Optimization of ICT Common Wealth Planning and Sharing based on Organic Economic Ecology and Theory of Knowledge Value Transformation

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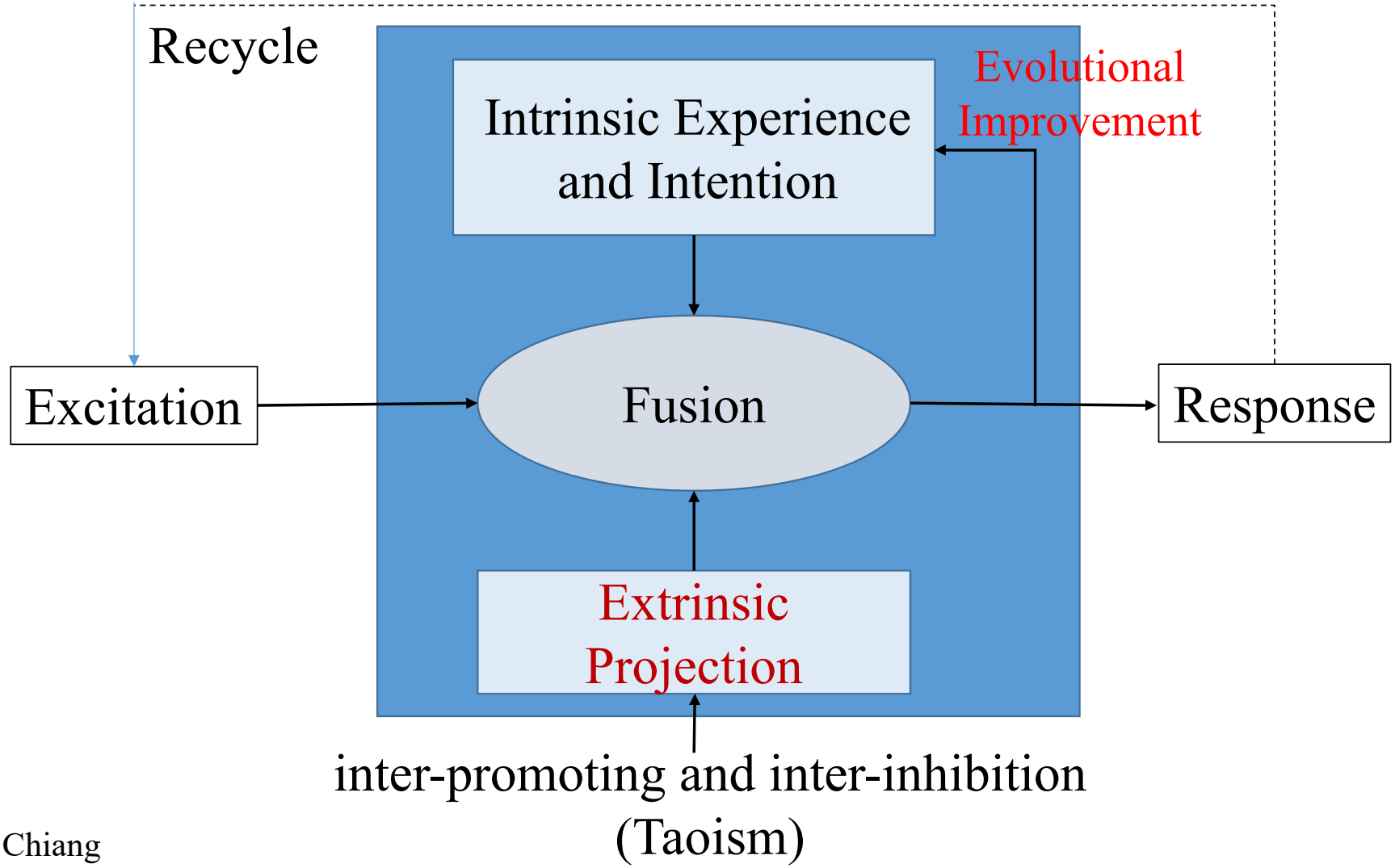
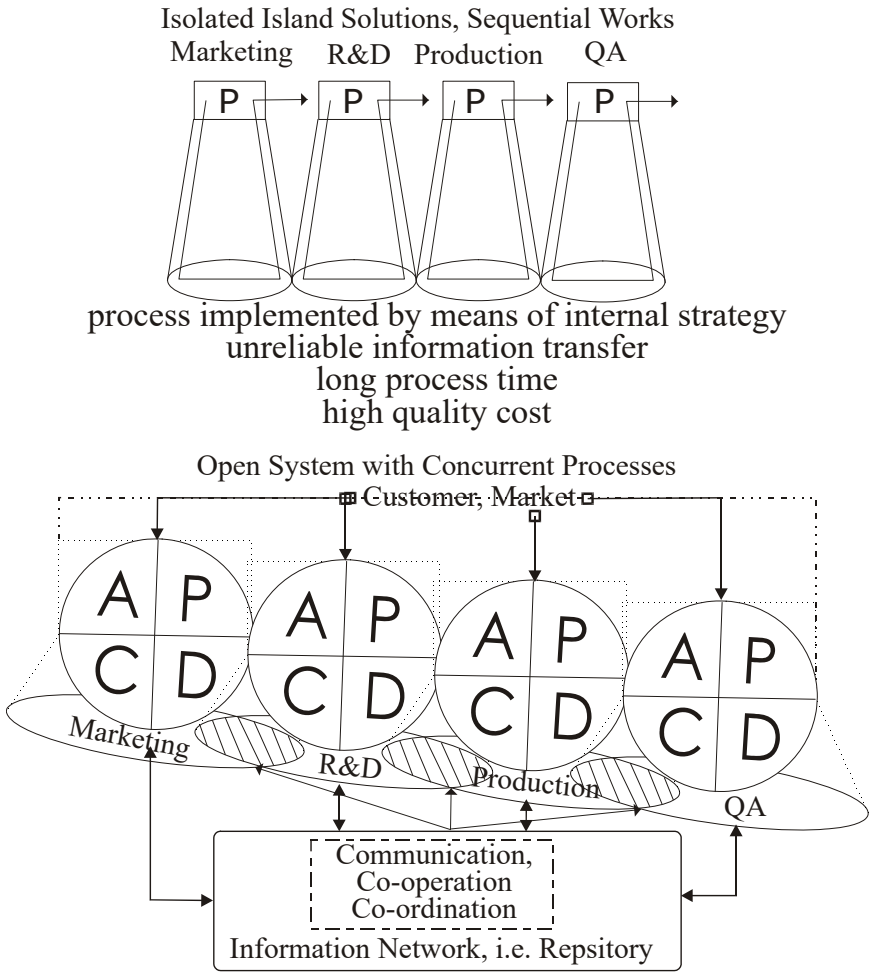
HyPloy(Hyper Ploy): Organic Element of Ecosystem



