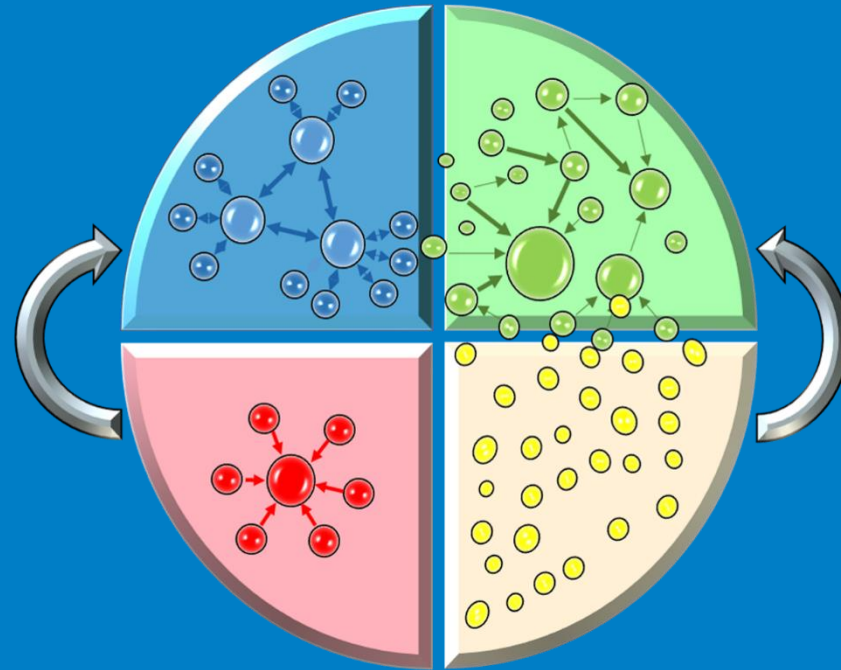# On Complex Value Systems in the Connected World

**Examining Structures and Dynamics of the ICT Driven Value Systems in Mobile Communication, Internet, and Transportation.**
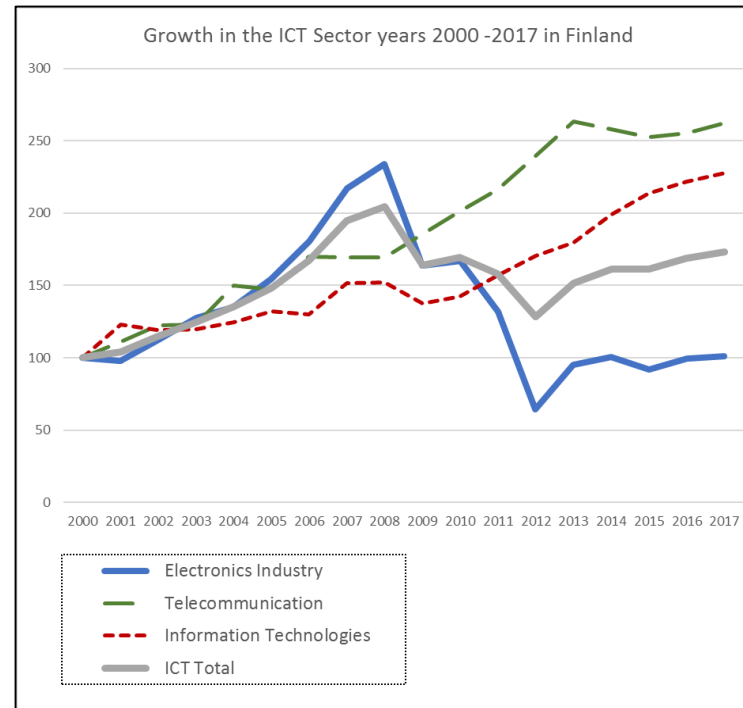


*Timo Ali-Vehmas, M. Sc.*

*April 5, 2019*

A'' Aalto University

# Great Success followed by Disruptive Destruction

Technology evolution maximized the business success within the maturing business model.
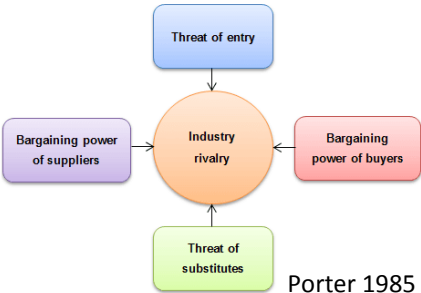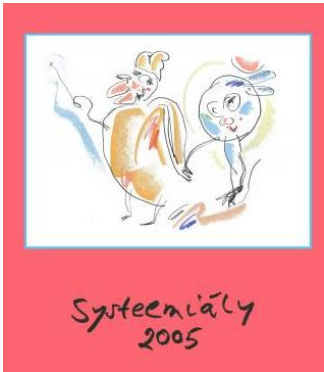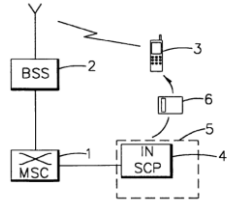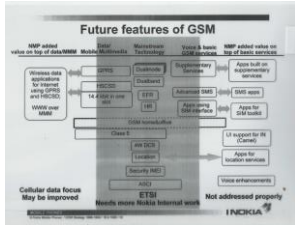
Weak signals*) visible many years in advance.

Technology evolution finally enabled disruptive business model to emerge.

Architectural innovation impossible to implement incrementally



Growth in the ICT Sector years 2000 -2017 in Finland

- Electronics Industry
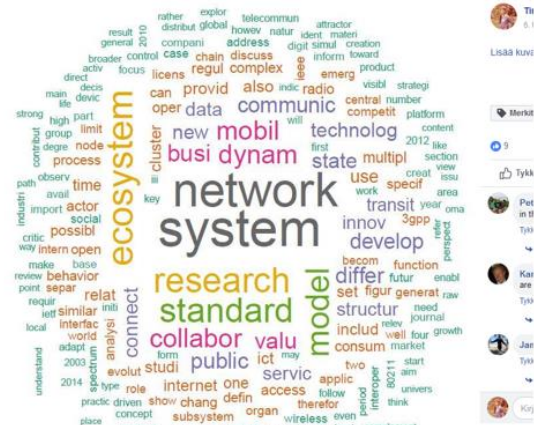- Telecommunication
- Information Technologies
- ICT Total

*) medium intensity, high deviation

# From System Design to Systems thinking, Systems intelligence and towards Network theories and Complex Value System Modelling



Porter 1985

"Bifurcation diagram"

- Stable orbits corresponding to a fixed $\lambda$

Emergent form, not visible in the function!

Barabasi 2002

On Complex Value Systems in the Connected World

Examining Structures and Dynamics of the ICT Driven Value Systems in Mobile Communication, Internet, and Transportation.

Timo A Ali-Vehmas

Evaluating

Modelling

| | THEORY | MODEL | REALITY |
|---|---|---|---|
| Complexity | Complexity | Complex Models | Complex Systems |
| Complex Value Systems | Complex Value Systems | Complex Value System Models | Complex Business Systems |
| Value Systems | Value Systems | Value System Models | Business Systems |

Modelling

Evaluating

Manson 2007

# How to examine Complex Value Systems?

**Set of Theories on**
- Complex Adaptive Systems
- Value chains and networks
- Business models and competition
- Diffusion of Innovations
- Regulation and Standardization
- Complex System and Modelling

**Separate Methods for Modelling and Evaluation**
- Qualitative Structural and behavioral analyses and value system modelling with complexity
- Complemented by Quantitative Dynamic simulations, Agent based modelling, Social network analysis

