Overcoming a Communication Barrier on the Way Towards a Global Sensor Network

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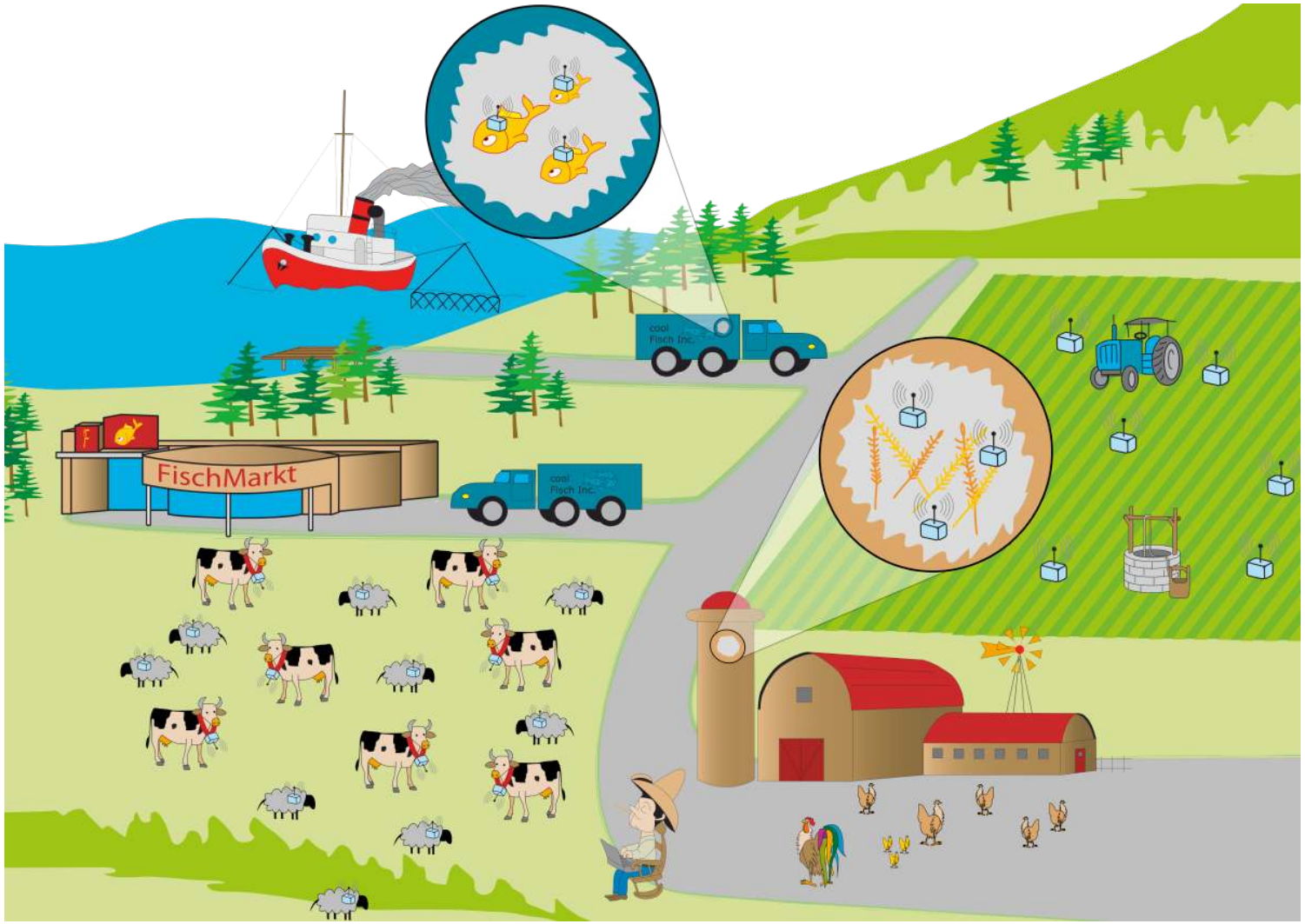
GSN – The Next Step in Sensor Networks



Outline

- The ZeuS-Project
- Heterogeneity: Chances and Challenges
- Communication Barrier in our 802.15.4 Network
- Solutions
- Outlook and Conclusion