Ecosystem based on HyPloy (HyQIS)



HyQIS: EU FP3-ESPRIT Project 8733, led by Prof. T. Pfeifer of RWTH University Aachen of Germany

- HyQIS is a systematics for Kaizen (Kanji of Continuous Improvement) for Total Quality Management (TQM), in which we also developed the concept of Quality of Service (QoS).
- HyQIS emphasizes Co-operation and Coordination.
- At that time, Hypertext was the best technique for Computer Supported Cooperative Works (CSCW).
- However, HyQIS only considered the quality of resources.

HyQVIS : Hyper Quality and Value of ICT Systematics

- Since middle of 1990s, the economic drive has shifted form managing of scarcity to producing abundance. The result is the decline of the cost/effect by the usage of resources and environment damages.
- For the common wealth planning and sharing, I have carried out a paradigm of Organic Economic Ecology, viz. HyQVIS (Hyper Quality and Value of Information Systematics) which emphasizes the coordination upon communication and cooperation.
- Thereby, I have led a research into Value aspect with reference to Roger's Innovation Diffusion Theory, where I consider Confucius pragmatism and altruism for value of service into HyQVIS. Therefore the Value is comparative in HyQVIS. I use the term "Hyper" to emphasize the marriage of female and male of Taoism as well as crossover of biological evolution.

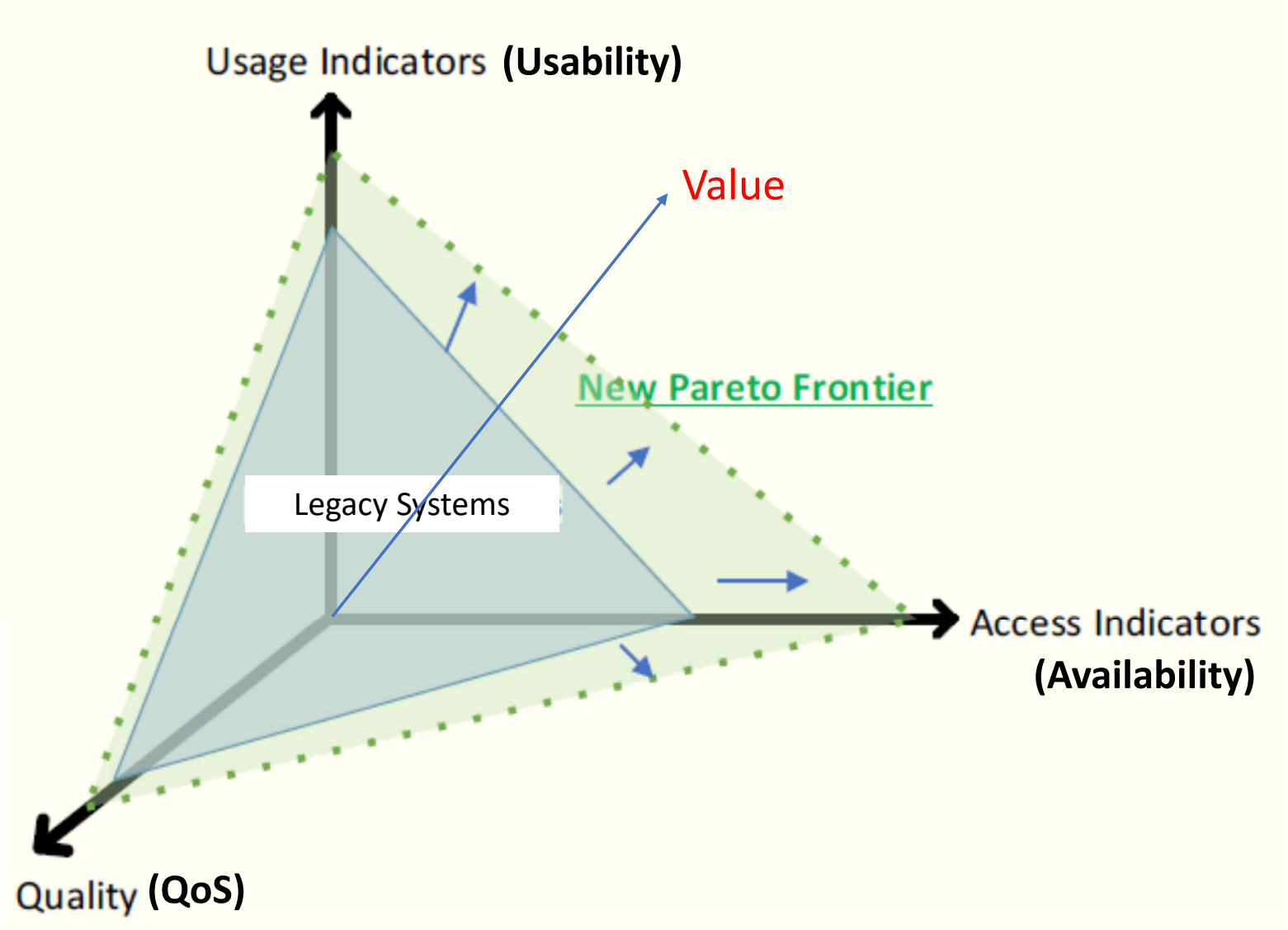
Theory of Knowledge Value Transformation

$$\arg\min_{A,U} \sum_{c \in S,T} \sum_{i=1}^{j} L[y_{c_i}, (A_c, U^T \vec{x_{c_i}})] + \lambda \mathcal{L}$$

