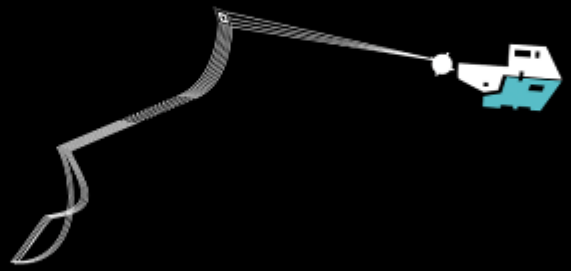
UNIVERSITEIT TWENTE.

Enterprise Interoperability with the Internet of Services

Marten van Sinderen

WEBIST 2011, 8 May 2011, Noordwijkerhout



Agenda

- Internet development
- Services science
- Internet of services
- Enterprise interoperability

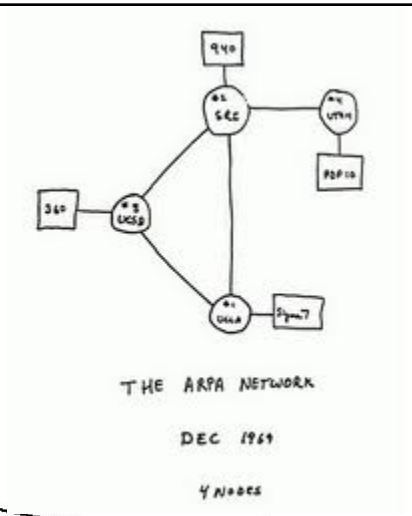
Internet development

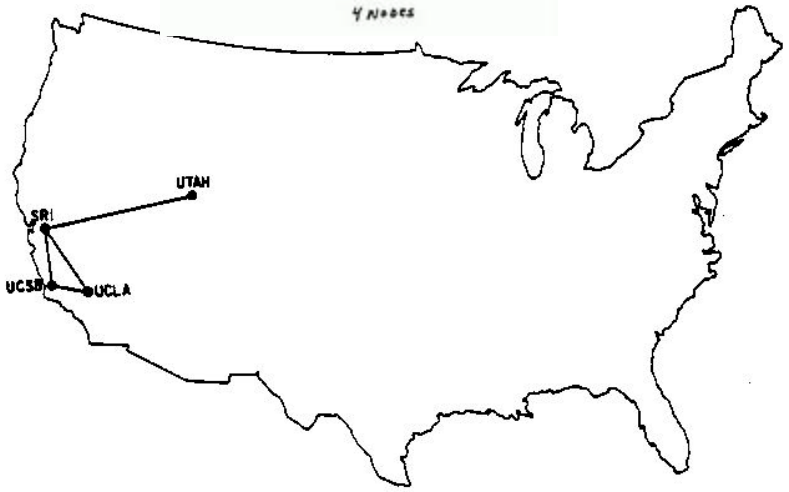
Internet development

- It all started 45 years ago …

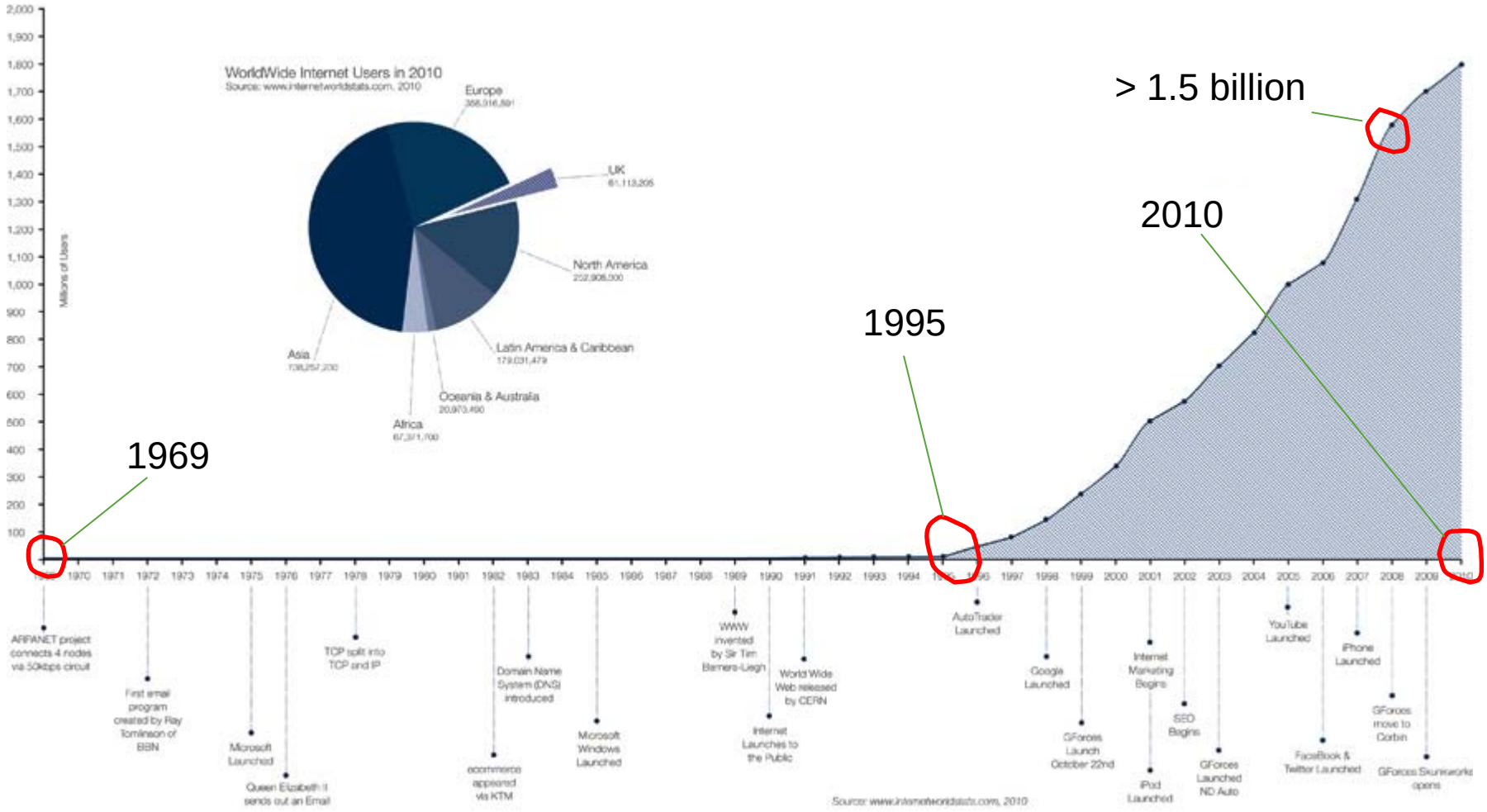
  … the ARPA computer network

- Connecting scarce research computers
- Initial growth was slow
- Initiated by Email





Internet growth



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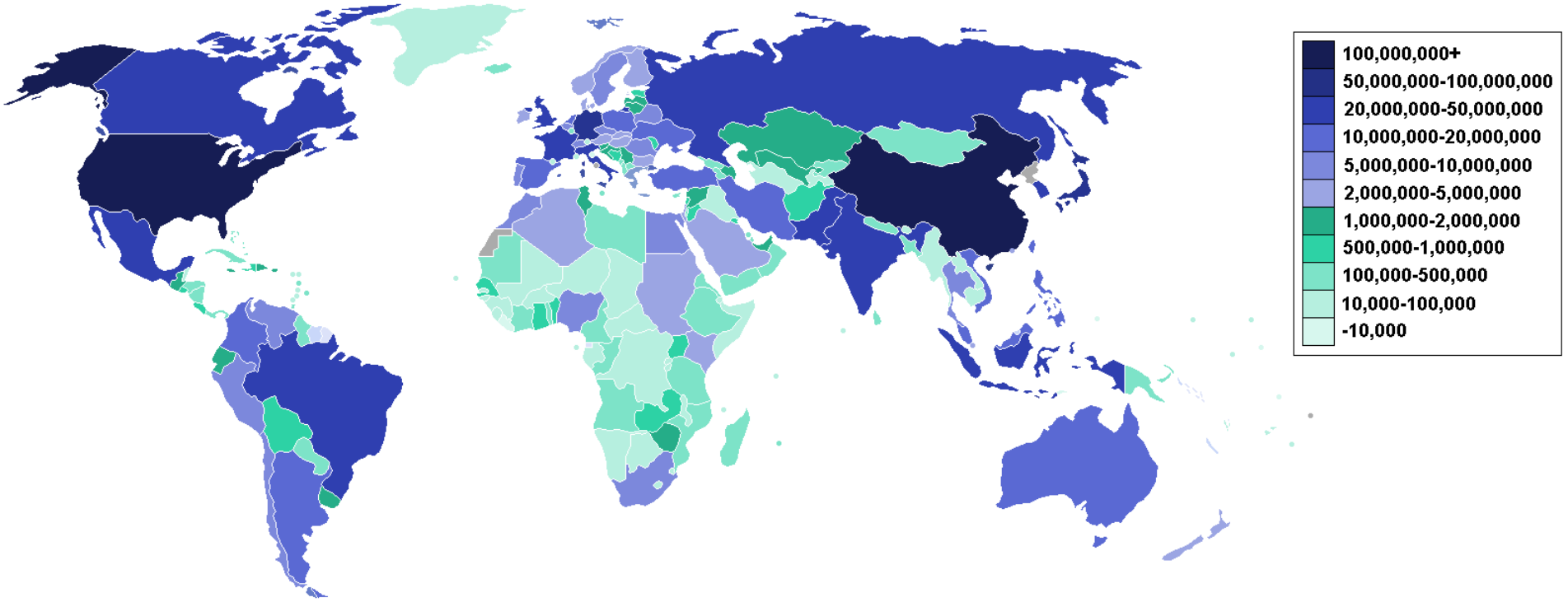

