An Architecture for Concurrent Future Networks

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Motivation

- 4WARD-Project: „Let 1000 networks bloom“
  - Network Virtualization
  - Vast amount of (virtual) networks
  - User might have multiple Networks side-by-side
- How can we do this?
  - How can we run multiple networks?
  - What must a node look like?
  - How do we connect an application to the correct network?
  - What about Security, QoS, and Mobility?
  - Rapid creation of such networks?

Definitions

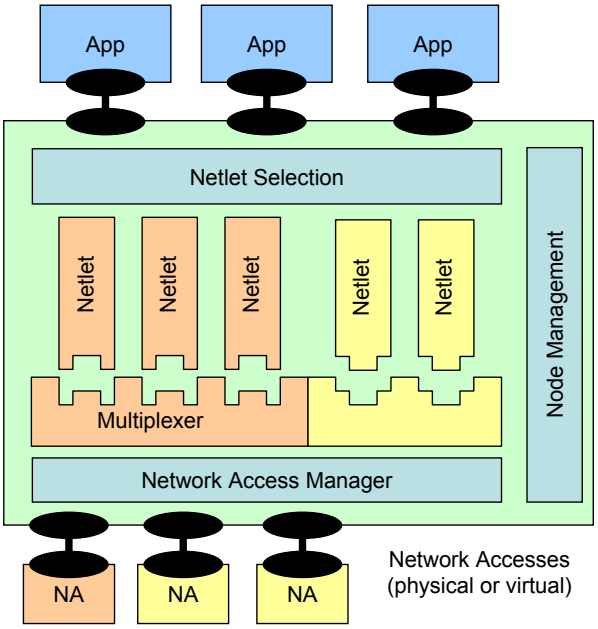
- Just to make life easier for us …
  - **Network Architecture** – A common understanding within a network. Usually involves common protocols as well as naming and addressing.
  - **Network Architect** – Designer of networks and/or network architectures.

Structure of this talk

- Motivation
- Definitions
- Node Architecture at a glance
- Important Concepts of the Node Architecture
- Node Architecture put together
- Rapid creation with the Design Process
- Conclusion and Outlook

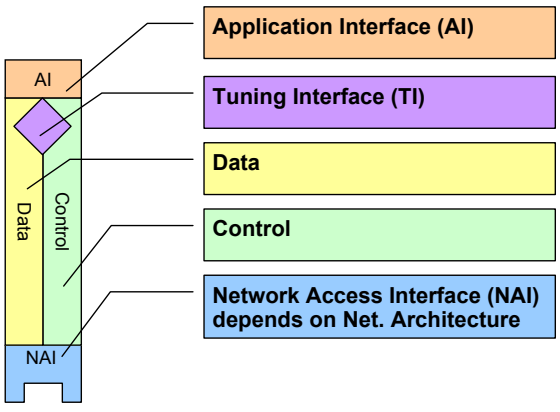
Node Architecture at a glance

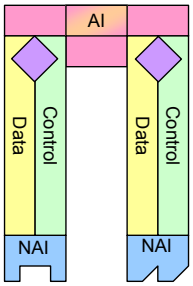
- Simplified version
- Netlet as Protocol Container
- Architecture-specific Multiplexer
- Network Access
  - Virtual or physical Networks
  - Network Access Manager



The Netlet – A container for Future Internet protocols

- Netlet (≈ Protocol Stack)
  - Is usually based on one Network Architecture
    - Fits usually just one Network Architecture
    - NAI has to be compatible to Network Architecture
  - Could be build many different ways:
    - Writing Code, Code Generation, 3rd party, Composition, …
  - "Interop Netlet" connects multiple Network Architectures





Application Interface – Moving forward from the Socket API

- Today's interfaces to the applications (e.g. Socket API) have drawbacks
  - Peer is described by address and not by name
    - Usually simple name resolution rule (e.g. IPv6 first, IPv4 second)
    - With 1000 networks, choice of the network important!
  - Applications might have requirements on communication!
    - Please protect this connection
- Needed changes:
  - Move name resolver from application to system
  - Allow application to influence choice of network with requirements

Network Access Interface – Transparently support Network Virtualization

- With 1000 networks, many of them will be virtual networks!
  - That means: Virtual Networks won't be special
  - Possibly the common case
- The Network Access Interface
  - Hides the differences of physical and virtual networks
  - Supports the description of the underlying network
    - e.g., latency, energy consumption, cost
    - Triggers of network events
    - So the selection of Netlets could also be based on the network properties

