



Technische  
Universität  
Braunschweig

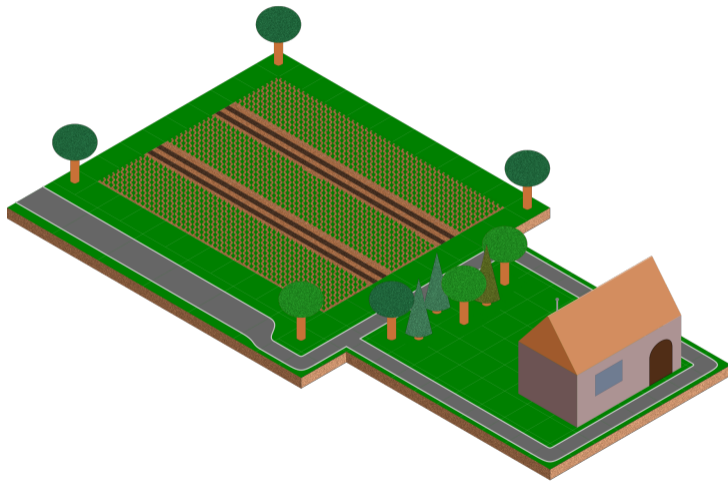
Institut für Betriebssysteme  
und Rechnerverbund

## miniDTN: A DTN Stack for 5€-WiFi-Nodes

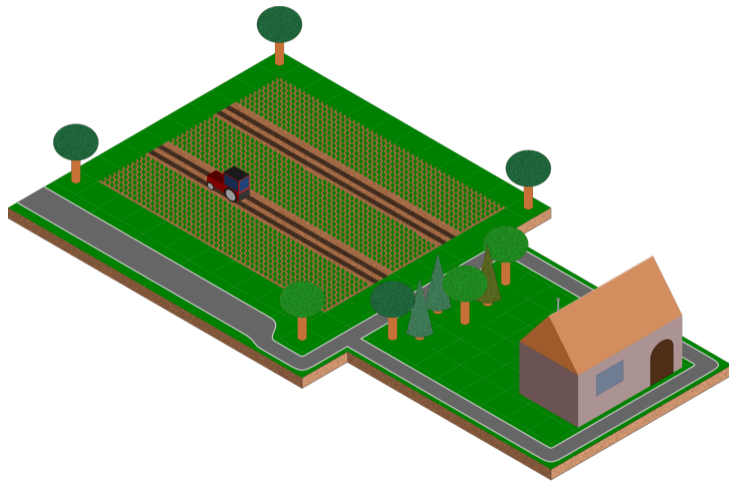
**Stephan Rottmann**, Alexander Willecke, Jan Käberich, Georg von Zengen, Lars Wolf, September 7, 2017