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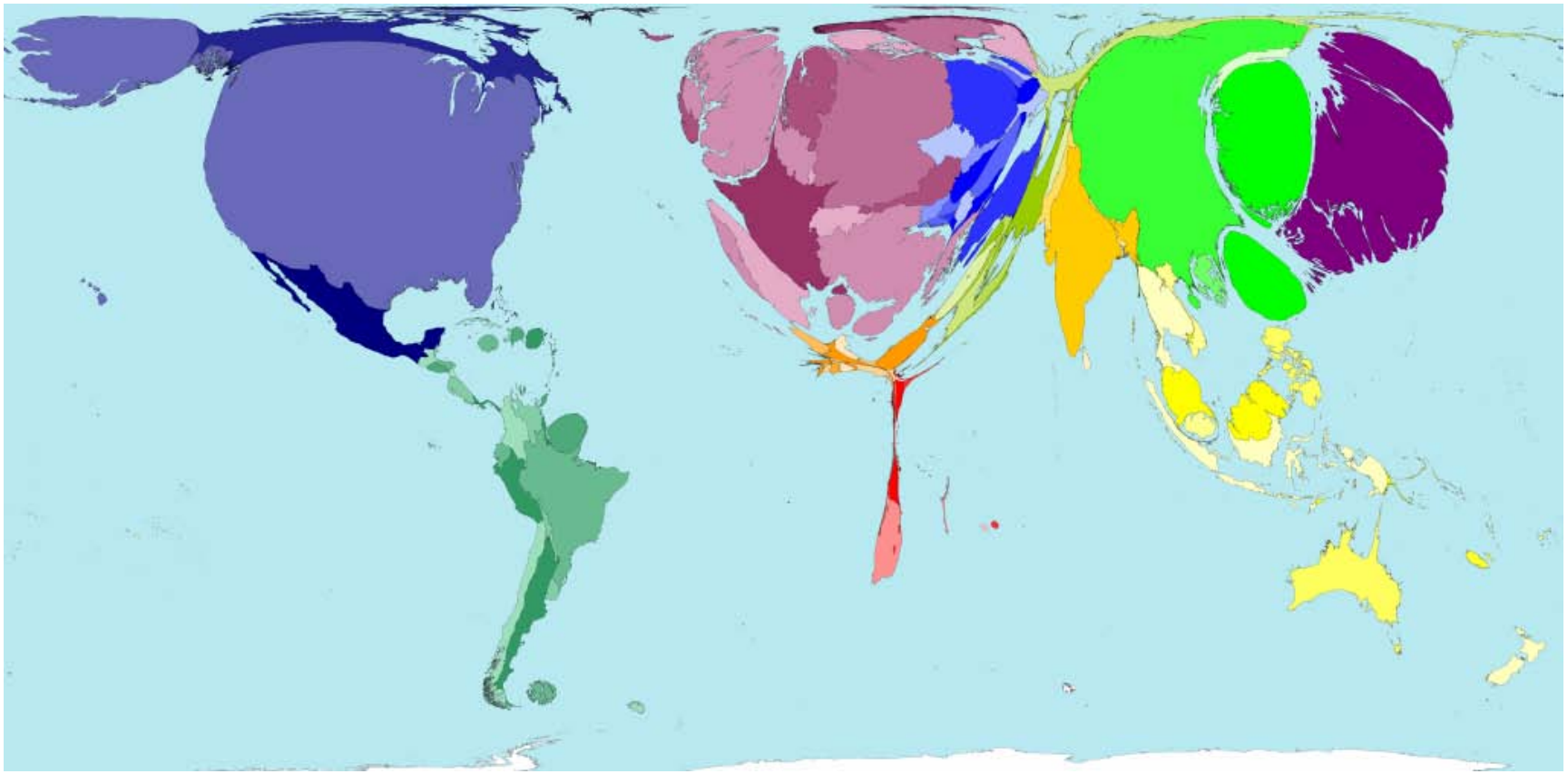
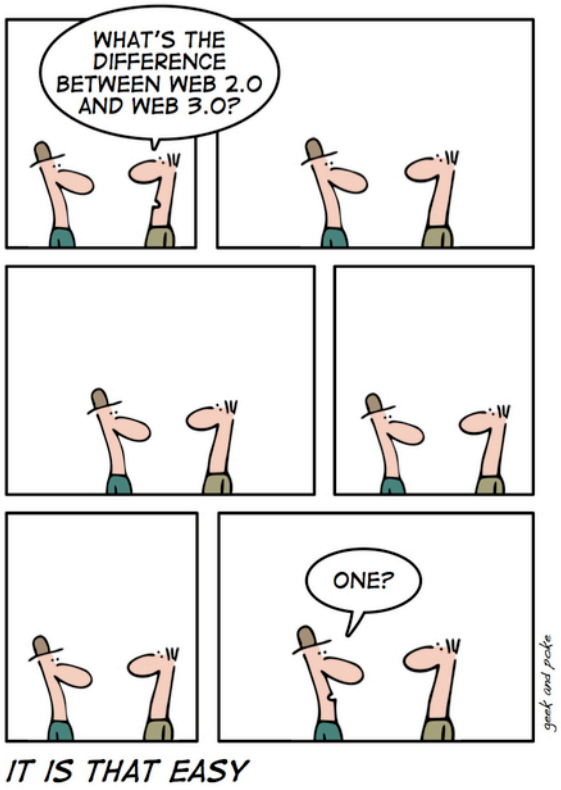


The Web

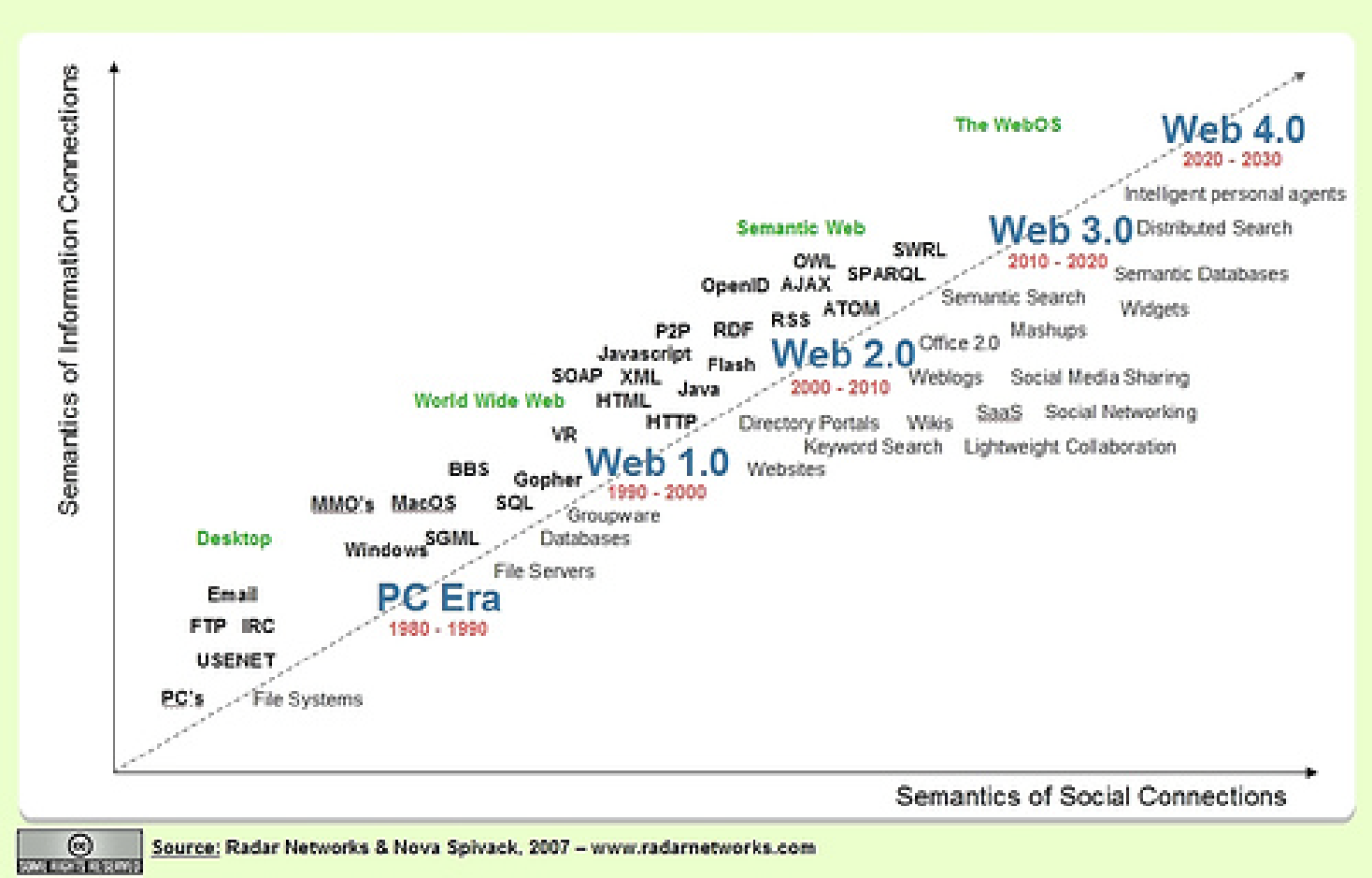
- The World Wide Web appeared 20 years later …

