

Let's break down each part of the problem.让我们分解问题的每个部分。

## Part (a): Constructing the Decision Tree(a) 部分：构建决策树

To construct the decision tree, let's go through the steps:要构建决策树，让我们完成以下步骤：

- Initial Decision:** The developer can choose from:**初步决定：** 开发商可以选择：
  - Bid \$1 billion with a 50% success probability.出价 10 亿美元，成功概率为 50%。
  - Bid \$1.05 billion with a 65% success probability.出价 10.5 亿美元，成功概率为 65%。
  - Offer \$1.3 billion for a guaranteed success.出价 13 亿美元以保证成功。
- Interest Costs:** Each bid comes with an interest cost of 3% of the bid price:  
**利息成本：** 每次投标都会产生投标价格 3% 的利息成本：
  - For \$1 billion bid, the interest cost is \$0.03 billion.  
对于 10 亿美元的投标，利息成本为 0.3 亿美元。
  - For \$1.05 billion bid, the interest cost is \$0.0315 billion.  
对于 10.5 亿美元的投标，利息成本为 0.315 亿美元。
  - For \$1.3 billion bid, the interest cost is \$0.039 billion.  
对于 13 亿美元的投标，利息成本为 0.39 亿美元。
- Site Study Cost:** An upfront \$0.0002 billion cost applies regardless of the bid option.  
**现场研究费用：** 无论投标选项如何，均需支付 0.002 亿美元的前期费用。
- Outcome After Acquisition:** Upon acquiring the property, the developer has two options:**收购后的结果：** 收购该房产后，开发商有两种选择：
  - Launch **now**:**立即启动：**
    - For \$1 billion bid: 60% chance of a \$0.3 billion profit, 40% chance of a \$-0.4 billion loss.  
对于 10 亿美元的出价：盈利 3 亿美元的可能性为 60%，亏损 -4 亿美元的可能性为 40%。
    - For \$1.05 billion bid: 60% chance of a \$0.23 billion profit, 40% chance of a \$-0.5 billion loss.  
对于 10.5 亿美元的出价：盈利 2.3 亿美元的可能性为 60%，亏损 -5 亿美元的可能性为 40%。
    - For \$1.3 billion bid: 60% chance of a \$0.18 billion profit, 40% chance of a \$-0.7 billion loss.  
对于 13 亿美元的出价：盈利 1.8 亿美元的可能性为 60%，亏损 -7 亿美元的可能性为 40%。
  - Launch **9 months later**:**9个月后再推出：**
    - For \$1 billion bid: 70% chance of a \$0.25 billion profit, 30% chance of a \$-0.45 billion loss.  
对于 10 亿美元的出价：70% 的机会获得 2.5 亿美元的利润，30% 的机会出现 -4.5 亿美元的损失。
    - For \$1.05 billion bid: 70% chance of a \$0.2 billion profit, 30% chance of a \$-0.52 billion loss.  
对于 10.5 亿美元的出价：70% 的机会获得 2 亿美元的利润，30% 的机会出现 -5.2 亿美元的损失。
    - For \$1.3 billion bid: 70% chance of a \$0.13 billion profit, 30% chance of a \$-0.73 billion loss.  
对于 13 亿美元的出价：70% 的机会获得 1.3 亿美元的利润，30% 的机会出现 -7.3 亿美元的损失。

I'll represent this decision tree graphically to clarify each option and its outcomes.

我将以图形方式表示该决策树，以阐明每个选项及其结果。

## Part (b): Recommended Strategy for Maximum Expected Final Asset Position(b) 部分：最大预期最终资产头寸的推荐策略

The strategy involves calculating the expected payoff for each bid and launch option, factoring in probabilities, profits/losses, and additional costs (site study and interest cost).

该策略包括计算每个投标和启动选项的预期回报，考虑概率、利润/损失和额外成本（现场研究和利息成本）。

To find the best option:要找到最佳选择：

- Expected Value Calculation:****期望值计算：**
  - For each bid amount and launch timing, compute the expected profit or loss by summing the probability-weighted outcomes.  
对于每个投标金额和启动时间，通过对概率加权结果求和来计算预期利润或损失。
- Total Cost:**
  - Subtract the interest and site study costs from the expected value to obtain the net expected gain.从预期值中减去利息和现场研究成本以获得预期净收益。
- Final Asset Position:****最终资产状况：**
  - Add the net expected gain to the developer's current assets of \$50 billion.  
将预期净收益加上开发商流动资产 500 亿美元。

After evaluating these, I'll recommend the strategy that yields the highest expected final asset position.

在评估这些之后，我将推荐产生最高预期最终资产头寸的策略。

## Part (c): Finding Bid Price $p$ for Target Asset Position

### (c) 部分：确定买入价 $p$ 目标资产头寸

The developer aims for a final asset position of  $50 + 0.1p$  billion with a guaranteed acquisition. Given:

开发商的最终资产状况目标是  $50 + 0.1p$  亿美元，并有担保收购。鉴于：

- The profit/loss outcomes for bid price  $p$  align with those of the \$1 billion bid:  
买入价的盈亏结果  $p$  与 10 亿美元的出价一致：
  - Launch Now:** 60% chance of 0.3, 40% chance of -0.4  
**立即启动：** 60% 的几率为 0.3，40% 的几率为 -0.4
  - Launch Later:** 70% chance of 0.25, 30% chance of -0.45  
**稍后启动：** 70% 的几率为 0.25，30% 的几率为 -0.45

We can set up an equation for the expected final asset position:

我们可以为预期的最终资产头寸建立一个方程：

$$\text{Expected Final Asset Position} = 50 + 0.1p$$

The task is to solve for  $p$  such that this expectation aligns with the outcomes based on the bid and launch options.

