Allocation Timing in Satellite Market

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BACKGROUND

Satellite spectrum and orbit rights are often assigned through FCC processing rounds. In a round-based system, firms are grouped and evaluated together, which resembles a **batch allocation**. In practice, however, some firms may already have an installed base in orbit when later entrants seek access. That environment is better captured by a **sequential allocation** with incumbency.

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RESEARCH QUESTIONS

Should satellite rights be allocated **in batch** or **sequentially** when an incumbent can deploy first and later entrants face interference-avoidance constraints?

We compare the two mechanisms and ask how allocation timing affects:

- **firm profits,**
- **consumer surplus,**
- and **social welfare.**

METHODS AND MATERIALS

We compare two allocation mechanisms in a two-firm satellite market.

Mechanisms

Batch allocation: both firms choose deployment simultaneously in **period 1**.

Sequential allocation: the incumbent (firm 1) deploys in **period 1**, while the entrant (firm 2) can enter only in **period 2**.

Demand: Inverse demand is linear: $P(Q)=a-bQ$, where Q is total # of satellites, a>0 is market size, and b>0 is how fast price falls with output.

Launch cost: We model the cost of deploying satellites as: $C(q)=\gamma/2\ q^2$. The parameter $\gamma>0$ captures the launch and deployment costs.

Incumbency: Under sequential allocation, firm 1 can deploy $s\in[0,X]$ in period 1. These installed satellites remain active in period 2.

Late-entry interference / priority: The only distortion is that the entrant faces a late-entry disadvantage proportional to the incumbent's installed satellites s.

We summarize this wedge by $\psi\geq 0$

RESULTS

Proposition 1 (Number of satellites pushed at equilibrium).

Under batch: $QB = 2a/(3b+\gamma)$.

Under sequential: $Q2S(s;\psi)=(2a+(\gamma-\psi)s)/(3b+\gamma)$.

The main comparison is therefore

$\mathbf{Q2S-QB = ((\gamma-\psi)s)/(3b+\gamma)}$.

This equation shows that sequential allocation raises output when the persistence effect of early deployment dominates the late-entry wedge.

Proposition 2. (Firm profits)

Under sequential allocation, the <u>*entrant*</u> is always weakly worse off than under batch allocation:

$\Pi S(s;\psi)\leq \Pi B$.

Moreover, a larger late-entry wedge always reduces the entrant's continuation payoff.

For the <u>*incumbent*</u>, the comparison is ambiguous. Sequential allocation gives firm 1 a first-mover advantage. The incumbent prefers sequential allocation if and only if

$\kappa\leq\kappa 1(s,\psi)$,
where $\kappa 1(s,\psi) = as-(b+\gamma/2)s^2+VS(s;\psi)-\Pi B$.

Proposition 3. (Consumer surplus and welfare)

Sequential allocation gives consumers an early-service gain: $(b/2)(s^2)$,

but it may weaken second-period competition. The consumer-surplus differential is

$\Delta CS(s;\psi)=b/2s^2+b/2(QS)^2-b/2(QB)^2$.
Hence consumers prefer sequential allocation when $s^2+(QS)^2\geq(QB)^2$.

Welfare satisfies

$WS-WB=\pi S+\Delta CS+(V1S-\Pi 1B)-(\Pi 2B-V2S)$.

So welfare improves only when the gains from early deployment and incumbency are large enough to offset the entrant's loss.

Round	Main applicants	Authorized
2016 Ku/Ka	OneWeb, SpaceX, Telesat, Kepler, LeoSat	5,482+
2017 V-band	SpaceX, Telesat, Theia	7,755+*
2020 Ku/Ka	Kuiper, SpaceX Gen2	10,736 initially
2021 V-band	Multiple applicants	not cleanly consolidated (34000+)

FUTURE DIRECTIONS

- **Endogenous bandwidth release.** Let the regulator choose how much additional spectrum to release after observing early deployment.
- **Dynamic multi-period entry.** Extend the model to multiple periods with new entrants arriving over time.
- **Operational buildout constraints.** Introduce use-it-or-lose-it rules and deployment deadlines to study over-promising versus actual launch.
- **Heterogeneous firms.** Allow firms to differ in launch cost, technology, or constellation size.
- **Calibration to FCC rounds.** Use observed applications and authorizations to connect the model more closely to current policy design.

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