Network Virtualization: a 4WARD approach

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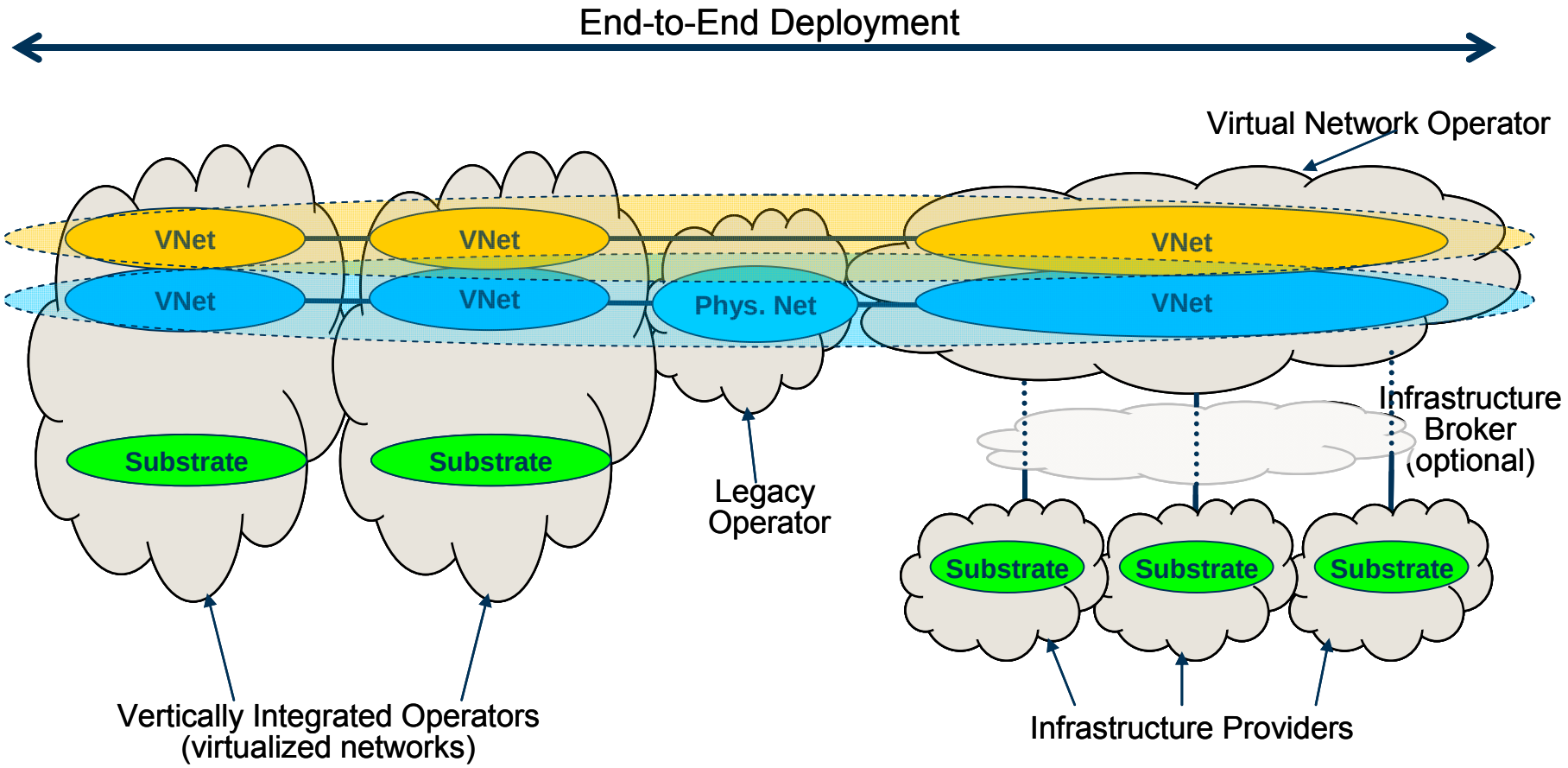
Presentation Outline