The ZeuS-Project

- „Reliable Information Retrieval in Energy Aware Ubiquitous Systems“
- 7 Subprojects, amongst others:
  - Energy-efficient, distributed query processing
    - In-network processing of queries
    - Demanding more resources on some nodes

ZeuS

energy efficiency	**demanding tasks**
Small memory	*Big memory*
Small CPU	*Big CPU*

Heterogeneity – Chances & Challenges

- Chances of heterogeneous sensor networks
  - Collaboration of different deployments possible
  - Different tasks in a SN: chose the right node for each task
  - Coping with heterogeneity allows building long living SN

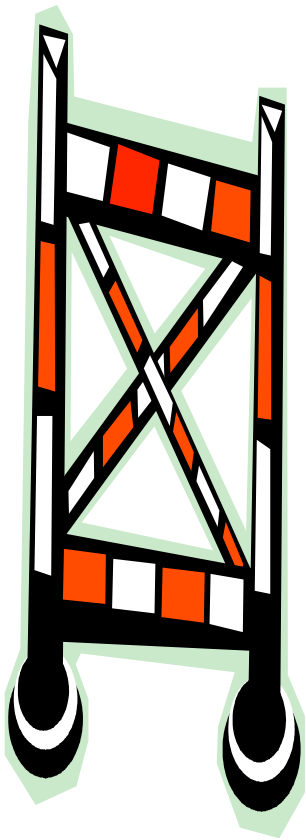



- Challenges of heterogeneous sensor networks
  - Hard to implement applications for different platforms
  - Hard to establish communication between heterogeneous platforms

Sun SPOTs / MICAz Motes

	MICAz Motes 	Sun SPOTs 
OS	Tiny OS (2.0.1)	Squawk JVM (orange)
Memory	512 KB Flash, 4 KB RAM	4 MB Flash, 512 KB RAM
CPU	8 MHz	180 MHz
Commu-nication	CC2420, IEEE 802.15.4, ActiveMessages, Dissemination, CTP	CC2420, IEEE 802.15.4, 6LowPAN, AODV, Radiogram, Radiostream

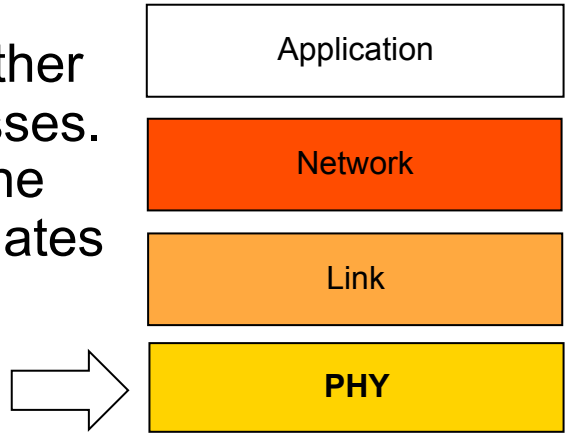
The Communication Barrier



Application	Application
Radiogram / Radiostream	CTP / Dissemination
6LowPAN (AODV)	ActiveMessage
IEEE 802.15.4	IEEE 802.15.4
CC2420 radio chip	CC2420 radio chip

Addressing Schemes

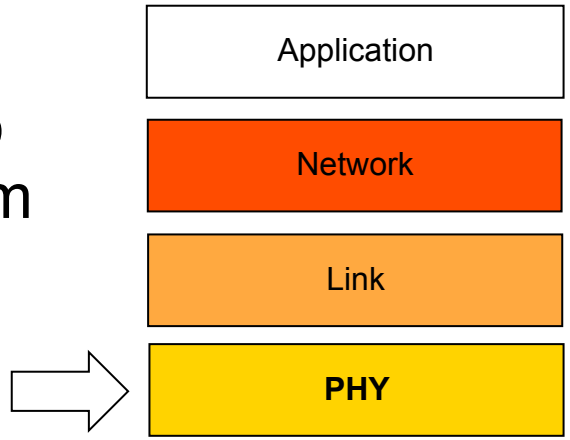
- Theory:
  - „All devices operating on a network of either topology shall have unique 64-bit addresses. …a short address may be allocated by the PAN coordinator when the device associates and used instead. “ [IEEE 802.15.4]



- Reality:
  - Sun SPOTs: auto-generated IEEE 64-bit address from hardware id.
  - MICAz Motes: 16-bit address configured at compile time.