**Independent Data for Modelling and Evaluation**
- Technical, commercial/operational business data
- Interviews
- Standardization data
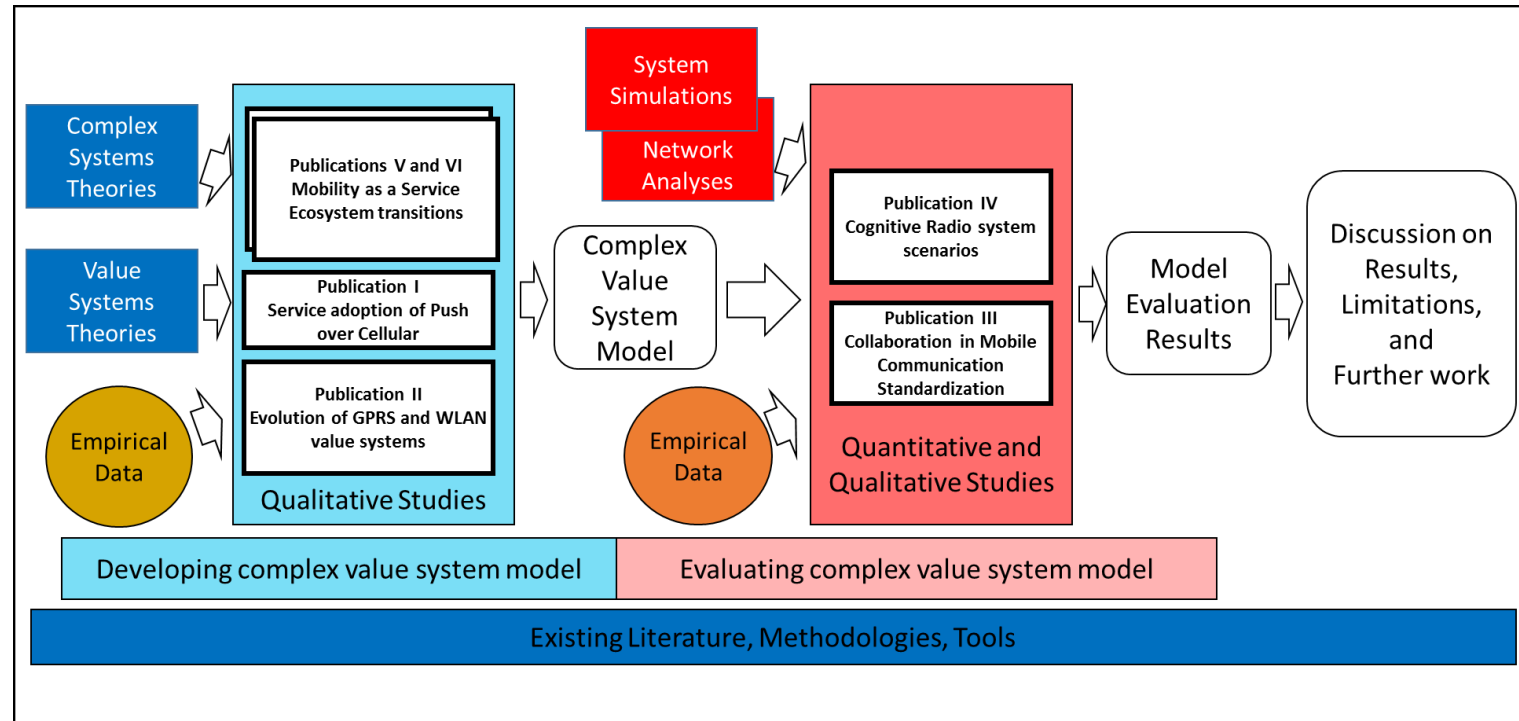


Research Question 1: How to develop a model to examine ICT-driven value systems and their evolution?

Research Question 2: Which criteria are suitable to evaluate the model?

# Diffusion analysis of a Service Enabler
# Case: Push to Talk over Cellular

## Examined Characteristics of the Service Enabler

- Technical and operative structures
- Challenges of hybrid value systems
- Issues of Service and Technology diffusion

## Observations

- Value for the customers is high
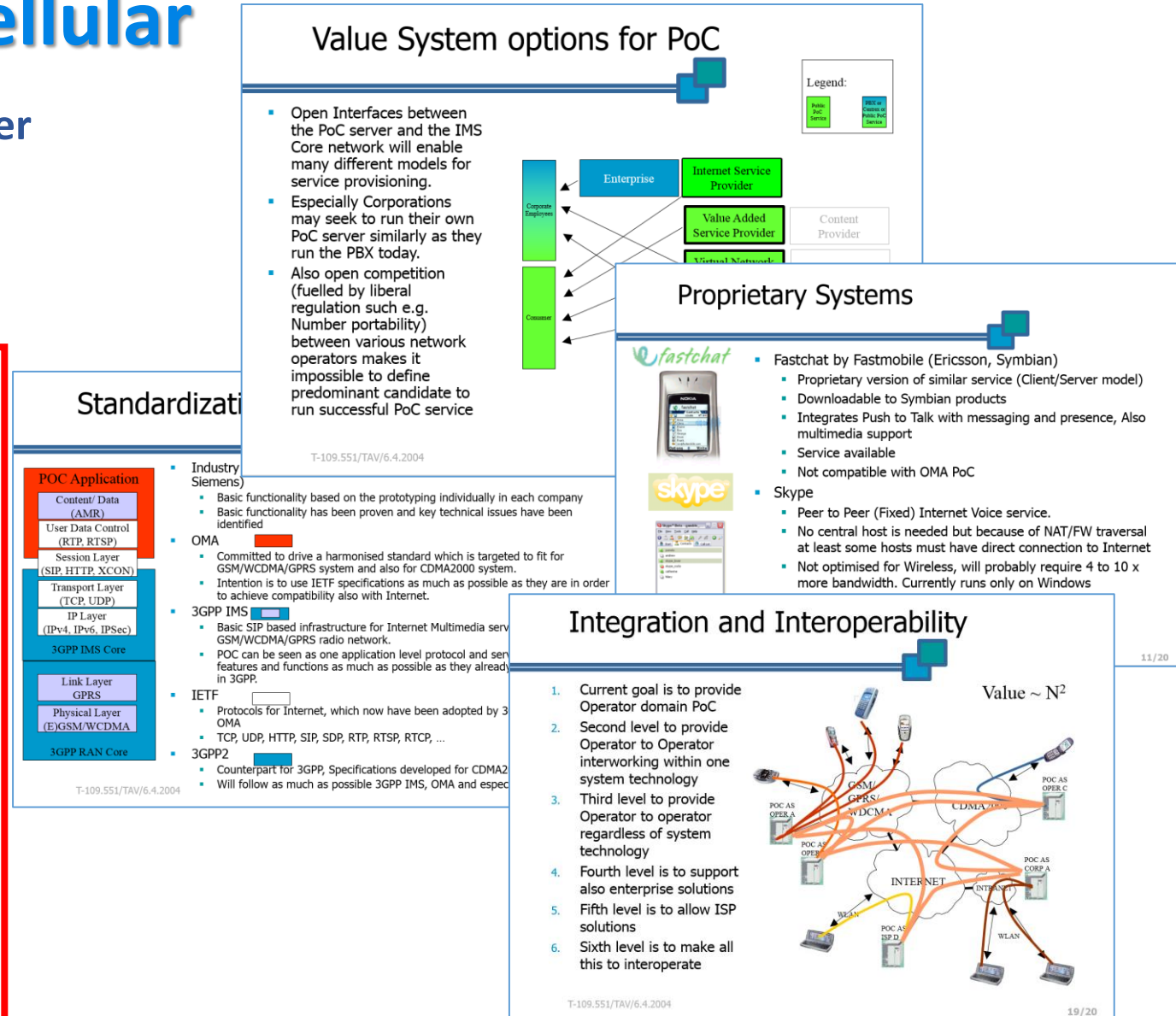- Multiple technologies and companies competing
- Active but ambiguous standardization effort
- Difficult to predict the success of the deployment

## Not seen what is missing

- Lack of common goal
- Lack of business protecting regulation
- Lack of systemic whole product



### Value System options for PoC

- Open Interfaces between the PoC server and the IMS Core network will enable many different models for service provisioning.
- Especially Corporations may seek to run their own PoC server similarly as they run the PBX today.
- Also open competition (fuelled by liberal regulation such e.g. Number portability) between various network operators makes it impossible to define predominant candidate to run successful PoC service

Legend, Enterprise, Internet Service Provider, Value Added Service Provider, Content Provider, Virtual Network, Corporate Employees, Consumer

T-109.551/TAV/6.4.2004

### Proprietary Systems

- Fastchat by Fastmobile (Ericsson, Symbian)
  - Proprietary version of similar service (Client/Server model)
  - Downloadable to Symbian products
  - Integrates Push to Talk with messaging and presence, Also multimedia support
  - Service available
  - Not compatible with OMA PoC
- Skype
  - Peer to Peer (Fixed) Internet Voice service.
  - No central host is needed but because of NAT/FW traversal at least some hosts must have direct connection to Internet
  - Not optimised for Wireless, will probably require 4 to 10 x more bandwidth. Currently runs only on Windows

11/20

### Standardization

POC Application
- Content/ Data (AMR)
- User Data Control (RTP, RTSP)
- Session Layer (SIP, HTTP, XCON)
- Transport Layer (TCP, UDP)
- IP Layer (IPv4, IPv6, IPSec)

3GPP IMS Core
- Link Layer GPRS
- Physical Layer (E)GSM/WCDMA

3GPP RAN Core

- Industry (Siemens)
  - Basic functionality based on the prototyping individually in each company
  - Basic functionality has been proven and key technical issues have been identified
- OMA
  - Committed to drive a harmonised standard which is targeted to fit for GSM/WCDMA/GPRS system and also for CDMA2000 system.
  - Intention is to use IETF specifications as much as possible as they are in order to achieve compatibility also with Internet.
- 3GPP IMS
  - Basic SIP based infrastructure for Internet Multimedia serv... GSM/WCDMA/GPRS radio network.
  - POC can be seen as one application level protocol and ser... features and functions as much as possible as they alread... in 3GPP.
- IETF
  - Protocols for Internet, which now have been adopted by 3... OMA
  - TCP, UDP, HTTP, SIP, SDP, RTP, RTSP, RTCP, ...
- 3GPP2
  - Counterpart for 3GPP, Specifications developed for CDMA2...
  - Will follow as much as possible 3GPP IMS, OMA and espec...

