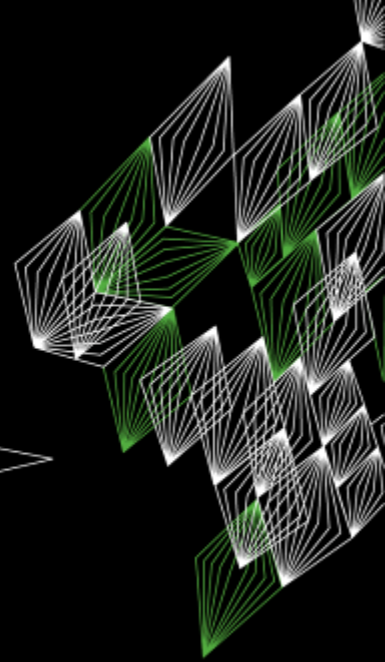


Enterprise Interoperability with the Internet of Services

Marten van Sinderen

WEBIST 2011, 8 May 2011, Noordwijkerhout





Agenda

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

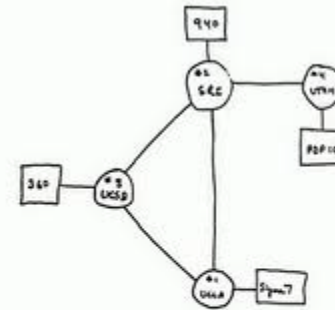


Internet development



Internet development

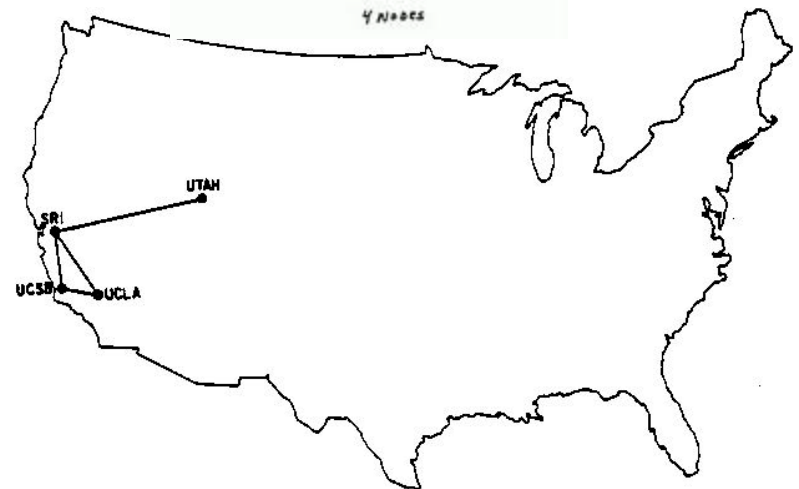
- It all started 45 years ago ...
... the ARPA computer network
- Connecting scarce research computers
- Initial growth was slow
- Initiated by Email



