International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.3013

(08/2014)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Future networks

Socio-economic assessment of future networks by tussle analysis

Recommendation ITU-T Y.3013

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	**Y.3000–Y.3499**
CLOUD COMPUTING	Y.3500–Y.3999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.3013

Socio-economic assessment of future networks by tussle analysis

Summary

The need for a socio-economic assessment of future networks (FNs) is documented in the "Social and economic awareness" objective and in the "Economic incentives" design goal of Recommendation ITU-T Y.3001.

Recommendation ITU-T Y.3013 introduces tussle analysis as a meta-method for such a socio-economic assessment of FN technology. Different methods are proposed to implement the three steps that comprise tussle analysis. The benefits of integrating tussle analysis into the standardization phase of FN technology are highlighted.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.3013	2014-08-29	13	11.1002/1000/12283

Keywords

Economic incentives, social and economic awareness, socio-economic assessment, tussle analysis.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Page

Recommendation ITU-T Y.3013

Socio-economic assessment of future networks by tussle analysis

1 Scope

This Recommendation describes tussle analysis and recommends it to complement FN design and standardization using socio-economic assessment. The scope of this Recommendation covers the following aspects:

– The importance of social and economic awareness of FNs, as identified by [ITU-T Y.3001];
– FN design for tussle principles, which ensure social and economic awareness;
– Tussle analysis as a meta-method to assess a FN technology's compliance with these principles;
– Recommended methods to implement the three steps of the tussle analysis meta-method;
– Benefits of the integration of tussle analysis into FN standardization.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3001] Recommendation ITU-T Y.3001 (2011), *Future networks: Objectives and design goals.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 future network (FN) [ITU-T Y.3001]: A network able to provide services, capabilities, and facilities difficult to provide using existing network technologies. A future network is either:

a) A new component network or an enhanced version of an existing one, or
b) A heterogeneous collection of new component networks or of new and existing component networks that is operated as a single network.

NOTE (added by this Recommendation) – The plural form "future networks" (FNs) is used to show that there may be more than one network that fits the definition of a future network.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 spillover: A special case of a tussle evolution, which is characterized by triggering a tussle in a functionality space that the original tussle was not about.

3.2.2 tussle: The entire set of stakeholders with conflicting interests over the usage and deployment of a technology and the resulting attempts to enforce these interests through technological, economic, or judicial means.

3.2.3 tussle evolution: An iterative interaction of stakeholders through technological, economic, or judicial means, to influence the outcome of the respective tussle.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ASP	Application Service Provider
DPI	Deep Packet Inspection
FN	Future Network
ICT	Information and Communication Technology
IP	Internet Protocol
ISP	Internet Service Provider
MACTOR	Matrix of Alliances and Conflicts: Tactics, Objectives and Recommendations
SWOT	Strengths, Weaknesses, Opportunities, Threats
TCP	Transmission Control Protocol
VoIP	Voice over IP

5 Conventions

None.

6 Introduction

Social and economic awareness is one out of four objectives for future networks (FNs) outlined in [ITU-T Y.3001]. This objective is motivated by the desire to reduce entry barriers for the various actors involved in the network ecosystem, and can be achieved by reducing life cycle costs and thereby allowing appropriate competition and an appropriate return for all actors.

Traditional engineering goals are focused on technical properties, such as effectiveness, efficiency and modularity. Contrary to other technologies, FNs are a means for socio-economic interactions between a wide group of participants with possibly conflicting interests. Therefore, designing FNs according to purely technically-driven engineering goals can lead to technologies that do not match the market and policy makers' needs, or that fail to satisfy other socio-economic demands, thus negatively affecting the technologies' adoption and long-term success.

Therefore, [ITU-T Y.3001] identifies the design goal of economic incentives for FNs. This design goal postulates that FNs are to be designed to provide a sustainable competition environment for solving tussles among the range of participants in the information and communication technology (ICT)/telecommunication ecosystem.

In the light of the objective of social and economic awareness and the related design goal of economic incentives, as determined in [ITU-T Y.3001], this Recommendation recommends that technically-driven FN design and standardization is to be complemented by a socio-economic assessment of FN technology. To this end, tussle analysis is proposed as a meta-method (see Note) to assess if a technology for FNs is designed in a socio-economic aware and incentive-compatible manner. In addition useful methods to implement the three steps of tussle analysis are recommended.

NOTE – A meta-method describes steps that need to be implemented by specific methods.

7 Design for tussle

Ideally, the introduction of a new FN technology should lead to a satisfying outcome for all involved stakeholders and it should not lead to spillovers to other functionalities. In cases where unsatisfied stakeholders or spillovers have to be expected, the technology designer should examine whether implementation changes could avoid these undesirable outcomes.

