# Adding Another Dimension to Small Satellite Constellations

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Alex da Silva Curiel, Rachel Bird, Steve Eckersley, Simon Laine, Victoria Irwin, Andrew Cawthorne, Prof Sir Martin Sweeting, Surrey Satellite Technology Ltd.
20 Tycho House, Surrey Research Park, Guildford, Surrey, united Kingdom, +44(0)1483 803803, a.curiel@sstl.co.uk, https://www.sstl.co.uk , @SurreySat

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## Abstract

Satellite constellations for Earth Observation almost invariably use duplicates of the same satellites to provide higher temporal resolution or greater coverage. The value of Big Data applications often depend on the fusing of different sensor information. If instead constellation satellites are equipped with a variety of sensors, these can be configured to provide more complex data products. Flexibility and in-orbit rearrangement can create a range of systems that can be configured on-demand to address a range of new applications.

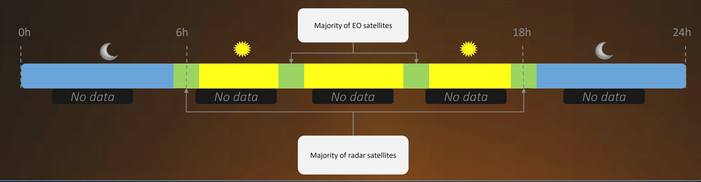
Small satellites and sensor capability have only recently advanced far enough to make such a systems financially viable. Key challenges in such systems are optimising the composition of the constellation with different sensors or capabilities in addressing different applications, and developing methods for fusing non-contemporaneous information to build capabilities that can only be achieved through a distributed system.

A common batch produced satellite platform with payload support, with interchangeable payloads supporting a range of application-specific constellations.

| Satellite | Payload | Summary specifications | More info |
|---|---|---|---|
| SSTL-Carbonite | High Resolution Optical | 1m optical, stills and 25 FPS video, RGB, 5x5km scan and target track | https://www.sstl.co.uk/getmedia/b38389d7-cb07-4308-944a-a91604deb47e/SSTL-CARBONITE.pdf |
| SSTL-DarkCARB | Medium Wave Infra Red | 4m, stills and video, MWIR, 4x4km scan and target track | https://www.sstl.co.uk/getmedia/6a9cc3bf-5bd5-469b-9a74-e689557ed959/SSTL-DARKCARB.pdf |
| SSTL-CarbSAR | X-band Radar | 0.5m X-band radar, 4km swath, Spotlight | https://www.sstl.co.uk/getmedia/9841ec69-9114-49b0-9875-151f7292ea93/SSTL-CARBSAR.pdf |
| SSTL-TrueColour | Wide swath super-spectral | 5m optical, 9 bands, 120km swath | https://www.sstl.co.uk/getmedia/20521ca1-b446-4481-a4b3-62e7e5ad518b/SSTL-TRUECOLOUR.pdf |
| SSTL-SDR | Radio Frequency Sensing | SDR Uplink and Downlinks, Data recorder, mission specific antennas | https://www.sstl.co.uk/what-we-do/mission-configured-spacecraft |

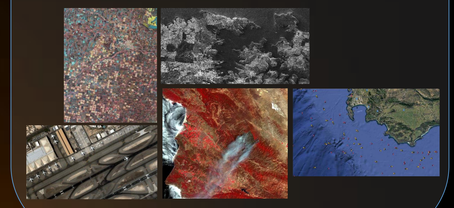
- Optical satellites operate mostly 10:30 and 13:30 during daytime
- SAR satellites operate mostly at 06:00 or 18:00

➢ There are few if any observation opportunities during large parts of the day. Multi-sensor constellations can support such high temporal resolution monitoring required in various applications.