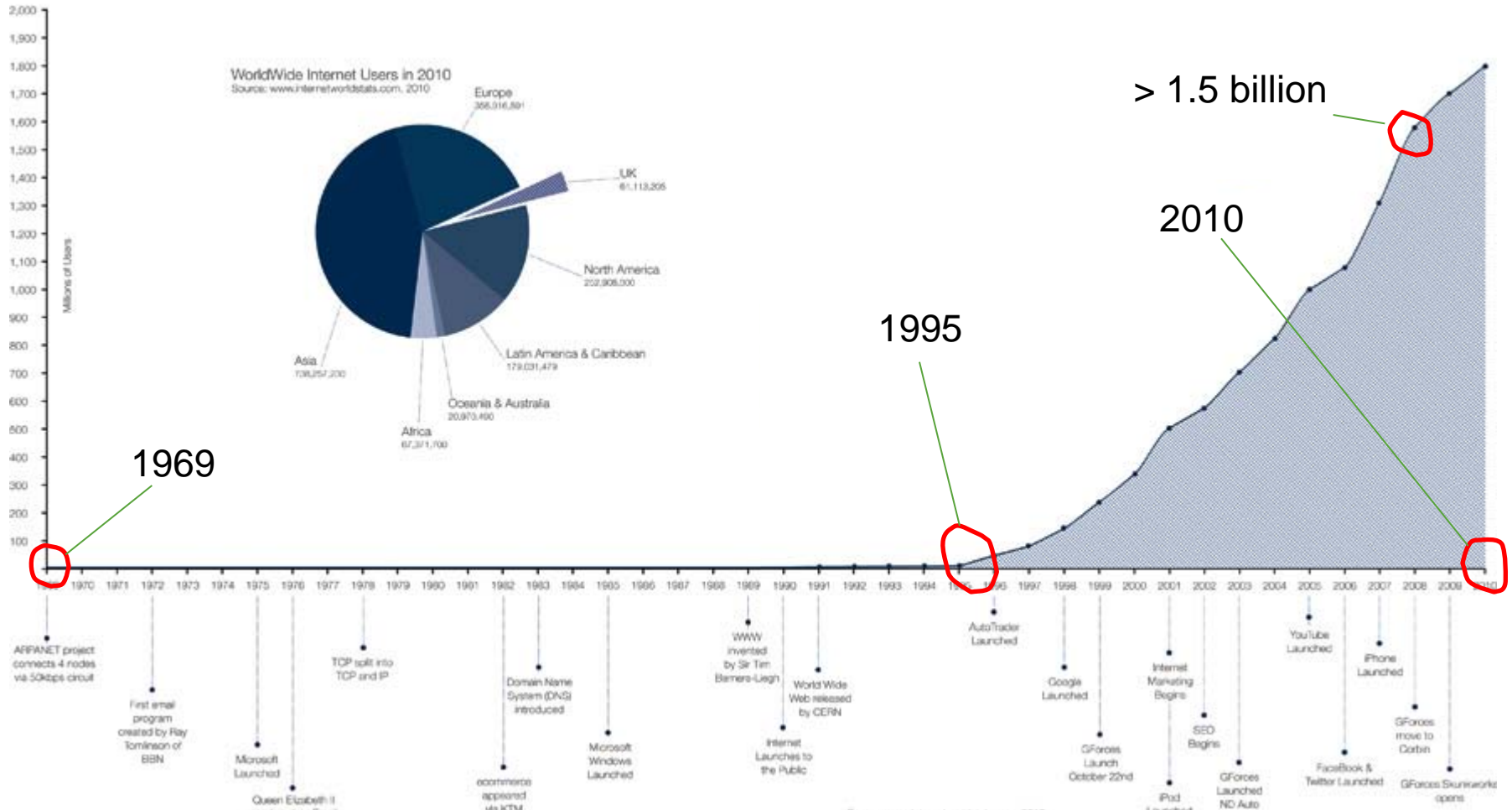
THE ARPA NETWORK

DEC 1969

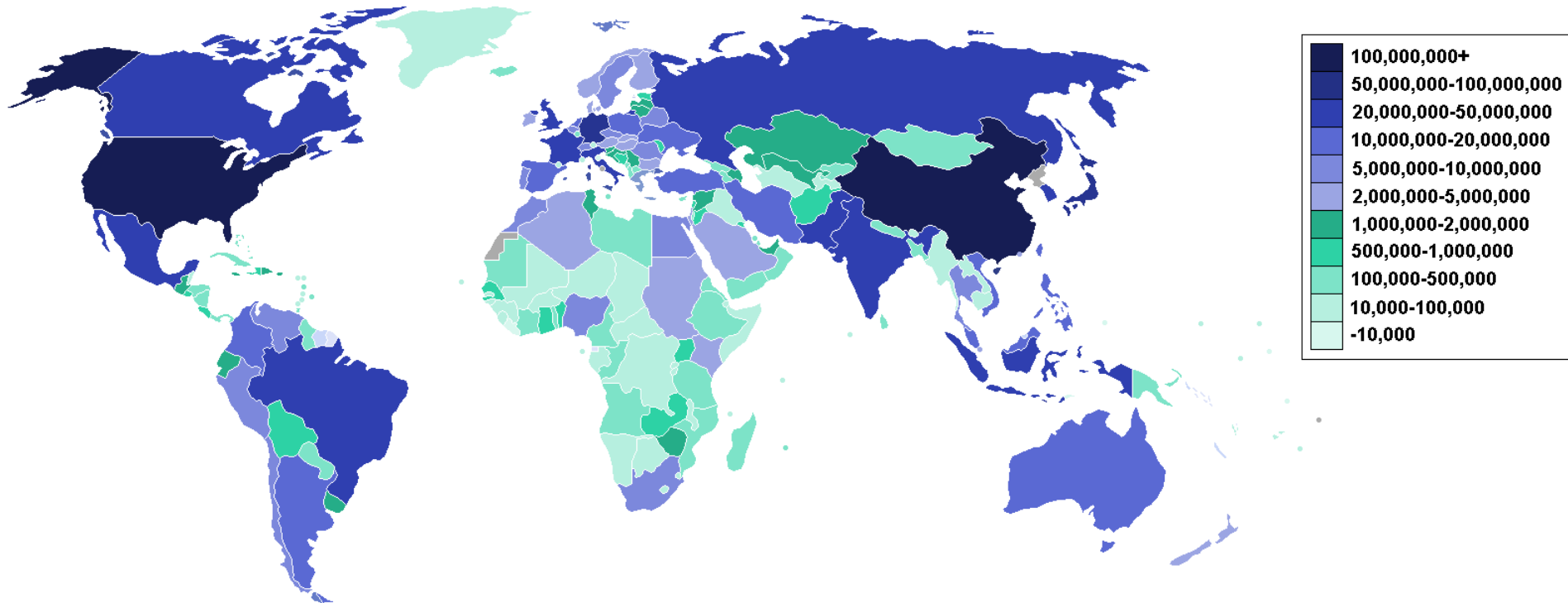
4 NODES



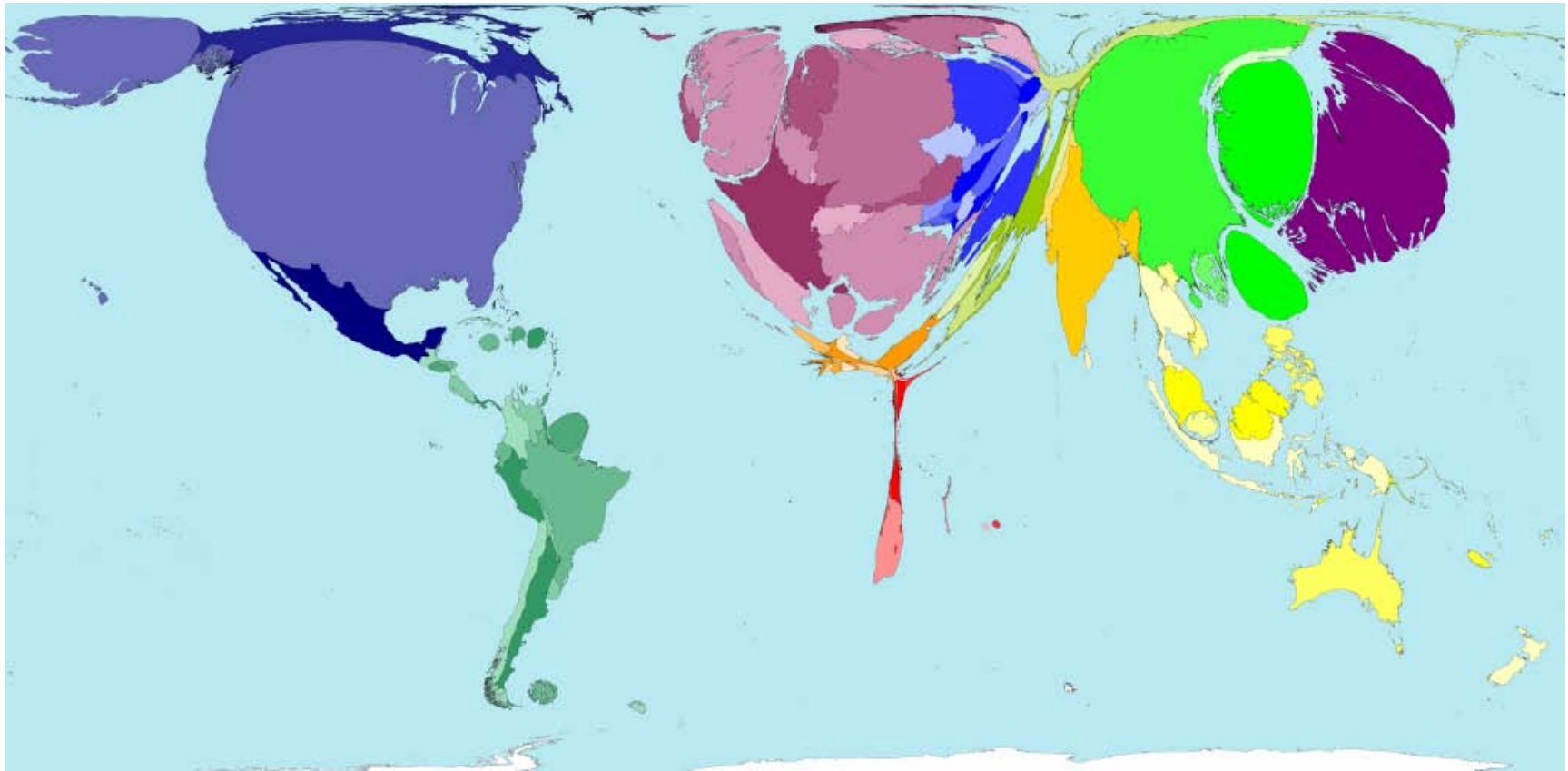
Internet growth



Internet growth

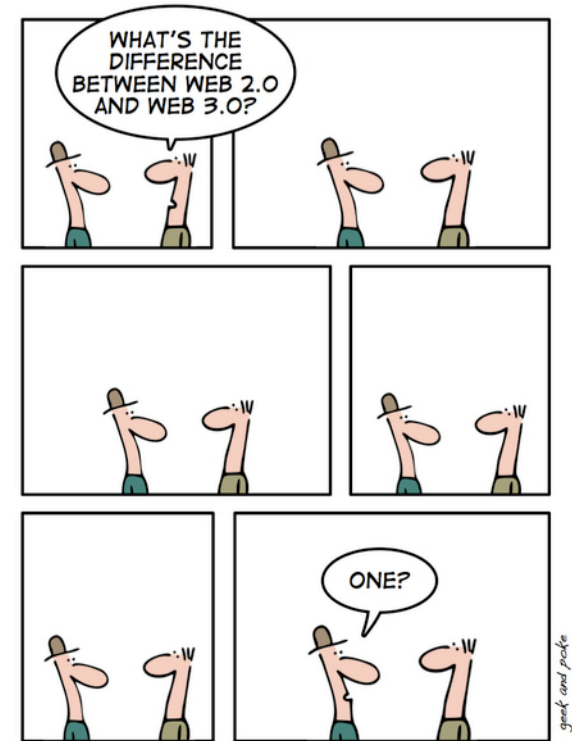