Starting from the center part of the individual i with its common quality feature vector (x_{ci}), we would like this part (sources S) maps to common quality feature space (Target T) by an organic function, which contains the mapping function $U_{s \to t}$ and parameter matrix A. We need to run this loop until all j individual ($i \in j$) complete the mapping and create the common feature space y_c.

- The objective is to find the argument sets that can minimize the cost of energy by optimizing A and U. The organic function is also the affine translation that combines the vector space of common feature domain and individual feature onto the new space of comparable feature domain.
- With the organization's features, we can prepare the transform function for the relations between the common features, individual features and the comparable feature space to generate the comparative value of each individual organic element in term of HyPloy.
- The optimization should obey a certain Law or de factor Consensus that reflects a moral spirit. The overall systematics is a Transformer from Knowledge domain on the semantic level to Comparative Value domain on the pragmatic level in terms of Automata.

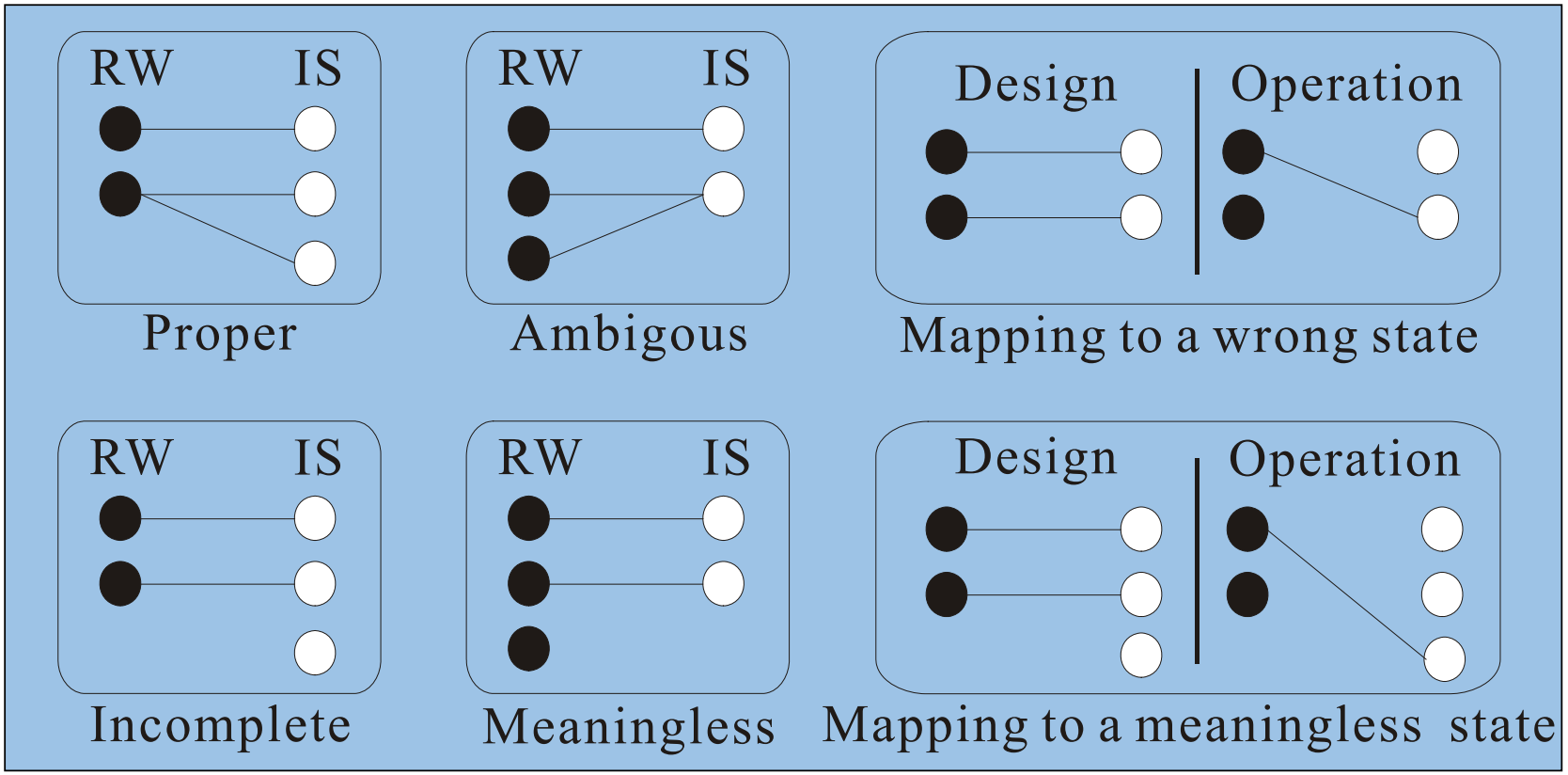
Pareto Optimality



Metrics for Pareto Optimality (ISO 25000)

