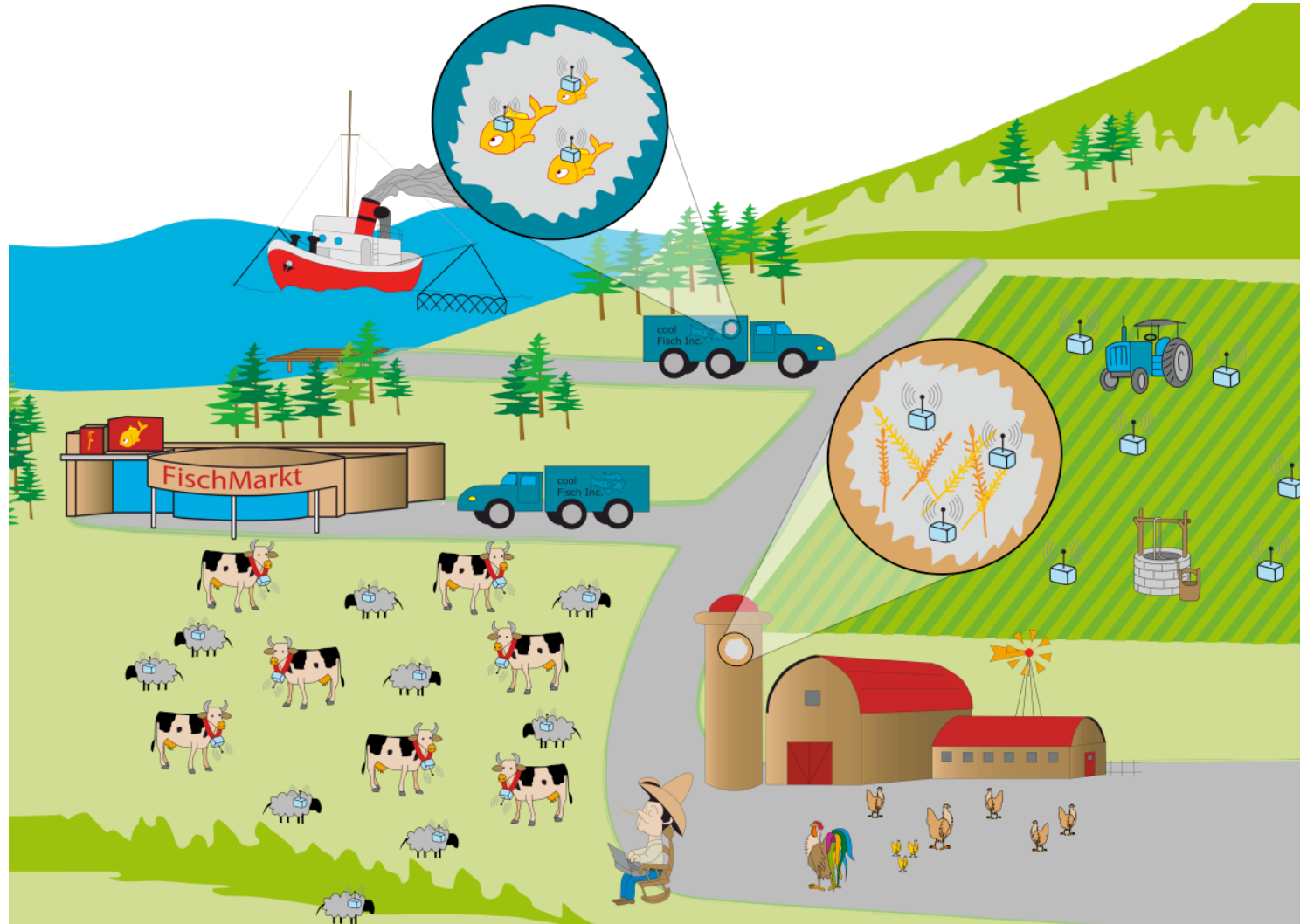


Overcoming a Communication Barrier on the Way Towards a Global Sensor Network



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

- „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

Small memory

Small CPU

demanding tasks

Big memory

Big CPU





• 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

	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

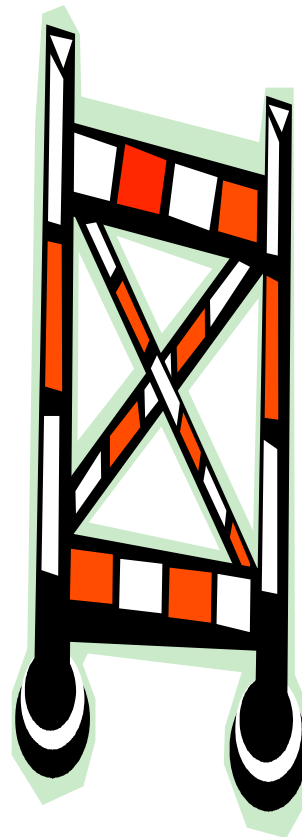
Application

