

Changing Markets in Operating Systems; a socio-economical analysis

Jonathan Liebenau,
Silvia Elaluf-Calderwood & Enrico Rossi
London School of Economics and Political Science (LSE)
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access (11) actors (3) analysis (4)
applications (11) boundaries (3) characteristics (2)
cheaper (2) cloud (2) compatible (3) competition (5) consumer (2)
consumption (3) content (4) control (10) creation (3)
data (6) devices (6) distribution (3) edge (4)
elements (6) eliminated (2) embedded (2) enabling (3) end (6)
establishing (3) exchanges (3) future (2) hardware (3) heterogeneous (2)
innovation (3) integration (4) internet (3) located (5) lower (2)
market (3) microsoft (2) mobile (2) models (5) modularity (5)
modules (6) multiple (2) network (8) open (3)
operating (3) order (3) OS (26) ownership (12)
personalized (3) platform (8) point (3) power (3) preference (2)
process (4) producers (5) production (4) provider (3)
questions (2) regulation (3) regulatory (3) roles (2) service (7)
significance (4) social (3) software (4) source (3) standard (4)
support (3) systems (8) technological (3) tested (2) therefore (2)
type (3) unix (3) used (2) user (14)

Presentation contents

- ◆ Exploratory work & motivations
- ◆ Project research questions & novelty approach
- ◆ Establishing relations of power structure in OS
- ◆ Platforms and competition
- ◆ New roles of ownership & control (platform analysis & data ownership/control)
- ◆ Shifting boundaries
- ◆ Preliminary conclusions; future research

Exploratory work and motivations for this research

- ◆ Our main purpose is to assess the character of OS market to better understand characteristics & consequences of fragmentation.
- ◆ We consider in our analysis effects on trade & innovation & on the significance for the architectures of networks in the digital economy.

Three core research questions

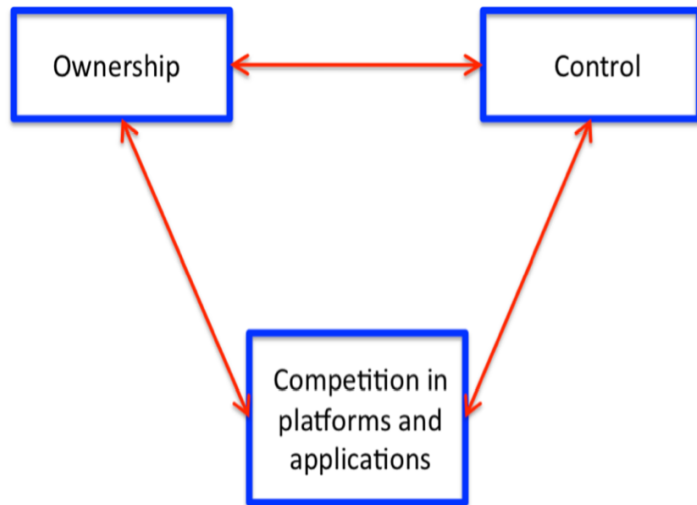
- ◆ Where does control reside in an ecosystem of devices, software & services?
 - ◆ *What happens when we distinguish between control & ownership*
- ◆ What is the significance of application & protocol standards in a heterogeneous network?
- ◆ What is the significance of application technologies with regard to use?