- Objectives
- Vision
- Related Work
- Main Innovations
- Technical Contributions
- Key Progress Achieved
- Future Work

Objectives

- To define the architectural approach to provision virtual networks on a shared infrastructure
- To develop the technologies that enable scalable instantiation and inter-operation of different networks on a shared infrastructure
- To demonstrate dynamically provisioned virtual networks in parallel using shared networking resources

Vision: Virtualized Networking Environment



State-of-the-Art and Related Work

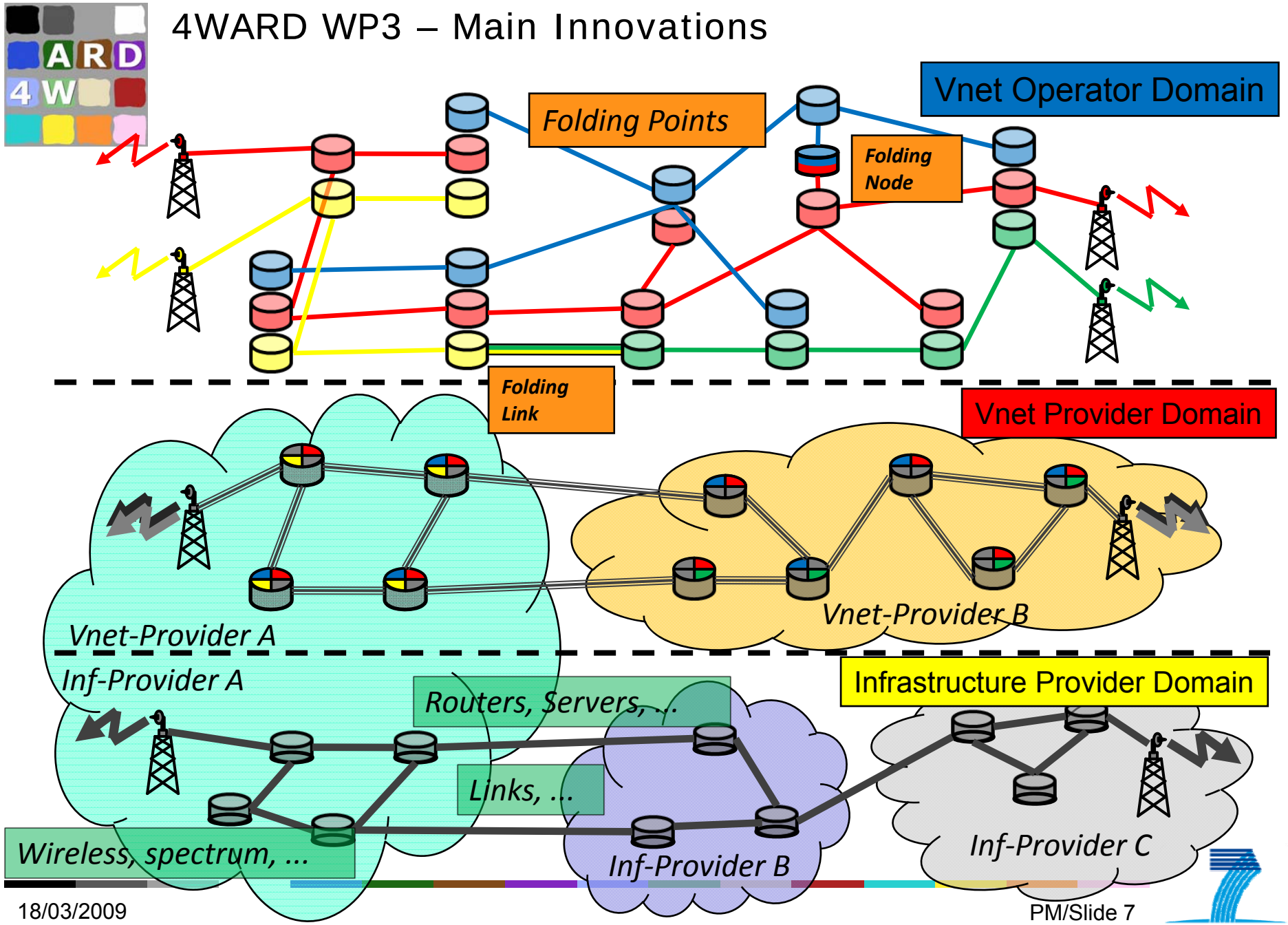
- Virtualization is being employed in several areas, e.g. operating systems, virtual servers
- Network Virtualization only available in parts, e.g. VLAN, Virtual IP-Routers, L2VPN/L3VPN
- Work in progress in the research community e.g. CABO, Cabernet, X-Bone, “Internet 3.0”, “Recursive Network Architecture”, “Clean Slate”

