Future Internet Programme Routing scalability

Hannu Flinck

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Strategic Centres for Science, Technology and Innovation (SHOK) in Finland

Industry

Research institutes
Universities

TiViT

Energy and environment	**Metal products and mechanical engineering**
Information and communication industry and services (ICT)	
Forest cluster	**Health and well-being**

Flexible Services Ecosystem

Cooperative traffic ICT

Future Internet

Device and Interoperability Ecosystem

National funding

**Shareholders**

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ICT SHOK Future Internet Programme

Vision: Future Internet = a <u>mission critical backbone</u> of global information society

Mission: Enhance the Internet technology and ecology as a *platform for innovation* while providing strong governance over the use of the network resources and information

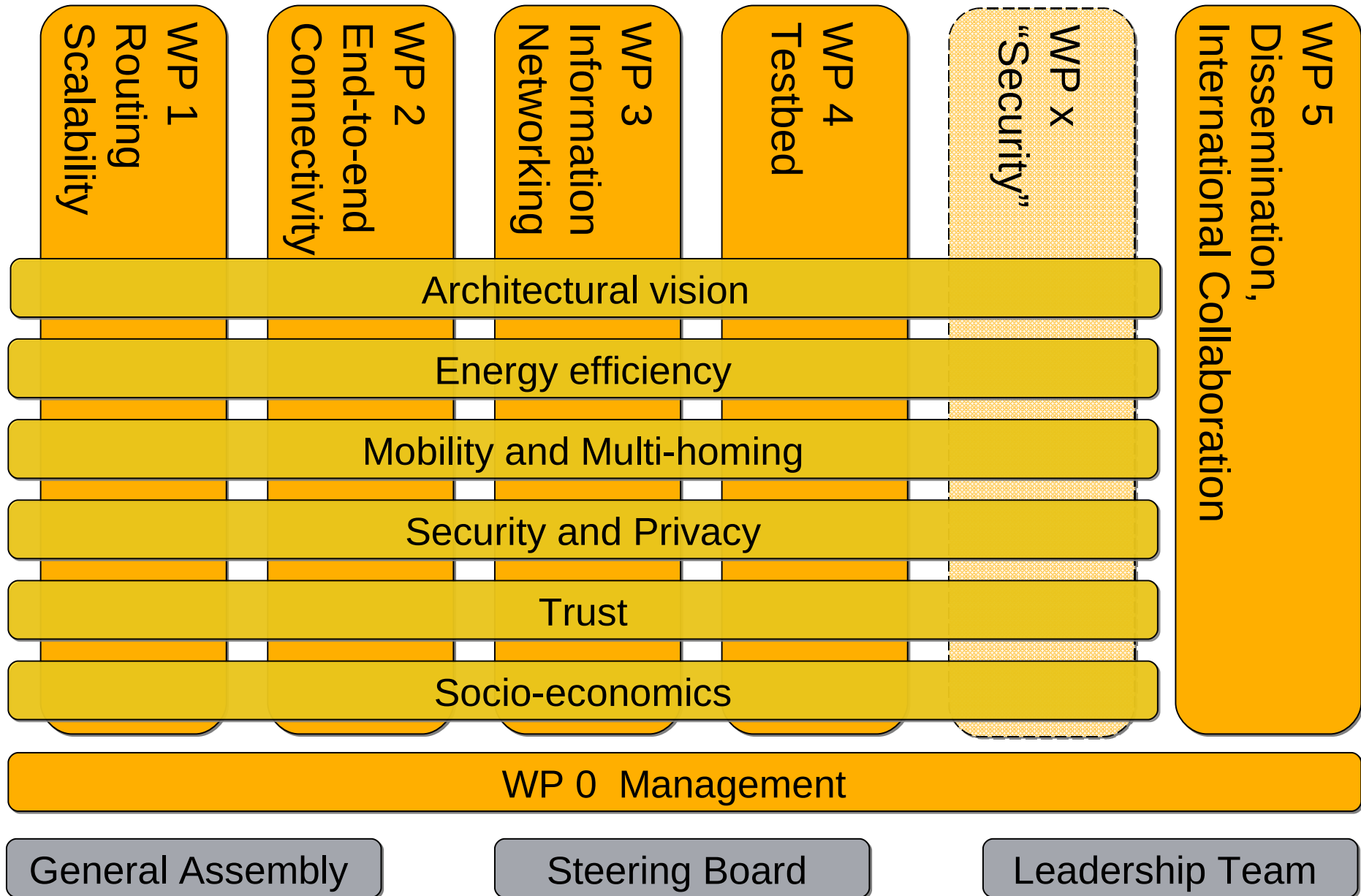**4 yr Strategic Research Agenda: www.futureinternet.fi**
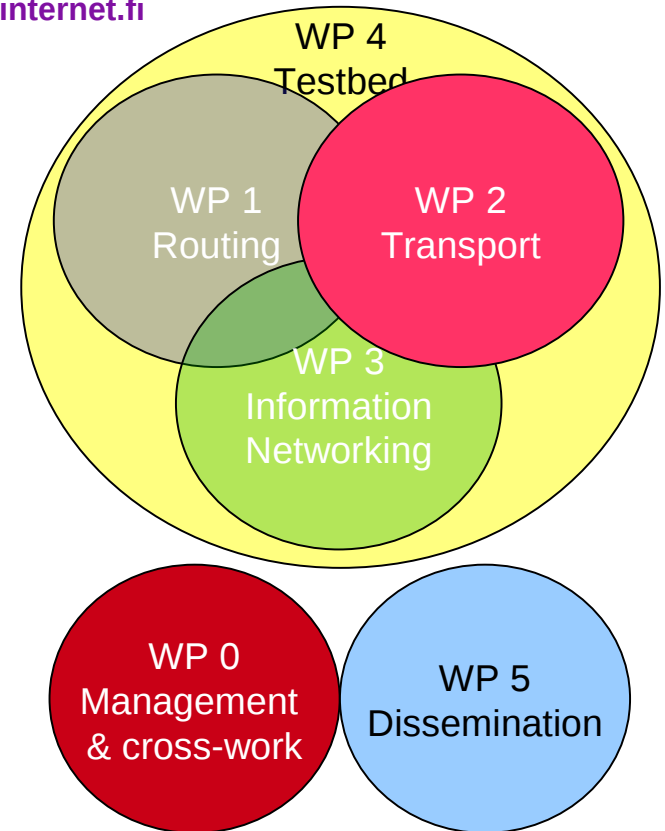
- 1st phase: April 2008 – May 2009
- 50 person years/1st year
- Tekes funding: 35% - 50% - 70/100%
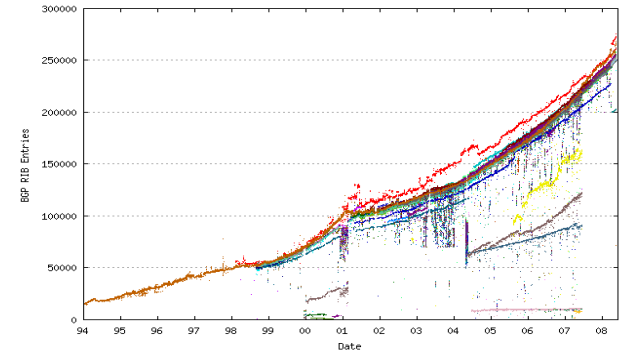
Future Internet Program Objectives