T-109.551/TAV/6.4.2004

### Integration and Interoperability

1. Current goal is to provide Operator domain PoC
2. Second level to provide Operator to Operator interworking within one system technology
3. Third level to provide Operator to operator regardless of system technology
4. Fourth level is to support also enterprise solutions
5. Fifth level is to allow ISP solutions
6. Sixth level is to make all this to interoperate

Value ~ N²

T-109.551/TAV/6.4.2004

19/20

# High level Structural Framework identified

**ICT Value System** creates value to the stakeholders

**Interdependences** and **common goals** define the system and its fundamental domains and boundaries
- Type and Number of the links
- Systemic clock cycle
- Man made rules and regulations

**Earlier literature provides Architecture**
- Four clusters
    - Content (Cloud, Big data)
    - Network
    - Consumer products
    - Consumer identity with Data
- Six Interfaces
    - Four interfaces well defined
    - Two interfaces are open for vertical bundling

**... and yields the generic Technical and Operative Structure for the Complex Value System Analysis**
- Each cluster and symbionic interface considered
- State of alignment between the clusters



Fransman 2010
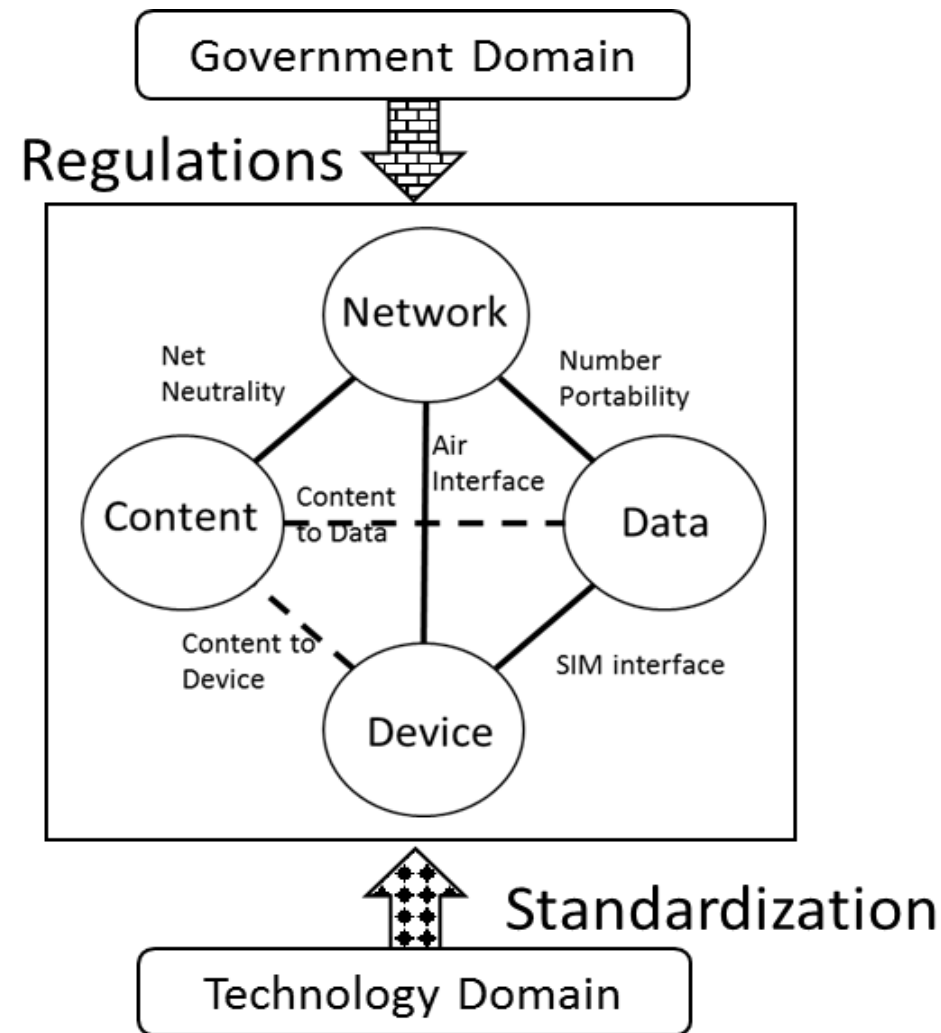
# Emergence of Complex Value Systems thinking Case: Wireless Access

Complex systems Dynamics applied to Value Systems
- Boundary conditions and Attractors

Analysis of Wireless Communications Access Networks:
GSM/GPRS and WLAN
- Business systems and business models
- Technical, Commercial/Operative Structures
- Observed dynamics and behaviors

Two successful Value Systems: Licensed and Unlicensed
- Regulation driven transitions towards Open Value Systems
- Standardization based interoperability
- Strong global customer/market pull

Anomaly ?:
- Two similar technologies used parallel in integrated products - without any interoperating services
  - Several "joint" projects, such as IMS, WLAN Interworking
  - Several "technology" fights, such as LTE><WiMax
  - Service tunneling and technology re-use applied successfully
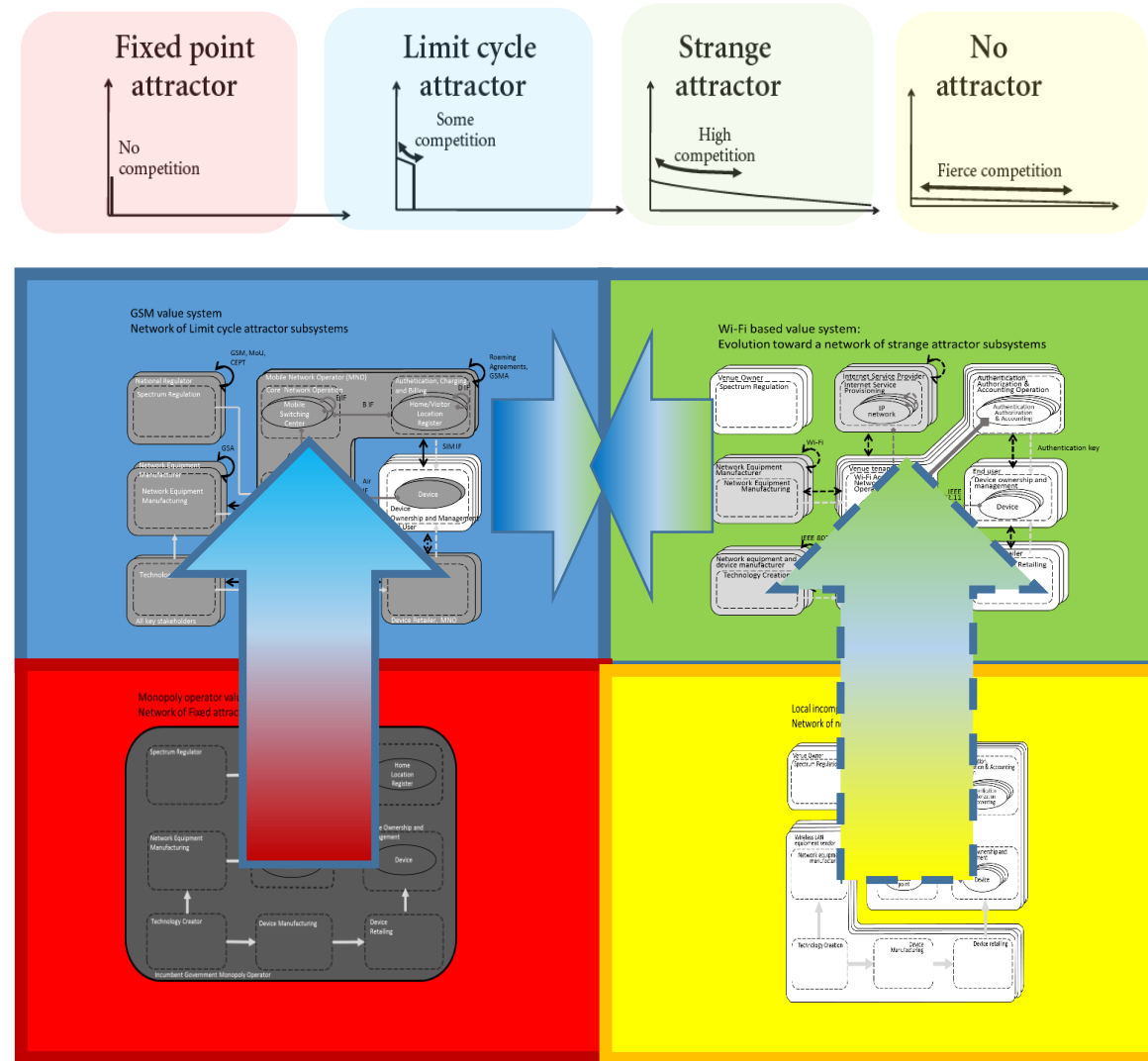
# Exploring other Value Systems
# Case: Mobility as a Service