## Applications

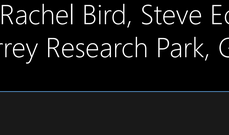
- Day and night surveillance and tracking
- Data fusion in big data applications
- Insurance and loss adjustment
- Maritime surveillance
- Disaster Monitoring
- Forest fire and hot spot detection
- Precision agriculture and forestry in cloudy areas

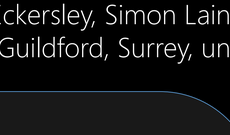


## NovaSAR and SSTL S1 4 as a pathfinder

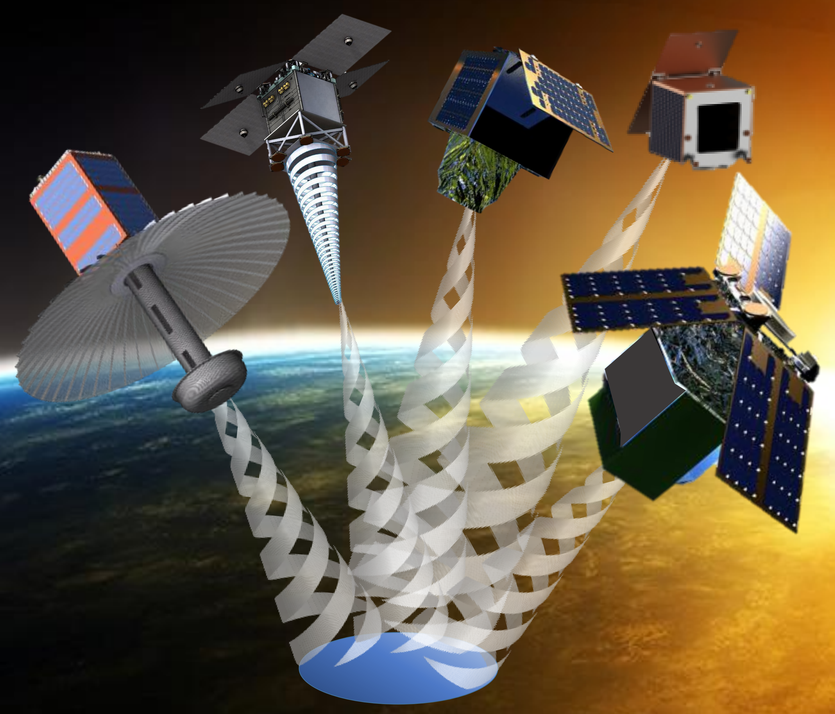
In the past year, the NovaSAR radar smallsat and the SSTL S1-4 high-resolution smallsats have been coordinated in close proximity on-orbit, observing targets of interest with different sensors.

Mitigating cloud cover, Miami airport SAR (left) and optical (right):



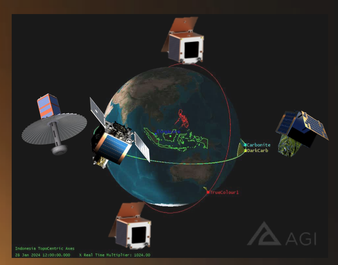



## Multi-sensor Satellite Constellation



## Example configuration

- Covering a typical equatorial area of interest
- 2x Wide swath satellite in polar orbit
- SAR, MWIR and Video in equatorial orbit




| Satellite | Payload | Day/ Night? | Through Cloud? | Through Smoke? | Video? | Detect fire? | Detect smoke? | Active radio devices? | Rapid Damage Assessment? | Large Area Damage Assessment? |
|---|---|---|---|---|---|---|---|---|---|---|
| SSTL-Carbonite | High Resolution Optical | | | | ● | | ● | | ● | |
| SSTL-DarkCARB | Medium Wave Infra Red | ● | ● | ● | ● | ● | ● | | ● | |
| SSTL-CarbSAR | X-band Radar | ● | ● | ● | ● | | | | ● | |
| SSTL-TrueColour | Wide swath super-spectral | | | | | | ● | | | ● |
| SSTL-SDR | Radio Frequency Sensing | ● | ● | ● | | | | ● | ● | ● |

- Combining a mix of different sensor satellites can offer a complex sensor network, tailored to specific applications.
- Careful design can also allow the constellation to be re-configured on-orbit depending on circumstances.
- Intersatellite links can enhance utility of the constellation