How Much Information: Measure, but What and Why? I.

Abstract: **The author recommends that the computations aiming at government-level decision-making should be standardized and standardization should be based upon the UN's SNA. The paper shortly describes the System of National Information Accounts (SNIA), which is a complex SNA conform system of indicators and accounts to measure information phenomena at the macro level and allocates in the system the indicators adopted in the frames of various „How much information" efforts. In the first part, the need for a complex system and the basic concepts: actors, their devices, products, stocks and purposes are described.**

1. Introduction, the Users of HMI Studies

HMI studies should meet the demand. So far the users of HMI studies are mostly the members of the academic community, market research institutions, multinational telecomm firms, producers of ICT industry, international organizations, groups of international players and national governments.

Academic community investigating the information societies to come is eager to get to hard sociologically interpretable data. *Scholarly descriptive* studies, based upon national information accounts, may reveal new facts and new laws, while *constructive studies* can envisage new societies; new societal systems of information and economic flows, which reshape societal memory, its accumulation and forgetting, new ways of societal reproduction of information, a new way of reproduction of society itself.

Market research institutions to forecast global information "universe" deal with technical aspects of infocommunication and compare world capacities with demand.

> The authors' natural question in Lyman and Varian (2000) is that of recording and storage industries: "How much information is there to store? If we wanted to store "everything," how much storage would it take?". IDC studies "digital universe". This approach might belong to one, who is going to identify an upper limit to the size of the market demand towards recording and storage devices – or a "global inspector", a "global CIO". CISCO focuses control of information flows and security aspects and henceforth asked for the size of global IP traffic and visual networking.

Multinational telecomm firms are not, or not-uniformly, involved in the national policy problems concerning the uneven distribution of stocks and flows between individuals, sectors, and countries. They should like to maximize profit and growth, extend their services as wide as possible - which itself may be a problem for central governments. As such, they support ideologies like "growth of ICT sector, as an unconditionally positive, governmentally to-be-supported element of societal development", "fighting digital divide" and "e-inclusion".

> ITU – representing the interests and efforts of telecomm corporations - launched several projects and published several books on the national and world indicators like this as ITU (2010a) and ITU (2010b).

Multinational telecomm firms are mostly not interested in the efforts aiming at revealing and understanding information-related national and international problems, which are beyond the scope of "market", or at analyzing and finding information policy options to resolve national and international conflicts. As a contrary, they are interested in destruction of bars and of limits to the growth. Engineers' viewing at technical problems, do not count with the issues of ownership of terminal points of information flows, and the economic flows accompanying information flows and the societal and international aspects of control.

Producers of devices and investors interested in technical-functional analysis of infocommunication not only serve the needs toward functions, but design a redistribution and regrouping of functions and reshape the life of people.

Groups of international players design a global and as much as possible uniform world-society by designing technologies and the socio-economic model of their distribution and use.

In central governments and partly in the EU, *information and information flows are subject to policies and regulation*. While serve its functions, those are viewed as a domestic and international power tool, as a resource, as a commodity, as cultural and moral value, and as an object of protection. EU has been interested – among others – in the information related issues of economic growth, employment, and cohesion of the Union

> Those are not only data, which must be protected, but individuals too. People are overwhelmed by information technology, and are not able to control their information flows, the flows from their cell phones either, and the occupation of people's information footprint seems to be the most crucial problem in the societies to come. Governments should help people with technical standards and supervision of development and operation to sustain people's ability to control their information flows.

1.1 The Need for a Comprehensive and Coherent System of Indicators

These and other aspects should be assessed and harmonized in the frames of a comprehensive *government (Prime Minister) level information policy,* which extends to the public and private sectors. A comprehensive information policy is a policy whose object are

non--industry-specific information flows or a policy that effects in all or most industries or for all or most individuals. Formulating and conducting a comprehensive information policy need an intellectual framework including general notions and concepts.

In the frames of its *general obligation to promote economic activity* in order to growth national wealth and income, particularly in countries with big markets, government may *provide a big homogenous marketplace for information production and distribution without unnecessary bars, synergy of government and market information suppliers*. To different extents in various countries with small markets, it requires the *protection or promotion of domestic information producers, the "bit industries" of its own*.

The traditional *cultural value* aspect requires that production, accumulation, use, export, import of those information goods and services that can be called "products of high culture", or "products of national culture" should be protected or supported. According to another approach, which define culture as civilization or "way of life", including culture of work, health culture, agriculture etc. in the country, governments should protect or support production, accumulation, use, export, import of those information goods and services that help nation to adopt the best way of life to live and survive. Acting in this role, they may limit excessive, overdone consumption of information waste, which is proved to have societally harmful consequences for people's health, including mental health.

Elected parliaments and governments, when regulating knowledge stocks and information flows in the information household of the country, should be the „webmasters or CIO-s of the networked information society".

The top-down government level information policy that emerges from national interests and considerations, may be conflicting with national industrial (e.g. cultural, telecomm etc.) and local or regional policies which represent industrial and local interests.

While regulating, national governments manage their countries, *not only global numbers, but indices and figures, which reflect* ***local situation from the aspects of local people*** *are needed*. Governments should be interested in people: individuals, families, households, employees and owners both as participants in information-, and in economic flows. Several aspects of management and control at the level of national governments require *many-sided and versatile approach with a system of comprehensive and coherent indicators and accounts instead of one or some independent indicators,* because only a system, like this,

is able to describe the rich diverseness of actors and their actions on the vast realm of information economy (Dienes 1994)..

