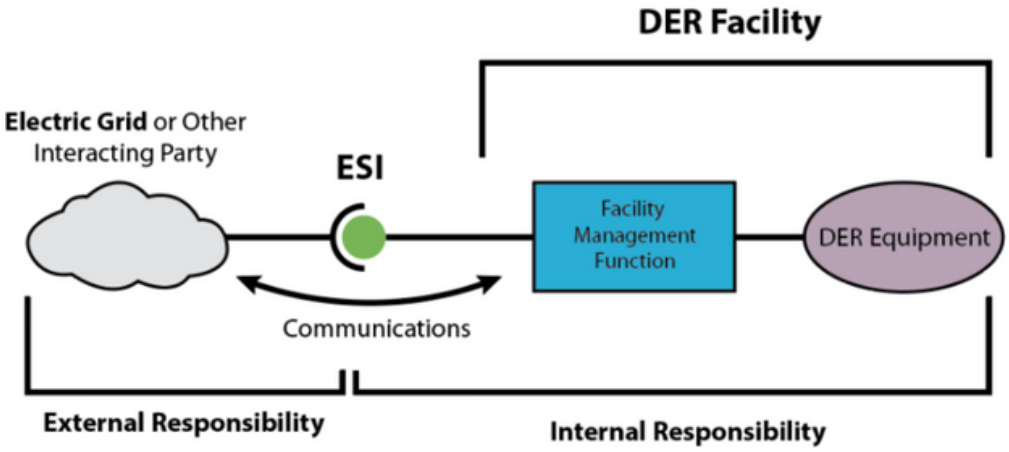
With open source, the audience and the pool of contributors is generally much larger, hence the drive to innovate will not be constrained by a single company's resources. Additionally, because the code is visible to everyone, it is not possible to do security by obscurity, hence these projects must do security properly and this often means they embrace world class best security practices.

Additionally, current grid architecture and approaches are such that Utilities either suffer the consequences of DER behaving independently, hence driving expensive grid upgrades to handle the worst case scenarios (e.g. where all loads and DER behaviors might coincide to overload existing distribution lines or substations), or they require deployment of complex central control systems for what is effectively a direct monitoring and control system for every significant DER on the grid (usually achieved via a DERMS or similar).

By separating the management and control of DER from the management and control of the grid with a marketplace of services, where DER facilities offer up and sell services (e.g. load shifting, volt/var optimisation etc) into a market which the

the Utility can engage with, then the Utility is empowered to see what is available and to also resolve grid constraints now or in the future.

If this market is kept simple, following the rules of electrical engineering and physics, it will be easy to create. It will be made possible by well defined software interfaces, interfaces that can be used to register a DER's available services which Utilities can browse and leverage for their needs. For Utilities it will be a simple case of using this market to balance their needs based on parameters of time, location, energy and money. This concept already exists and it is called the Energy Services Interface (ESI) [3].



But isn't this just the same as 2030.5 or OpenADR I hear you say? In some respects, yes. But in a few very important ways the ESI goes further, resolving issues not previously addressed. Specifically the ESI has defined APIs for DER facilities to register their services (i.e. it is self provisioning), it is not providing direct control of devices (as 2030.5 intends) and due to its adherence to first principles (electrical engineering and physics) it is able to remain very simple while still addressing the necessary use cases.

[3] https://www.gridwiseac.org/pdfs/forum_papers11/hardin_paper_gi11.pdf (ESI concept founding document)

Eliminating Silos

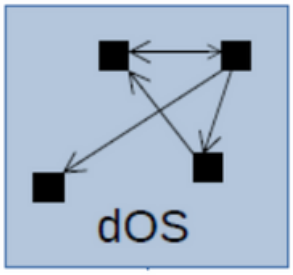
Okay, let's take a look at a few relevant open source tools…

There are many open source tools targeted at supporting the needs of the grid and DERs in general. OpenFMB, VOLTTRON, Fledge and SolarNetwork are just a few examples and they each come with slightly different focuses resulting in different strengths. Here we will look at three different aspects of these platforms which will be classified under these three titles: "Publish Subscribe", "Plugins" and "DER Network APIs".