Internet technologies should be designed to allow for variations rather than imposing a particular outcome [b-Clark05]. Accordingly, the stated "Design for tussle" goal is based on the perception that the Internet is a rather unpredictable system and it is very difficult to assess whether a particular outcome will remain desirable in the future.

The tussle analysis methodology helps in designing FN technology that is designed for tussle. A technology such as an Internet communication protocol is designed for tussle if it complies with the "Design for choice" and the "Modularize the design along the tussle boundaries" principles, whereby the technology should:

– lead to a stable outcome by allowing all involved stakeholders to express their interests and affect the outcome ("Design for choice" principle);
– avoid spillovers to other functionalities ("Modularize the design along the tussle boundaries" principle).

The "Design for choice" principle provides guidance in designing technology that allows for variation in outcome. Useful properties of this principle include:

– "Exposure of list of choices" suggesting that the stakeholders involved must be given the opportunity to express multiple alternative choices and which the other party should also consider;
– "Exchange of valuation" suggesting that the stakeholders involved should communicate their preferences in regard to the available set of choices (for instance by ranking them in descending order);
– "Exposure of choice's impact" suggesting that the stakeholders involved should appreciate what the effects of their choices are on others;
– "Visibility of choices made" suggesting that both the agent and the principal of an action must allow the inference of which of the available choices that has been selected.

The "Modularize the design along tussle boundaries" principle helps in identifying whether tussle spillovers can appear. A technology designer can check for the following two conditions:

– "Stakeholder separation", or whether the choices of one stakeholder group have significant side effects on stakeholders of another functionality (another tussle space), for example, create economic externalities between stakeholders of different tussle spaces;
– "Functional separation", or whether different stakeholders use some functionality of the given technology in an unforeseen way to achieve a different goal in some other tussle space, i.e., the functionality of technology A interferes with (and possibly cancels) the functionality of technology B.

8 Tussle analysis

FN technology should undergo a systematic socio-economic assessment during technology design and technology standardization phases in order to anticipate the extent to which the FN technology is designed for tussle. Tussle analysis [b-TussleAnalysis] determines the recommended meta-method for conducting such a socio-economic assessment.

When applying tussle analysis to FN technology, the following steps, for which concrete methods are given in clauses 8.1 to 8.3, have to be performed:

Step 1. Identify all primary stakeholders and their characteristics for the functionality under investigation (see clause 8.1).

Step 2. Identify tussles among identified stakeholders (see clause 8.2).

Step 3. For each tussle (see clause 8.3):

– Assess the impact to each stakeholder (short-term, mid-term or long-term depending on the context);

– Identify potential ways for stakeholders to circumvent negative impacts (or gain unwarranted advantages) and the resulting tussle evolution (the term tussle evolution is related to other notions described in Appendix I);

– For each such manipulation technique, apply tussle analysis again.

Figure 1 provides a graphical representation of the steps to be performed in tussle analysis. Each step is shown as a horizontal rectangle with arrows denoting transitions. All steps need to be applied in the context of one or more functionalities (rounded vertical rectangles).

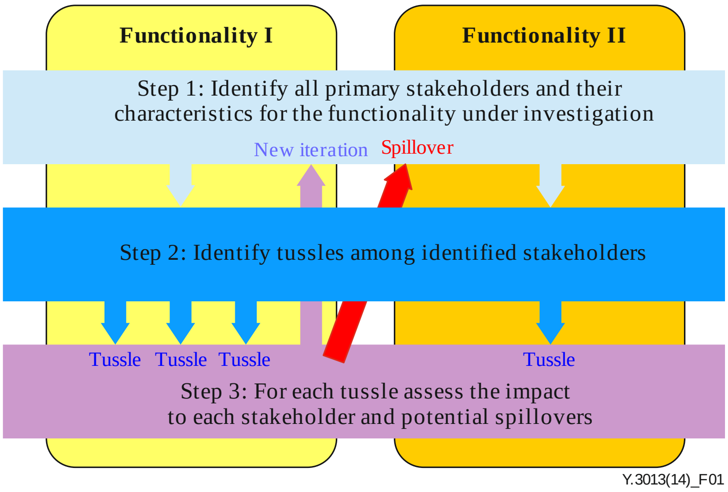

Figure 1 – High-level view of tussle analysis methodology

In the ideal scenario the tussle outcome is an equilibrium point where the following two conditions hold:

Condition 1 All stakeholders in this functionality derive a payoff that is considered fair, therefore they will not take means to change the outcome and thus the tussle will not evolve further, and;

Condition 2 No stakeholder in another functionality, who was receiving a fair payoff before, gets an unfair payoff after this tussle equilibrium has been reached, i.e., the tussle does not spillover.