Lakoff's epochal works on metaphors (Lakoff 1987) have revealed that language reflects "folk-psychology" of phenomena and processes: the world itself, as it is represented in our mind and brain. In English, Hungarian and in a number of other languages, *information seems to be a fluid*; it has volume, it flows, can be produced, outputted, inputted or consumed, it conserves, it can be stored and it has a volume and the law of conservation is valid for its flows..

> On the subdevice level, Max-flow Min-cut Theorem for network information flow (as in TCP-IP) by Ahlswerde (2000) has revealed that it is in general not optimal to regard the information to be multicast as a passive, inert “fluid” which can simply be routed or replicated. Employing coding at the nodes, bandwidth can in general be saved.

Economic values also obey the rules governing the behavior of "fluids", this is why stock and flow models can be defined and applied worldwide both in microeconomic book-keeping, and macroeconomic national-accounting. Government policy-makers obviously need a stock and flow model, and particularly a model, which follows the processes in both monetary and natural quantities.

> The popular theories concerning economic behavior of "information" that predict or declare that information can be consumed unless its volume in the process would change, like in Repo (1986), contradict to the intuitive contents of the concept itself, which reflects in the word usage, and the traditional official statistics of information goods. These theories describe economics of ideas instead of economics of records, the material carriers of ideas.

> Short et al. (2011) is going to take into their census every flow delivered as output, and considers counting data that is stored on some media somewhere in the firm to be an opposite extreme alternative. However only the account of both stocks and flows gives a proper insight into information pehenomena.

The System of National Information Accounts (SNIA (1994)) and later versions have been designed keeping in mind the aforementioned aspects and have been based upon SNA, the System of National Accounts (ISWG et al 1993).

The SNIA emerged from the efforts in HCSO from 1982, which evolved to SNIA Version 1.1 in Dienes (1994) and later versions.

1.2. A Complex System Should Be Based upon the SNA

The System of National Accounts is „a statistical framework that provides a comprehensive, consistent and flexible set of macroeconomic accounts for policymaking, analysis and research purposes. It has been produced and is released under the auspices of the United Nations, the European Commission, the Organization for Economic Co-operation and Development, the International Monetary Fund and the World Bank Group."

The fundamental question of the SNA is "Who does What by What means for What purpose with Whom in exchange for What with What changes in Stocks?"

> Machlup and especially Porat were the first to adopt official statistical nomenclature and indicators including those of SNA, to characterize the objects which were called then primary and secondary information economy. These authors adopted *output-based definitions and classifications* for information economy. Governments should adopt output-based models so as to influence and regulate the future activities of actors in the economy and society.

2. Basic SNIA

The SNIA as is, has been based upon the same *fundamental general concepts* as SNA 1993 and its successor SNA 2008. These include *actor, institutional unit, sector, good, service, commodity, transaction*, *stock, flow*, *account, balance.* The very same concepts, however, have sometimes been interpreted in a wider environment, due to the needs to reflect information phenomena, and to include events and objects that are beyond the scope of SNA. *On the formal plain*, SNIA consists of definitions, explanations, indices, raw and report tables and accounts.

The accounts of the SNIA are designed to provide *analytically useful information about state of affairs and processes of information activities taking place in society, such as production, consumption and accumulation of information assets.* They should do this usually by aggregating actions and transactions between institutional units. As far as the transition from raw data to the accounts of SNIA is not feasible without a subtle analysis and distinction

of the *physical processes* taking place during actions, these physical processes with *elementary actors* are studied first, wherever it can be done.

SNA asks: "Who does What by What means for What purpose with Whom in exchange for What with What changes in Stocks?" *SNIA asks*: Who does What by What means for What purpose with Whom in exchange for What with What changes in Information stocks?

2.1. "Who does?", and "With whom?" - the Actors of the System

Without specifying the units, between which information flows are to be measured, reliable results can not be expected.

> The goal of the HMI Program described by Short at al. (2011) is to create a census of the world's data and information. How much information is created and consumed annually – by the "World"? A more detailed definition of actors of "the World" reliable would be needed for interpretation of the figures, because volume of flows depends on the allocation of interfaces between units.

The SNA and SNIA records and aggregates flows between and stocks of *institutional units*. The SNIA should be closed in the sense that both ends of every flow should be recorded.

2.1.1. Elementary actors and institutional units: corporations, non-profit institutions and government units.

The *recorded elementary actors of physical information flows* in the SNIA are individuals and machines (devices). Individuals themselves and their capacities and the institutional units, the normal actors of the system, that own or use devices and employ individuals –will be aggregated into sectors. HMI studies mostly do not define exactly the elementary actors between which the flows would be measured. Reading the authors' works, I tried to identify the actors they studied, but explicitly did not name, and the Table 1. contains the results.

Table 1. Terminals of elementary, physical information flows in the accounts of various authors[1]

No	Elementary actors: terminals of the physical flow	de Sola Pool (1984)	HCSO (1990)	Lesk [2] (1997)	Lyman & Varian [8] (2000)	Dienes (2003)	CISCO (2009)	IDC (2008)	Neuman (2009)	Bohn & Short (2010)	Short et al. (2011)	Dienes (2010)
1	Individuals	Yes	Yes	Yes	Yes	Yes	No	No[6]	Yes[5]	Yes	No	Yes
2	Devices	No	No	No	No	Yes	Yes[7]	Yes[6]	Yes[5]	No[2]	Yes[4]	No

[1] "Yes" if the elementary actors of the kind have been studied concerning at least one product and at least one indicator. For instance, at Pool 1984 Organizations="Yes", because he calculated at least "Supply" of broadcasting stations without any limitation, that is, its work extended to organizations.

