Duisburg, a Lively Industrial, Cultural and High Tech Center on the Rivers of Rhein and Ruhr

- International ***Logistics*** center w/ world-largest inland harbour
- International ***Steel Production*** center
- International ***Science & High Tech*** center
- Home of ***Fine Arts***

The City of Duisburg

Brief Chronicle

1st…5th century Roman settlement

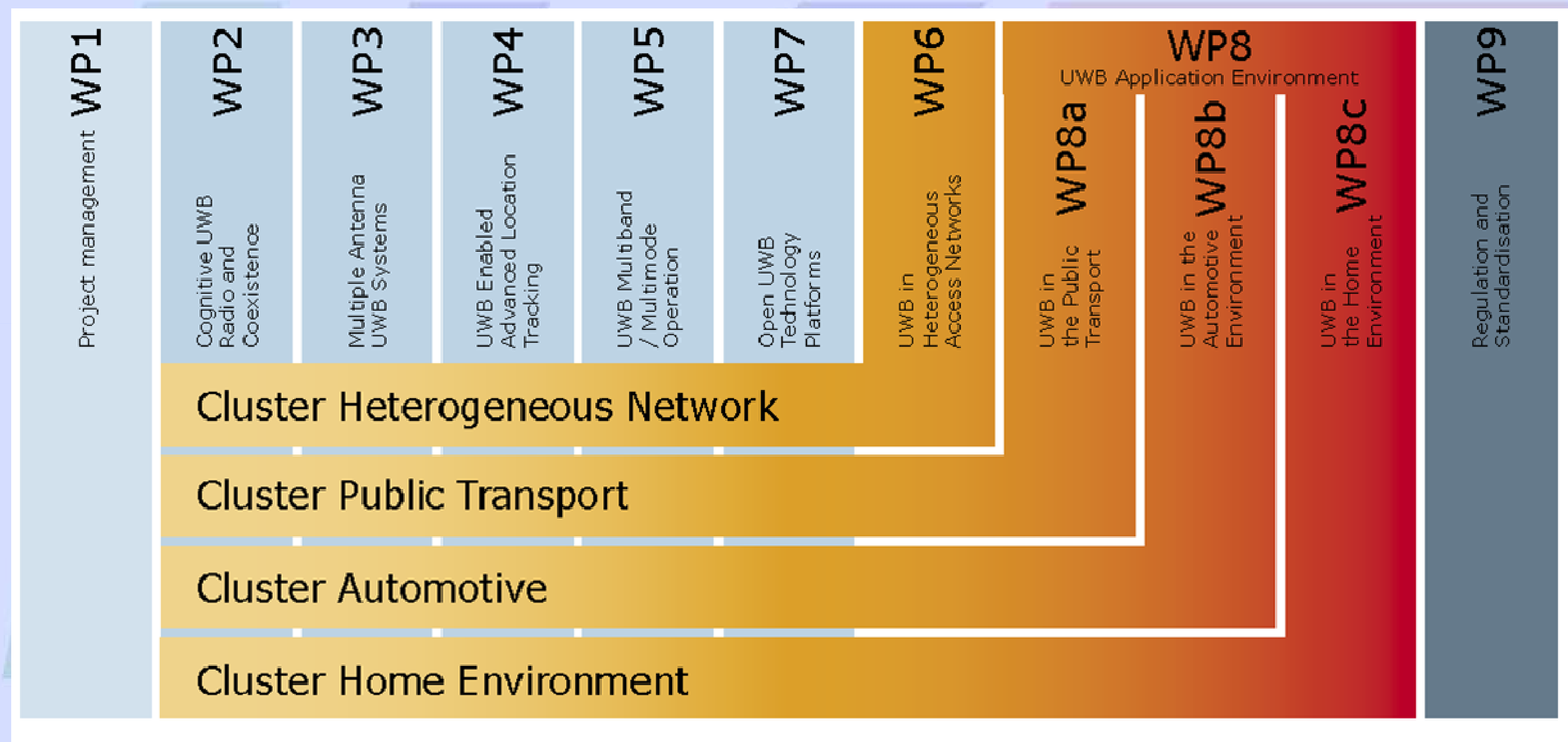
… and on June 8, 793, came the Vikings
and occupied Lindisfarne (Holy Island),
which marked the beginning of the Viking Time

Lindisfarne (Holy Island),
Northumberland

Outline

- EUWB Project Organization
- Motivation
- Applications
- Localization and Tracking Principle
- Simulation Results
- Conclusion

EUWB Project Organization



Motivation

Ultra-Wideband radio technology (UWB-RT) will contribute to the prospering of many markets like public safety, consumer and business applications.

Major European industry sectors consequently demand the introduction of UWB-RT in their respective areas.

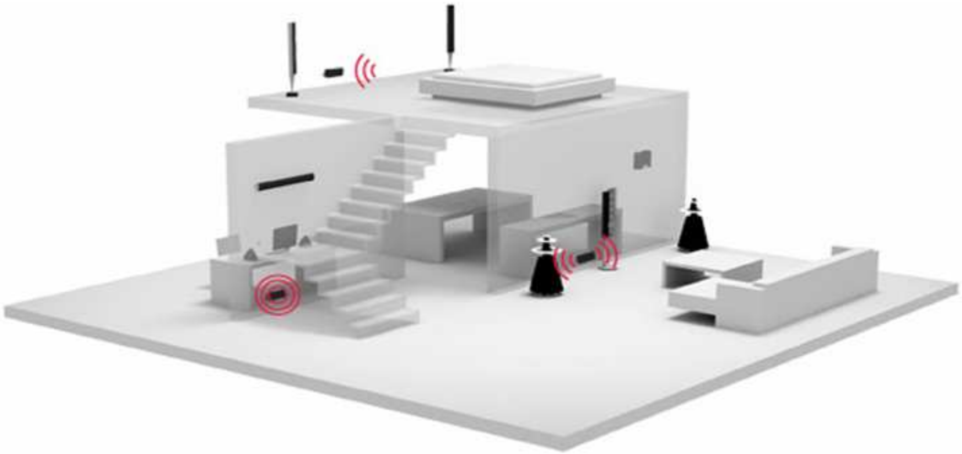
Following this demand, the EUWB project was formed in April 2008 as a successor of the FP6 PULSERS Phase II project.

UWB-RT enables
- short range wireless communications with data rates > 1Gbit/s,
- precise real-time localization and tracking.

