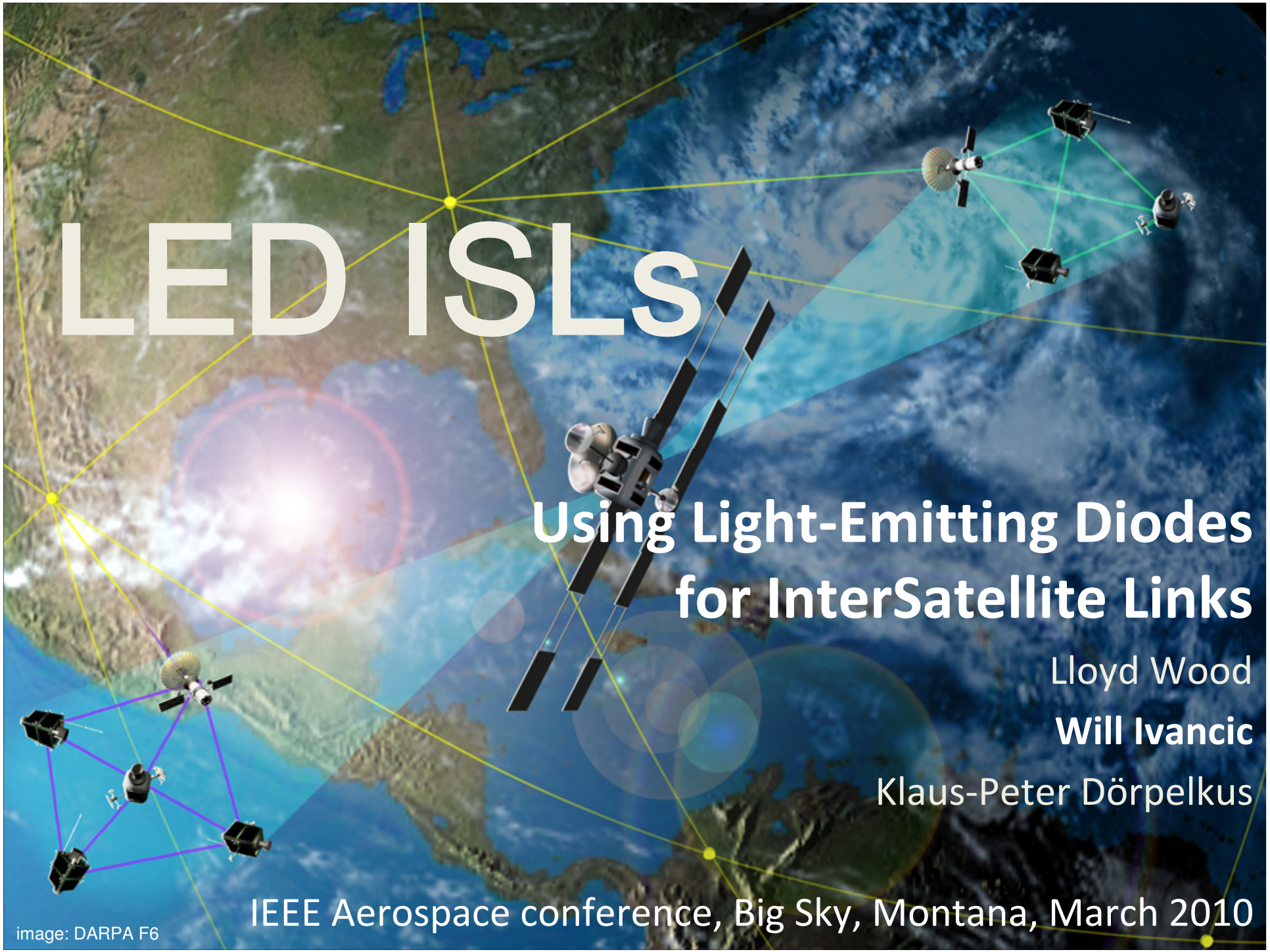

LED ISLs

Using Light-Emitting Diodes for InterSatellite Links

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IEEE Aerospace conference, Big Sky, Montana, March 2010

image: DARPA F6

Laser intersatellite links

- Have been subject to much engineering work.
- Intended to communicate long distances (thousands of km) at high rates – GEO/GEO (were planned for *TSAT*), LEO/GEO (ESA *Artemis* Silex), LEO (were planned for *Teledesic/Celestri*)
- Heavy, complex assemblies to do accurate pointing, slewing. Little adoption.
- But engineering overkill for local control communications between local satellite clusters.
- So, don't use lasers. Use LEDs instead. Cheaper, lighter, last longer. But lower rates, lower distances. Different application scenarios.