[2] all data delivered directly to people at home

[2] Lesk 1997 studied only stocks of products, devices and "human memory" ~ stocks of human knowledge.

[3] Only human consumption was observed

[4] Only the output of the "core" devices was observed

[5] Output~ "avg stations per market *avg bcast hours day * radios per household * pen". consumption~ "mins per person" or of usage

[6] Output~ information that is either created or captured in digital form and then replicated, Stocks~ „store"

[7] Global IP traffic ~inputs+outputs

[8] Flow ~ output of originals, stocks

SNIA should consider an advanced cognitive model of individuals and human information processing. For some purposes intraindividual units will also be used. These units, the *faculties or modules of massively parallel human brain are*, to which the *levels of cognition* can be attributed. These levels are: the sensory level, the level of grasping of the meaning of what was said (semantic memory), the level of *conscious* grasping of the sense of what said, and the long-term autobiographic memory-formation levels of the experience. Accordingly, various versions of SNIA account the information that goods and services convey to *"sensory"* or at *"conceptual-perception"* level.

In principle, there were *several ways open to define institutional units* for SNIA. One of the ways was to accept the institutional units of SNA. The reformulation of the SNA definition so as to get a *"mutatis mutandi" definition* is also straightforward. According to such a definition, an institutional unit is capable in its own right (being independent)

#1 owning information assets

#2 incurring liabilities

#3 engaging in information activities

#4 engaging in information transactions with other institutional units

"Informational independence" of a unit has been defined by a generic rule by the rights of the unit to request, use, consume, output information n its own name, which right is not influenced directly by other units,

The *information rights of various business and government units* frequently are not determined exactly. These rights are frequently not well documented and are operationalizable in traditional organizations. Rights of a unit may be decentralized and designated to its departments. That means, when a department is authorized to act under its own name, that department substitutes the whole institutional unit when it acts in certain functions. By this, no new actor appears on the scene, just an actor delegates certain functions to certain individuals.

Within computer networks various *users' groups* have been defined as units. *Computers* record their privileges. These inventories of *access rights* and *privileges* provide a sound and operationalizable basis for making statistics on transactions made on or by computer networks. These groups define various units called *"virtual communities"*. Such communities may become included as institutional units. The rules of institutionalization of such groups will greatly define "information household" in the future information societies.

So far most HMI studies are national, extending to the U.S., or Hungary, or extending to the World and covering all domestic and non-domestic institutional units of each kind.

Organizations are corporations, non-profit and government organizations. If “Enterprises” in Short et al. (2011) cover the units of the corporations sector, and I am not sure about it, it may be an example for a sectoral study. The *concept of public,* and *private national* and *foreign controlled*, *subsidiary, associate, ancillary and quasi corporations* and *non-profit organizations* will be accepted here as SNA applies it with all limitations and extensions.

For *central government,* the SNA (1993) declares that "central government is considered as a large and complex sub-sector in most countries which is generally composed of a central group of departments or ministries that make up a single institutional unit plus, in many countries other institutional units". As a contrary to this, what is *experienced* in central governments of most countries is a large set of institutions having *different degrees of informational and economic autonomy and distributed control.* In Hungary none of them has the right to own goods or assets and most units have the rights b) and c). The soft condition d) seems met even for territorial units of ministries. Due to the partly opaque operation of central governments and the diversity of solutions, the *definition of units within central government* may impose difficulties and has significant consequences for the perceived dimensions of information flows. Among the *consequences* one can mention that if central government is accepted as a single unit, all interdepartmental flows should be classified as intra-unit flows, and volume of output and input may be radically less than if informationally or economically independent units are considered each and all. However, this issue isn't just a technical one, it *concerns the foundations of the government and state*.

A good account (both SNA and SNIA) should reflect the real centralized, hierarchic or distributed character of the government (and state). Such an approach wouldn't ab ovo declare the government as one entity in every country and wouldn't ab ovo define the position of government units in the system.

Just such an approach could make SNA (and SNIA) suitable for drawing not only economical but - what is inseparable and inspiring - social conclusions. Volume of information flow between agencies would reflect factual activities of the government.

> Departments in a "totalistic" state are totally subordinate to the formal/informal head of the government or state; and such a state is monolithic. At the same time, in a democratic and constitutional state, departments can freely undertake contractual contacts with private and non-private units, and the (federal) state budget contains several separate items for many of them, which items are not redistributable. They also have the right and the obligation to manage the assets that are assigned to them, and are *economically independent* to a significant extent.

Information does not flow freely within government, not even in total states. In a democratic constitutional state which respects privacy, free flow of information is not only

impossible, but forbidden by law which defines the scope of various authorities and measures in order to protect privacy.

Government agencies accomplish mostly information activities. In their traditional shape, these agencies had no goods that could have been exploited as capital goods. A new situation emerges with impact of government data banks. With tying up some plus efforts to organize the data into a database under an on-line database management system, the whole system automatically turns to a capital good. A database can be exploited so that it is able to provide on-line services. Many of them functions as working capital indeed, which is not characteristic for a non-profit organization. At this point, regulation of independence and interfaces of government agencies has got more significance.