What are the main innovations of 4ward?

4WARD WP3 – Main Innovations

- 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 *signalling & control*
  - *Dynamic management* of virtual networks
- Virtualisation of diverse resources in a common framework
  - Routers, links, servers
  - Wireless infrastructure, spectrum
  - Folding points providing interworking between virtual networks
  - Unified management interfaces

4WARD WP3 – Main Innovations

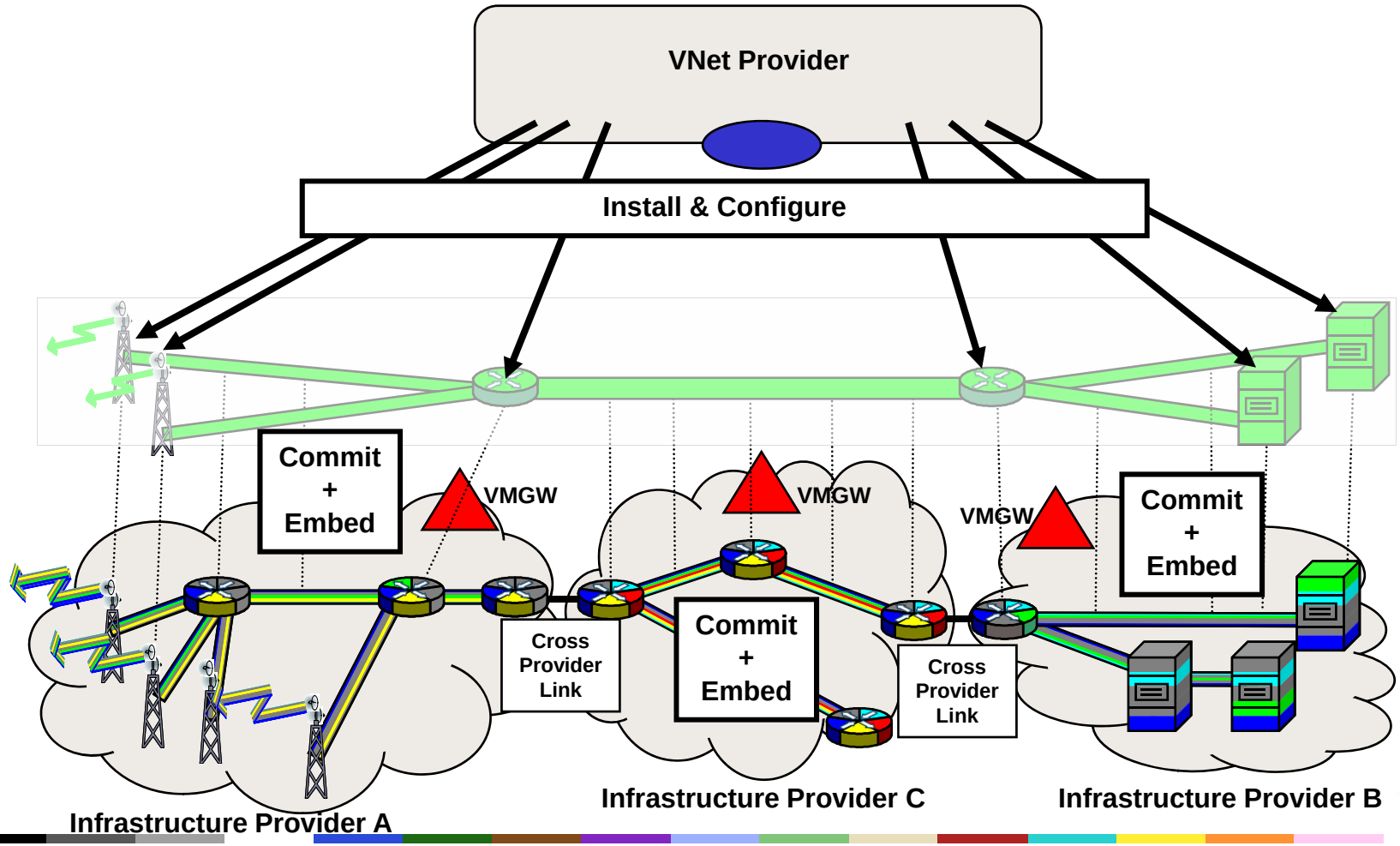


Main Technical Concepts

(D3.1.0 Virtualisation Approach: Concept (draft), internal)

