## Project: IEEE P802.15 Working Group for Wireless Specialty Networks (WSN)

**Submission Title:** Evolution of 4z enabling optimized many-to-many ranging for dense environments

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**Source:** Jean-Marie André (ST microelectronics), Sven Zeisberg (HTW), Erik Mademann (ZIGPOS)

**Contact:** ST microelectronics, 19 boulevard de la mer Caspienne, 73372 Le Bourget du Lac, France

**E-Mail**: jean-marie.andre {at} st.com, sven.zeisberg {at} htw-dresden.de

**Re:** Call for contributions to IEEE 802.15 TG4ab

**Abstract:** Evolution of IEEE 802.15.4z enabling efficient scheduled positioning systems

**Purpose:** Propose evolutionary extensions to IEEE 802.15.4z for scheduled ranging concerning ranging roles in slot assignments and initiator picking of responders.

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| PAR Objective | Proposed Solution (how addressed) |
|---|---|
| Safeguards so that the high throughput data use cases will not cause significant disruption to low duty-cycle ranging use cases | |
| Interference mitigation techniques to support higher density and higher traffic use cases | Reduce number of messages in dense positioning systems |
| Other coexistence improvement | Reduce signal aggregation |
| Backward compatibility with enhanced ranging capable devices (ERDEVs) | |
| Improved link budget and/or reduced air-time | reduce air-time by avoiding transmission duplication and or merging messages of various types |
| Additional channels and operating frequencies | |
| Improvements to accuracy / precision / reliability and interoperability for high-integrity ranging | |
| Reduced complexity and power consumption | Less messages will optimize power consumption in dense environments. |
| Hybrid operation with narrowband signaling to assist UWB | |
| Enhanced native discovery and connection setup mechanisms | |
| Sensing capabilities to support presence detection and environment mapping | |
| Low-power low-latency streaming | |
| Higher data-rate streaming allowing at least 50 Mbit/s of throughput | |
| Support for peer-to-peer, peer-to-multi-peer, and station-to-infrastructure protocols | The proposed scheme supports infrastructure-based positioning systems. |
| Infrastructure synchronization mechanisms | The proposed extension allows multiple synchronization schemes |

# Requirements for location tracking in dense environments

In dense environments like manufacturing halls or logistics center a lot of items must be tracked, and multiple location tracking solutions must be implemented (eg DL-TDoA, UL-TDoA, TWR) at the same venue.

Multiple sequences of ranging may be required simultaneously:
- Ranging between the anchors in order to keep them synchronous
- Ranging between the anchors and the tags to run location algorithms

To accommodate as many simultaneous rangings as possible, we suggest to allow several messages to be merged into one single UWB frame. This maximizes the use of available time slots.

