Looking 4ward to the Future Internet

Carmelita Görg
Universität Bremen
Contents

- Introduction – who, why and what?
- Migration and Innovation – 1000 networks bloom
- How can we build these networks?
- What do we want or connect in these networks – people, things, information ...
- How to transport data? What is a path?
- How can we manage these networks?
- A Summary
Geographical distribution

- Ericsson
- KTH
- SICS
- Nokia-Siemens-Networks
- VTT
- Alcatel-Lucent
- Deutsche Telecom
- Univ. of Bremen
- Univ. of Karlsruhe
- Univ. of Paderborn
- NEC
- Univ. of Lancaster
- Univ. of Surrey
- WIT
- Siemens
- TPUCN
- Alcatel-Lucent
- France Telecom
- GET-INT
- LIP6
- IST-TUL
- PTIN
- Robotiker-Tecnalia
- Telefonica
- Telekomunikacja Polska
- Univ. of Basel
- Telcom Italia
- Technion
- Rutgers University
- © 4WARD Consortium
Acknowledgements

- 4WARD Consortium
- 4WARD is funded by the European Commission under the EU’s 7th Framework Programme
- www.4ward-project.eu

Network (R)Evolution – How?

- Is it just IPv7 or IPv8 … or creating an alternative?
- By adding and patching we run into the risk of “obesity and a weak immune system”
- Or should we even dare to think of tailor-made networks, fit for the purpose and reliable?
- Will migration work?

- How can we solve this?
The Facets of 4WARD

- Combination of clean-slate research approaches to address the **Network of the Future**
- Size: Roughly 23 M€
- Time 2 years
Network virtualisation as a meta-architecture in a commercial setting
- Enable co-existence of diverse network architectures
- Enable deployment of innovative approaches
- Enable new business roles and players
  - Allow split of infrastructure-/network-/service-providers
  - Lower barriers of entry
  - „Market place“ for shareable network resources

Provisioning and virtualisation management framework
- On-demand instantiation of virtual networks at large scale

Virtualisation of diverse resources in a common framework
- Routers, links, servers – can all be done today but need a unifying e2e approach
- Extension on the virtualisation of the wireless infrastructure and spectrum
- Folding points providing interworking between virtual networks
eedn1

Need a slide on folding points. The rest is doable. Too much text on the slide - I deleted a few subb ullets.
Norbert Niebert; 17.09.2008
Possible Provider Roles in a Virtualised Environment

End-to-End Deployment

Virtual Network Operator

Vertically Integrated Operators (virtualised networks)

Legacy Operator

Infrastructure Providers

Infrastructure Broker (optional)
Virtualisation of diverse resources in a common framework

Dynamic management of virtual networks

Enable co-existence of diverse network architectures

Enable new business roles and players
Virtual Radio Framework

- Virtualisation of Wireless Resources & Efficient Spectrum Sharing
- Flexible and cost-efficient deployment of new radio technologies
- Harmonised access of slices to a common radio resource block

- Slices can implement their own protocols/methods
  - routing, mobility management, naming
  - radio protocols, channel coding, smart antenna steering
  - cross layer optimisation

- Scheduling and isolation
• High-performance virtual router platform for modern commodity hardware
• Evaluation of virtualised forwarding planes in terms of isolation and fairness
VNet Instantiation Process

VNet Provider

Query
(abstracted network descr. + query language)~
Request
(abstract description)~
(mapping)

Commit Request
Commit
Embed

Initiate Inter-Provider Links

Infrastructure Provider A
Commit + Embed

Infrastructure Provider B
Commit + Embed

Infrastructure Provider C
Commit + Embed

VMGW
Peering Point

23/11/2008
© 4WARD Consortium Confidential
How far have we come?

- Draft architecture
- Scalable mapping algorithms using data mining technology
- Initial definition of signaling and control interfaces
- First version resource description language
  - Modelling of resources and networks
  - XML-based
  - Used for request and offer
  - Additional query language for complex requests
- Virtual Radio concept
- Early prototyping and testbeds
- Controlled Interworking concept
But how to design a network architecture?

- By reusing and patching existing protocols we forgot to develop tools for clean slate design esp. for the more detailed network architecture specifications.
- Can such a design toolkit and process be easily developed and used?
- Where can we find reusable components other than protocol specs and implementations?
- How can we ensure interoperability?
Overview of 4WARD’s Network Design Process

Requirements

Model Driven Design Process (including iterations)

Network architect
(needs to have knowledge about networks – works off-line, before (!) operation of the network)

Building blocks, Netlets, Abstract strata, Architecture patterns

Composition of functionality (CFI)

Inter-operability

4WARD Architectural Framework

“Blue Print” of network Architecture (selected netlets/strata)

Netlets, Strata

Prototype Repository

Implementation

© 4WARD Consortium Confidential
What a new network architecture could interconnect

- We are used to think a network consisting of nodes (end + forwarding) and links.
- What if we start to network the information we are looking for?
- Triggered by Van Jacobsen and others a new view on interconnecting information has emerged ...
- that could change the way we engineer networks fundamentally.
- The Networking of Information is looking into this from a systems perspective.
Information Objects and Data Objects

Aggregation IOs

All About Song1

Paris

Encoding IO

Song1

Virtual Entity IO

Eiffel

Service IO

Data Objects

Song1.mp3

Song1.wav

Lyrics.txt

Eiffel.jpg

Files

Song1.mp3

Song1.wav

Lyrics.txt

Eiffel.jpg

Service1

23/11/2008
How to transport?

- Can we assume that turning wireless and optical media into copper will work forever?
- And why is it efficient to do transport innovations only as overlays?
- What can be gained with a completely fresh view on transport mechanisms?
- The Generic Path is an answer to these questions...
An architecture and a set of mechanisms

- the *Generic Path* architecture
  - a much richer class of data flows, beyond TCP, UDP
  - state within the network, as necessary but no more than necessary
  - common management interfaces, to set up and tear down flows and to query their status
  - explicit identification, notably to facilitate control of multi-flow applications like videoconferencing

- mechanisms for assured performance and efficient operation
  - to exploit techniques like network coding and cooperative transmission
  - to choose the "best" paths for the considered transport
  - to ensure resource sharing is "fair" and meets application requirements
  - to manage the mobility of users, networks and information
Management?!

- The most urgent need in a dynamic world is Self-Management
- Automation of Management has been a research topic for many years
- Does it provide in practice more than automated settings on FI routers?
- Can we rely on this?
- What are the new approaches in this area?
Monitoring and adaptation

- INM functions aim at predictability
  - Local optimization loops reduce time to react
  - Trade-off between accuracy, timeliness and overhead
  - Tunable objectives in adaptation algorithms
  - Anomaly detection to perform isolate exceptions in the network

- Final objective
  - Build full control control loops
  - Maintain service-level objectives
  - Enforcing required OAM functions
Summary

- 4WARD follows a number of technical innovation approaches in all areas of future networking
- They all start from a clean-slate perspective, defining radically new solutions for the Network of the Future
- After 11 month work first results look promising
- Now the hard work of refining and integrating starts towards a new

Network of the Future
as a Family of Networks
Future Internet Summer School 2009
Universität Bremen
July 20-24, 2009
Mixture of courses, presentations and invited talks by 4ward in cooperation with other Future Internet projects, e.g. EuroNF, ANA, Chianti, …
Courses for graduate students and researchers
See 4ward website or www.comnets.uni-bremen.de
References