Internet growth



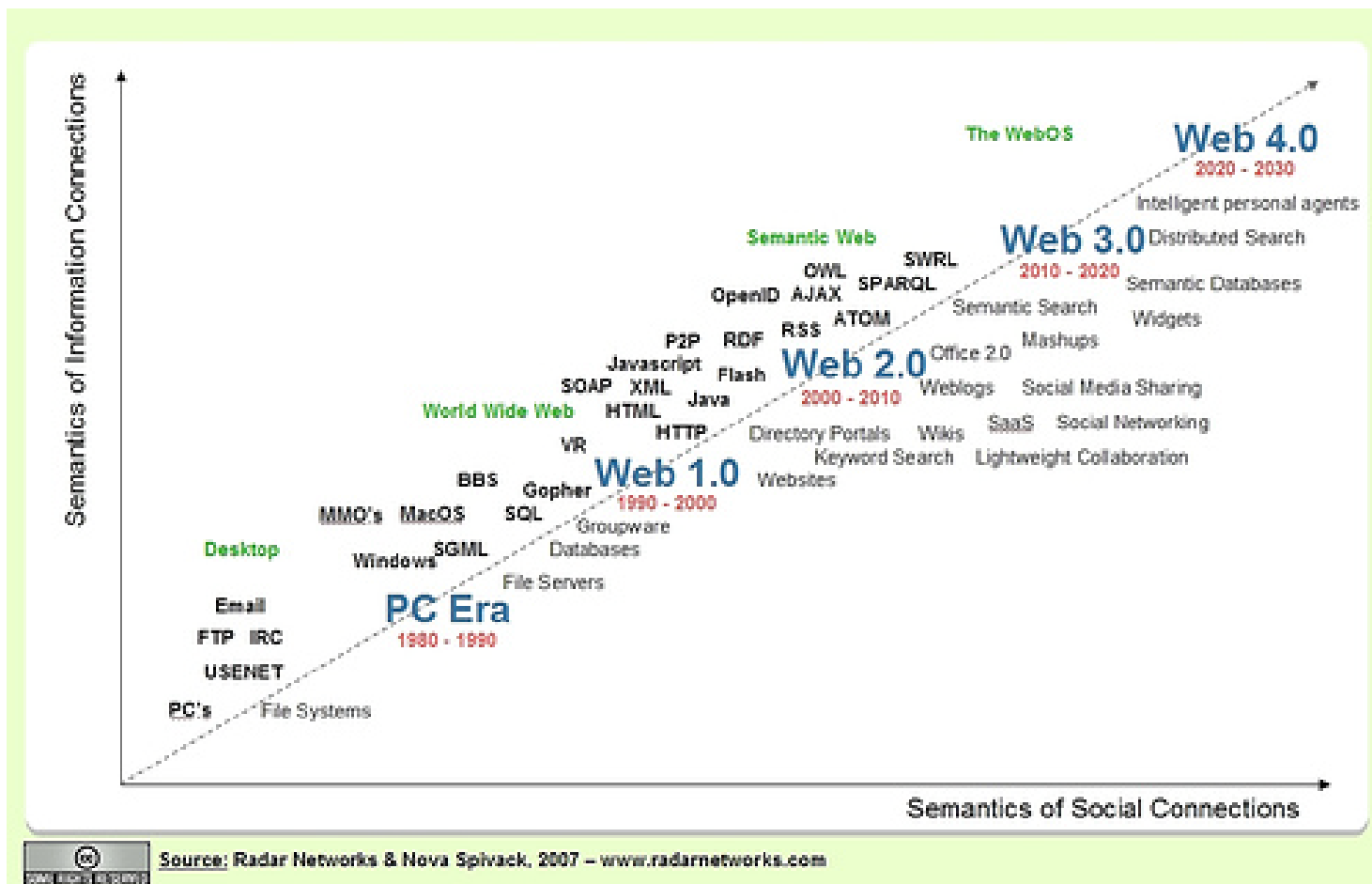
The Web

- The World Wide Web appeared 20 years later ...
... proposed by Tim Berners-Lee as a Hypertext project
- Followed by new generations Web X.0