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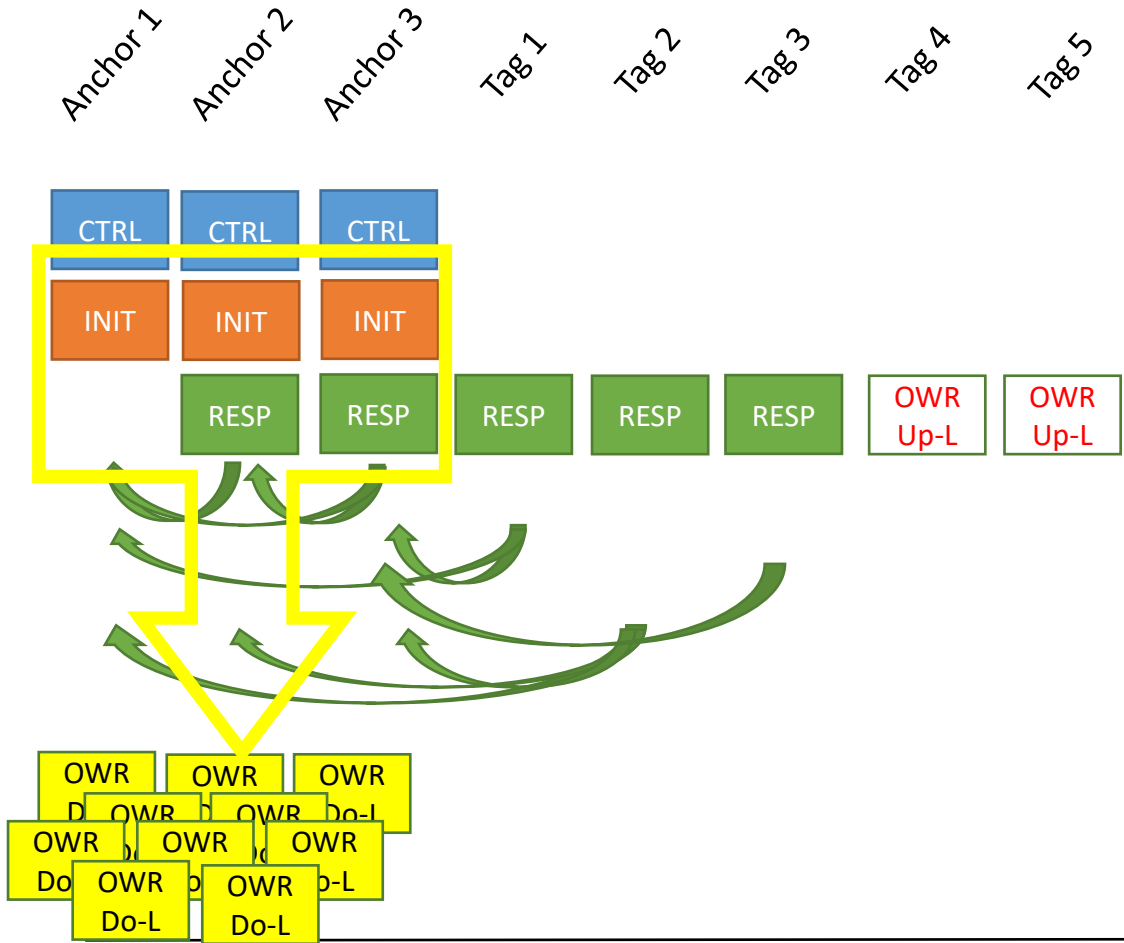
# Multiple rangings scheduled sequentially
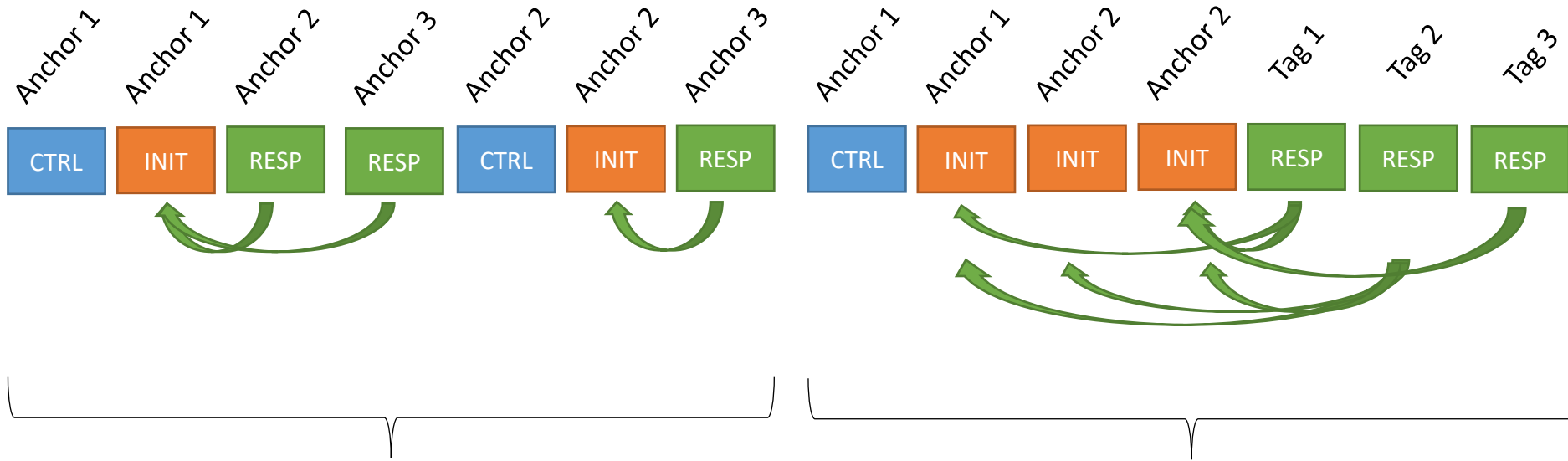


Ranging between anchors                               Ranging with tags

# Multiple rangings organized simultaneously



Cumulating multiple functions into one single UWB frame makes the whole system much more time-efficient (6 time slots vs 14) for dense ranging use cases

# Allowing messages to carry multiple roles

There are multiple occasions defined in the existing IEEE 802.15.4z where messages can carry multiple roles:

- Non-deferred reports: a single message carries the response to an **initiation message** as well as the **report** part

- **RCM** & **Initiation** roles can be merged into one single message in general

- DS-TWR realization with 3 messages: the 2nd message carries the role of **responder** and **initiator**

Conclusion:     the concept of multiple roles for messages is already existing in IEEE 802.15.4z.