If both conditions hold then the analysis of this particular tussle is completed and the focus should be shifted to the remaining tussles identified in Step 2. In the case where Condition 1 is not met, a new iteration of the methodology must be performed by making assumptions on the most probable policies adopted by unhappy stakeholders, i.e., the future evolution of the tussle must be investigated. Similarly, a new iteration must be performed for each spillover to other functionalities when Condition 2 is not met.

Ideally, a new technology should lead to a stable outcome without spillovers to other functionalities. In the case where no such stable outcome can be expected, the technology designer should examine whether a change in the implementation details would lead to a better outcome.

8.1 Stakeholder identification methods

In order to implement Step 1 of tussle analysis, a method should be chosen that achieves a high level of completeness and relevance with respect to stakeholder identification.

The identification of as complete a set of stakeholders as possible is crucial, since all further steps in tussle analysis depend on the range of identified stakeholders. If a stakeholder is missing, potential tussles involving that stakeholder cannot be captured in the analysis (Step 2), rendering the analysis as a whole incomplete and/or leading to incorrect analysis results (e.g., a stable outcome might be anticipated in Step 3).

The following types of methods (see Appendix II for a methods overview) are recommended for identifying a set of stakeholders that satisfies the goals of completeness and relevance:

– Personal observation

– Interviews

– Role-playing simulations (partly recommended)

Any person familiar with the characteristics of the technology to be analysed is able to determine an *a priori* complete set of stakeholders according to personal observation. Personal observation covers not only own experience and knowledge, but also literature study. Personal observation and interview methods are especially beneficial when applied in combination. While personal observation is recommended to determine an a priori candidate stakeholder list, which in turn may support the basis for identifying suited interview partners, interviews are recommended in order to validate a stakeholder's involvement (relevance) and to identify other relevant stakeholders that were not covered in the a priori stakeholder list (completeness). Role-playing simulation methods (e.g., Delphi method, focus groups) show benefits over the additional effort as long as participants are representatively selected.

Appendix III provides a collection of stakeholders specific to Internet technology, which should be used to verify and extend the list that was compiled with those methodologies listed above.

8.2 Tussle identification methods

In order to implement Step 2 of tussle analysis, a method should be chosen that achieves a high level of completeness and relevance with respect to stakeholder incentives, conflicts and available choices (see "Design for choice" principle in clause 7).

Identifying an as complete set of tussles as possible is an important goal to ensure an all embracing tussle analysis. Since the relevance of tussles to a considered functionality varies, tussles have to be ranked accordingly during Step 2 so that Step 3 can be performed only for tussles which are classified as relevant. Therefore, it is crucial to completely characterize stakeholders by their incentives and the range of choices they have available. This is not always easy to obtain since this information might be considered as business confidential, or there might be a hidden agenda.

The following types of methods (see Appendix II for a methods overview) are recommended for identifying a set of tussles that satisfies the goals of completeness and relevance:

– Role-playing simulation

– Personal observation

– Risk management

– MACTOR method

– SWOT analysis (partly recommended)

– Interviews (partly recommended)

Assuming that participants were selected carefully, role-playing simulations (e.g., Delphi method, focus groups) constitute the most highly recommended methods, because they endorse a group-based approach rather than an individual approach. Bringing several motivated and knowledgeable experts into a group with each expert adopting a dedicated stakeholder role considerably increases the likelihood of relevant tussles being identified (see [b-TussleCookbook] for information on how to guide these role-playing simulations). This is supported mainly by the confrontational, debate-oriented and direct (but moderated) interaction among participants in for example a focus group. If effects of group dynamics should be avoided, the Delphi method may be prioritized over the discussion-oriented focus group method.

Individual approaches, such as personal observation, risk management and the MACTOR method determine recommended methods as well, especially when personal observation is combined with risk management or with the MACTOR method. Even though not based on the thoughts, ideas and opinions of several experts, risk management's focus on identifying candidate factors with a negative and quantitatively or qualitatively evaluated effect on a system is highly beneficial in identifying tussles. Equally, the MACTOR method is suited for the identification of tussles due to its focus on giving an overview of possible alliances and conflicts in a business ecosystem.

SWOT analysis might be selected as an alternative instrument to the MACTOR method and interviews might determine a valid instrument to complement personal observation (validation of identified tussles in interviews with stakeholders).

8.3 Tussle impact and tussle evolution methods

In order to implement Step 3 of tussle analysis, a method should be chosen that achieves a high level of plausibility.