Novelties in research

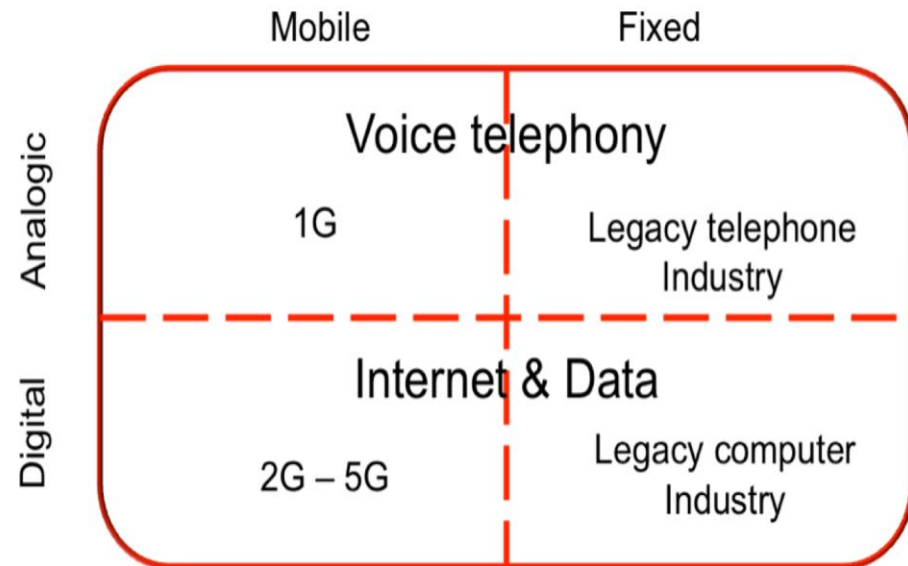
- ◆ Boundaries between the standard roles of consumption and production are blurred in the consideration of operating systems.
- ◆ Novel concepts of ownership apply.
- ◆ The decoupling between services and physical supports raises issue of control rather than ownership.

Establishing structures of power in OS

1

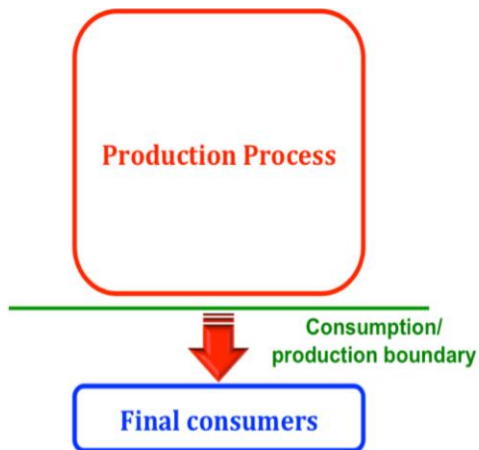


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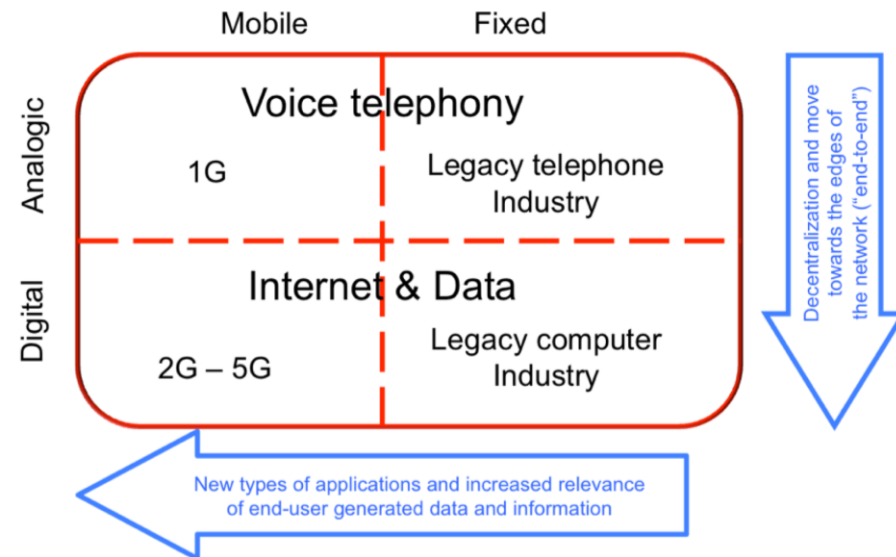
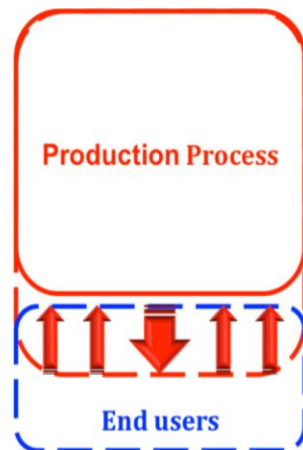