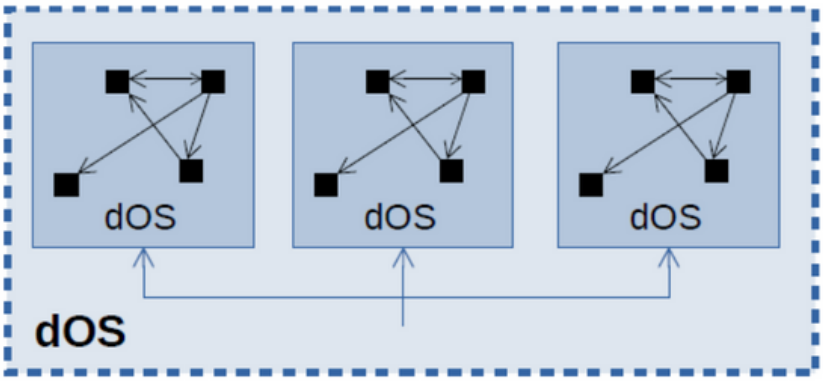
2.1 Publish Subscribe

Platforms like OpenFMB, VOLTTRON and Fledge are targeted at providing a distributed computing environment where publish and subscribe messages are the dominant paradigm (e.g. they may be leveraging technologies like DDS or MQTT). A publish subscribe paradigm is a powerful tool for software developers and engineers trying to solve distributed problems. Due to this approach, these platforms create what can be viewed as a kind of distributed Operating System for the management of DER (I'm going to shorten "distributed Operating System" to dOS, I suggest it be pronounced "d" OS to avoid confusion with a certain Disk Operating System). So let's move on to looking at how and where these tools might be best applied within the grid.

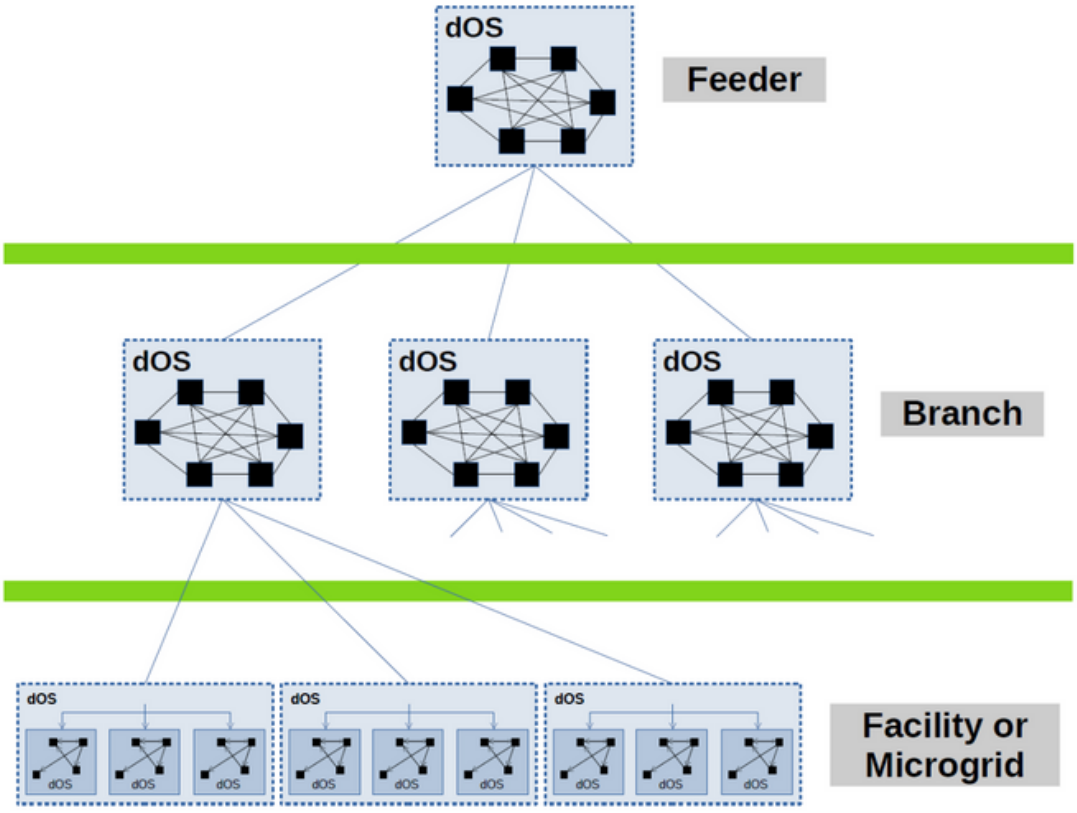
1. One obvious application might be to use a dOS to automate and manage devices in a facility or building (VOLTTRON is a perfect example of this), treating every device in the facility as a DER, respecting the occupants' needs for comfort and then optimising those DER using the dOS to satisfy external grid requests (i.e. offering and providing services to the grid). The DER within the facility and the messages between those DER over the dOS can be symbolized using the diagram below:



2. That same application can then conceptually be expanded to encompass multiple facilities and/or buildings within close proximity into a larger single dOS, hence offering more flexibility to the dOS algorithms engaged in offering services to the grid. This can be symbolized as shown below:



3. Projects like OpenFMB are expanding the scope of the dOS concept beyond buildings, into grid infrastructure, including the distribution grid and beyond. In this case it will likely be augmenting an existing SCADA / ADMS solution, it may look something like the following as it satisfies various needs at different levels within the distribution grid:



Note: One thing that is important with the dOS approach is that the scope of each individual dOS must be kept within some maximum size, otherwise the dOS may become overly intertwined and complex and in the worst case scenarios it becomes so intertwined that it can suffer from discovery storms during startup (e.g during initial commissioning or during a black start event). Hence there is a need to design each dOS carefully and maintain multiple smaller scope dOS projects inside larger systems. Maintaining strict control in the design and deployment phases will ensure success.

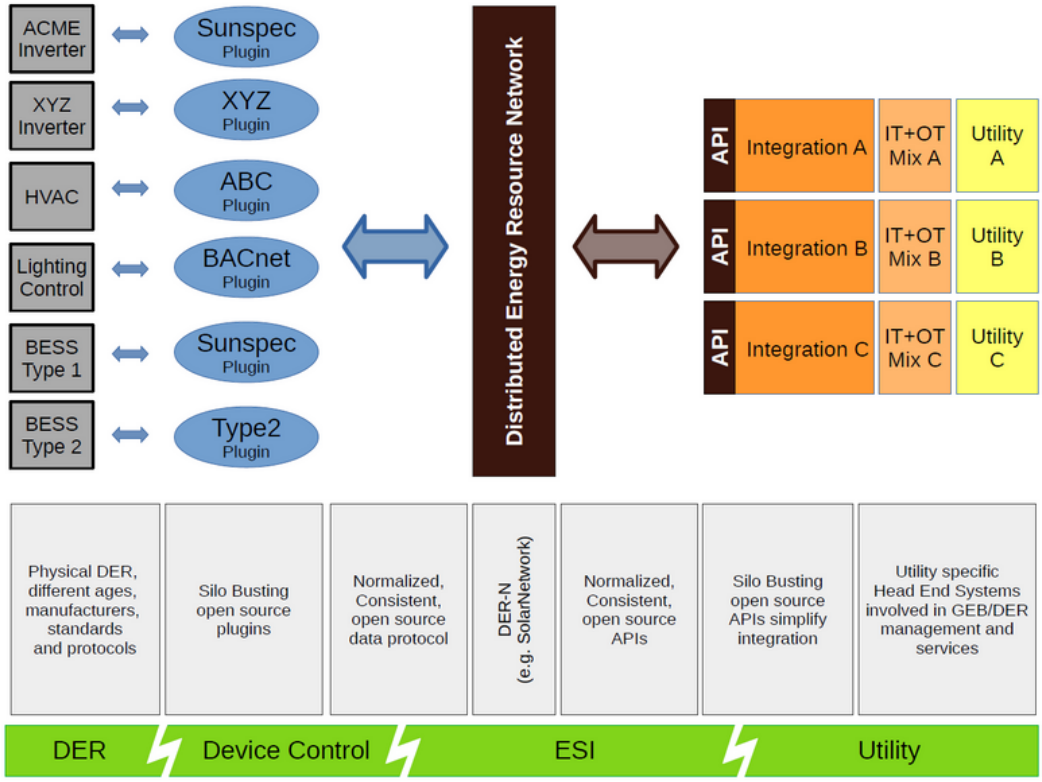
2.2 Software Plugins

Another common feature of open source projects addressing DER complexity is the use of plugins or adaptors to “translate” the communication layers of the many physical devices in the field, devices made by many different manufacturers, serving many different purposes and market segments, leveraging many different protocols. These devices can be the latest and greatest devices, sporting the latest modern protocols, or they can be decades old, sometimes only supporting proprietary protocols. In worst case scenarios the manufacturer who would normally supply software updates and drivers etc is no longer in business. Solutions designed to engage with this wide variety of devices need ways to efficiently deal with this reality, that is the purpose of software plugins.

