# Invariants – A New Design Methodology for Network Architectures

## Contributions
- The concept of architectural invariants
- Their use to aid the design and evaluation of new systems

## Examples of invariants
- The IPv4 address in the current Internet
- Port numbers
- The SIM card in mobile phones

## Background – Standards and interoperability
- Standardization is the means to achieve *interoperability* between components from different vendors
- Many standards can *evolve* during the lifetime of the system
- Sometimes we however come to a point when it is *not possible* to make changes without *obsoleting old components*

## Evaluation of architectures
- Can invariants be used to evaluate and compare network architectures?

## Overall criteria
- *Is the set complete?*
  - If the explicit invariants do not handle important communication requirements, implicit invariants are likely to appear to fill the gaps
- *Is the set independent?*
  - Avoid invariants that express the same constraint, i.e., remove redundant invariants

## Detailed criteria
- Does an invariant affect many components or just a few?
- Does an invariant affect many aspects of an architecture or just a few?
- Does an invariant affect silicon or just bits?
- Does an invariant have security or privacy implications?
- Does an invariant have internal flexibility?

## Two kinds of invariants
- *Explicit invariants*
  - are planned or predicted fixed points
- *Implicit invariants*
  - are unplanned or unpredicted fixed points

## What are invariants?
- *Invariants* are the details in a system design that *cannot* be changed
- Can be thought of as *least common denominators* or *fixed points*
- *Claim:* all complex systems-of-systems have invariants!

## Invariants-aware design
- By identifying the invariants early in the design process, we can make sure that they don't limit future evolution in undesired, or unknown ways

## Collaborators
- Marcus Brunner, Lars Eggert and Stefan Schmid, NEC Network Laboratories, Heidelberg, Germany
- Robert Hancock, Siemens / Roke Manor Research, Roke Manor, UK
- Bengt Ahlgren, SICS, Stockholm, Sweden
  Work partly done within the EU Ambient Networks project

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*Bengt Ahlgren* <bengt.ahlgren@sics.se>