  … proposed by Tim Berners-Lee as a Hypertext project

- Followed by new generations Web X.0

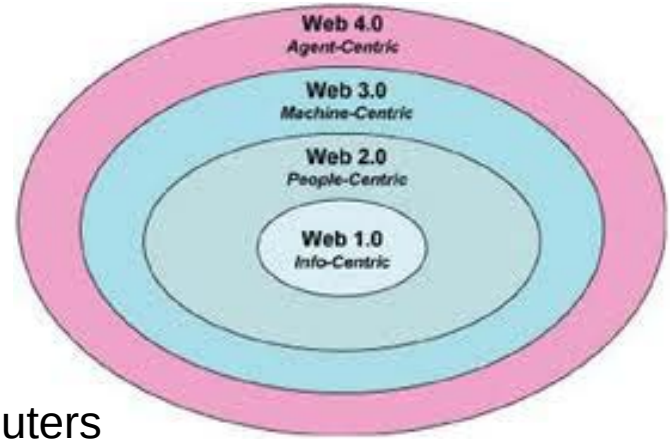


Web evolution



Web evolution

- Web 1.0: linking information written by others
- Social Web (Web 2.0): interact and collaborate through social media
- Services Web: adding computational capabilities
- Semantic Web (Web 3.0): make information understandable for computers
- Smart Web (Web 4.0): combine all of the above, connect physical and digital world



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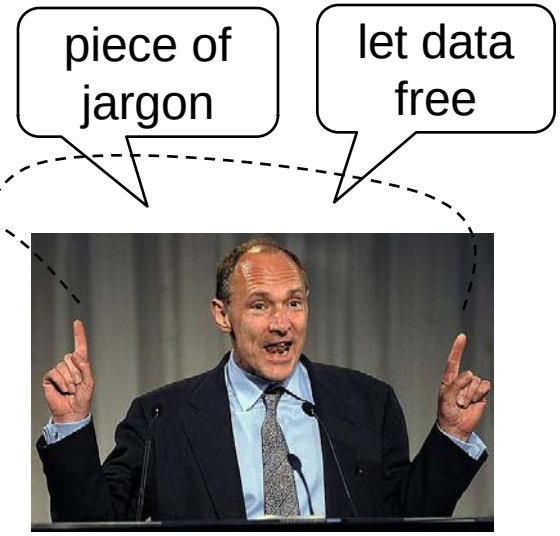
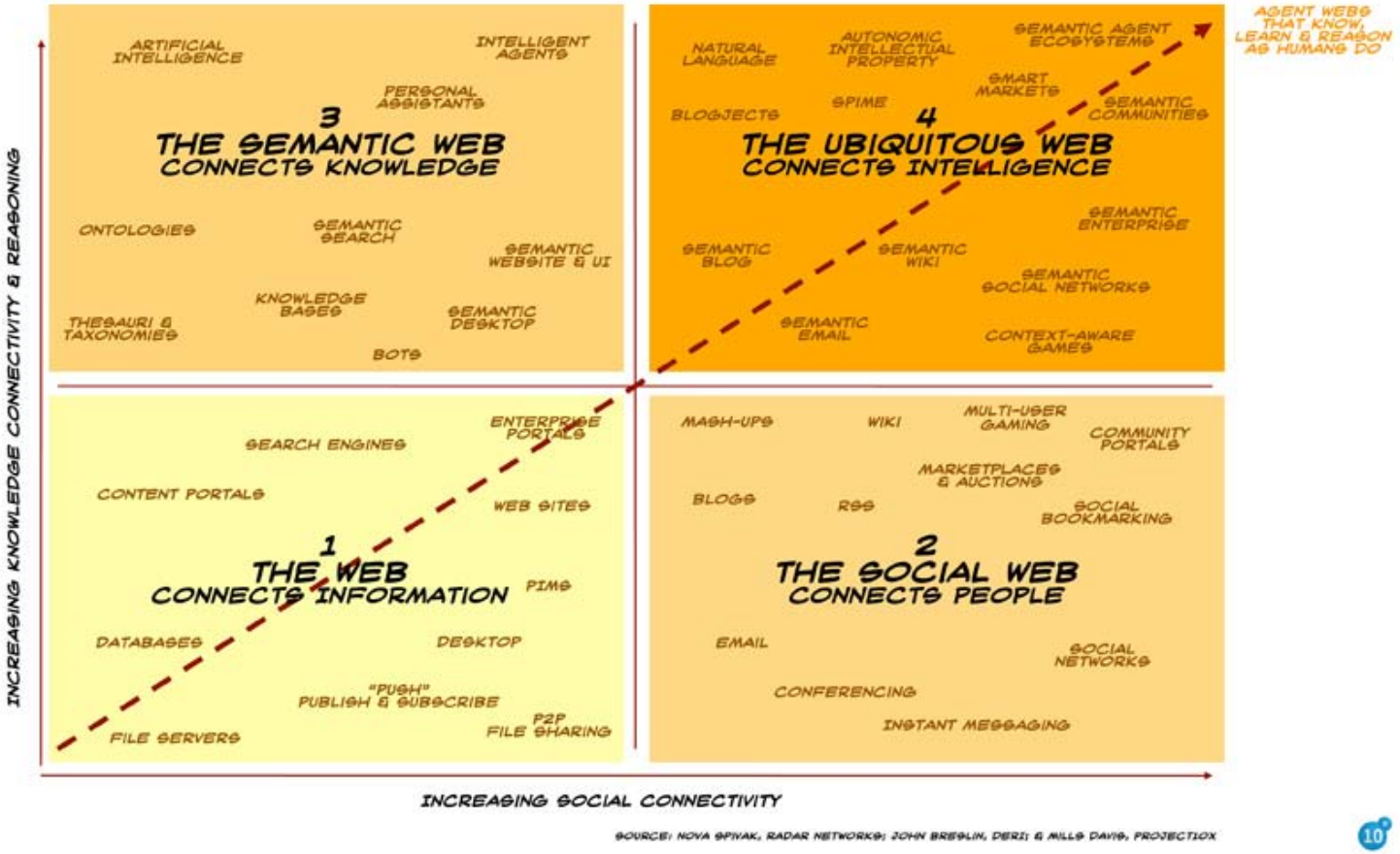


Web evolution

What is the evolution of the internet to 2020?