Institut für Betriebssysteme und Rechnerverbund

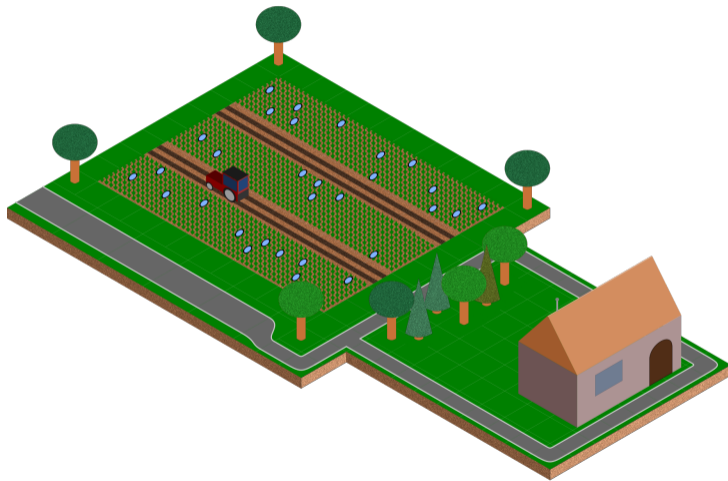
# Motivation



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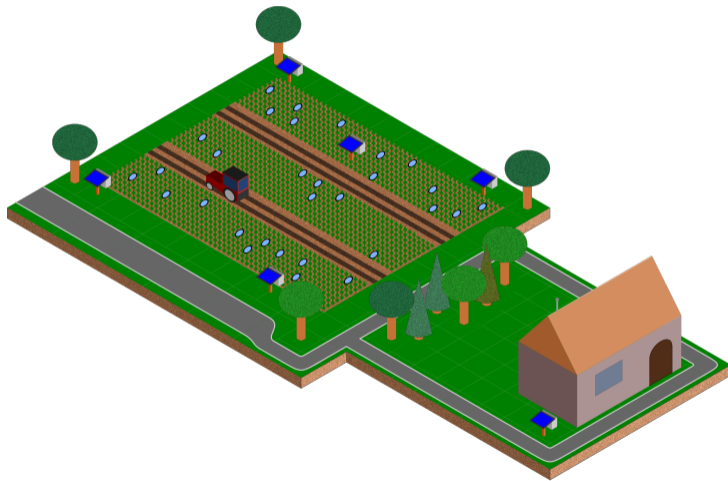


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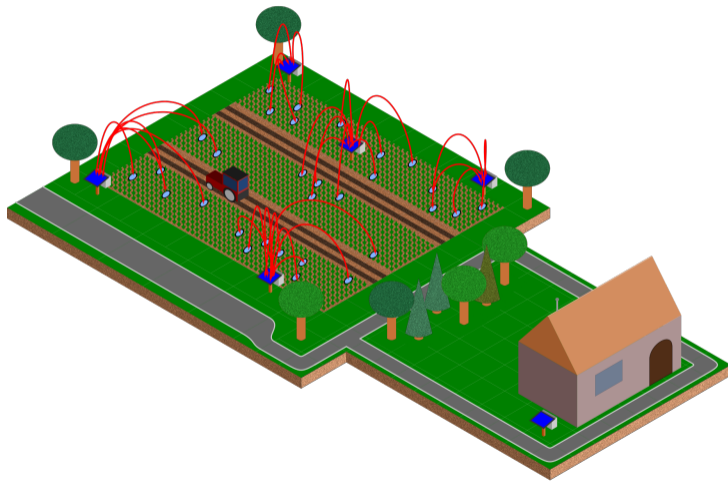