So far the HMI studies have not analyzed several kinds of government information assets and flows in the frames of a comprehensive study.

The flows from and to international organizations should be treated as flows with the rest of the world despite the international agreements which may oblige nation-states to supply data.

2.1.2. Individuals in the households and as employees.

Information activities of individuals in the capacity of consumers of information services have been included in several HMI studies, but their output in capacity of consumers raised less interest. Appearance of web2 and recognition that private individuals generate more traffic and content than organizations may induce new research.

In the SNA *a household* is a small group of persons who share the same living accommodation, who pool some, or all, of their income and wealth and who consume certain types of goods and services collectively, mainly housing and food.

Families constitute *private households*. Members of religious orders living in monasteries, prisoners, long-term patients in hospitals, troops of armed forces belong to *institutional households.* This definition in SNA (1993) and its interpretation are accepted,

though the concept of "household" could have been bound to common information production and consumption either.

Such "information stocks in the household" - as family libraries, family photo-albums, archives or collections of records - are eventually in the *common property* and use of the household members. Also some information services - like TV broadcasting - and the TV set are *used and consumed together,* which may be conceptualized as commonly. However, several actions within households are made individually - as teaching children, watching TV (using visual output from TV sets) and so on. In the SNIA individuals, members of households, both alone or cooperating may produce information and individuals are the most important producers of human knowledge and a number of information services which make the bulk of information output.

The SNIA is going to study interindividual flows and calls individuals together the households sector.

In the SNIA, individuals (with an employer), *act in two capacities:* either as a private individual or an employee and these *capacities are thought to be discernible in time.* In computations, individuals in their free time will be considered to act consciously as private individuals, and during working hours as employees.

Due to general rules of the SNA, the units controlled by other units must not be treated as independent units of the system. Complex institutional units in SNIA control their employees, only at the level of tasks and jobs, which is far no total control, thus *employees should not be considered as belonging to them*. Accordingly, output of services completed by employees and human information consumption on workplaces will be recorded both in the employer's and the employees' subsector.

Employee's produced knowledge assets will be assumed to contain the knowledge he/she has acquired during his/her employment at the employer except skills. The use of this knowledge by the employee in his/her capacity as a private individual is under the control of his/her employer and is limited. *Skills* will be defined for the purposes of the system as the

durable, long-term generic knowledge produced or grown by the employee using and transforming information he/she received. This is a narrow interpretation of the concept of skills neglecting physical skills.

> The authors of Short et al. (2011) do not include in their definition the information that people may see or hear while at work and not processed by servers, i. e. do not account a significant part of volumes employer produces for employee and that employee consume and use for producing or letting to grow their knowledge, though under computer monitoring, information flows from and to employees can be operationalized and directly measured, or can be calculated from model computations.

2.1.3. The establishments of institutional units and the sectors of SNIA.

Actual institutional units and establishments engage in more than one kind of activities and concerning them one can distinguish:

- *principal activity* (whose gross value added exceeds that of any other activity c arried out within the same unit,
- *secondary activities* carried out in addition to the principal activity,
- *ancillary activities* -- "supporting" activities which are undertaken to create the conditions within which the activities of an enterprise can be carried out

A number of information activities, as *"management", "data processing",* are mostly classified as ancillary activities in practical accounts of corporations. As the case of holding companies and management consultant firms show, management may be a self-contained – information - activity. SNIA should treat these information activities as primary and secondary activities in dependence of their volume. *SNIA is "result oriented"* it should record the information outputs, inputs and assets in institutional units -- by groups of information goods and services -- independently that their activity is kept to be a principal, a secondary or an ancillary activity

Sectors are groups of actors which have political and hence analytic significance. Table 2 shows the coverage of kinds of sectors by studies.

Table 2. Sectors (Classes of actors) of SNIA, described by various HMI studies

No	Actor class	de Sola Pool (1984)	HCSO (1990)	Lesk (1997)	Lyman & Varian (2000)	Dienes (2003)	Cisco (2009)	IDC (2008)	Neuman (2009)	Bohn & Short (2010)	Short et al. (2011)	Dienes (2010)
0	Regions[1]	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	No
1	Nation/country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
1.1	Organizations	No	Yes	No	No	No	No	Yes	No	No	No	No
1.1.1	Governments	No	Yes	No	No	No	No	No	No	No	No	No
1.1.2	Corporations	No	Yes	No	No	No	No	No	No	No	No	No
1.1.3	Non-profit	No	No	No	No	No	No	No	No	No	No	No
1.1.4	Information economy	No	No	No	No	No	No	No	No	No	No	No
1.1.4.1	Primary information economy	No	No	No	No	No	No	No	No	No	No	No
1.1.4.2	Secondary information economy	No	No	No	No	No	No	No	No	No	No	No
1.2	Individuals	No	Yes	Yes	No	Yes	No	No	No	No	No	Yes
1.2.1	Employees	No	No	No	No	No	No	No	No	No	No	No
1.2.2	Ethnic and language communities	No	Yes	No	No	No	No	No	No	No	No	No
2.	Rest of the world (overseas)	No	Yes	No	No	Yes	No	No	No	No	No	Yes

[1] Like “World”, “EU 27”, “Africa”, “North”, “OECD members” etc.

Short et al. (2011), when measure “enterprise information”, actually are going to measure indicators of the corporations sector. Bohn & Short (2010) are going to study the information flows to people at home, their information consumption in capacity of private individuals. The total information consumption of the household sector would contain the information flows to devices, too.