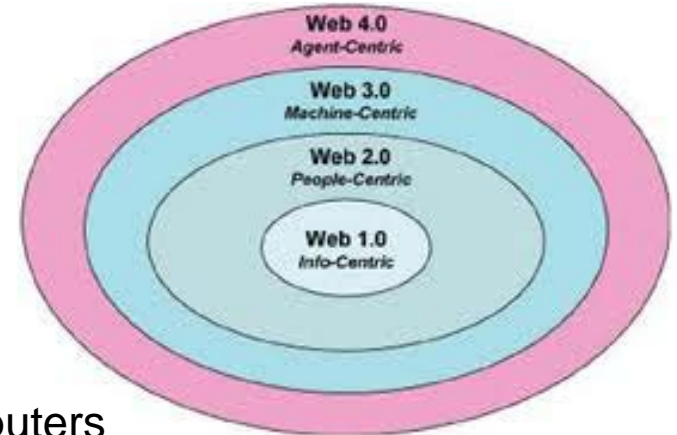
IT IS THAT EASY

Web evolution



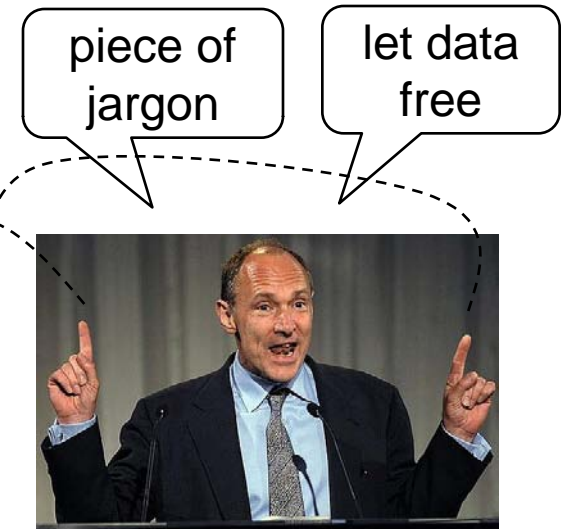
Web evolution

- 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



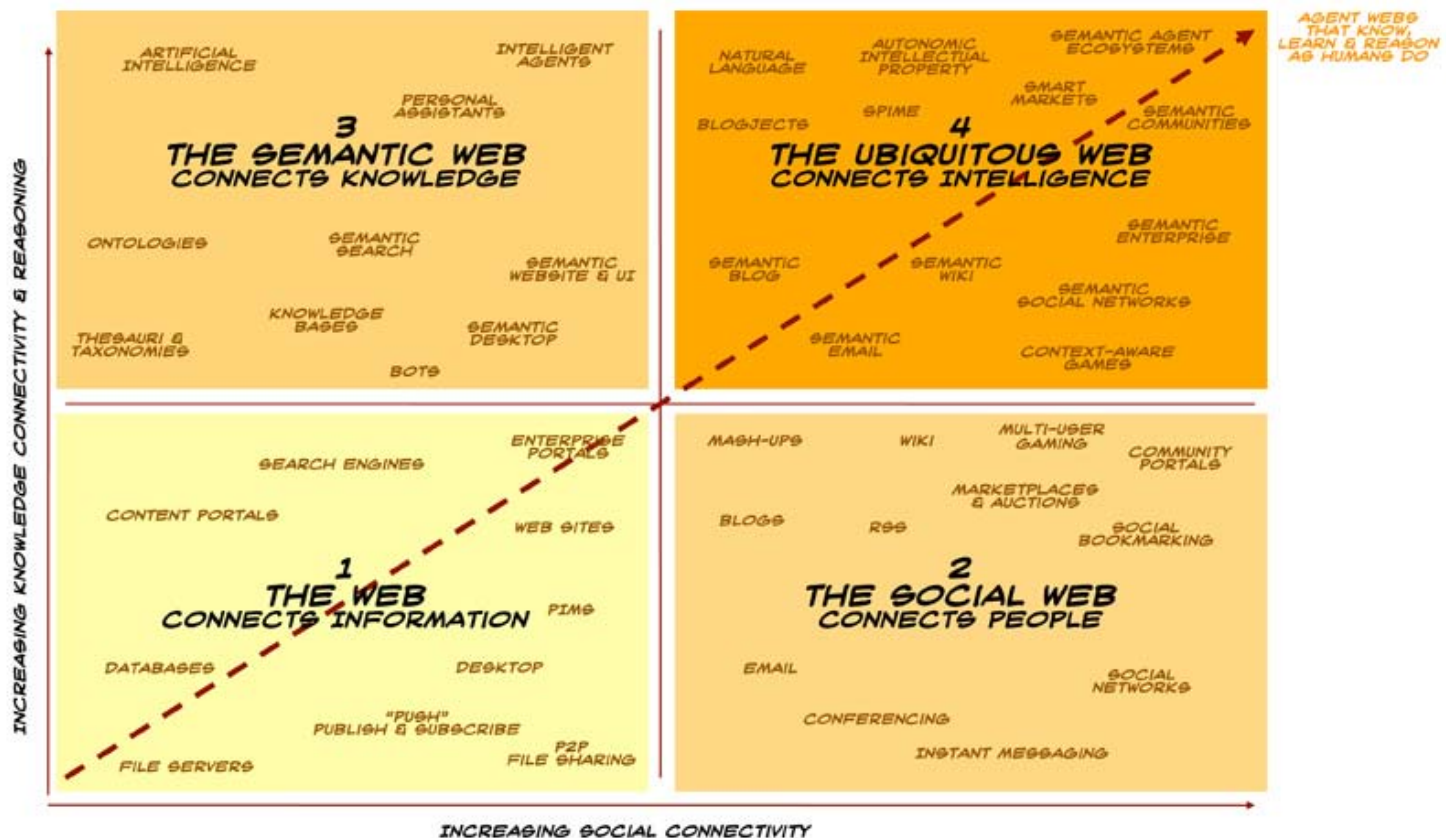
Web evolution

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Web evolution

What is the evolution of the internet to 2020?



SOURCE: NOVA SPIVAK, RADAR NETWORKS; JOHN BRISLIN, DERZ; & MILL & DAVIS, PROJECTION

Shifting trends

- Innovation trends over time



Agriculture



Industry

Services

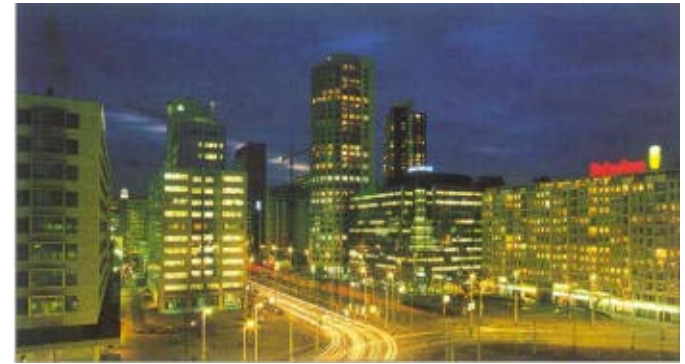


Services economy

- Services sector is fastest growing industrial sector worldwide
 - Major source of revenue
 - 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



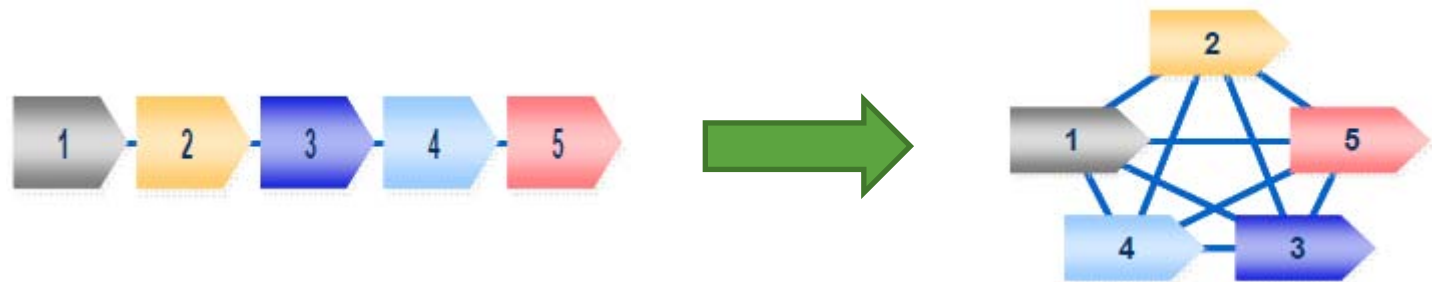
Changing business context



- 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 disciplines, 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 transfer

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

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GRADUATE
SCHOOL

SERVICES SCIENCE

- [Profile leading Professor](#)

Programme

- [Programme summary](#)
- [Detailed programme structure](#)
- [Description of Research Area](#)
- [Participating Research Groups](#)