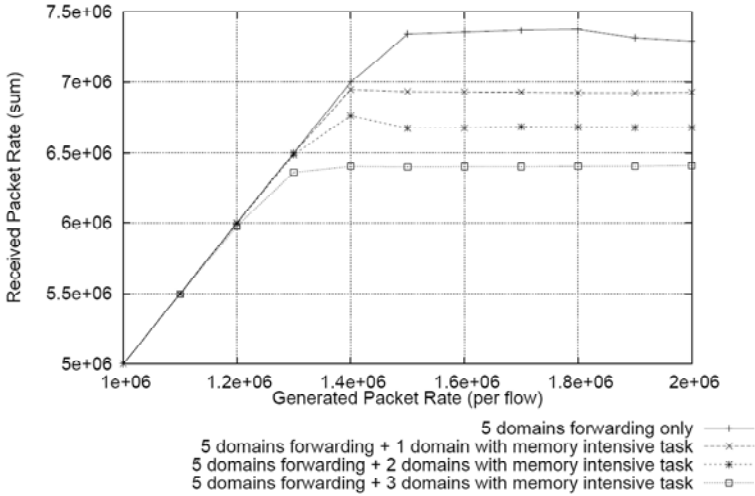
- Virtual Network (VNet) Architecture (T3.1)
  - Architectural Components
  - Virtualisation Scenarios & Business Roles [PMMG09]
  - Resource Description
  - …
- Virtualisation of Resources (T3.2)
  - Virtual Radio Framework [SAC08], [MPC09]
  - Virtual Router Performance [EGH09]
  - Folding Point Concept
  - …
- VNet Provisioning and Management: (T3.3)
  - Mapping & Embedding Framework [HoLZ08a], [HoLZ08b]
  - Signalling and Control Protocols [BW09a], [BW09b]
  - …
- Evaluation (T3.4)
  - Feasibility Tests
  - Integrated Tests & Demonstrations
  - …