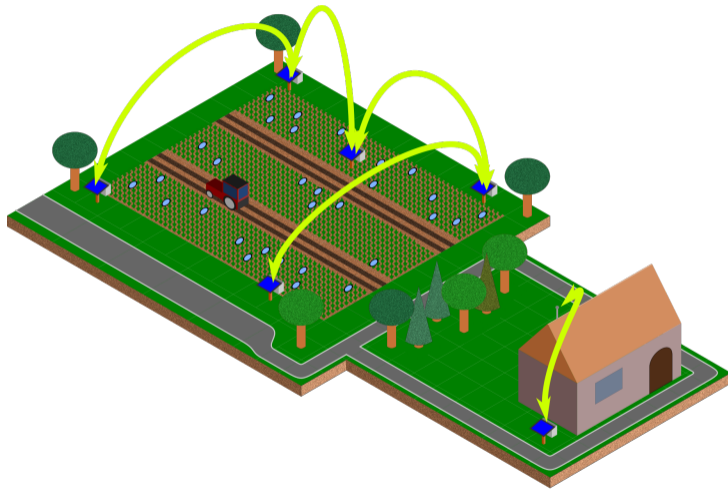
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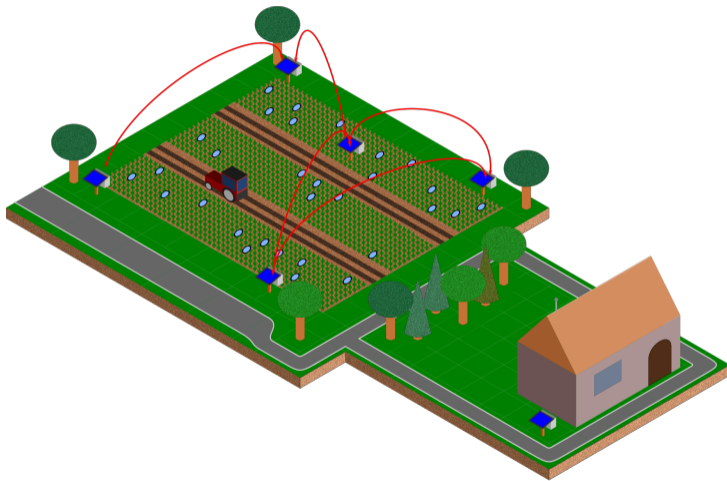
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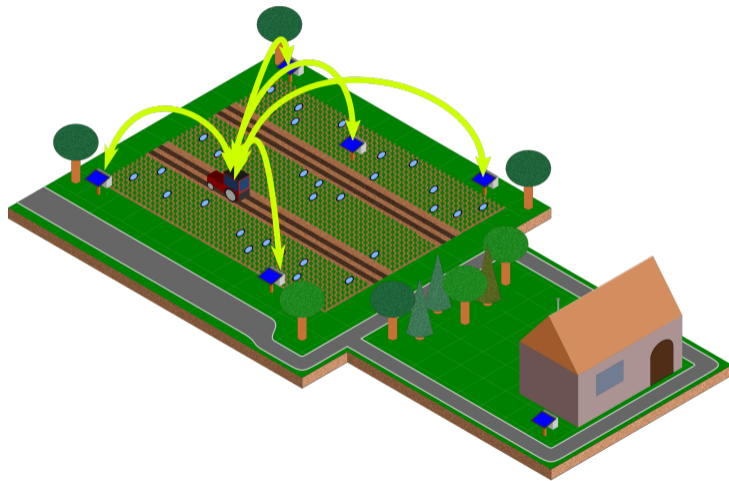
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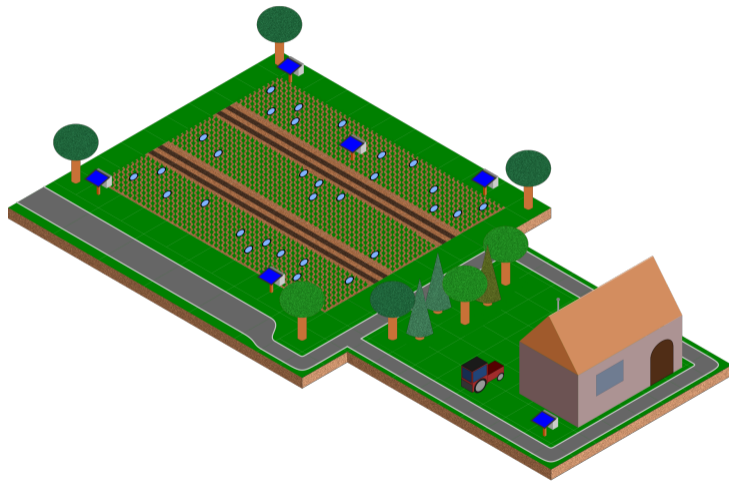
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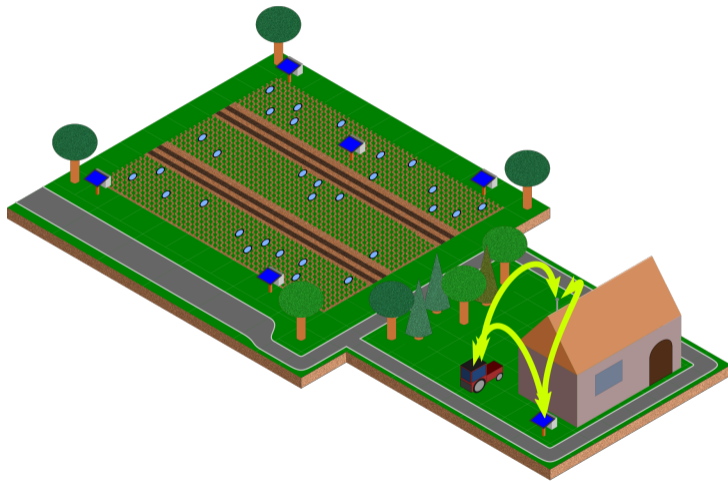
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## Example: Smart Farming

- Heterogenous nodes
  - “Traditional” WSN
  - Larger nodes deployed on field
  - Mobile nodes
  - Gateways
- All nodes use same protocol
  - Unreliable links and mobility





