

TakaLinkAgent: An agent submitted to the ANAC 2026 SCM League

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June 23, 2026

Abstract

This report describes **TakaLinkAgent**, a synchronous negotiation agent for the SCML standard setting. The agent is designed to achieve robust profitability while avoiding three major failure modes: raw-material shortages, excessive selling commitments, and overstocked inventory. Its strategy combines inventory-aware procurement with limited forward contracting, reservation-aware sales control, trust-based partner selection with a dynamic adoption ratio, asymmetric negotiation-cap control, and mode-aware adaptive pricing. The implementation integrates four modules—**MarketAnalyst**, **PartnerEvaluator**, **TradeAllocator**, and **SmartPricing**—with explicit tracking of future buying and selling contracts. The agent estimates projected incoming supplies, remaining production capacity, and effective sellable capacity, and uses these estimates consistently across proposal generation, counteroffer construction, and response decisions.

1 Introduction

In the SCML standard setting, agents must buy raw materials, convert them into products, and sell them through concurrent negotiations. A profitable strategy must therefore coordinate procurement, production feasibility, and sales commitments under uncertainty. In particular, large score drops are often caused by three risks: shortage of raw materials, overcommitted sales that trigger shortfall penalties, and excessive inventory. TakaLinkAgent was designed to address these risks in an integrated way by linking buying, selling, and pricing decisions to inventory state and projected future contracts.

2 Agent Design

2.1 Core Architecture

TakaLinkAgent is implemented as a subclass of **StdSyncAgent** and combines four functional modules: **MarketAnalyst**, **PartnerEvaluator**, **TradeAllocator**,

and **SmartPricing**. The agent stores future buying and selling contracts and maintains step-level reservation variables to prevent inconsistent commitments during synchronous negotiations. These components are coordinated through the main routines `first_proposals()`, `counter_all()`, `propose()`, and `respond()`.

2.2 Buying Strategy

2.2.1 Inventory Policy

The buying strategy is based on an explicit inventory policy computed at each step. Let L denote the number of production lines, N the total simulation steps, and t the current step. Define the remaining horizon ratio $\rho = (N - t)/N$. The agent computes a target inventory I^* and a maximum inventory $I^{\max}$ as:

$$I^* = \lfloor L(1.0 + 0.4\rho) \rfloor, \quad (1)$$

$$I^{\max} = \lfloor L(1.8 + 0.3\rho) \rfloor. \quad (2)$$

Procurement decisions are made by comparing I^* with the secured inventory, defined as the sum of current input stock I_{in} and projected incoming deliveries I_{proj} . This makes the strategy forward-looking rather than purely reactive. When the current inventory already reaches $I^{\max}$, procurement is suspended for that step.

2.2.2 Forward Contracting

Because supply chains have non-negligible lead times, TakaLinkAgent includes limited forward procurement across near-future steps. When the gap between I^* and the secured inventory exceeds $0.3L$, the agent distributes purchase proposals to available suppliers for steps $t + 1$, $t + 2$, and $t + 3$. Suppliers are sorted by trust score σ_i and partitioned across these steps based on pool size, with the per-step quantity capped at $0.4L$ to avoid over-purchasing.

2.2.3 Emergency Procurement

To prevent complete production deadlock, the agent includes a limited emergency procurement mechanism activated only when $t \leq 2$, t is not the final step, current input inventory is zero, no future supply has been secured, and procurement need is positive. In such cases, the agent temporarily relaxes conservative behavior and proposes a minimum purchase quantity to bootstrap production.

2.3 Selling Strategy

2.3.1 Capacity-Aware Sales Control

The selling strategy is explicitly capacity-aware. TakaLinkAgent constrains sales using the *effective sellable capacity* C_{sell} :

$$C_{\text{sell}} = \min(I_{\text{in}} + I_{\text{proj}}, L(N - t)) - Q_{\text{secured}} - \delta, \quad (3)$$

where $L(N - t)$ is the remaining production capacity, Q_{secured} is the total already-contracted future sales quantity, and $\delta = \max(1, \lfloor 0.05L \rfloor)$ is a safety margin. Sales offers and acceptances are rejected whenever they would exceed C_{sell} .

2.3.2 Reservation-Aware Control

Because multiple negotiations proceed simultaneously within a single step, evaluating each offer independently can accidentally create overcommitment. To avoid this, TakaLinkAgent tracks provisional reservations r_{sell} and reduces the remaining capacity at every sales decision made during the same step. The effective capacity for any decision is $\max(0, C_{\text{sell}} - r_{\text{sell}})$. This mechanism reduces same-step overselling and stabilizes performance.