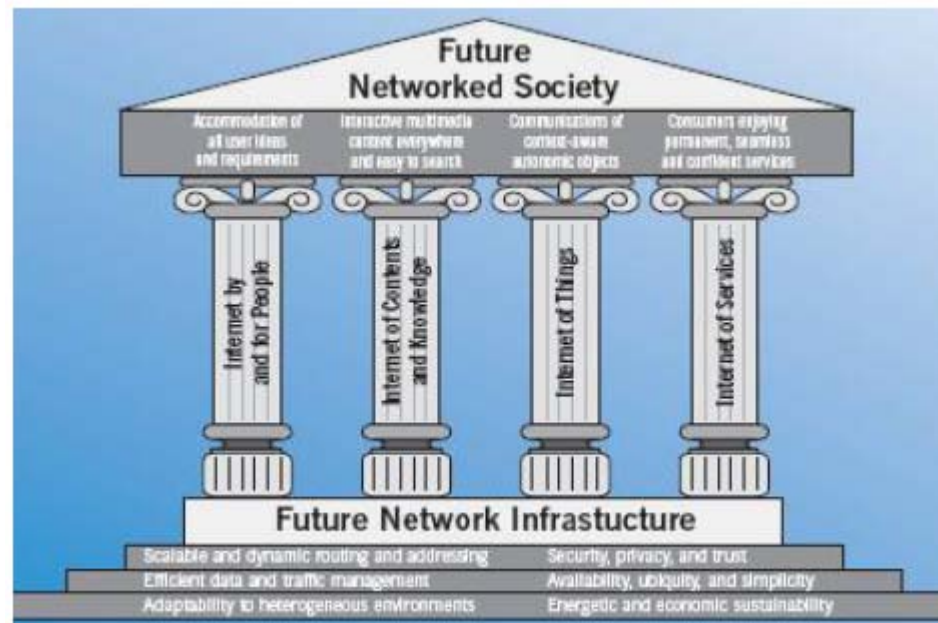
Internet of Services

- 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

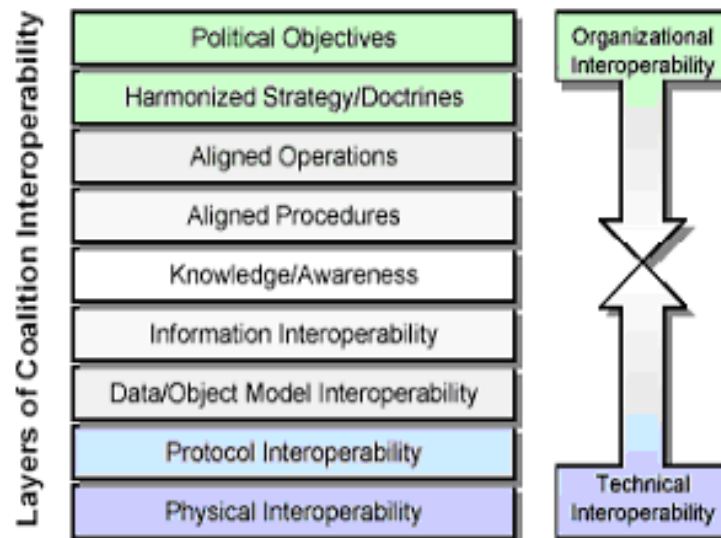
Basic interoperability requirements

- 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



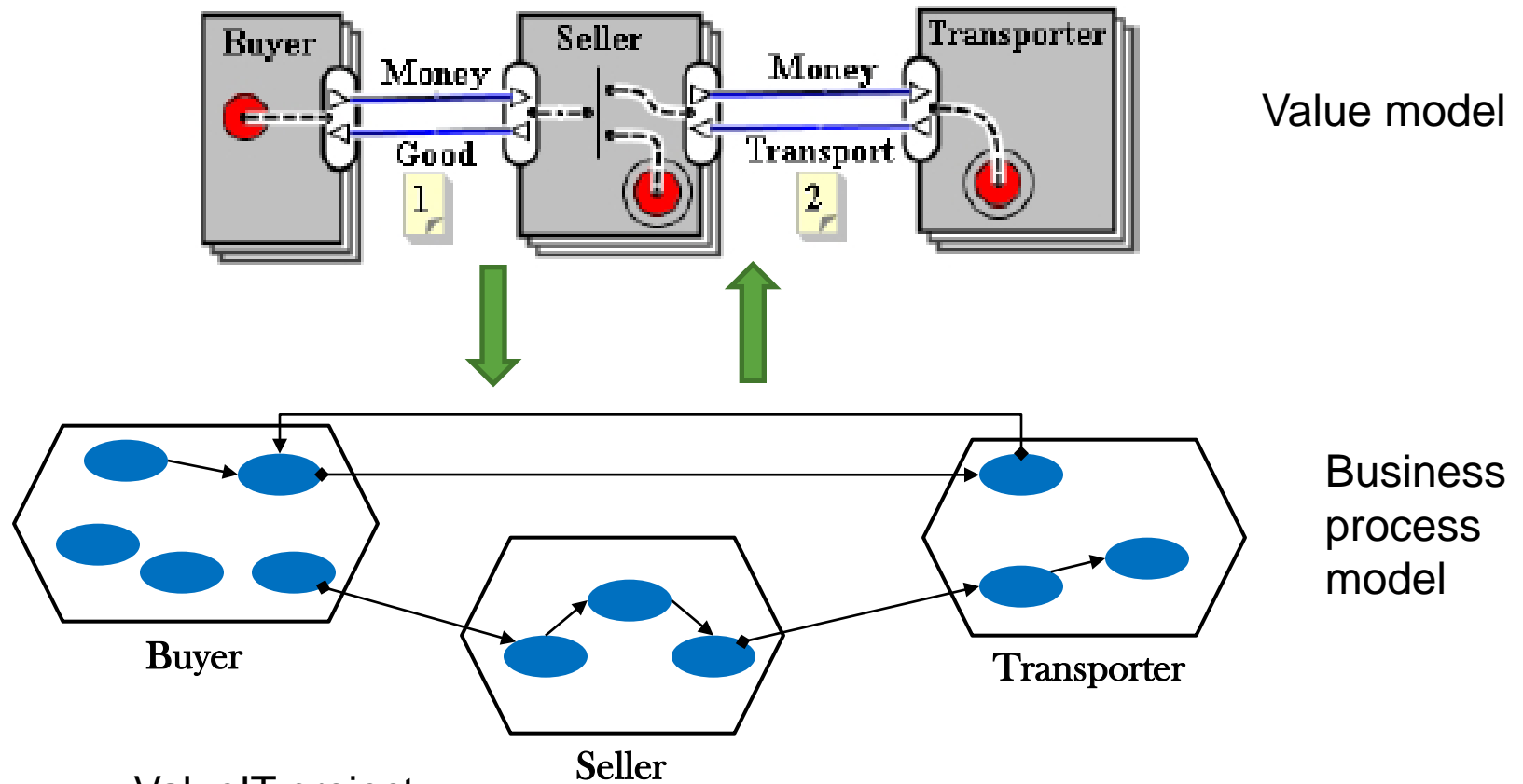
Enterprise interoperability challenges

- 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



ValueIT project,

<http://www.e3value.com/projects/ourprojects/value-it>

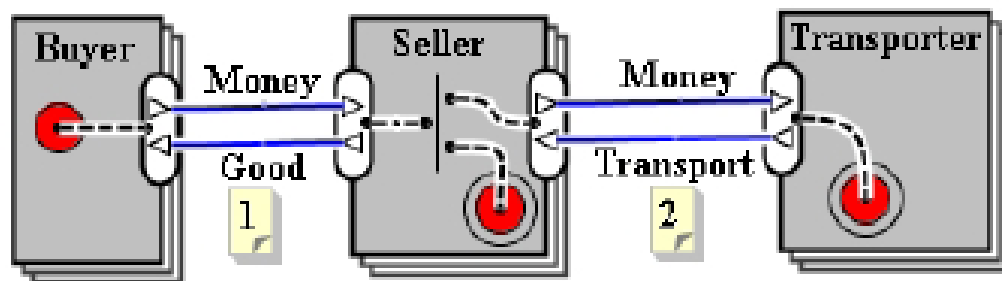
Trust

- 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

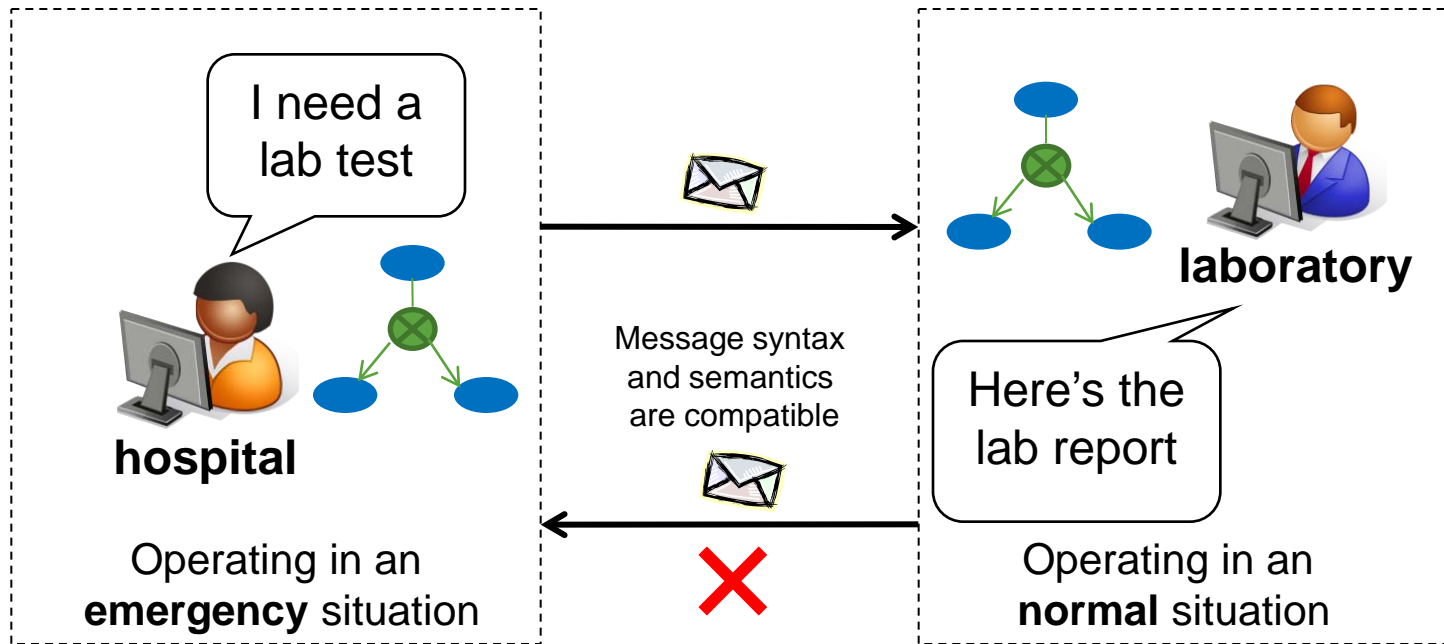


$$T^v(B \Rightarrow A) = \sum_{S_k \text{ TA}} w_k T_{S_k \Rightarrow A}^v$$
$$\sum_{S_k \text{ TA}} w_k = 1$$