Porat's primary information economy is defined as those institutional units, whose principal (dominant) output is an information good or service, and the *secondary information economy* is defined as the information activity of units which do not belong to primary information economy.

Population in several countries, particularly in large countries is divided. There are politically important *groups formed by using a common language, being of common geographic region of origin, common kinship or tribal origin, common race or color or sharing common culture or more of these criteria or by coming from relicts of former historical states* like Tibet, Catalunia, or Wales. The domestic sectors *ethnic groups* are defined as those resident individuals who declare themselves or are qualified by local law to

belong to the given ethnic community and the institutional units owned by these residents or non-residents.

Information flows between employees and employers have always been an area of conflicting interests and subject of debates. Rights of employees to use employer's information (trade secret) and rights of employer to use employee's information (patents, copyright, privacy) are subject to regulation. In the SNIA employees constitute a subsector of the individuals' sector.

National and other smaller-than-nation sectoral figures come from the national aggregates of groups of resident units and flows. An *institutional unit is resident in the country*, when it has *a centre of economic interest* within a country, when there exists some location -- dwelling, place of production, other premises -- within the economic space of the country on or from which it engages, and intends to continue to engage, in economic activities and transactions on a significant scale, either indefinitely, or over a finite but long period of time.

The rules of the SNA for *identifying the residence of corporations and quasicorporations* in a country should mostly be valid in SNIA. Production by site offices and "offshore" units should be treated as domestic production in the country they are operating in, if they are engaged in a significant amount of production of goods and services there, or own land or buildings there. They must maintain at least one (information) production establishment there which they plan to operate over one year or more and maintain a complete and separate set of accounts of local activities, pay income taxes to the host country, etc.. If the unit is *operating a mobile equipment for more than a year in another country*, the unit is resident of the country in which the production occurs.

Telecommunication imposes several problems for accounting transborder and domestic flows. Students, diplomats, military personnel, travellers and tourists, seasonal- and border-workers, locally recruited staff of foreign embassies, the crews of ships and medical patients should be treated as *residents of the country from which they originate*.

Institutional units that are *resident in abroad,* are classified as the *"rest of the world"*. Information transactions between resident and non-resident units should be recorded in order to obtain a complete accounting for resident units and units of an "ethnic community".

2.1.4. Devices and platforms.

International and national statistical classifications of products hardly can cope with their proliferation of input, output and processing devices. They are connected to each other and/or the outer world, the environment by channels and separated by interfaces. Each device may be produced by integrating, and may contain smaller input, processing and output devices. The figures obtained in a census for information flows heavily *depend on the interfaces defined*.

Each processor of a massively parallel device – like human brain - can be viewed as a device, outputs signals, which then may be returned and reprocessed, but these flows, as device-internal flows generally, will not be accounted in SNIA. The SNIA will exclude “dark information”, the information built in microchips embedded .in non-information devices, even if this “out of user control” information will prevail and define the far future.

> *The authors Short et al. (2011)* have built their account onto a census of servers. They define *enterprise server information* as the flows of data processed by computer servers as inputs plus the flows delivered by servers as outputs. But data may be stored and processed on rented devices of another institutional unit by the data-owner or by another institutional unit. Whose information output is the information output in these processes, and how should information use and intermediary information consumption be accounted? For sectoral studies these questions are not avoidable.

Client devices that sit at “the edge” of the *Core-Edge computing environment* are important terminals of the on-line individual—device flows and should not be excluded from the system. A *platform* is a set of interconnected devices to provide channels for information flows between an individual and a device and between devices communicating under a well defined protocol.

TV programming can be received from terrestrial and satellite broadcasting by an analogous or digital receiver, and a parabola, cable TV networks, via ISDN or various Internet services by a computer or a handy – all different platforms. Mobile phone users can subscribe various packages with various geographical coverage, access costs and bandwidth. Their set and the service they subscribe together is their platform. People can play games with high performance gaming PC-s, standard PC-s, game consoles, mobile phones, and handheld game devices are various platforms.

2.2. "What does by What means?" – The Products and Media in the SNIA

A number of actions can be accepted as "production", ending with the output of a good or a service. Those that end with a unique product, can be called an *original item,* which then can be reproduced providing *copies* of information goods and services.

Information goods and services are called together *information products*.

Information goods are durable tangible physical objects
- that have been intentionally created to carry or convey information, their principal function is to carry information, and
- over which ownership rights can be established, and
- whose ownership can in principle be transferred.

An intentional activity that leads to the change of volume of information of goods, or human knowledge of an actor, or to a non-durable signal delivered, so that no new information good is created, will be called *information service.* The rental transactions of produced information assets will be considered as non-information services either is the object an information good or produced human knowledge

A drama or a poem, grasped as a work, like Poe's "The raven" exists in several tangible copies as well as in the creator's and users' brain. The work itself, *is not an information good*, those are only its copies on various media. When speaking about a work, people refer to mental representations. The tangible and mental copies will be treated as output, accumulation, assets, consumption and natural loss of produced human knowledge and information goods and services, respectively.