Since tussle analysis is about anticipating a candidate technology's impact in consideration of tussles emerging among stakeholders, Step 3 has to ensure that such anticipation is based on reasonable and traceable grounds. Therefore, the more formal a method is (reproducible results), the more risk-oriented it is (dealing with aspects uncertainty and probability) and the more dynamics-oriented it is (complex system modelling covering feedback cycles), the better it is suited.

The following types of methods (see Appendix II for a methods overview) are recommended for assessing tussle impact and tussle evolution, satisfying the goal of plausibility:

– Game theory
– Risk management
– System dynamics
– Role-playing simulations
– Interviews (partly recommended)
– MACTOR method (partly recommended)
– SWOT analysis (partly recommended)

Game theory is the recommended method when a single tussle round with well-known incentive structures can be modelled and played out in a formal and quantified manner. Risk management leads to comparable result quality as it allows for a qualitative and quantitative evaluation of previously identified factors and the resulting effects, considering risk dimensions and probability. Game theory and risk management are both less suited for assessing evolution over time, even though it is technically possible to model multi-round games. If evolution, dynamics and causal loops are prioritized, system dynamics is the recommended method. System dynamics is the method best suited to cope with simulations of various outcomes when multiple stakeholders interact over a longer modelling horizon. Due to the focus on actions and counter-actions in an interactive, complex modelled system, system dynamics is the primary recommended method for Step 3 in tussle analysis. However the trade-off is the significant effort expended in modelling.

If a not fully formal, not quantified method is acceptable, role-playing simulations, in particular focus groups, are recommended. Focus groups profit from their unique ability to understand the dynamics of the major tussles by observing stakeholder behaviour.

Interviews, the MACTOR method and SWOT analysis may determine valid complementary instruments for validation purposes of results originating from the use of the other recommended methods.

9 Tussle analysis in FN technology standardization

The integration of a socio-economic assessment by means of tussle analysis into the standardization process of FN technology will improve the quality of according standards by increasing their level of social and economic awareness in terms of, e.g., incentive compatibility, adoption potential, marketability and compliance with regulatory requirements. In particular, a tussle analysis during the standardization phase identifies if a standard needs improvement to avoid unstable outcomes or spillovers upon release. Such improvement is achieved by further research on the technology or by design and implementation changes. If improvement is not possible by such means, the prior knowledge of instabilities, allows for timely information for administrations about the need for regulations to stabilize such unstable outcomes. Therefore, a tussle analysis during the standardization phase allows publishing of standards without destabilising effects or, at least mitigation of destabilizing effects by timely regulative provisions.

In addition, the publication of the results of the performed tussle analysis increases the standard's value to and acceptance by different stakeholders. If the results indicate a high-adoption potential and a highly stable outcome, this provides for a strong support and investment signal for manufactures and operators, which will also increase the overall adoption of the standard. Furthermore, promising research fields will be revealed to academia, e.g., investigating disruptive technologies, which also generates feedback to be integrated into subsequent standards. For administrations a tussle analysis provides reference points to identify needs for regulations and develop these more efficiently.

Therefore, a tussle analysis performed during the standardization phase allows the standard to be improved not only by accounting for socio-economic considerations but also by recording and publishing these considerations in a formal and comprehensive manner, thereby making published Recommendations more appealing. Thus, it is advantageous to integrate tussle analysis into the standardization process of FN technology and to publish this socio-economic assessment alongside the respective standards.

Appendix I

Tussle notions

(This appendix does not form an integral part of this Recommendation.)

The long-term goals of each stakeholder with respect to a specific Internet functionality define the stakeholder's strategy that is, finally, implemented by policies. These policies take into account the technological, economic and judicial restrictions and other stakeholders' socio-economic aspects. However, a tussle involves not only the interests of stakeholders, but also how these conflicting interests are expressed through the available technological, economic, or judicial means, e.g., which technology is chosen for a specific functionality and how the technology's resources and parameters are configured. Since this expression may change in reaction to other stakeholders' moves, a tussle will usually lead to an iterative process of stakeholder interactions, which is termed tussle evolution. By this process the tussle may evolve into new tussles or trigger tussles for different functionalities, where the latter effect is termed spillover.

A tussle outcome is characterized by the benefit or satisfaction that each involved stakeholder gets at a distinct point of the tussle evolution. The level of benefit can vary substantially among stakeholders. If the outcome is not considered fair by all stakeholders, these will try to change the outcome, which results in a tussle evolution. In particular, if the tussle outcome is considered "unfair" by a subset of stakeholders, it can evolve into a new tussle based on:

– Socio-economic decisions alone, e.g., stop using that functionality, stop doing business
– Out-of-band actions, e.g., asking a regulator to intervene, making coalitions for taking coordinated technology decisions, or
– New socio-techno-economic decisions following the basic socio-economic technology cycle, e.g., introduce a radically different technology or use a technology option in an unforeseen way

All these reactions characterize an unstable tussle outcome. It is likely that unstable outcomes will lead to tussle evolution and possibly destabilize other functionality spaces as well (spillover). However, a stable tussle outcome can also create spillovers in the case where some users of the established functionality find some new, not previously anticipated, uses of it, which interfere with other functions of the ecosystem. These are cases of negative externalities (i.e., adverse effects) between different functionality spaces. Positive externalities may also appear, for example more resources become available to functionality due to the introduction of a more efficient technology to another related functionality.