Radiogram Radiostream

6LowPAN AODV

IEEE 802.15.4

CC2420 radio chip



Application

CTP Dissemination

ActiveMessage

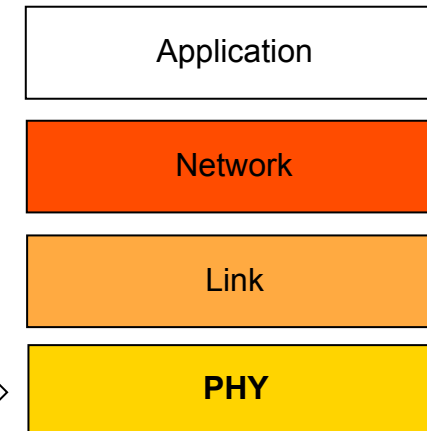
IEEE 802.15.4

CC2420 radio chip



•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]

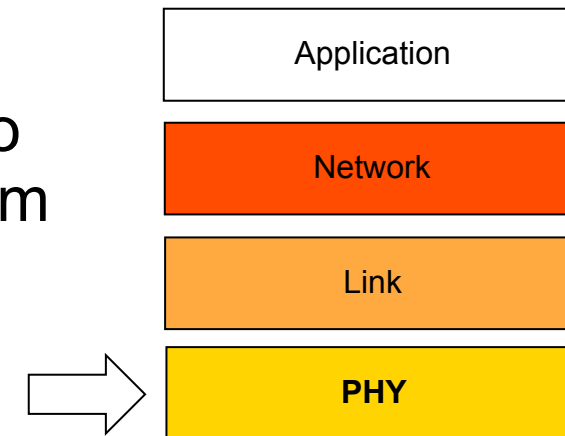


•Reality:

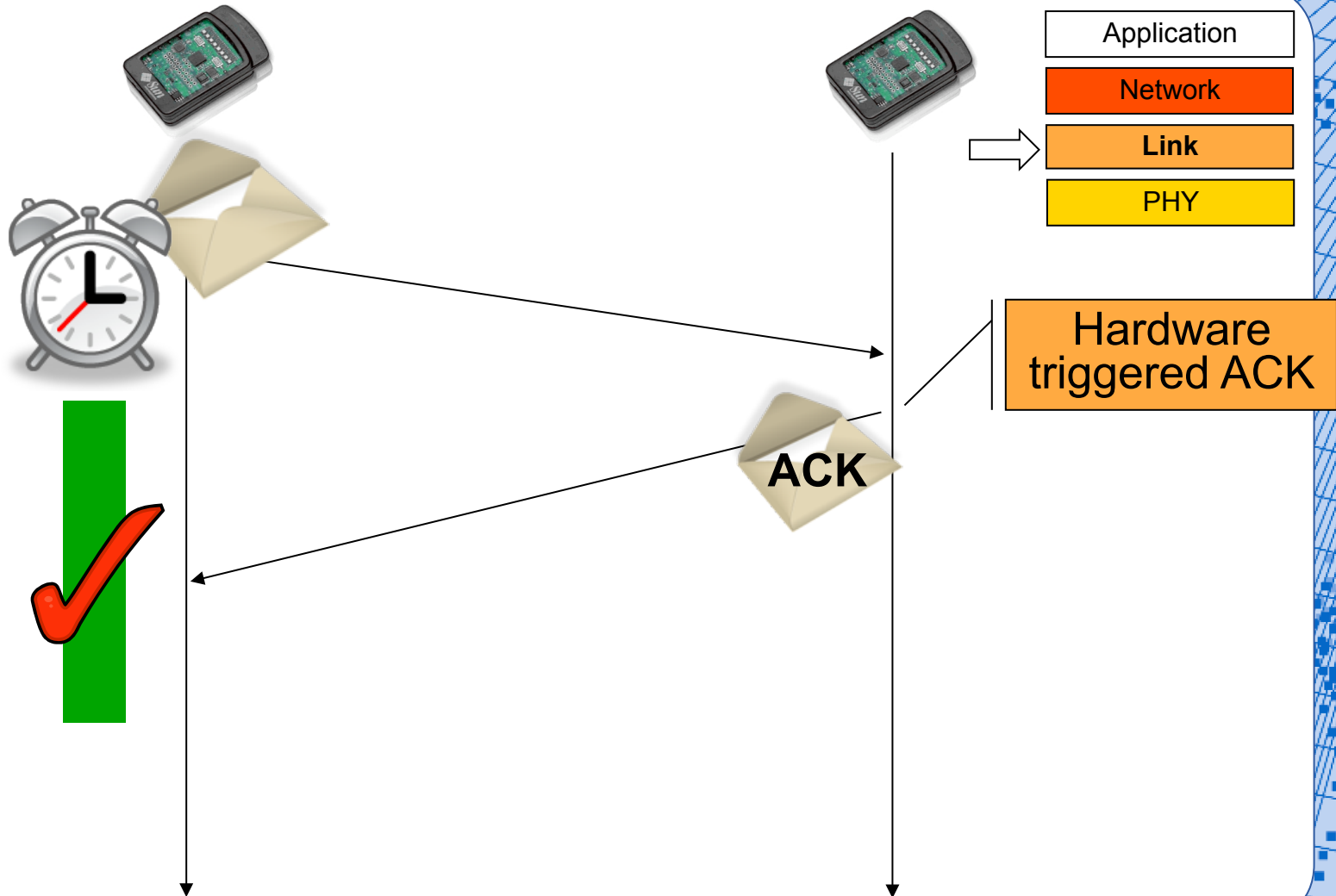
- Sun SPOTs: auto-generated IEEE 64-bit address from hardware id.
- MICAz Motes: 16-bit address configured at compile time.