Low-end disruption

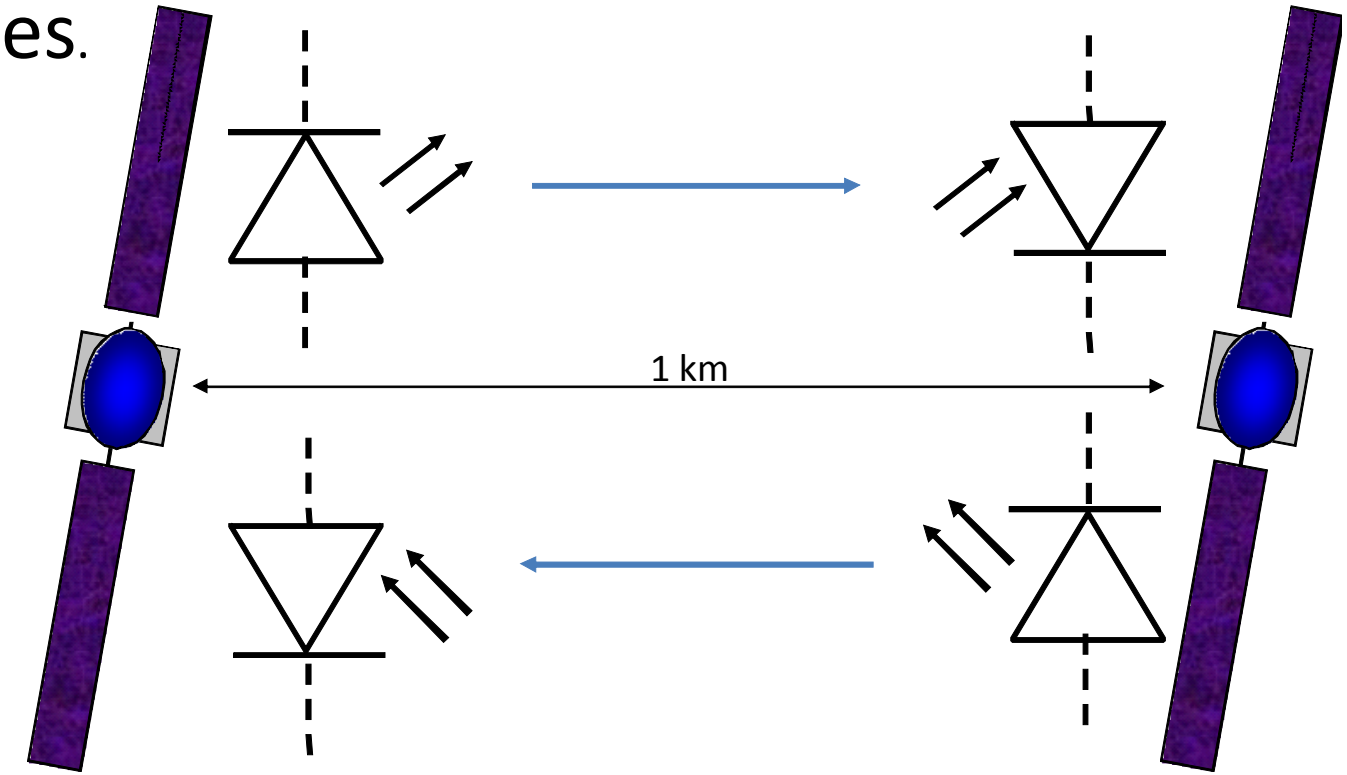
- Symptom described by Clayton Christensen in *The Innovator's Dilemma/Innovator's Solution.*
- Idea is that new technologies percolate in at the low end, meeting needs that existing high-end technologies don't meet. Interest in low-end technology drives its adoption and improvement.
- This is an example of that – satellites can't always support bulky lasers, as that means sacrificing fuel or transponder mass. Lasers not needed for communication in a stationkeeping cluster, unsuitable for small low-end satellites. LEDs are lighter, smaller, will last longer – though with considerable limitations in range and rates.