I.1 General example

Figure I.1 illustrates how tussles can evolve inside a single functionality space or affect another functionality. Assuming a discrete-time model and that initially only functionality B is observed to be in a stable state. At a given time T1, both tussles A1 and C1 (for functionalities A and C respectively) reach equilibrium, but tussle A1 has a spillover effect and triggers a new tussle B1 in functionality B. At a later given time T2, both tussles A2 and B1 have reached equilibrium. Even though functionality A has now reached a new and stable outcome, it has a spillover to functionality C and makes the previously stable outcome of C1 unstable. Thus, the tussles of functionalities B and C evolve further in time (not shown).

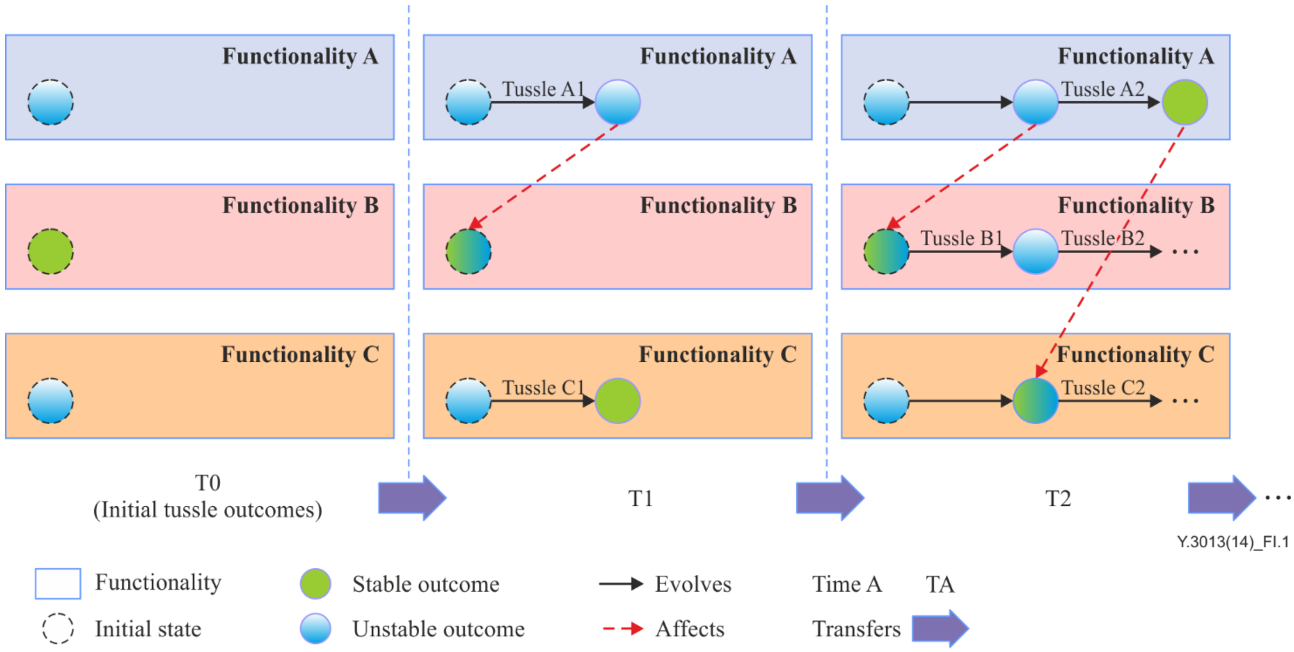

Figure I.1 – Tussle evolution due to instability and externalities

I.2 Specific example

A detailed example of the tussle evolution related to sharing bandwidth on a common link with the transmission control protocol (TCP) is given in this clause and illustrated by Figure I.2, which shows the tussle evolution that occurs due to instability and externalities. Stakeholders appear on the left of each rectangle, while the positioning of an outcome denotes whether it is considered fair or not.

When TCP was proposed in the early 1980s, it was assumed that hosts would initiate a single connection for each session. The algorithm suggested for controlling how instantaneous bandwidth is being shared can be considered fair in the sense that if *k* connections are instantaneously active in a bottleneck link, then each of them would take 1/*k* of the bandwidth.