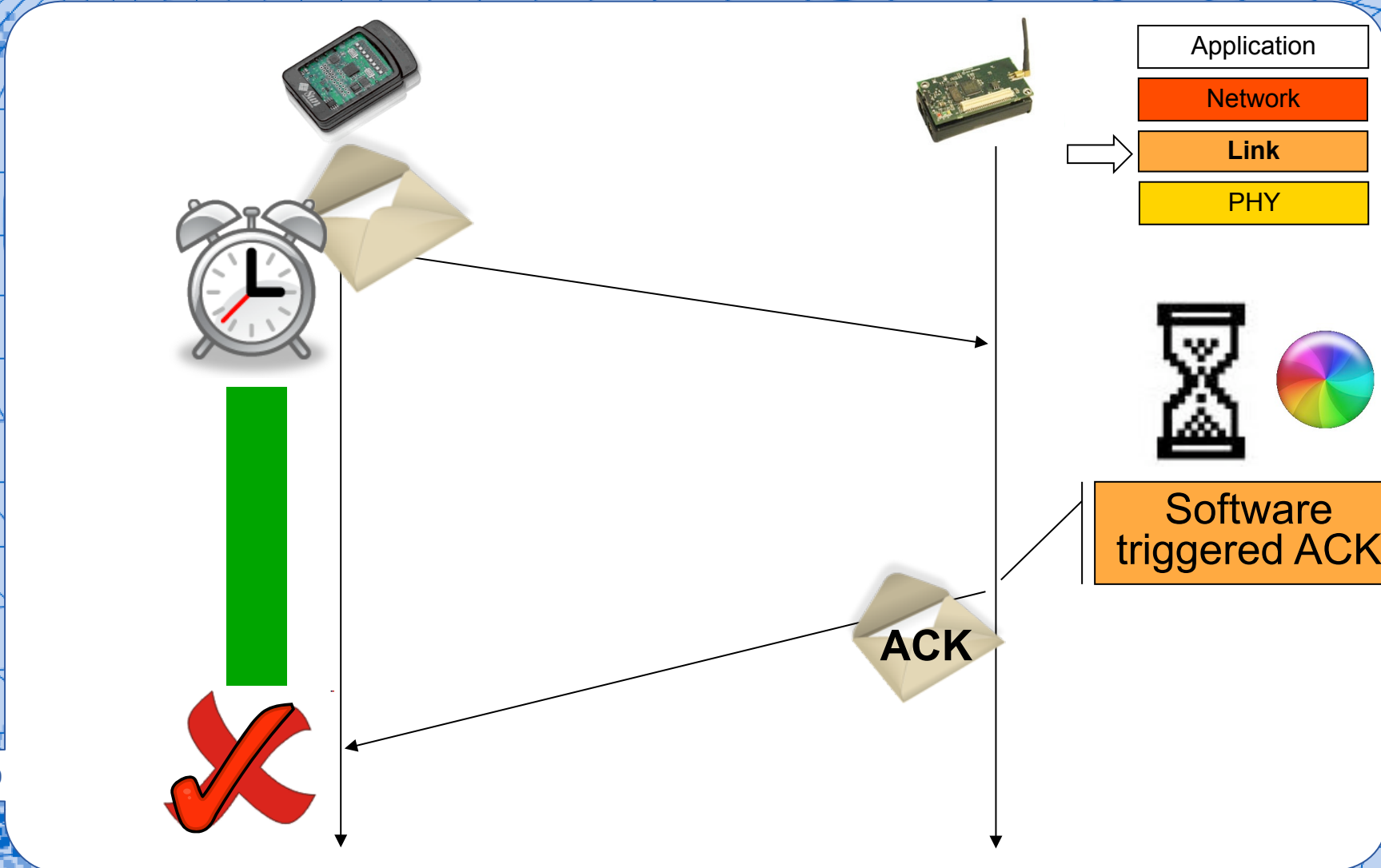
- **Workaround for small network**
 - Extend Sun SPOTs radio driver to autogenerate 16bit addresses from hardware id
 - Configure radio chip to do address recognition for 16bit address as well