**Motivation**

- Enthusiastic ambitions in Finland to renew all the transportation business.
- For better consumer services
- For sustainable ecosystems

**Applying the ICT modelling to Mobility as a Service**

**Discoveries and Observations**

- Fragmented and Monopoly value systems only
- Opportunity to much higher value creation is real
- Lack of systemic thinking impose significant risks
- Lack to regulative or other drivers for system transition
- Lack of forums for interoperability to emerge

**Policy Recommendations**

- All options have different sets of pro's and con's
- Utilize each systemic option as needed
- Modelling is a useful lens to foresee potential opportunities and problems



**Open**

**Possible state**

**Smart Mobility services with Licensed model**
- **Services:** Basic mobility services with end-user choice provided by private actors and regulated by the public sector
- **Vehicles:** Interoperable vehicle (e.g. bus) fleets providing basic services regulated by public sector
- **Infrastructure:** Privately operated infrastructure licensed by the public sector for a given period of time

**Smart Mobility services with License-exempt model**
- **Services:** A loosely coupled network of heterogeneous actors, services and technologies
- **Vehicles:** Shared vehicles (car sharing, ride sharing)
- **Infrastructure:** Shared infrastructure (e.g. parking spaces)

**Possible state**

**Centralized**

**Decentralized**

**Smart Mobility services with Monopoly model**
- **Services:** Public sector central role in providing services
- **Vehicles:** Vehicle (e.g. bus) fleets controlled by Public actors
- **Infrastructure:** Government and municipality controlled infrastructure

**Smart Mobility services with fragmented model**
- **Services:** Isolated services and devices (vehicle manufacturers, aftermarket devices, fleet management systems)
- **Vehicles:** Vehicles controlled by isolated household and enterprises
- **Infrastructure:** Isolated private infrastructure (e.g. parking spaces)

**Current state**

ITS and Smart Mobility services currently locked into closed vertically integrated centralized and decentralized solutions

**Closed**

**Current state**

# Towards a Model = Four Value System states + Sixteen possible transitions

## System state analysis reveals

- Boundary Conditions
- Structure
- Dynamics and Behaviors
- Understanding of the systemic state, able to identify one of the four options

## Analysis of system state transitions reveals

- 16 possible transitions =>
- 7 analyzed transitions in this research
- 5 observed transitions beyond the publications
- 1 possible transition impossible to observe

New system states

Old system states — Real World examples discussed in Publications [and other examples in parenthesis]

| | New System state is Fixed | New System state is Limit cycle | New System state is Strange | New System State without attractor |
|---|---|---|---|---|
| Old System state is Fixed — Analysis in Publications I and II and V/VI | IDEN network replaced by CDMA 1x as a consequence of Sprint overtaking NEXTEL | 1G cellular systems replaced by 2G GSM system in Europe; *Possible Licensed MaaS in Finland* | Arpanet transition to University domain Internet | Regulation model change from monopoly to laizzes faire (e.g. Broadcast radio liberalization in Finland) |
| Old System state is Limit cycle — Publication II | Full consolidation of actors (e.g. 2G to 3G transition in China using TD SCMA) | 2G system evolution (GSM) to 3G (UMTS) | Regulation change from licensed to license-exempted (e.g. Data roaming enabling OTT Internet value system in EU) | Regulation model change from licensed to laissez faire (no good example) |
| Old System state is Strange — Publications V/VI, Publication II | *Possible Global platform leader gaining "Winner take all" in MaaS* | Multiple platforms build federated interoperability (e.g. Facebook identity used in social networks) | Open Internet and Web and wireless access collaboration | Loss of common interest (e.g. Forking in open source sofware) |
| Old System state without attractor — Analysis in Publication II and V/VI | External intervention (no good example ) | External intervention (no good example) | WLAN networking based on IEEE 802.11; *Possible License-excepted MaaS in Finland* | State transition from a random state to another random state is a meaningless case |

# Research Result 1: The Process revels the Qualitative Model

**Process:**

- Traditional "V" shape System design approach applied to Value Systems

**Applications to business problems:**

- Alignment of subsystems removes service diffusion obstacles
- Forecasting possible System transitions
- Avoiding Hybris of Hybrids
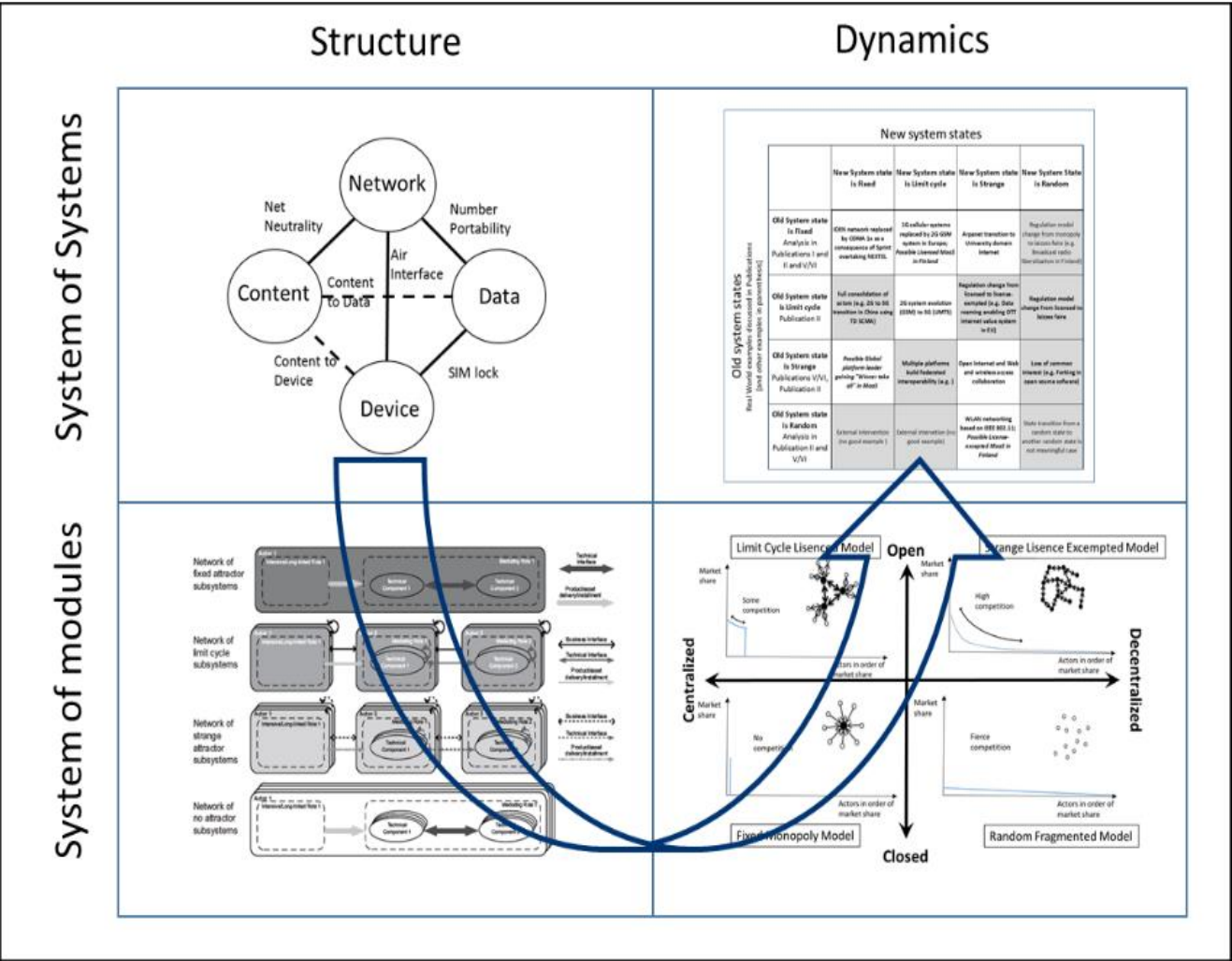


The Qualitative Model

# Responding Research Question 1: Assessing the Propositions

To address the research question Research Question 1, the following detailed propositions are derived:

P1: Boundaries influence the resulting system state of the ICT-driven value system.

