



Analyzing the Market Growth in API Economy using Time-evolving Model

Hiroki Yoshikai, Shin'ichi Arakawa, Tetsuya Takine, Masayuki Murata

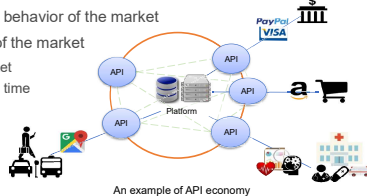
Advanced Network Architecture Research Laboratory, Osaka University
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Background

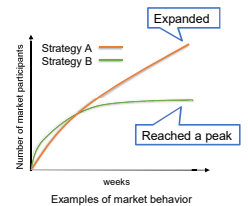
- **API economy**
 - Economy that creates new value by connecting corporate services converted into APIs
 - Supply and consume services via APIs
 - Activated by indirect network effects
- **Equilibrium points under a certain platform strategy [4]**
 - Important in understanding the qualitative behavior of the market
 - Platform strategies differ for each phase of the market
 - Important to capture the behavior of a market as the number of participants changes over time



[4] S. Sen, R. Guerin, and K. Hosanagar, "Functionality-rich versus minimalist platforms: A low-sided market analysis," ACM SIGCOMM Computer Communication Review, vol. 41, pp. 36–43, Oct. 2011.

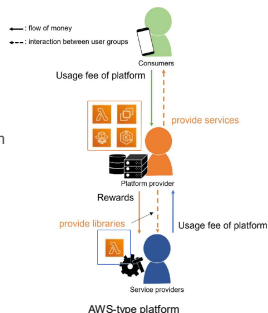
Motivations & Approach

- **Motivations**
 - Capture the behavior of a market
 - as the number of participants changes over time
 - Identify the sustainability conditions
 - to expand the number of market participants
 - to ensure market participants' profits
- **Approach**
 - Modeling a time-evolving market
 - Azure-type platform with API providers
 - AWS-type platform with no API providers
 - Comparison of market behavior across different platform strategies



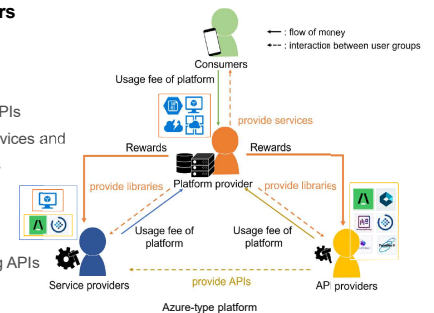
AWS-type platform

- **Platform provider**
 - Collects usage fees
 - Rewards service providers
- **Service providers**
 - Develop services using libraries provided by the platform
 - Many functions need to be developed on their own
 - increasing development costs
- **Consumers**
 - Pay usage fees to the platform
 - Use various services developed by service providers



Azure-type platform

- **Platform providers/Consumers**
 - Similar to AWS-type platform
- **Service providers**
 - Develop services early by using APIs
 - Easier development of diverse services and
 - Further reduce development costs
- **API providers**
 - Develop diverse functions
 - Lower development costs by using APIs in a complementary relationship

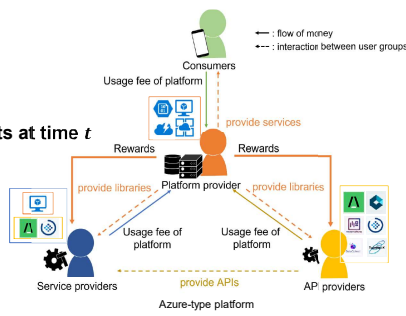


Market participants

- Platform p
- Consumers $u_i: u_1, u_2, \dots$
- Service providers $s_i: s_1, s_2, \dots$
- API providers $a_i: a_1, a_2, \dots$

State \mathcal{M}_t of market participants at time t

- $\mathcal{M}_t = \{P_t, U_t, S_t, A_t\}$
- $P_t = \{p\}$
- $U_t = \{u_1, u_2, \dots, u_i, \dots, u_{U(t)}\}$
- $S_t = \{s_1, s_2, \dots, s_i, \dots, s_{S(t)}\}$
- $A_t = \{a_1, a_2, \dots, a_i, \dots, a_{A(t)}\}$



$U_p(t)$: Profit

- $U_p(t) = p_c \cdot S(t) + p_a \cdot \hat{A}(t) + P(t) \cdot (1 - \alpha_s - \alpha_a)$

$P(t)$: Source of the fee to Service/API providers

- $P(t) = p_c \cdot U(t) - I_p(t)$

$I_p(t)$: Cost of capital investment in platform at time t

- $I_p(t) = \eta(p_c \cdot U(t))$

$F(t)$: Number of libraries held by the platform

- $F(t+1) = F(t) + e^{-\gamma \cdot F(t)/I_p(t)}$

$U(t)$: Number of consumers

- $U(t+1) = U^{early}(t) + U^{major}(t)$

Amount of change in number of early adopters

- $\frac{d}{dt} U^{early}(t) = \zeta U^{early}(t) \left(1,0 - \frac{U^{early}(t)}{K(t)}\right) - \delta(t) \frac{d}{dt} o^{early}(t)$