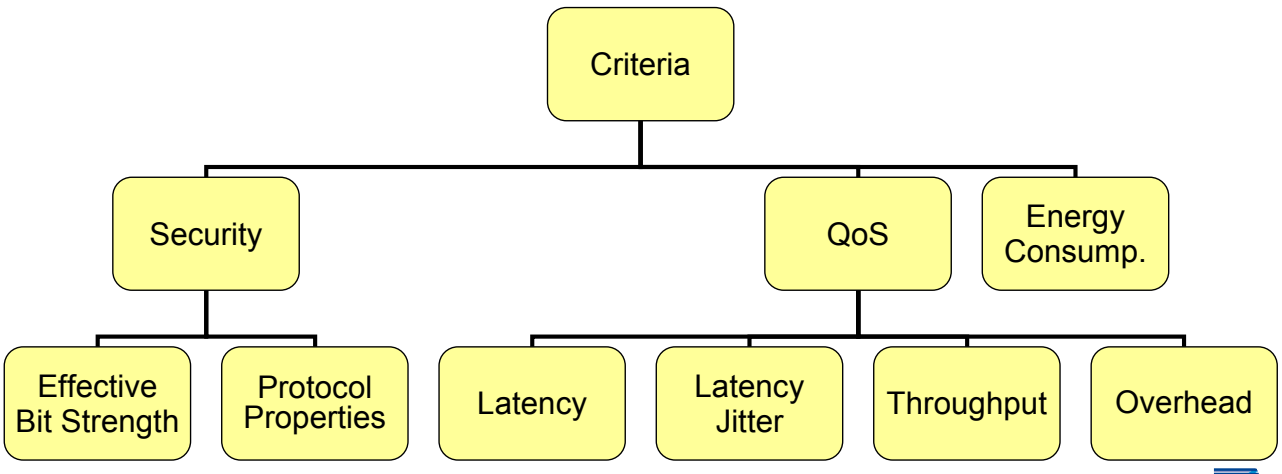
Automatic Selection – Choosing the best Netlet

- With “1000 networks” the user cannot just manually choose the network!
- Idea:
  - Let application, user, and administrator describe requirements/goals
  - Description of underlying network
  - “Estimate” the Netlet’s behavior
  - Rank the Netlets based on this
- This is based on Multi Attribute Utility Theory (MAUT) and [1]

[1] Lars Völker, Christoph Werle, Martina Zitterbart, ***Decision Process for Automated Selection of Security Protocols***, 33nd IEEE Conference on Local Computer Networks (LCN 2008), IEEE, p. 223--229, Montreal, QB, Canada, Oct 2008.

Criteria

- To determine what’s *best* we need to describe Netlets!
- We looked at several criteria, here some examples



Calculating total value

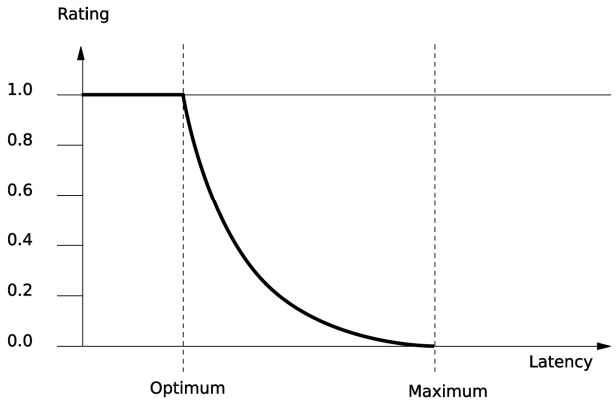
- How to aggregate the criteria to overall utility:

$$v(a_i) = \sum_{j=1}^{m} w_j * v_j(c_j(a_i))$$

Meaning	Abbreviation
Alternative i	a_i
Criterion j	c_j
Weight for criterion j	w_j
Attribute value of a_i with regard to criterion c_j	$c_j(a_i)$
Value function for criterion c_j	v_j
Total value of alternative a_i	$v(a_i)$

Value Functions

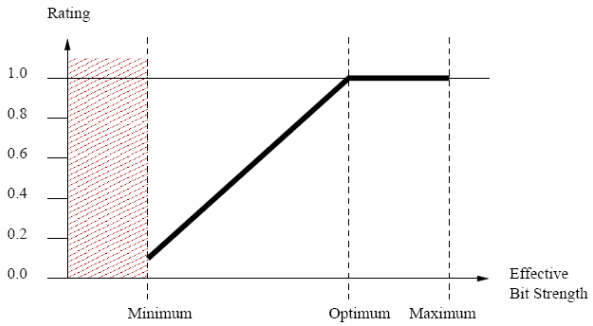
- Function to “translate” the individual criteria’s values to a (generic) utility
- This function has to fit to the criterion
  - Each criterion could have a specific value function
  - It should be adaptable



A possible Value Function for Latency

Strength of Security!?