- Measure of QoS: Degree to which the response and processing times and throughput rates of a resource or system, when performing its functions, meet requirements, i.e. quality w.r.t. ISO 8402 and ISO 9000.
    - Throughput
    - Efficiency
    - Latency
- Measure of Availability: Degree to which the amounts and the maximum limits of a resource or system parameter meet requirements.
    - Amount of the resource
    - Uptime: the measure of time a given service is up and available to be used by the appropriate end users.
    - Downtime: not available to the end users
- Measure of Usability: Degree to which types of resources used by a system or user, when performing its functions, meet requirements.
    - Functional completeness - Degree to which the set of functions covers all the specified tasks and user objectives.
    - Functional correctness - Degree to which a product or system provides the correct results with the needed degree of precision.
    - Functional appropriateness - Degree to which the functions facilitate the accomplishment of specified tasks and objectives including Easy to Use，Usefulness (TAM: Technology Acceptance Model), and Compatibility, viz. co-existence and interoperability.

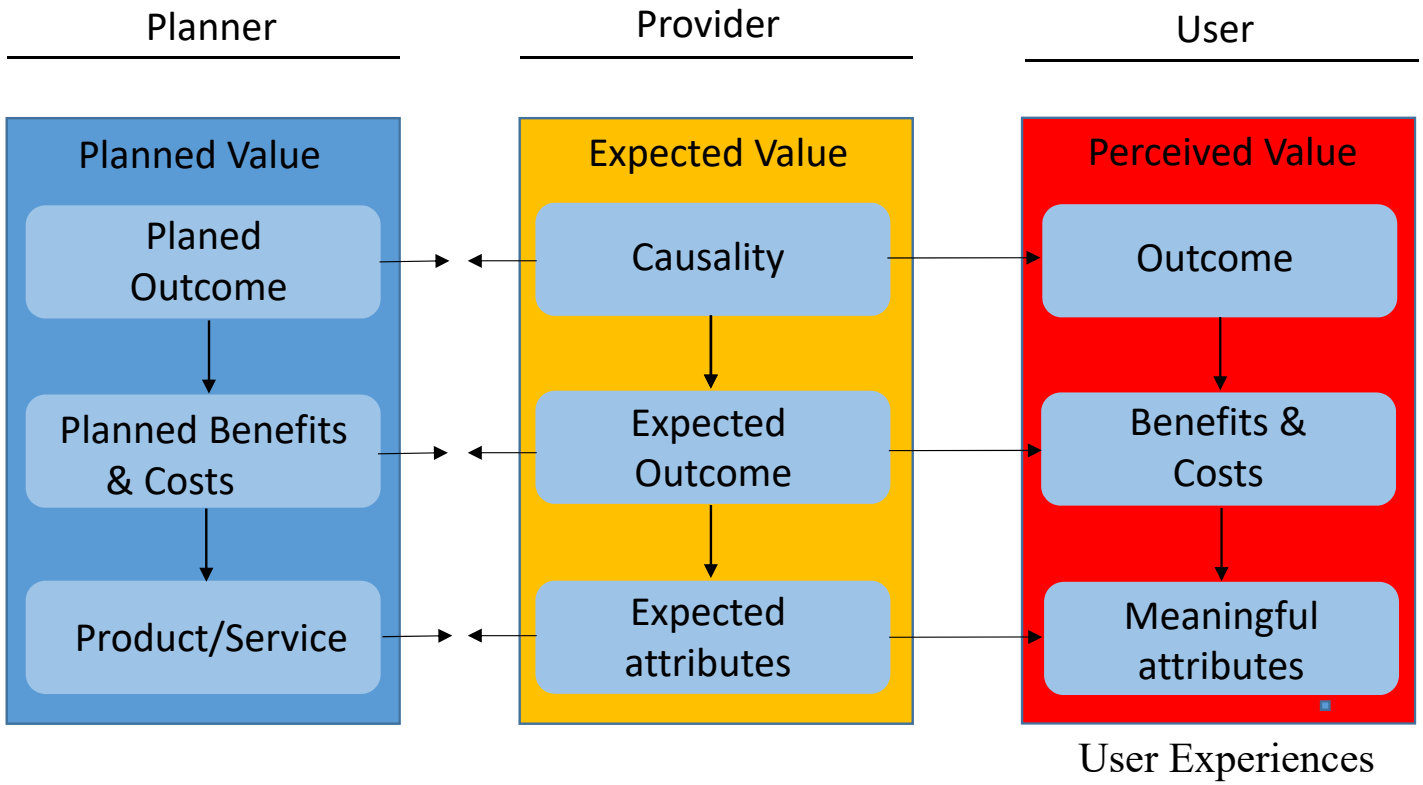
Knowledge of HyQVIS: Information with Quality



RW: Real World, IS: Information System

Value of HyQVIS

- Real Value, usually measured by money
- Comparative Value:



Modified from "API Economy", Moilanen, *et al*

Compulsory Attendance of Coordinating Organ

- The organic entities to construct the ecosystem
- Space for adaptive optimization
- Risk management

Considerations for Mobile Spectrum Splitting and Sharing

- Available Spectrum (Availability) and the expected Value
- The revenue of operators, who participate the ecosystem, and the Discounting Factors
- WACC(Weighted Average Cost of Capital)
- NPV(Net Present Value)