Services science

Shifting trends

- Innovation trends over time

Agriculture

Industry

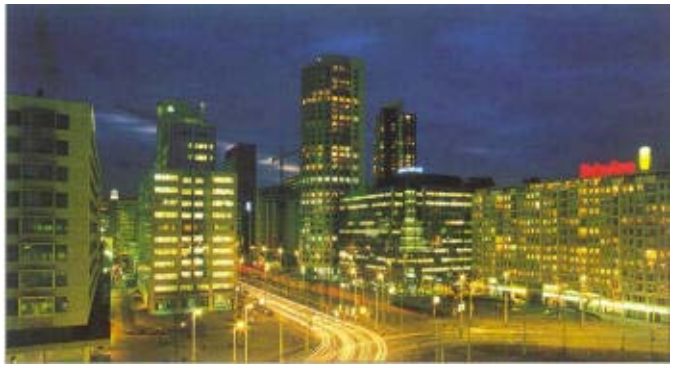
Services

Services economy

- Services sector is fastest growing industrial sector worldwide
  - Major source of revenu
  - Major source of employment
- In the Netherlands
  - 70% of Gross Domestic Product
  - 50% of net national income
  - 80% of labour force

Services economy

- Main sectors (in the Netherlands)
  - Transportation, goods distribution
  - Financial services
  - Tourism
- Fastest growing
  - Personal communication services
  - Specialized computer services

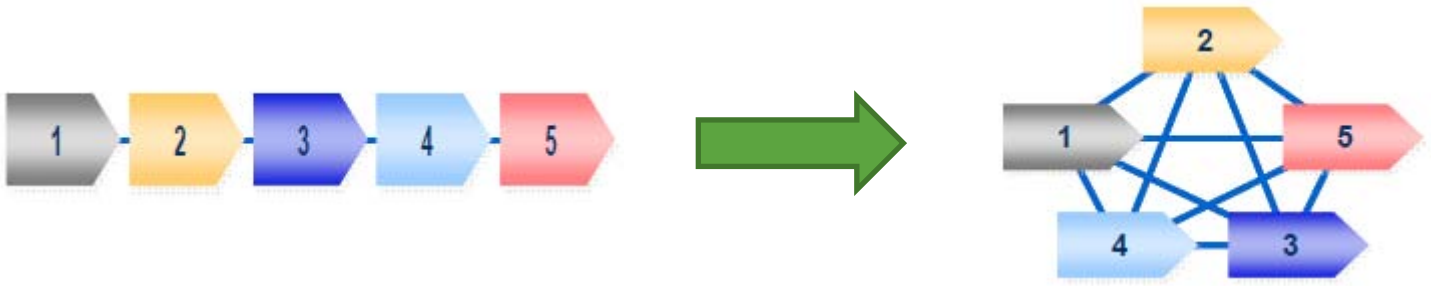


Changing business context

- Investments in ICT have previously been driven by focus on increase of efficiency and top-down change of business processes
- Assumptions*
  - Stable demand exists for durable products with a low price
  - Scale and complexity of work requires experts that specify what needs to be done
  - Common workers submit to experts' rules in return for higher productivity, profit and pay

* Source: EC (2008), Unleashing the potential of the European knowledge economy

From value chain to value network



- Change of focus
  - From hierarchy to network
  - From process to people
  - From directed structure to relationship
- Flexibility!

Multi-disciplinary perspective

- Contributions from research developments in different disicplines, especially
  - Computer science: information systems, software engineering, databases, knowledge engineering
  - Business administration: business modeling, change management, marketing, financial engineering
- Interpretation of service
  - Business services
  - ICT services
- Integration of social, physical and digital worlds

Services science

- Need for research and education program that bridges these disciplines
  - Transfer of knowledge from one to another discipline
  - Creation of new (interdisciplinary) knowledge
  - Establishment of ‘unified service theory’
- Societal relevant delivery
  - Trained service professionals for the services industry
  - Knowledge sharing and knowledge transer

Example: Services science at University of Twente

- Embedded in Twente Graduate School (http://www.utwente.nl/education/tgs/)
- Research orientation
- MSc and PhD phases, total of 5 years
- Rooted in existing Master programs of Business Information Technology and Computer Science, and in national Research Schools

Twente Graduate School

Home > Programmes > Services Science

HOME
ORGANIZATION
PROGRAMMES
PROSPECTIVE STUDENTS

SITEMAP
SEARCH
PRINT VERSION

Advanced Optics | Computational Science | Dependable and Secure Computing | Ethics and Technology | Fluid Physics | Governance of Knowledge and Innovation | Human-centered Interaction Technologies | Industrial Engineering | Learning in Educational and Training Settings | Next Generation Energy and Resources | Novel Nanomaterials | **Services Science** | Wireless and Sensor Systems

TWENTE GRADUATE SCHOOL

SERVICES SCIENCE

- Profile leading Professor

Programme

- Programme summary
- Detailed programme structure
- Description of Research Area
- Participating Research Groups

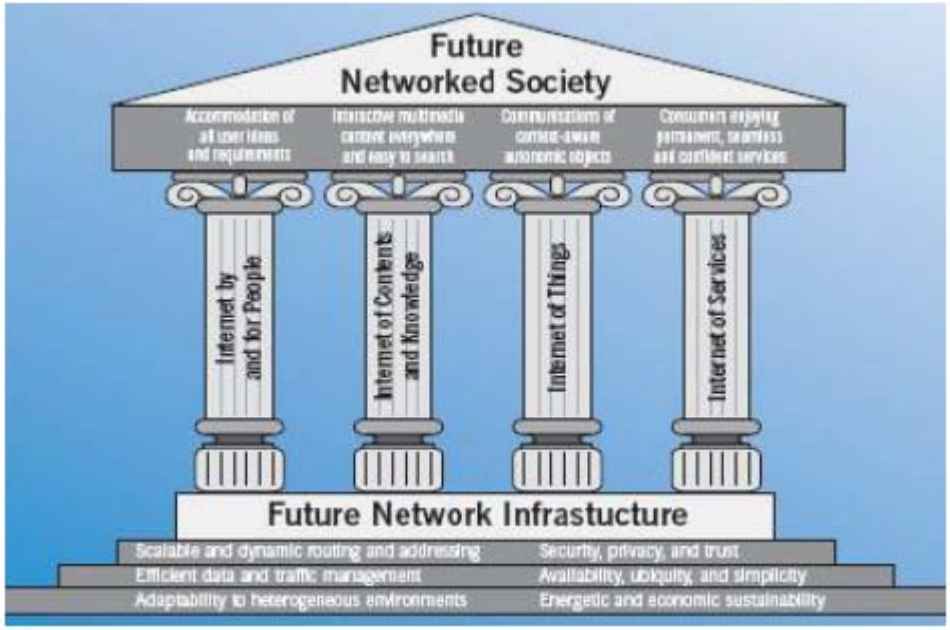
Internet of Services

- The current Internet is a great success
  - 1.5 billion users (2008)
  - 3 billion hosts (2008)
- But: growth and requirements led to many piecemeal solutions
  - Impact on simplicity and transparency
  - Operating costs start to increase more than proportionally to the number of hosts
- Current architecture is approaching saturation point*

* Source: Cross ETP vision document (2009), Future Internet

The Future Internet

- Empowerment of users, assisting society in emergency situations
- Global information exchange of human knowledge
- Secure, accountable, reliable without impeding privacy and dignity
- Adaptability features based on context, content, etc.



Pillars of the Future Internet

- Internet for and by People
  - Facilitate every day life, user as ‘prosumer’
- Internet of Contents and Knowledge
  - Intelligent processing and rendition of information
- Internet of Things
  - Real world phenomena can be sensed, objects can be addressed
- Internet of Services
  - Service-orientation everywhere
  - Services are composable, contextualized, proactive, personalized

Enterprise interoperability

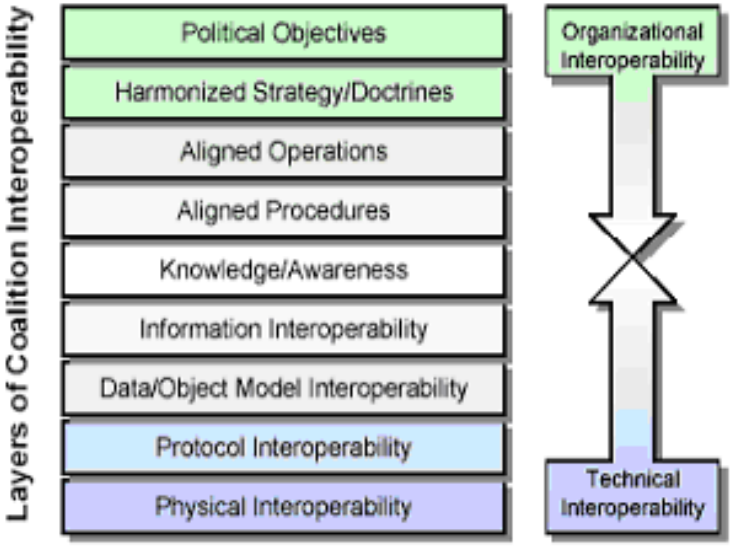
- Enterprise interoperability is needed to support the dream of an open en borderless economy
  - ICT is important enabler
- Business context for enterprise interoperability has changed / is changing
  - Dynamic value networks
  - Internet of Services
- Enterprise interoperability should not just connect business organizations, but stimulate value creation based on innovation

Basic interoperability requirements

- Business level
  - Understand each other's external procedures and the communications induced by these procedures
  - Act on received communications as expected by (agreed with) the partner
- Technical level
  - Automate procedures and communication with message-based information exchange and processing