Amount of change in number of majorities

- $\frac{d}{dt} U^{major}(t) = U^{early}(t) - \delta(t) \frac{d}{dt} o^{early}(t)$

$U_{a_i}(t)$: Profit

- $U_{a_i}(t) = \alpha_a P(t) \frac{F(a_i, S_t, A_t, R_t)}{\sum_k \alpha_k F(a_k, S_t, A_t, R_t)} - p_a - K_a(F + J(T_i))$

$F(a_i, S_t, A_t, R_t)$: Number of uses of API provided by a_i

- $F(a_i, S_t, A_t, R_t) = \frac{1}{\hat{A}(t)} \exp(-0,003I(T_i))$

$K_a(x)$: Development cost

- $K_a(x) = 25e^{-0,003 \cdot x}$ the more complementary APIs they use the more development costs decrease

Incremental model

- $A(t+1) = A(t) + a_{birth} + \hat{A}(t) * 0,01$

$\hat{A}(t)$: Number of participants at time t

- $\hat{A}(t) = \sum_k \Delta_{k|\mu \geq 0}$

$U_{s_i}(t)$: Profit

- $U_{s_i}(t) = \alpha_s P(t) \frac{G(s_i, S_t, A_t, R_t)}{\sum_{s_k} G(s_k, S_t, A_t, R_t)} - p_s - \{K_s(F + |\Phi(A_t)|)\}$

$G(s_i, S_t, A_t, R_t)$: Number of uses of service provided by s_i

- $G(s_i, S_t, A_t, R_t) = \frac{1}{S(t)} \exp(-0,012I(V_i))$

$K_s(x)$: Development cost

- $K_s(x) = 25e^{-0,003 \cdot x} + 20$ the more APIs they use the more development costs decrease

Incremental model

- $S(t+1) = S(t) + s_{birth} + \hat{S}(t) * 0,015$

$\hat{S}(t)$: Number of participants at time t

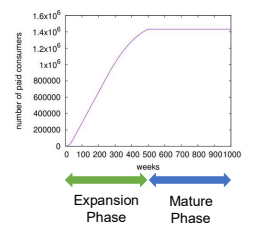
- $\hat{S}(t) = \sum_k \Delta_{k|\mu \geq 0}$

Incremental model of consumers

- Based on the number of premium members of Japanese service

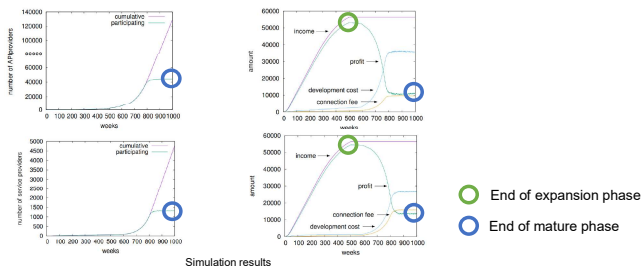
Comparison of market behavior across different platform strategies

- basic: allocates 35% of the fees collected from consumers to service/API providers respectively
- high margin: allocates 10% respectively
- low margin: allocates 50% respectively
- high usage fee: 10x usage fees for service/API providers



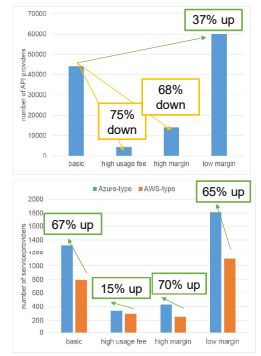
● Perspectives of evaluation

- Market growth: Number of market participants at the end of mature phase
- Platform for coexistence: Profit of each participant at the end of expansion phase and mature phase



● Comparison of platform strategies

- High margin and high usage fee
 - increase platform profitability
 - decrease market participants
- Low margin
 - increase profits for service/API providers
 - increase market participants



● Comparison with an AWS-type platform

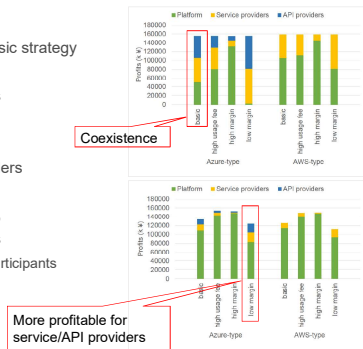
- Lower development costs for service providers
- Decrease in effectiveness of API providers
 - in reducing development costs
 - when platform usage fees are high

● Expansion phase

- Coexistence can be achieved by basic strategy
- Azure-type platform are about 3% more profitable for service providers

● Mature phase

- Ensure profits for service/API providers by low margin settings
- Azure-type platforms are about 20% more profitable for service providers
 - Easier to ensure profits for market participants during a mature phase



● Conclusion

- Time-evolving market model with API providers
- Observation of market behavior using the model
- Results
 - Market growth
 - Azure-type platform decreased the cost of developing services by 25% and increased the number of market participants by 67%
 - Platform for coexistence
 - Feasible when the platform allocates 70% of its revenue to service/API providers
 - Azure-type platforms are more profitable for market participants during a mature phase

● Future Work

- Model in which market behavior depends on strategies of each market participant