Cost Function for the optimization

- The Cost for Equipment Construction
- The Revenue of Operators

Other Affecting Factors: Simultaneous Multi-Round Auction

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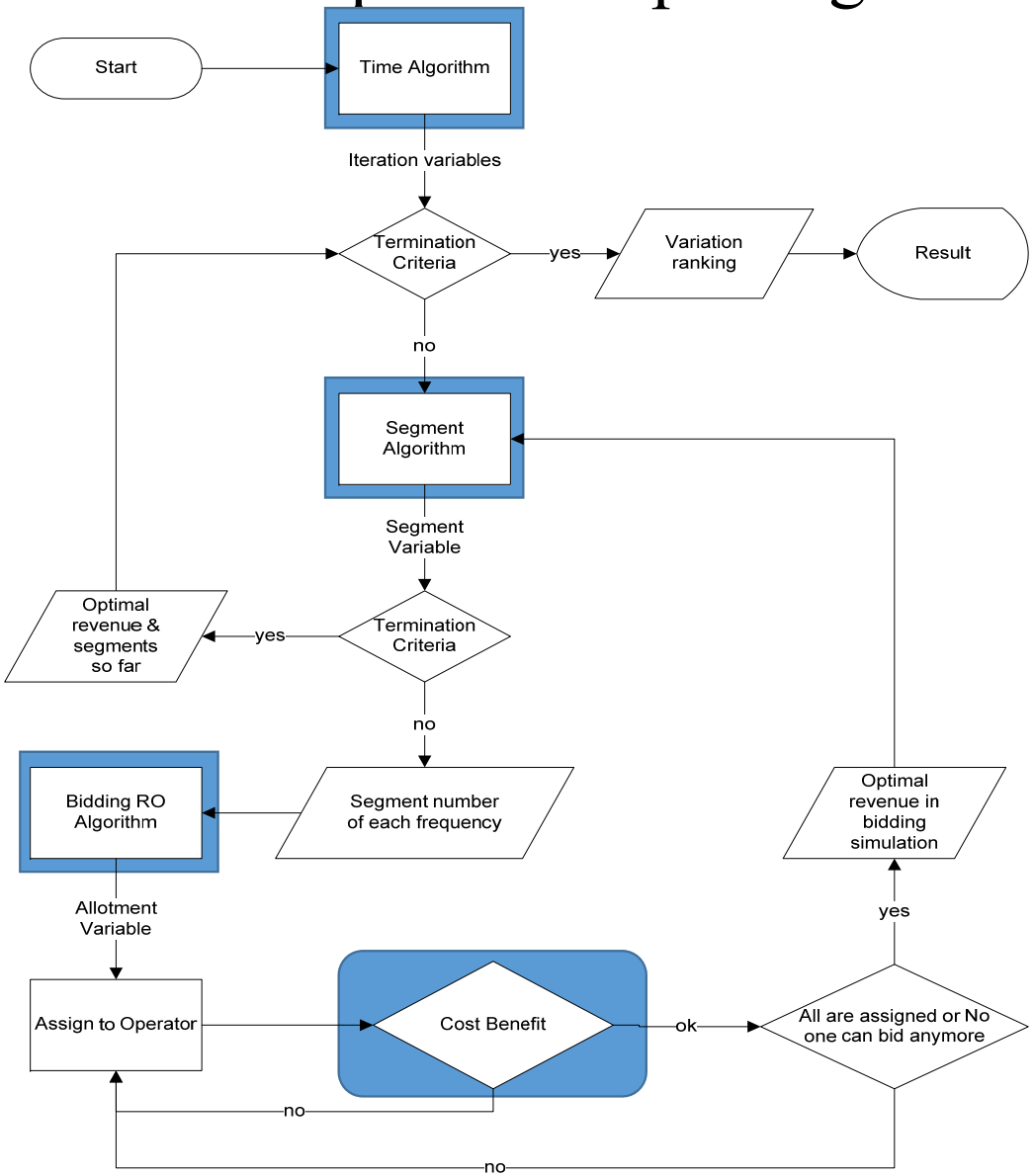
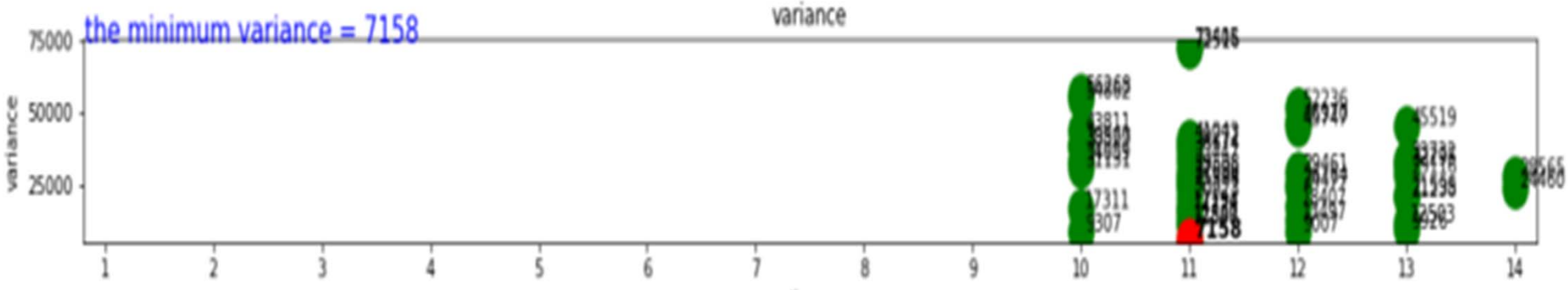
Optimization Algorithm

- Random Optimization (RO, Statistics, Divide)
- Simulated Annealing (SA, Physics, Equilibrium: Divide and Conquer)
- Genetic Algorithm (GA, Biology, Conquer)
- Ant Colony Optimization(ACO, Biology)