# Extending managing multiple roles frames

The role of frames/slots can be described in the Ranging Control Phase of a Ranging Round, where RCM provide a description of the various messages to be exchanged during the ranging round. Alternatively it is described in a joint RCM/Init message.

We are suggesting here to extend the identification of the messages in order to allow for more variations of multi-purpose messages.

- ✓ Allow/clarify in scheduled ranging mode explicitly a double definition of time slots containing a response to a previous initiation and at the same time containing an initiation for potential later response frames in the round.
- ✓ Consequently allow also extending the already allowed RCM/Initiation merging to become also RCM/Initiation/Response merging in slots.

These extensions/clarifications will be helpful in particular for many-2-many ranging use cases, e.g. in dense DL-TDoA scenarios anchors message exchanges.

Jean-Marie Andre, Sven Zeisberg, Erik Mademann

# Allow Responders to pick initiators

In a ranging round a Response message is currently associated to one Initiation message as early as either during the RCM message in the Ranging Control Phase or during a joint RCM/Initiation message in the Initiation phase.

For scheduled ranging in case of having more than one initiator we are suggesting to extend this approach by allowing:

- ✓ **The possibility for a responder to select (multiple) initiation message(s) and include the related timing information into a single response message, hence to gather the selected (multiple) response(s) into one single message on air.**
- ✓ **So the responder selects during operation the initiator, which he is considering in its transmission time slot for placing time relation information**