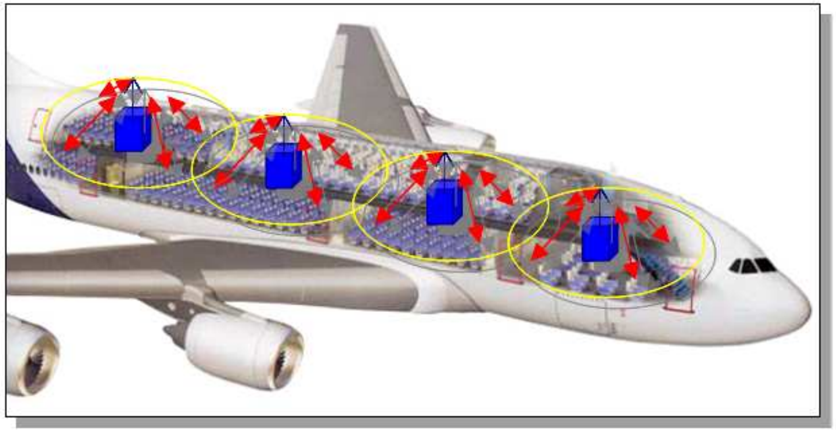
UWB-RT with localization and tracking lends itself for deployment in many application areas.

Application Areas of Ultra Wide-Band (UWB)