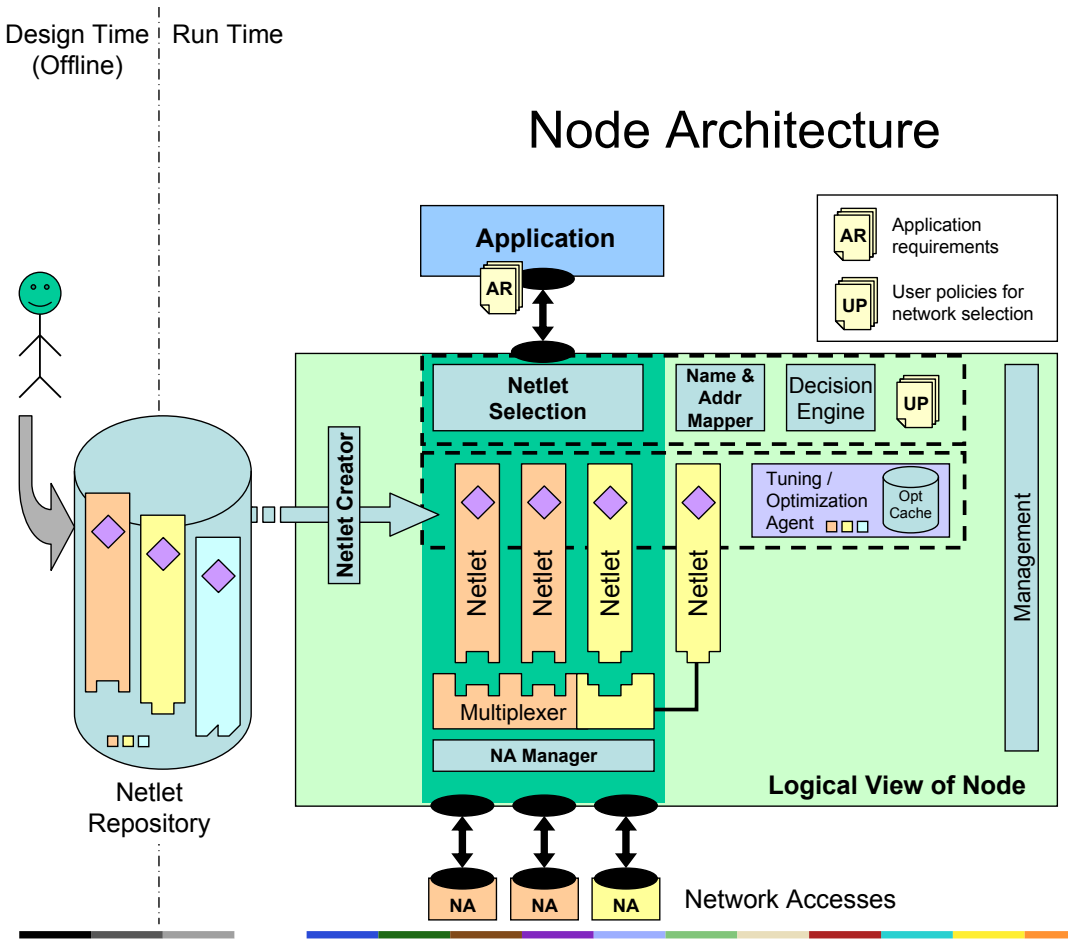
- Determine Effective Bit Strength (EBS) of involved cryptographic primitives:
  - Authentication, Key Exchange, Encryption, Message Authentication
  - Aggregate those EBS values using the Min-Function
  - EBS → Utility Value
    - Value is not linear for most users