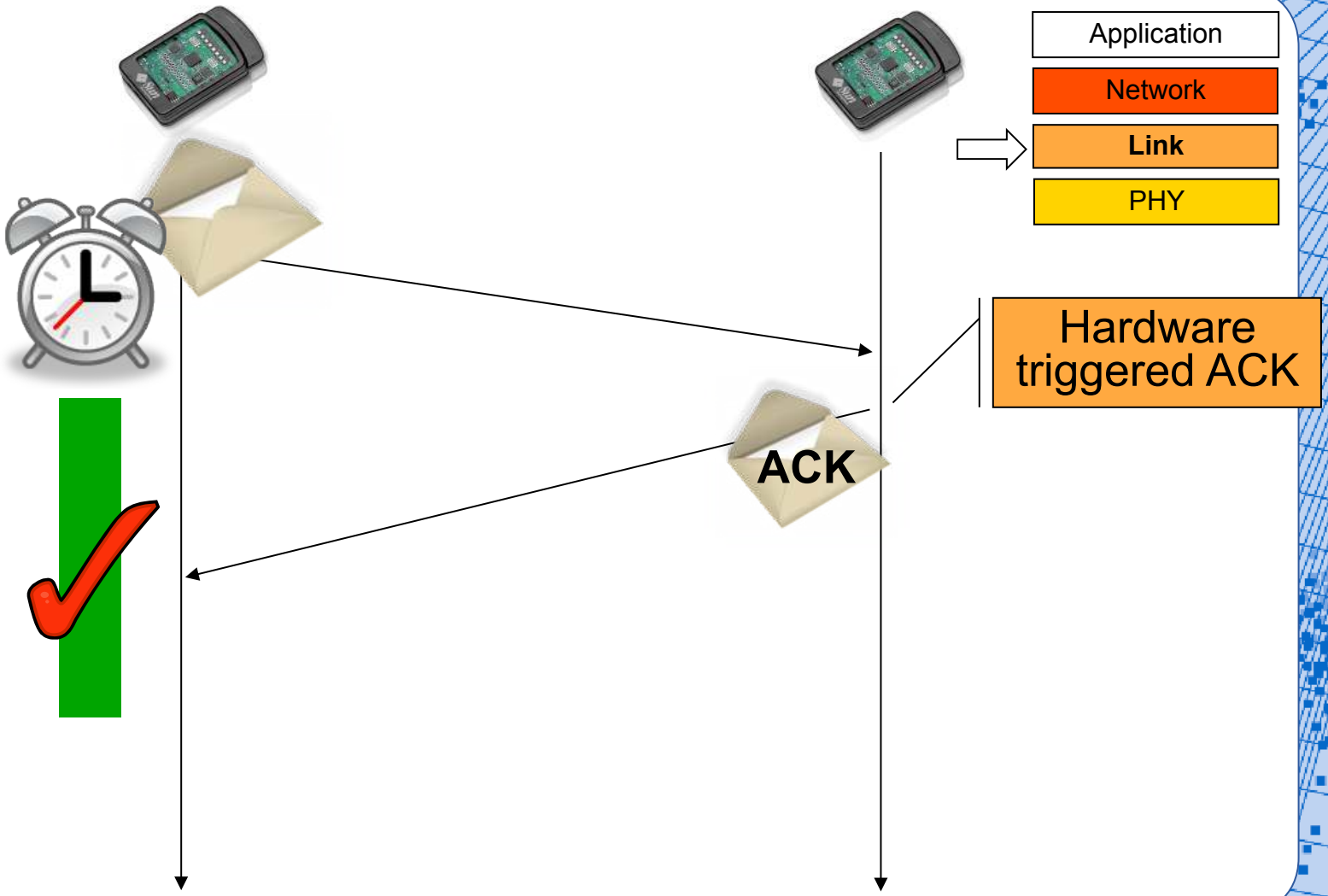
Addressing Scheme

- Workaround for small network
  - Extend Sun SPOTs radio driver to autogenerate 16bit addresses from hardware id
  - Configure radio chip to do address recognition for 16bit address as well