Establishing structures of power in OS

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4



Platforms & competition (i)

Modularity in production

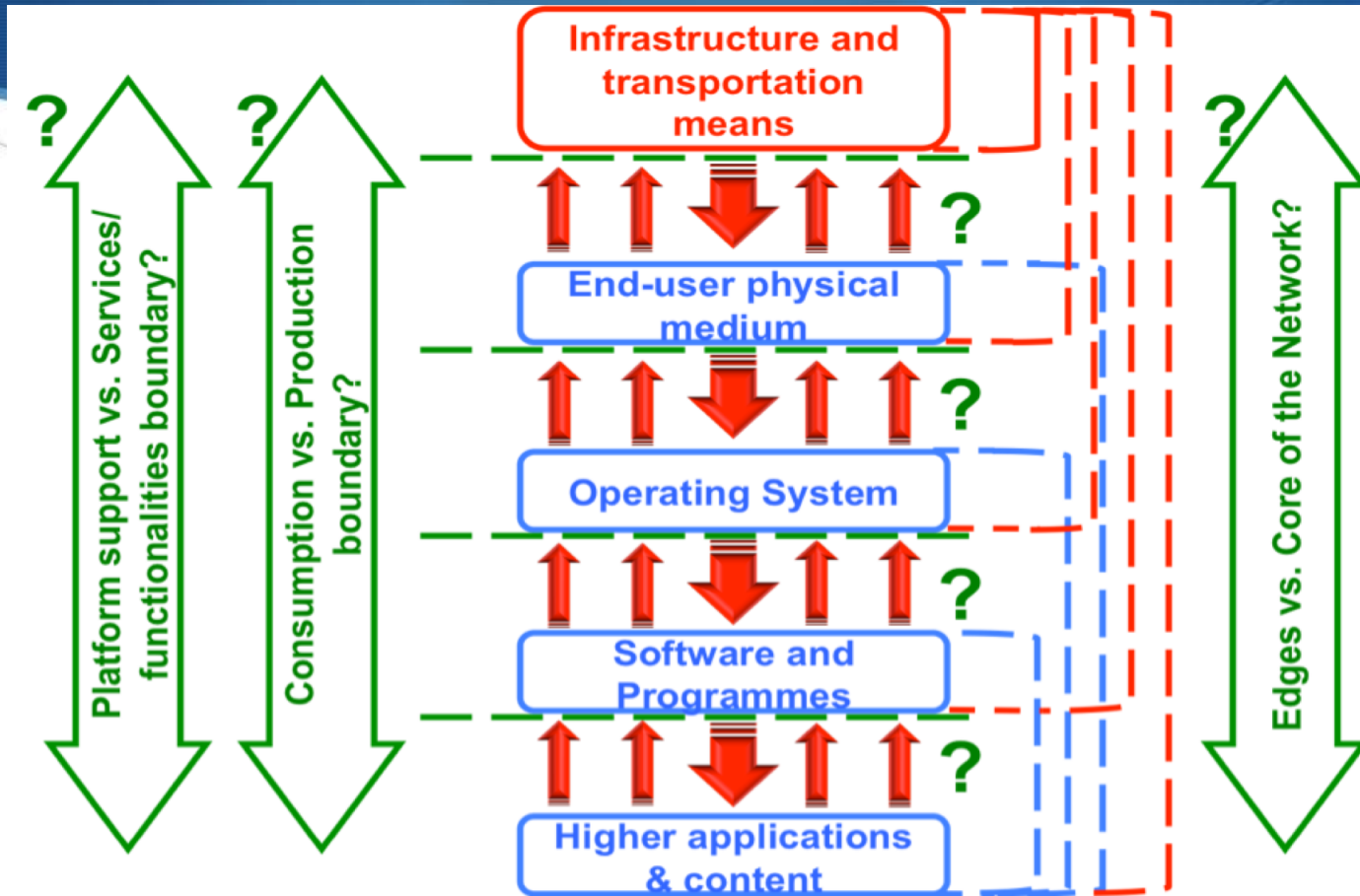
- Identifies the set of elements (modules) interconnected among each other (& compatible), located in the network core
- These are therefore in producers' domain (ISP, VPN, network providers in general, etc.)
- Two characteristics of this type of modularity
 - Producers own the elements (or modules);
 - These elements are always inputs in the production process (or are part of the production process); they are used to deliver some type of service to end users