P2: Structures and dynamics characterize the state of the ICT-driven value system.

P3: State transitions restructure the ICT-driven value system and drive new dynamics.

Assessing the Propositions through the qualitative analysis

Table 13. Propositions in the light of qualitative studies

| PROPOSITIONS/ CASE STUDIES | P1 | P2 | P3 |
|---|---|---|---|
| Wireless access | +++ | +++ | +++ |
| Push over Cellular | ++ | ++ | ++ |
| Mobility as a Service | ++ | + | +- |

Immature and limited case
Evaluation is not realistic

# What kind of Criteria can be used to evaluate the model ?

The model builds on the qualitative analysis of the internal structures and dynamics in the Value Systems

Therefore, Independent evaluation focuses on Quantitative analysis of the Value System boundary conditions.

- Regulation of the most scarce resource
- Standardization of the system interfaces

**Evaluation criteria**

- Model Calibration
- Usefulness of the Model
- Independence
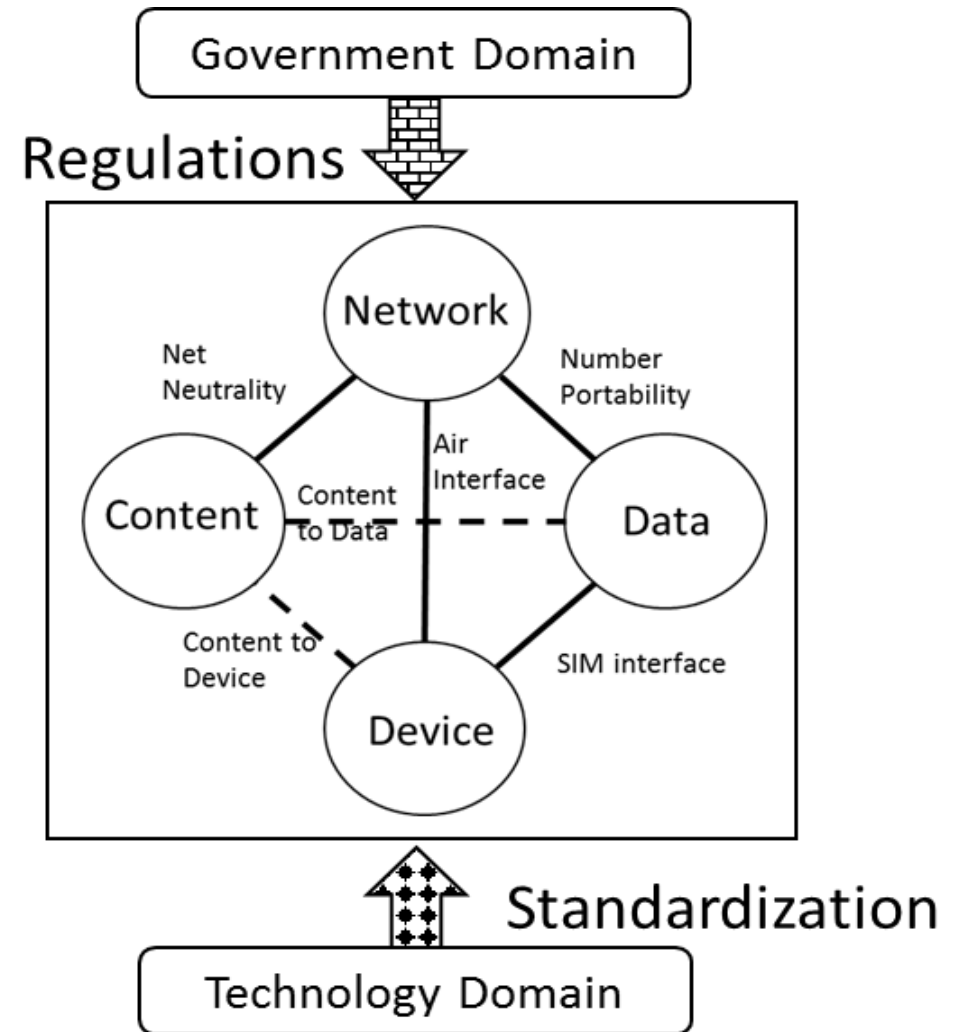
# Impact of the availability of the radio spectrum
## Case:  Lisenced and Lisence-exempted value systems

Motivation: Using Cognitive Radio technologies in Mobile Communications and in Internet Radio access for 5G

Model calibrated for two business relevant real world use cases
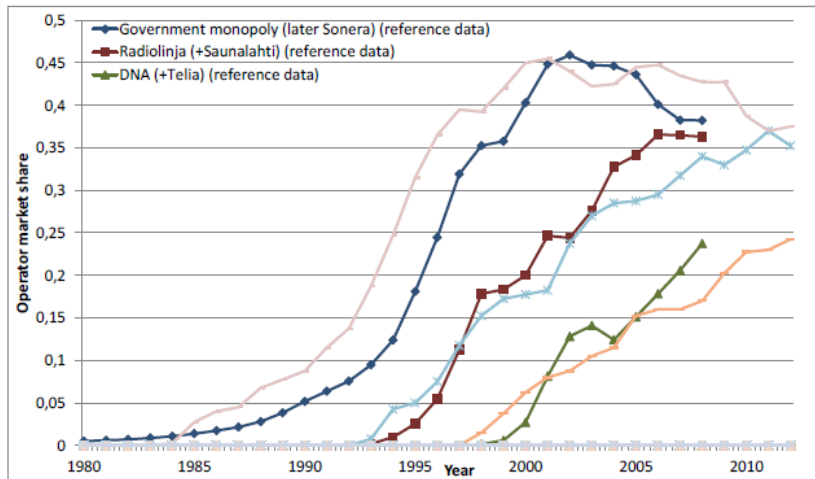


Scenario analyses yield all four possible system states as a function of available scarce resources independently of the initial states
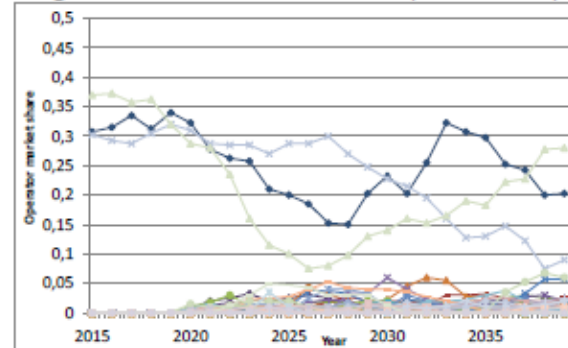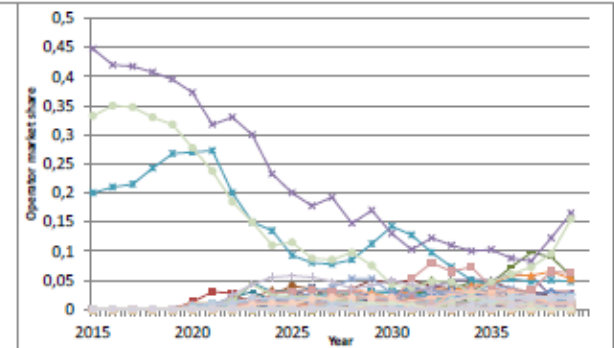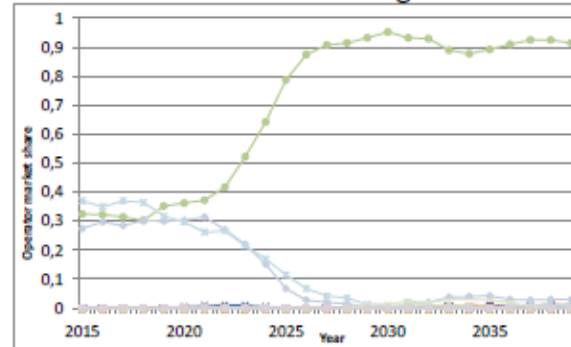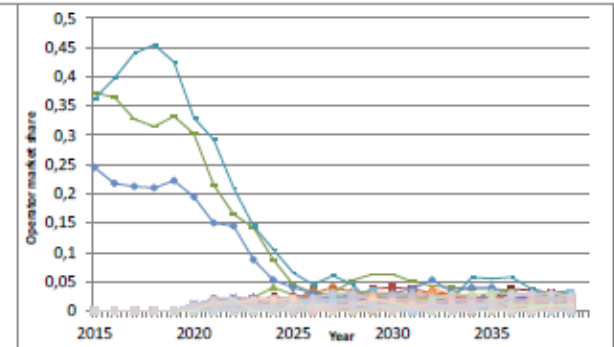