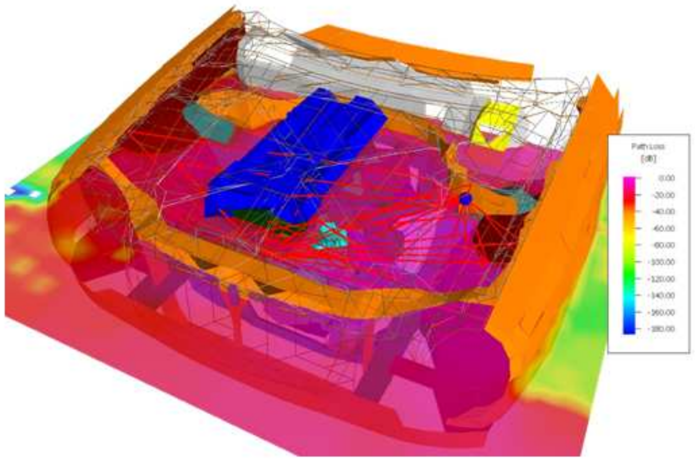
Intelligent Home



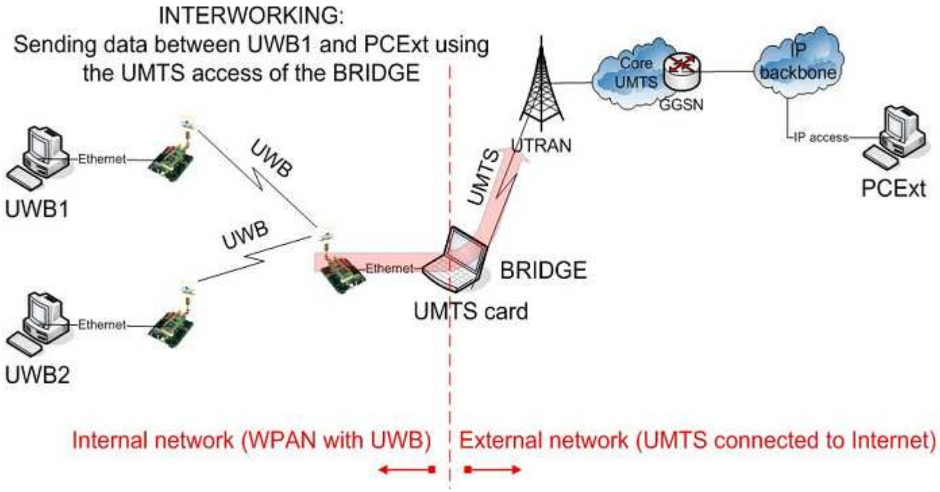
Transportation



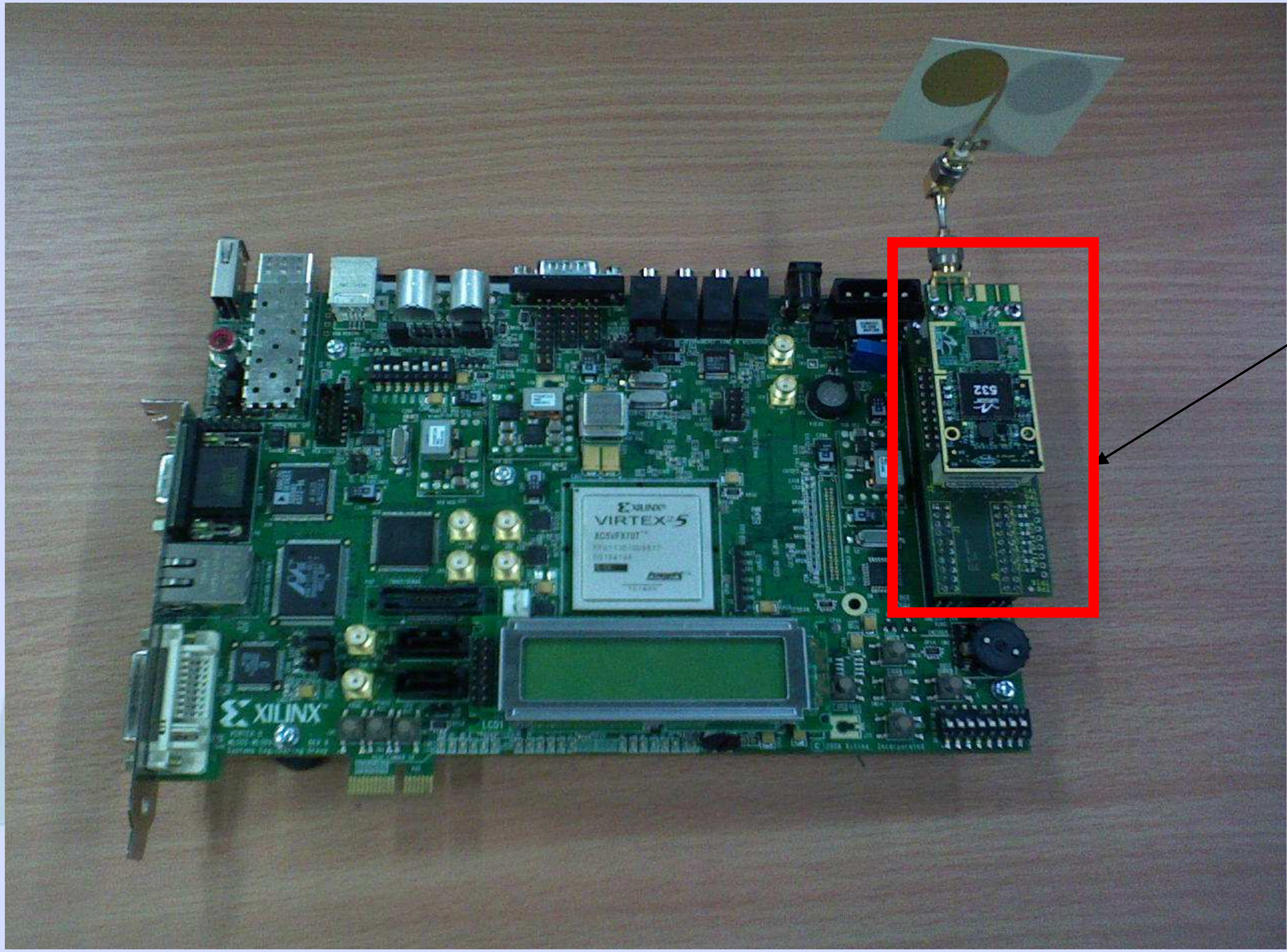
Automotive



Heterogeneous Network

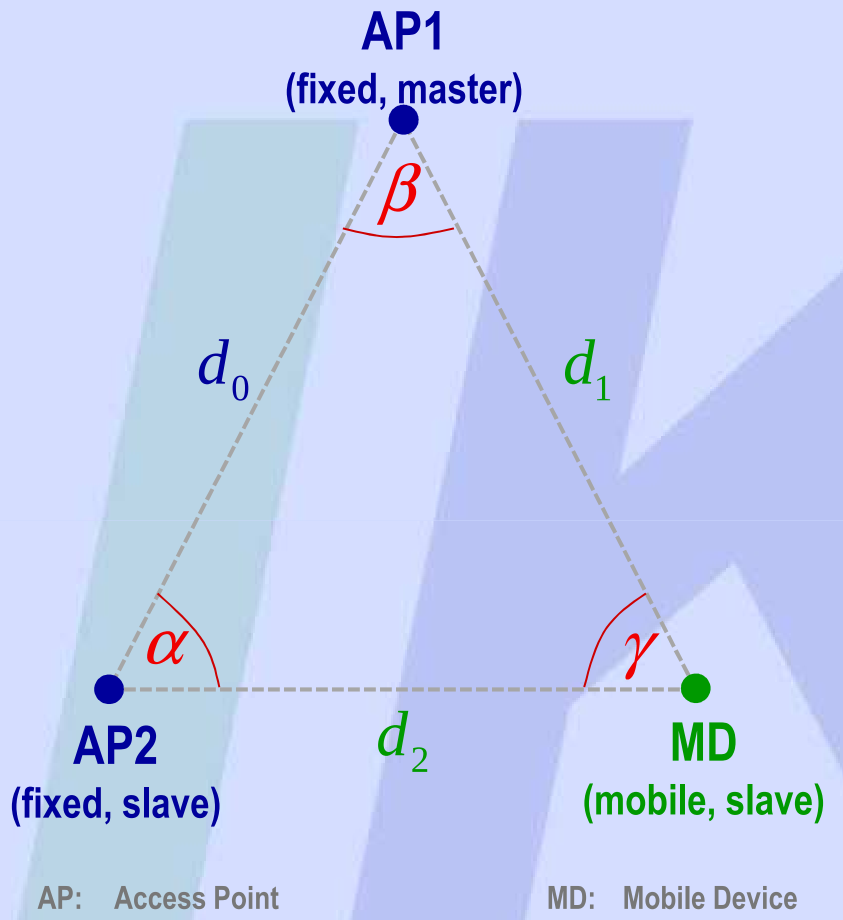


UWB HDR Platform Realized by the EUWB Project
ML507 with integrated WIS 532 module



WIS 532 PHY module on TES MAC-PHY-369 I/F daughter card adapter.

Localization and Tracking



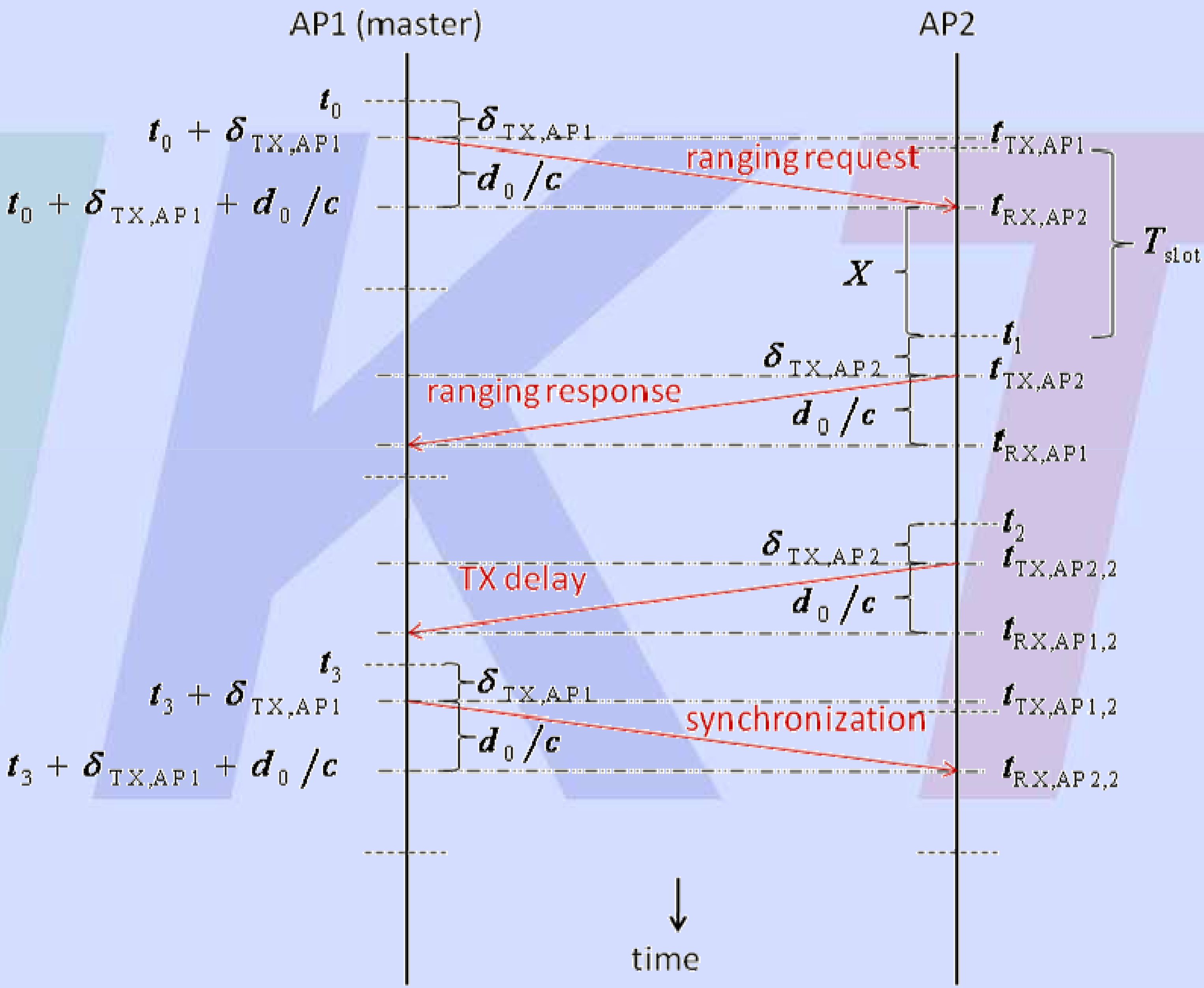
Procedure with three steps:

- **Step I:**
  Synchronization
  of the fixed mounted infrastructure
- **Step II:**
  Localization
  of a mobile device
- **Step III:**
  Triangulation, Mapping

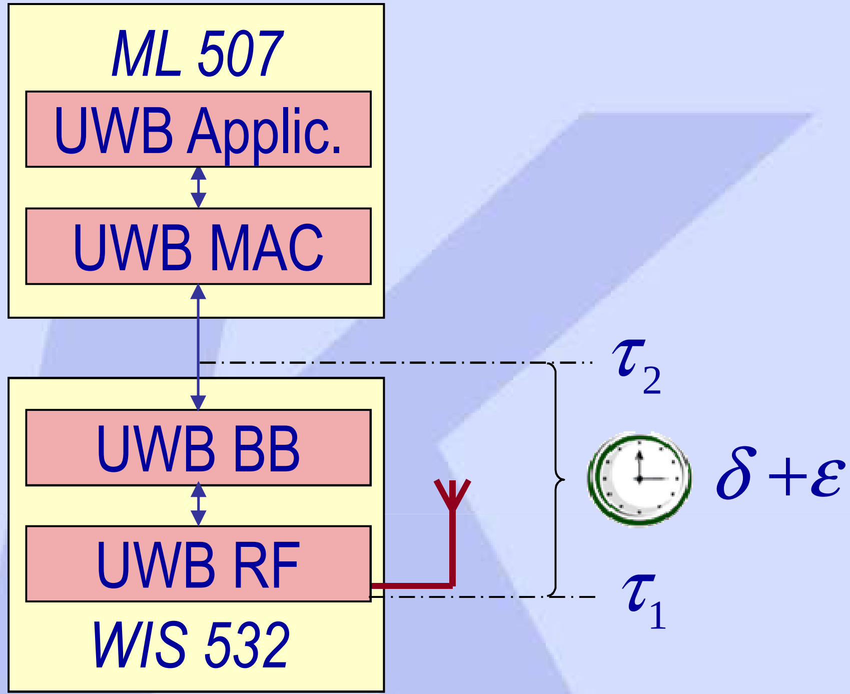
Novel aspects of the LT application:

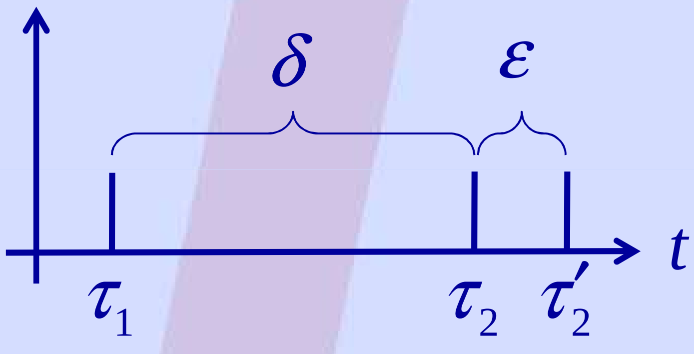
- Fixed transmission and reception delay owing to MAC TDMA framing.
- Stochastic processing delays at transmitters and receivers.

