Implementing a Flexible Event Pipeline to Improve User Experience in Sat-Tycoon

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Satellite Tycoon (Sat-Tycoon) is a multi-player strategy-simulation game where players act as satellite-internet providers. The focus of this project was to implement a flexible event pipeline into Sat-Tycoon. The market of megaconstellations providing internet services is rising and it is challenging to predict what business strategies will succeed in an industry dependent on a variety of physical and economic factors. Sat-Tycoon aims to create a virtual environment where these business strategies can be explored via players' actions. The original mechanics of Sat-Tycoon simulated indirect interactions between players through customer acquisition but lacked complex event scenarios that motivated players with truly challenging and insightful gameplay. The addition of an event pipeline enhances this gameplay by creating more engaging interactions that encourage players to formulate more robust strategies. To model these distinct scenarios, an event pipeline was constructed to generate events based on characteristics such as the duration of the event, the terrestrial region affected by the event, and the type of affected resources. Based on these generated characteristics, the pipeline then utilizes a program to determine which players are affected and carry out the effects of the event. Ultimately, the event pipeline communicates this event's effects to the player(s) so that they can utilize this information to refine their game strategy.

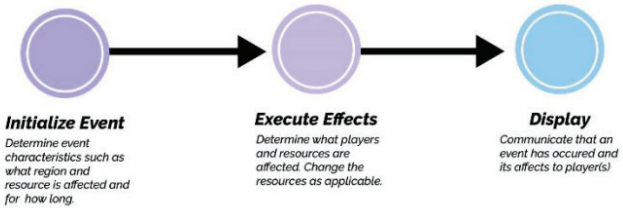

Fig. 1 Illustrates the sequential steps of generating an event in the event pipeline.

A JavaScript Notation Object (JSON), a file structure used to store and format data, was developed to contain the unique characteristics of an event while being ab[1]stract enough to simulate other types of events utilizing the same data structure. To determine which abstract characteristics should be specified in this data structure, the team created a list of categories of events that have a substantial impact on a satellite-internet provider's resources, revenue, and the target market's finances; these events included satellite collisions, natural disasters, magnetics storms, launch failures, and cyber-attacks. Considering these types of events, the abstract characteristics relevant in each event were the number of players affected, the type of affected resource, the duration of the event, the probability of the event occurring, and the affected region. A JSON file where each event category contains specific events described with abstract event characteristics. For example, the file contained multiple natural disaster events, some of which simulated earthquakes with varying magnitudes and locations. The JSON file can be expanded to include more variations of natural disasters like tornados and even more categories of events not originally considered.

Sat-Tycoon runs on a concurrent game loop in which variables like population, consumer demand, and players' revenues are updated at a consistent interval throughout the game. Utilizing this structure, a new function was added to roll for active events to create random obstacles in the game environment. At a set frequency, the game loop will generate a random number which will be compared against a particular instance of an event picked from the JSON file mentioned above. If the randomly generated number is less than the probability of that particular event occurring, then the effects of that event will be calculated. A program was developed to pull the characteristics of a particular event from the JSON file and calculate the effects for each player based on the event's characteristics. An example

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would be if an earthquake occurred in India, the program would calculate the distance between each player's ground stations and the location of the earthquake. If the program determined a ground station was in the affected region it would temporarily change the ground station status to inactive therefore this ground station would not be servicing customers and contributing to the player's revenue. Another function was created to handle updating the active events which will check if an event is still affecting the game environment. If the updating active events function determines that an event is no longer affecting the game environment because of the predetermined end date, the function handles reverting the affected resources to their original state if applicable.

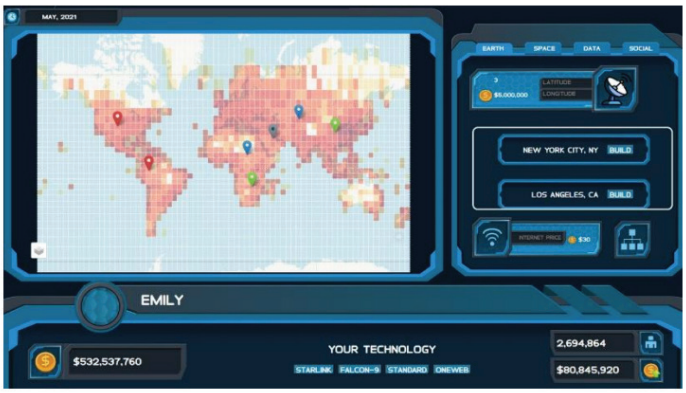

Fig. 2. User interface displays which player's ground stations are affected by a natural disaster.

The last step of the event pipeline is communicating changes in events to players so that they can utilize this data to formulate their strategies. Sat-Tycoon had a pre-existing system for updating front-end displays for users. A function was created to compress the active events data to a simplified list. This simplified list of events was sent to the front end where relevant information was extracted and compared to previous events. If the front end detected a new event was added or an event had ended it would send a direct chat to the player notifying them of this change.

Statement of Research Advisor

Emily started contributing to the Sat-Tycoon project in fall semester 2021, focusing on human-computer interaction. In spring semester 2022, she became the lead developer of the graphical user interface, a significant escalation of responsibility. In the academic year 2022-2023, her focus has been on designing and implementing a flexible events pipeline to support environmental events such as natural disasters. Not only has this significantly increased the simulation's realism, it also is an important step toward making the game more fun for humans to player. Emily has engineered the pipeline in a flexible manner to facilitate adding events in future, hence her contributions may be expected to impact this project for a long time to come.

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References

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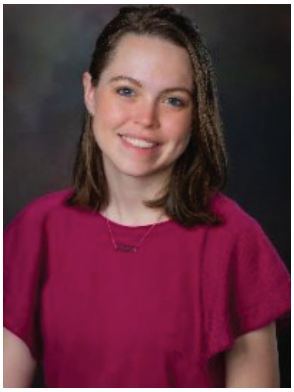
Authors Biography



Emily Kimbrell is a junior-year student pursuing a B.E. degree in Software Engineering with a minor in statistics at Auburn University. She has been working on Sat-Tycoon for two years where she has played a key role in improving user experience through developing intuitive user interfaces and expanding game mechanics to create an engaging experience for players.

Daniel R. Tauritz is an associate professor in the Department of Computer science and Software Engineering, Interim Director of the Auburn Cyber Research Center, and Director for National Laboratory Relationships in the Samuel Ginn College of Engineering. His research interests include computational intelligence approaches to complex real-world problem solving with an emphasis on national security problems in areas such as cyber security, cyber physical systems, and critical infrastructure protection.