Basic interoperability requirements

- Syntactic interoperability: valid messages
- Protocol interoperability: valid message ordering
- Semantic interoperability: understandable content
- Process interoperability: intended effect



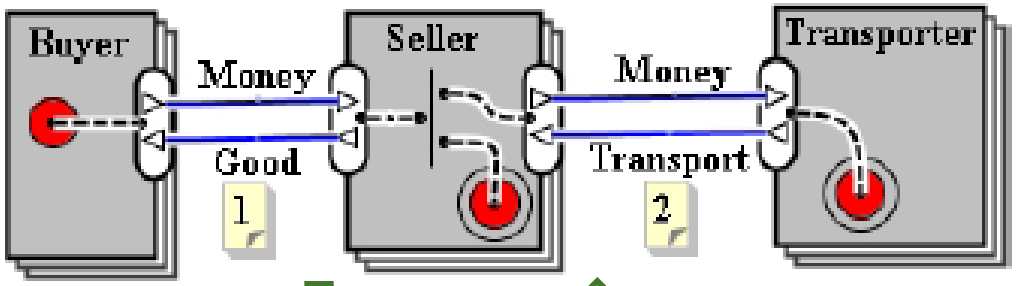
Enterprise interoperability challenges

- Many, including
  - Value and revenue distribution
  - Assess and build up trust
  - Pragmatic interoperability
  - Personalization
  - Support change
  - Allow “Fuzziness”

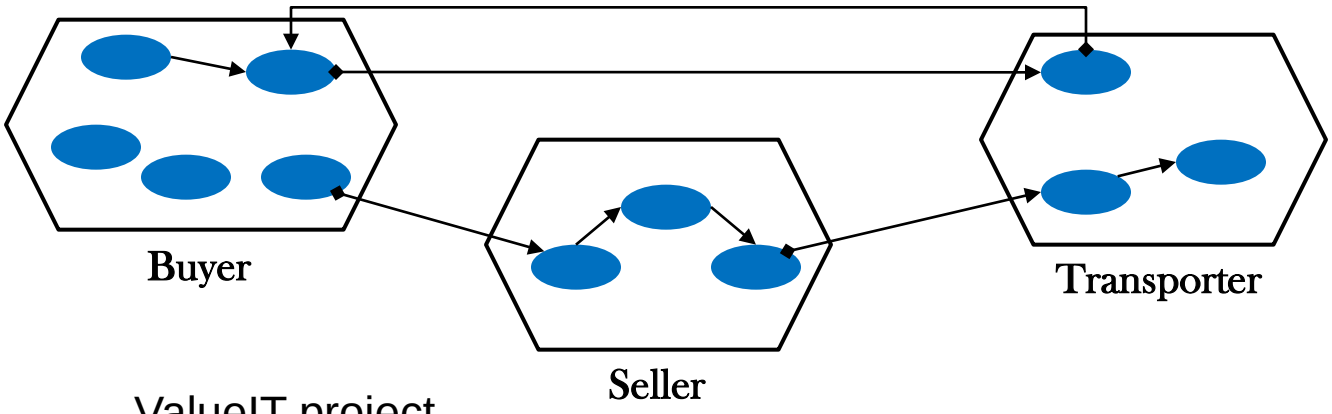
Value distribution

- In traditional supply chain (value chain) the flow of value is static
  - Tangible product from supplier to customer
  - Money from customer to supplier
- In dynamic business webs (value networks) the flow of value is more dynamic with exchange of tangible and intangible value
  - Each partner should experience a positive net effect of the collaboration
  - Sustained or accumulated over period of collaboration
- Need for explicit value modelling!

Example: value modelling



Value model



Business process model

ValueIT project,
http://www.e3value.com/projects/ourprojects/value-it

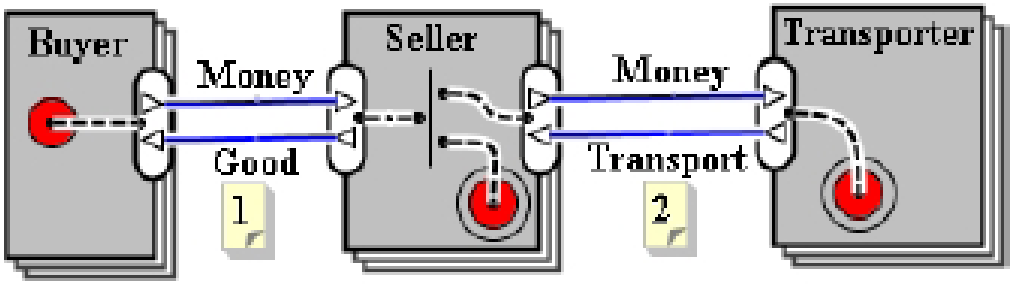
Trust

- Partners in a business web are assumed to act trustfully: a certain level of mutual trust is needed to start the collaboration
- Each partner makes a trade-off between the costs of measures and the risk of trusting others
- Need for modelling trust explicitly as a key component of collaboration

Example: trust-aware business web

- Extend value modelling with consideration of trust*
  - Partner will act to guard reputation, for sake of future relationships
  - Information dissemination on Internet provides powerful check
- Assess trustworthiness using deep reputation assessment
- Take account of trustworthiness of partner who expresses opinion about other partner

* Fatemi et al. (2011), Trust and value webs, accepted at EDOC 2011



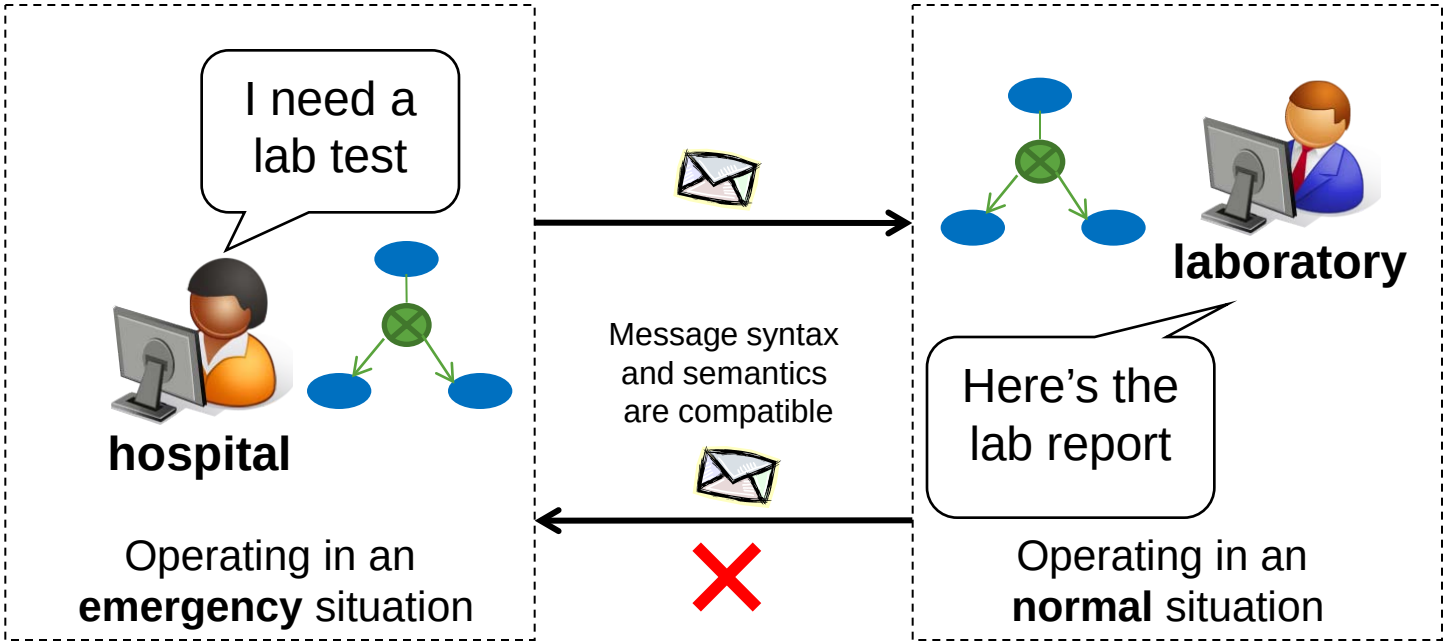
$$T^v(B \Rightarrow A) = \sum_{S_k \top A} w_k T^v_{S_k \Rightarrow A}$$