- Breakthrough world-class results

- Clear differentiation from other FI initiatives (high quality & focus)

- Leadership position in standardization and EU research initiatives

- International cooperation involving best international researchers and possibly getting some of them to join the FI program

- Cooperation with other ICT SHOK SRAs

- The program shall be open for new members to join based on their competences (SMEs and research institutes).

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WPs, cross-WP work and governance bodies

WP 1 Routing Scalability

WP 2 End-to-end Connectivity

WP 3 Information Networking

WP 4 Testbed

WP x "Security"

WP 5 Dissemination, International Collaboration

- Architectural vision
- Energy efficiency
- Mobility and Multi-homing
- Security and Privacy
- Trust
- Socio-economics

WP 0 Management

General Assembly   Steering Board   Leadership Team

WP1: Routing scalability activities

- Background:

- The complexity of the Internet routing system increases faster than the Internet itself is growing.

  - Routing the size growth: multi-homing and IPv4 depletion
  - The original design criteria of the routing machinery not meeting the future needs
  - IRTF/IETF activities in the area

- Research question for the WP1 of FI Program:

  - How would the routing system of the Future Internet servicing several billions of mobile users running real time applications look like?

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Close relationship with the IETF and IRTF

- IETF Internet area director, Jari Arkko (LMF)
  - Belongs 5-person program committee of the Routing research group
  - strategic direction of the Routing research group

- Christian Vogt (LMF) main author of
  - Six/One - a host-based method that supports multi-homing and network-controlled traffic engineering in a scalable fashion
  - Six/One Router - a router-based method that enables multi-homing, network-controlled traffic engineering, and provider-independent edge network addressing in a scalable fashion
  - A hostname-oriented host stack architecture - a fundamental, yet backwards-compatible re-design of the existing host stack architecture.

- Hannu Flinck, Jouni Korhonen (NSN)
  - RRG work, renumbering and IPv6 transition

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WP1 activities in the first project year

- Activity 1.1 Routing problem validation
- Activity 1.2 Indirection layer
- Activity 1.3 Address aggregation and the Mapping system
- Activity 1.4 Routing in the Network of Future
- Activity 1.5 Host based Multi-homing approach

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Activity 1.1 – Routing problem validation

- Collecting the observed real-life routing problems and the remedies used for them (e.g., route flapping – route flap damping)

- Understanding the theoretical limitations of various routing methodologies (e.g., instabilities of link-state protocols, BGP rule-set convergence)

- Operator interviews to collect operational experience

Current status:

Problem Validation document

- Collected and summarized BGP issues and experimentation data

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Activity 1.2 - Indirection layer
Objective

- Increase the flexibility of the routing system in a scalable manner, facilitating provider independency and traffic-engineering-compatible multi-homing

- Solutions will be based on a *separation* of the currently overloaded functions of IP addresses as host identifiers and packet-forwarding directives.

- Contribute solutions to the Internet Research and Engineering Task Forces (IRTF, IETF), and back up the solutions with prototypes.

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Address Indirection
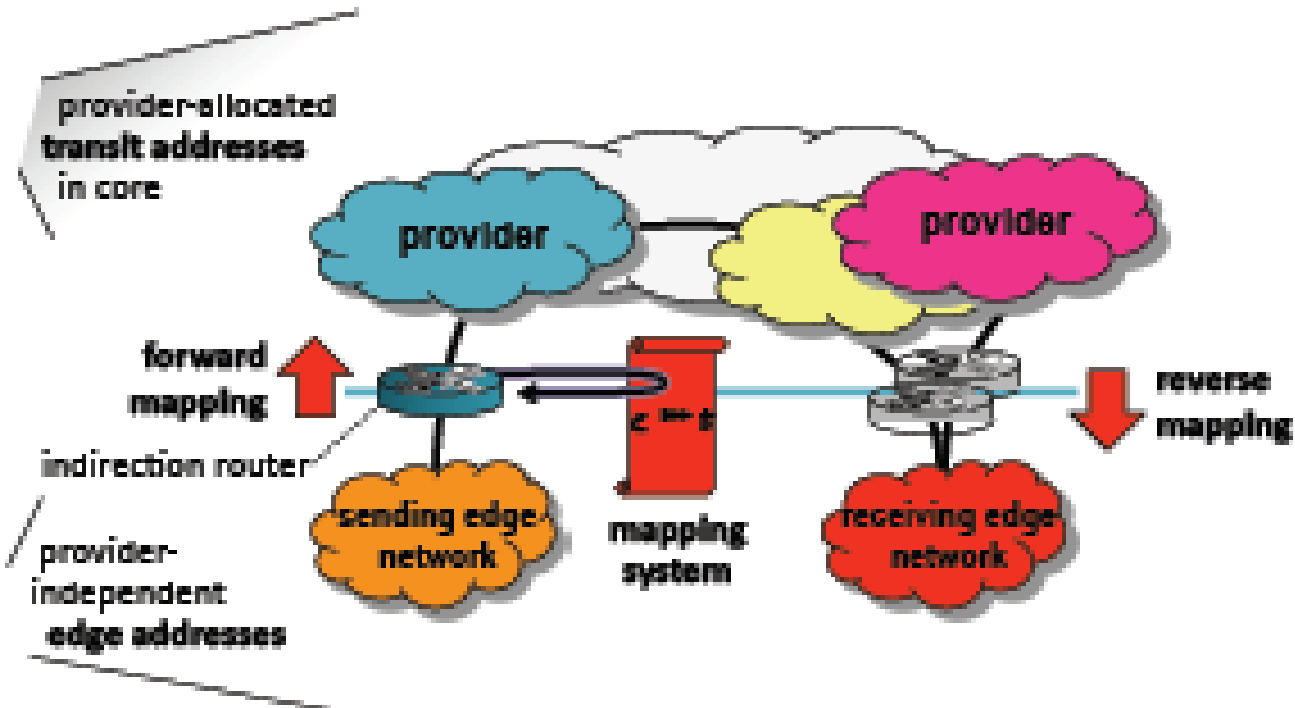
- decouples addressing at edge from Internet core
- global mapping system for remote edge addresses