2.4 Partner Selection

Negotiation partners are selected dynamically by **PartnerEvaluator**. For each partner i , the success-rate-based trust score is computed as:

$$\sigma_i = \frac{s_i}{s_i + f_i}, \quad (4)$$

where s_i is the number of successful deals and f_i is the number of failed negotiations. A partner encountered for the first time is initialised with $\sigma_i = 0.5$. Partners are ranked by σ_i in descending order, and the top fraction p_{today} is selected as primary partners. In addition, a mode-dependent number of partners is sampled randomly from the remaining pool for exploration: 2 partners in Aggressive mode, 1 in Neutral mode, and 0 in Conservative mode. The value of p_{today} depends on the current mode: 0.85 (Aggressive), 0.60 (Conservative), or 0.70 (Neutral). The selected partners are then passed to **TradeAllocator**, which distributes the required quantity evenly: partners are sorted by σ_i in descending order, a base quantity is assigned equally to each, and any remainder is allocated one unit at a time to higher-ranked partners.

2.5 Dynamic Negotiation-Cap Control

To prevent over-negotiation, the agent limits the number of simultaneous negotiations via a dynamic cap τ_t . The base cap is $\hat{\tau} = 0.1L$. Define the inventory ratio $r_t = I_t/L$ and the remaining horizon ratio $\phi_t = (N - t)/N$. The adjustment factors are:

$$f_{\text{inv}}(r_t) = \begin{cases} 1.5 & (r_t < 0.3), \\ 0.7 & (r_t > 0.8), \\ 1.0 & \text{otherwise,} \end{cases} \quad f_{\text{time}}(\phi_t) = \begin{cases} 0.8 & (\phi_t < 0.2), \\ 1.0 & (0.2 \leq \phi_t < 0.6), \\ 1.3 & (\phi_t \geq 0.6). \end{cases} \quad (5)$$

The final cap is:

$$\tau_t = \max\{1, \lfloor \hat{\tau} f_{\text{inv}}(r_t) f_{\text{time}}(\phi_t) \rfloor\}. \quad (6)$$

TakaLinkAgent further applies asymmetric caps for buying and selling. When $r_t < 0.3$ (low inventory), τ_{buy} is scaled by 1.4 and τ_{sell} by 0.8; when $r_t > 1.0$

(high inventory), τ_{buy} is scaled by 0.8 and τ_{sell} by 1.4. As an extreme-overstock safeguard, when the total inventory I_t exceeds $3L$, the buying cap is set to $\tau_{\text{buy}} = 1$ and the selling cap is widened to $\tau_{\text{sell}} = \max(1, 3L)$, overriding the normal formula. Mode scaling is then applied on top: Aggressive mode multiplies τ_{buy} by 1.5 and τ_{sell} by 1.2; Conservative mode multiplies τ_{buy} by 0.7 and τ_{sell} by 0.8.

2.6 Pricing Strategy

Price generation follows a two-layer structure. The base price is produced by **SmartPricing**. Let $p_{\min}$ and $p_{\max}$ be the admissible price bounds, $\Delta p = p_{\max} - p_{\min}$, and σ_i the trust score of partner i . The base counter-offer prices are:

$$p'_{\text{buyer}} = p_{\min} + \beta(1 - \sigma_i) \Delta p, \quad (7)$$

$$p'_{\text{seller}} = p_{\max} - \alpha(1 - \sigma_i) \Delta p, \quad (8)$$

where $\alpha = \beta$ is set by mode: 0.2 (Aggressive), 0.1 (Conservative), and 0.15 (Neutral). As $\sigma_i \rightarrow 1$, the buyer price approaches $p_{\min}$ and the seller price approaches $p_{\max}$, meaning the agent proposes prices more advantageous to *itself* when dealing with high-trust partners. The rationale is that reliable partners are more likely to accept assertive offers, so the agent exploits high-trust relationships to capture more margin; conversely, low-trust partners receive more concessive prices to increase the probability of reaching an agreement. **SmartPricing** also applies a mild seller-side discount when output inventory exceeds L , computed as $\min(0.30, (\text{out_inv}/L - 1.0) \times 0.1) \times \Delta p$; the discount grows linearly with overstock and is capped at 30% (reached when output inventory reaches $4L$).

On top of this base, the agent wrapper `get_smart_price()` applies an additional seller-side discount when the input inventory exceeds $I^{\max}$. The discount rate is proportional to the overstock degree and is capped at 10%, providing a second layer of pressure relief against excess input inventory.