$$\sum_{S_k \top A} w_k = 1$$

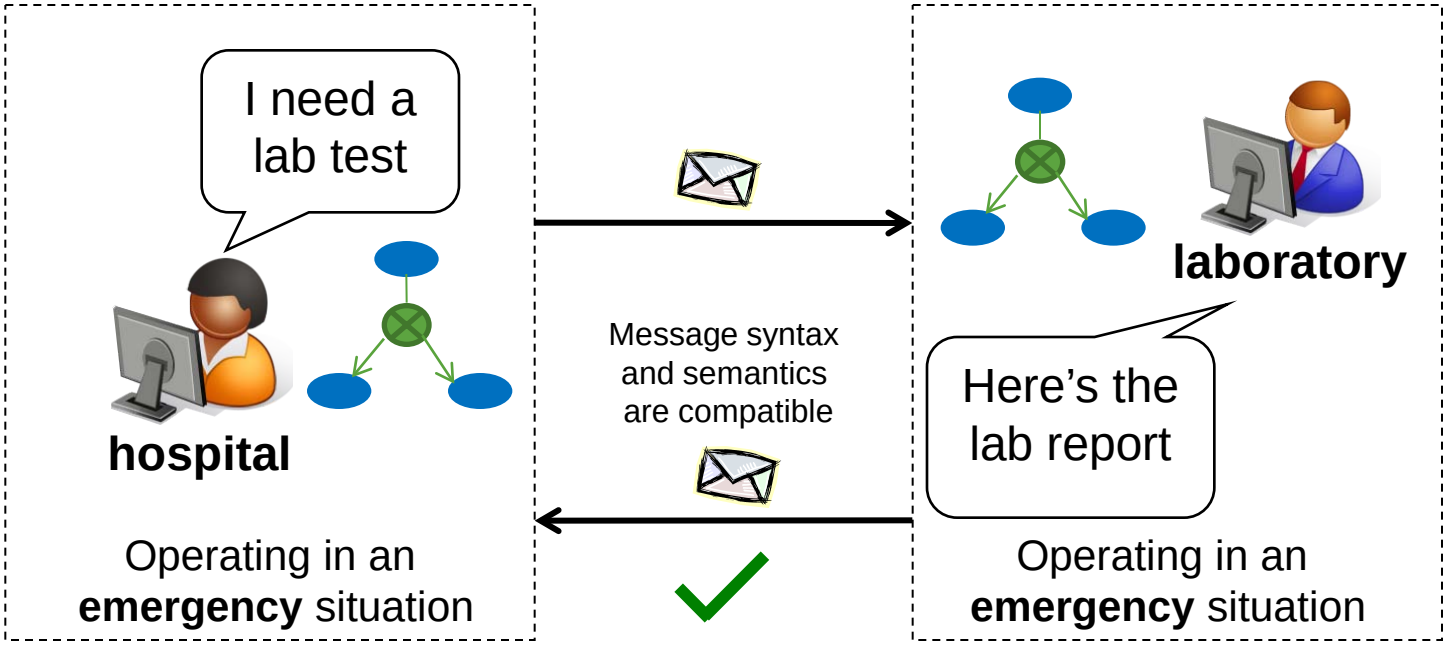
Pragmatic interoperability

- Extends semantic interoperability, similar to process interoperability
  - If a message is received, and correctly understood, it should be processed with the intended (agreed) effect
  - Effect may be ‘visible’ only after prolonged collaboration, involving several message exchanges
  - Understanding and processing generally depends on context

Example: pragmatic interoperability in context



Example: pragmatic interoperability in context*



* Asuncion et al. (2011), Towards pragmatic interoperability, IWEI 2011

Personalization

- Services can have added value if they are personalized to the needs of the end-user
  - Dynamic discovery and composition of services on demand in response to user request (Internet of Services)
  - Configuration of properties and behaviour based on context sensing (Internet of Things)

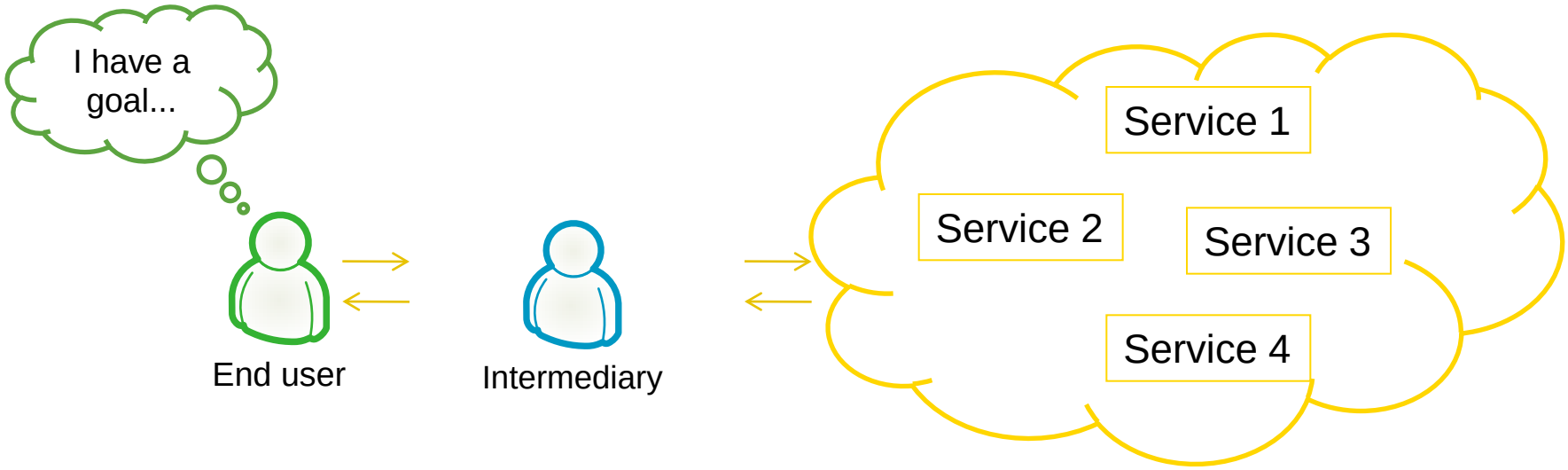
Example: User-centric dynamic service composition

- Users want to have personalized on-demand service provisiong
- Requirements are moving from ‘production for the masses’ to ‘production for the individual’

- Proliferation of context-aware resources and applications available as services
- Mobile devices and networks allow users to access these services from any place at any time

Example: User-centric dynamic service composition

- Although there are many services available, personalisation and on-demand requirements of end-users may require intermediaries to adapt the available services to the goals of the end-users



