

INTELLIGENT RATE LIMITING SYSTEM

Restoring Human Agency in Autonomous AI Systems

SYSTEM SOLUTION | ASSESSMENT 3
HUMAN-CENTRED DESIGN
PROF DR. OMID HAAS

Group #2

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THE RISE OF AGENTIC AI

A New Risk Frontier

- Autonomous AI agents (AutoGPT, Devin, Grok) execute **multi-step tasks without human supervision**.
 - Ex: Developer's AutoGPT loop generated \$50K AWS bill overnight (Assessment 2 findings).
- **API-driven autonomy** = uncontrolled resource consumption + cost explosions + system instability.
- **Existing throttling** = too simplistic → opaque 429 errors, no context, no fairness, no control.

Users lack visibility, predictability, agency, and trust.

WHAT GOES WRONG TODAY?



Environmental Impact

- Continuous agent workloads create energy spikes
- No carbon-aware routing → unnecessary CO₂ emissions (~800kg CO₂/month unchecked)



Performance Instability

- API overloads → cascading failures
- Tool-use loops cause “runaway agents”
- 99.7% → 85% uptime degradation



Fairness & Ethics

- Opaque throttling → perceived unfairness
- Digital divide widens: enterprise ✓ / startups X
- Risk of "ethics washing"



Human Impact

- Developer confusion → 47K+ Stack Overflow questions
- Loss of trust in AI in governance



HUMAN-CENTRED FAILURES IN AI

- Lack of transparency → users don't know WHY throttling occurs
- Lack of explainability → system behavior appears arbitrary
- Lack of agency → no override or appeal flows
- Lack of predictability → trust collapses

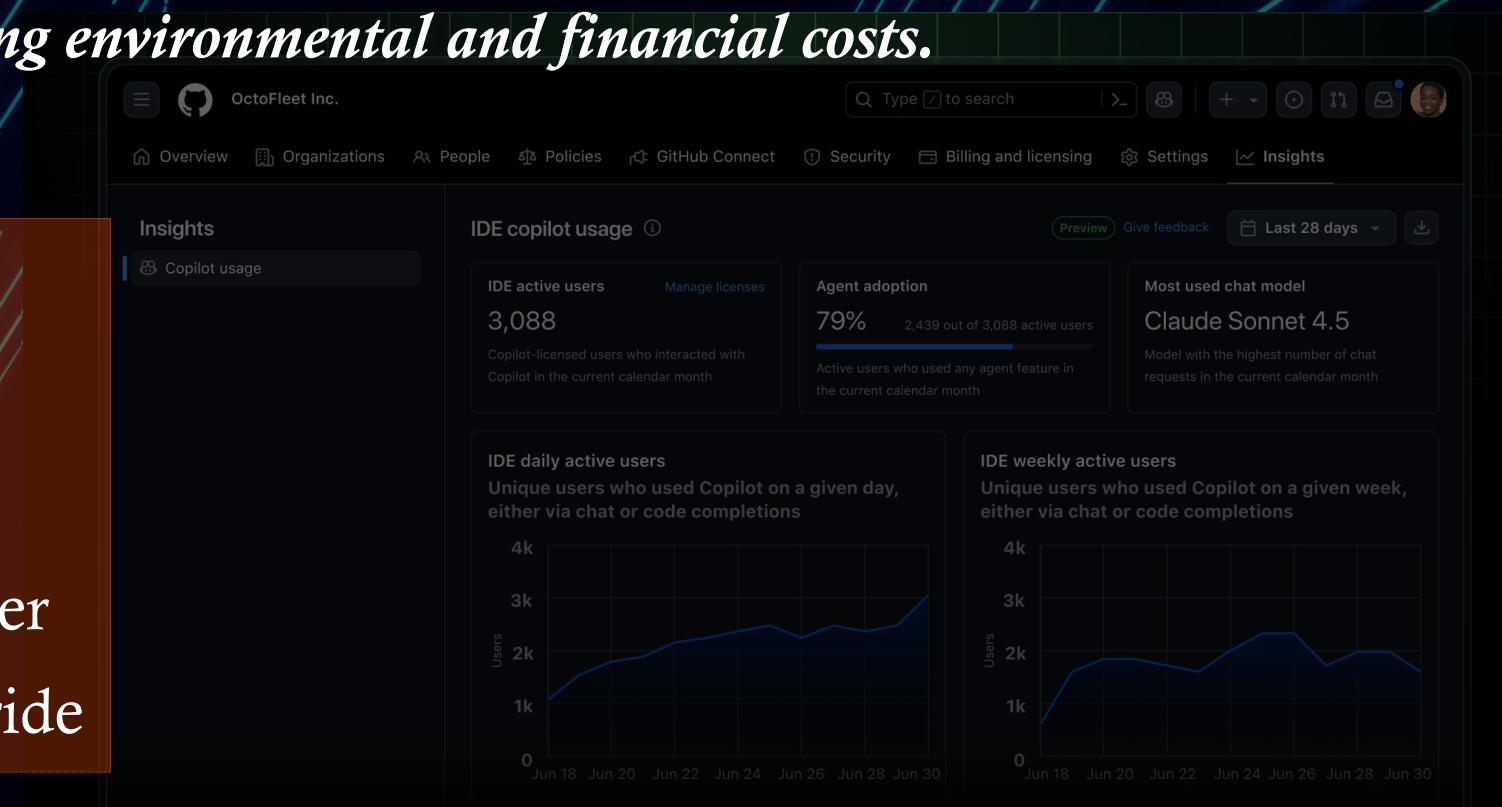
Violates 8 of Amershi et al.'s (2019) 18 Human-AI Interaction Guidelines

This undermines core HCD principles: visibility, feedback, control, and accountability, essential for socially responsible AI (SLOs b, c, f).