Localization And Tracking Messaging



Transceiver PHY Layer Delay



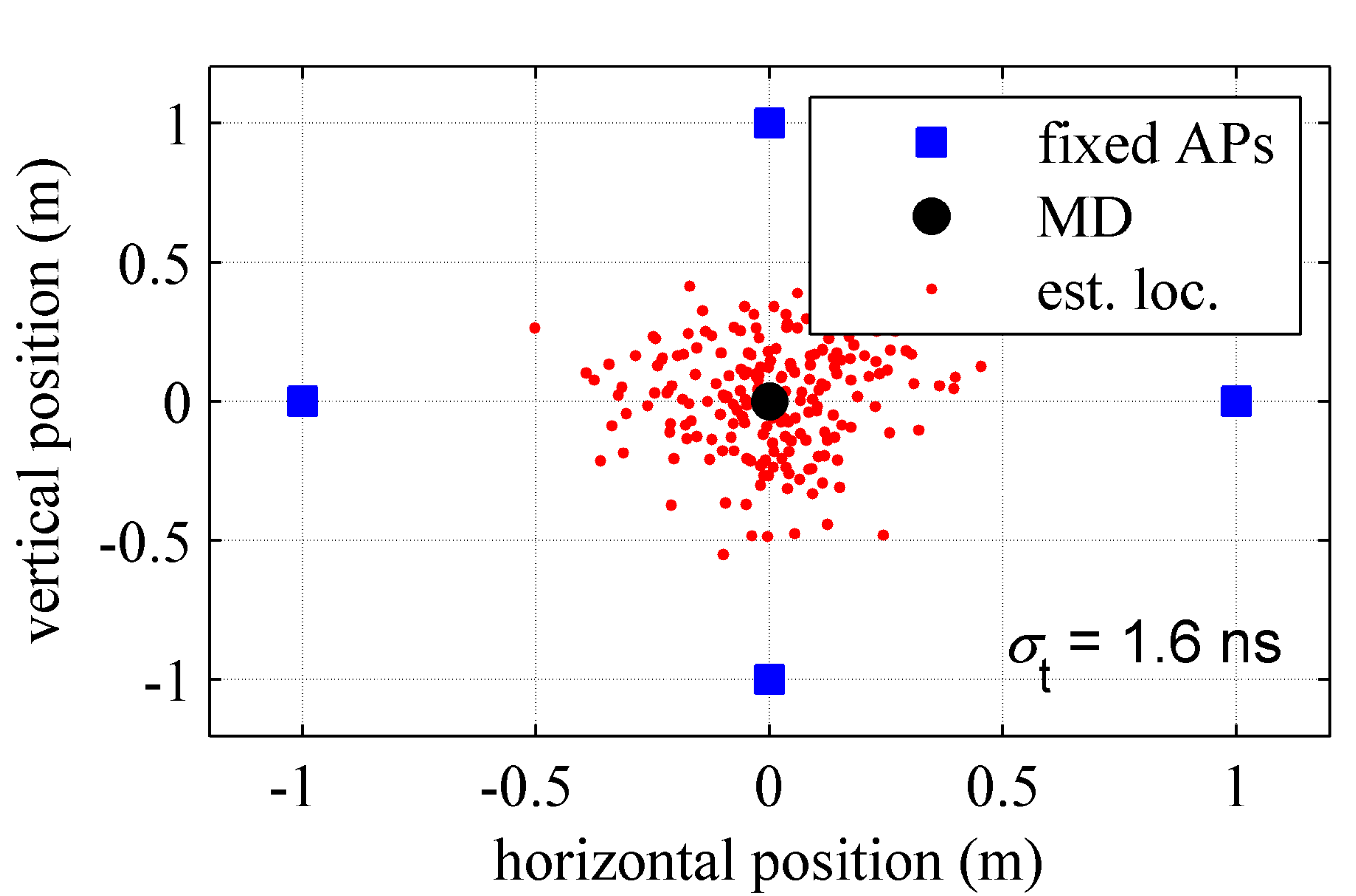


Measurements proved that

- ε is approximately Gaussian distributed
- with zero mean and
- with standard deviation σ_t.