## Example: Smart Farming

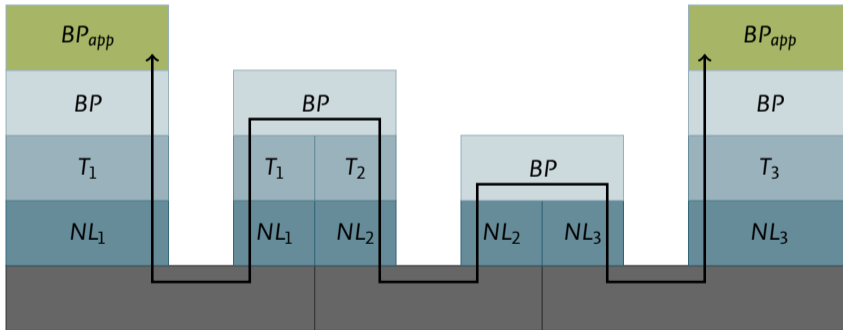
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**DTN: Delay/Disruption Tolerant Network**



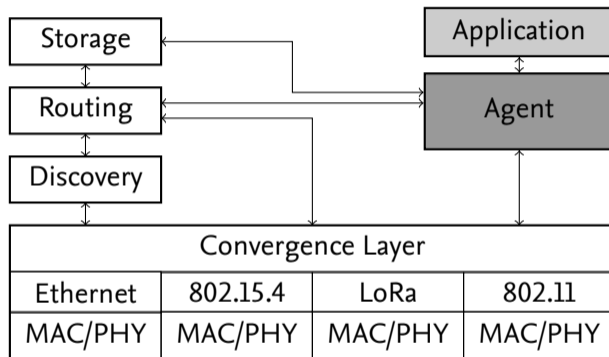
# Bundle Protocol

- Delay/Disruption Tolerant Network
- Overlay network
- Multiple network/transport layers supported at single node
- RFC4838, RFC5050



- Based on  $\mu$ DTN
  - $\mu$ DTN runs on 8/16 Bit controllers (Atmel AVR, TI MSP430)
  - Contiki OS
- Ported to FreeRTOS
  - Common OS for 32 Bit controller
  - Easy to use on common platforms
- Portability

# Architecture



# Requirements

## Software

- FreeRTOS
- LwIP 2.0.0 (for TCPCCL and dgram:udp)



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## Hardware

- Any Controller running FreeRTOS
  - ESP32
  - STM32F407VGT
- Radio or Communication Interface
  - AT86RF233: IEEE 802.15.4
  - SX1272: LoRa
  - Ethernet/WiFi
- SD-Card (optional)

# Features and Limitations

## Features

- Multiple Convergence Layers, can be used at the same time
  - dgram:lowpan: IEEE 802.15.4 and LoRa
  - dgram:udp: Ethernet and WiFi
  - TCPCL: Ethernet and WiFi
- Bundle Storage in RAM or on SD-Card
- IPND discovery
- Compatible to  $\mu$ DTN, IBR-DTN

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## Limitations

- ipn addressing scheme only
- Bundle size > 8 kB impractical



# Using *miniDTN*

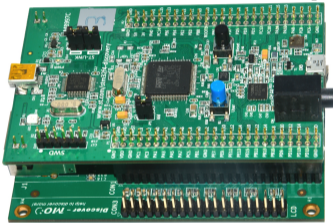
- Clone git at `https://gitlab.ibr.cs.tu-bs.de/minidtn/minidtnStack`
- Add code to toolchain
- Use/modify/create headers in `platform/`
- Start Agent in code

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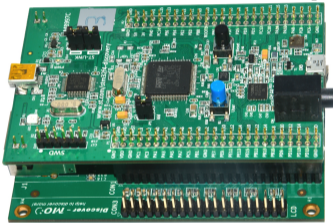
Examples can soon be found at `https://gitlab.ibr.cs.tu-bs.de/minidtn/`