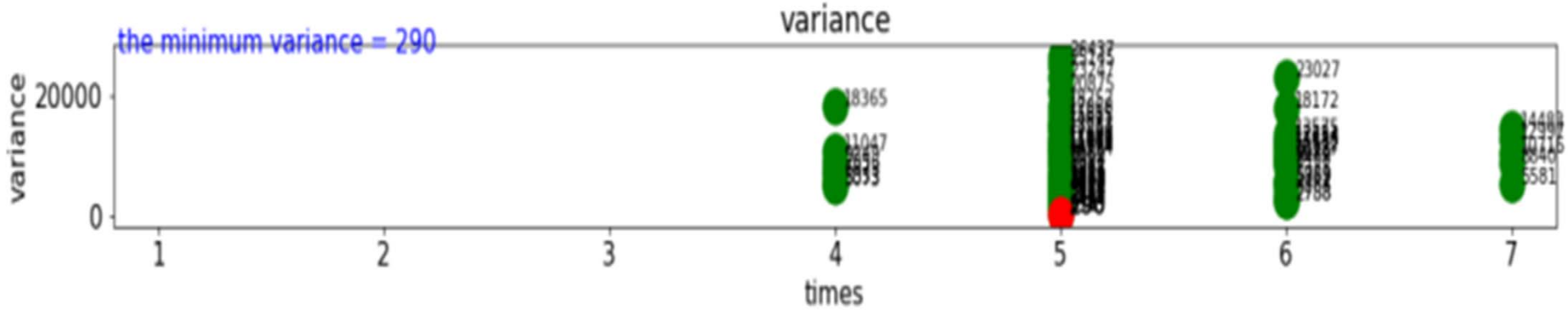
Optimization Process of Spectrum Splitting and Assignment



Simulation of the splitting and Auction

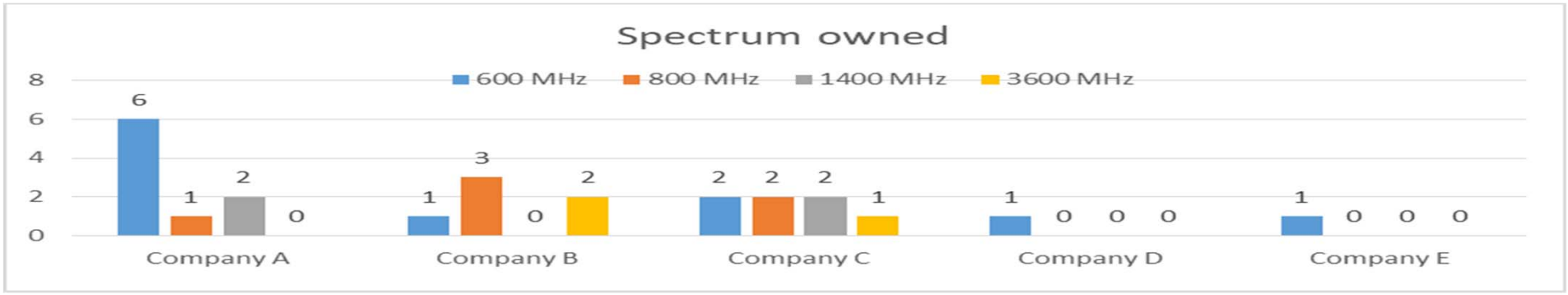


No. of iterations of SA & RO



No. of iterations of GA & RO

Result of Simulation



SA & RO

GA & RO

Summery

- Due to the random walk property of RO, the experiment converges quickly while assigning the segments to each operator. This conforms to the status of the operators' decision in the last moment that all decisions could be based on limited information and the speculation of competitors' reaction(inter-inhibition) and are required to be made on the instant.
- By means of optimization, the time for the decision of spectrum splitting and assignment is much shorter and the final benefit is more than expected.
- The result of RO & SA shows that the governmental authority earns more than expected and the number and price of segments each operator wins reflects the financial status and the market share. It means the governmental authority can earn in a rational manner and the operators can operate in a fair and safety way (QoS), i.e. less of risk.
- The result of RO & GA shows that the governmental authority can earn more than that of SA, but the result favors stronger one, operator A and C, and brings the risk to the smallest ones, viz. operator D and E, that wins only one segment of highest frequency with higher price. It means that the weaker fall in a risky situation in providing the mobile services and cannot guarantee their QoS, i.e. resulted from elitism of GA. And, when the mutation occurs, the system may be dominated by the giant, possibly operator C, and out of the control of the governmental authority and becomes strange attractor in terms of Chaos Theory.
- The theory and the systematic approach can serve as a well-formed referral guideline for planning and sharing of common wealth in the regions of different cultures.

Platform Economy

- In the Platform Economy, A **platform** is a **economic service model** that creates value by facilitating exchanges between two or more interdependent groups, usually users and providers.
- This term is used by analysts to describe the competitive nature of digital innovation.
- In order to make these exchanges happen, **platforms** harness and create large, scalable networks of users and resources that can be accessed on demand.
- **Platform economy** is the tendency for computing to increasingly move towards and favor digital **platform service models**. Platforms are underlying computer systems that can host services that allow users, entrepreneurs, institutions and the general public to connect, share resources or promote (in terms of HyPloy) their services. And, it results in so-called digital transformation.