Limitations:   Agent based dynamic simulations can not be used for accurate predictions.
Only two initial states studied

# Collaboration for Interoperability in Standardization
# Case: Mobile Internet, Convergence of Value systems

**Historical high level business goal:**

- Fully Interoperable Standards for multimode consumer devices and telecommunication networks

**Business challenges:**

- Value creation, capture and sharing using technologies to exploit limited resources
- Evolution of Value systems
- Convergence of competing Value systems

**Standardization Challenges:**

- Provide required standards for liberalized used of scarce resources, level the business competition and provide value through interoperability
- Deep collaboration requires deep alignment within the SSOs.
- Each relevant SSO has its own history and own business context

**After 40 years of intensive work:**

- Highly Successful Mobile Communication and Internet businesses
- Development and Re-use of Technologies is not an issue.
- Re-use of Value system behaviors is an issue

Analyses positions the standardization activities according to the system dynamic states the value systems
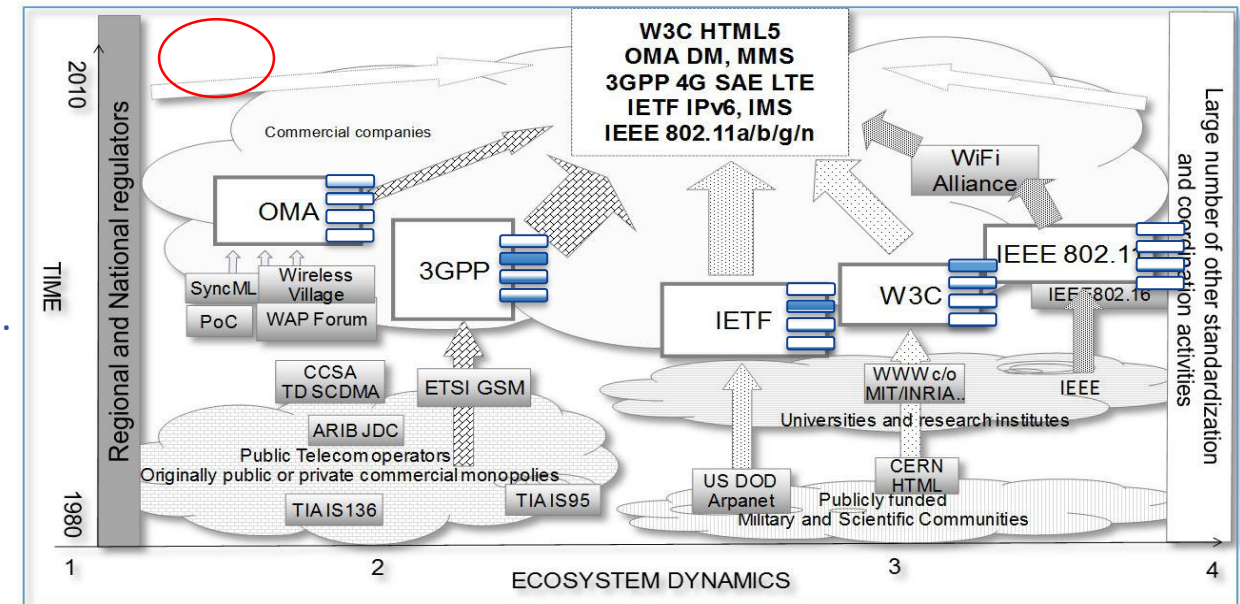


Value system dynamics

# Social Network Analysis makes intuition visible

Full IETF network
2879 Contributors
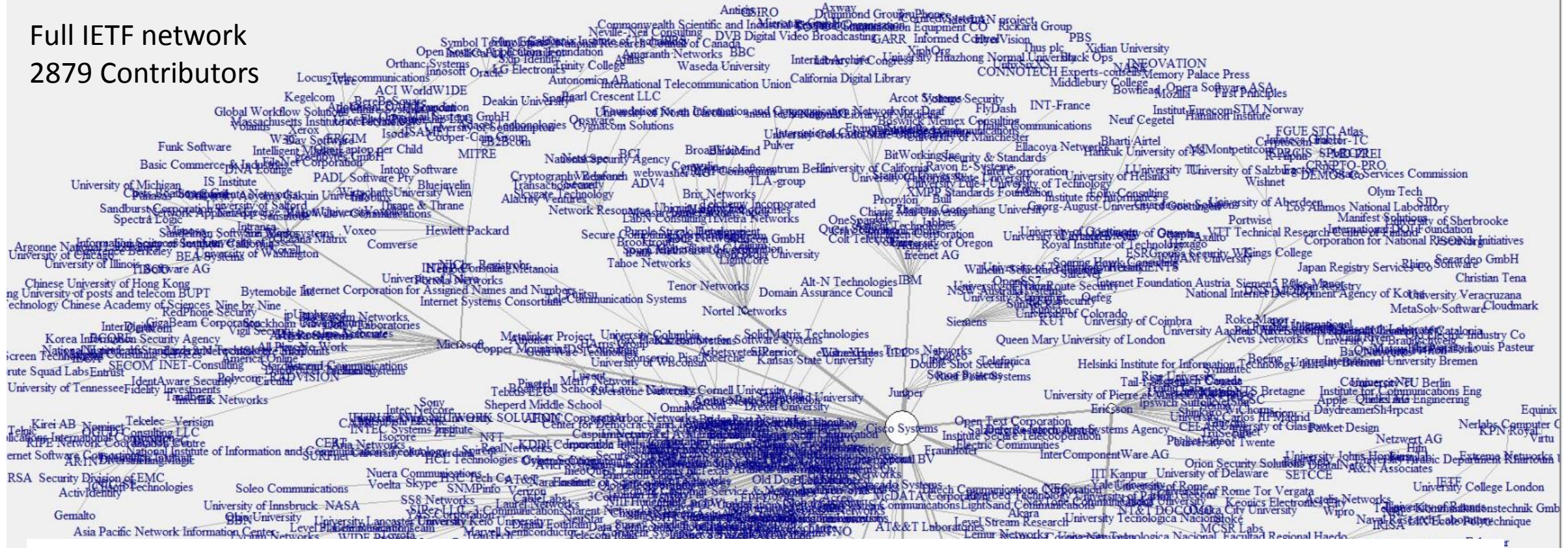


## ... but visialization is not enough. Better tools are mandatory

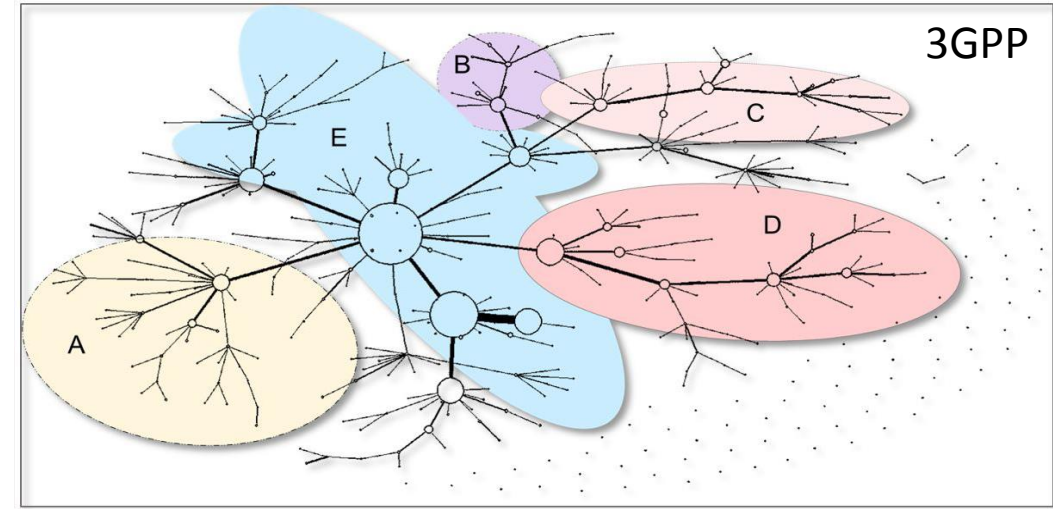# Social Network Analysis makes intuition visible - Calibration