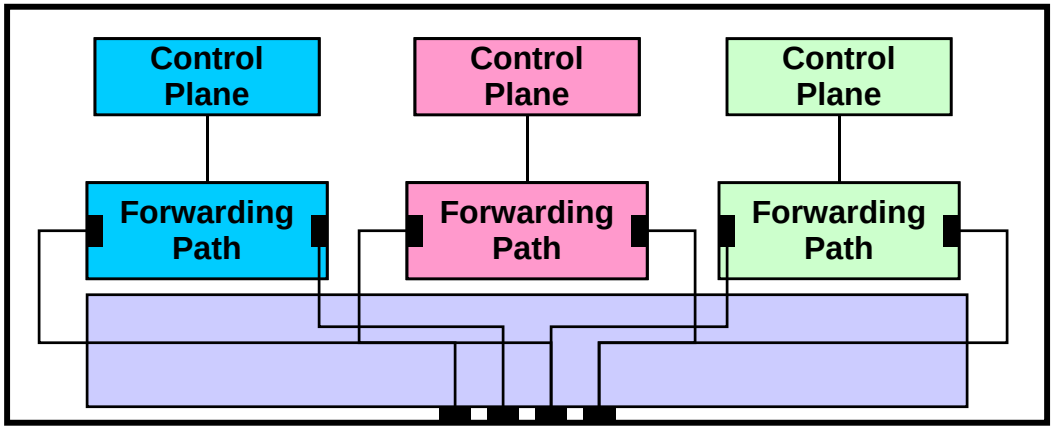
VNet Instantiation Process



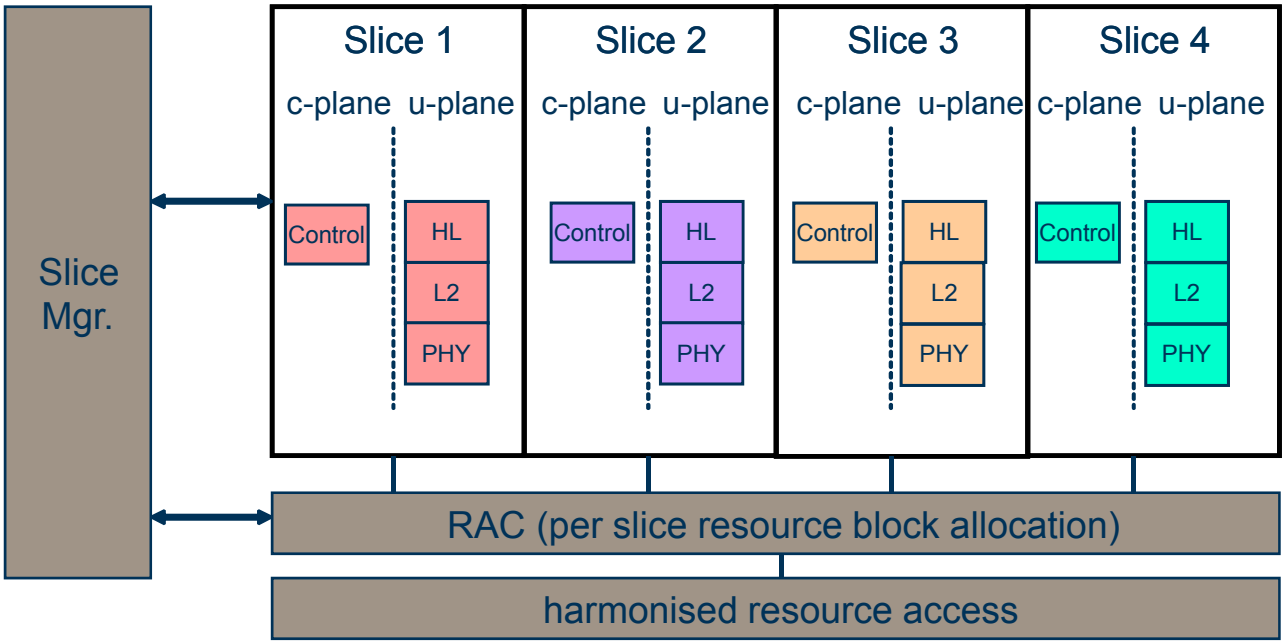
Programmable Virtual Router Performance

- Software-based router platform based on commodity hardware
- High degree of flexibility and programmability, yet good forwarding performance
  - E.g. Dell PowerEdge 2950, 2x Intel X5355 quad-core CPUs, 64-byte packets: ~7MP/s
- Evaluation of virtualised forwarding planes in terms of isolation and fairness





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

Key Progress and Fulfillment of Objectives (1/3)

- To define the architectural approach to provision virtual networks on a shared infrastructure

  - Development of specific scenarios
    - Drive architecture work
    - Create common framework
  - Draft network virtualization architecture
    - Players and services
    - Interfaces
    - Data models and Description Language
  - Initial analysis of business aspects and incentives

Key Progress and Fulfillment of Objectives (2/3)

- To develop the technologies that enable scalable instantiation and inter-operation of different networks on a shared infrastructure
  - Mapping & embedding framework (virtual ↔ physical resources)
    - Scalable discovery and mapping algorithms
  - Signaling & control: Interfaces and protocols
    - Provisioning, migration, end-user attachment, access to management functions
  - Virtualization of resources
    - Efficient software-based virtual routers with good isolation
    - Wireless virtualization: Virtual radio concept, virtual radio resource management
    - Integration of existing link virtualization technologies into framework
  - Folding Points
    - Definition of functionality
    - Placement and deployment using the VNet provisioning framework