Platform Economy

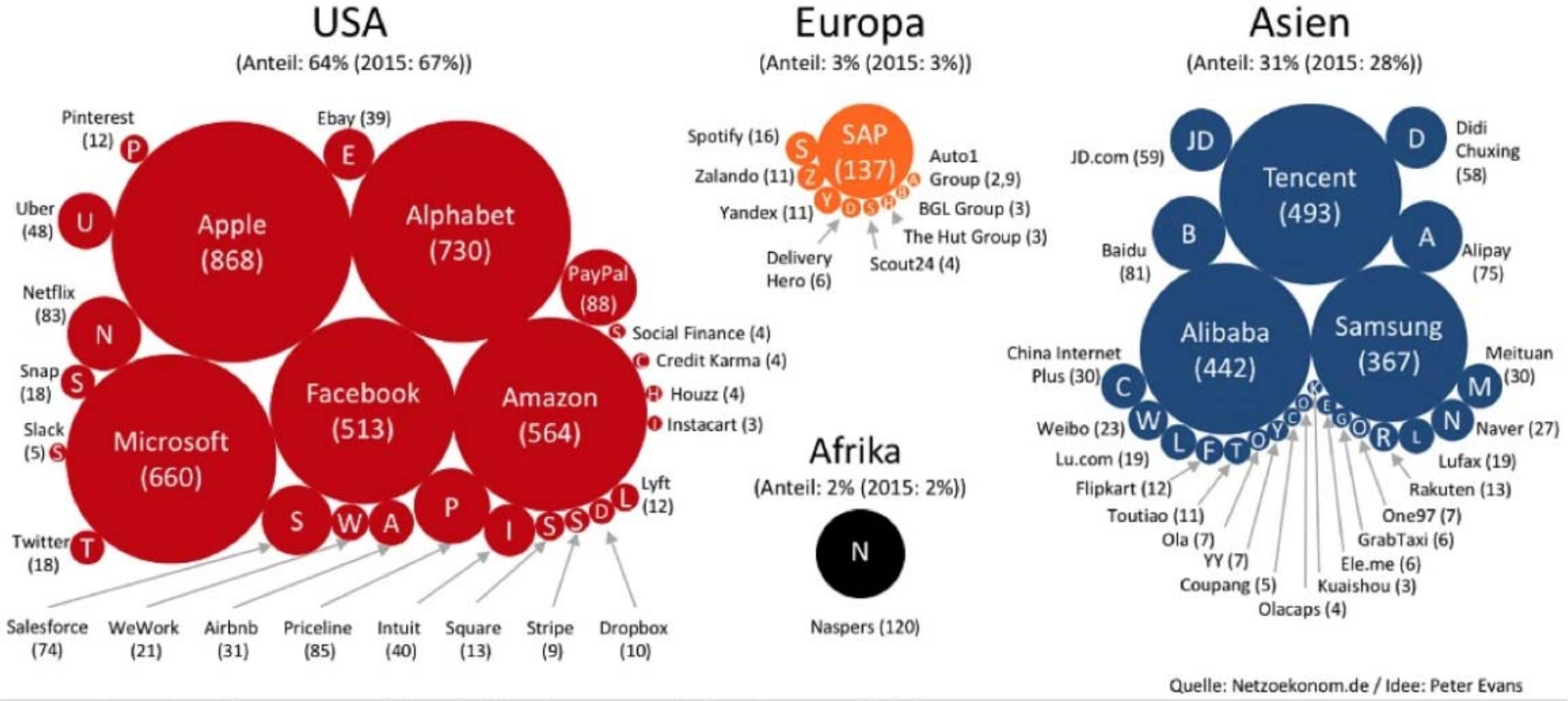
There are three major types of platforms within the platform economy:

- Transaction platforms - Also known as digital matchmakers, these are platforms that serve as a type of virtual working space or meeting place for various groups of people.
- Innovation platforms - These provide technology frameworks to users that can be adapted to individual use.
- Integration platform - This is a combination of the transaction and innovation platform, similar to online application Workspaces.

Sharing Economy- This is the idea that users would prefer to share resources/services rather than buy or own them, esp. Open Data, and services become common wealth. The platform economy facilitates this as an institution can develop a digital economic platform that users can log onto to gain access to resources/services through a subscription. The platform service providers earn profits from externality of economics.

The imbalance of platform economy

The 60 most valuable global platforms in billion USD on December 31, 2017



Quelle: Netzoekonom.de / Idee: Peter Evans

Source: Dr. Holger Schmidt (TU Darmstadt)