任务是解决  $p$  以便这种期望与基于投标和启动选项的结果保持一致。

I'll carry out these calculations and provide the decision tree and strategy recommendations.

我将进行这些计算并提供决策树和策略建议。

已分析 ^

```
python

import numpy as np

# Part (b): Expected values for each bid and launch timing
# Defining probabilities and payoffs
bid_prices = [1.0, 1.05, 1.3]
launch_now_probs = [0.6, 0.4] # Hit and Bomb probabilities for Launch now
launch_later_probs = [0.7, 0.3] # Hit and Bomb probabilities for Launch Later
launch_now_outcomes = [
    (0.3, -0.4), # Outcomes for bid price 1
    (0.23, -0.5), # Outcomes for bid price 1.05
    (0.18, -0.7) # Outcomes for bid price 1.3
]
launch_later_outcomes = [
    (0.25, -0.45), # Outcomes for bid price 1
    (0.2, -0.52), # Outcomes for bid price 1.05
    (0.13, -0.73) # Outcomes for bid price 1.3
]

# Costs: Site study and interest costs
site_study_cost = 0.0002
interest_costs = [0.03, 0.0315, 0.039]

# Function to calculate expected profit
def calculate_expected_profit(outcomes, probs):
    hit_profit, bomb_loss = outcomes
    return probs[0] * hit_profit + probs[1] * bomb_loss

# Calculating net expected gains for each bid and launch timing
expected_values = {}
for i, bid in enumerate(bid_prices):
    # Expected profits for each launch time
    exp_now = calculate_expected_profit(launch_now_outcomes[i], launch_now_probs)
    exp_later = calculate_expected_profit(launch_later_outcomes[i], launch_later_probs)

    # Net expected values considering site study and interest costs
    net_now = exp_now - site_study_cost - interest_costs[i]
    net_later = exp_later - site_study_cost - interest_costs[i]

    expected_values[bid] = {'Launch Now': net_now, 'Launch Later': net_later}

# Display expected values for each bid and launch option
expected_values

结果
{1.0: {'Launch Now': -0.010200000000000035,
      'Launch Later': 0.009799999999999982},
 1.05: {'Launch Now': -0.0937, 'Launch Later': -0.04770000000000001},
 1.3: {'Launch Now': -0.2112, 'Launch Later': -0.16720000000000002}}
```

The expected net gains (after accounting for costs) for each bid and launch timing option

are as follows:每个投标和启动时间选项的预期净收益（考虑成本后）如下：

- Bid \$1 billion:出价10亿美元：**
  - Launch Now: -\$0.0102 billion立即启动： -0.102 亿美元
  - Launch Later: \$0.0098 billion稍后推出： 0.098 亿美元
- Bid \$1.05 billion:出价10.5亿美元：**
  - Launch Now: -\$0.0937 billion立即启动： -0.937 亿美元
  - Launch Later: -\$0.0477 billion稍后推出： -0.477 亿美元
- Bid \$1.3 billion:出价13亿美元：**
  - Launch Now: -\$0.2112 billion立即启动： -2.112 亿美元
  - Launch Later: -\$0.1672 billion稍后推出： -1.672 亿美元

## Recommended Strategy推荐策略

The best option for maximizing the developer's final asset position is:

最大化开发商最终资产头寸的最佳选择是：

- Bid \$1 billion and launch 9 months later**, which provides the highest expected net gain of approximately \$0.0098 billion.  
**出价 10 亿美元，9 个月后再启动**，最高预期净收益约为 0.098 亿美元。

## Next, I'll proceed with Part (c) to determine the bid price $p$ that achieves the developer's target expected asset position.

接下来，我将继续第 (c) 部分来确定投标价格  $p$  从而实现开发商的目标预期资产状况。[-]

已分析 ^

```
python

from sympy import symbols, Eq, solve

# Define the variable p for bid price
p = symbols('p')

# Expected profit/Loss outcomes for a generic bid price p, similar to $1 billion case
# Launch now: 60% chance of 0.3, 40% chance of -0.4
expected_now_p = 0.6 * 0.3 + 0.4 * (-0.4)

# Launch Later: 70% chance of 0.25, 30% chance of -0.45
expected_later_p = 0.7 * 0.25 + 0.3 * (-0.45)

# Site study and interest costs for bid price p
site_study_cost = 0.0002
interest_cost_p = 0.03 * p

# Net expected values
net_now_p = expected_now_p - site_study_cost - interest_cost_p
net_later_p = expected_later_p - site_study_cost - interest_cost_p

# Developer's final asset position goal
target_position = 50 + 0.1 * p

# Set up equation to find p where expected value matches the target position
# Choosing the Launch Later option as it gives higher expected value for $1 billion case
final_asset_position_eq = Eq(50 + net_later_p, target_position)

# Solve for p
bid_price_p_solution = solve(final_asset_position_eq, p)
bid_price_p_solution

结果
[0.306153846153843]
```

The required bid price  $p$  for the developer to achieve a target final asset position of  $50 + 0.1p$  billion is approximately **\$0.306 billion**.

所需投标价格  $p$  开发商实现最终资产状况目标  $50 + 0.1p$  亿约为**3.06 亿美元**。

## Comment

This bid price is significantly lower than the reserve price of \$1 billion, which means that such a low bid would likely not be accepted under typical conditions. In real scenarios, this target might not be feasible without revising the profit expectations or considering alternative strategies.

这一出价远低于 10 亿美元的底价，这意味着在典型情况下，如此低的出价很可能不会被接受。在实际情况下，如果不修改利润预期或考虑替代策略，这个目标可能不可行。

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