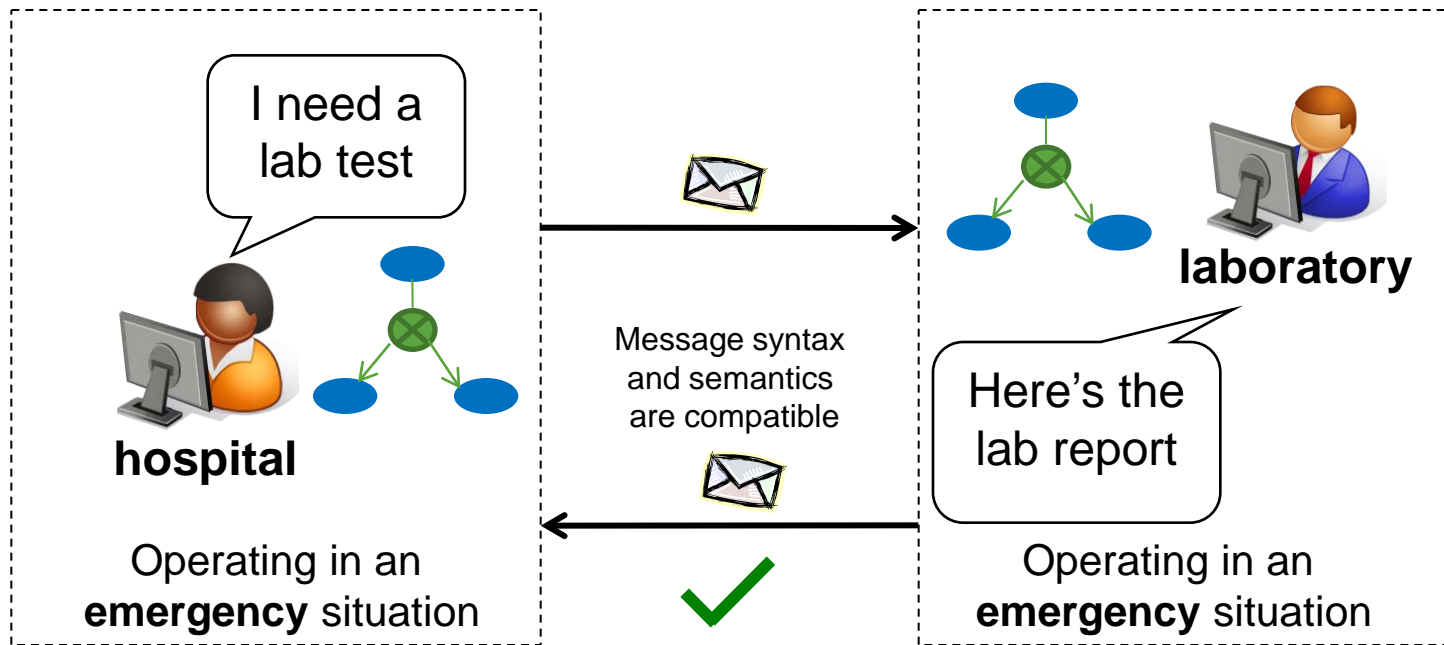
Pragmatic interoperability

- 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)

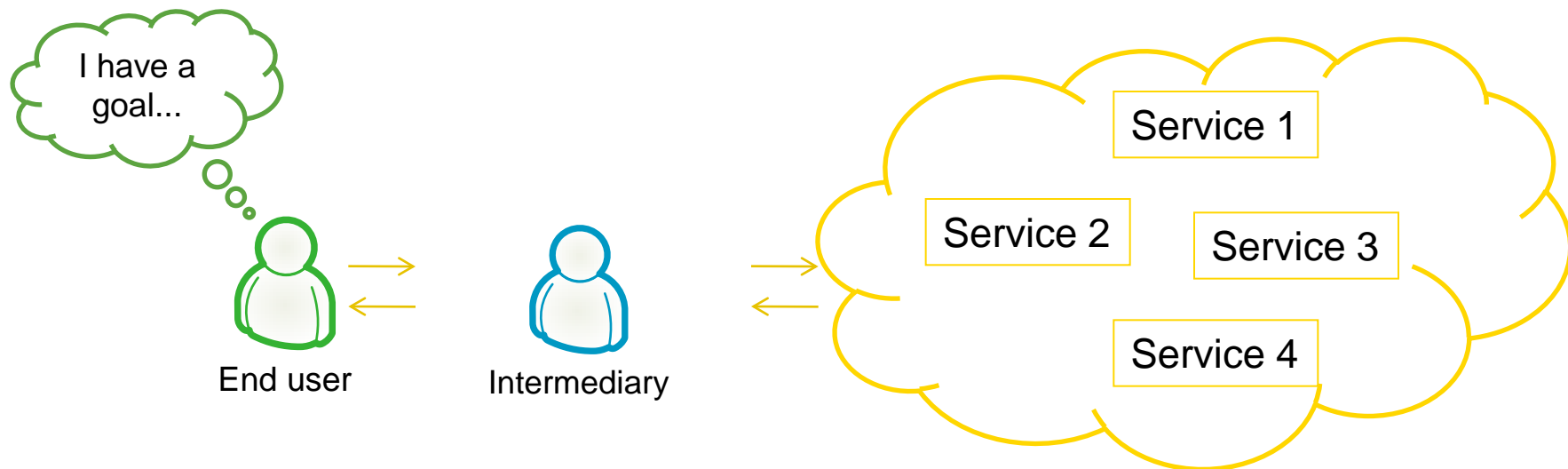
Example: User-centric dynamic service composition

- Users want to have personalized on-demand service provisioning
- 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



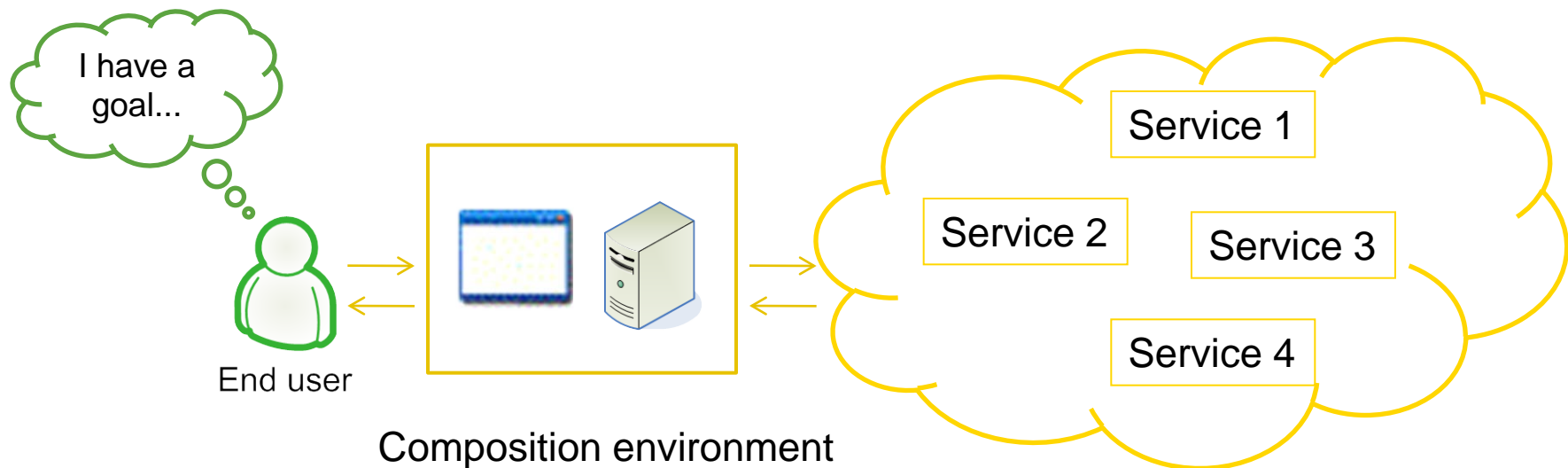
Example: User-centric dynamic service composition