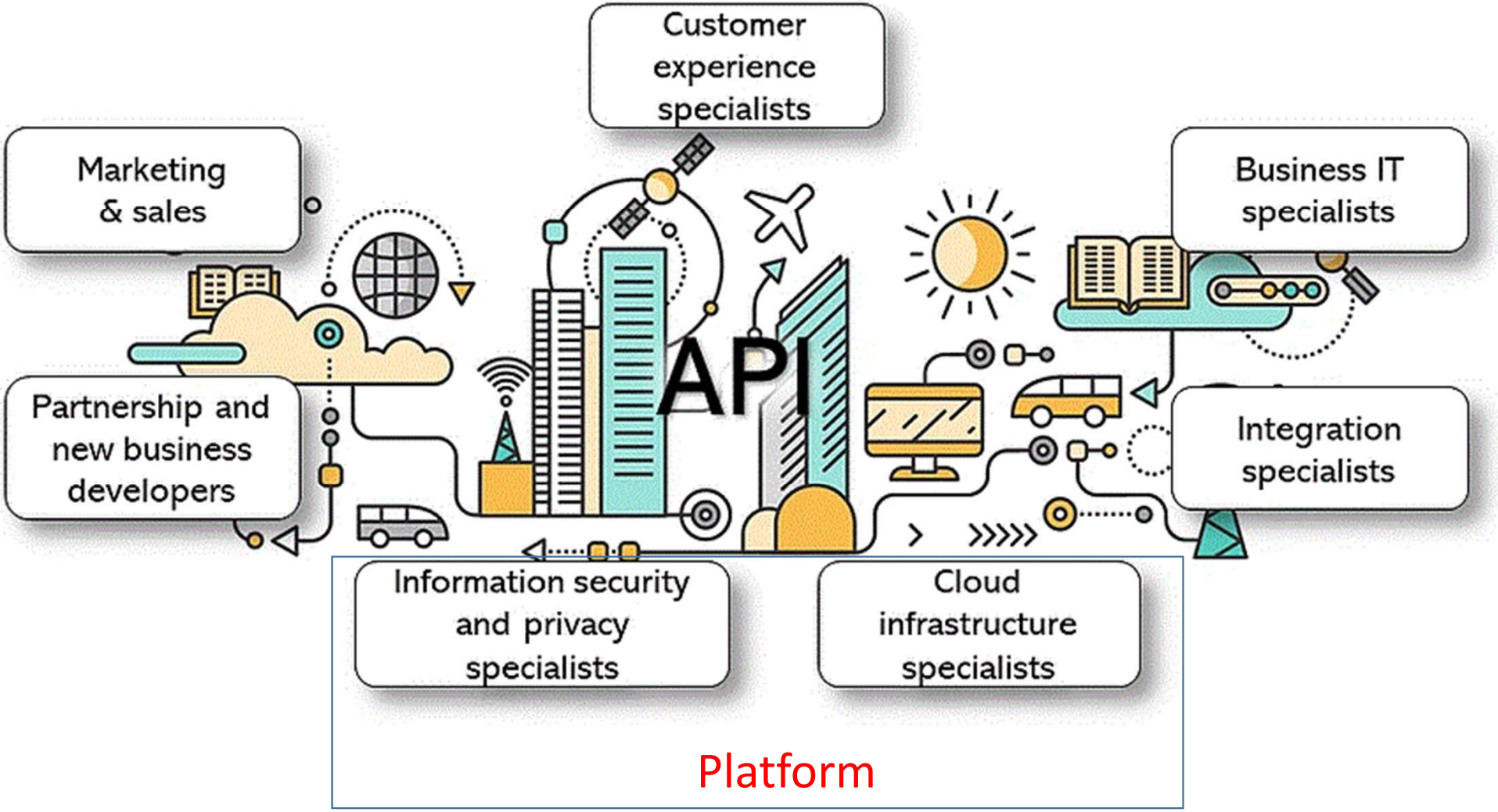
API Economy

- In API Economy, institution utilizes resources efficiently and quickly to create added value for own users. These resources can be for example data or function provided by other organizations.
- Building blocks utilized are own APIs and open APIs provided by other organizations (free or commercial) in addition to developer communities. These enable quicker adaptability to unpredictable and faster changing user needs.
- Defining characteristics of API Economy are competing for popularity among application developers and considering them as primary users. In brief, services are offered from organizations to developers.

API and Platform Economy

- APIs enable interaction with platform economy operators.
- One's service model may encounter a "forced opening" of APIs at any time – see it as an opportunity.
- If one's competitor offers (or is forced to provide) APIs, having the best developer experience is a significant competitive factor.
- The API economy is not just part of platform economy, but APIs can be used for increasing internal productivity or for offering different service models.

Synergy of API and Platform Economy



With reference to "API Economy", Moilanen, *et*

Factors influencing the organization of Organic Ecosystem

- Ideal state equally according to HyQVIS
- Shared Economy
- Feasible state stable core, e.g. the way as Simulated Annealing
- Dominant participants and Federation of Organic Systems and hidden conflicts of self-regulation and social welfare
- API security
- Collaboration and Competition in terms of according to HyQVIS
- The challenge of open API management is the Partner API in the intersection area.

Organization for API and Platform

- Initial state and ideal state
- Mode 1: Centralized regime, e.g. cloud without API
- Mode 2: Multiple Organs with unified rules for Open API
- Mode 3: Multiple Organs without unified rules, only Private API
- Mode 4: Partially centralized group, e.g. hybrid clouds
- Mode 5: Autonomous, i.e. independent agents, e.g. blockchain

Results of Analysis of Complexity

- Because the systems is in the planning phase, we only analyse the complexity, i.e. efficiency and security(risk), and costs.
- Fully centralized regime can accomplish the development and update of the system within polynomial time complexity.
- Partially centralized group with some unified arrangements is worse than Multiple Organs forming the ecosystem. With consideration of the communication costs in practice, fully centralized regime is even worse than fully autonomous agents.
- The costs for maintenance and jointing the ecosystem may becomes the extra social cost and inevitably the friction costs of consequent resource exchanges.
- By the fully centralized regime, only the authority can benefit from the system because the scope of the governance lies in the system and however the influence will be greater in corresponding to the expansion of networking. For the situations of deadlock of policy or difficulty of building the law or consensus, it is the possible way to enter open systems such as the condition in Africa.
- The result shows the federation of multiple organs with unified rules for Open APIs or middleware, e.g. Grids, is most efficient and effective as well as less of costs, more robust for security, less of risks.
- Federated computing becomes the next edge of the collaboration and ICT resource sharing in the API and Platform Economy.

Conclusion

- HyQVIS can be used for Planning and Sharing Common Wealth.
- The Theory of Knowledge Value Transformation emphases the optimization process that can be used to realize the coordination needed by HyQVIS .
- In case of mobile spectrum, the optimization can shorten the time for spectrum slitting as well as assignment and maximize the benefits as well as minimize the risk. The result of SA & RO shows that the governmental authority earns more than expected and the number and price of segments each operator wins reflects the financial status and the market share. The operators can operate in a fair and safety way. The result of GA & RO shows that the governmental authority can earn more than that of SA, but the result favors stronger one and brings the risk to the smallest ones. The result could be a referral guideline for planning and sharing of common wealth in the regions of different cultures.
- For API and Platform Economy, we have built five kinds of Ecosystems. The Analysis shows, the federation of organic groups, e.g. Grids with Open API or middleware, is most efficient as well as less of complexity and costs, more robust for security, less of risks.
- Federated computing becomes the next edge of the collaboration and ICT resource sharing in the API and Platform Economy.
- Blockchain is a kind of decentralized and fully distributed system where every node(VM) owns the blockchain on its local storage. On the contrary, Cloud is a kind of centralized system and save the data on the centralized storage on the network. It is difficult to joint Blockchain and Clouds. Using API aided Federated Computing to connect Blockchain and Cloud is the best way to solve the problem of distributed storages.

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