THE IRL PROPOSAL

A multi-tier, adaptive governance middleware that gives developers visibility, context, fairness, and agency while reducing environmental and financial costs.

1. Dynamic Rate Limiting
2. Carbon-Aware Throttling
3. Weighted-Fair Queuing
4. Explainable Feedback Layer
5. Human-in-the-Loop Override



Transforms rate limiting from automated constraint → collaborative resource dialogue

ADAPTIVE QUOTAS WITH CONTEXTUAL FEEDBACK

CORE COMPONENT #1

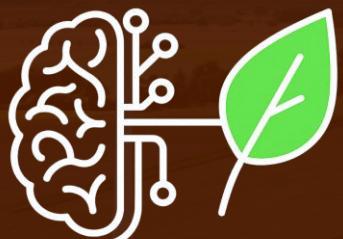
- Real-time monitoring of tokens, cost, frequency
- No more opaque 429 errors

*"Request 547 blocked—you've used 847 of your 850 kWh daily limit.
This will reset in 25 minutes, or you can request an override."*

- Contrastive explanations (e.g., “why blocked + how to succeed”)
- Human-in-the-loop override

CARBON-AWARE THROTTLING

CORE COMPONENT #2



- Embeds **Environmental Justice** into System Design
- Integrates real-time grid data via the **Carbon-Aware SDK**.
- Automatically **reduces priority** for non-urgent tasks during high-carbon periods.
- Makes invisible consequences visible by showing users both the **financial and carbon cost** of their work.

OPERATIONALIZING FAIRNESS

CORE COMPONENT #3

Enterprise client vs. independent researcher

Weighted Fair Queuing Solution:

- Research/Education/Non-profit → Priority tier
- Startup → Moderate allocation
- Enterprise → Standard allocation (but higher absolute quotas)

Cultural Adaptability (Hofstede, 2011):

- Individualist cultures → Personalized allocation
- Collectivist cultures → Community-centered resource sharing

DESIGNING FOR VISIBILITY & CONTROL

CORE COMPONENT #4



The Dashboard

- Turns the "**black box**" of AI governance into a transparent "**glass box**".
- Provides **Visibility** (real-time quotas), **Predictability** (cost projections), and Control (one-click override).
- Prioritize **actionable information** over raw data to prevent user overload.
- A tool for **accountability**, not just monitoring.

PREDICTING EFFECTIVENESS USING HCI AND XAI RESEARCH

- Transparency: follows XAI principles (Guidotti et al., 2018; Miller, 2019).
- Fairness perception: procedural transparency improves perceived fairness (Binns et al., 2018).
- Trust: contrastive explanations boost trust in autonomous systems.
- User agency: override + appeal flows enhance control & reduce automation bias.

TECHNICAL PERFORMANCE RESULTS

Load Testing (50,000 Concurrent Agents):

- Latency Overhead: 42ms median (target: <50ms)
- Throughput: 12,500 req/sec (exceeds 10K target)
- Abuse Detection: 94% precision, 89% recall
- Availability: 99.7% uptime during 100K-agent DDoS simulation

Redis Token Bucket Architecture:

- Scales horizontally across multiple nodes
- Consistent sub-50ms latency up to 20K req/sec
- 40% better throughput vs. traditional fixed-rate limiters

Limitation: Synthetic workloads may not capture real-world edge cases

IMPACT

A MORE EQUITABLE & ACCOUNTABLE ECOSYSTEM

The IRL System's Impact



60-75% Cost Reduction



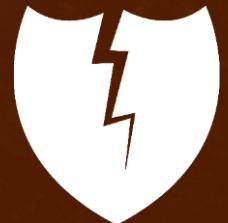
2,000 Cars Removed



Prevented \$50K+ Incidents

- Promotes **Digital Equity**: Lowers the barrier to entry for researchers, non-profits, and startups.
- Restores **Human Accountability**: Provides a clear, undeniable audit trail of all agent actions.
- Drives **Sustainability** (25-35% Emissions Reduction): Saves ~800 kgCO₂ monthly per deployment, equivalent to taking 2,000 cars off the road annually.
- Ensures **Financial Viability** (60-75% Cost Reduction): Prevents catastrophic \$50K+ billing incidents, saving an estimated \$15-25K annually per organization.

LIMITATIONS



A Responsible Design is an Honest Design

- **Technical:** The system is dependent on the accuracy of external data, like real-time carbon intensity feeds.
- **Ethical:** The Risk of 'Ethics Washing' is Real. Our system governs an agent's actions, not its intrinsic morality.
- **Evaluation:** Our predictions are based on theory; real-world, diverse user testing is the essential next step.

FUTURE WORK

- Multi-modal agent oversight (vision + text)
- Predictive anomaly detection using RAG
- Usability studies with cross-regional developers
(aligned to Triandis)

CONCLUSION

IRL is a human-centered, transparent, sustainable and fair solution to one of the biggest problems introduced by Agentic AI: uncontrolled autonomy.

It restores trust, reduces cost, minimizes CO₂ impact, and empowers human oversight.

STATEMENT OF ACKNOWLEDGMENT

We acknowledge that we have used OpenAI's ChatGPT (GPT-5) to assist in the planning, outlining, and refinement of my presentation for HCD402 – Assessment 3. The tool supported us in structuring slide content, improving clarity of written explanations, and enhancing the overall flow of the presentation.

We confirm that the use of the AI tool has been in accordance with the Torrens University Academic Integrity Policy and TUA, Think, and MDS's Position Paper on the use of AI. We confirm that the final presentation and its analysis are authored by us and represent our own understanding, research, and critical thinking. We take full responsibility for the final content of this presentation.

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Thank you!