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Kendall Rutledge: ”A new toolset”

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Groups work with large systems these days. An electrical distribution grid can span hundreds of kilometers or more.

The border system surrounding a country can be a thousand kilometers long. An atmospheric scientist deals with a space associated with the size of the full planet (multiple thousands of kilometers 2 and the volumetric component to add in there).

If your “system of interest” involves spatial scales ranging from a kilometer (or so) up to global proportions, you have a challenge to manage it optimally or characterize it sufficiently.

When short time scales are important to your system assessment or control, this increases your optimization or characterization challenge. Period.

Kendall Rutledge.

A local example

Recently, some of us in Österbotten observed/experienced a several day disruption in electrical Power service associated with the passing of a rare winter storm providing wind with unprecedented high speeds for our area.

The company repairing the problemed electrical distribution system (which spans tens of kilometers) most likely realized that lots of information that could have aided their repair process and shortened the disruption time was missing.

As system size and complexity increases, that need for information to manage it optimally and characterize it sufficiently also increases. These are givens.

Man-built and natural systems are similar in this space/time cumbersomeness respect. Marine and border migration monitoring, agricultural, future smart and present energy distribution, transportation, oceanic, atmospheric, climate, forest horticultural, ecological, tectonic and communications systems is a short list of examples. Space and time issues just combine to make managing/observing large systems technically difficult.

Satellites offer a new solution

The present development of space-platform-based constellations of nanno-satellites implementing communications systems will allow new IOT capabilities that will provide a game-changing infrastructure.

In this new game, better control of large-scale spatially distributed man-built systems will become more feasible. This development will come to be recognized as part of the first "major enabling accomplishment" of the "new space" activities in the future.

Earth observation processes to monitor and characterize natural systems will likely benefit from this accomplishment too. IP methods will make using these new IOT communication systems seamless. Such use will likely double the latency statistics compared to land based systems but for most system monitoring/controll processes, this may be sufficient.

A way to think about this enabling technology using current constructs: “it will provide the functional communications equivalence of a 4G cellular communications tower within several kilometers from any point on the planet’s surface”. Any spatial point on the planet, my quotes.

You will be able to connect from anywhere with your small antennae. The difference from this and now is huge.

The “toolset” up there in the title is about existing “new space”capabilities plus those currently being developed.

Combined they will create new tools for addressing the challenges described earlier to control and characterize complex systems spread out over the whole planet or portions of it.

New space is the future

You could say, it’s a new day in space and old space is giving way. Space based systems can be implemented in “new space” much faster and cheaper as compared to “old space”.

Multiple smaller individual satellites used in constellation arrangements can make a huge difference in what can be accomplished.

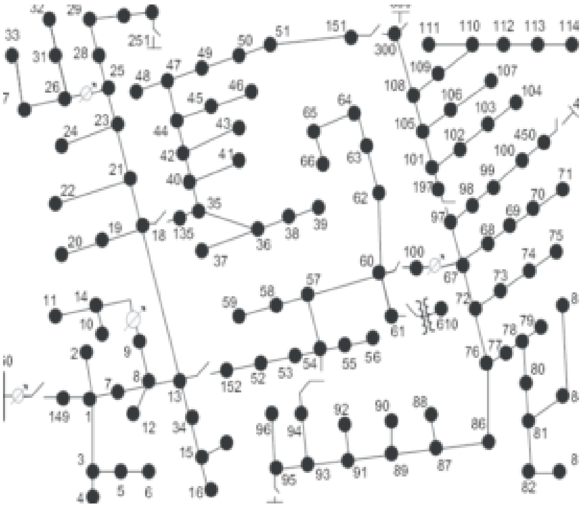
Already "new space" has accomplished what old space processes could not. For example, a company called Planet has implemented a "string of pearls" satellite constellation including approximately 100 nanosatellites that collectively sample every square meter of the planet (at a few meters resolution) once per day. As usual, the software development is behind the hardware development and startups are scrambling to monetize this data.

Numerous technologies are maturing which (when combined) offer a new, affordable toolset to help manage and improve the characterization and control of spatially dispersed systems (such as those mentioned above). This process is well underway and for some years now more countries are supporting these "new space" initiatives.

Likely, this support has been rationalized based on ROI values reported by governments that see space technology and associated spinoffs creating factors ranging from 7 to 14.

Indeed a functioning new space service industry has developed that is recently demonstrating signs of maturity and rapidly increasing its capabilities.

Finland and Sweden have and are participating in these processes.



A gridlab-D model diagram showing the locations of residences and power system components as part of an electrical distribution grid.

The technologies coming together to push these "new space" technology advances are micro-electronics, computing power advances (for ground facilities and satellite onboard functions), launch system capabilities, machine learning advances for processing spatial data, energy capture/storage improvements and advances in small-scale plasma propulsion systems.

It is mostly about advances in microelectronics engineering and fabrication that bring us to the current position.

What´s in it for our region?

Give some thought to all the capabilities that are implemented in your single 174-gram iPhone X.

Seventeen such functional units could be packed into a single 3U cubesat to provide energy Collection and storage, satellite orientation assessment and pointing adjustment/control, master system control, dynamic active temperature control, plasma propulsion control, multiple communications systems and one or several payloads to accomplish the primary mission purposes. Before recent advances, such high- density packaging simply was not accomplishable.

So what is the point here? In our region, the energy industry and its supply chain partners are dealing with very large spatially extended systems. As this group moves into more complex smart grid systems, their information requirements will significantly increase.

In our region, the forestry industry manages and harvests from very large spatially extended systems. What benefit would come if they saw the forest instead of the trees daily?

Nationally, border surveillance systems use “to-the-horizon” information because the technology limits extended vision. Locally the agriculture community misses the optimal fertilization and watering schedules within large plots because the information is missing and estimating it from tractor height is especially difficult.

Perhaps it is timely to consider newly available tools.

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