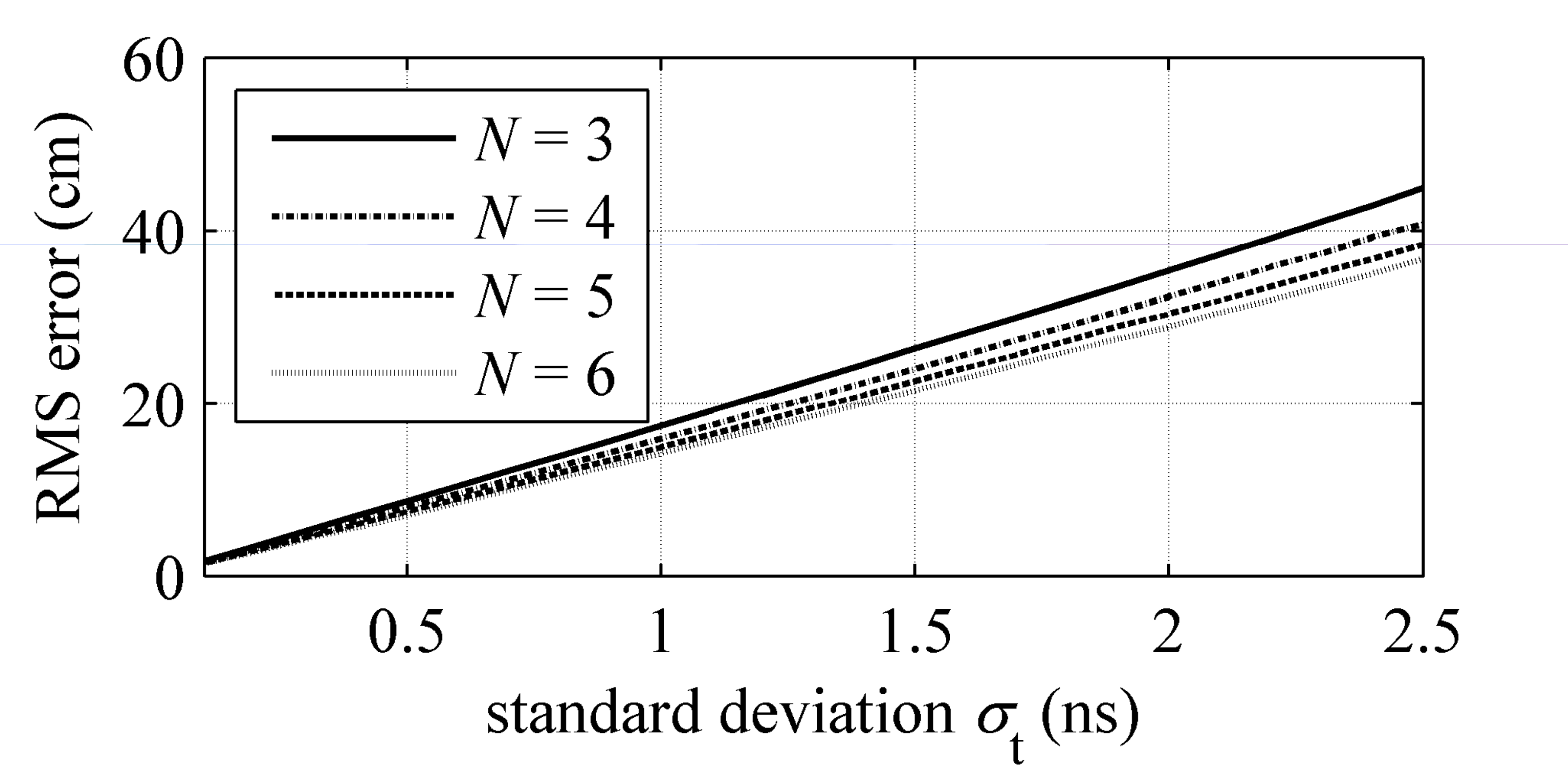
An Application

Simulation Results /1



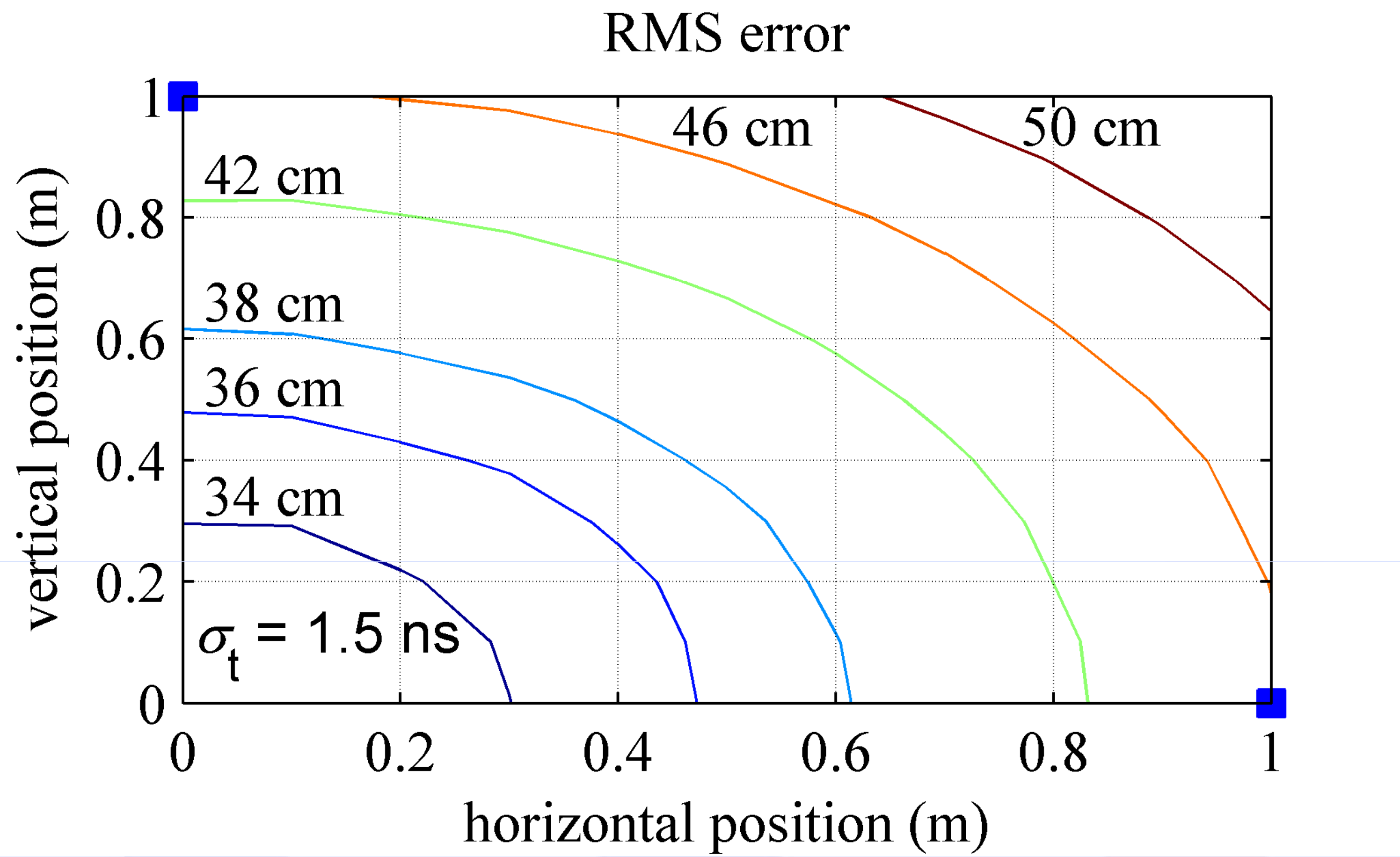
- Multiple results of the localization and tracking process.
- Four access points and one mobile device located in the center.
- Location estimation errors result from the variance of the processing with a standard deviation σ_t of 1.6 ns.

Simulation Results /2



- Root mean squared (RMS) estimation error as a function of the standard deviation σ_t for maximum likelihood type position estimation.
- The standard deviation σ_t should be smaller than 2 ns to guarantee an RMS error lower than 30 cm when using four access points.

Simulation Results /3



- Contours of the root mean squared (RMS) localization error
- Four access points are arranged equally spaced on a circle with radius 1m
- Only one quadrant plotted due to symmetry

Conclusion

- Position estimation to provide localization and tracking (LT) has been an important application for UWB-RT.
- In order to provide well-working solutions, a simple application which does not have to rely on elaborate PHY layer messages is required.
- A novel and implementable LT procedure is proposed, considering realistic conditions.
- The novel LT procedure provides desirable performance.