## STM32F4 Discovery

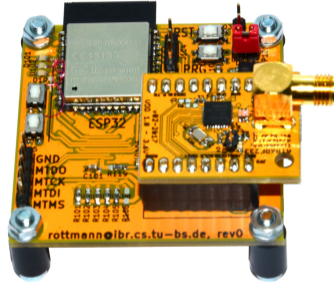


# Platforms

## STM32F4 Discovery

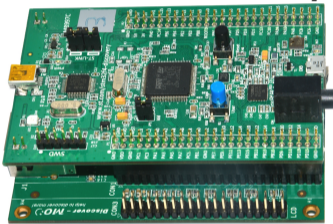


## ESP32

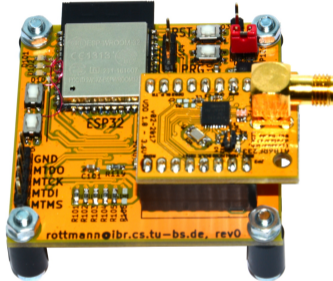


# Platforms

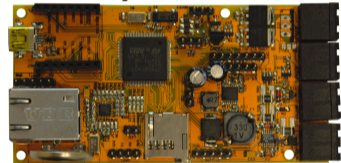
## STM32F4 Discovery



## ESP32



## Amphisbaena



# Amphisbaena

## Two Platforms

- Both platforms are running a DTN stack
  - *miniDTN* on MCU platform
  - *IBR-DTN* on Raspberry Pi
- Communication stacks compatible to each other



# Amphisbaena

## Two Platforms

- Both platforms are running a DTN stack
  - miniDTN* on MCU platform
  - IBR-DTN* on Raspberry Pi
- Communication stacks compatible to each other
- Both appear as single node**



DTN Neighbors		
Protocol	State	Address
ipn:130.o		
DGRAM:UDP	discovered	ip=fe80::7650:fb7d:7b4c:a76f%wlano;port=4556;
DGRAM:LOWPAN	discovered	addr=130;pan=1920;
ipn:1466.o		
DGRAM:LOWPAN	discovered	addr=1466;pan=1920;

**Two-Platform Node**

IBR-DTN

miniDTN

## Platforms

- ESP32
- Amphisbaena
- Raspberry Pi 3
  - Linux, running IBR-DTN



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## Communication Links

- Ethernet @ Amphisbaena
- WiFi @ ESP32
- IEEE 802.15.4 @ all platforms

# Evaluation

## Platforms

- ESP32
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- Raspberry Pi 3
  - Linux, running IBR-DTN

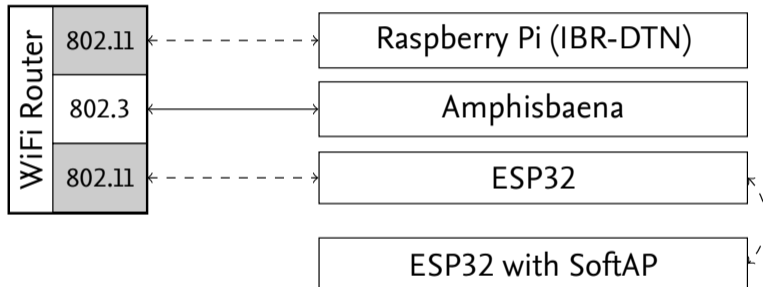
## Payload Size

- 16, 32, 64, ..., 8192 Byte

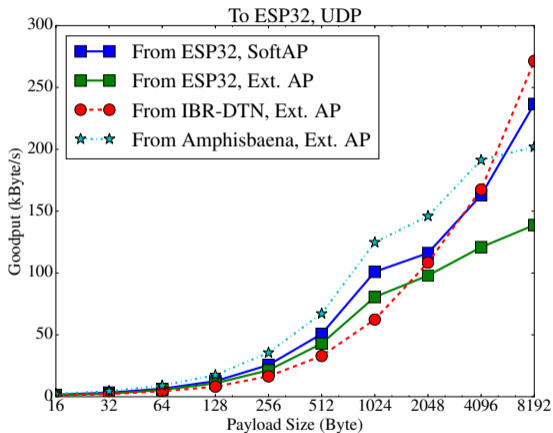
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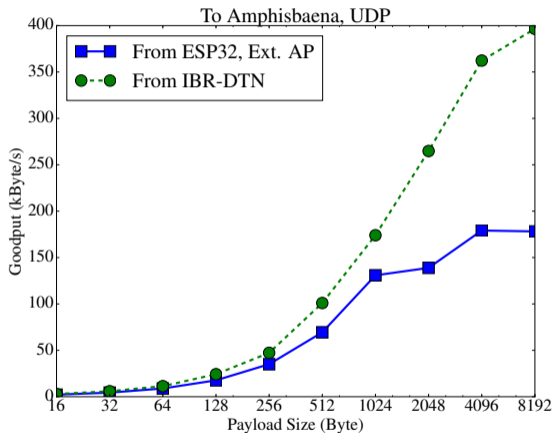
# Evaluation Setup



