B. Improved Localization in a Cluster-Tree Topology

In this section we explain a solution for the constraints of the range-based localization in a cluster-tree network. With this solution we want to improve the localization and thus to reach a trade-off between the connectivity of mesh topology and energy saving of cluster-tree topology.

For Zigbee cluster-tree topology, ranging among parent and children can be done with RSSI using the data interchange of frames [3]. Also for 802.15.4a, ranging among parent and children can be done using the message sequence for ranging explained in the standard [2] that also uses data frames interchanging. We propose the following solution to increase the ranging between coordinators overcoming this parent-children based connectivity:

• Ranging is controlled by MAC layer: the ranging application is done in a MAC level, as in the IEEE 802.15.4 standard. The application layer (that controls the localization algorithm) calls the corresponding MAC primitives directly for doing ranging between two nodes.

Fig. 4. RCAPS solution with the superframes structures of the corresponding parent and children of three interconnected clusters.

In order to follow this solution, the MAC level frames for ranging should work with the Zigbee or upper layer superframe structures without collisions. For that an scheme is proposed:

• Ranging during the CAP of the superframe (RCAPS): A coordinator $j$ can do ranging with its parent coordinator and with its child coordinators using the ranging interchange of frames defined in the standards. The improvement is that this coordinator $j$ also uses the CAP of its parent cluster superframe for ranging with its brother coordinators (coordinators with same parent that follow the same superframe) within range. Figure 4 shows the RCAPS solution with the superframes structures of the corresponding parent and children of three interconnected clusters. In Figure 5 the interchange of frames between two brothers of a