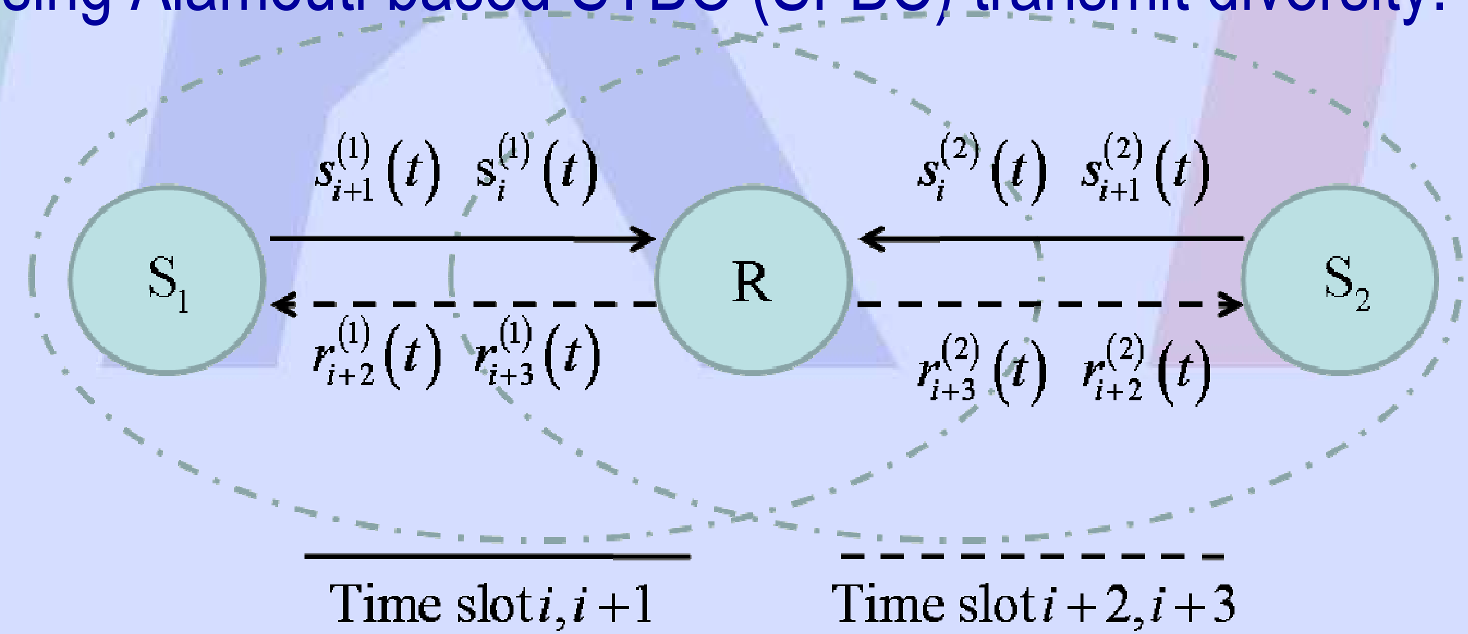
The Future – Cooperative Relaying
MINEC Example – 3 Nodes Relay Network

Two source nodes, S_1 and S_2, with a single antenna each.

One relay node, R, with two antennas.

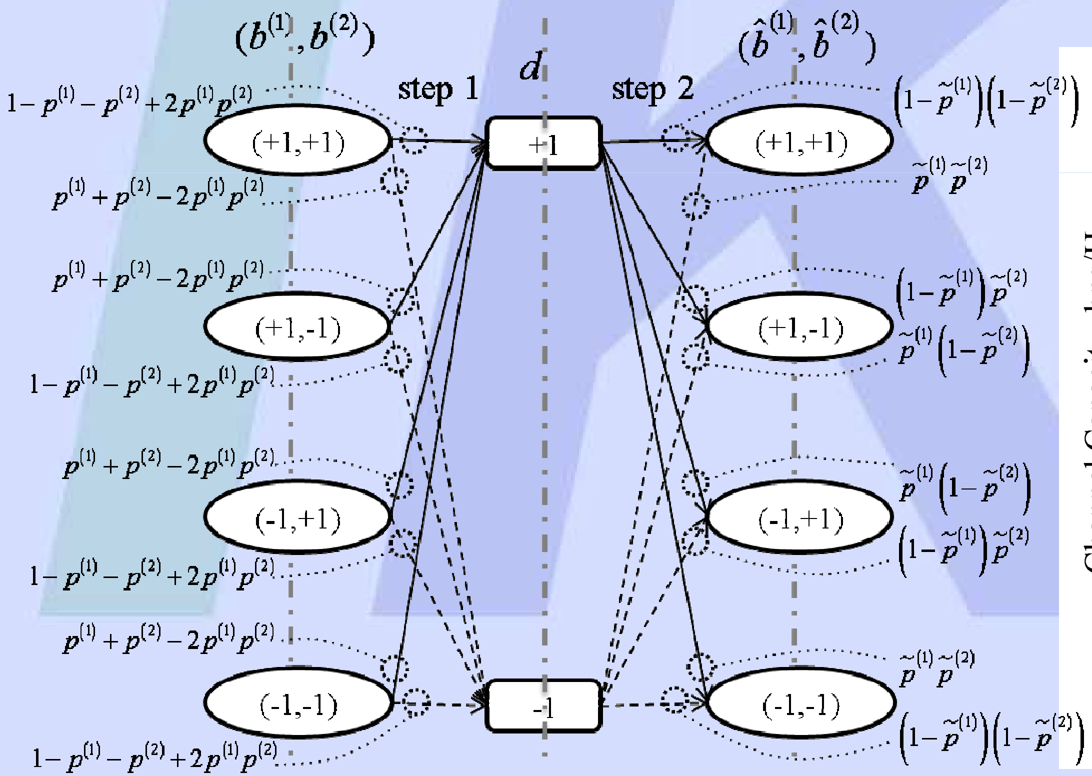
MINEC step 1: S_1 and S_2 transmit signals independently and simultaneously to R. Spatial Multiplexing MIMO reception is used at R.

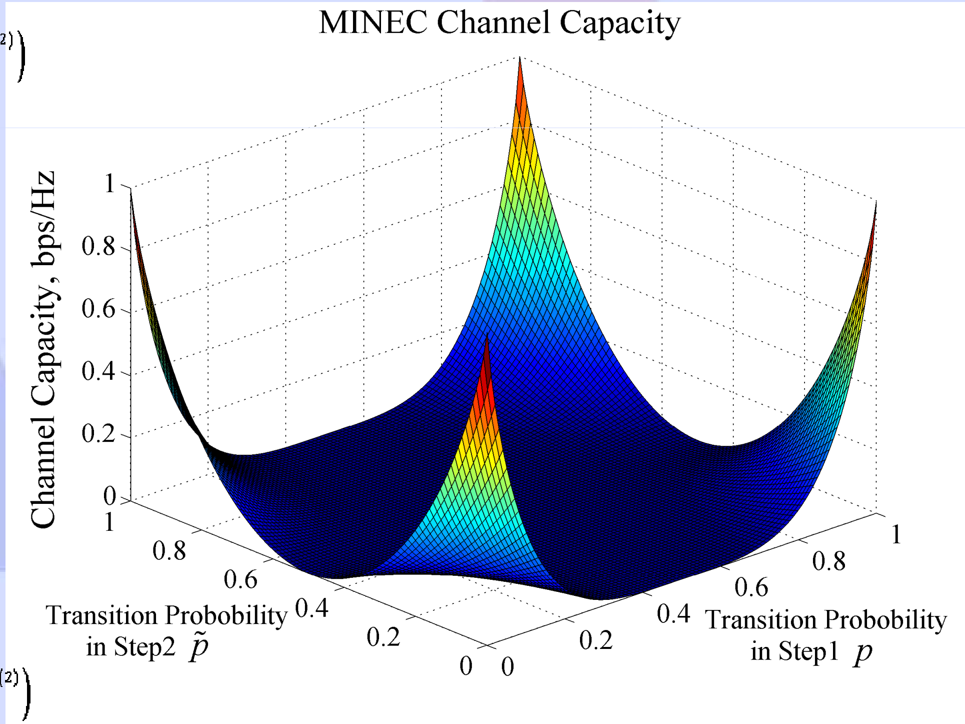
MINEC step 2: R transmits network encoded versions of the detected signals using Alamouti based STBC (SFBC) transmit diversity.