**Network Structures**

- Active and less active companies
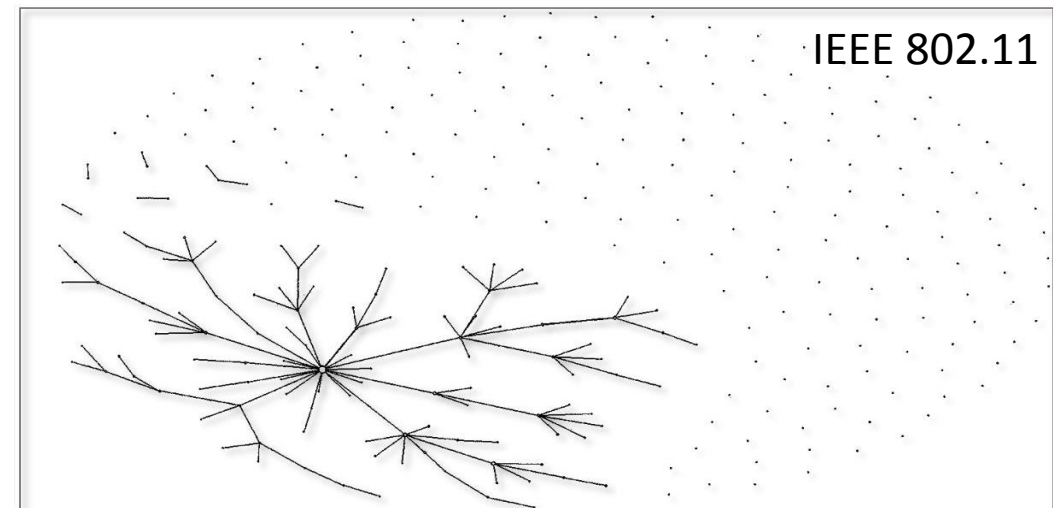- Collaborative and Competing companies
- Clicks and Groups

In full alignment with Interviews and experiences
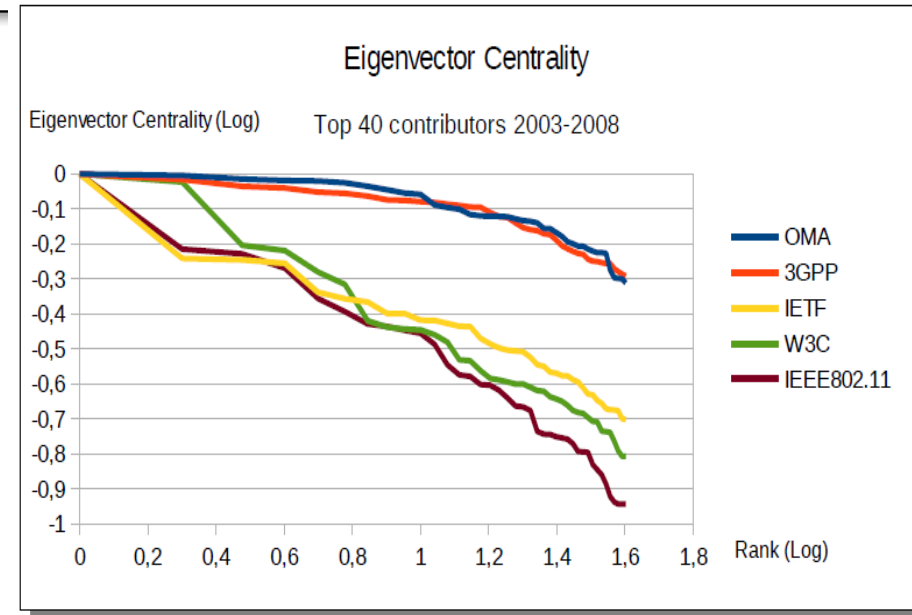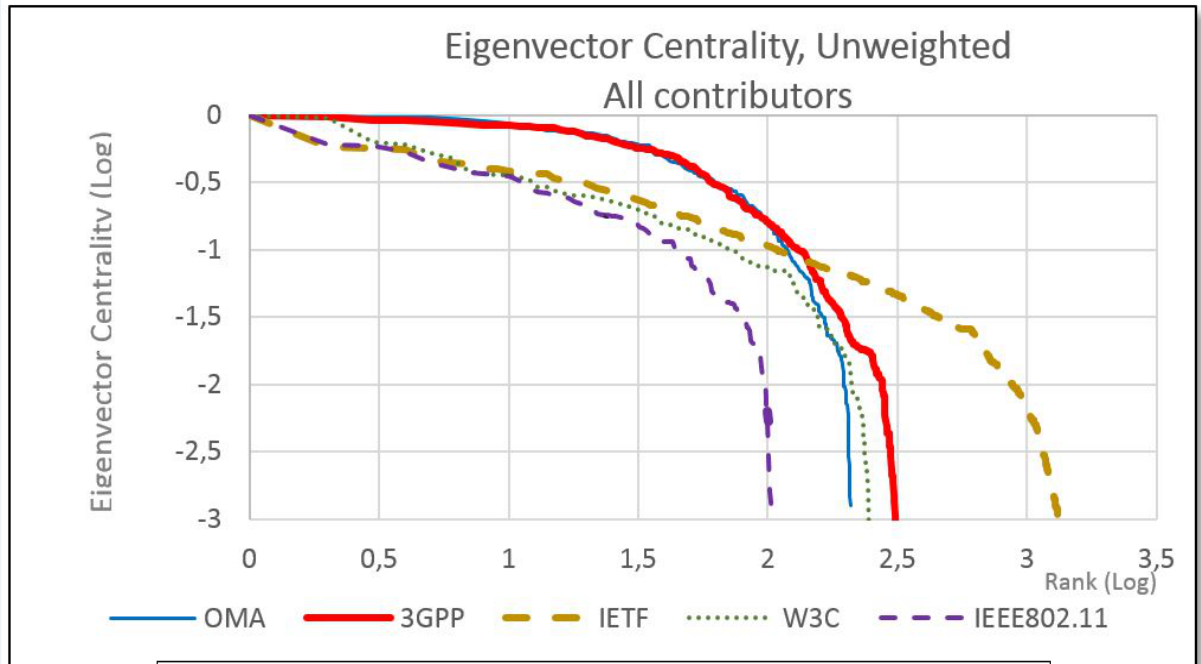- Strong evidence of the validity of the data for model calibration

Maximum Spanning tree



3GPP

Maximum Spanning tree



IEEE 802.11

# Social Network Analysis makes intuition visible - Evaluation

**Network Dynamics: Eigenvector Centrality**
- Observed behaviors fall into two main groups
  - Mobile Communications (3GPP, OMA)
  - Internet (IETF, W3C, IEEE802.11)

- The two groups show different type of collaboration logic
  - Extensive collaboration and decision making
  - Strong leader driven collaboration

- Standardization collaboration aligns with the system dynamics indicated through the value system modelling
  - Regulated through scarce resource and globally agreed interoperability (3GPP)
  - Voluntary collaboration with only few externally set requirements (IETF, W3C, IEEE802.11)

- Anomaly observed
  - Without external requirements or resource limitations, extensive collaboration model implemented (OMA)
  - Close collaboration with the 3GPP "synchronizes" the behaviors
  - Root cause of systemic failure of OMA based services



Eigenvector Centrality, Unweighted
All contributors



Eigenvector Centrality
Top 40 contributors 2003-2008

# Social Network Analysis makes intuition visible - Bonus

**Network Dynamics: Assortativity**
- Standardization is an industrial process
  - Active contributors each collaborate with their best less active friends (Assortativity is negative)
  - Long term sustainable stability needed in global standardization (standard development rather than standard definition)