Platforms & competition (ii)

Modularity in consumption

- Identifies the set of elements (modules) interconnected among each other (& compatible) located at the edges of the network, i.e. in the domain of the end user
- More ambiguous than production; (ownership boundaries at the edge may be blurred)
- These elements are mainly outputs of a production process: they are sold to the end user by whoever produces them

Platforms and Competition (iii)

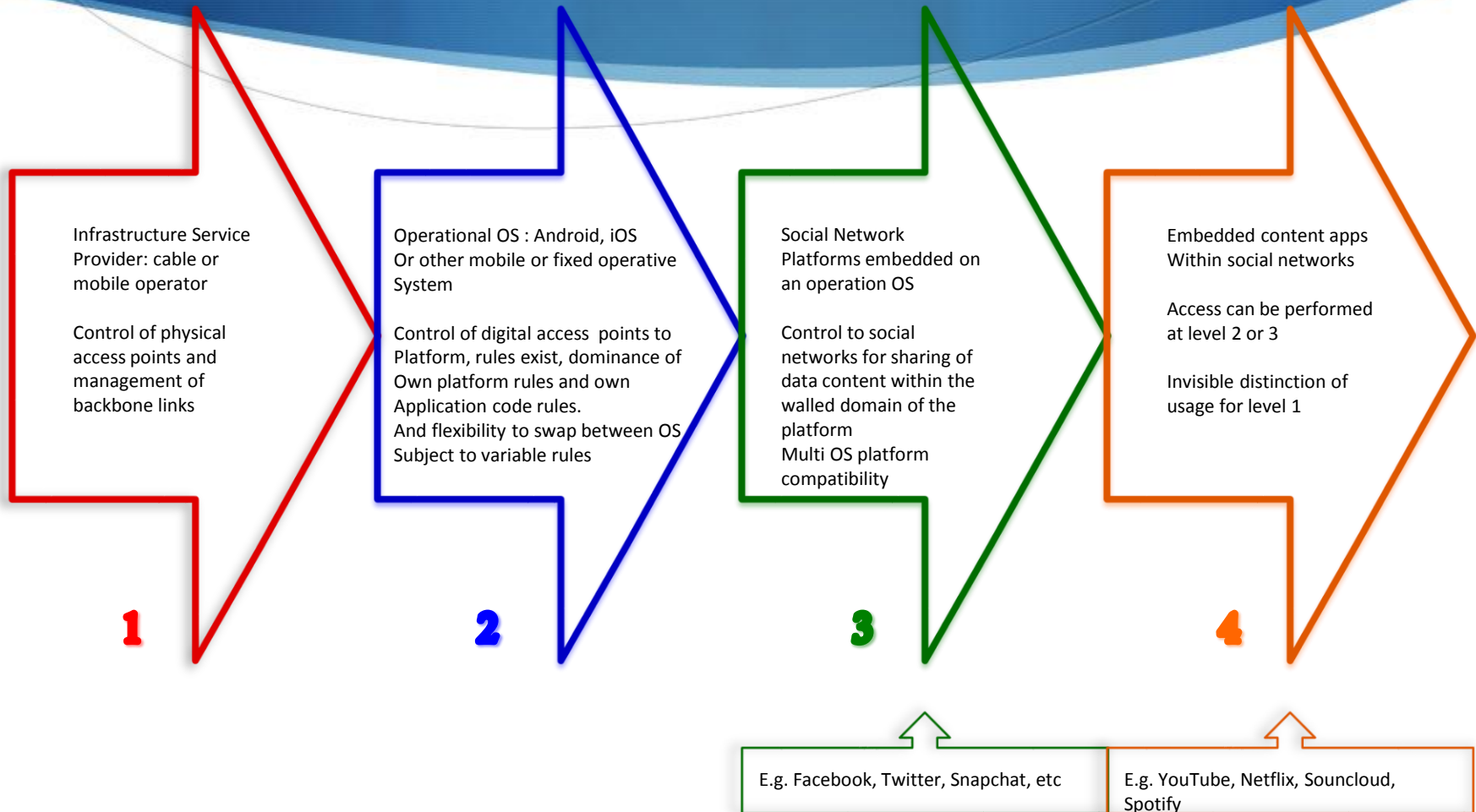


A current research problem concerns the interpretation of the feedback, identified as question marks

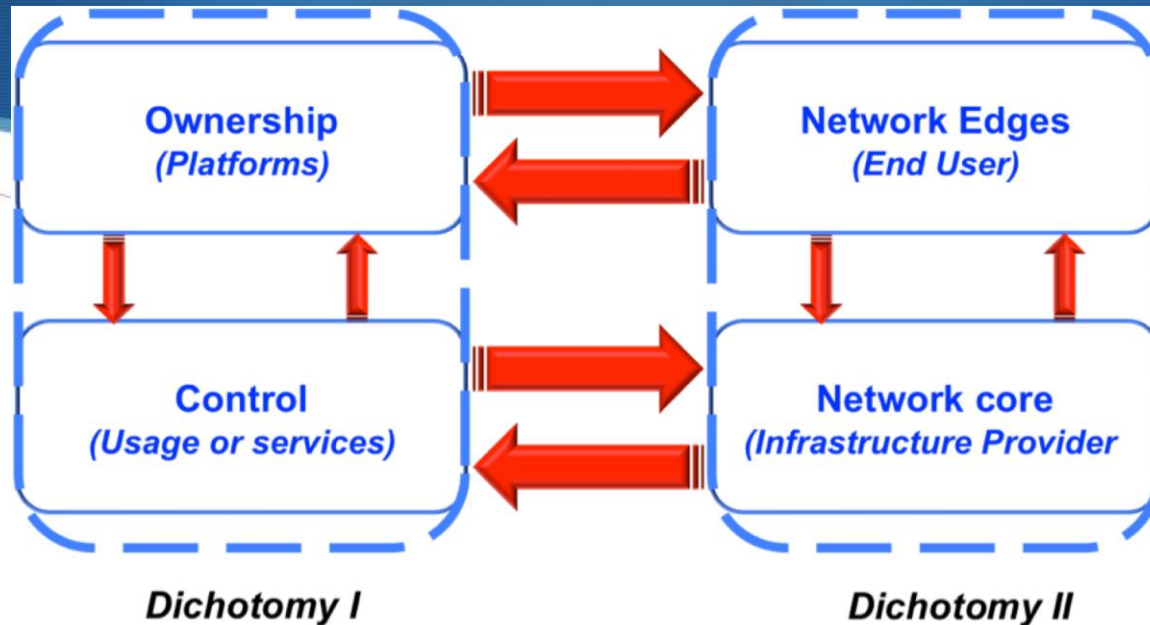
New roles of ownership & control

- ◆ Control, access & ownership in the physical layer in platforms
 - ◆ Backbone networks, internet exchanges, private links, fiber and copper networks, access exchanges, access points
- ◆ Control, access & ownership of intangible assets:
 - ◆ Ownership of data among various actors cooperating (or competing)
 - ◆ Relationships with the OS provider

Internet Platform Analysis



Shifting boundaries: Analysis example



1. The boundary defining ownership: who owns what & where;
2. The boundary defining the relationship between (tangible/intangible) platform & services that can be obtained: who controls what & where;
3. The boundary separating consumption from production: who is selling something to whom & where.

Preliminary observations

- ◆ Where the end user ownership/control of the various modules is located vis-à-vis the producers' ownership/control of the same elements.
- ◆ Where the decoupling between the underlying platform support is located vis-à-vis the functionality set (or service set) supported by it.
- ◆ Whether the service flows are all pointing down-ward (as in a standard setting where the end user at the edges is just consuming what is offered), or whether the end user is actually operating as a producer, thus using its modules and mediums in order to pipe further services (applications, data or information) into the network in a decentralized way.

