ICT Trends: Challenges for Society and Economy

ICT-Enabled Ecosystems – Research Challenges

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ICT as Enabling Technology

Provide integrated communication enablers for efficient operation of society.
Intelligent Transport Systems
- Zero fatalities supported by co-operative intelligence
- Energy efficient multimodal transport via new information and control services

Intelligent Energy Systems
- ICT infrastructure for full distribution grid energy exchange automation
- Quality-aware real-time information management for human and automated control
Residential, Business, and Personal Communication (Telco)

- Flexibly and cost-efficiently realize high-quality connectivity
- Reliable estimation of user-perceived service quality
- Increase quality and dependability through observation, detection and automatic recovery
- Quality-adaptive new services utilizing seamlessly integrated interaction devices
ICT Enablers

- Dependable Communication
- Integrative Quality Management
- Networked Data Acquisition, Analytics, & Interfacing
- Ubiquitous Access and Interaction
Dependability
- ability to deliver service that can justifiably be trusted

Dependable Communication
- Guarantees to meet performance bounds (e.g. delay, message loss) within range of operation conditions
- Reliable and timely detection of violation of operation conditions

Safety-Critical System Design
- absence of catastrophic consequences

Key Challenges: Variability of
- Propagation environment / link quality
- Nodes density and mobility
- Application context and cross-traffic
- Human behavior
Dependable Wireless Communication

- Understanding & Modelling Dynamic Channels
  - Example: variability in road crossing scenario
  - Necessity for adaptive non-stationary channel estimation algorithms
  - Challenge: estimation in scenarios with low duty cycle

- Assuring Link Properties for Wide Range of Operation Conditions
  - Example: enhancement via relaying
  - Difficulty of relay selection in non-stationary channels
Protocol Design and Service Enablers: Timed reliable Communication Protocols, e.g.

- Periodic message transmission with certain repetition level
- Parameter choice based on timing and reliability requirement
- Timeout-based detection of message loss; disconnection ('safe state') in case of too frequent loss
- Parameter choice impacts resulting 'safe state' transitions → availability
Dependable Communication: Integration Challenge

→ Understanding and utilizing dependencies of functionalities on different layers in design and analysis
ICT Enablers

- Dependable Communication
- Integrative Quality Management
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- Ubiquitous Access and Interaction
Motivation: Challenge of Quality Metrics

“Quality of Experience (QoE) is the **degree of delight or annoyance of the user** of an application or service. .... ”

- **Usage scenario**: e.g. work, entertainment
- **Influence of communication network performance**: e.g. PC, smartphone, tablet
- **Context**: Physical Context, Social & Cultural Context, Task
- **User**: Usage History, Demographic Background, Expectations
- **System**: Codec, Client Device, Transmission Network, Application

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Example: Stallings – QoE Model for Video

Model of impact of relevant impairments on QoE

- Strong impact of the number of stallings (freezes)
- Duration of stallings is less critical (but still relevant)
Integrative Quality Management

- Understanding and modeling of complex stakeholder-centric quality metrics, particularly with regard to human quality perception.
- Reliable and scalable end-to-end quality measurement reflecting the perspective of relevant stakeholders.
- Smart fault diagnosis and trouble-shooting mechanisms.
- Efficient resource allocation schemes that optimize for multiple goals (fairness, costs, revenue, customer satisfaction, etc.).
ICT Enablers and related research challenges

- Dependable Communication
  - (see before)
- Integrative Quality Management
  - (see before)

- Networked Data Acquisition, Analytics, & Interfacing
  - Efficient and scalable access to distributed sensor information
  - Pre-processing/aggregation of data from heterogeneous distributed sources
  - Data analysis for large scale heterogeneous data streams
  - Data quality metrics and their inference in the online system
  - Presentation of dynamic data to stakeholders and adequate feedback loops

- Ubiquitous access and interaction
  - Flexible configuration and adaptation of available resources in the networked environment
  - Cost-efficient ubiquitous connectivity through cloud-RAN concepts and self-organizing cooperative approaches
  - Integrated use of multiple, heterogeneous access techniques and devices
  - Seamless user interaction with information in the surrounding environment
  - Understand and exploit benefits of virtualization on different functionality layers
ICT Enablers and related research challenges

- **Dependable Communication**
  - (see before)

- **Integrative Quality Management**
  - (see before)

- **Networked Data Acquisition, Analytics, & Interfacing**
  - Efficient and scalable access to distributed sensors
  - Pre-processing/aggregation and provisioning of data
  - Data analysis for large scale heterogeneous data
  - Data quality metrics and their inference in the online data access and management system
  - Presentation of dynamic data to stakeholders and end-users

- **Ubiquitous access and interaction**
  - Flexible configuration and adaptation of available resources in the networked environment
  - Cost-efficient ubiquitous connectivity through cloud-RAN concepts and self-organizing cooperative approaches
  - Integrated use of multiple, heterogeneous access techniques and devices
  - Seamless user interaction with information in the surrounding environment
  - Understand and exploit benefits of virtualization on different functionality layers
Realization in Application-Oriented Research @ FTW

- Evolving Convergent Networks
- Network Intelligence
- User-centric Service Quality & Innovation
- Vehicular Communication & Services
- ITS Data Management
- Intelligent Energy Systems
- Transceiver Architecture & Algorithms

TELCO
TRANS PORT
ENERGY
Cross-Domain
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