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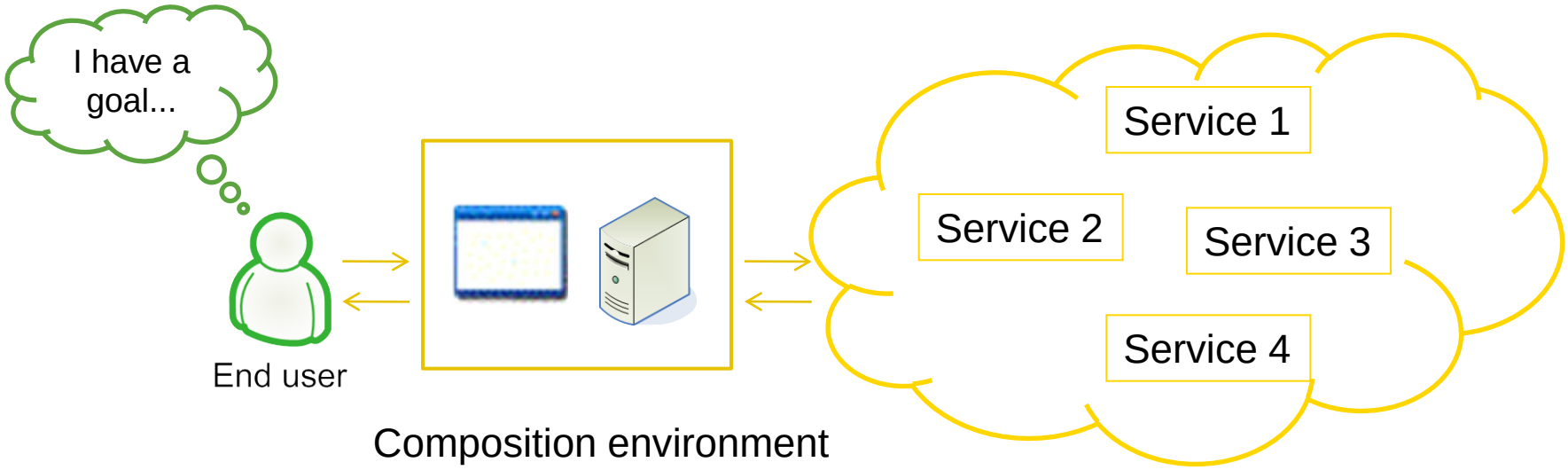
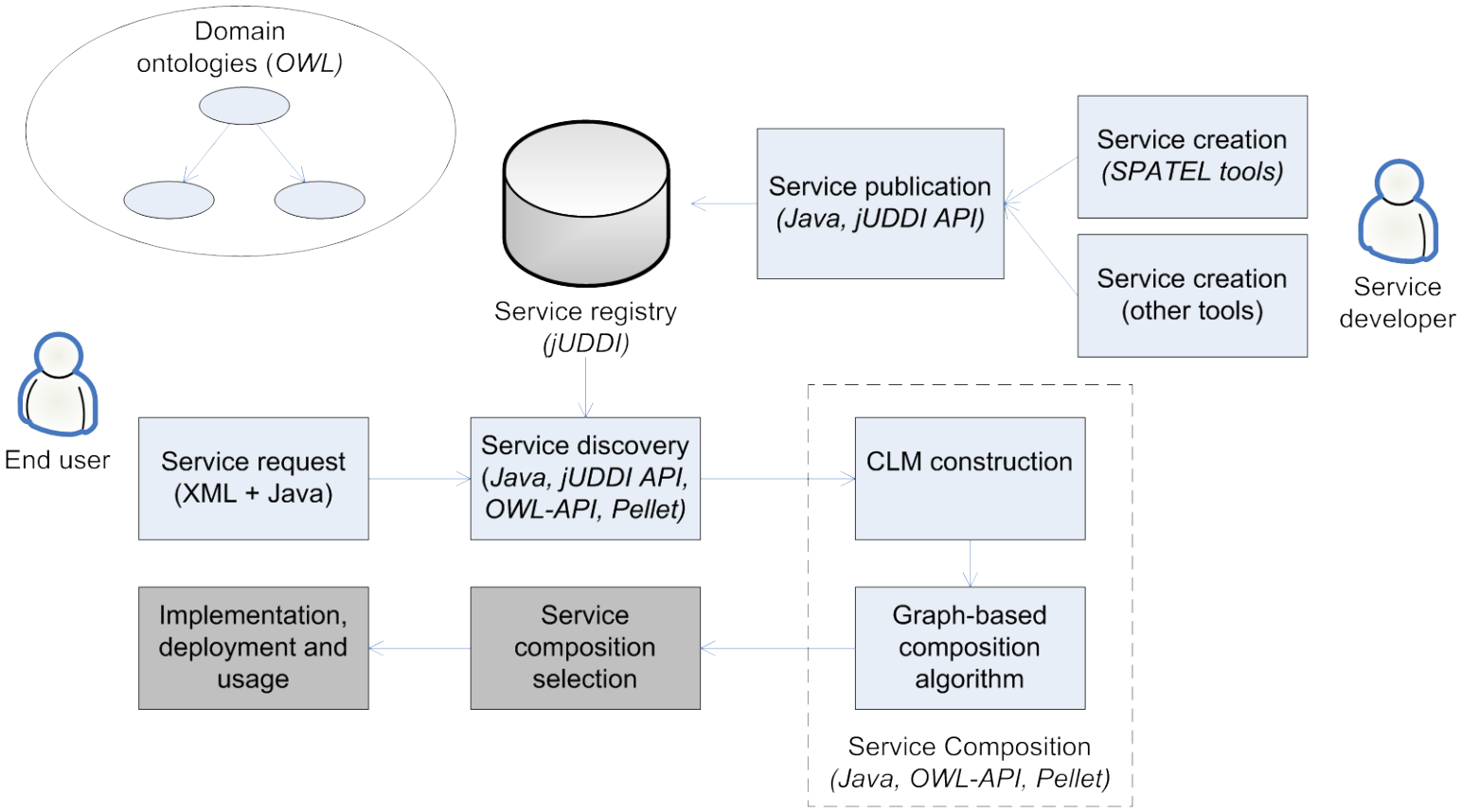


SPICE project, http://www.ist-spice.org

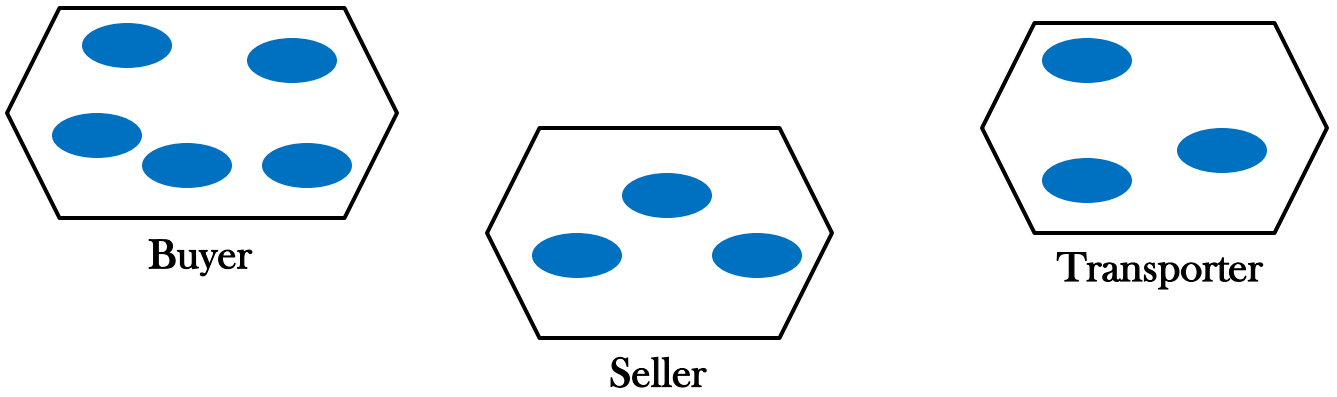
Example: DynamiCos*



* Silva (2011), User-centric service composition, PhD Thesis

Change

- Change is certain factor of modern business webs
  - Change of business requirements and technology capabilities
  - Change in business structure: partners and services



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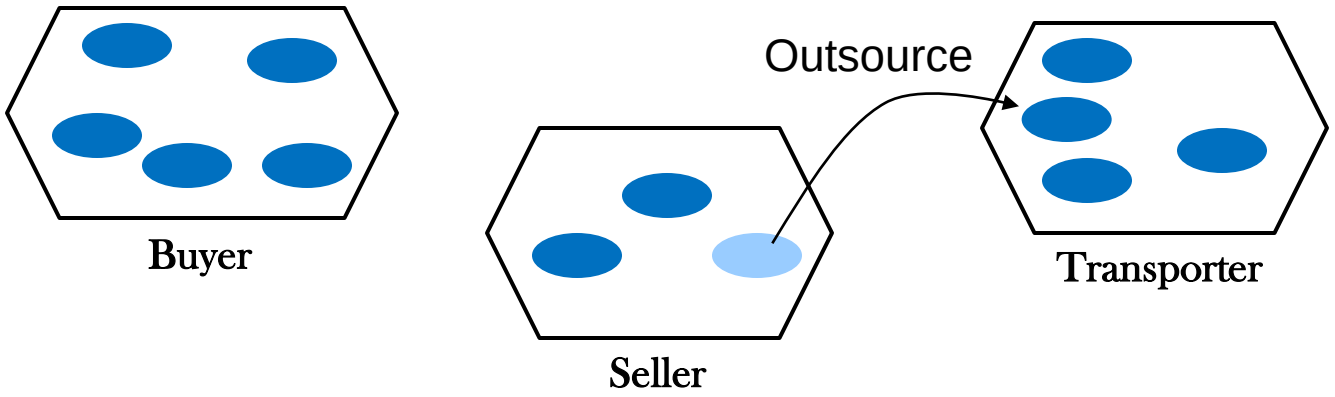

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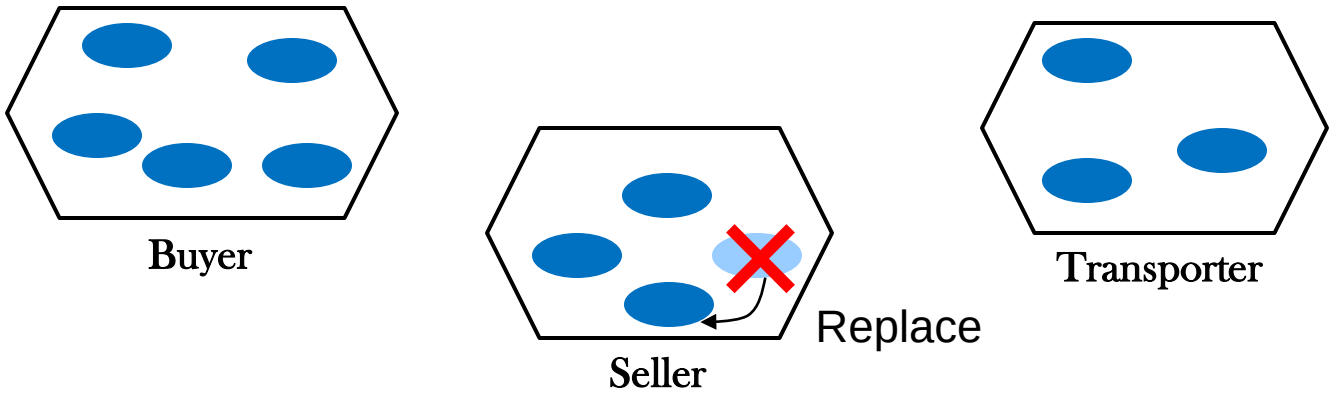