3 Risk Management via Mode Switching

MarketAnalyst detects the short-term profit trend from the most recent five steps. Define:

$$\Delta B = \frac{1}{3} \sum_{j=0}^2 B_{t-j} - \frac{1}{2} \sum_{j=3}^4 B_{t-j}, \quad (9)$$

where B_t is the balance change (profit) at step t . The operational mode is determined as:

$$\text{mode} = \begin{cases} \text{Aggressive} & (\Delta B > 50), \\ \text{Conservative} & (\Delta B < -50), \\ \text{Neutral} & \text{otherwise.} \end{cases} \quad (10)$$

Aggressive mode enlarges negotiation caps, widens partner exploration, and grants more generous price concessions. Conservative mode shrinks caps and

prices more cautiously. This switch aligns procurement, sales, and mode-aware pricing with the short-term market trajectory; pricing behavior is thus conditioned on the analyst mode after profit-trend-based mode switching.

The integrated risk control addresses three failure modes. **Shortage risk** is mitigated by target-based procurement, projected incoming estimation, forward contracting, and the emergency bootstrap mechanism. **Overselling risk** is addressed through capacity-linked selling and reservation-aware step-level commitment control. **Excess inventory risk** is managed by the maximum inventory threshold, mode-driven cap reduction, and inventory-pressure price discounts on the selling side.

4 Evaluation

4.1 Experimental Settings

To evaluate the performance of TakaLinkAgent, simulations were conducted using the SCML standard-track tournament runner with the following settings:

- `n_steps`: 50
- `n_configs`: 5
- `n_runs_per_world`: 1

We added `GreedyStdAgent`, `SyncRandomStdAgent`, and `RandomStdAgent` as competitors. We conducted this experiment five times, recording the score for each agent in each trial.

4.2 Results

Table 1 shows the results of the experiments, including the average scores across the five trials for `TakaLinkAgent`, `GreedyStdAgent`, and `SyncRandomStdAgent`. This table show that TakaLinkAgent achieved an average score of 1.0872, outperforming the other two agents, which had average scores of 0.7038, 0.6332, and -0.1244.

Table 1: Experiment Results

Experiments	TakaLinkAgent	GreedyStdAgent	SyncRandomStdAgent	RandomStdAgent
1	1.1032	0.5966	0.5334	-0.4696
2	1.0252	0.6874	0.5787	-0.2206
3	1.1656	0.8679	0.7347	-0.1666
4	1.0730	0.6488	0.6219	-0.2443
5	1.0680	0.7181	0.6971	-0.0095
Average	1.0872	0.7038	0.6332	-0.1244
Min	1.0252	0.5966	0.5334	-0.4696
Max	1.1656	0.8679	0.7347	-0.0095

4.3 Ablation Study

Table 2 shows the mean score when each component is disabled one at a time under the same experimental settings.

Note that Table 2 was obtained in a separate batch from Table 1; the Full TakaLinkAgent baseline (1.1987) therefore differs from the average in Table 1 (1.0872).

Removing any single component consistently degraded performance. The largest drop occurred when Asymmetric Negotiation-Cap Control was disabled ($\Delta = -0.2441$), confirming it as the most critical component. Reservation-Aware Control ($\Delta = -0.1153$), Forward Contracting ($\Delta = -0.0977$), and Two-Layer Pricing ($\Delta = -0.0802$) showed substantial contributions. Mode Switching ($\Delta = -0.0528$), Emergency Procurement ($\Delta = -0.0670$), and Trust-Based Partner Selection ($\Delta = -0.0424$) had smaller but consistent effects; the modest impact of partner selection is consistent with its role as a distributed mechanism whose benefit accumulates across many negotiation rounds rather than appearing as a single-step gain.

Table 2: Ablation study: mean score when each component is disabled

Configuration	Mean Score	Δ vs. Full
Full TakaLinkAgent	1.1987	—
without Reservation-Aware Control (r_{sell})	1.0834	-0.1153
without Forward Contracting	1.1010	-0.0977
without Mode Switching (fixed Neutral)	1.1459	-0.0528
without Asymmetric Negotiation-Cap Control (symmetric τ)	0.9546	-0.2441
without Emergency Procurement	1.1317	-0.0670
without Trust-Based Partner Selection (uniform sigma=0.5)	1.1563	-0.0424
without Two-Layer Pricing (wrapper discount disabled)	1.1185	-0.0802

Conclusions

TakaLinkAgent integrates inventory-aware procurement (target/maximum inventory policy, limited forward contracting, emergency bootstrap), reservation-aware capacity-constrained selling, trust-based partner selection with dynamic adoption ratio, asymmetric negotiation-cap control with an extreme-overstock safeguard, and mode-aware adaptive pricing conditioned on profit-trend-based mode switching. This multi-layer design reconciles short-term profit with long-term stability and reduces catastrophic low-score outcomes by enforcing feasibility and inventory consistency across concurrent negotiations. As a result of the experiments, TakaLinkAgent achieved a higher average score than other agents in all five trials. Furthermore, a decrease in scores was observed when each component was disabled, demonstrating the effectiveness of its integrated strategy under the standard SCML settings.