- 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



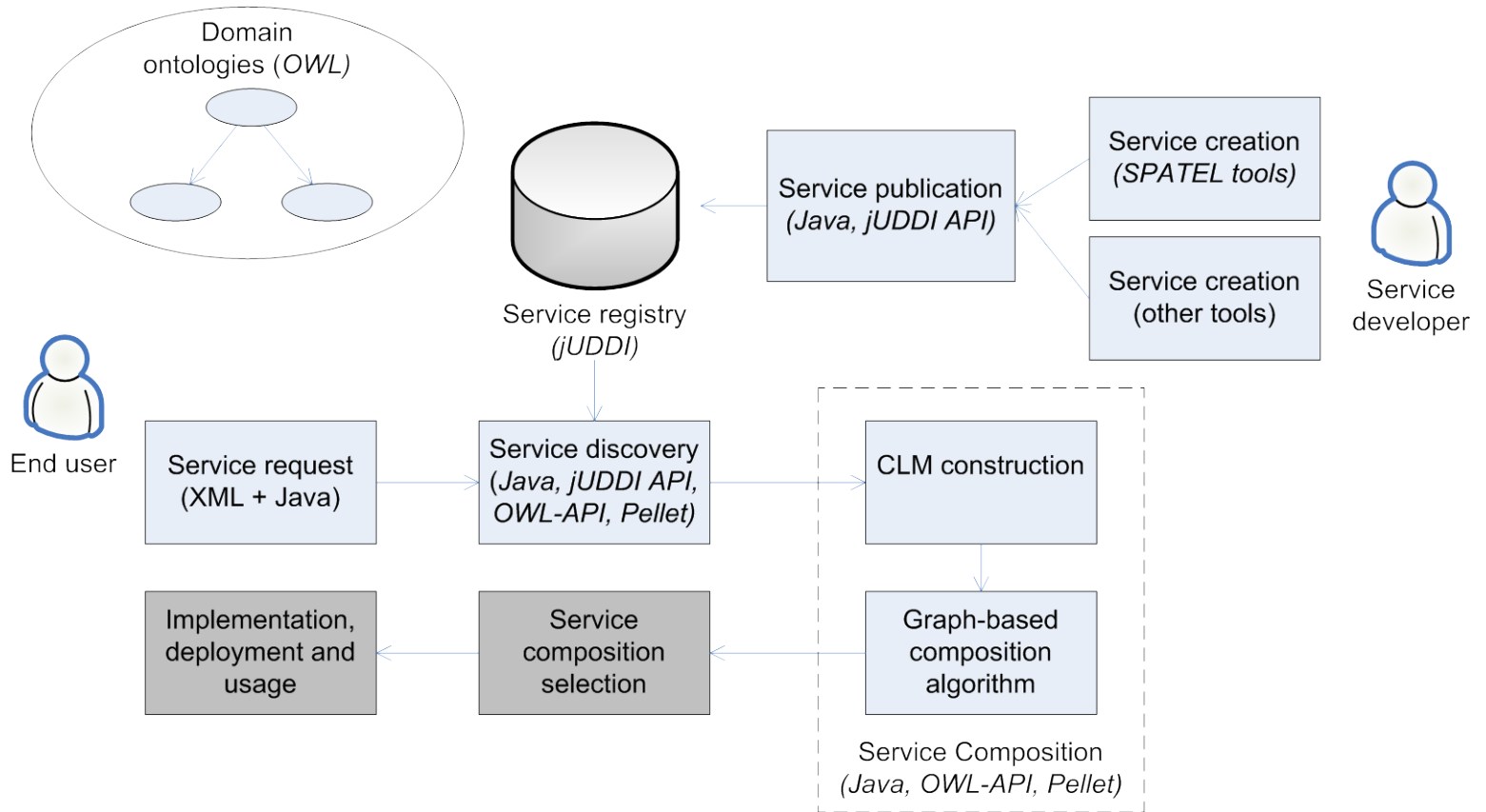
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SPICE project, <http://www.ist-spice.org>

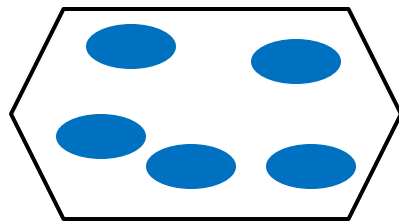
Example: DynamiCos*



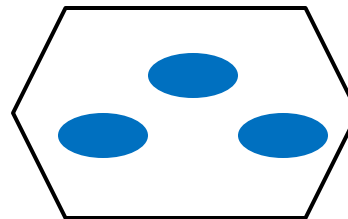
* Silva (2011), User-centric service composition, PhD Thesis

Change

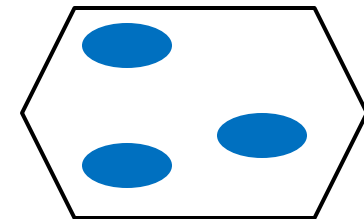
- Change is certain factor of modern business webs
 - Change of business requirements and technology capabilities
 - Change in business structure: partners and services