Table 3. Some non-information products, which carry information

Medium	Product, examples	Lyman & Varian (2000, 2003)	IDC (2008)	Bohn & Short (2010)	Short & Bohn (2011)	Dienes (2010)
liquid crystal	displays	No	No	No	No	Partly
LED diodes	displays	No	No	No	No	Partly
textile	T-shirt, flag,	No	No	No	No	No
other	traffic tables, light ads, trams, cabs, watches, museal objects etc.	No	No	No	No	No

Various author's rights can be bound to externally various appearances to the very same content, so the concept of "originals" should be refined. Lyman & Varian (2000 and 2003) calls the originals "unique information".

Paintings on aeroplanes, or ubiquituos inscriptions on and inside the buildings, and everywhere, even on such things like pencils, light bulbs, or eggs are good examples of *durable signals on or in non-information goods.*

Short et al. (2011) declares that they „used industry standard benchmarks to define a consistent measure of *server work performed, and converted it* into its byte equivalent." In SNA an SNIA the object and result of productive activity may be a(n information) good or a(n information) service. The volume of information goods that are outputted is measured „as they are", disregarding the amount of digital work spent for its production. If an information service is rendered, then this service may be defined as „digitally processing a digital object" or „lending/spending computing capacity for a digital object" for keeping up-to-date a database or similar, and then the amount of computations, the work" can be accounted as the measure of this output. Anyway, the amount of digital work spent for calculation of famous mathematical constant „π" to a certain accuracy, and the volume of the result: a record of the output itself with its many decimals on a carrier, are quite different amounts and different things. The amount of digital work depends on the desired accuracy, but always should be more, than the store for „π" itself.

Table 4. Media on/in which information is recorded and typical kinds of products discussed in various HMI studies

Media	Kinds of information products: examples	Lyman & Varian (2000, 2003)	IDC (2008)	Short & Bohn (2011)	Dienes (2010)
paper	documents, books, posters	Print only	No	No	Yes
air	oral communication, cinema's service, theatrical services	No	No	No	Yes
aether	land based and satellite broadcasting on air	Originals only	Yes	No	Yes
magnetic layer	Winchester, floppy	Yes	No	No	Yes
plastics	CD, DVD	Yes	No	No	Yes

(optical)					
vinyl	records	Yes	No	No	Yes
film	diapositives, professional movie-films, X-ray films, transparencies	Yes	No	No	No
semiconductor	memory chips, pen-drives	Yes	No	No	Yes
copper wire	phone, Internet	Yes	Yes	Yes	Yes
fiber cable	cable-TV	Yes	Yes	Yes	Yes
human brain		No	no	No	partially

Lyman & Varian (2000) adopts the word “media” for various kinds of products as well as for kinds of information carriers.

2.2.1. Kinds of goods and services carrying information.

The nomenclature of products in HMI studies has not yet standardized, therefore various authors adopt various classifications, whose harmonization is not easy. In Table 5. and 6. I tried to summarize the coverage of information goods and services by HMI studies.

Lyman & Varian (2000) distinguish stored information (~information goods) and information flows (~information services). Hilbert et al. (2011) estimated the world's technological capacity to store, communicate, and compute information carried by information goods and services in the tables, rather than estimating real stocks and flows. They try to classify the capacities functionally in a hybrid way, by "basic information operations" and their „most prominent technologies". Actually they classify mostly information goods and services *by their function* to *products* for storage and communication by carriers, with the two subgroups analog/digital. The third functional box of "computation", which concept, here, covers *devices for computing,* has been divided into two classes: *application-specific* and *general-purpose*. Though these devices doubtlessly take part in the consumption, processing and output of information this third box brings ambiguity into the system, because they can contribute to the output of information services or goods, but they themselves are no information commodities. Those are no devices, but the provision of computing capacity or computing services, which are information commodities, which can be the products of economic and information flows and transactions. At the same time, the coverage is not perfect, for instance the class of digital communication seems not to cover the transfer services that telecom companies render to each other, including backbones, leased line services, the transfer of calls between two edge-service provider, the group of services for businesses like proprietary virtual networks (which actually is a computing service) etc. Paper based newspapers and advertisements are qualified as broadcast.

The elaboration of a standard classification of information products is the key element in standardization of HMI studies.

Short et al. (2011) exclude from their study the information goods recorded on semiconductors, paper and other kinds of media, called "data at rest". However, without accounting a significant part of stocks, information assets, no comprehensive picture on information economy and society can be drawn. Bohn & Short (2010) neglect public education which leads them to the false conclusion that only three activities contribute a significant amount of information to private information consumption.

Table 5. Classes of information goods studied by various HMI authors

No	Class	de Sola Pool (1984)	Dienes (1992)	Lyman & Varian (2000, 2003)	Neuman (2009)	CISCO (2007)	Bohn & Short (2010)	Short et al. (2011)	Dienes (2010)	Hilbert & López (2011)
	Newspaper	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
	Magazines, periodicals	Yes	Yes	Ye	Yes	No	Yes	No	Yes	Yes
	Book	Ye	Ye	Yes	Yes	No	Yes	No	Yes	Yes
	Office documents	No	Yes	Yes	No	No	No	No	Yes	Yes
	Home documents	No	Yes	Yes	No	No	Yes	No	Yes	Yes
	Telephone directory	Yes	Included in books	No	No	No	Yes	No	No	No
	Direct mail	Yes	Included in mails	No	No	No	Yes	No	Included in mails	Included in mails
	Mail	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
	Photographic films	No	Yes	Yes, paper-based photos included	No	No	No	No	No	No
	Record, magnetic tape, cassettes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
	Hard disk drives	No	Yes	Yes	No	No	No	No	Yes	Yes
	Floppy disks (camcorder, PC, server)	No	Yes	Yes	No	No	No	No	Yes	Yes
	Removable magnetic disk drives	No	Yes, included in hard disk drives	Yes	No	No	No	No	Yes	Yes
	Optical disks (Music CD, data CD-ROM, DVD)	No	Ye	Yes	Yes	No	no	No	Yes	Yes
	Motion pictures	No	Ye	Yes	Yes	No	No	No	Yes	Yes
	Still pictures, diapositives, small camera negatives		Yes	Yes	No	No	No	No	No	Yes
	X-ray films	No	Yes	Yes	No	No	No	No	No	Yes
	Recorded ROM, RAM, chip-memories	No	Yes	No	No	No	No	No	Yes	Yes
	Telex	Yes	Yes	No	No	No	?	No	No	No
	Telegraph: voice and paper delivery	Yes	Yes	No	No	No	No	No	No	No
	Mailgram	No	No	No	No	No	No	No	No	No
	Fax	Yes	Yes	No	No	No	No	No	No	No