Why not just use short-range radio?

- Reuse of terrestrial radio equipment (e.g. 802.11) is limited by terrestrial frequency assignations that are suboptimal for wider frequencies available in space. (Plus, equipment is not space-qualified or radiation-hardened.)
- Radio can require more complex EM testing against other onboard payloads.
- Light is more easily directed or blocked.

Possible scenario

- 1km between stationkeeping satellites.
- Low rate – just a couple of Mbps.
- Ideal for command and control/TT&C.
- Increases in rate and distance as technology improves.

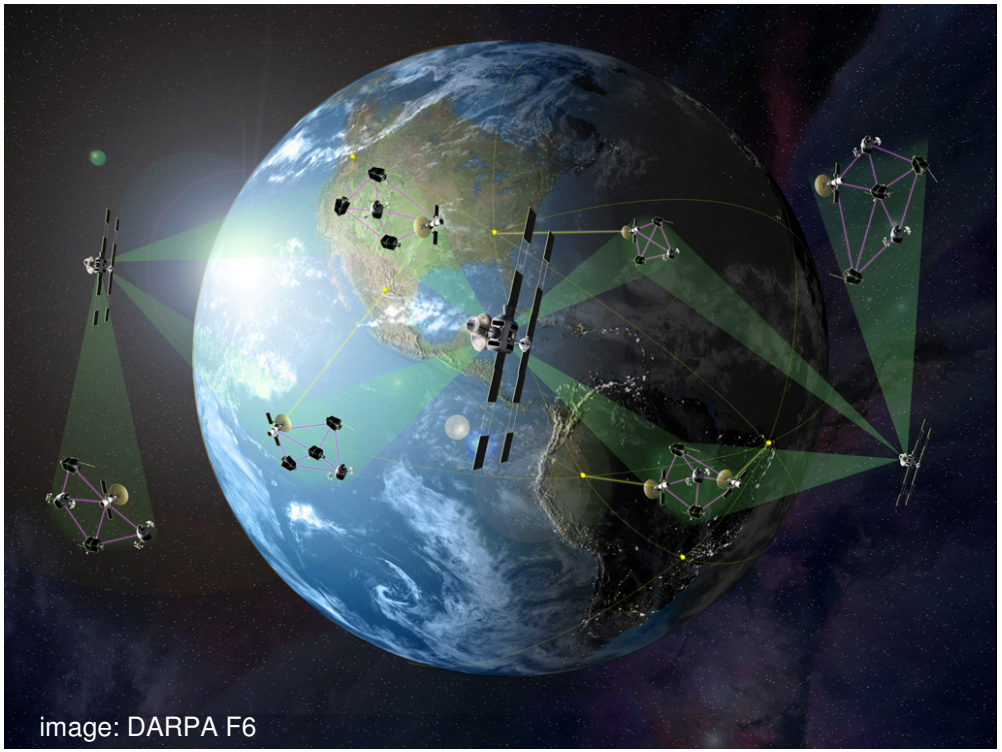


Other possible LED applications #1

Proposed Orion docking. Image: NASA

Docking – LED communication comes into play as spacecraft near, continues once receivers and transmitters are perfectly aligned once docked.

Other possible LED applications #2



Fractionation – The DARPA F6 project looks at separating spacecraft into parts in formation-flying cluster. Separate satellite parts communicate, and can be commanded together as a virtual satellite.

LED technology improving with time

- Bigger, brighter LEDs.
- Larger, more sensitive, avalanche photodiodes.
- Technology improvements lead to link budget improvements - higher power/distance/symbol rates, even without focusing optics adding mass.
- Spread beam can be a bonus, as then accurate pointing is not needed; allows positioning assembly to be simplified.
- LED signalling demonstrated across 167km in Tasmania in atmosphere, February 2006.
- **LEDs worth evaluating for some ISL applications.**

Thankyou.