SolarNetwork (and others) leverage plugins to make it possible to use any device as a DER in a facility. Being open source, these solutions already offer a large range of device and protocol specific plugins available and free to download from GitHub. If you are dealing with a device never seen before, a new plugin can easily be written by your software team (or outsourced to another team). In most cases a new plugin can be developed and tested in less than a week.

2.3 DER Network based APIs:

The third piece in the open source tool box is what we call “DER Network APIs” (or DERN API for short). The purpose of these APIs is to make it easy for cloud or mobile apps to access live and historical data from any DER in the network and where authorization has been granted to interact with and control the relevant DER devices.



Whether these DERN APIs are hosted on back office bare metal servers or they are running on cloud based infrastructure provided by the likes of AWS, Google or Azure, it doesn’t matter. All these options are made available and possible because this functionality is provided by open source software which you are free to deploy as you see fit. The key point is that many of these open source tools provide powerful backend APIs that make building cloud, mobile or remote back office applications much simpler than might otherwise be the case. These DERN APIs can be leveraged by Utilities or aggregators or similar (e.g. Ecogy Energy manages its DER portfolio and provides services to its customers and the grid leveraging the Solar Network platform and it’s APIs as the base for building it’s software solutions).

Separation of Concerns

Okay, now it's time to take a look at how we can separate the concerns of DER operators and grid operators.

Most of the current ideas and technology solutions are looking to find elegant ways to offer a direct control solution to grid operators (i.e. so they can have full and direct control over DERs on the grid), this is the opposite of what we are advocating for here. So how might one address this status quo situation and provide for separation of concerns as we move into the future?

If we can create a set of "Market based APIs" between DER and the grid, we can open up the possibility for third party vendors to offer a range of services that plug DER (i.e. energy consuming, generating or storing devices) directly into this market while enabling the DER operators at each facility to retain control of how their devices ultimately behave, hence allowing them to retain control of how to optimize and best deliver occupant comfort or other such considerations. These vendors' services would provide the facility or building occupants with a consistent underlying experience (even though different vendors may have different branding and styling) in their products, the fundamental data set and process required to achieve the market based results will be the same across the board. The ESI mentioned previously is intended to define and standardise what this means, GWAC and SEPA are progressing this work.

Once these "Market based APIs" are logically defined, how might one implement these "Market based APIs"? I would advocate for leveraging the open source tools similar to those discussed in section 2 above to implement these APIs, hence creating the opportunity to reap the rewards of diverse innovation, inclusivity and best practice verifiable security techniques across the entire ecosystem. Of course one can still provide proprietary implementations of these API if so desired.

The key point is that these "Market based APIs" create the separation of concerns which is likely the primary opportunity and advantage being discussed here.

Conclusion

Combining these approaches...

Okay, so we have busted silos at the device level leveraging “open source plugins”, we have leveraged “publish subscribe“ technologies creating distributed operating systems to solve distributed compute challenges, we have abstracted away the complexity of all these different DER with “DER Network based APIs” and finally we have simplified the overall grid stability and control problem by separating concerns leveraging “Market based APIs” at different layers within the grid.

Additionally, if the majority of the software tools being used here are open source, we will be allowing for innovation, optimizations and refinements to be contributed by many parties, while retaining consistency and separation through well defined APIs. This will be essential for rapid improvement and broad long term adoption of these technologies. In short, we need to adopt an Agile mindset and an Agile approach to raise the bar and accelerate the proliferation of DER with the ultimate goal of decarbonizing the grid and locking in long term resiliency.

The future is here, it’s in its infancy, but already it is being adopted by commercial entities and local projects to solve their very real problems in ways that would otherwise not be possible. To fully realize this opportunity, there is still plenty of work to do.

So let’s get to it!