Table 6. Classes of information services studied by various authors

No	Class	de Sola Pool (1984)	Dienes (1992)	Lyman & Varian (2000, 2003)	Neuman (2009)[1]	CISCO (2007)	Bohn & Short (2010)	Short et al. (2011)	Dienes (2010)	Hilbert & López (2011)
	Spectator sports, theatres, musei, cultural and entertainment services	No	Yes	No	Partly	No	Partly	No	Yes	No
	Movies' services: feature films, documentaries	Yes	Yes	No	Yes	No	Yes	No	Yes	No
	Education: primary, secondary and tertiary education	Yes	Yes	No	Yes	No	No	No	Yes	No
	Courts' services	No	Yes	No	No	No	No	No	No	No
	Police, public prosecutors'services	No	Yes	No	No	No	No	No	No	No
	Local and central governments' services	No	Yes	No	No	No	No	No	No	No
	Engineering services	No	Partly	No	No	No	No	No	No	No
	Financial services	No	Partly	No	No	No	No	No	No	No
	Economic services	No	Partly	No	No	No	No	No	No	No
	Phone services	Yes	Yes	Yes	Yes	Partly	Yes	No	Yes	No
	Data services	Yes	Yes	No	No	No	No	No	Yes	No
	Radio programming (originals)	Yes	Yes	Yes	No	No	No	No	Yes	Yes
	Radio broadcasting	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes
	TV programming (originals)	No	Yes	Programming only	No	No	No	No	Yes	yes
	TV broadcasting	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes
	Cable TV studios (originals)	No	Yes	Programming only	No	No	No	No	Yes	Yes
	Cable TV distributing services	Yes	Yes	No	Yes	No	Yes	No		Yes
	Internet services	No	No	No	Yes	Yes	Yes	No	No	Yes
	IRC, messaging services,	No	No	Yes	No	No	No	No	No	No
	www	No	No	Yes	No	No	No	No	No	No
	e-mail, mailing list	No	Yes	Yes	No	No	No	No	No	No
	Usenet, FTP, Telnet	No	No	Yes	No	No	No	No	No	No
	Computer mediated flows	No	No	No	No	No	Yes	No	Yes	No
	Manual creation of digital data: keyboarding, mousing, touching	No	Yes:	Yes	No	No	No	No	No	No
	Audio and audiovisual display of programs	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes

[1] This author – following the simplification made by Pool (1984) and even earlier - coupled the output of broadcasters (~"no.bcast stations per avg market * avg % bcast hours day * TVs per household * pen") with the use and consumption of home programming-displayers' services (~"mins viewing per person").

Table 7. Products, accounted in SNIA, but not belonging to commodities

No	Class	de Sola Pool (1984)	Dienes (1992)	Lyman & Varian (2000, 2003)	Dienes (2003)	Neuman (2009)1	CISCO (2007)	Bohn & Short (2010)	Short et al. (2011)	Dienes (2010)
1	Personal oral communications	No	Yes	No	Yes	No	No	No	No	Yes

2	Produced human knowledge	Bo	Yes	No	Yes	No	No	No	No	Yes

In the SNA and the SNIA a *commodity* is a market good or service.

2.2.2 "What changes in stocks?" The stocks and information assets in the SNIA.

Information goods can be produced or acquired and accumulated to form *stocks*. The term "stocks" has been used *in two senses* in the SNIA. The first and more general meaning of the term refers to the set of all information goods. The second meaning, however, refers to those that are at their producers as own production for output, work-in-progress, materials and parts, or commodities purchased to be sold.

SNA 1993 defines *assets* as entities over which ownership rights are enforced by institutional units and from which economic benefits may be derived over a period of time. In the SNIA, *information assets s.s.* consist of those information goods that have been used for a longer period, repeatedly, for producing information. *Information assets s.l.* comprise the assets of information goods and of produced and non-produced human knowledge.