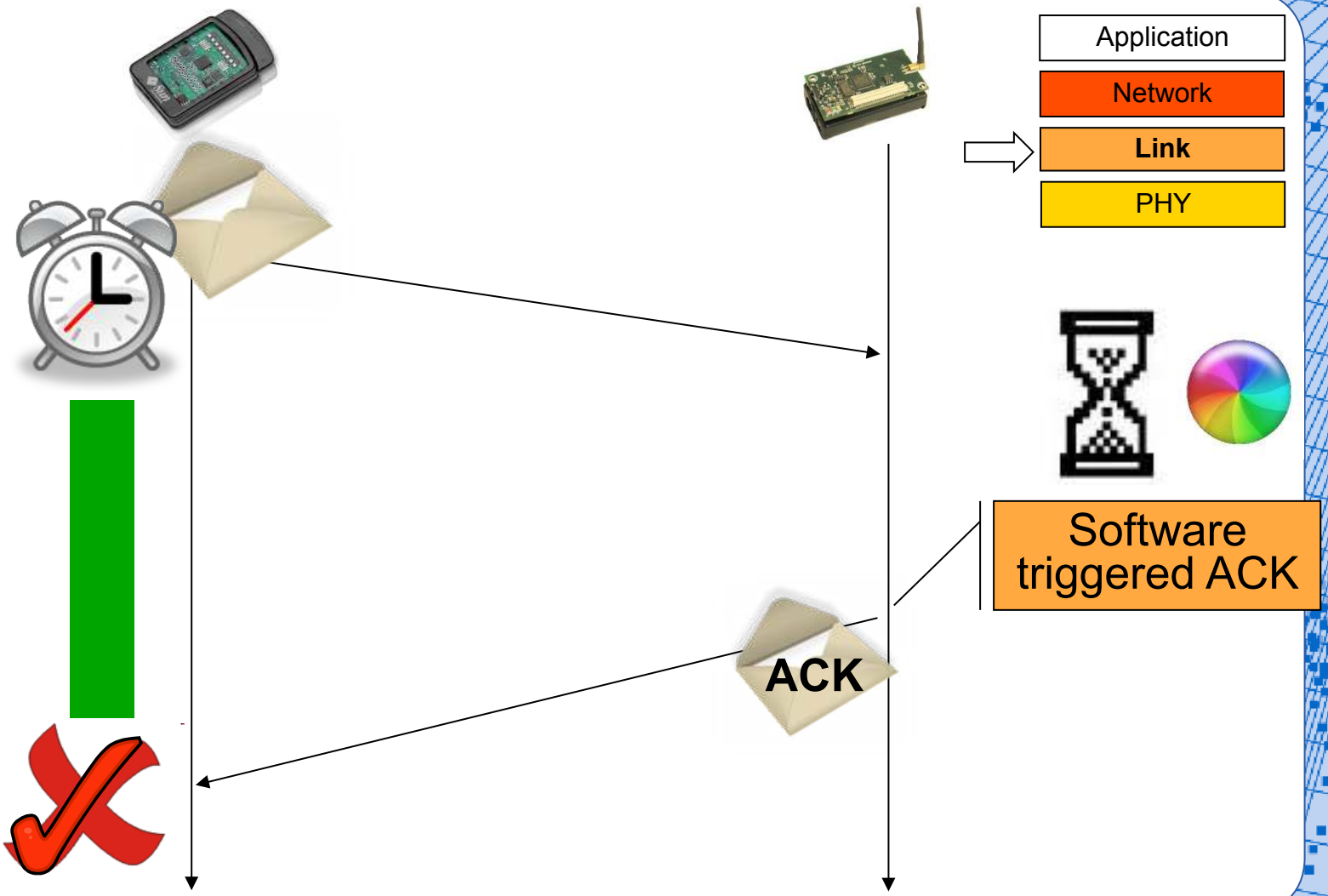


- Open question for global scale networks
  - Assignment of unique addresses
  - Resolving of addresses