The Future – Cooperative Relaying
MINEC Capacity Evaluation

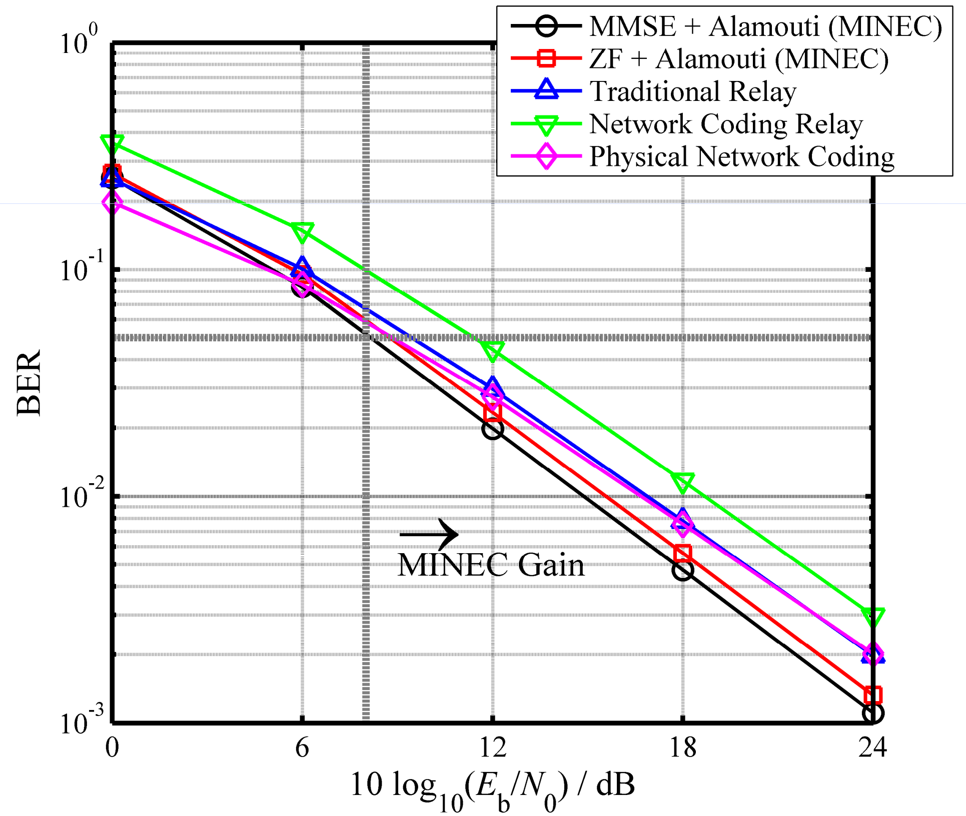
- Binary symmetric relay network channel model.
- Probabilities of erroneous transmission at 1st and 2nd steps, p and $\mathring{p}$, respectively.

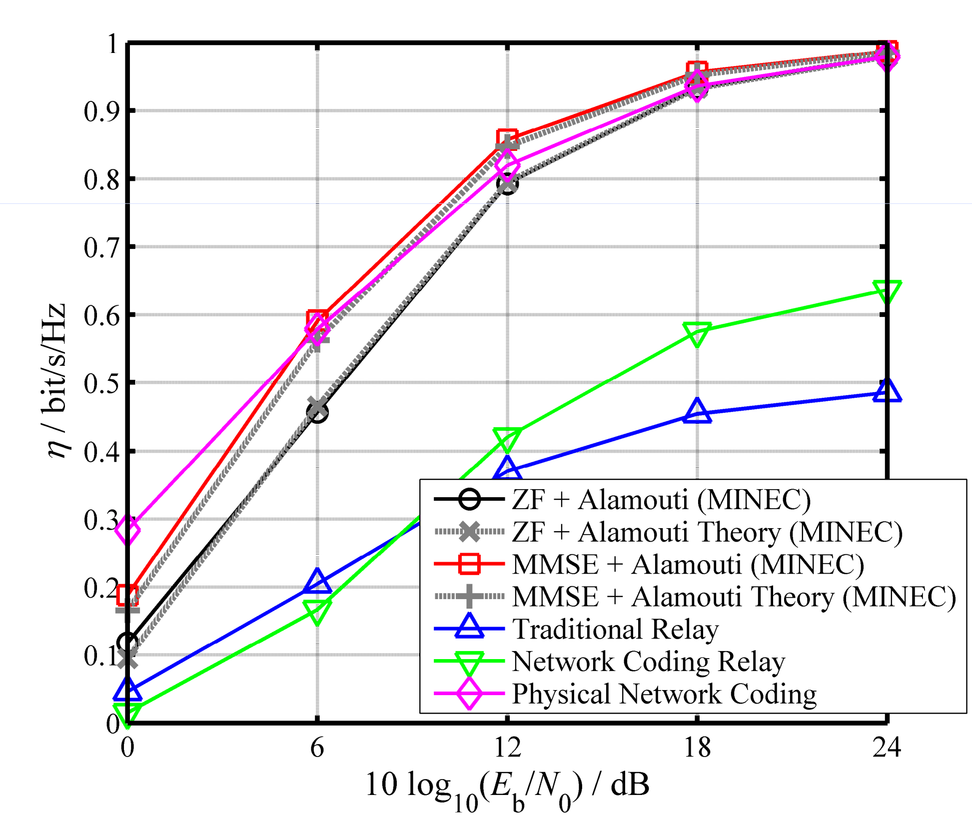




The Future – Cooperative Relaying
MINEC Monte-Carlo Simulations

- Linear receivers for MINEC step1, MRC receiver for MINEC step 2.
- Comparison between MINEC and other techniques, e.g. traditional relay, network coding relay and physical network coding.





Thanks for Attending Today’s Seminar!

Hope To See You In Duisburg!