> Landauer (1984) estimated the quantity of learned information in long-term memory and found that it is roughly 200 Mbyte. This is obviously a rough underestimation, which comes out of his methods, which do not cover the sensory level either. He concluded that people only take in and remember about a byte a second, which is in contradiction with the results of several ERP (event related potential) studies, which show that after 1-200 msec people already have an overall grasp of a whole sentence. Yu (2010) showed that the rate of a neuronal population of no more than 9 cells in lateral geniculate nucleus of a macaque monkey plus 1-12 surrogates reached 150 bit per second

> Short et al. (2011) assume that most information that will be produced, will not be stored, or stored only for a short time and never used. In my opinion, while big organizations will have the resources to create the tools to use and exploit big and heterogeneous databases, individuals mostly can not afford this. Individuals will not be able to integrate their very heterogeneous and not-structured personal data, their information shadow and footprint on a large-scale and exploit them, and obviously do not protect their data accordingly. They will more and more have to turn to specialists: credit advisor, marriage advisor, property advisor, tax and legal advisor, dietetic and life conduct advisor, education advisor, job consultant, health consultant etc., A „specialists' society", when to come first, will consist of the net of advisors, which all will follow standardized codes and protocols of profession, and which have the capacity to access and process the databases, individual can not afford. The professionals concerned

might be integrated first by professions and later by power groups. Later on, the net of standard human and automatic advisors with obscure philosophies from grey sources might contour politically correct ways of conducting life and take the control over individuals. Asked and uninvited and media-mediated patterns of behavior may gradually limit the freedom of individuals. The masses of „good" individuals controlled by latent powers outputting generic and individual-specific rules will be the basis of governance and self-regulation – facing with all those who will try to find their own way, within the system.

Due to annual consumption (like erasing), new acquisitions, disposals and the stocks held from the past year, the amount of information assets at the end of a year can be less or more than the amount of annual production for own use.

This is why Bohn & Short (2010) found that for most storage devices, their nominal capacity is much *smaller* than the data that can be housed on the device over a period of time

In accordance with the extended production boundary, the *asset boundary of SNIA also extends over that of SNA:* a number of goods held by households, corporations and governments has not been included in assets of SNA, which is the case with human knowledge, government databases which involves the issue of "production in government", and many more.

In accordance with the SNA, among others, gross information capital formation, its consumption and information valuables will be distinguished. *Genetic assets* - as yet - will not be treated.

2.2.2.1. Human knowledge.

Human brains – like our devices - *are modular, hierarchic structures with many levels of representation, which are at least*: the sensory level, the level of grasping of the meaning of what was said, the level of conscious grasping of the sense of what said, and the long-term memory-formation levels of the experience. Individuals have a not complete control over modules of their brain.

Though neuroscientists are far from understanding the structure and operation of human brain elaborated *working models* like Baddeley's (1997), and *hundreds of indicators* are available to characterize the behavior of human brains under specific circumstances: for instance in Miller (1999). Our present understanding of human mind, its operation as an information processing machinery and its faculties, modules should be reflected in its treatment in the SNIA.

Individuals maintain a permanent interaction with their environment through their senses. This is mostly a non-conscious process and "Environment" is not a transactor. Thus the *more or less permanent flux of information at the input and output of vigilant (neurons of) senses* mostly should be treated at the sensory level in the system. *Spontaneous, non-volitional internal mental processes*, like spontaneous experiential information acquisition without conscious control (non-controlled, spontaneous sensing as just gazing, looking, hearing or perception as a self-contained activity of an individual) may be classified as a natural process. Direct unconscious experiencing of the environment -- when there are no signals that have been created intentionally by an actor of the system available -- will also remain beyond the production boundary.

Births and deaths, will be recorded as *economic appearance and disappearance of non-produced assets*. Human knowledge will be calculated *to enter or leave the country by emigration and immigration* – mostly *human capital transfer from or to abroad*. *Natural growth and loss of human knowledge* will be recorded in *conditional units* to be treated separately from information goods and services. Several studies in psychology indicate that *natural growth and decline* of various skills and abilities follows a similar trajectory with time. Hence *maturation and senescence* the processes of natural growth and decline of human knowledge may be estimated as a function of age.

At the *sensory level*, human information acquisition -- *creation of human knowledge* -- is almost automatic, and it might be classified as a "natural process": spontaneous, and independent of the control of the individual. In this way, the sensory level, as a part of human information acquisition might be out of the production boundary of the SNIA. However, during specified activities, like learning in the school, the *whole process of information*

acquisition of an individual, as well as its product, his knowledge should be treated as being under his willed control, and as such will be kept production. If in the SNIA the acquisition and accumulation of *human knowledge* as a whole were put aside, this would create a strange situation: human information consumption, as that in the course of education -- accounted both in SNA and SNIA -- should essentially be considered as *waste. Consistency requires that at least those cases of human information acquisition when (produced) information goods and services are consumed during intentional acquisition should be treated as production.*

The SNIA intends to make a *distinction between produced and non-produced human knowledge. Human knowledge acquired and accumulated should be considered at each level* as produced or non-produced information asset.

Due to our consistency condition, *using media as a principal activity*, as listening to radio, watching TV or cinema-films as well as speech and music, learning when attending various kinds of education and training (together with reading), particularly at the level of consciousness, are always considered *conventionally* as a non-natural process. Acquisitions into the short term memory will not be considered.

Following Lynn & Vanhanen (2002), IQ should be acknowledged and used as a measure of human assets. On the micro and sector level, the changes in the volume of produced human knowledge of employers might be recorded here due to *changes in employment*.

2.5. "With What Purpose?" – The Purposes of the Actors

The *purpose* of the actor determines the character of the action. A flow may be initiated by the producer or a consumer. The market producer, as a rule, outputs an information good so as to realize profit or to fill its obligation to do so. The consumer may wish to purchase a good or to get to it illegally (espionage) or entitled to get free information. The purpose of the actor makes an action a transfer or market output.