But due to the introduction of peer-to-peer applications for file sharing, this outcome can no longer be considered stable. Users of such applications can open multiple TCP connections for the same file and get disproportionate bandwidth share in relation to traditional users (called interactive).

This new outcome cannot be considered stable either, since the ability of an Internet service provider (ISP) to offer other services was threatened by the great increase in peer-to-peer traffic. ISPs responded by introducing middle boxes for inspecting data packets. These dedicated machines use advanced technology, such as deep packet inspection (DPI) techniques, in order to identify and throttle peer-to-peer traffic.

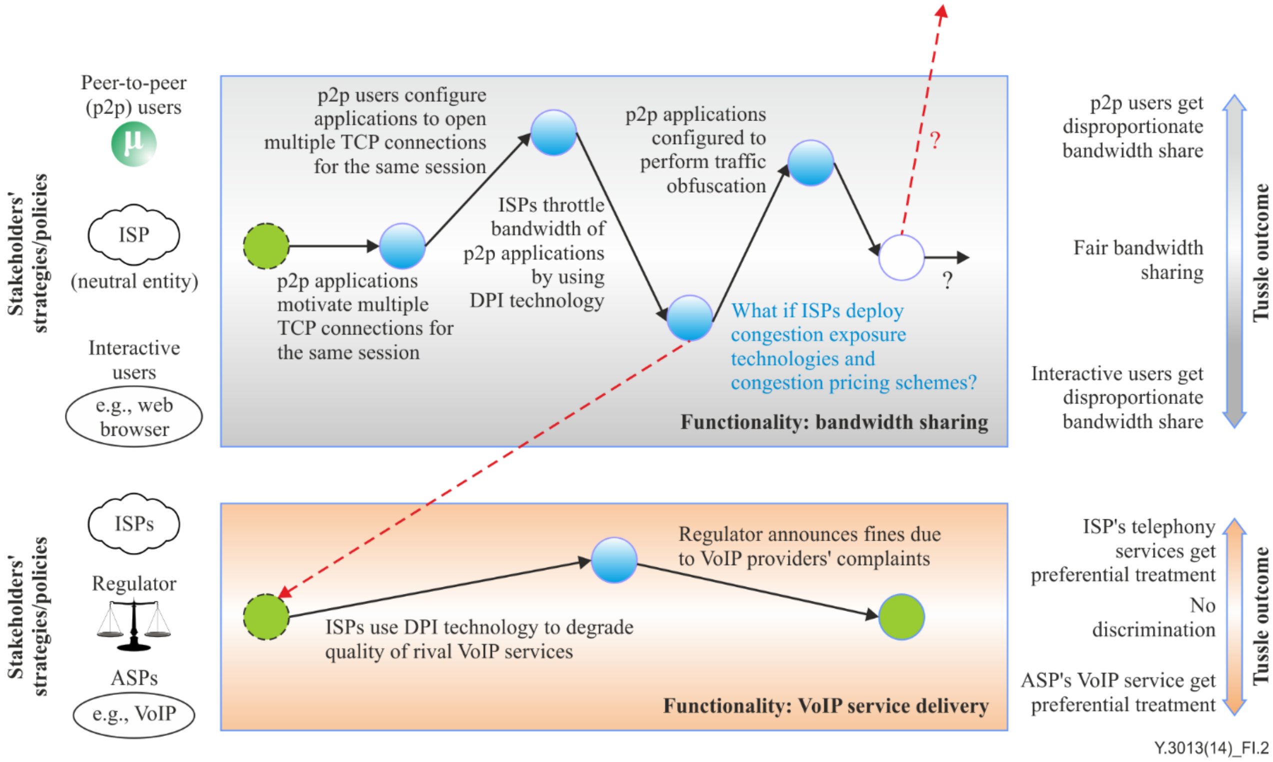

Figure I.2 – Tussle evolution due to instability and externalities for the bandwidth sharing case study

Even though this new bandwidth allocation outcome can be considered fair, it is not stable either. Peer-to-peer applications started performing traffic obfuscation, e.g., by encryption, in order to decrease downloading time.

At the same time, DPI technology, which was installed to throttle peer-to-peer traffic, allowed ISPs to identify traffic that directly competes with the complementary services they offer. A famous example was an ISP's attempt to degrade the quality of third-party voice over IP (VoIP) services offered by application service providers (ASPs) that threatened traditional telephony services often offered by an affiliate of the ISP. This is an example of a spillover to another functionality, which was solved by affected users asking the regulator to intervene (judicial means) for discouraging anti-competitive tactics. In the interests of graphic simplicity the "VoIP service delivery" functionality in Figure I.2 is assumed to reach a stable outcome.