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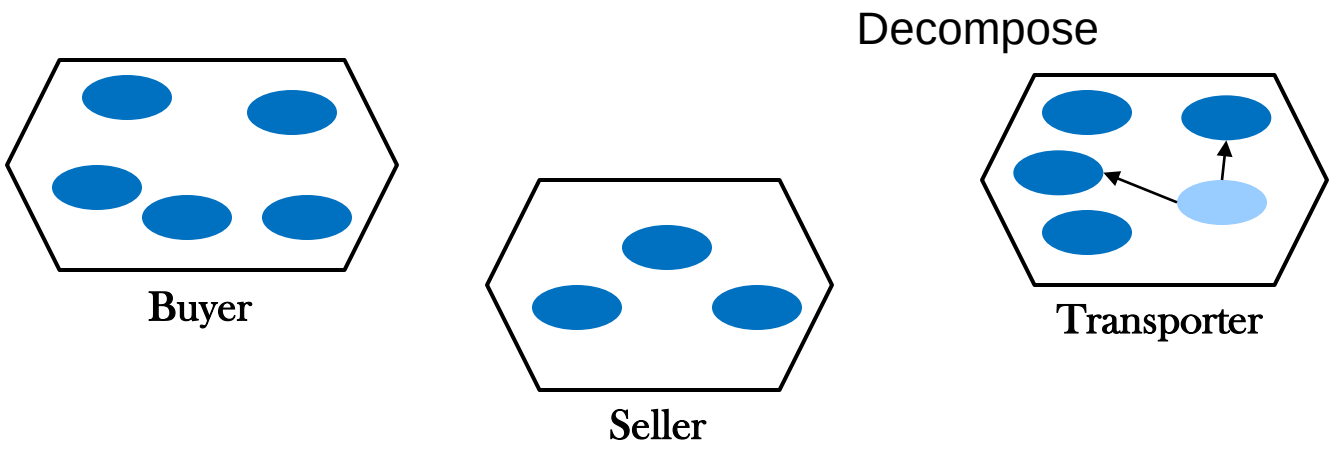

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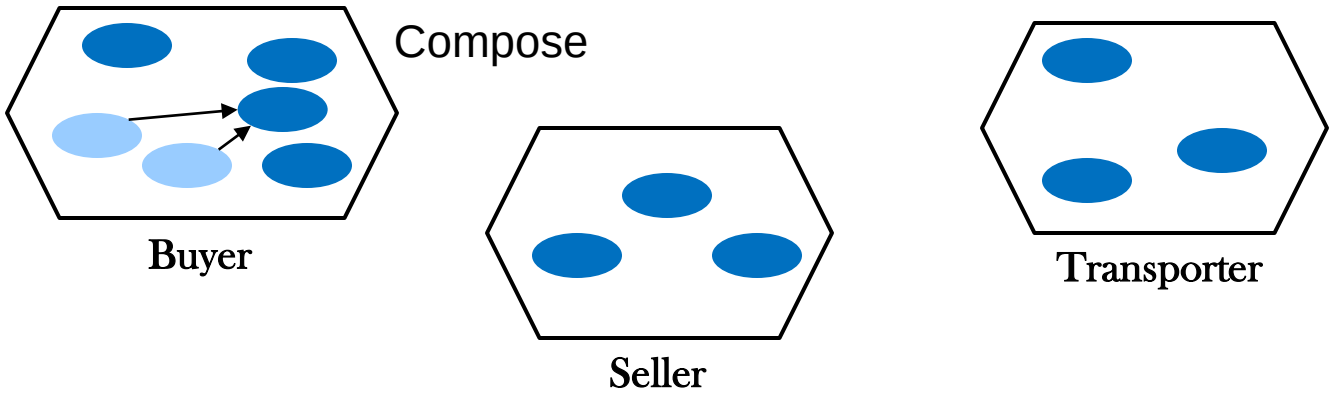

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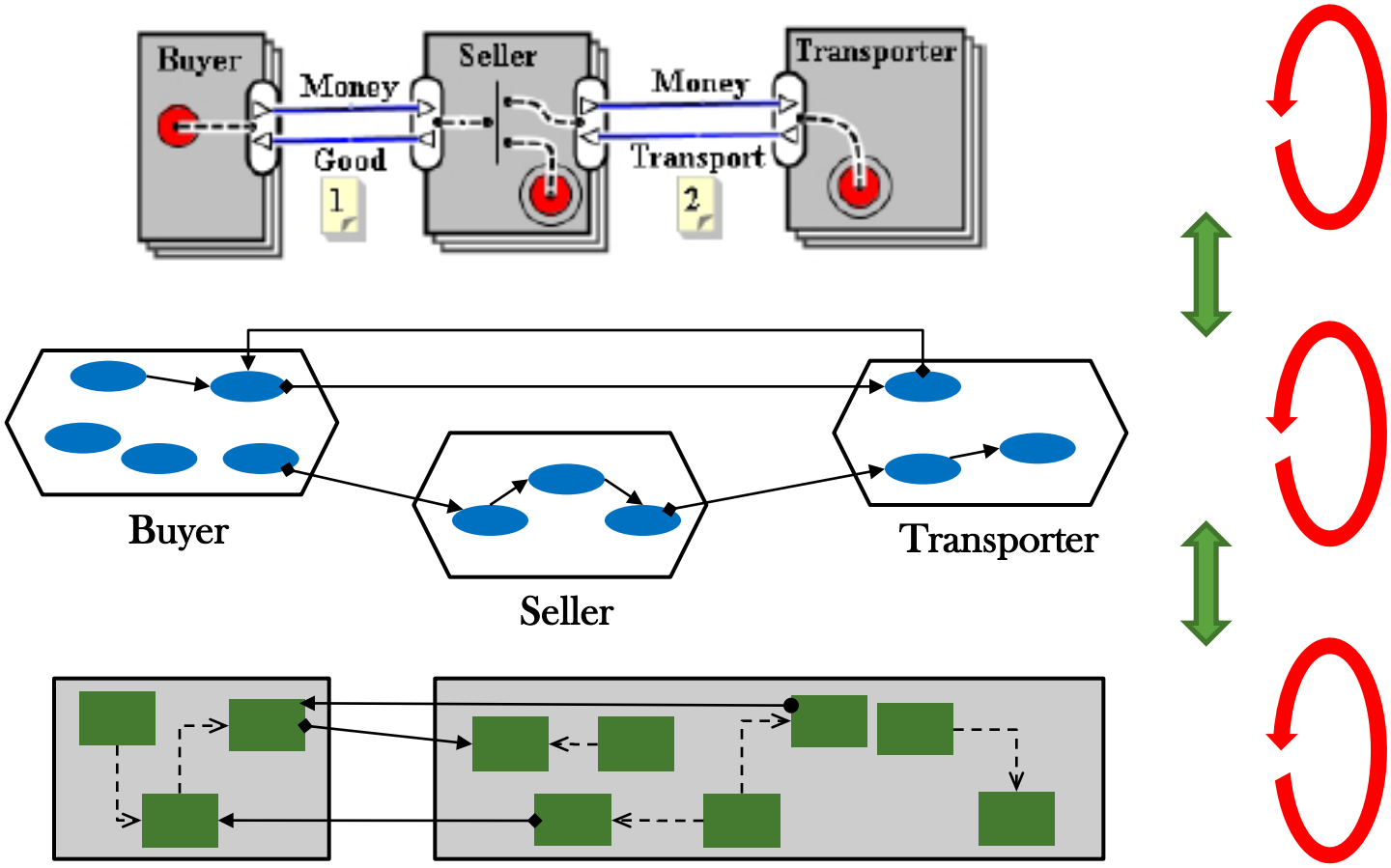
Buyer
Money
Good
1
Seller
Money
Transport
2
Transporter
Buyer
Seller
Transporter

“Fuzziness”

- With the ongoing integration of the physical and digital world, computer solutions should become more tolerable to imperfection
- People can easily ‘recognize’ acceptable solutions
- Computers should employ ‘fuzzy’ algorithms to find, match and compose services

Conclusion

- The current Internet has come a long way since its inception as a 4-node network
- Clear signs that the limits of growth has been reached with the current architecture → the Future Internet
- We are witnessing a shift to a services economy, with changing business context → value networks
- Enterprise interoperability is needed to connect business organizations and stimulate value creation
- We face interesting challenges to realize this ambitious vision of enterprise interoperability: flexibly initiate collaborations over the Internet, geared towards value creation


Thank you
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