Source: C. Vogt/Ericsson

Activity 1.2 - Indirection layer
Current status

- Six/One solution proposal designed, published, and successfully presented and pushed within the Routing research group.

- Six/One Router solution proposal designed, published, and successfully presented and pushed within the Routing research group.

- A hostname-oriented host stack architecture designed at high level, published, and successfully presented within the Routing research group.

- Solution space analysis published.

- A number of related presentations and publications in other forums

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Activity 1.3 - Address aggregation and Mapping Systems

- Study Mapping System alternatives:
  - Push: full mappings are pushed (similar to BGP routing table distribution)
  - Pull, Hybrid Push-Pull
  - DNS
  - DHT

- Impact of peering relationships between the IPS and roaming agreements that are the basis for GRX and IPX

Current status:
  - The role of DNS as a mapping system studied
  - Renumbering mechanisms

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Activity 1.4: Routing in the Network of Future

Task 1: Routing in power-law random graphs.

Develop scalable routing algorithms based on recent advances in the theory of compact routing

Current status:

- An analysis of compact routing schemes proposed in the literature was done.

- Drafted how to add policy based routing support to the compact routing paradigms

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Activity 1.4: Routing in the Network of Future

Task 2: Scalable wire-speed routing

Current status

• Preliminary requirements for L2 routing have been drawn up and documented in a report.

• Existing L2 routing schemes have been studied and documented in a separate report.

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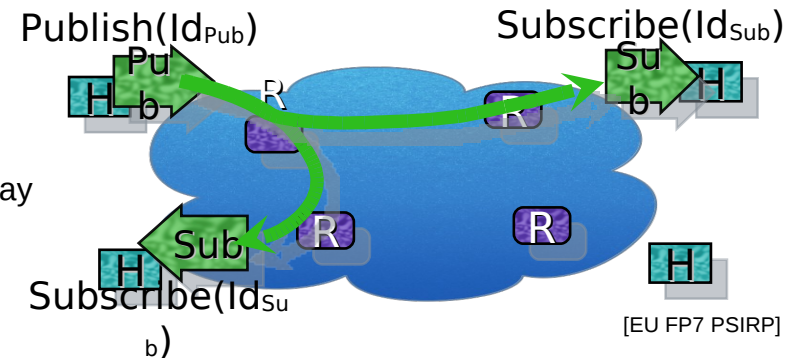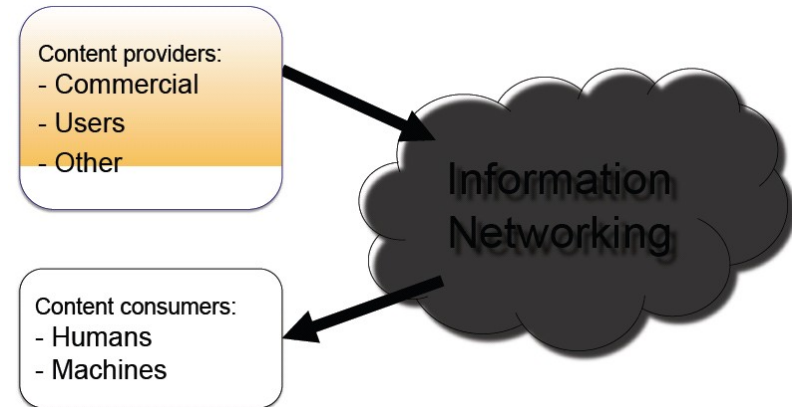# *Activity 1.5:* **Host based Multi-homing approach**