Link Layer: Timing



Link Layer: Timing

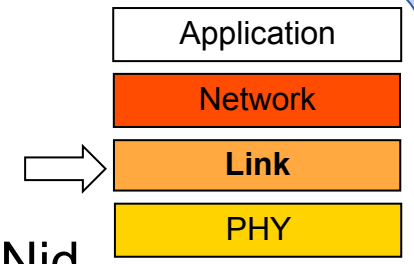


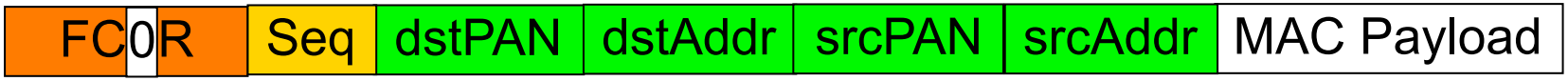
Discussion

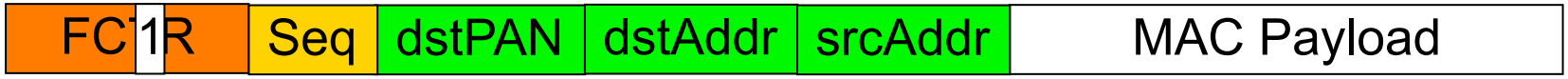
- Drawback
  - 802.15.4 ACK carries no address
  - Mapping DATA ←→ ACK relies on small time slot
  - Increased time slot increases probability of accepting wrong ACKs in dense networks
- Advantage
  - Easy to integrate in other subprojects:
    Need only to modify one platform, works with off-the-shelf motes

Link Layer: Header Flags

- PAN-addresses can be compressed:
  - If srcPAN = dstPAN header must contain only one PANid
  - Sun SPOTs expecting packets with only one PANid

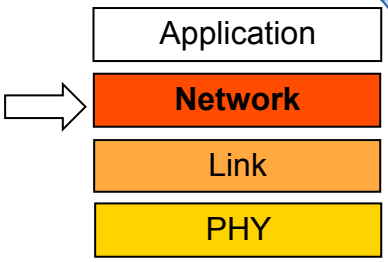




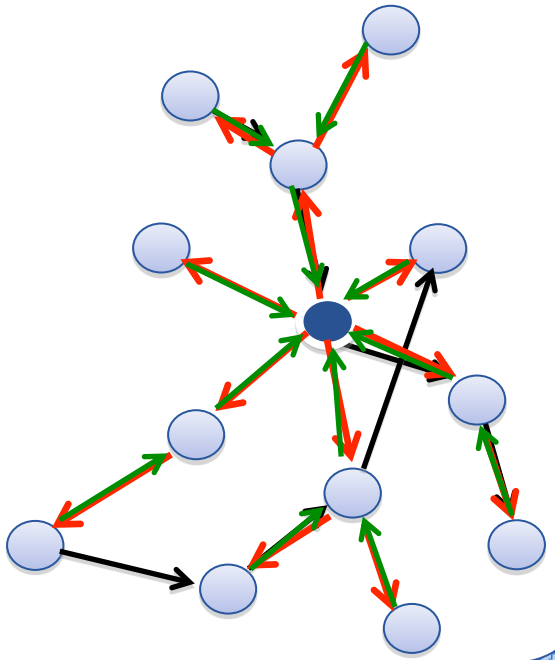


- Solution:
  - Missing implementation in Sun SPOT stack added

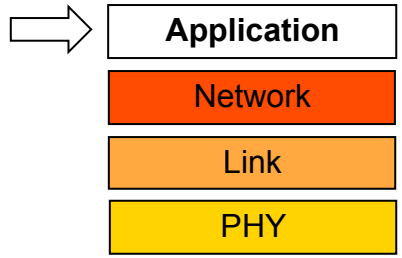
Network Layer: Multihop Connectivity



- Problem
  - No common network protocol for TinyOS and Sun SPOT available
  - Different platforms – different communication patterns
    - Sun SPOT (6LowPAN / AODV): unicast, node-to-node
    - TinyOS (CTP, Dissemination): many-to-one/one-to-many
- Solution
  - Porting CTP & Dissemination to the Sun SPOT platform



Application Layer: Payload Length



- Problem
  - Internal representation of packet datastructure differs
    - TinyOS: using fixed offsets, buffer size defined at compiletime (default 29 byte)
    - Sun SPOTs: using dynamic offsets in packet datastructure, buffer size = max packet size (128 byte)
- Workaround
  - Restrict payload length on Sun SPOTs as well to guarantee compatibility on heterogeneous paths.

Conclusion and Outlook

- Conclusion
  - GSN will contain heterogeneous platforms
  - No off-the-shelf compatibility yet
  - Interoperability must become design goal for platforms
- Outlook
  - Testkit for MAC layer communication would ease development
  - Addressing in a GSN: commonly accepted approach still to come
    - Who assigns addresses?
    - How many kind of addresses does a GSN need?