Influencing the Decision Process

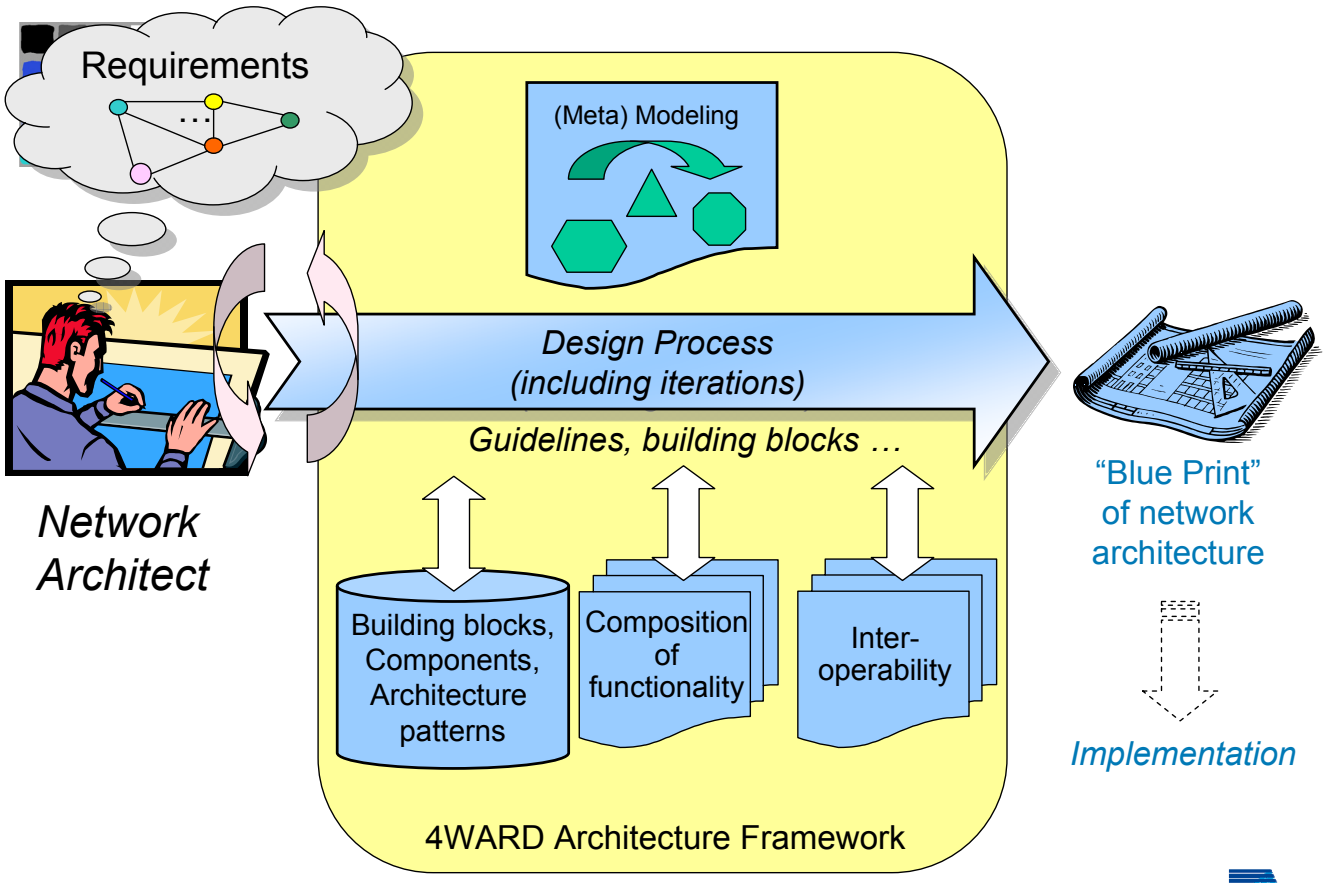
- Value functions
  - Can be replaced and/or adjusted
- Weights
  - Put criteria into proportion
- Requirements
  - Describe which values are ok for criterion
  - Works also for qualitative criteria

Node Architecture



Design Process – Accelerating the Creation of Netlets

- Iterative process aiding the future network architect to design new networks
- The network architect will start with his own requirements and will refine them during the process
- He will derive a *Blue Print* for the network architecture's components and functionalities
- With this *Blue Print*
  - Components of the network architecture can be implemented (if not using standard components already existing on the market)
  - Network topologies can be designed by network administrators



Conclusion / Benefits

- Create a new network architecture if needed
  - Every virtual network can have their own
  - You could even have applications come with their own
  - Has to be a simple process!
    - The Design Process enables this
- Netlets can be treated as almost arbitrary black boxes
  - Approaches like RNA and SILO can run in a Netlet
  - We try to not introduce too many invariants
    - Allow for future development
- Choosing the Netlet and Network Architecture dynamically

Thank you for your attention

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Dipl.-Inform.
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