In order to anticipate such socio-economic interactions through technological, economic, and judicial means, research projects already apply tussle analysis to enrich their technology development via socio-economic considerations and also publish these in their deliverables [b-ETICS], [b-ICN], [b-SmartenIT] and [b-FLAMINGO].

Appendix II

Methods overview

(This appendix does not form an integral part of this Recommendation.)

Each of the steps described in clauses 8.1 to 8.3 can be performed using several different techniques, or methods, while some of these methods can be used for more than one step. Table II.1 provides an overview of such popular methods (rows) and their suitability to carry out a particular step (columns).

Table II.1 – Overview of methods for implementing tussle analysis steps

Methods	Stakeholder identification	Tussle identification	Tussle impact and tussle evolution
Interviews	Highly relevant	Relevant	Relevant
Personal observation	Highly relevant	Highly relevant	Less relevant
Role-playing simulation	Relevant	Highly relevant	Highly relevant
MACTOR method	Prerequisite	Highly relevant	Relevant
SWOT analysis	Prerequisite	Relevant	Relevant
Game theory	Prerequisite	Prerequisite	Highly relevant
Risk management	Prerequisite	Highly relevant	Highly relevant
System dynamics	Prerequisite	Prerequisite	Highly relevant
NOTE 1 – See [b-MACTOR] and [b-MACTOR2] NOTE 2 – See [B-SWOT], p. 2-6. NOTE 3 – See [b-GameTheory], p. 460-482. NOTE 4 – See [b-Risk], p. 18. NOTE 5 – See [b-Dynamic].			

Interviews are the most widespread method for gaining information about a situation from the stakeholders involved or other experts. Starting from an initial set of candidate stakeholders, interviews can help validate their own involvement and identify new stakeholders. Furthermore, depending on the set of questions, this method can be used for learning what possible strategies are to be followed by each stakeholder at each particular phase of the technology cycle. Finally this method can be used for evaluating candidate outcomes from the perspectives of separate stakeholders as fair, biased for, or biased against that stakeholder.

Personal observation is another method used to understand how stakeholders react to certain circumstances. Own experience or related literature can be used as well when it is difficult to study the value network and candidate reactions to events. However, as not all outcomes may occur or be realized during the observation period, this method is less suitable for characterizing the attractiveness of different outcomes to each stakeholder.

Role-playing simulation involves the interaction of multiple participants in a hypothetical environment. Examples include group-based discussions such as the Delphi method and focus groups. Such methods can help identify major stakeholders if the sample of participants is carefully selected, but the major advantage of role-playing simulation methods is their ability to identify and understand the dynamics of the major tussles by observing stakeholders' behaviour.

SWOT analysis is a framework for understanding the strengths, weaknesses, opportunities and threats facing a particular stakeholder at a given situation. It assumes knowledge of the major stakeholders and tries to identify tussles by predicting how they could harm a particular stakeholder, as well as the opportunities for the stakeholder. Thus SWOT analysis tries to evaluate the attractiveness of potential outcomes, but rarely studies interactions (reactions and spillovers).

The **MACTOR method** (matrix of alliances and conflicts: tactics, objectives and recommendations) attempts to give an overview of possible alliances and conflicts in a business ecosystem. Having identified the set of stakeholders, this approach tries to document candidate tactics (strategies) that could lead to other outcomes and then evaluate the attractiveness of each outcome to participants. Like SWOT, the tactics do not focus on reactions.

Game theory is a branch of mathematics that aims at finding and evaluating the possible equilibrium outcomes for a specific scenario in a system with rational participants. Not only major stakeholders should have been identified, but candidate strategies must be known as well, in order to predict the outcomes of multi-party interactions. Multiple rounds of actions can be considered, but at the trade-off of increased complexity.

Risk management is a method for identifying candidate factors that can have a negative effect on a system and for quantitatively or qualitatively evaluating those effects in order to take precautions. When performing risk analysis, although the actors are considered to be known, the factors that can have negative impact, including the level of their impact, must be identified. Because the main focus is not the evolution over time, further reactions by other stakeholders are usually not considered.

System dynamics is another method for simulating the possible outcomes (e.g., a technology reaching the critical mass adoption level) when multiple stakeholders interact. These actors, as well as their interactions, are identified using out-of-band means and encoded into system variables and statistically driven events, respectively. The main focus is the assessment of outcomes and their evolution over time, since possible reactions can be modelled.

Appendix III

Stakeholder overview

(This appendix does not form an integral part of this Recommendation.)