Further research

- ◆ Mapping triggers to understand the shifting in boundaries for regulatory, technological, & social factors.
- ◆ Building a model that can be tested with economic variables
- ◆ Testing hypothesis for law & regulatory implications
 - ◆ Links to Open Source analysis is a partial view

Extra Slides

Data Ownership/Control

- Network layer
- Control of ID user (SIM)
- Authentication
- Encryption (hardware)
- Location based services
- Monetary transaction verification and processing
- All types of protocols to manage traffic (networks OS)
- Net neutrality

1

- OS layer
- Identification
- Authentication
- Encryption (software)
- Location based services
- Gateway for accessing information faster or with profile preferences (databases)
- Unique protocols for distribution of content
- Strong Inter operability

2

- Social platforms
- Identification
- Location based services
- Access to information in layers 1 and 2
- Profiling and privacy
- Meta data
- Personal data
- White box interoperability with platform OS
- Monetary transactions

3

- Content
- Identification
- Location based services
- Access to information in layers 1 - 2 - 3
- Profiling & privacy
- Meta data
- Personal data
- White box interoperability with platform OS
- Monetary transactions
- High reliability service
- Traffic preference rules ideal

4

Continuing research: triggers

Regulatory

Cheaper hardware and increase in available bandwidth and mobile device access to data without service caps.

Main OS systems created in the USA: Unix, Microsoft Windows, Apple OS, IBM support for Unix and Windows. Linux created internationally, but common family to Unix.

Competition between OS regulated by competition practice and debate focused on specific access to applications: e.g. Netscape vs. Mozilla browsers, embedding of mail applications.

Simplification of content licensing process

Privacy regulation has lagged behind innovations in the OS world

Future regulation will look into issues of AI and IoT integration to heterogeneous OS applications

Technological

Diversification and expansion of user ownership of devices: desktop, laptop, mobile phone, tablet, appliances at home, smart TVs etc., leading to the IoT

Demands or requirements to develop robust (stable) but also lower power (sustainability) and memory consumption

Enabling of OS platform owners to access users profiles and potentially enable within walls monetary transactions.

OS aim to provided personalized/context aware experience and content recommendations

Compatibility of applications' data exchange (files on all formats) enabling sharing and distribution over clouds

Elimination of hardware control of peripherals, switch towards software based control.

Miniaturization and ubiquitous systems for monitoring and control using OS will be the norm.

Business

OS has significantly eliminated the irregularities of cloned software in most countries (exception China, Russia, etc.) and this has led to cheaper or open source access to software either with one standard installation or cloud access to applications. Revenue model for licensing has changed over time.

OS has implemented, integrated and embedded solutions to extract valuable metadata on users' activities and preferences, and this info has allowed OS creators and platform owners to establish strategic partnerships for provision of add-on services and multiplatform integration.

Although the personal user/business user is dominated by proprietary OS, the internet backbone is run to a higher degree on Open source OS.

The flexibility of OS platforms allows for the constant innovation or the creation of new models for content creation funding.

New metrics and analysis perspectives are used to strategize the expansion and impact of OS in multiple devices and screens.

Market is consolidated in a few actors that have huge influence on both internet standards and device hardware manufacturing.

Further lower the entry cost to access OS applications.

Social

Share models of collaboration and distribution of content have had an impact on OS creation, major actors such as Microsoft moved from one-computer stand-alone installation of OS to distributed models of access of applications.

In the developed world there is a high level of penetration for the use of multiple devices simultaneously, and the social demands are for seamless integration and minimum restriction on the transference of data.

Users perceive a personalized experience within the walls of one OS systems as acceptable. However, the user preference to choose when and what to use ought to be above the constraints of the OS system.

There are significant advantages to keep the consumption of OS systems with verified identity and privacy architecture within the OS, as many users automatise many aspects of their everyday life to be managed or at least mapped by applications in OS systems.