# Example: Many-2-many with **responder selected** initiators (based on e.g. radio visibility,…)



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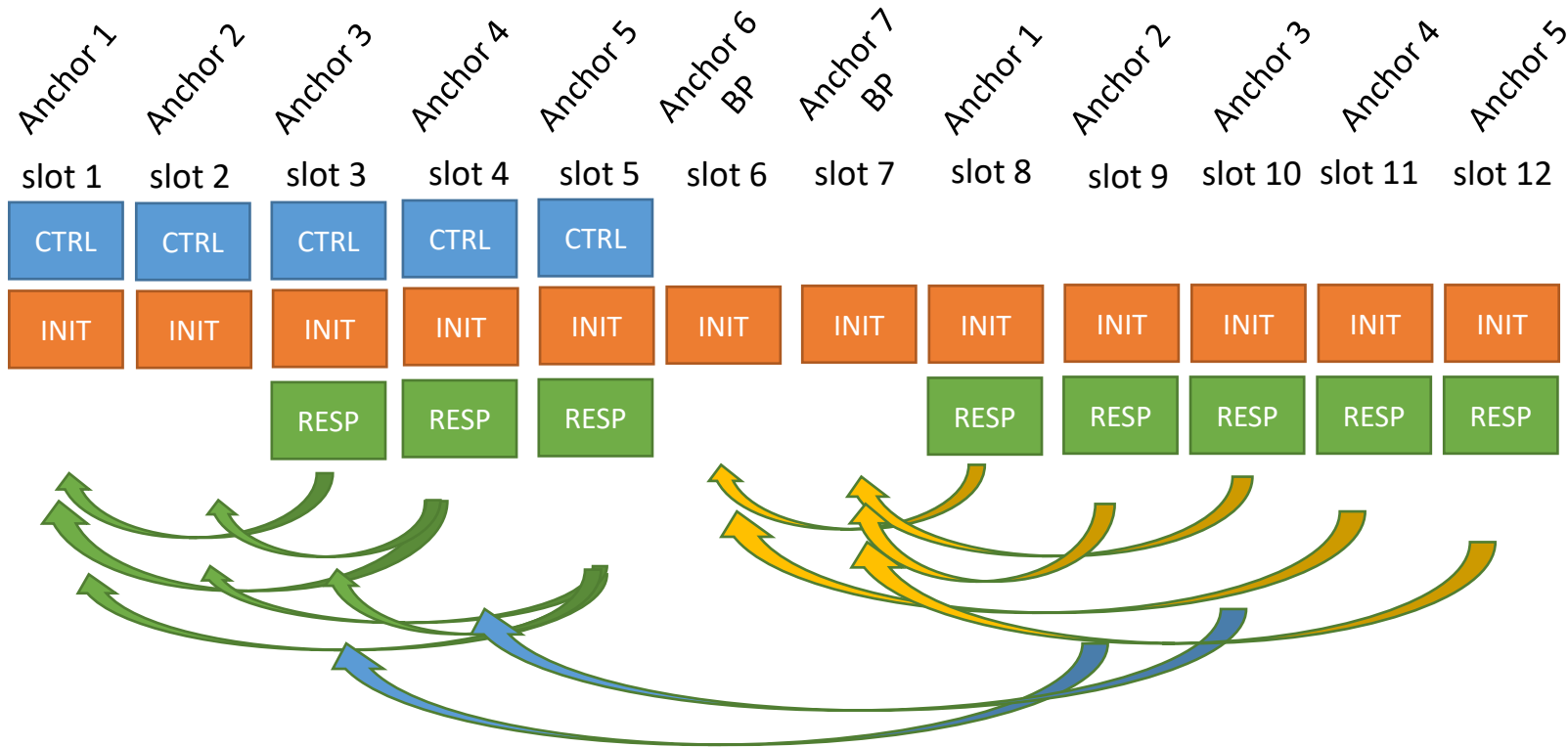
# Geo-Map of many-2-many with **responder selected** initiators (based on e.g. current radio visibility, response calculation time, …)
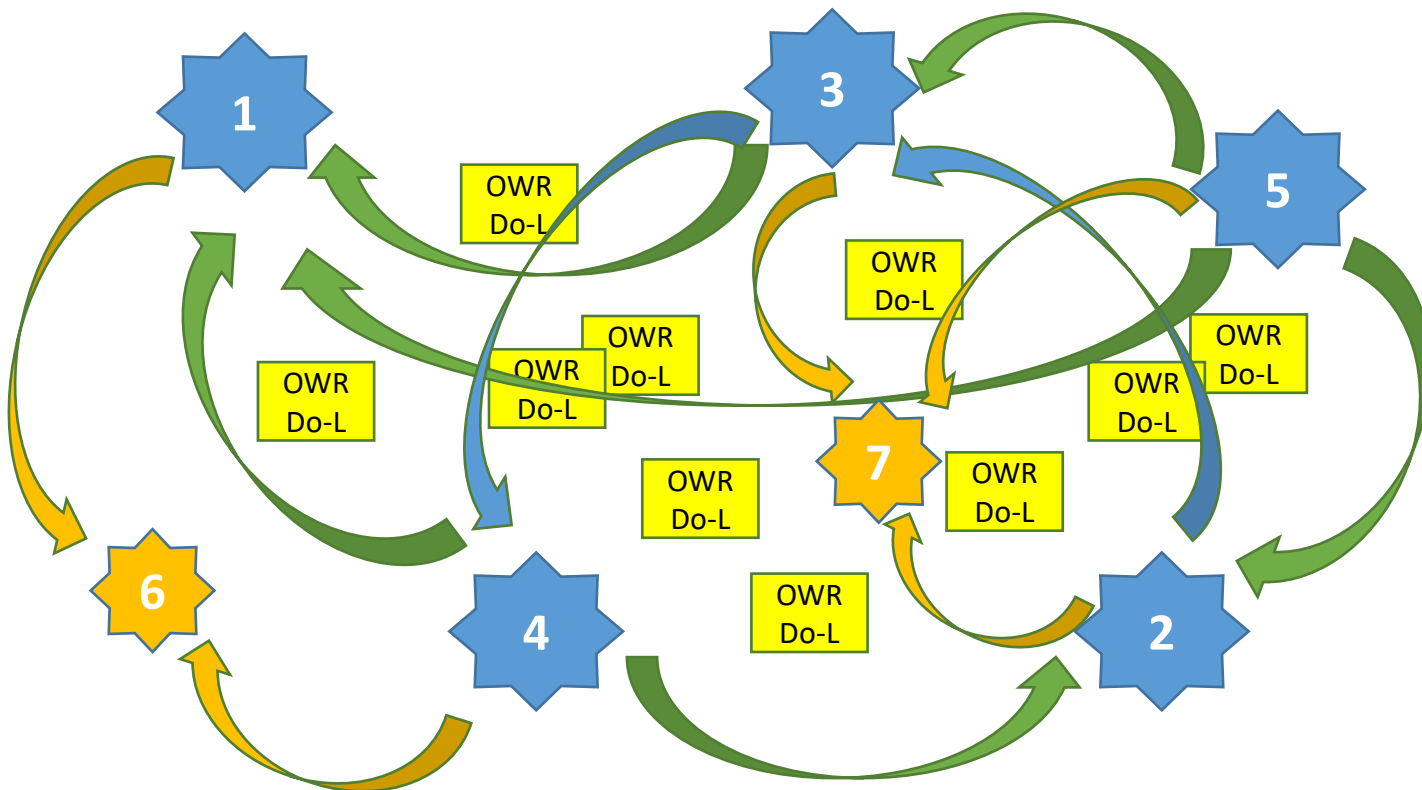
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# Thank you for your kind attention.

# Are there any questions?