The following list shows a collection of stakeholders specific to Internet technology. The list is helpful when performing Step 1 of tussle analysis (see clause 8.1) and has been compiled from an analysis of 16 European research projects for designing and implementing future Internet technology. First-level entries determine generic roles, meaning that a generic role represents a group of stakeholders. Instantiations of these groups are listed as second- and third-level entries. This stakeholder list is not claimed to be conclusive, especially with respect to second- and third-level entries.

Internet stakeholders:

– Technology makers
    - Industry standardization consortiums
    - Consumer electronics manufacturers
    - Network element vendors
    - Application developers
    - Software development kit (SDK) publishers
    - Research projects
– Connectivity providers
    - Edge ISP
    - Transit ISP
– Information providers
    - Content distribution networks
    - Directory service providers
    - Application service providers
    - Brokers (market place providers)
    - Communication providers
    - Gaming providers
    - Financial service providers
    - Internet retailers
– Infrastructure providers
    - Network component providers
        - Network exchange points
        - Last mile providers
        - Dark fiber providers
        - Gateway providers
    - Sensor operators
    - Venue owners
    - Cloud operators

– Users
  - Customers
    - Residential
    - Business
  - Roamers
  - End-users.
– Policy makers
  - Regulators
  - Legislators
  - Administration authorities
  - Researchers
  - Security agencies
– Content owners
  - Professionals
  - Amateurs

Bibliography

[b-Clark05] Clark, D.D., Wroclawski, J., Sollins, K.R. and Braden, R. (2005), *Tussle in cyberspace: defining tomorrow's Internet*. IEEE/ACM Transactions on Networking Vol. 13, No. 3, June, pp. 462-475.

[b-Dynamic] Forrester, J. (1971), *Counterintuitive behavior of social systems, Technology Review*, Vol. 73. No. 3, pp. 52-68.

[b-ETICS] Kalogiros, C., Courcoubetis, C., Stamoulis, G.D., Dramitinos, M. and Dugeon, O. (2012), *Socioeconomic Tussles Analysis of the ETICS Approach for Providing QoS-enabled Inter-domain Services*. In Future Network and Mobile Summit 2012, Paul Cunningham and Miriam Cunningham (Eds.). IIMC International Information Management Corporation, July, pp. 1-8.

[b-FLAMINGO] Radhika, G. (Edt.) (2013), *Basics, Requirements, Scenarios, and Architecture*. FLAMINGO Deliverable D7.1.
http://www.maps.upc.edu/rashid/files/D7.1.pdf

[b-GameTheory] Aumann, R.J. (1987), *Game Theory, The New Palgrave: A Dictionary of Economics*, 2nd Edition.

[b-ICN] Kostopoulos, A., Papafili, I., Kalogiros, C., Levä, T., Zhang, N. and Trossen, D. (2012), *A Tussle Analysis for Information-Centric Networking Architectures*. In The Future Internet, Federico Álvarez et al. (Eds.). Springer, Heidelberg, Germany, pp. 6-17.

[b-MACTOR] Godet, M. (1991), *Actors' Moves and Strategies: The MACTOR Method, Futures*, pp. 605-622.

[b-MACTOR2] Godet, M. (1994), *From Anticipation to Action. A Handbook of Strategic Prospective*, Unesco Publishing, Paris, France.
http://unesdoc.unesco.org/images/0009/000970/097082eb.pdf

[b-Risk] Crockford, N. (1986), *An Introduction to Risk Management*, Woodhead-Faulkner, 2nd Edition, Cambridge, U.K.

[b-SmartenIT] Papafili, I., Stamoulis, G.D. (Eds.) (2012), *Report on Stakeholders Characterization and Traffic Characteristics*, SmartenIT Deliverable D1.1.

[b-SWOT] Pahl, N., Richter A. (2007), *SWOT Analysis – Idea, Methodology and a Practical Approach*, Grin Verlag, Nordestedt, Germany.

[b-TussleAnalysis] Kalogiros, C., Courcoubetis, C., Stamoulis, G.D., Boniface, M., Meyer, E.T., Waldburger, M., Field, D. and Stiller, B. (2011), *An Approach to Investigating Socio-economic Tussles Arising from Building the Future Internet*. In The Future Internet, John Domingue et al. (Eds.). Lecture Notes in Computer Science (LNCS), Springer, Heidelberg, Germany, Vol. 6656, May, pp. 145-159.
http://nes.aueb.gr/publications/FIA_BOOK2011-FI_Socio-economic_Tussles.pdf

[b-TussleCookbook] Kalogiros, C., Pickering, B., Waldburger, M., Poullie, P. and Stiller, B. (2012), *The Tussle Analysis Cookbook*.
http://www.scribd.com/doc/124674901/The-Tussle-Analysis-Cookbook

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects and next-generation networks**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2014