- Belongs to "elimination" class of IRTF solutions
  – Elimination of the need for Provider Independent addresses

- Basic Idea:
  – Use of DNS "hints" and SCTP to deal with multi-homing
  – FQND has several A and/or AAAA records
  – Applications should try to initiate connections to more than one address
  – No need for Provider Independent Addressing (eliminates PI need)

- Studied on HIP multi-homing
  – First draft report on the issues and initial results was written.

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WP 2: End-to-end connectivity

- Activity 2.1 **Models for Energy-Aware Internet Communication**
  - Wireless Network Interface energy model implemented in NS-2
  - Article "Modeling WLAN Energy Consumption in a Mobile Handset"
  - Extensions to NS-2 radio environment model and WLAN link adaptation in NS-2 on-going

- Activity 2.2 **Communication in Challenged Environments**
  - Simulation model for studies of impact of mobility for information centric networks.
  - Energy saving strategies in wireless broadband solutions
  - Delay tolerant Network (DTN) functionality, test bed and applications

- Activity 2.3 **Developments in Internet Transport**
  - Performance of Reed-Solomon on embedded devices: viable
  - Study on TCP-like reliable transport protocols
  - Contributions to IETF standardization in the transport area:
    - Forward RTO-Recovery (F-RTO): An Algorithm for Detecting Spurious Retransmission Timeouts with TCP

- Activity 2.4 **Policy-based Resource Management**
  - Concept development on the roaming and interconnection cases
  - Basic simulator implementation for WLAN and HSPA (3GPP) models, simulator (general functionality, statistics, etc.), network selection algorithms and policy server now exists. Simulation scenarios without mobility support also included.

- Publications
  - 3 IETF contributions
  - 2 conference papers
  - 1 article submitted

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WP 3: Information networking

- Long-term topic
- Initial key issues identified:
  - Architecture
  - Naming
  - Implementation
  - Performance
  - Security
- Specific study items:
  - geo-aware social sharing of media in mobile P2P networks
  - p2p file sharing system
  - NS-3 based simulation environments
  - CDNs
  - federated architectures for name resolution in flat namespaces
  - lightweight security measures for BitTorrent
  - partial streams for streaming data in a P2P network
  - social mobile P2P prototype design and simulation
  - EU FP7 4WARD and PSIRP cooperation
  - NetFPGA implementation; implementing forwarding in a pub/sub way
- Publications:
  - 4 conference papers (+ 7 submitted)
  - 10 conference/workshop presentations
  - 1 book chapter

Content providers:
- Commercial
- Users
- Other

Information Networking

Content consumers:
- Humans
- Machines

Publish(Id$_{Pub}$)

Subscribe(Id$_{Sub}$)

Pu

Su

H

b

R

R

b

H

Sub

R

R

H

H

Subscribe(Id$_{Su}$

b)

[EU FP7 PSIRP]

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WP 4: Testbed

- **Backbone network (Partner: CSC)**
  - Investigation of NSN-VTT point-to-point test connection
  - Established initial contact with TKK Comnet about a test connection
  - Planning and building the fiber/DWDM network
  - Planning and building a metro fiber network in Oulu region

- **Access network (Partners: TUT, HIIT)**
  - Reorganization of the network infra in TUT to support the separation of the research and production networks
  - Formulation of the policies for flexible access to and utilization of the research network by partners inside and outside of the university
  - Plans for using the TREX internet exchange point to facilitate L2 and L3 interconnection of testbeds and for providing other kinds of testbed environments, such as anycast testbeds or interconnection testbeds.
  - Early planning for a WDM exchange point, based on TREX.

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Conclusion

Future Internet program is developing a platform of innovation addressing key questions of

- scalability

- energy awareness

- new use modes such as information centric communication

- security and trust

The program is open for new partners, especially SMEs.

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