Key Progress and Fulfillment of Objectives (3/3)

- To demonstrate dynamically provisioned virtual networks in parallel using shared networking resources
  - Small-scale prototypes, e.g.:
    - Virtual management interface & resource DB
    - Virtual routers
    - Folding Point testbed
    - Components of provisioning framework on HEN testbed (Lancaster)
  - Interconnection of testbeds

Dissemination

- 15 Papers published/accepted plus presentations at 4 workshops
- FISS'09 (Future Internet Summer School): with presentations & demonstrations
- IRTF NVRG: presentations of the 4WARD virtualisation concept were prepared and held at two "BAR BOF" meetings during the last two IETF meetings
- Program Committee participation with several conferences and workshops related to the topic, e.g. KiVS, ICC, ITCSS, VISA, GENI proposal review

Future Work

- Refinement of the architecture
- Continue to investigate specific concepts and methods in the areas of resource virtualisation
- Evaluate the developed algorithms and protocols
- Extend current testbed activities, moving to evaluation phase
- Continue the cooperation with NetInf, In-Network-Management, New Architecture Framework, Generic Path

THANK

YOU

SEVENTH FRAMEWORK PROGRAMME

WP3 Publications

- [BW09a] R. Bless, C. Werle. "Control Plane Issues in the 4WARD Network Virtualization Architecture". Invited paper at "Workshop on Overlay and Network Virtualization" at KiVS 2009, March 2009.
- [BW09b] R. Bless, C. Werle. "Network Virtualization from a Signaling Perspective". Submitted to Future-Net '09 International Workshop on the Network of the Future 2009 in conjunction with IEEE ICC 2009, June 2009.
- [EGH09] N. Egi, A. Greenhalgh, M. Handley, M. Hoerdt, F. Huici, L. Mathy, and P. Papadimitriou. "Designing a Platform for Flexible and Performant Virtual Routers on Commodity Hardware". Invited Paper, Proc. Workshop on Overlay and Network Virtualisation, Kassel, Germany, March 2009.
- [HoLZ08a] I. Houidi, W. Louati and D. Zeghlache. "A Distributed Virtual Network Mapping Algorithm". Proc. 2008 IEEE International Conference on Communications (ICC 2008), May 19-23, 2008, Beijing, China, pp. 5634 - 5640.
- [HoLZ08b] I. Houidi, W. Louati and D. Zeghlache, ”A Distributed and Autonomic Virtual Network Mapping Framework”. The Fourth International Conference on Autonomic and Autonomous Systems, ICAS 2008, March 16-21, 2008, Gosier, Guadeloupe, pp. 241-247

WP3 Publications (cont.)

- [MNBG09] C. Marquezan, G. Nunzi, M. Brunner, L. Granville. “Autonomic Communications & Network Virtualization: A Real Self-organizing Model for Substrate Networks”. Submitted to IEEE Journal of Selected Areas in Communications
- [MNGN09] C. Marquezan, J. Nobre, L. Granville, G. Nunzi, D. Dudkowski, M. Brunner. “Distributed Reallocation Scheme for Virtual Network Resources”. To appear in IEEE ICC'09, Dresden, June 2009
- [MPC09] E. Miguel, S. Pérez and J. M. Cabero. “Virtualisation of the wireless medium: a simulation-based study”. To appear in IEEE 69th Vehicular Technology Conference: VTC2009, April 2009
- [PMMG09] P. Papadimitriou, L. Mathy, O. Maennel, A. Greenhalgh. Implementing Network Virtualization for a Future Internet. Submitted to 20th ITC Specialist Seminar on Network Virtualization, May 2009
- [SAC08] J. Sachs, S. Baucke. "Virtual Radio – A Framework for Configurable Radio Networks”. To appear in Wireless Internet Conference (WICON), Maui, USA, November 17-19, 2008.