- Exceptions
  - IETF used to be a forum of academics which was opened for global companies to participate
  - IEEE802.11 is a small single interface project that re-organize itself for each standard release.
  - W3C recovered gradually from Browser wars of the early days.
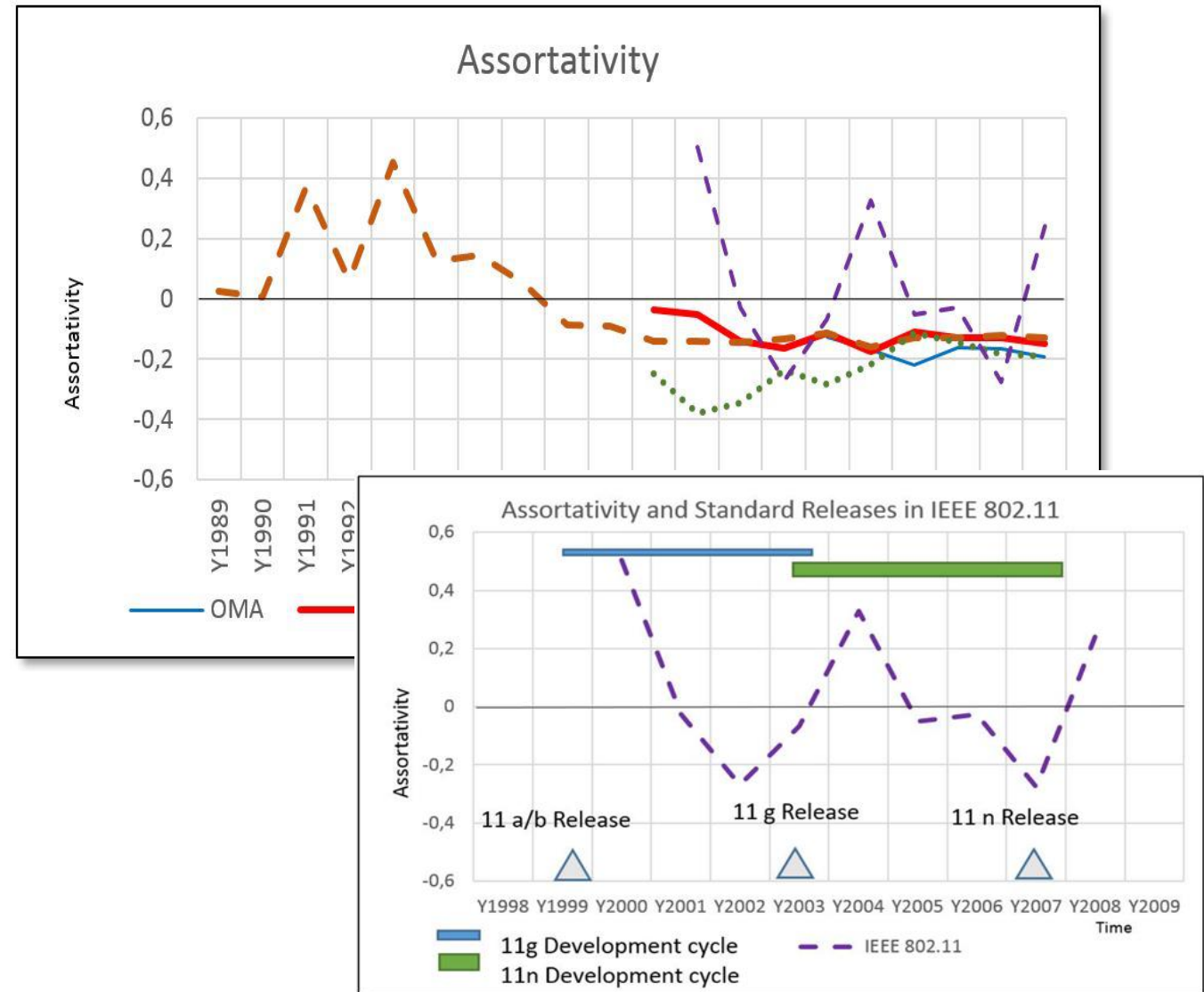
# Addressing Research Question 2:
# Quantitative and qualitative Analyses to evaluate the model

**Calibrating the model**

EC11: Level of openness of the standardization

EC12: Level of centralized coordination in decision making in standardization

EC13: Alignment of simulated and empirical market dynamics

**Usefulness of the model**

EC21: Visibility of the complex value system states in the actions of the stakeholders

EC22: Measurability of the complex value system states transitions

EC23: Measurability of the internal alignments in complex value systems

EC24: Consistency of the quantitative studies

**Independence of the analyses**

EC31: Independence of modelling and evaluation

*Table 20. Qualitative summary of the evaluation studies*

| EVALUATION CRITERIA/ RESULTS | EC11 | EC12 | EC13 | EC21 | EC22 | EC23 | EC24 | EC31 |
|---|---|---|---|---|---|---|---|---|
| Requirements fulfilled | ++ | +++ | +++ | +++ | ++ | ++ | +++ | +++ |
| Applicability in system states | 1,2,3,4 | 1,2,3,4 | 1,2,3,4 | 2,3 (1,4) | 1,2,3,4 | 2,3 | 2,3 (1,4) | 1,2,3,4 |

# Conclusions: Responding the Research Questions

**Research Question 1**
- Modelling is possible, a Model is defined and it provides significant new insights

**Research Question 2**
- Criteria defined for a Limited Evaluation of the Model. Evaluation provides quantitative evidence and insights to complement the qualitative results of the Complex Value System modelling.

**Detailed results that make the research rewarding**
- Scientific results related to theories and methodologies
- Business guidance and policy making
- Awareness of Limitations
- Applicability of the results for Further research

# Future Outlook: Toward ICT Driven Data Economy
# From Data to Information … To Knowledge and Wisdom

## Contributions of telecommunications…

Has improved the life of billions

Has enabled global networking and collaboration of people

Has implemented multiple options for people to communicate

Provides Interoperable platform for new services to emerge

**Provides a prudent and consistent system model to explore sustainable options for ICT driven value systems**
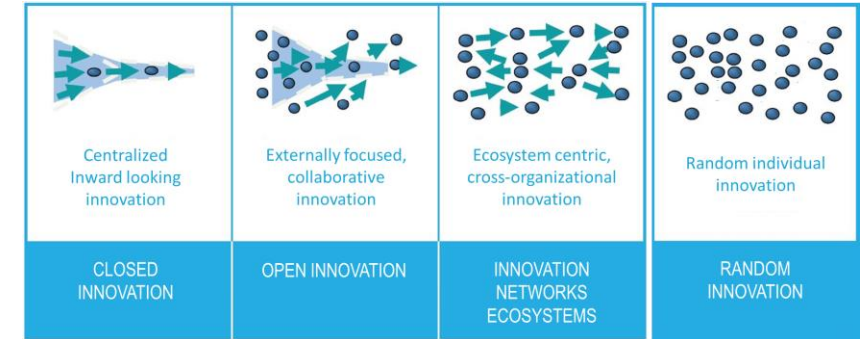


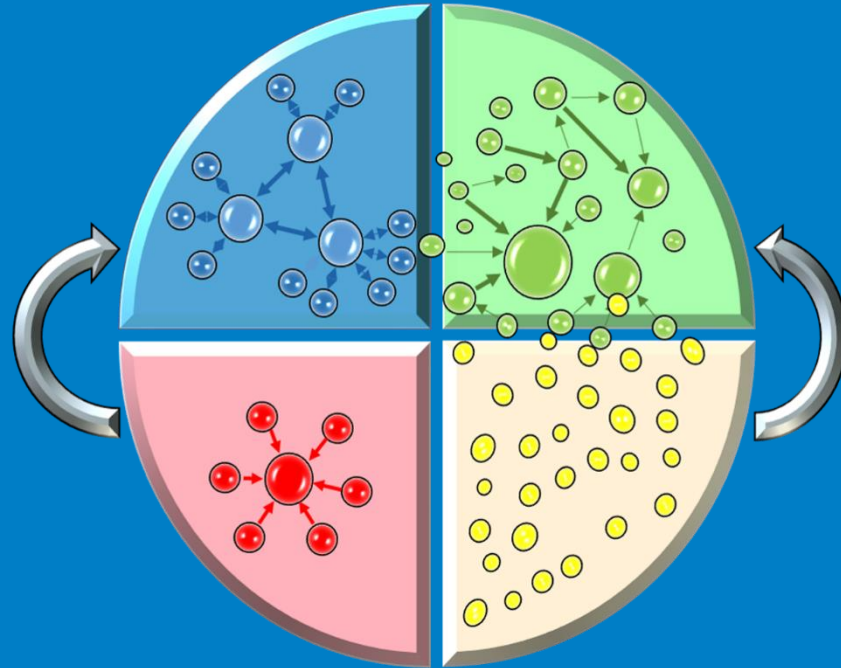## … to be reused for Public and Private Partnership for Data Age

❖ Liberalization of Radio Spectrum and Data in sustainable ways for new products and services through Innovations

❖ Equal, predictable, and transparent business environment

❖ Compatibility and Interoperability according to Value system borders

## Consumers, End-users, Citizens… All of us

❖ Consumer choice. Always !

# On Complex Value Systems in the Connected World



# Thank you