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



Link Layer: Timing

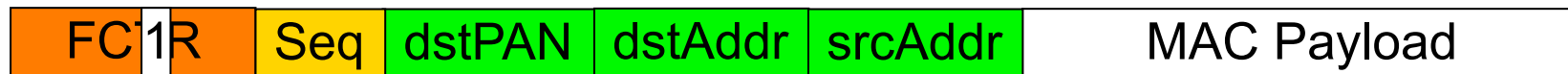
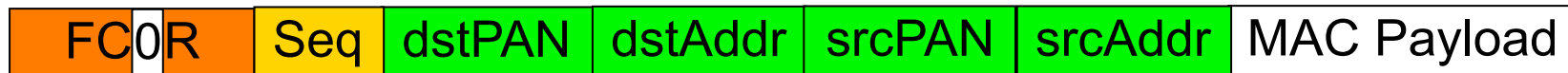
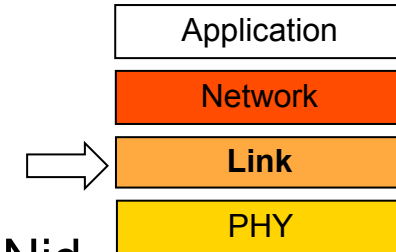




- Drawback
 - 802.15.4 ACK carries no address
 - Mapping DATA \leftrightarrow ACK relies on small time slot
 - Increased time slot increases probability of accepting wrong ACKs in dense networks
- Advantage
 - Easy to integrate in other subprojects:
Need only to modify one platform, works with off-the-shelf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

- PAN-addresses can be compressed:

- If srcPAN = dstPAN header must contain only one PANid
- Sun SPOTs expecting packets with only one PANid



- Solution:

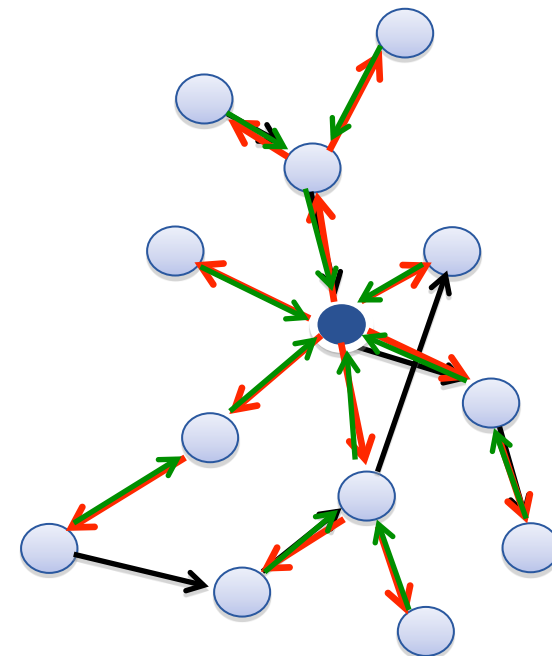
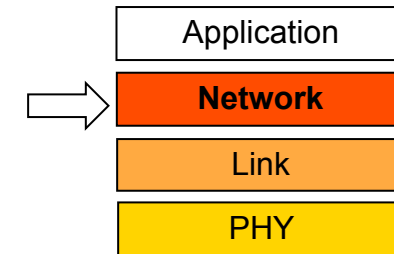
- Missing implementation in Sun SPOT stack added

● 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

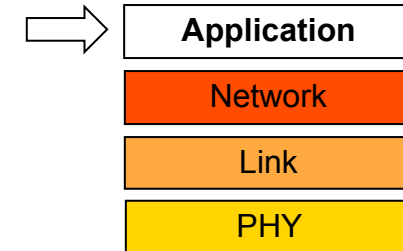
● Solution

- Porting CTP & Dissemination to the Sun SPOT platform



● 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
 - 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?