BCQM VII Stage–2 Checkpoint Lab Note
Cloth extraction, survival, and metric stability (v0.1)

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Checkpoint scope

This note consolidates the first Stage–2 ("cloth") computational milestone in BCQM VII. Stage–1 (BCQM VI) established: (i) two-step emergence (connectivity first, islands later), (ii) separability of space-connectivity and clock coherence via ablations, (iii) time-resolved "space on, islands fluctuating" behaviour, and (iv) ball growth as the robust geometry diagnostic on the short active slice. Stage–2 now defines a persistent geometry object ("cloth") beyond the yarn-like active slice and tests whether geometry diagnostics become stable across seeds and settings.

Artefact handling (local organisation)

For this checkpoint the following organisation was adopted:

- All derived summary tables (Jaccard survival and metric-distance results) were collected into a local `csv/` folder on the Desktop.
- Raw run folders (bring-up and ensemble) remain under `outputs_cloth/`, and the corresponding zip archives are retained alongside them.

Stage–2 cloth definition (v0.1)

The Stage–2 cloth extractor is bin-based and minimalism-preserving:

- The run is partitioned into bins (here: 80).
- A lockstep-supported "core" is identified per bin using overlap membership at a low threshold ($w_{\mathrm{lock}} = 0.10$).
- "Persistence" is computed from per-bin *usage* of events and directed edges by core members (presence counted once per bin), without storing mutable weights on primitives.
- Concurrent edges/events (count$\geq$2 within a bin) are retained as a reinforcement diagnostic, but not used as the sole backbone criterion.

Two persistence thresholds were explored:

- **hits1:** `min_bin_hits`=1 (permissive; yields a connected cloth core)
- **hits2:** `min_bin_hits`=2 (stricter; isolates repeated cross-bin structure)

Bring-up sequence (what changed and why)

The initial attempt to define an edge cloth using *concurrent edges only* was found to be too sparse at this scale: edge concurrency is real but rarely repeats across bins. A refinement was therefore introduced:

- define the edge cloth core from edges *used by the lockstep core* across bins (presence hits),

- while keeping concurrent edges as a separate reinforcement diagnostic.

This produces a meaningful connected edge cloth at hits1, while preserving a minimalism-aligned story (no mutation of events/edges).

Ensemble design (checkpoint)

Two ensembles were run with $W_{\text{coh}} = 100$, bins=80, 5 seeds per case:

- $N \in \{4, 8\}$
- $n \in \{0.4, 0.8\}$
- hits1 and hits2 persistence thresholds

Explicit core/halo lists (`core_edges_used`, `core_events_used`) were logged to enable survival analysis.

Survival results: sets versus geometry

Set survival (Jaccard across seeds)

For hits1, event-core sets are highly reproducible at high cross-link pressure (n=0.8), while edge-core sets are not:

- hits1, N=8, n=0.8: event Jaccard mean ≈ 0.964; edge Jaccard mean ≈ 0.0097.
- hits1, N=4, n=0.8: event Jaccard mean ≈ 0.944; edge Jaccard mean ≈ 0.0171.

For hits2, edge cores typically collapse to tiny recurrent pockets or empties, giving poor or trivial edge-set stability.

Metric survival (ball-growth curve stability across seeds)

A key Stage–2 finding is that the *geometry diagnostic* can be stable even when exact edges are not. Using ball-growth fraction curves $|B(r)|/|C|$ normalised by the cloth component size, pairwise curve distances across seeds show:

- hits1: small distances (e.g. L2 RMS ~ 0.004 to 0.010 depending on N and n), indicating a reasonably stable geometry *class* across seeds.
- hits2: larger distances at n=0.8 and trivial zeros at n=0.4 (empty cloth cores), indicating that hits2 is too strict for the present epoch/binning.

Thus, hits1 is the appropriate working baseline for Stage–2 cloth geometry at this run length: it yields a connected cloth and stable ball-growth curves, while hits2 is better treated as a later robustness test once epochs are lengthened.

Interpretation and Stage–2 milestone

This checkpoint establishes the first workable Stage–2 "cloth" regime:

- A connected edge-based cloth core can be extracted without storing mutable weights on primitives (bin-based usage hits by lockstep core).
- Event-core persistence is strong at high n, supporting the idea of stable "places" at Stage–2.
- Edge microstructure varies across seeds, but the ball-growth geometry diagnostic is comparatively stable across seeds in the permissive hits1 regime.

The emergent picture is therefore: stable cloth geometry should be assessed at the level of *diagnostics* (ball growth, diameter-like proxies), not at the level of exact edge identity, at least at the current scale.

Next steps

1. Increase epoch length (or adjust binning) to enable stricter persistence thresholds (hits2/hits3) to yield connected edge cloths.
2. Introduce and compare sliding-window concurrency (Stage–2b) to test sensitivity to bin boundaries.
3. Define a "core + halo" reporting standard for cloth outputs (core used-by-core; halo used-by-all), and add survival metrics for both.
4. Once a longer-epoch connected edge cloth is obtained at hits2+, revisit diffusion-based diagnostics on the cloth object (only if a genuine intermediate scaling regime is demonstrably present).

Interpretation: concurrency versus cloth. As implemented in the current Stage–2 code, *edge concurrency* is a within-bin co-use test: the same directed transition $(u \to v)$ is taken by at least two threads in the same bin. This is therefore closer to an *instantaneous channelisation* signature (tailgating / co-selection) than to a persistent cloth backbone. At the present epoch length and binning, concurrent edges are real but rarely repeat across bins, so they do not by themselves yield a stable cloth subgraph.

A useful mental model is the hierarchy:

- **Edge concurrency** ⇒ "channel is active now" (instantaneous funneling).
- **Used-by-core bin hits** ⇒ "channel is carved" (routes that persist across bins).
- **Cloth core** ⇒ "carved channels form a stable background" (persistence across longer epochs / stricter thresholds).

This explains why concurrent edges do not yet show a robust cloth at the current sampling scale: cloth is a long-run stabilisation object, while concurrency is a short-run activity indicator.

Strict persistence at longer epochs (hits2, $\times 10$). We repeated the strict persistence ensemble (hits2: `min_bin_hits`=2) at $\times 10$ epoch length. The result is qualitatively unchanged: the strict edge core remains a collection of tiny recurrent pockets (mean cloth component size ≈ 3), and exact edge-set survival across seeds remains near zero (nontrivial cases). However, the *metric-level* diagnostic is more stable than edge identity: ball-growth fraction curves show comparatively small cross-seed distances in the high-cross-link regime (especially for $N = 8$, $n = 0.8$). We therefore interpret hits2 at this scale as a *motif detector* (recurrent microstructure) rather than the Stage–2 "cloth" backbone. The connected cloth used for geometry tests remains the permissive hits1 definition, while stricter persistence will require either different definitions (e.g. event-filtered edges or quantile persistence) or a different measurement grain (coarser binning).