Anton A. Esin (IITP RAS, Moscow, Russia). Teletraffic Capacity in Periodic Microcells: A Continuous-State Model for High-Speed Aggregators.

Theorem (Velocity-Aware Signal Dynamics and Teletraffic Stability in a Periodic Microcell). Let $Q_t \in [q_{\min}, q_{\max}]$ denote the received signal level (in dB) of a mobile aggregator moving with fixed speed $v_0 > 0$ through a single periodic cell $\mathbb{S}^1$. Let $S_t = \{x(0) + v_0 t\} \in \mathbb{S}^1$ denote the user's intra-cell position (modulo the cell length). Suppose that Q_t evolves as:

$$dQ_t = -\alpha(Q_t - q(S_t, v_0))\, dt + \sigma(v_0)\, dW_t + dL_t,$$

where the mean signal profile is given by

$$q(s, v_0) = q_0 - a\, d_\varepsilon(s)^\gamma - bv_0 - c\ln(1 + v_0),$$

with $d_\varepsilon(s) = \sqrt{s(1-s) + \varepsilon^2}$, a smooth approximation of the minimum distance to the nearest base station within the periodic cell.

Assume reflection at $q_{\min}$ and $q_{\max}$, ensuring the aggregator stays within the serviceable signal range.

Then:

1. The joint process $(Q_t, S_t) \in [q_{\min}, q_{\max}] \times \mathbb{S}^1$ admits a unique smooth stationary distribution $\pi_{v_0}(q, s) \in C^\infty$.
2. For any signal-based service function $u(q)$ (e.g., transmission rate, access policy), the long-run average service capacity is:

$$\mu(v_0) = \int_{\mathbb{S}^1} \int_{q_{\min}}^{q_{\max}} u(q)\, \pi_{v_0}(q, s)\, dq\, ds.$$

3. The mobile aggregator can sustain a data arrival rate λ_{in} without backlog growth (i.e., system is stable) if and only if:

$$\lambda_{\text{in}} < \mu(v_0).$$