Buyer



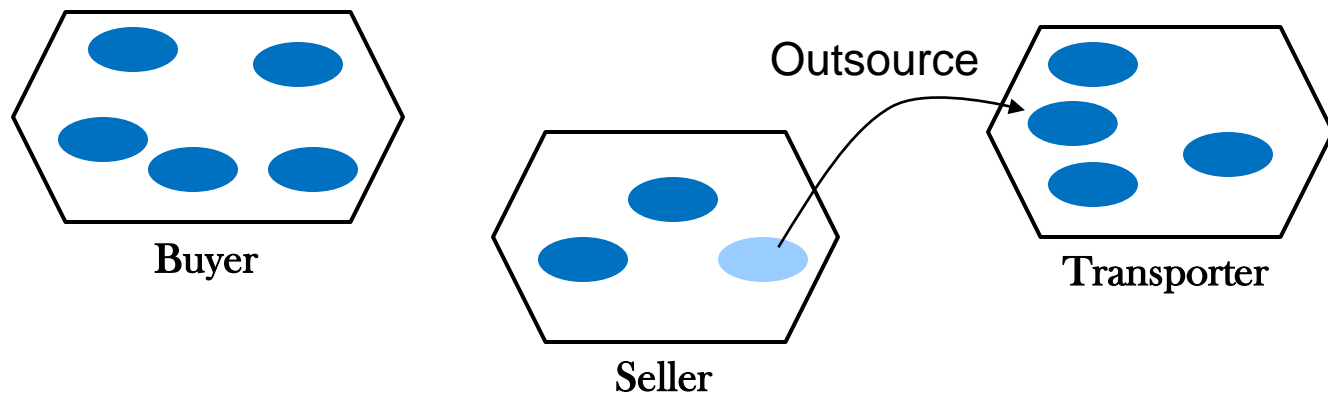
Seller



Transporter

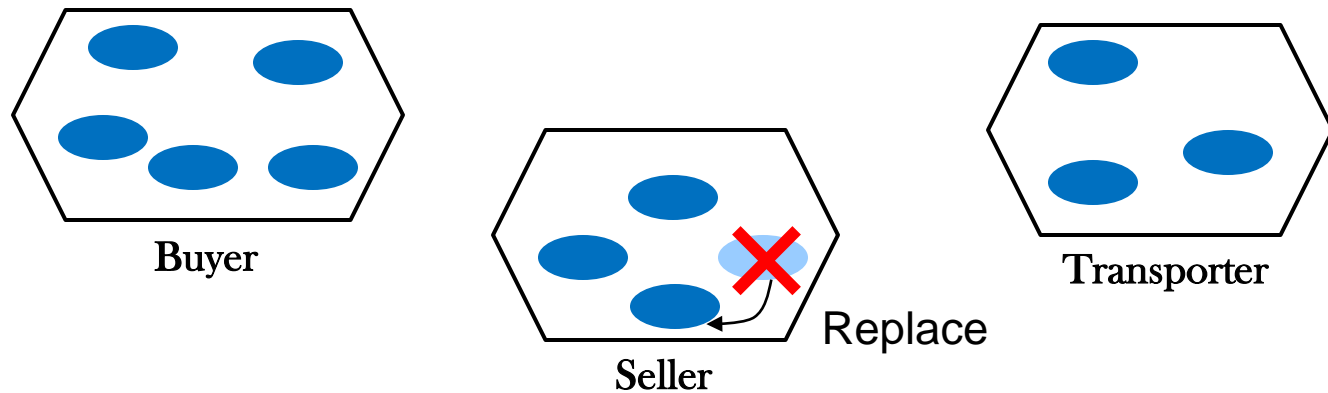
Change

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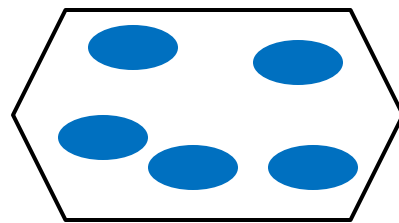
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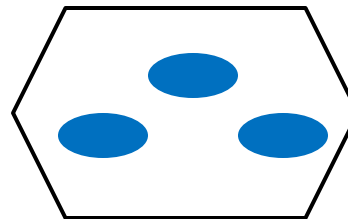


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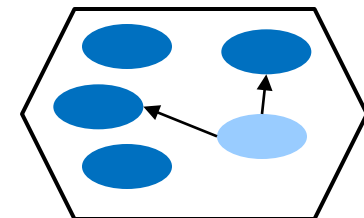


Buyer



Seller

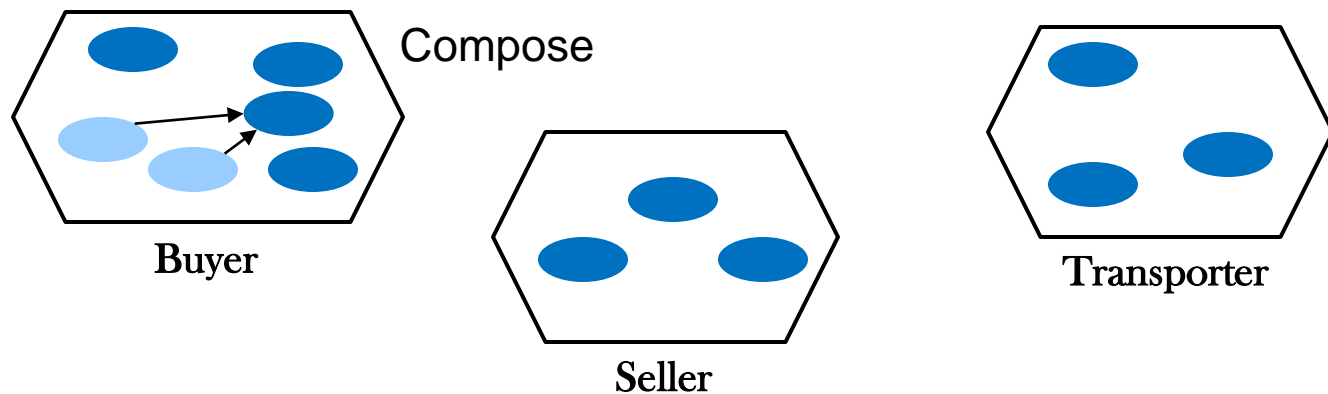
Decompose



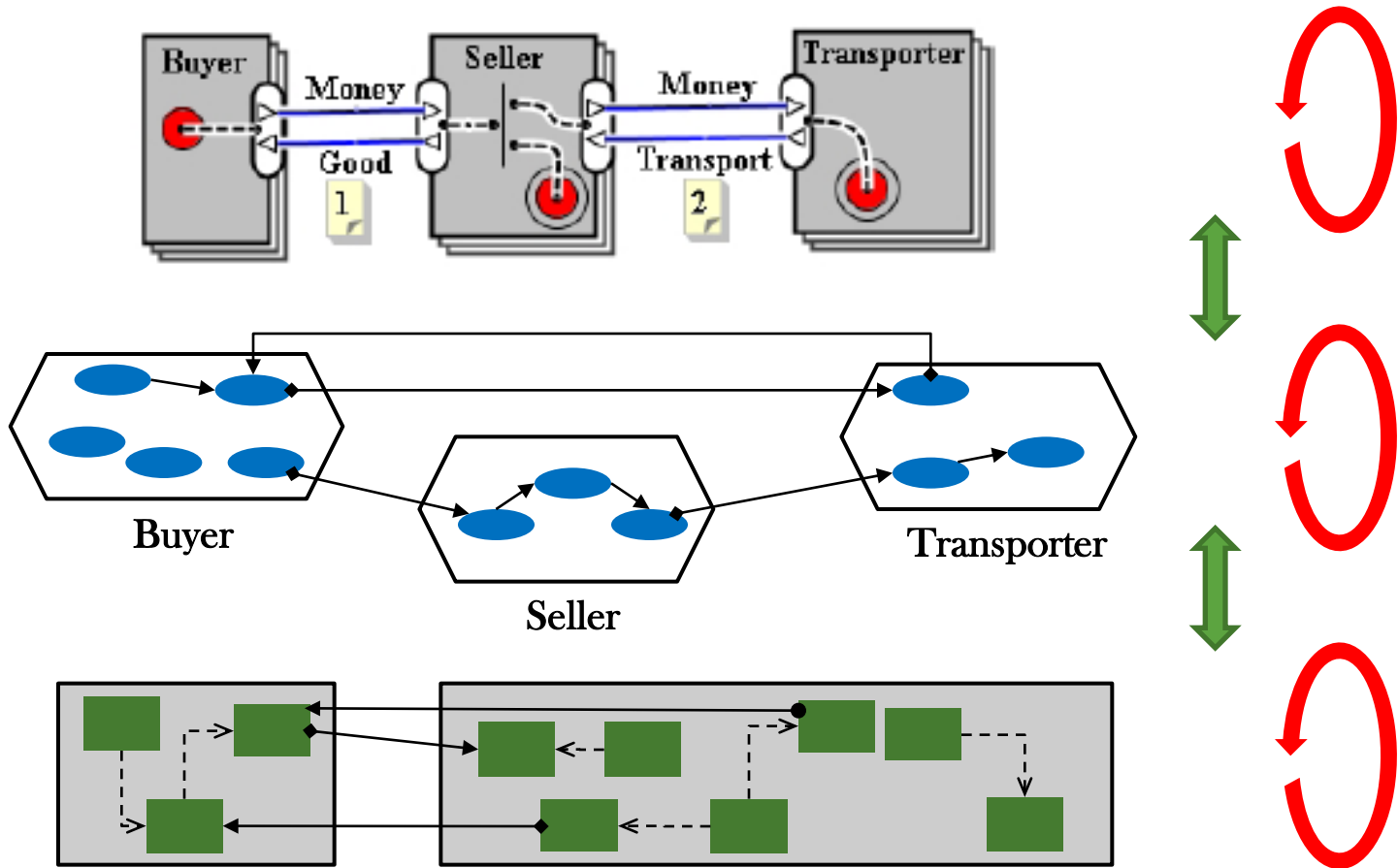
Transporter

Change

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



Change



“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