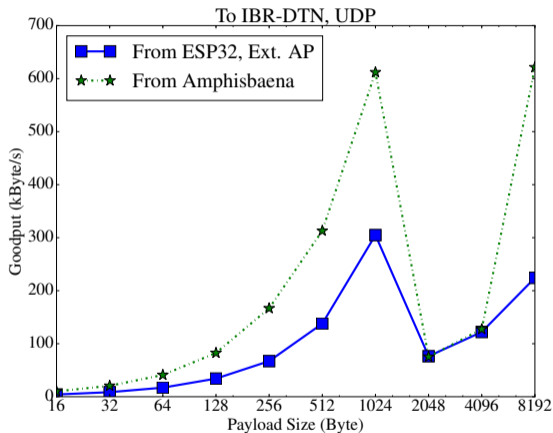
# Evaluation Results: Goodput (dgram:udp)



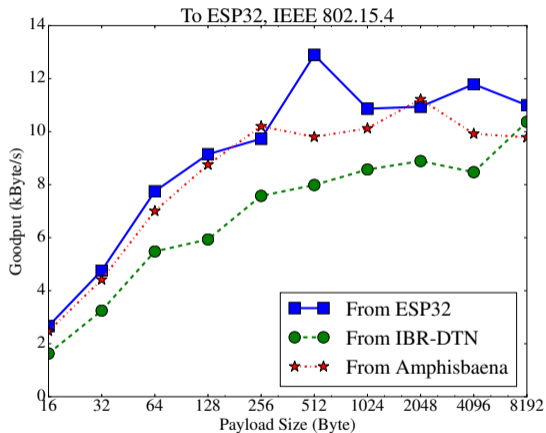
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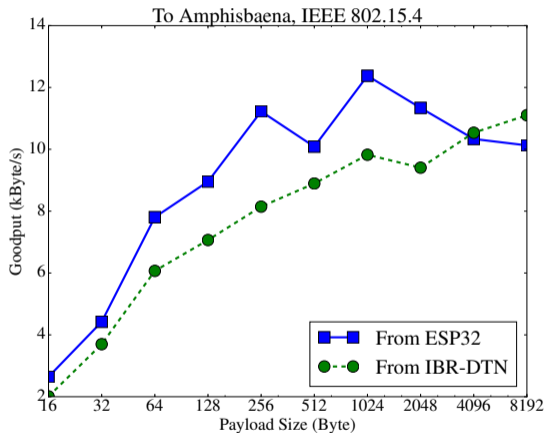
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# Evaluation Results: Goodput (IEEE 802.15.4)

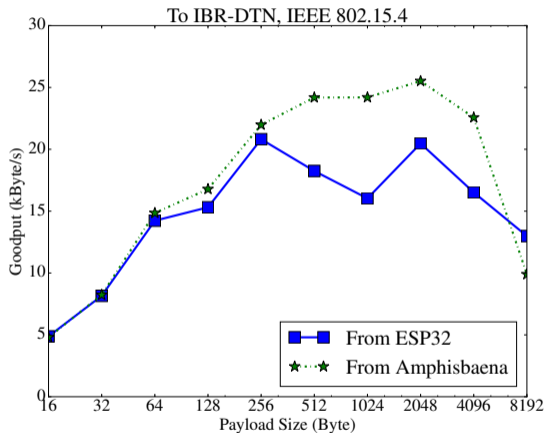


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# Conclusions

## miniDTN

- Communication stack for heterogenous networks
- Communication via different interfaces
- Bridge between low power interfaces and IP
- Easy portable to platforms running FreeRTOS
- Several hundreds of kByte/s goodput via UDP

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**Thank You! Questions?**

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